PROPERTY RIGHTS OR PROPERTY WRONG: DO PROPERTY RIGHTS MATTER IN HOUSEHOLD ACCESS TO IRRIGATION WATER? EVIDENCE FROM MID-HILLS, NEPAL

BISHNU PARIYAR

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ABSTRACT

Whilst the development of irrigation infrastructure has been proposed as a vehicle for poverty reduction in many developing countries, the distributional aspects of irrigation interventions, particularly households' level of access to irrigation water have rarely been explored. Furthermore, previous empirical studies on irrigation performance have been overtly objective and technical with little regard to farmers' needs and concerns. The premise of this is that 'objectivity' is a necessary but insufficient measure of access to irrigation water. In addition to this, whilst irrigation interventions have had some success in ensuring access to water for crop cultivation, the impact of such interventions have been varied amongst irrigation governed by different property right regimes.

In response to these concerns, this multidisciplinary study uses mixed methodologies of data collection and analysis to explore a subjective measure of households' access to water from irrigation systems managed by different property right regimes. Using a case study approach, an in-depth institutional analysis of the three irrigation systems has been carried out to identify institutional factors which contributed to unequal level of access to irrigation water.

The findings demonstrate that households' level of access to water is influenced by socio-economic status, the physical nature of the canal systems and institutional characteristics of the management regimes. The results from the quantitative analysis reveal a clear pattern of differentiated access to water in irrigation systems under different property right regimes. The results indicate that the tail-enders, female-headed households, *dalits* and small farmers appear to have weak access to water from the canals. However, farmers along these heterogeneities have different levels of access to water in irrigation systems governed by different property right regimes with farmers in the farmers managed irrigation system performing significantly better than the agency managed and jointly managed irrigation systems. The thesis concludes that institutional dimensions should be taken into consideration by policymakers in order to ensure better access to water in irrigation interventions.

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AUTHOR'S DECLARATION

I declare that the work in this dissertation was carried out in accordance with the Regulations of the University of York. The work is original except where indicated by special reference in the text and no part of the dissertation has been submitted for any other degree. Any views expressed in the dissertation are those of the author and in no way represent those of the University of York. The dissertation has not been presented to any other University for examination either in the United Kingdom or overseas.

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LIST OF ABBREVIATIONS

AD: Anno Domini

ADB: Asian Development Bank

ADB-N: Asian Development Bank of Nepal

AMIS: Agency Managed Irrigation System

BC: Before Christ

BIMC: Begnas Irrigation Management Committee

BIS: Begnas Irrigation System

BNP: Basic Needs Programme

BS: Bikram Sambat

BSA: British Sociological Association

CAD: Canal Area Development

CAPI: Computer Assisted Personal Interviewing

CATI: Computer Assisted Telephone Interviewing

CDR: Central Development Region

CPR: Common Property Resource

DADB: District Agriculture Development Bank

DADO: District Agriculture Development Office

DfID: Department for International Development

DIHM: Department of Irrigation, Hydrology and Meteorology

DIO: District Irrigation Office

DMI: Department of Minor Irrigation

DOA: Department of Agriculture

DoI: Department of Irrigation

EDR: Eastern Development Region

FAO: Food and Agriculture Organisation

FMIS: Farmers Managed Irrigation System

FMISPT: Farmers Managed Irrigation Systems Promotion Trust

FWDR: Far-Western Development Region

GOI: Government of India

GON: Government of Nepal

HMG: His Majesty's Government

HMG-N: His Majesty's Government-Nepal

HPC: Hindu Pollution Concept

IDSN: International Dalit Solidarity Network

IFAD: International Fund for Agricultural Development

ILO: International Labour Organisation

IMF: International Monetary Fund

IMT: Irrigation Management Transfer

INGO: International Non-Governmental Organisation

IP: Irrigation Policy

IR: Irrigation Regulations

IUCN: International Union for Conservation of Nature

JMIS: Jointly Managed Irrigation System

MoF: Ministry of Finance

MSL: Mean Sea Level

MWDR: Mid-Western Development Region

NFIWUA: National Federation of Irrigation Water Users' Associations

NGO: Non-Governmental Organisation

NWCF: Nepal Water Conservation Foundation

NWRS: National Water Resources Strategy

O & M: Operation and Maintenance

PRA: Participatory Rural Appraisal

PI: Principal Investigator

PIM: Participatory Irrigation Management

PIMC: Phalebas Irrigation Management Committee

PIS: Phalebas Irrigation System

PPP: Purchasing Power Parity

RCC: Reinforced Concrete

RIMC: Rainastar Irrigation Management Committee

RIS: Rainastar Irrigation System

SE: Standard Error

UNDESD: UN Department of Economic and Social Development

UNDP: United Nation Development Programme

USAID: United States Agency for International Development

VDC: Village Development Committee

WDR: Western Development Region

WRA: Water Resource Act

WRID: Western Regional Irrigation Directorate

WRR: Water Resource Regulation

WUA: Water Users' Association

WUO: Water Users' Organisation

LIST OF NEPALI AND COLLOQUIAL TERMS USED IN THE THESIS

Ati-sudra: The Lowest caste in Hindu caste hierarchy in India

Baisya: Nepali caste of businessmen/businesswomen

Balighare: systems of patron-client relationship in Nepal

Begar: O & M activities in Terai

Brahmins: Highest caste in Hindu caste hierarchy

Chapari: Soil with green grass attached

Chhetriya: Nepali caste of soldiers and warriors

China jhane: O & M activities in FMIS

Dashain: The biggest Hindu Festival in Nepal (also called Dashara)

Dhobi khola: A local stream in Kathmandu valley

Dittha: Superintendent responsible for looking after irrigation systems

Gahak: Water division structure in FMIS

Haliya: A form of Patron-client relationship (bonded labour) in Nepal

Jhara Jane: O & M activities in AMIS

Jhara: Weeding

Jhikra: Wodden twigs

Katuwal: Messenger of the Dalit caste

Khet: Productive low land with irrigation facilities

Khoriya: Unproductive land

Kulo: Stream or canal

Lapcha: Soil with green grass attached

Muluki Ain: Civil Code

Nahar: Canal

Pakho: High land with no irrigation facilities

Pandit: Priest

Pathi: Nepali metric unit

Purohit: Priest

Raj kulo: Royal canal

Rig Veda: One of the Vedas, Hindu religious book

Ropani: Nepali metric unit for measuring land

Sal tree: A strong tall tree (*Shorea robusta)*

Simal tree: A type of tree, plant *Bombax ceiba*

Subba: Revenue collector, taxman

Sudra: The lowest caste in Hindu caste hierarchy in Nepal

Tar: Relatively flat land in hilly area

Terai: Flat land in the Southern part of Nepal

Tihar: Festival of Lights, Diwali

Zamindar: Landlords

CHAPTER ONE:

INTRODUCTION

1.1 Chapter Overview

The importance of water to both human wellbeing and environment is immense. Water use, particularly for agricultural purposes, contributes significantly towards the livelihoods of millions of farmers across the world, particularly in developing countries. Whilst the demand for food, as a result of population growth, is increasing, the availability of water for irrigation is decreasing as a result of climate change and excessive use. Population growth coupled with the impact of climate change presents the challenging task of using natural resources, including irrigation water, in a sustainable and equitable way. Different property right regimes have been put in place to manage irrigation resources across the world and Nepal is no exception. The aim of this Chapter is fourfold. Firstly, the chapter highlights the importance of irrigation to sustain peoples' livelihoods and reduce poverty. Secondly, the chapter describes different modalities of irrigation management in Nepal and puts the research in context. In doing so, the problems associated with the current irrigation governance and the current gaps in knowledge in Nepal are identified and the need for alternative ways of studying irrigation governance is highlighted. Thirdly, the chapter presents the analytical framework which will be used to analyse the data in the thesis. Fourthly, the structure of the thesis is outlined.

1.2 Introduction

Irrigation water impinges on many aspects of human life in a myriad of complex ways, including: providing systems of livelihood; improving food production in a way that underpins food security; sustaining ecosystems; and contributing to the local economy. Emphasising the importance of irrigation water, Daniel Bromley contends that *"irrigation has become a dominant part of man's relentless pursuit of enough to eat"* (1982 p.1). Irrigation water is particularly important in agricultural areas where rainfall is irregular, scant and insufficient, in order to supplement water from rainfall and to avoid crop failures. It is argued that adequate, timely and equitable water distribution is absolutely critical for enhancing agricultural productivity and improving food security, which underpins the livelihoods of many local farmers (Hussain and Hanjra, 2004; Lipton, *et al.,* 2002a; Hussain *et al.,* 2002a). Whilst timely and adequate water supply is necessary for crop growth, equitable distribution of water is critical for collective action as inequity creates disincentives amongst farmers to engage in collective action necessary for managing irrigation canals (Fujiie *et al.,* 2005; Bardhan and Dayton-Johnson, 2002). Thus, irrigation has been advocated as a vehicle for rural development and poverty reduction. In recent decades, there has been a resurgence of interest in the dependency of rural households on natural resource bases, particularly Common Pool Resources (CPRs). It is generally reported that poorer households make greater use of and are more reliant on natural resource bases, which contribute substantially to sustaining their livelihoods. Particularly, poorer households derive a greater proportion of their income from local commons, compared to their richer counterparts (Cavendish 2000; Beck and Nesmith 2001; Fisher 2004; Shackleton and Shackleton 2006). However, in absolute terms, richer households, particularly those with market accessibility, derive more benefits than do their poorer counterparts (Cavendish 2000; Dasgupta, 1993). The difference in appropriation of benefits by users of CPRs can be explained by the observation that richer households keep large livestock herds and to feed them they gather considerable quantities of forest products such as trees, grass fodder and leaf litter (Adhikari *et al.,* 2004). Furthermore, households can sell the products received from CPRs, such as firewood from the forests and fruits, vegetable and cereal crops grown using irrigation water at the local markets, which are dominated by the richer households (DfID, 2003; Upadhyay *et al.,* 2005; Deshingkar *et al.,* 2003a).

There is a growing recognition of the link between poverty and environmental degradation (Lele, 1991) in which poor households are trapped in a vicious circle of poverty and environmental degradation. The proponents of the 'poverty pollute' argument posit that in order to cope with the poverty and population growth farmers extend crop growing onto fragile marginal lands and degrade them, which reduces yield and further impoverishes them (Dasgupta and Maler, 1995; Mink, 1993). This school of thought assumes that greater reliance on natural resources equates to greater appropriation of benefits by poorer households, making them the primary beneficiaries of natural resources (Campbell *et al.,* 2001). Contrary to this assumption, a growing number of studies report that the degree of resource dependency does not equate to the level of benefit appropriation, nor are the asset poor households the primary beneficiaries of the local commons (Adhikari, *et al.,* 2004; Kumar, 2002). In addition to the issues discussed above, the management of water resources, including irrigation water, have come under greater scrutinity particularly due to the increased demand for water, whilst the supply of fresh water is decreasing as a result of climate change and over exploitation. The issues associated with demand for water, water scarcity and their implications for irrigation management are discussed below.

1.3 Population Growth, Water Scarcity and Irrigation

The world is facing two quite alarming problems. Firstly, population growth has put extra pressure on increasing agricultural production to feed the ever increasing population. Since the early 1970s, global demand for water has increased consistently by an annual rate of 2.4 per cent, with much higher trends in developing countries particularly due to water intensive agricultural activities and increasing urbanisation (Clarke, 1993). According to the United Nation Development Program (UNDP), the availability of water at a level below 1000 cubic meters is considered to be water scarcity, while below 500 cubic meters is considered a state of absolute scarcity (UNDP, 2006). Hydrologists estimate that if the annual per capita fresh water availability of a country falls below 500 cubic meters, the country falls into the category of absolute water scarcity. After crossing this line, the country is almost certain to face inherent water deficit problems, which may threaten public health and socio-economic development. It is estimated that about a quarter of the world's population, i.e. 1.4 billion people (33 percent of developing world) live in absolute water scarcity areas and 1.2 billion of these do not have access to clean water (WHO, 2008). The demand for water is ever increasing and its use has been growing at more than twice the rate of population increase over the last century (FAO, 2010). If the present trend of water use continues, it is estimated that by 2025 more than one billion people living in arid areas will face absolute water scarcity (Seckler *et al.,* 1998). It has been estimated that by 2025, a staggering 800 million people will be living in countries or regions with absolute water scarcity, and two-thirds of the world population could be living under water stress conditions (*op.cit.* p.3). The situation will be exacerbated as rapidly growing urban areas place heavy pressure on neighbouring water resources.

Evidence indicates a close association between water scarcity and food insecurity, with higher water scarcity leading to reduced food security (Rosegrant, 1997; Seckler *et al.,* 1998). Many researchers have shown that higher agricultural production leads to downward trends in world food prices and agricultural outputs can be increased through irrigation facilities (Rosegrant and Perez, 1995; Trostle, 2008). Also, areas with irrigation facilities are found to have lower rates of poverty (World Bank, 2009; Hussain *et al.,* 2002). Indeed, in many developing countries, spiralling population growth and increasing water scarcity are likely to pose a serious constraint on food security, levels of poverty and overall economic development. Urgent calls are being made for conservation and the efficient use of water as Grigg suggests "--*the real crisis in water is a creeping crisis—it comes on slowly but it demands a response right now*" (1996 p.3).

Secondly, increasing water scarcity has added pressure to use water more efficiently. The world population reached 6 billion in 1999 and with current trends it is estimated to reach 7 billion in 2011 and 8.1 billion in 2025 (PRB, 2008 p.4). The global population is estimated to increase by almost 50 percent by 2050 (UN, 1999 p.4). Currently the Total Fertility Rate (TFR) of developed countries is 1.7 and it remains alarmingly high, at 4.7 amongst the least developed countries (Getis *et al.,* 2004). By 2050 the global grain demand is estimated to double (Gilland, 2002). The pressure created by population growth is highlighted by Thomas Malthus *"The power of population is indefinitely greater than the power in the earth to produce subsistence for man"* (Malthus, 1798 p.17). The impact of rapid population growth on food security has received considerable attention over the past decades (Pinstrup-Anderson, 1995). Population growth continues to out-strip food availability in many countries and evidence from many developing countries indicates that countries with high population growth are the same countries suffering from acute food insecurity (FAO, 2009a). In recent years, food production has lagged far behind population growth in nearly two thirds of developing countries (FAO, 2007). The Sub-Saharan region was hard hit as food production fell in 31 of the 46 African countries (FAO, 2005a).

The direct benefits of irrigational development are felt at both local and household levels, with higher production, higher crop yields, and reduced risks of crop failure, year-round and non-farming employment opportunities and increased food security. The total contribution of irrigation to global food production is estimated to be in the range of 25-50 percent with 60 percent of cereals coming from irrigated agriculture (Turner *et al.,* 2004; ICID, 2009; Sundquist, 2007). By 2030, estimates indicate that almost 70 percent of the world cereal production will come from irrigated land (FAO, 2005b). Understandably, irrigation is the single most important consumer of water in both developed and developing countries, although its importance to developing countries is crucial. Agriculture alone consumes about 70 percent of the fresh water worldwide, whilst the remaining 20 percent and 10 percent are used for industrial and domestic purposes respectively (Wiebe and Gollehon, 2006 p. 25).

Ever since the practice of irrigated cultivation began in Mesopotamia in 4000 BC, irrigation has remained an important part of sustaining human life. Advancements in modern agricultural practices have increased the world's agricultural output to feed more than five billion people, with global cereal production doubling in the last 50 years (Spielman and Pandy-Lorch, 2009). The increase in crop yields have come mainly from greater inputs of fertilisers, pesticides, new crop strains and irrigation (Tilman, *et al.,* 2002), which has increased the *per capita* food supply (FAO, 2009b). Areas with irrigation facilities have increased rapidly following the beginning of the 'Green Revolutions' in the mid 1940s (Seckler *et al.,* 1998). The worldwide area under irrigation has increased dramatically from 40 million Ha in 1900 to more than 277 million Ha in 2003 (Field, 1990; Seckler *et al.,* 1998; Li, 2007). The further expansions of irrigation facilities are estimated to increase the total arable area of developing countries by 120 million Ha in 2030 with more than 80 percent of the projected expansion of arable land taking place in sub-Saharan Africa, Latin America and South Asia, the areas with the world's most chronic food shortages (FAO, 2005a). The 'Green Revolutions', stimulated governments in different countries to invest heavily in the agricultural sector, both with the use of improved varieties of crops and the development of agricultural infrastructures to increase crop production to feed the growing population. Consequently, the world's irrigated land grew at an annual expansion rate of two percent from 1961-1992 and to around one percent from 1993-2003 with a peak of three percent in 1978 (Li, 2007 p.3).

Nepal's total irrigable land is estimated to be about 1.7 million Ha, of which only 1.2 million Ha (i.e. 70 per cent) has access to some form of irrigation, which contributes to 33 percent of the total agricultural output (WECS, 2002; DoI, 2007a). Of this, only 41 percent of the irrigated land has access to year around irrigation facilities. The remaining 59 percent of irrigated areas has access to water mostly during the Monsoon season only.

1.4 Irrigation for Poverty Reduction

The relationship between poverty reduction and irrigational development has become a topical issue amongst academics and policy makers alike. An international conference on freshwater management in Bonn in 2001 concluded that "*combating poverty is the main challenge for achieving equitable and sustainable development and irrigation water plays a vital role in relation to human health, livelihoods, economic growth as well as sustaining ecosystems*" (UNESCO, 2001 p.2). There is a general consensus that irrigation development in agricultural countries can be a significant help in reducing poverty (Fan *et al.,* 1999; Ravallion and Datt, 1996; also see Mellor, 2001; Desai, 2002).

Considerable work conducted in the last five decades in Asia has shown that the multitude of tangible positive externalities associated with irrigation development are considered to be the most potent source of higher farm incomes and hence the driving force in poverty reduction (Mellor, 2001; Hussain and Hanjra, 2004). Studies in India concluded that agricultural output and irrigational development coupled with enhanced literacy levels contributed towards poverty reduction and that access to irrigation was found to be critical for rural poverty reduction (Sakthivadivel *et al.,* 2002).

Furthermore, crop diversification, intensification and shifts from subsistence to commercial crops were likely to help poorer households by reducing food prices (Hussain and Hanjra, 2004). Writing on Indian irrigation systems, Dahawan and Datta (1992) posited that in irrigated rural settings, up to three crops a year could be grown as compared to just a single crop a year in rainfed settings. Indirectly, irrigation development acts as a production and supply shifter and helps boost aggregate growth where both rich and poor households benefit.

Drawing on macro level data, Lipton *et al.* (2002) compared the prevalence of poverty with the amount of land irrigated in Africa and Asia. They found that regions with higher irrigated crop land had higher poverty reduction rates. Similar studies were carried out by the World Bank and demonstrated that Sub-Saharan Africa experienced the world's worst forms and levels of poverty, with an absolute poverty level of 47.7 percent in 1990 and 41.1 percent in 2004, and with just 3 percent of irrigated crop land (Chen and Ravallion, 2007). In contrast, the experiences of East Asia and the Pacific, North Africa and the Middle East with 35-40 percent of irrigated crop lands showed higher poverty reduction in the 1970s (*op.cit.* p.3). Hussain *et al.* (2002b p.5) studied intra-country experiences of poverty reduction resulting from irrigation and found that the incidence of chronic poverty in the rainfed areas of Sri Lanka and Pakistan were likely to be 10 percent and 5 percent respectively greater than their adjoining irrigated areas. Furthermore, the authors noted that poverty head counts ranged from 18-53 percent in irrigated and 21 -66 percent in rainfed settings – a difference of 20-30 percent between the two settings (*ibid.*). Research has shown that a one percent increase in agricultural production could reduce poverty by an equal amount, highlighting the role of irrigated agriculture in poverty eradication (Thirtle *et al.,* 2001).

On the production side of the poverty-irrigation relationship, irrigation development creates localised demands for both farm and off-farm income, indirectly generating economic activities. A study by Liedholm and Meade (1987) concluded that because of the spill over effects of expanding agricultural activities, non-farming employment opportunities expanded readily. The governments in many developing countries have invested heavily in the agricultural sector through a series of research, development and technology transfer initiatives under the aegis of the 'Green Revolution'. These initiatives included the development of high yielding varieties of crops, expansion of the irrigation infrastructure, and distribution of hybridized seeds, synthetic fertilisers, and pesticides to farmers. As a result of these initiatives, many developing countries boosted agricultural production with a 4-6 percent annual growth rate, which has helped to reduce poverty (Mellor, 1995).

Angood *et al.* (2002) presented a case study of three Farmer Managed Irrigation Systems (FMIS) in Nepal and concluded that small scale irrigation developments are effective tools for rural poverty reduction. Following Angood *et al.'s* study, Brabban *et al.* (2004) re-examined the impact of the same three irrigation schemes and concluded that irrigational development could have significant positive impacts in all dimensions of development - human assets, natural assets, financial assets, physical assets and social assets (Brabban *et al.*,2004).

However, research into the relationship between irrigation and poverty have mostly involved aggregate macro level analysis. Although much work has been conducted in relation to the implications of local level socio-economic differences on forest management (Adhikari, 2003; Luintel and Timsina, 2003), very little work has been conducted in irrigation development. The growth aspects of irrigation are well accepted. Despite the close links between irrigation development and poverty reduction, there is still a considerable polarisation on dimensions of equity. A growing body of literature suggests that unequal growth can lead to a skewed income distribution, raising questions about the strength of irrigation development in reducing poverty (Squire, 1993; Lipton and Ravallion, 1995; Ravallion, 1995; Hussain, 2007; Narayanamoorthy, 2007). In many developing countries, the distribution of irrigation water is land based, which makes irrigation development inherently biased against the landless and land poor. Furthermore, head and tail inequity, also known as upstream-downstream inequity has been well documented (Hussain, 2004). In his synthesis studies of 307 irrigational systems during 1970-89, Freebairn (1995) found that both inter-farm and interregional inequalities widened in 80 of the studies. Banik *et al.* (2003) in their study of natural resource endowments and poverty in a tribal belt of Chhotanagpur Plateau (India) demonstrated significant differences in the benefits accruing to higher landholding households from higher social strata as compared to those from lower caste affiliations (Banik *et al.,*2003).

Since Nepal exhibits a highly skewed land distribution, the probability of inequitable water distribution is high. Furthermore, the existence of the caste system with a dominance of higher castes in policy domains, and disproportionately higher land distribution amongst them has meant that the same groups are deriving many of the benefits from the irrigational development in Nepal. Ethnic minorities, indigenous people, and the *dalits*, who represent a significant number of land-poor households marred with poverty, have tended to lag behind in benefiting from irrigational development. More work needs to be done to inform policy makers about the trajectories through which the benefits of irrigation development trickle down in heterogeneous Nepalese irrigation communities.

1.5. Rationale for Undertaking this Research in Nepal

Although a detailed review of irrigation policies is presented later in Chapter Two (Section 2.11), this section makes a case for undertaking this research in Nepal. It highlights the policy relevance of this research and the contribution to knowledge that this thesis aims to make.

1.5.1 Relevance to Irrigational Development in Nepal

Irrigational development is of special interest for a predominantly agricultural country like Nepal where almost one-fifth i.e. about 18 percent of its total land area is used for agriculture (CARE-Nepal, 2001; CBS, 2004) and more than 76 percent of the total population engages in agriculture for its livelihood (MoF, 2001), contributing to up to 40 percent of national GDP (Adhikari, 2001). Also, Nepal is the second richest country, following only Brazil worldwide in terms of its potential fresh water resources, and possessing about 2.27 percent of the world's potential water resources (CBS, 1999). A country report on Nepal's environmental statistics notes that, all together Nepal has about six thousand rivers of approximately 45 thousand kilometres in length (Kharel and Suwal, 2001). However, despite being water-wealthy and having 30 percent (Pant, 2003) irrigation-based agricultural production, 42 percent of the net cultivated land has access to some form of irrigation (CBS, 2004 p.3), while just 41 percent of the irrigated land receives year –round irrigation (Mishra and Bhattarai, 2003).

1.5.2 Relevance to Poverty Reduction in Nepal

With an average per capita Gross Domestic Product (GDP) of US$ 260 and per capita income of US$ 1237, Nepal remains the poorest country in South Asia and ranks as the twelfth poorest country in the world (World Bank, 2010; IMF, 2010). About nine million people, which is about 31 percent of the population, are currently living under the absolute poverty line with a daily income of less than one US dollar a day. Nepal ranks the 144th country on the UNDP's human development measure with a Human Development Index (HDI) measure of 0.553, which is lower than all its South Asian neighbours except Pakistan (UNDP, 2009). Within Nepal, rural poverty outstrips urban poverty. Rural poverty, which stands at 44 percent of the rural population, is almost double that of urban settings (23 percent of the urban population) (*op.cit.* p.2). The HDI for urban settings is 0.581, while for rural settings remains at 0.452 (UNDP, 2004). Also, the Human Poverty Index (HPI) records indicate that rural human poverty exceeds urban poverty with the HPI value being 42.0 and 25.2 respectively. The national HPI of Nepal remains at 32.1, ranking Nepal 99th among 135 countries for which the index has been calculated (UNDP, 2009). The poverty intensity level and severity gap for the urban area is 7.0 and 2.8 percent respectively. The same measures for rural areas remains 12.5 and 5.1 percent respectively, while overall for Nepal it is 12.1 and 5 percent respectively (NPC, 2003 p.25). The differences in poverty levels between rural and urban settings call for special attention because poverty in Nepal is predominantly a rural phenomenon where nearly 90 percent of the population live and 55 percent of the population undertake agriculture for their livelihoods and remain below the absolute poverty line, far higher than in any other sector (CBS, 2001). Thus it is imperative to prioritise rural poverty reduction, particular in the agricultural sector, if poverty in Nepal is to be reduced. The development of irrigation in improving the agricultural sector in Nepal is very important. Also, if the anti-poverty impacts of irrigation are to be maximised, the distributional aspects of irrigation should also be taken into account.

1.5.3 Relevance to Equity in Natural Resource Distribution

Nepalese agrarian relations are characterised by unequal land distribution where land endowments are concentrated amongst rich peasants and landlords (SAAPE, 2004). Furthermore, unequal cultivable land and access to productive resources such as irrigation have reinforced the already high level of poverty in Nepal. Latest figures from the Nepal Living Standard Survey (NLSS) indicate that a vast majority of agricultural households rely on subsistence farming from small farms. About 45 percent of small farmers operate in less than 0.5 ha of land, occupying 13 percent of the agricultural land while 8 percent of large farmers operate in 2 ha or more, occupying about 31 percent of the total agricultural land (CBS, 2004 p.4). The concentration index for agricultural land is 0.50 (0.54 in 1997), reflecting a highly uneven distribution of land resource in Nepal (Pant, 2003; CBS, 2004).

A vast majority of poor, landless and land-poor citizens undertake agricultural activities for their own consumption and for landlords. In doing so, a significant proportion of agricultural households (about 28 per cent, of which 7 percent are landless and 21 percent operate in rented- land) work on a crop share basis also known as *adhiya* (a system in which the total production is equally divided between farmers and landlords) or *tyahu* (a system in which, landlord and the farmer share two-thirds, and one third of the total production respectively) or some type of contractual basis (CBS, 2004). However, in both *adhiya* and *tyahu* systems, production costs such as labour, fertiliser and so on are borne by the farmers themselves without any contribution from their landlords. According to the census of 2001, about 25 percent of the households are considered to be agricultural landless (with no land or owning less than two *Ropanis*[1] of land). Landlessness and poverty are more acute among the *dalits*, as out of all absolutely landless, 22 percent are *dalits* (Basnet, 2004). Amongst the *dalits*, the average landholding per household is 2.46 *Ropani*es of *khet* (irrigated land) and 4.5 *Ropanies* of *pakho* land (semi arid and rainfed land respectively). This has a major implication for food security. It is reported that more than 50 percent of the *dalits* suffer from food deficiency (Dahal *et al.,* 2002). Sharma *et al.* (1994) in their study of socio-economic status of *dalits* and indigenous tribes in Nepal noted that food security amongst the *dalits* was severely constrained. They reported that in almost 21 percent of the *dalit* households, the food grain produced in a year lasted less than 3 months. For about 19.4 per cent, food grain lasted for 4-6 months, while only 14.5 percent could grow food grain enough to last for a whole year. A mere 5.1 percent of them produced surplus food grain. The *dalit* castes represent the poorest segment of the population, where about 46 percent of the *dalits* remain under the poverty threshold. Given these circumstances, it is important to evaluate whether poorer households usually affiliated to lower castes have same level of access to water compared to the richer households, usually from higher caste backgrounds, in deriving benefits from irrigation canal development in Nepal.

1.5.4 Relevance to Policy shift in Irrigation Management in Nepal

From a management perspective, Nepalese irrigation systems can be broadly divided into three categories: Government Managed Irrigation Systems (AMIS); Farmers Managed Irrigation System (FMIS); and Jointly Managed Irrigation System (JMIS). Firstly, the AMIS are designed and constructed on the basis of engineering and agronomy, with due consideration to cropping patterns, irrigation efficiency and

[1] 20 *Ropani* = 1 hectare

effective rainfall (Pradhan, 2005). They are primarily funded and maintained by government initiatives and managed by the Government of Nepal through its auxiliary body-the Department of Irrigation (DoI).

Secondly, the FMIS are initiated, constructed and maintained by communal efforts. The conceptualisation and construction of the FMIS are based on indigenous knowledge making extensive use of locally available construction materials, which have often declined in recent years (Pradhan, 2000). The salient features of the FMIS are: irrigators' direct involvement in management; effective monitoring and sanctioning mechanisms; and financial and management accountability (Ostrom, 1990). In the FMIS, along with day to day administrative tasks, the farmers are more involved in all aspects of irrigation management, including water acquisitions, allocation, distribution drainage, resource mobilisation for Operation and Maintenance (O & M) activities, decision making and conflict resolutions (Uphoff, 1986; Pradhan, 1989).

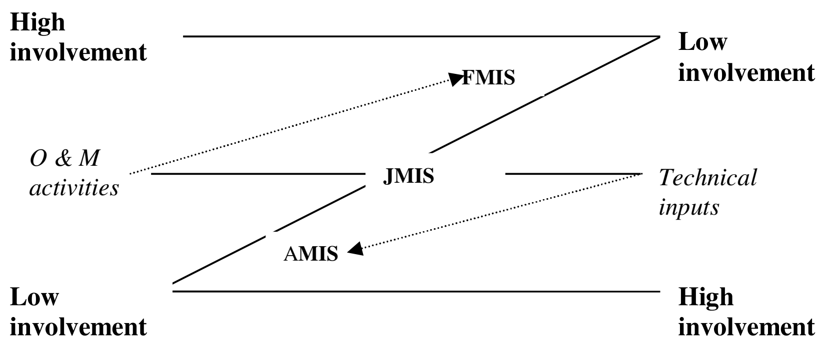
Thirdly, the JMISs are constructed and managed by the Government through the DoI in the first stage of development, and transferred to local communities after essential communal capacity building. Irrigation systems under JMIS management regimes are essentially co-managed systems with technical inputs from government while responsibilities for O & M activities and lower level decision making is transferred to the beneficiary farmers. The devolution of irrigation systems and resultant co-management structure is the product of a policy shift in the early 1990s, where a gradual retrenchment of government involvement in construction, maintenance and operation of irrigation systems with increasing irrigation management roles for users (DoI, 1992). The major themes prioritised in the Water Resource Acts (WRA) 1992 are:

- to develop cost-effective, viable, sustainable and environmentally efficient irrigation systems;
- to bring uniformity to the irrigation development process and projects of all concerned governmental, non-governmental and donor agencies;
- to decrease government involvement and encourage people's participation in irrigation development and management;
- to increase capabilities of governmental and non-governmental irrigation institutions for the research and training related to technical and social aspects of irrigation management;
- to develop laws giving WUAs rights to collect water tax and to use it for further development of the system;
- to increase the farmers' capabilities in resource mobilisation for rehabilitation and construction works in traditional FMIS

(DoI, 1992)

Based on the degree of involvement of farmers and/or government in the management of irrigation systems, Figure 1.1 illustrates the irrigation management modalities in Nepal.

Figure 1.1 Irrigation Management Modalities in Nepal



Whilst the Irrigation Management Transfer (IMT) programmes have been widely advocated by the Government of Nepal, its impacts have rarely been explored. Although the main remit of this thesis is not to evaluate the impacts of the IMT programmes, this research is a three way comparative case study of irrigation systems which are governed by three different property right regimes. By considering a case study where an IMT programme has been implemented and comparing it to other irrigation systems, this thesis highlights some of the issues pertaining to households' access to water from canals, which are jointly managed by the beneficiary farmers and the government.

1.6 Scope and Rationale of the Thesis

Irrigation organisations provide a fertile terrain for the study of property right structures and their relationship with natural resource management, partly because access to water, land, labour and capital are all intrinsically involved in irrigation organisations (Pradhan, 1990). The existence of different kinds of property rights structure in irrigation systems, which often change over time and space, has meant that careful attention is required to both technical and socio-economic aspects of irrigation systems (Coward, 1980). Di-Gregorio *et al.* (2008) assert that property rights play a crucial role in the study of irrigated agriculture. In addition to use patterns and benefits allocations, irrigation systems require infrastructural investments and provisions, and as such, irrigation organisations involve constant negotiations over acquisition, allocation, water distribution, resource mobilisation and conflict resolution (Ostrom *et al.,* 1993; Kelly, 1983; Uphoff, 1986).

The differing nature of property rights and the extent of control over water and infrastructure lead to different levels of resource mobilisation in irrigation governance. Hilton (1992), in her comparative study of irrigation systems in Nepal, drew some important conclusions. More decision making autonomy to irrigators, and control over water and infrastructure, the reliability of water delivery and limited and indirect agency interventions, are key to effective local resource mobilisation. Pasaribu and Routray (2005) in their study of FMIS in Indonesia conclude that water inadequacy and unreliability fuels conflicts in irrigation systems which in turn weaken institutional arrangements governing irrigation systems. The accountability of a water user's association is the main factor influencing the success or failure of an institutional role in the sustainability of irrigation systems (Pasaribu and Routray, 2005).

The degree of autonomy, both financial and managerial, are critical for the better management of the irrigation system because they help to incorporate local socio-economic and geo-physical dimensions. Hunt (1989) argues that irrigation communities function well in systems where property relations such as rights, duties and roles have substantial local control. The sustainability of the irrigation system depends on the principles used for water distribution and system management, as they define the institutional domains for resource mobilisation (Parajuli, 1999).

The alternations in property right structures and conflicts emanating from them have been well documented (Coward, 1986; Leach, 1961 also see Pradhan, 1992; Tamaki, 1977). Irrigation organisations are essentially socio-economic organisations which involve rights, duties, powers, privileges, and forbearance of various kinds, which are influenced by the nature of property rights and institutions governing irrigation organisations. The physical nature of infrastructure coupled with the economic nature of irrigation enterprise represents a mosaic of interactions amongst various actors, including landless farmers (Bloch, 1975; Coward, 1980; Lowie, 1948).

Writing on conflicts over water rights between two villages in Western Nepal, Pradhan and Pradhan (2000) argued that the readjustment of property rights structure is vital in maintaining functional irrigation systems. Similar conclusions were drawn by Lowie (1948) in his study of irrigation interventions in eastern Africa. Bloch, in his study of two indigenous irrigation canals in Madagascar, reported that the creation of powerful forms of property relations have significant effects on social structures in connection with natural resources. For example in the Meria community in Madagascar the scarcity of land where paddy was cultivated supported endogamous principles of marriage. The endogamous marriage practiced in the Meria community helped to "*to keep outsiders away and to stop them getting claims to highly valued land resources and irrigation water for paddy cultivation"* (Bloch, 1975 p. 211).

Comparative studies of the FMIS and AMIS have demonstrated that the former consistently outperform the latter in all the commonly used performance indicators, such as increased efficiency, equity, irrigation area coverage and water productivity (Loitos *et al.,*1986; Pradhan, 1989; Tang, 1992; also see Hilton, 1992; Martin and Yoder, 1986; Yoder, 1986). Similar patterns are observed in other indicators of performance evaluation, such as cost recovery, cropping intensity, crop yields and increased income from agricultural activities (Trawick, 2001 and 2008; Tanaka and Sato, 2003). In contrast, the many AMISs have gained notoriety for their underperformance or sub-optimal performance, neglect of maintenance, theft and vandalism of water control structures, environmental degradation and erosion of local social capital (Ubels, 1990; Cambell, 1995). Some scholars, such as Groenfeldt, argue that, *"---governments cannot do everything, and there are some things that they are simply not very good at doing and one of them being irrigation systems*" (2000 p.2).

However, despite the research highlighted above, there is a dearth of comparative studies on equity aspects of irrigation intervention in south Asia, particularly in Nepal. There are a few exceptions, however (Maskey *et al.,* 1994; Bhutta and van der Velde, 1992; Hill *et al.,* 2008). Maskey *et al.* (1994) studied on-farm water distribution management in two medium-scale irrigation systems in the Yamdi watershed area in Western Nepal. The irrigation systems considered for the study were governed by two different property right regimes, namely the FMIS and the AMIS. The study reported that although there was no significant difference in the frequency with which farmers irrigated in different locations in the FMIS there was a significant difference in the irrigation frequency amongst the farmers in the AMIS, particularly at its tail end. The differences in the frequency of irrigation in the systems differed between water abundant and water scarce periods. Paddy grown during the Monsoon season when water is available in abundance shows a reasonable degree of equity in its distribution between head and tail reach farmland. However, wheat grown in the dry season with a limited supply of water, rendered evidence of unfair distribution demanding better management of irrigation water.

A similar study by Bhutta and van der Velde (1992) in the three distributaries of the Chenab Irrigation System in the Punjab region of Pakistan reported a significant head and tail inequality in water distribution. The outlets located in the head of the canal received water which was almost 150 percent of its design capacity, while those located at the tail end of the canal received only 8 percent of its design capacity (*ibid*). Consequently, the upper two-thirds of the canal withdrew considerably more than their fair share of water from the canal, while the majority of the farmers located in the lower one-third of the distributaries received less than half of their intended supply.

A comparative study of a branch canal in a FMIS and AMIS (Hill *et al.,* 2008) demonstrated that farmers in the FMIS were self-governed and had designed and implemented equitable rules for water access, while the farmers in the AMIS lacked an equitable water distribution mechanism. The presence of dispute resolution mechanisms in the FMIS and their lack in the AMIS has meant that the farmers in the former were able to facilitate their self-realisation of equitable solutions to the problems they faced while the farmers in the latter were unable to do so. Hill *et al.'s* comparative study pointed out that the even though the Water Users' Association (WUA) in the FMIS were not formally registered, they were more accountable to the farmers as they were elected by the local community, compared with the WUA in the

AMIS. Since the WUA members were elected by the beneficiary famers, they had to be impartial in their conduct, including equitable distribution of irrigation water. However, in the AMIS, the informal presence of unelected higher level committee members, without even basic information such as the size of the management areas, raises doubts at the system level regarding how and for whom decisions are being taken and money spent (*ibid*).

As a response to the disappointing performance of the AMIS, governments in many developing countries have initiated a transfer of management responsibilities to the beneficiary farmers under the aegis of 'Irrigation Management Transfer' (IMT) with expectations of increasing performance, enhancing efficiency, reducing operation and maintenance costs and controlling the destruction of irrigation infrastructures (Meinzen-Dick *et al.,* 1997; Murray-Rust and Svendsen, 2001; Sam-Amoah and Gowing, 2001). Many studies appear to consider and recommend the transfer of irrigation systems to the users as the panacea for underperforming irrigation systems (Renault, 2001; Yercan, 2003).

While the success stories of FMIS are well documented (Loitos *et al.,* 1986; Tang, 1992; Hilton, 1992; Yoder, 1986; Lam, 1998), there are still abundant cases where irrigation systems have deteriorated partly because of a lack of technical and financial resources (Pradhan, 2000). Furthermore, a lack of sufficient water in both the sources and the canals and increased costs to the beneficiary farmers has meant that many FMISs are susceptible to failure (Sakurai and Palanisami, 2001). Evidence from India and Pakistan have shown that arguments of 'uncritical acceptance of equitable water distribution in all FMISs' has become untenable (Shah *et al.,* 2000 p.2). Studies have shown that results of many JMISs are also rather mixed despite enormous technical and financial contributions by agencies, both government and external (Wade, 1987; Levine, 1981; Hilton, 1990; Shivakoti, 1992).

It should be pointed out that whilst some comparative studies, including those reviewed above on the performance of irrigation systems under different property rights have been undertaken, those have mainly been characterised by macro level project appraisal studies, which tend to have an overwhelmingly technical focus (Laitos, 1986; Pradhan *et al.,* 1988; Renault *et al.,* 2007). Such studies have been undertaken which followed technical procedures and not surprisingly produced technical outcomes laden with technical jargon, which the local farmers have found very difficult to understand. Whilst 'objectivity' is a necessary measure of access to irrigation water, it is insufficient since it ignores the subjective measure of access to water.

Also, despite a large body of literature on the success of CPR systems in conserving local resources (Wade, 1988; Berkes, 1989; Ostrom, 1990; Berkes and Folke, 1998), empirical discussions with regard to the distributional aspects of irrigation resources particularly from farmers' perspectives have not been properly explored. Against this background, it is imperative to investigate the roles of property rights regimes, which are designed to manage irrigation systems on farmers' ability to access irrigation water. More crucially, it is important to broaden understanding of the roles of institutions in enabling or preventing farmers from accessing irrigation water from the canal systems.

To this end, this thesis has two key aims:

- Firstly, to investigate whether property rights structures have an impact on farmers' ability to access water from the canal systems.

- Secondly, to investigate the role of institutions in water distribution and to identify and elaborate some of the enabling factors for equitable water distribution in the canal systems in Nepal.

1.7 Focus, Research Objectives and Research Questions

1.7.1 Focus

This study focuses on institutional aspects of irrigation management in Nepal, giving consideration to property rights, group heterogeneity, equity and distributional aspects of the current institutional arrangements. In particular, the empirical emphasis is placed on the distributional implications of irrigation resources under different property rights regimes. The thesis investigates irrigation polices in Nepal in general, as well as more specific issues related to property rights structures and other institutional arrangements, which have a bearing on farmers' ability to appropriate benefits from the irrigation systems.

Through a comparative and an in-depth institutional analysis, the thesis aims to establish the extent of differences on the farmers' ability to engage on irrigation issues and the extent of benefits derived by farmers with different capabilities from irrigation systems governed by different property rights regimes. It is hoped that the findings from this thesis will provide a better understanding of the policy changes in the management of irrigation systems in Nepal, particularly the distributional aspects and the design principles of institutions. Furthermore, it is hoped that findings from this research will highlight the ways in which the marginal and the most vulnerable farmers can use the policy changes to improve their livelihoods and ensure the long term sustainability of the irrigation systems. The comparative institutional analysis of the three irrigation systems aims to yield policy inputs in terms of broadening understanding of good practice and policy transfer from one irrigation system to another.

1.7.2 Research Objectives and Research Questions

There are two overarching objectives of this thesis. Firstly, the thesis aims to investigate if the property rights structures have an impact on the farmers' ability to access water from the canal systems. Secondly, the thesis aims to broaden our understanding of the role of institutions in water distribution and to identify and elaborate some of the enabling factors for equitable water distribution in the canal systems. As mentioned earlier in Sections 1.6 and 1.7 above, there is a dearth of studies on the distributional aspects of irrigation interventions, particularly from the farmers' perspectives. The brief literature review presented in Section 1.7 indicated that irrigation systems which are governed by different property rights structures have different performance outcomes, at least on objective measures. However, it is still unclear as to why property rights structures have differential outcomes in terms of farmers' ability to access to water from the irrigation canals. In response to this gap in the literature, this thesis attempts to explore implications of property rights regimes on farmers' abilities to ensure this access. In Nepal, a good water supply enables farmers to grow upto five crops a year. However, a lack of good water supply restricts the farmers to grow only one crop in a year. A detailed discussion on the conceptualisation of access to irrigation water is presented in Chapter Two (Section 2.9) and the creation of weak and strong access to irrigation water is presented in Chapter Three (Section 3.9). The access score is created by asking the farmers about the quality of service i.e. water supply to their field in three distinct dimensions of access including adequacy, reliability and equity for the three cropping seasons in Nepal. The responses are weighted and added together to compute a composite access score with value ranging from 0 to 3. In the context of this thesis, the mean access score of 1.73, which is just over half of the maximum value of 3, is considered as the boundary between weak and strong access to irrigation water. The average access score indicates that the water available to the farmers is considered to be enough for cultivating at least two crops in a year. The households' ability to grow two crops a year is considered to be critical for their food security. This thesis uses data from the Participatory Rural Appraisal (PRA) process which was carried out during the focus group discussions and the household survey data to distinguish between a weak and strong access to irrigation water. The notion of strong and weak access is based on farmers' perceptions and is subjective in nature. In order to understand the relationship between the property rights regimes and the farmers' levels of access to irrigation water, this thesis attempts to answer the following two high level research questions:

1. Under which property rights structures do farmers have better access to irrigation water?
2. What roles do institutions play in enabling this access?

The literature review presented in Chapter Two indicates that farmers have different capabilities within society and that a farmer's socio-economic position within society influences his ability to benefit from natural resources such as irrigation water. In order to understand the ways in which the farmer's socio-economic position within society influences the ability to derive benefits from natural resource bases, the over arching research questions have been further broken down into five constituent questions. Since this research is a comparative study of irrigation systems governed by different property rights regimes, the constituent questions listed below combine the farmer's socio-economic status and how this influences his ability to access water under different property rights regimes. For the purpose of this thesis, households have been divided into different landholding categories, namely small landholders (marginal farmers), medium landholders and large landholders. A detailed description of these types of farmers is presented in Chapter Three (Section 3.6.3.2).

1a). Are the farmers from the *dalit* community benefiting equally from irrigation systems under different property rights regimes?
1b). Are marginal farmers benefiting equally from the surface irrigation systems governed by different property rights regimes?

1c). Under which property rights regimes do the 'tail-enders' have the best access to water from the canal system?

1d). Are households headed by females benefiting equally from irrigation systems under different property rights regimes?

2a). Which institutions enable farmers to access water from the irrigation canals?

2b). What are the lessons that irrigation systems governed by different property rights structures can learn from each other to maximise their impact on farmers' abilities to access water?

It is believed that breaking down the bigger research questions into above constituent questions will help to assess whether property rights regimes have any bearing on household access to irrigation water and if so, to identify the enabling institutional structures that are 'farmer friendly' in terms of their ability to access water from the canal systems. It also provides operationalisable research questions, listed above.

1.8 Theoretical and Analytical Framework

Several researchers (Ostrom, 1990; Quinn *et al.,* 2007; Axelrod, 1986; Baland and Platteau, 1996; McKean, 2000; Wade, 1988) have suggested that the CPR theory has promising characteristics for use as a foundation for understanding the rules of natural resource management. This thesis will be based on an institutional approach to natural resource management, which emphasises the role of both formal and informal (customary) institutions which are designed and implemented, and informal institutions which have practiced over time to manage natural resources and to solve some of the problems emanating from conflicting interests in doing so. The theoretical perspectives used in this thesis follow the institutional approach adopted by Douglas North who defines institutions as "---*humanly devised constraints that shape human interaction that ultimately affects the performance of economy by their effects on the costs of exchange and production---*" (1990 p.1). The institutions serve as an action arena where the players are involved in actions and interactions. Some institutions facilitate interactions whilst others constrain them and in the absence of institutions, social interactions would be very difficult if not virtually impossible to effect. Institutions are governance structures which provide action arenas for environmental transactions, shape incentives of parties to given transactions and consequently contribute to a range of possible outcomes (Williamson, 1985). In the context of natural resource management, institutions can be viewed as a set of accepted norms, behaviours and rules for making decisions in terms of eligibility and ineligibility to control and use resources, resolution of conflicts, implementation of rules and monitoring mechanisms to ensure compliance and to generally manage and exploit nature resources.

In this thesis, the Institutional Analysis and Development (IAD) Framework provides a conceptual scaffold for analysing and understanding the pattern of interactions amongst different stakeholders in managing irrigation resources. It should be pointed out that the thesis conducts its own empirical work, for which a number of data collection methods have been employed. Data for this thesis are collected through a household survey, Focus Group Discussions (FGDs), Key Informants Interviews (KIIs) data and documentary analysis. The IAD framework is used to make sense of the findings from the empirical study undertaken for this thesis. The following section describes the IAD framework and its application in managing irrigation resources.

1.9 The Institutional Analysis and Development (IAD) Framework

Developed by Elinor Ostrom and other scholars associated with the Workshop in Political Theory and Policy Analysis at the Indiana University, the Institutional Analysis and Development (IAD) framework has been in common use for a wide range of institutional settings, notably for the development of theories of common pool resources (CPRs) since the 1990s (Ostrom *et al.*,1994). The IAD framework takes the traditional approach to analyzing public policy problems from "*stages heuristic*" (Sabatier and Jenkins-Smith, 1993 p.1) i.e. problem identification, agenda setting, formulation, adoption, implementation and evaluation (Anderson, 2002) to action situations and actors involved in policy making, policy delivery and policy outcomes. The IAD framework provides intellectual scaffolding for a coherent structure to inquiry (Schlager, 1999). According to the IAD framework, both policy process and policy outcomes are assumed to be affected by four major variables, which are external to the individuals or groups involved in the actions or interactions. These variables include the following: (a) attributes of the physical world; (b) attributes of the community within which actors are embedded; (c) rules that create incentives and constraints for certain actions; and (d) interactions with other individuals (Ostrom, *et al.,* 1994). In the context of this thesis, action is considered the individual's capacity to be involved in and acquire benefits from the irrigation canals.

The IAD framework analyses action taken by the individual in a particular *action situation*. An action situation is conceived as *"a social space where individuals interact, exchange goods and services and engage in appropriation and provision activities, solve problems, or fight"* (Ostrom *et al*., 1994 p.28). The action situation includes four elements: (a) participants and their positions; (b) information available to the participants to choose (or not to choose) a particular course of action; (c) outcomes of the actions taken (or not taken); (d) costs and benefits of the actions; and (e) the link between the above mentioned four features (*op.cit*. p.29). The participants, both individuals and groups who take part in the action situation, are called actors. These have the following characteristics: *"(a) the preference evaluations that actors assign to potential actions and outcomes; (b) the way actors acquire, process, retain, and use knowledge contingencies and information; (c) the selection criteria actors use for deciding upon a particular course of action; and (d)* *the resources that an actor brings to a situation"* (*op.cit.* p. 33). The actors affected by irrigation interventions are irrigators (farmers), irrigation bureaucracy (DoI), donor agencies and other individuals (non-irrigators) who reside in the canal command areas.

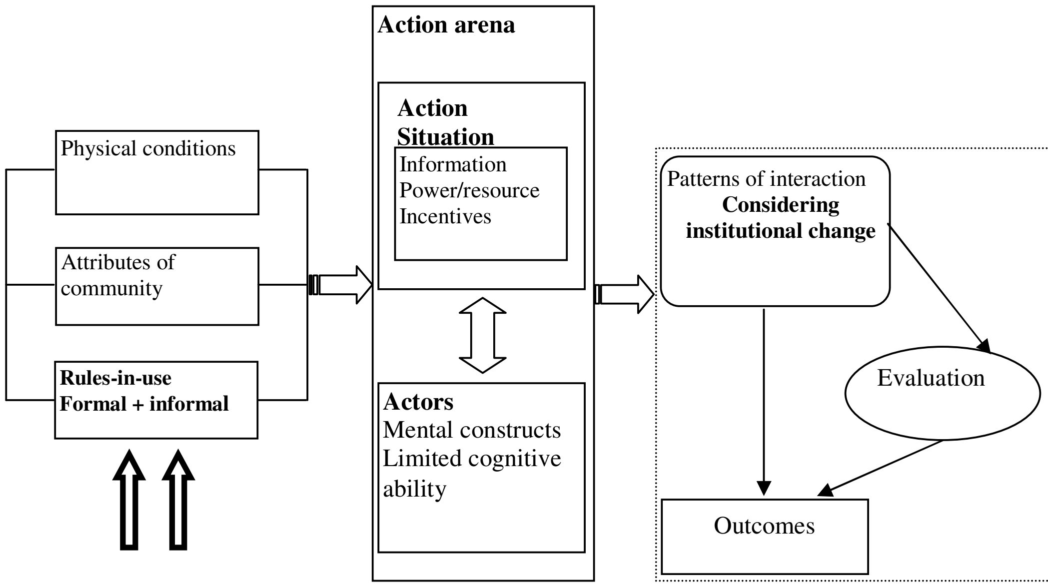
The IAD framework provides a unique opportunity to investigate and link rules of engagement and policy outcomes from an actor perspective. The choice of IAD over other institutional frameworks such as environmental entitlements (Leach *et al.*,1997) and the sustainable livelihoods framework – which has also been recently used as a basis for institutional analysis (Messer and Townsley, 2003), have been influenced by a number of considerations. Firstly, the IAD framework is efficient in linking the local settings with higher decision levels, i.e. those where central (governmental) policies and rules governing policy-making are decided. At an operational level, the IAD framework is well structured and coherent, and in which decisions directly affect the management of natural resources to the collective-choice level, where decisions impact the rules that affect the operational level. The collective-choice level is finally linked to the constitutional level, where decisions impact the rules that govern how decisions are taken at the collective-choice level (Clement *et al.,* 2007).

Secondly, the IAD framework explicitly considers local conditions as potential determinants of individual behaviour. The factors that affect the action arena where decisions are taken by individuals are divided into material conditions, i.e. the physical state of the environment where actors evolve rules and attributes of the community, which can be broadly assimilated as cultural determinants, as shown in Figure 1.2.

The IAD framework emphasises that the users of natural resources operate in a complex natural and socio-economic system in which the natural resource base is located. The users co-ordinate their activities in accordance with the rules designed and implemented for the management of these resources. These activities are influenced by the action arena where they operate together. The action arenas are affected by various factors such as: attributes of physical world; attributes of community; and rules-in-use. The appropriators use rules for ordering their own relationships, various attributes of the physical world and the nature of the community in which the action arena occurs. To understand these institutional issues, as noted by Ostrom *et al.* (1994), it is important to analyse in-depth how rules combine with the physical and community world to generate particular types of situation.

The management of irrigation systems is also guided by various rules at the level of the irrigation system. Through the use of the IAD framework, this thesis investigates the rules used for water distribution in three irrigation systems governed by different property rights regimes. It is noted that in community managed irrigation systems farmers develop a wide range of rules to specify rights and responsibilities among themselves (Tang, 1992) and it is most important that they enforce those rules without the involvement of external agencies. The situation is not same for all irrigation systems.

Figure 1.2 The Institutional Development and Analysis (IAD) Framework



Source: Ostrom *et al.* (1994)

General observation itself shows that the configuration of rules varies depending on the mode of governance of the irrigation systems. In many irrigation systems, constructed and managed by state agencies, the rules at the system level were suggested from higher level offices, not necessarily developed by the users (Lam, 1998). A detailed application of the IAD framework for the purpose of this thesis is presented in Chapter Six (Section 6.2).

1.10 Structure of the Thesis

This thesis consists of a further six chapters. Chapter Two presents a detailed and comprehensive review of the literature within the scope of the research. Firstly, the notion of property is defined and its applications in natural resource management are established. Different property rights regimes designed and implemented for the management of natural resources are presented. Secondly, the chapter describes property rights in the context of irrigation management and discusses irrigation management as a property rights problem. Thirdly, the chapter briefly discusses the role of heterogeneity, including the role of power relations in irrigation management. Fourthly, the chapter presents a critique of the current methods of measuring performance of access to irrigation systems and argues for an alternative approach to measuring a household's level of access to irrigation water by asking farmers to define their own levels of access rather than those defined by the irrigation engineers and irrigation bureaucracies.

In Chapter Three the thesis presents a detailed description of the methodological approach taken in the research. It describes the rationale for an in-depth comparative study of irrigation institutions taken to answer the research questions and also presents a brief description of the research sites, including respondents' socio-economic characteristics, demographic features, geographical locations and cropping patterns. The choice of three particular irrigation systems for an in-depth case study is discussed. Similarly, the chapter presents a detailed sampling framework and the criteria used for the household survey. A detailed elaboration of the methods used for generating qualitative data through expert interviews and focus group discussions is presented, as are the ethical issues considered for the research. Finally, the chapter presents a brief description of the data analysis methods used.

Chapter Four will present empirical evidence concerning the level of household access to irrigation water in the three different irrigation systems considered for this study. This chapter addresses the research questions using various statistical tests.

Variables such as socio-economic characteristics of the respondents and resource specific characteristics of the irrigation systems are considered in the analysis. This chapter identifies variables that have influence on household access to irrigation water as defined by this thesis.

Chapter Five presents a regression model to assess the household level of access to irrigation water from the canal systems, which are governed by different property rights regimes in Nepal. A cumulative index (level of access) is created by combining three variables, namely reliability, adequacy and equity and is used as a dependent variable to investigate the household level of access to irrigation water. Variables identified in Chapter Two, which are assumed to affect the household level of access to irrigation water, are used in constructing the models. This chapter presents the results of the regression analysis and discusses the findings.

Taking a qualitative approach, Chapter Six presents a detailed comparative analysis of institutional arrangements, which are designed and implemented for the management of the three irrigation systems considered in this research. This chapter seeks to demonstrate why some irrigation systems are better than the others in terms of enhancing irrigation water. An Institutional Analysis and Development (IAD) Framework is used to explore the 'action situations' and pattern of interactions of the farmers in terms of water distribution. The Chapter aims to explain the *'whys'* and '*hows*' of discrepancies in household level of access to irrigation water in the three irrigation systems identified in Chapters Five and Six.

Chapter Seven describes the main findings of the thesis and draws conclusions from the research. It also presents policy implications of the research findings of the thesis. Last but not least, the thesis suggests some of the lessons that can be learnt from this research and gives future suggestions for research in irrigation governance.

CHAPTER TWO:

LITERATURE REVIEW

2.1 Chapter Overview

This chapter presents an extensive literature review, which synthesises arguments from a wide range of literature, particularly property and property rights theory. Firstly, the notion of property is explained in the context of this thesis. Secondly, the chapter describes the notion of property rights in general terms and, in particular, property rights in the context of natural resource management. A detailed review of different types of property rights regimes designed to manage natural resources is provided. Thirdly, the chapter reviews the roles of heterogeneity and power relations in the farmers' ability to access water from the canal systems. Fourthly, the chapter explains how the nature of irrigation resources constitutes a property rights problem and how the notion of property rights can be used to analyse irrigation management. The influence of power relations on farmers' engagement in and benefit from appropriation of irrigation resources are explored. Fifthly, the chapter illustrates the complex interactions of different domains in governance and presents a brief critique of the methodologies used for measuring performance of the irrigation system and the household level of access to irrigation. It is argued that an over-emphasis on 'objectivity' in measuring irrigation performance, which disregards farmers' perceptions, has led to an insufficient measure of access. Therefore, 'objectivity' is a necessary but not sufficient measure of access to irrigation water. In response, the chapter presents an alternative approach in measuring household levels of access to irrigation water and then reviews the variables which could have an influence on this access. Using the variables indentified in the literature, the chapter finally presents a model for household access to irrigation. The model presented in this thesis uses property rights as a theoretical framework to develop some of the research questions presented in Chapter One.

2.2 The Notion of Property

The notion of property and its application to the study of socio-economic organisations, including the management of natural resources, has attracted a great deal of interest both from academics and policy makers alike. In earlier days, through the vantage point of a natural law, John Locke argued that *"-----individual can claim everything on earth that takes it through his labour"* (Locke, 1689 p.151). This strong contention appeared in his later writing as he argued *'-----every man should have as much as he could possibly make use of---- since there is land enough in the world to suffice double the inhabitants----"* (*ibid*). Locke's emphasis on a self-centred notion of property argued that the government should maintain insignificant roles in the creation and distribution of property rights. Rather, they should help in the recognition, facilitation and enforcement of natural rights (Wong, 2004). However, it is now well acknowledged, particularly via the recognition of limits to growth theorem, that natural resources are finite and the pressures on them are increasing and their uses should be sustainable. Meadows *et al.* in their influential report for the Club of Rome argued that:

"If the present growth trends in world population, industrialization, pollution, food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next one hundred years-- the most

probable results will be sudden and uncontrollable in declines of both population and industrial capacity" (1972 p.117).

The recent resurgence in property literature is a clear indication of an increasing use of property rights as a tool for individuals to speak out, demand rights and ultimately legitimise their claims over resources and services (Ignatieff, 2000; Wiber, 2005). Dixon (1941) argues that property is the relationship between people and surpluses emanating from material objects with some economic value in their possession. Hallowell (1943) confronting Dixon's assertion of property rights as the relationship between people and objects, argues that property rights are *"social institution i.e. a system of relationship amongst people involving rights, duties, powers, privileges, forbearance--- of some kind"* (Hallowell, 1943 p.9). For Hallowell, the property relationship is triadic: 'A' owns 'B' against 'C' where A, B and C represent individual, object and other individual respectively (Hallowell, 1943 p.59). Interestingly, Dixon's over-emphasis on economic surplus, excluding social aspects and Hallowell's over-emphasis on social aspects, omitting economic aspects, makes their conception of property rights incomplete, partly because the relationship is often socio-economic rather than either economic or social alone.

Following an anthropological perspective, von Brenda-Beckmann argues that, property rights are "*sanctioned social relationships between persons with which they relate to each other with respect to the resource/object of some value*" (1996, p.7). It is argued that by virtue of property rights individuals are privileged and authorised to undertake particular action related to the resources (Commons, 2006; Schlager and Ostrom, 1992). The object/ resource can be both material and immaterial but the relationship is not with the object itself. The sanctioned social relationships, embedded within the property rights, provide an institutional configuration for the formation, operation and functioning of social and economic organisations (Barzel, 1997). In pluralist and heterogeneous societies, claims for stakes and participation in resource management are accelerating and consequently new institutional arrangements are evolving to redress past wrongs and redistribute productive assets including land, labour and capital (Wong, 2004).

However, in recent decades there has been a shift in conceptualising property rights. The literature on property rights has increasingly attempted to widen its scope and scholars have begun to conceive of property as a bundle of rights to explore the relationships between people and the valuable resources surrounding them (Wiber, 1993; F. von Benda-Beckmann; 1995, 2000 & 2001; K von Benda-Beckmann *et al.,* 1997; F.and K von Benda-Beckmann, 1999). The '*bundle of rights*' approach to defining property avoids over simplistic notions of property, an endemic problem in earlier studies of property (Wiber, 2005 p.6). For example, Daniel Bromley argues that property rights are *"capacity to call upon the collective to stand behind one's claim to a benefit stream"* (1991, p.15). Bromley's definition of property rights attempts to reiterate the existence of a socio-economic relationship between the individuals who claim rights over certain goods and services and the institutional circumstances in which they claim such rights. Randall (1981) also recognised the existence of a triadic relationship and argued that relationships between people with respect to the use of resources are specified by the property rights and penalties for any contraventions to these relationships. In an abstract sense, property is not a material possession but a capability to exercise rights over the possession *per se* and is a social relationship (Ely, 1914; Macpherson, 1978).

Alfred Hallowell, an American anthropologist, gets to the heart of the nature of property and argues that:

"----In property relations, processes of social interaction are validated by traditional beliefs, attitudes, and value, and sanctioned in custom and law, it is apparent that we are dealing with an institution extremely fundamental to the structure of human societies as going concerns---- property rights are institutionalized means of defining who may control various classes of valuable objects for a variety of present and future purposes and the conditions under which this power may be exercised" (1955 p.246). As such, property rights theory is useful in the study of irrigation management, as the distributional aspects such as the benefits from the irrigation canal are inherently related to the socio-economic power relations between farmers.

2.3 Property Rights in the Natural Resource Realm

Based on property rights structures, natural resources can be put into two categories - those where property rights are assigned and those where property rights are not assigned (Tietenburg, 2005). However, as Wiber (2005) has pointed out, the nature of property relationships varies quite dramatically across four major elements, including *social units* (entities considered capable of holding property rights and obligations); *property objects* (values attached to the objects); *relationships* (rights-obligations interface) and *spatial-temporal dimensions* (location and time horizon). Hoogendam (1995) has postulated four categories of resources namely: private property; common property; public property; and open access property. With private property, the stakeholders possess all rights including usage, management rights, benefits and transferability rights. For example, private land owned by an individual can be used for cultivation, can be left barren or can be sold to another person as per the owner's wish. Common property (*res communis*) encompasses a situation where a group of members collectively and co-equally hold the rights over the resource base, which varies according to the rules agreed upon by the group members (Circiacy-Wantrup and Bishop, 1975). For example, community forestry, communal irrigation canals, communal pastures and so on, are collectively owned and managed by a group of users. The possession of rights by the state or auxiliary institutions over the resource or object is often referred to as public property (for example, national defence and government buildings) while situations where no rules and regulations governing the use and management of resources are called open access property (*res nullius*). Examples of open access property include national parks and national forests. However, very few resources fall into only one of the categories mentioned above, as natural resources are less often governed by those idealised types and it is often the case that a combination of two or more types of rights are applied in managing natural resources (Poudel, 2000).

Garret Hardin's seminal article entitled 'the tragedy of the commons' triggered a renaissance era and reincarnated property rights as a locus of intellectual enquiry in natural resource management (Hardin, 1968). Hardin argued that in the absence of well defined property rights and rules governing the Common Property Resources (CPR), the resource bases encounter their unfortunate fate of depletion. In Hardin's own words:

" As a rational human being, each herdsman tries to maximise his gain--- the rational herdsman concludes that the only sensible course for him to pursue is to add another animal and another and another--- Therein is the tragedy. Each man is locked into a system which compels him to increase his herd without limit--- in a

world that is limited. Ruin is the destination towards which all men rush, each pursuing his own interest in a society that believes in the freedom of commons. Freedom in a commons brings ruin to all"

(Hardin, 1968 p.1244)

Hardin's concept has been widely used to explain species extinction, over exploitation of forests, fisheries, problems of overgrazing, water and air pollution, public land encroachments, misallocation in oil and natural gases, ground water depletion and other problems of resource misallocation (Stevenson, 1991; Dasgupta and Heal, 1979). In the absence of well defined property rights, 'free riding' is a common problem where the rational individual's unconstrained use of resources leads to over-exploitation, degradation and ultimately depletion of natural resources, i.e. the "*tragedy of the commons"*. Using the non-repeated Prisoner's Dilemma Game, Runge (1981) concluded that during times of uncertainty, the rational individual's trust in collective outcomes declines and a propensity to maximise his own utility is conspicuous, with catastrophic implications for resource sustainability. However, in the repeated Prisoner Dilemma Game, provided there is an indefinite number of interactions where each individual becomes acquainted with the other's strategic actions, free riding is still possible but much less likely (Axelrod, 1981; Kimber, 1981; Snidal, 1985). Campbell and Sowden argue that, *"--- rational players who know each other's likely actions should have no trouble in establishing co-ordinations in these games"* (1985 p.102). However, evidence suggests that individuals interacting with each other an indefinite number of times become acquainted with each others' actions and adopt different strategies to maximise individual gains instead of collective outcomes (Luce and Raiffa, 1957). In such circumstances, particularly in the absence of a proper mechanism for monitoring individuals' activities, there still exists some chances of defrauding and trust in collective outcomes remains low. This is because individuals perceive that defrauding will yield more short term benefits than the benefits gained though cooperation.

Hardin's critics argue that the tragedy of the commons is applicable to resources with open access (*res-nullius*) where property rights are not assigned and enforced, but not to the CPRs where property rights are clearly assigned (Circiacy-Wantrup and Bishop, 1975; Runge, 1984; Bromley and Cernea, 1989). They argue that many grazing lands, which Hardin himself had predicted to get depleted overtime due to over-grazing, have remained decently managed within common property regimes for centuries before their decline (Cox, 1985). Adhikari (2002), reviewing Hardin's critics, argued that the commons' tragedy cannot be explained by blaming inherent flaws in common property management, but from internal institutional inconsistencies, failure to capture a socio-economic context of resource bases, and institutional weakness in controlling over-exploitation and design and enforcing collective action decisions.

2.4 Property Right Regimes

Hanna and Jenttoft (1996) posit that, together with labour and technology, property rights maintain connectivity between individuals and natural resources. In the context of natural resources the very existence of property rights are facilitated by the institutions designed and implemented for the management of resource bases. Bromley (2003) argues that, property rights regimes are authority systems, a '*unit of coercion*' with legitimacy to impose sanctions and enforce a structure of property rights and obligations. The property rights structure takes various forms, depending on the '*unit of coercion',* often characterised by different combinations of property rights, in terms of access, withdrawal and stewardship (Fuchs, 2003). Berkes (1996) contends that the *modus operandi* for interactions between the social system and natural systems are defined by property rights regimes. The most common categories of property rights regimes discussed in the literature include: state property regimes; private property regimes; common property regimes; and non-property regimes (open-access) (Hanna *et al.,* 1996; Bromley, 2003 also see Berkes, 1996; Feeny *et al.,* 1990).

2.4.1 State Property Regimes

In a state property regime, rights for access to and control over natural resources are owned exclusively by the state. The possession of exclusive ownership rights has meant that the state as a unit of coercion, controls and regulates the use of resource bases. Examples of resources managed by this regime type include national forests, national parks and hunting reserves. Acheson (2000) argues that the state maintains its authority to protect resources in two ways: (1) through nationalisation of resources for example capturing a swath of land for creating park land; (2) through legislative procedures, by passing laws to assume rights over resources, for example the Nepalese government passed legislation to nationalise thousands of hectares of village forests through the enactment of the Forest Nationalisation Act 1975.

Under state property regimes, the state exercises its rights in two ways. Direct mechanisms are put in place, where the state itself acts as unit of coercion via its auxiliary agencies. Concessions for an individual or group to use resources may still be available, but they depend on the forbearance of the state (Bromley, 2003). Indirect (lease-out) mechanisms are enacted, where individuals or groups are granted only *usufruct* (usage) rights over resources, i.e. the resource can be used for a fixed period of time or as long as the usufructuaries manage the resource without causing damage. The usufruct rights provide individuals with the facility to use resources that do not belong to them. For example, the 'tree growing association' in the Indian state of West Bengal consists mainly of landless and marginal farmers where individuals have not been granted land titles but the group has been given usufruct rights to the land and ownership rights to its produce (Cernea, 1985). It should be noted that the usufruct rights are not necessarily granted on a permanent basis. Nonetheless, the authorities grant usufruct rights for a duration, which is considered a reasonable length of time to achieve the objective of such a transfer to local users. Bromley (2003) suggests that state property rights regimes are characterised by distinct ownership-control rights and are actual rights to use. In the state property rights regime, usually but not always, the state (on behalf of citizenry at large) assumes ownership while management-control and use rights are maintained by bureaucrats and citizenry respectively.

States often use economic tools such as taxes and subsidies to secure better management of environmental resources, while some states, particularly those in fiscal crises, decentralise the management of resources partly because the management costs are high (Meinzen-Dick and Knox, 2001). However, resources managed by state property rights regimes continue to face problems of free riding, as individuals appropriate benefits from resources without contributing toward their management or bearing the costs of management (Ostrom, 1990). The 'common good' nature of many natural resources, including irrigation water are rivalry in consumption and it is very difficult to exclude individuals from using the resource. The common good aspect of irrigation water presents a real problem as regards free riding, particularly when monitoring mechanisms are absent or weakly enforced. Furthermore, an inadequately defined property right makes it extremely difficult to exclude free riders and monitoring becomes very costly (Williamson, 1975). It is also suggested that state lack of effective enforcement mechanisms might lead to some degree of devolution of management to local users (Berkes, 1996). In order to avoid the tragedy of the commons, many countries have transferred property rights to local users. For example, in some irrigation systems in the Philippines, productivity and sustainability of water use were enhanced only after the successful and active integration of farmers' participation in all aspects of design of distribution, enforcement and monitoring mechanisms (Maleza and Nishimura, 2007).

2.4.2 Private Property Regimes

Private property regimes, also known as individual property regimes (*res privatae),* are the most commonly practised in resource management. Under private property regimes, exclusive ownership is assigned to named individuals or corporations, together with control, access and a bundle of socially accepted uses (Fuchs, 2003). The right holders have exclusive usage rights and can exclude others and regulate the management of the resource bases. The private property rights regimes assume that the robustness of rule enforcement can be enhanced and '*free riding*' controlled (Berkes, 1996). Bromley (2003) claims that the presence of strong moral and legal sanctions to exclude excess populations coupled with state power to effectively resist unwanted intrusion has meant that private property regimes are more stable and adaptable. Proponents of private property regimes argue that problems of over-exploitation and degradation of resources can only be resolved by creating and enforcing appropriate private property rights (Demsetz, 1967; Johnson, 1972; Smith, 1981 also see Cheung, 1970; Circiacy-Wantrup & Bishop, 1975; Runge, 1984; Bromley and Cernea, 1989). However, in private property rights regimes, the incentive structures tend to come from an economic but not necessarily an environmental view point (Wong, 2004). It is important to recognise that resource sustainability depends not only on use but also on the characteristics of both the market and resources (Berkes, 1996; Gadgil and Berkes, 1991). Rational agents, who are managing natural resources under private property rights regimes, are often susceptible to short term economic gains ignoring long term resource sustainability and the useful role of cultural capital in managing natural capital (Berkes and Folke, 1992). For example, an individual with ownership of a private forest might clear it without considering ecological impacts. Some scholars, such as Acheson (2000), have recognised circumstances which are unfavourable to resource sustainability even though they meet economic criteria. Acheson (2000) argues over exploitation of resources is eminent in conditions in which financial interest rates exceed resource growth rates, encouraging the owner to maximise profit through the rapid use of resources. In the wake of risk and uncertainty, property rights holders might adopt strategies to yield maximum immediate results, assuming high discount rates, and a short time horizon (Adhikari, 2002) leading to the over-exploitation of the resource (Alcheson, 2000; Heikkinen and Kuosmanen, 2003 also see Wesseler *et al.,* 2003).

2.4.3 Common Property Regimes

Under this type of regime, the property rights are held by an identifiable group of users who have the right to exclude non-right holders and regulate the use of CPRs (*res communes*) through constraints placed on use (Ciricy-Wantrup and Bishop, 1975; McCay and Acheson, 1987, also see Berkes *et al.,* 1989; Bromley, 1989 & 2003; Stevenson, 1991). However, it is unlikely that rights holders have exclusive transferable rights, but only access and usage rights (Feeny *et al.,* 1998). Common property regimes are preferred where resources demonstrate rivalry or substractibility and a non-exclusionary nature (Ostrom and Gardner, 1993; Berkes and Farer, 1988). Finite resource availability and competition by multiple users and the substantially high costs of exclusion has meant that resources are subject to depletion or degradation (Varughese, 1998). Hence, CPRs share the first attribute with purely private goods and the second attribute with purely public goods.

The CPR regime originates either from legal recognition (*de jury*) or customary practice (*de facto*). Whatever the foundational framework for CPR regimes, the successful exclusion of non-owners is the rule rather than the exception (Berkes, 2004). Bromley (2003) makes an interesting comparison between common property (*res communes*) and private property (*res privatae*) for the group of co-owners. Bromley posits similarities between the two, partly as a result of the exclusion of non-owners, while all others are included in all aspects of use and in decision making processes. The group of co-owners resembles the individual in private property regimes, where rights are held with corresponding duties associated with the exercise of those rights. Bromley (2003) conceived common property regimes as social units with identifiable membership and boundaries, linked up with common interests, socio-cultural norms and often with their own endogenous unit of coercion (authority). However, the co-owner groups vary in nature, size and internal structure across a broad spectrum. The existence of rights and duties remains eminent between co-owners and non-members. The co-owners involved in managing the resource have the right to exclude non-members, while non-members are obliged to abide by the rules of exclusion. Internally, members within groups have rights and duties with respect to use rates and operation and maintenance activities (Bromley, 2003). However, the fundamental difference exists between common property regimes and open access, as there are no definite users and every potential user has usage rights while none has explicit legal or customary obligatory liabilities for the exercise of neither these rights nor the legal capability to exclude others. Therefore, an open access regime is dominated by the notion of mutual privilege, devoid of rights and obligation, while common pool regimes are framed within legal and/or customary rights and duties, with the ability of co-owners to exclude non-members (Bromley, 1991).

2.4.4 No-property Right Regimes (Open-Access)

In open access regimes, resources can be used by anyone with a social and economic capability to harvest the resources without bearing the costs associated with resource management. Under this type of regime, resources are managed either by poorly defined property rights, or in the complete absence of property rights. The open access scenarios exist either in the absence of property rights, or by a breakdown of management structures to enforce rules, establish certain norms and values and relate members with the resource base due to institutional misfit and corruption (Makepe, 2006; Robbins, 2000). Bromley (2003) argues that, in the absence of property rights, it is logically inconsistent to assert- as many often do –*"everybody's property is nobody's property rather it can only be argued that everybody's access is nobody's property"* (p.95). Similar views were expressed by Aristotle as early as 400 B.C: *"what is common to the greatest number has the least care bestowed upon it. Everyone thinks chiefly of his own, hardly at all of the common interest"* (cited in Ostrom, 1990 p.1) This type of property right regime might be acceptable where supply is plentiful with low demands on the resource, as McKean asserts that "*no management is required for resources available in abundance --- when demand is* *too low to make the effort worthwhile. While at least in the short term, open access regimes might be able to manage the resource, but in the long term continual exploitation leads to resource degradation and possibilities for ultimate depletion of resources remain high and real* " (2000 p.10). In the long term, the supply side (rate of resource regeneration) declines over time while demand continues to increase owing to the pressure of economic and population growth (Swaney, 2003). Considerable evidence has shown that the supply side of the fugitive natural resource can be reduced to zero, mainly because of physical and economic exhaustion, and sufficiently high rates of use can stub out the generative capacity (Dasgupta and Heal, 1979; Stevenson, 1991).

In the absence of well defined property rights structures, the exploitation of natural resources generates two kinds of externalities to other users; symmetrical and asymmetrical (Stevenson, 1991). Symmetrical externalities represent situations where the externalities generated are inflicted on those imposing and other users simultaneously - reciprocal externality. For example, ground water, unregulated woodlands and forests, open grazing ground, fishery, wildlife and the common oil and gas pool. The asymmetrical externality represents situations where the externality is non-reciprocal and those inflicting impose costs on others while bearing no costs whatsoever; for example, a factory chimney dirtying clothes on a washing line that is close to the factory.

Wallace (1981) in his studies of open access forests, illustrated several important implications for resource use under open access regimes. In these situations, over exploitation usually takes place in two ways. Firstly, even with the availability of substitutes, users prefer 'free goods' to other goods, as the costs emanating from harvesting is higher to the society than to individuals. Also, individuals make usage decisions with short term horizons, and extract resources until their marginal costs[2] and benefits of resource abstraction equalise in a particular year. Secondly, users' short-sighted thinking drags them to opt for short term benefits rather than long term resource sustainability through a pattern of unbalanced use leading to over exploitation of resources (Wallace, 1981).

Under open access regimes, the use of capital intensive harvest instead of alternative non-intensive harvest at unsustainable levels by free riders has meant that resources are susceptible to over exploitation (De Lopez, 2001; Agnello and Donnelley, 1977; Kasulo and Perrings, 2006). As argued by Bromley (2003), the open access regime represents a situation where everyone's access is nobody's property and lacks individual incentives to make sustainable use of resources, assuming that free riders enjoy benefits at the expense of their efforts (Varughese, 1999).

Table 2.1 General Classifications of Goods

	Excludable	**Non-excludable**
Rivalry in Consumption	*Private Goods* example: cars, food, gold ring	*Common Goods or CPR* example: fish stock, irrigation systems, community forests
Non Rivalry in Consumption	*Club Goods* example: highways, zoos, national parks	*Public Good* example: street light, national defence, air

[2] Marginal cost is defined as the cost incurred in producing every additional product or service (resources) while marginal benefit is the satisfaction for consumption of every additional resource (Begg *et al.*, 2008). If the marginal benefit of using the resource is higher than the marginal cost, then individuals and group using the resources will continue exploiting them until the marginal cost equals the marginal benefits.

Table 2.1 presents the nature of the goods based on their rivalry and excludable natures. Private goods are both excludable and prone to rivalry in consumption, while common goods are prone to rivalry but non-excludable in nature. The finite flow of water in the irrigation canal (rivalry) and the high costs associated with exclusion pose a challenge to managing irrigation systems (see more in Section 2.6 below). The thesis will examine the natural resources, which are governed by the three types of property rights regimes namely the AMIS, FMIS and the JMIS mentioned above.

2.5 Property Rights, Collective Action and Heterogeneity

The relationship between natural resources and the characteristics of the resource users have engendered a great deal of interest amongst academics and policy makers alike (Chambers, 1977; Wade, 1988 Ostrom, 1994; Lam, 1998). The role of heterogeneity on collective action, which is required for commons management, requires elaboration. Firstly, the notion of heterogeneity needs clarification here. In simple terms, it refers to the socio-economic differences that exist between the natural resource users. Literature on heterogeneity suggests that it emanates from different sources; for example, political heterogeneity (little agreement amongst the committee members or between committee members and users); heterogeneity in endowments (unequal access to land and other resources); heterogeneity in wealth and entitlements (large differences in crop production and cattle); economic interests (types of crop and diversity in the use of irrigation) and socio-cultural heterogeneity (education, castes, values and life orientation). In this thesis, heterogeneity is taken as the characteristics of the household, ranging from socio-economic attributes such as caste, gender, size and the location of the landholdings, the level of trust, farmers' agronomical knowledge and other resources, specific characteristics like the nature of water feeding the irrigation systems, cement lined canals, and the shape and gradient of canals.

The development of institutions required for the management of natural resources involves collective action from all members of the community involved in managing the resource base in question. In the case of irrigation, members of the WUA are involved, who organise and invest in the management of irrigation systems. The structure and composition of the community and the group heterogeneity/ homogeneity emanating from it has wider implications for efficient and equitable CPR management (Agrawal, 2001; Oakerson, 1986; Poteete and Ostrom, 2004; Bromley and Cernea, 1989; Arnold, 1998). It is argued that equitable resource distribution amongst the users is vital for successful and sustainable CPR management.

Table 2.2 presents studies which have investigated the relationship between heterogeneity and collective action. The literature suggests that this relationship is not straight forward. There are two competing schools of thought in the natural resource management literature which deal with the effects of local level heterogeneity in community based resource management.

The first school of thought argues that local level socio-economic heterogeneities impose constraints on collective action and institution building (North, 1990). Unless guided by rules, regulations and robust institutional arrangements, the diverse interests amongst stakeholders have meant that fraud and uncooperative behaviour are not uncommon (Kanbur, 1992; Kant, 2000; Bardhan, 1993).

Table 2.2 Some Developments on Heterogeneity and Collective Actions

YEAR	AUTHOR(S)	TYPE OF PAPER	TYPE OF HETEROGENEITY	RELATIONSHIP
1965	Olson	Theoretical	Wealth	Positive
1986	Bergstrom *et al.*	Theoretical	Wealth	Positive
1989	Cernea	Empirical	Class	Negative
1992	Kanbur	Empirical	Wealth	Negative
1995	Bardhan	Empirical	Wealth	Negative
1996	Sarin	Empirical	Interests	Negative
1996	Shanmugaratnam	Empirical	Wealth	Negative
1996	Baland and Platteau	Theoretical	Socio-political	Positive
2000	Vedeld	Empirical	Socio-political	Ambiguous
1998	Baker	Empirical	Wealth	Positive
1998	Baland and Platteau	Empirical	Wealth	Ambiguous
1998	Molinas	Empirical	Wealth Gender	Inverted U Negative
1999	Baland and Platteau	Empirical	Socio-economic	Positive
1999	Chan *et al.*	Empirical	Wealth	Ambiguous
2000	Bardhan and Dyton-Johnson	Empirical	Wealth	U-shaped
2001	Bardhan *et al.*	Theoretical	Wealth Locational	U-shaped Negative
2001	Varughese and Ostrom	Empirical	Socio-cultural	Ambiguous

Adopted from Pérez-Cirera (2004)

The extent to which resource users co-operate and their confidence, depends on the level of trust that they maintain during the interactions that take place while managing the commons. Seabright (1993) proposed a model commonly referred to as the "*habit forming cooperation model*", which demonstrates that co-operative actions emanate when stakeholders' trustworthiness is initiated and maintained. Studies from community forestry in Nepal (Adhikari and Lovett, 2006), council forestry in India (Somanathan *et al.,* 2002), tax compliance in the USA (Graetz *et al.,* 1986) and voting behaviour in the USA (Green and Shachar, 2000) demonstrate cases where rules can be designed and followed through to form habits or norms.

The second school of thought argues that group heterogeneity is conducive to governance of local commons and facilitates collective action for the efficient utilisation and conservation of natural resource bases. Mancur Olson (1965) in his seminal book '*The Logic of Collective Action*' argued that in heterogeneous communities, collective action can prevail if stakeholders with the greatest economic interests and most powerful influence can initiate collective action. Collective action is successful if initiated by privileged stakeholder(s) in circumstances where large starts-up costs are required for local resource governance (Baland and Platteau, 1996). However, the propensity on the part of privileged stakeholders to contribute towards collective action may be to the result of anticipation of a greater share of the returns, called the '*Olson Effects*'. It is argued that increasing socio-economic inequality could provide incentives and engender users' interests in voluntary contributions to the management of local commons (Baland and Platteau, 1999). However, the *Olson Effects* have come under increasing scrutiny over the last two decades. Baland and Platteau (1999) report excessive interests of larger parties in resource management and decreased interests of the small parties, as the local elite appropriate disproportionate amounts of benefits from natural resources. In essence, the *Olson Effects* increase the free rider problem in the provision of public goods, i.e. too many small parties enjoying efforts contributed by privileged parties. It is equally plausible that the local elite lose interest in investing in the management of natural resources because small users might be free riding at their expense. Dayton-Johnson and Bardhan (2002) report a U-shaped relationship between group heterogeneity based on production functions. It is argued that in communities with a higher degree of heterogeneity amongst users, the privileged members completely fund and co-ordinate collective action while in less heterogeneous communities, shared common interests amongst users are sufficient to provide social capital for undertaking collective action. Some political scientists argue that social capital makes a positive contribution towards CPR management (Pretty, 2003; Putnam *et al.,* 1993; Akerlof and Kranton, 2002). Positivists argue that social capital entails a notion of shared identity and helps to establish recursive relationships amongst the CPR users, whose actions and expectations are guided by a set of agreed rules contributing positively to overcoming the problems of collective action. Furthermore, it is argued that social capital helps to ensure economic efficiency in resource governance by reducing transaction costs and controlling fraud and dishonesty amongst the resource base users (Ostrom, 1994; Room, 1980; Quibria, 2003), increase in knowledge and information flow (Anderson *et al.,*1994), increased cooperation, less resource degradation and depletion (Daniere *et al.,*2002), more investment in common lands and water systems, and improved monitoring and enforcement (Koka and Prescott 2002). However, a growing number of political ecologists report that the role of social capital in CPR management is highly contentious (Bryant, 1992; Ribot, 1998; also see Collier and Gunning, 1999; Otsuka and Tachibana, 2001; Cramb, 2004; Durston, 1998). Sceptics argue that internal differences, tensions and stratifications are always present in both horizontal and vertical networks of users imposing serious collective action problems. Peet and Watts argue:

'*These tensions occur not only at a given spatial scale, but also across geographic scales, and indeed resolving these tensions is important for building more robust users' associations'* (1996 p.36).

While it is accepted that individuals connected by a close-knit network can provide impetus for economic dynamism and collective outcomes for its members, it also has the potential to dilute personal incentives to work hard. Social capital can lead to moral hazard and give rise to free riding where it provides a safety net that can penalise success and reward failure (Sobel, 2002). The individuals involved in the management of natural resources have different priorities over natural resources and capacity to benefit from them. Therefore, their willingness to participate in collective action depends on those priorities and capacity. For example, a farmer with a primary employment in non-agricultural related sector, such as business or service, and with a secondary employment in agriculture sector, perhaps will be less enthusiastic to contribute towards collective action. Similarly, a poverty stricken farmer belonging to a dalit *caste* group might not be able to contribute much to the collective action as he/she has to take extra work as a wage labourer or a porter to supplement his/her income from farming. Also, individual willingness to engage in collective action depends on the expected pay off from collective actions and the activities of other individuals who are also participating in collective action. A lack of trustworthiness and inequitable resource distribution amongst users reduces the opportunity for collective action. Under such circumstances, the willingness to engage in collective action becomes increasingly difficult. Therefore, habit forming behaviours are unlikely to emerge in heterogeneous communities where diverse political and socio-economic interests prevail (Seabright, 1993). Socio-economic heterogeneities are both causes and consequences of differential access to and command over natural resource bases (Kant, 1998).

Some scholars argue that successful natural resource management can co-exist even with substantial inequity (Quiggin, 1993). In heterogeneous settings, privileged members might derive more benefits from the CPR resource bases, albeit with the complete acknowledgement of other members. Of course, there is bound to be some degree of heterogeneity in any society and it is quite difficult to find a completely homogenous community, not least in terms of socio-economic and power relations within the community. It is equally plausible that group differentiation entails unequal power distribution, which underpins the use of, and control over natural resources such as irrigation canals. Also, group heterogeneity does not guarantee collective action and sustainable use of CPR bases (Sobel, 2002). It is often the case that in any given community, significant group heterogeneities exist.

Other rational choice theorists argue that while shared socio-cultural features might provide some empathy for collective action, this action, however, is guided by economic interests. Cleaver (2000) argues that an individual's motivation for becoming involved in effective CPR management is dominated by economic motivation. Users often evaluate costs and benefits associated with collective endeavours. If they are convinced that the likelihood of receiving benefits exceeds the costof being involved in CPR management, then they are more likely to be enthusiastic about undertaking collective action. The embeddedness of economic transactions in social life influence individual action and perception in managing local CPRs (Granovetter, 1992). Homogenous socio-cultural characteristics coupled with shared economic interests make collective action easier (Jodha, 1996; Kant and Cooke, 1999; Saxena, 2000). Conversely, the existence of group heterogeneity amongst users imposes enormous challenges for collective action. It is argued that diverse socio-economic interests and different perceptions regarding CPRs might lead to recurring disputes amongst users and create factions (Fresson, 1979). While the constraints imposed by heterogeneity are acknowledged, there is considerable disagreement as to what constitutes heterogeneity and the nature, trajectory and scale of its influence over natural resource governance remain highly inconclusive (Adhikari and Lovett, 2006). In fact, the role of heterogeneity in collective action continues to be a theoretical puzzle. Although the main remit of this thesis does not concern the impact of heterogeneity in collective action, it does make a case for equity considerations in CPR management and for seeking opportunities for the most deprived and marginalised community members.

2.6 Commons Dilemma in Irrigation Management

Irrigation canals are managed through various institutional arrangements. They are privately managed, communally managed, state managed and jointly managed. For the purpose of this research, a comparative analysis of a communally managed irrigation system (FMIS), an agency managed irrigation system (AMIS) and a jointly managed irrigation system (JMIS) have been considered. Irrigation water demonstrates inherent characteristics of common pool resources (CPRs). There is rivalry and a non-exclusionary facet to its nature (see Table 2.1 for the nature of goods) and it is usually managed communally by a group of individuals (Ostrom and Gardner, 1993). The finite flow of water in an irrigation canal is accessed by multiple users and withdrawing water by an individual has implications upon the availability of water to other appropriators. Although the WUAs can design and implement rules to exclude individuals who are not members from using the water, the costs of doing so can be substantially high, commonly called 'transaction costs' (Williamson, 1999). The costs associated with excluding certain individuals from water harvesting arises from many sources, including the cost of diverting water away from them, and the costs associated with designing and implementing monitoring mechanisms. Also, the non-stationary nature of the irrigation water and the demand placed on it in crucial times (for example, paddy transplanting) creates added complexities. Paddy transplantation takes place over a short period of two weeks (from the end of June to mid-July) when demand for water is extremely high. For paddy crops, the total growing season of an annual crop can be divided into four growth stages: (a) initial stage, from seed sowing to 10 percent ground cover; (b) the crop development stage, from 10 to 70 percent of ground cover; (c) the mid-season stage, which includes flowering and grain setting or yield formation and (d) the late season stage, including ripening and harvesting. In general, the agronomists have identified that the late season stage in the growth of paddy is the least water sentitive while the mid-season stage is most sensitive to water shortages (Smith *et al*., 1996). The mid-stage season is characterised by the highest crop water needs; water shortage during this stage of paddy growth has a significant negative effect on the total crop yield. According to the guidelines issued by the FAO, the irrigation requirement in most part of the mid-hills of Nepal is that a water layer of 100 mm should be established after the transplantion, and maintained throughout the growing season. However, the water layer should be reduced to 20-50 mm during the latter part of the vegetative stage and brought back to 100 mm during the mid-season stage (Brouwer *et al*., 1989; Smith *et al*., 1991). In the absence of appropriate institutional arrangements to design and implement property rights, and monitoring mechanisms against fraud, many complex problems arise while managing local commons.

2.7 Property Rights and Power Influence in Irrigation Management

As in any institutional arrangement, irrigation resource governance is inherently a political process and power relationships (both formal and informal) play a major role in both crafting rules and appropriating benefits. Any attempt to institutionally analyse irrigation governance should be viewed through the lens of power, process and practice and how these shape a farmer's access, control and use of irrigation water. Robert Chambers posits:

--*a central and universal issue in the distribution of irrigation water is who get, what and where. This is the very stuff of politics and it is surprising that political scientists, political anthropologists and those who study political economy have not devoted more attention to it. Where water is scare and often constraining and when individual farmers and communities of farmers compete for it, the focus is on the processes of allocation and acquisition which determine the access of users to water* (1977 p.345).

In resource governance, as Hasler (1993) argues, mediation and expression of power hegemony are essentially reflections of contesting and negotiating interests amongst the stakeholders. Negotiations are games of give and take ingrained between and within various levels of society. Asymmetrical information, insufficient knowledge, low participation along with unequal power distribution, results in inequitable benefit appropriation from the local commons. This spreads a wave of disincentives for collective action and degradation of the natural resource bases are inevitable (Perez-Cirera and Lovett, 2006). However, the impact of power in CPRs management is very puzzling. Baland and Platteau (1996) argue that greater control over production factors, including control over labour, information and knowledge, provides incentives to contribute more time and efforts in CPR management, with beneficial effects for the entire community. However, in their subsequent studies, Baland and Platteau (1999) report that in pursuance of their private interests, powerful and influential members can and quite often do eschew adherence to rules, undermining collective action and sustainable use of resources (Perez-Cirera and Lovett, 2006). Nepal provides a fertile ground for investigating the impact of informal power that emanates from socio-economic heterogeneity and the mechanisms through which different property rights regimes are designed and implemented in managing irrigation systems can combat the growing inequity in water distribution.

Importantly, owing to unequal power distribution and differential access to and control over natural resources, the difference between resource-rich and resource-poor households is widening in relation to land ownership, water resources and a lower rate of participation in resource governance (Vaniya and Taneja, 2004). Furthermore, higher transaction costs incurred in the management of resources have immense implications for the welfare of asset-poor households (Adhikari and Lovett, 2005).

The concept of livelihoods has gained an increased currency amongst both the development practitioners and academics in recent years (Ellis, 1998, Batterbury, 2001; Chambers and Conway, 1992; also see Carney, 1998; Bernstein, 1992; Francis, 2000, 2002; Radoki, 2002). The livelihoods approach to understanding the welfare of the rural population concerns the links between individual or household assets and the different ways in which households have access to mediating processes, including institutions and regulations to make use of the asset profile in their disposition (Allison and Ellis, 2001). The concept of livelihoods has been defined by Chambers and Conway (1992) as:

"--- Livelihood comprise the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance if capabilities and assets, while not undermining the natural resource base---" (p.9)

The livelihoods of many farmers depend on the success of their agricultural practices, which in turn depends on the quality of the irrigation service. The success or failure of irrigation systems in meeting their objectives has a direct and immediate impact on the farmers' livelihoods. The welfare of many farmers depends on the success of irrigation systems, as its consequences are directly felt by the farmers in economic terms: poor irrigation service to his/her field plots results in reduced agricultural production and reduced income, and perhaps financial hardship and poverty.

This thesis uses the notion of livelihoods as defined by Chambers and Conway (1992) and argues that if policy interventions aimed at improving the livelihoods of rural poor widen the gap and maintain a rift (in terms of social, economic and power differentiation) between rich and poor households, the urgency for critical examination of power relations and sound understanding of differentiation is essential, while formulating policy interventions to support rural livelihoods and sustainable use of natural resources is necessary.

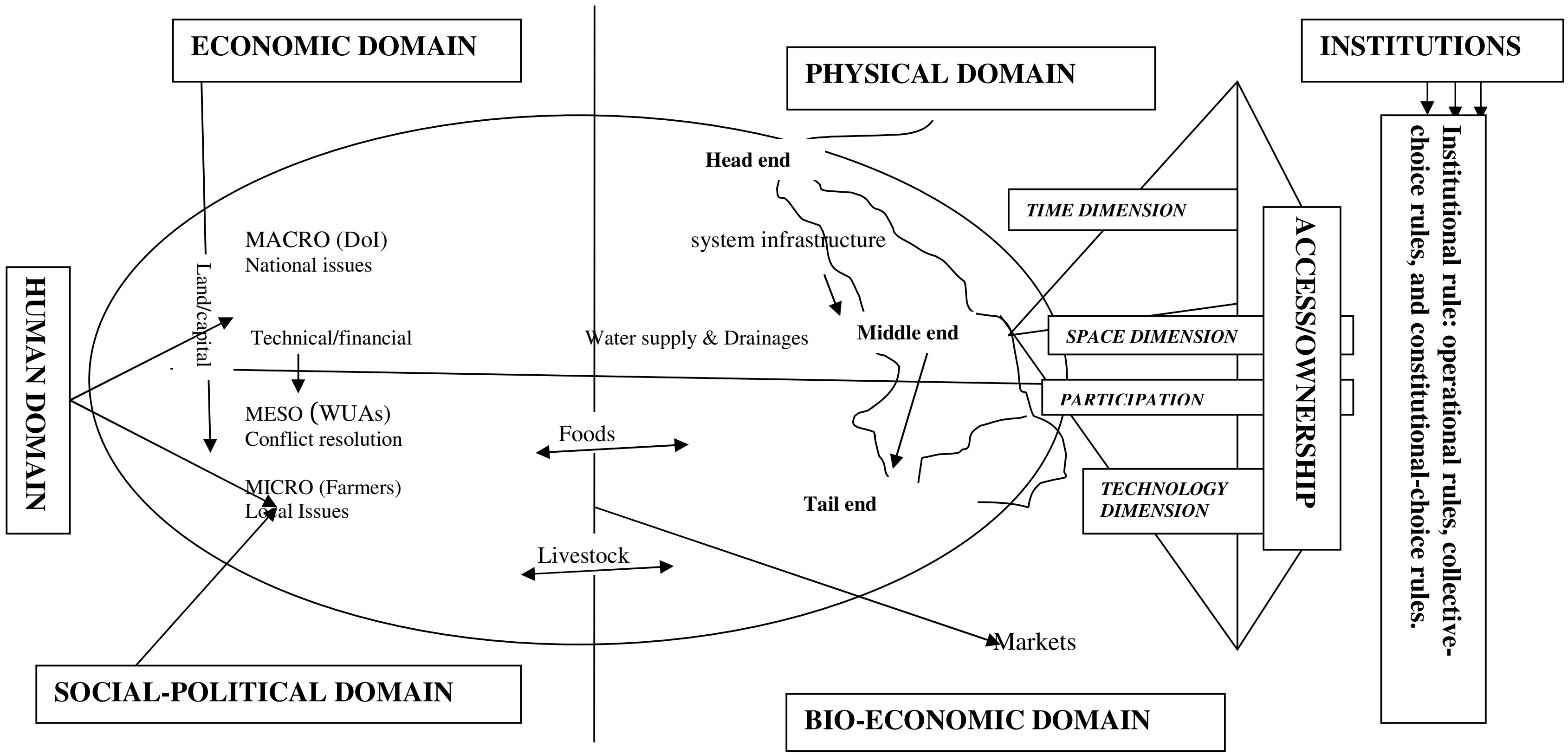
2.8 Interactive Domains in Irrigation Governance

In the previous sections in Chapter Two, we have reviewed the notion of property rights and their application in irrigation management. This section of the thesis proposes a model for access to water under different property rights regimes, focusing on different domains that the literature suggests have interactive effects on irrigation governance. In order to construct the theoretical model, this thesis combines the IAD framework presented in Chapter One (Section 1.10) and a model proposed by Chambers (1988) (with certain modifications to suit this research) to illustrate the nature of interactions taking place across the various domains. It is argued that irrigation governance encompasses complex interactions in different domains, including physical, human, socio-political and economic, presented in Figure 2.1 below.

The model presented in Figure 2.1 illustrates the different domains in irrigation management. Firstly, the physical domain includes canal infrastructure both at the main and branch levels of the canal. At the main canal level, the physical domain includes weirs, diversion dams, canal, gates, and water sources while the physical domain at the branch canal level includes water courses, fields, crops, field channels and so forth. Secondly, the bio-economic domain includes biological factor such as crops and economic factors such as input and O & M costs, production of CPRs, and the consumption and sale of the product derived from the CPRs. Thirdly, the model captures a human domain, which includes all interactions amongst individuals involved in the irrigation system both at a farming household level as well as the irrigation bureaucracy. Fourthly, irrigation management consists of a socio-political domain, which encompasses interactions amongst individuals and occurs in their social and operational structures, their interests, conventions and conflicts and resolutions.

The viability of irrigation projects are assessed primarily on the basis of their impact on the livelihoods of the beneficiary farmers. Although performance is taken as a yardstick for measuring the success of irrigation policies, performance based on an economic efficiency criterion alone does not necessarily represent the best and most accurate measurement of policy success (Wade and Seckler, 1990). While studies in the early 1990s have shown some useful insights into elucidating and measuring irrigation performance (Small and Svendsen, 1992; Svendsen and Small, 1990), little work has been done on measuring the access level of the farmers in the irrigation systems, especially in the context of property rights regimes.

Figure 2.1 Interactive Model of Irrigation Management



Source: Adopted with modifications from Chambers (1988)

In order to measure the performance of irrigation systems against set criteria, researchers have developed different indicators. The literature on irrigation performance indicators demonstrates common performance criteria, such as adequacy, efficiency, timeliness and equity (Molden and Gates, 1990; Bird and Gillott, 1992; Rao, 1993 also see Oad and Levine, 1985; Oad and Podmore, 1989). These indicators can be related to financial, economical, management and water delivery objectives, depending on the nature of the study (Tongongar *et al.,* 2008). The adequacy of water delivery in the canal system is defined as its ability to deliver the targeted quantity of water to the command areas (Molden and Gates, 1990), and is taken as a percentage ratio of the volume of water actually delivered to the volume of water targeted to be delivered. However, Clemmens and Bos (1990) consider adequacy of irrigation water as the percentage ratio of the volume of water available to the farmers to the volume of water they require for crop production. This indicates the relative amount of extra water the irrigation system needs to deliver for crop cultivation. Ideally, irrigation systems are trying to achieve this ratio as close to one as possible. If the ratio of the volume of water available to the farmers to the volume of water they require for crop production is between .89 and 1, then it is considered to be a good performance. Similarly, if the ratio is between .80 and .89, it is considered to be a fair performance of the irrigation system. However, if a ratio is less than .80, it indicates a poor performance of the irrigation canal (Molden and Gates, 1990). Data on the volume of water available to farmers can be obtained from the discharge rates, while the amount they require can be obtained from agronomic data, such as crop-water requirements and conveyance losses from seepage and evaporation.

Similarly, efficient use of water use is considered an important agronomic indicator of irrigation performance, particularly in areas with a limited water supply (Sinclair *et al.,* 1984; Howell, 2001). The efficiency of irrigation systems is measured as a percentage ratio of the required or targeted amount of water to the volume of water actually delivered. Efficiency indicators have two components: (a) water conveyance efficiency; and (b) water application efficiency (Majumdar, 2004). The conveyance efficiency is used to evaluate the efficiency of an irrigation system in carrying water to its destination, and measures the efficiency of the channels conveying water from the source to the field plots. The conveyance ratio is defined as the percentage ratio of the amount of water delivered to the fields to the amount of water diverted from the source. However, water application efficiency refers to the efficiency of water application to the field and measures how effectively the water is actually used by the farmers. It is defined as a percentage ratio of water stored in the crop root zone to the amount of water delivered to the fields (Rogers *et al.,* 1997). Other researchers, such as Bos (1979) and Tongongar *et al.* (2008) define the efficiency of irrigation systems as the percentage ratio of volume of water required for crop production to the volume of water available to the farmers for crop production. If the value of this ratio is more than 0.84, the system's performance is considered very efficient, while values between 0.7 and 0.84 and less than 0.7 are considered fairly efficient and inefficient respectively (Tongongar *et al.,* 2008 p.272).

Studies on the performance of irrigation systems argue that the reliability of a water supply is an important dimension in the performance measurement (Murrey-Rust and Snellen, 1993; Renault and Vehmeyer, 1999; Makadho, 1996; Oad and Sampath, 1995; Renault, 1999). The notion of reliability of a water supply is the degree to which water delivery conforms to the prior expectations of the users. It measures the predictability of the water supply from the canal system over time and spatial scale, assessing whether farmers receive the amount of water and at the time that they have been promised. The reliability dimension is particularly significant in areas where a water delivery service is well defined and agreed upon between the users and the WUA as the farmers' expectations would be the same as those agreed (Renault and Wahaj, 2003).

Similarly, equitable water distribution is also considered an important aspect of irrigation management. Equity is associated with fairness in distribution of resources as agreed by the members of the irrigation community. The notion of equity reflects the way in which the water resource is spatially distributed. It is defined as the spatial uniformity of the ratio of water delivered to the amount of water targeted (Majumdar, 2004), measuring variations in the relative water delivery from one location to another. It is suggested that good performance of an irrigation system in terms of its ability to distribute water equitably is indicated by a value of a ratio is 0 and 0.1, while a value greater than 0.25 shows poor performance (Sampath, 1990; Bird and Gillott, 1992). However, the current measures of equity only consider spatial variations in the distribution of water, and fail to consider how the water is distributed across different users.

Performance measurement has been a recurring agenda item in irrigation management and consequently a considerable amount of work has been undertaken in recent decades (Gorantiwar and Smout, 2005; Bastiaanssen and Bos, 1999, also see Appendix 1). For Lenton (1986), irrigation performance is the system's ability to achieve the established objectives. Likewise, Charles Abernethy describes irrigation performance as '*its measured levels of achievement in terms of one, or several, parameters which are chosen as indicators of the system's goals*' (1989 p.4). For Murray-Rust and Snellen (1993), performance measurement is the process of assessing the '*degree to which an organisation's products and services respond to the needs of their customers or users, and the efficiency with which the organisation uses the resources at its disposal*" (cited in Gorantiwar and Smout, 2005 p.3).

A number of common themes emerged from the literature, focusing on the performance of irrigation systems, which can be summarised as: (a) adequacy of the water supply in meeting crop growth in a given season; (b) timeliness of water delivery matching the crop growth stage and the expectations of the farmers;(c) fairness in water distribution amongst multiple water users (Abernethy, 1986; Chambers, 1988; also see Molden and Gates, 1990; Goldsmith and Makin, 1991). However, these irrigation performance indicators tend to be generated by engineers and agronomists and have an explicit technical focus. Apart from being overtly technical (which can make the indicators difficult for farmers to understand), farmers are denied the opportunity to assess the performance of their own irrigation systems. Also, good performance against these technical measures does not necessarily mean that farmers are satisfied with the level of service. The technical nature of the measures imposed on the farmers may also lead to resentment towards technical experts, increasing farmers' dissatisfaction and in turn limiting their participation in irrigation management (Lam, 1998). To measure and corroborate the conceptualisation of access, the thesis uses three dimensions of access, namely reliability, adequacy and equity, which are described in detail below.

2.9 Conceptualising Access: Objectivity and Subjectivity

It is becoming increasingly clear, that access to and control over natural resource bases helps to sustain livelihoods in the developing world. It is also clear from reviews in Chapter One (Section 1.7) and Chapter Two (Section 2.8) that there is a dearth of literature directly examining the performance of irrigation systems and access to irrigation water from the farmers' perspectives (Svendsen and Small, 1990). Although some 'subjective' studies have been carried out in the past which discuss the objectives and the management of irrigation development (Bottrall, 1981; Lethem and Ng, 1983; Levine and Coward, 1986), almost all of them assume the perspectives of the irrigation managers, with total disregard for the farmers who use the irrigation resources. However, one exception is an influential report by Douglas Vermillion on an Indonesian irrigation system which considers the perspectives of the local farmers in measuring irrigation performance (Vermillion, 1989). The study considered the changes in the design principles that farmers made in their irrigation systems, which helped to enhance their level of access to irrigation water. The study by Vermillion (1989) identified several of the farmers' basic design criteria, including water rights and equity, some of which have implications for the performance of irrigation systems. Access to the resource is closely related to property rights, as MacPherson posits: *"a right in the sense of an enforceable claim to some use or benefits of something"* (1978 p.3). However, access is a much broader concept than rights, as it is associated with the ability or capacity of an individual or group to claim benefits from the resources (Ribot, 1998). Having access to irrigation is not just about having rights to water from the canal system. Firstly, demand for water depends on the type of crop, type of soil, temperature and crop growing season, amongst other factors. The necessity for water depends on the season, as some seasons have more water from the Monsoon than others. Crops require a timely and adequate water supply to give maximum yield to the farmers. Thus, a reliable source of water, capable of delivering a timely and adequate supply, is crucial for crop cultivation. Also, access needs to be equitable, as inequitable water distribution creates waves of disincentives for the management of irrigation canal infrastructures (Perez-Cirera and Lovett, 2006; Hardin, 1968).

Although flow measurement has become the standard criterion for assessing irrigation performance, in rural settings flow measurements are often not properly accorded (Rao, 1993; Lankford, 1998; Horst, 1999 also see Palmer *et al.,* 1991; Faci *et al.,* 2000). Also, there are problems with measuring and monitoring of irrigation schedules (Goussard, 1996; Horst, 1996). Even if the data on flow measurements are available, the quality of the data cannot be guaranteed, particularly at the secondary and tertiary field channel levels. Reasons for this include: lack of data on water delivery; equipment malfunction; lack of desired equipment; and a lack of motivation on the part of staff to collect such data (Murray-Rust and Snellen, 1993). Furthermore, in the process of measuring access to water, some researchers use only one indicator, such as the number of hours spent in irrigating per week, whilst others choose several dimensions and combine them to form a composite index of access without explaining the rationale behind the variables considered (Lam, 1998). Whilst the use of a single indicator lacks comprehensiveness, an arbitrary choice of multiple dimensions as a measure of access suffers from methodological flaws such as omission of important dimensions, combination of irrelevant variables, inadequate representation of users' perspectives and excessive use of assumptions (Goussard, 1996; Horst, 1996). Both the above mentioned approaches pose serious concerns for the validity and reliability of not only indicators, but also of subsequent findings (Schmid and Klimoski, 1991).

In response to the dearth of literature on farmers' perception about the performance of irrigation systems, this thesis has taken a broader approach to access is adopted in this research. This thesis argues that any effort to evaluate the performance of irrigation systems should be based on a set of criteria set forth by the farmers who are using the irrigation system, rather than the irrigation managers and engineers, who do not necessarily appreciate the needs of the local farmers (Chambers, 1988 p.30). Shivakoti (1991) concurs with Seven and Small (1990) in outlining the usefulness of farmers' perceptions in evaluating the performance of irrigation systems. He argues that irrigation managers can better understand and accommodate farmers' behaviours and attitudes towards their irrigation canals when they understand their perceptions about the irrigation canals (Shivakoti, 1991 p.18).

Since the farmers who use the irrigation system for water are the consumers of the irrigation services and the producers of the agricultural output which the irrigation systems aim to achieve, the performance of irrigation systems should be measured and evaluated on the basis of farmers' experience. As Chambers (1988) argues "*a good irrigation system, for a farmer, is the delivery to his or her farm, of an adequate, convenient, predictable and timely water supply for their preferred farming practices"* (p.31). Therefore, the use of farmers' perceptions for measuring the performance of irrigation systems is critical.

As described above, access is traditionally defined by distinct but related components - reliability, adequacy and equity and this thesis also adopts these measures to assess the household level of access to irrigation water. The following section presents a detailed treatment of the issue.

2.9.1 Reliability

Whilst the measurement of reliability, particularly its objective measurement, was briefly introduced earlier in this Chapter in Section 2.8, this section describes the notion of reliability used in the context of this thesis in detail. Conceptually, reliability is understood as the ability of the irrigation system to deliver a water supply as scheduled to meet the crops demand and produce optimal plant growth. Reliability is defined as the ratio of the amount of water actually supplied in the field plots to the water required or the scheduled supply. In this sense, reliability is a function of the predictability of water supply, i.e. the timeliness of the water supply in the canal (Makadho, 1996). It measures the confidence in the irrigation system to deliver water from the source to the field plots, where it is ultimately utilised for crop production. On the one hand, a reliable water supply minimises the risk of crop failure and on the other, it helps to design proper schedules of farming operations in order to achieve optimum crop production. A reliable water supply is critical not just for crop production, but also for enhancing users' participation in irrigation management and irrigation related activities, including the O & M activities. The level of collective action on the part of the irrigators depends on the expected pay-off from the resource base; hence, the collective action decreases with unreliability in the water supply and often leads to hostility towards the entire irrigation project because the water supply in the canal is not only unpredictable but also scarce (Howarth, *et al.,* 2007; Ostrom, 1990).

2.9.2 Adequacy

Previous studies on irrigation performance have identified the adequacy of the water supply as one of the important measures of performance of irrigation systems (Van der Meer, 1971; Molden and Gates, 1990; Bird and Gillott, 1992 and Rao, 1993). In particular Van der Meer (1971), in his studies of Taiwanese rice irrigation argues that the adequacy of a canal irrigation system can be assessed by using farmers' perceptions: *"farmers stole water because they could not get as much as* *they needed and wanted at convenient times --- [or] because they believed their fields had not received their due according to the water rights customs"* (cited in Svendsen and Small, 1990 p.393). Adequacy measures the deviation of actual water supply from required water supply measured by the crop's water requirements (Makombe *et al.,* 1998). Measured as the ratio of the amount of water actually supplied in the field plots to the water required for crop growth, adequacy assesses how well the irrigation service requirements are met both in time and space by the irrigation scheme. The adequacy measures take account of a variety of users' farming needs including farming operations and land preparations (Oad and Sampath, 1995). It is important to acknowledge that irrigation systems may have a reliable water supply, but may not have an adequate supply, and vice versa. Farmers might prefer reliability to adequacy in water supply because with adjustments in the amount of land cultivated, farmers can avoid crop failure through a reliable supply of water.

2.9.3 Equity

Equity concerns fairness in water distribution. It measures the access to a fair share of the water resources according to the amount specified by water rights (i.e. actual water supply to users in relation to their allocated water share). Equity is difficult to measure, not only because it is a subjective concept but also because of wide variation in water rights systems. A farmer's water share depends on water allocation rules set forth by the WUA concerned. Four bases for assignment of water rights are commonly discussed in the literature. These are: (i) *Equal division*: all households that are members of the irrigation group receive equal water share for example, the Balinese *subak*. (ii) *Proportional to land-holding size*: households receive a water share proportional to the size of their land-holding, for example, the Nepalese *Raj Kulo (*Yoder, 1994*)*. (iii) *Crop water requirements*: water shares differ according to the water requirements of the different crops grown, for example, the Spanish *heurta* (Maass and Anderson, 1978; Carruthers and Clark, 1981). (iv) Water *markets*: finally, water shares are fully or partially disassociated from these underlying bases if a market exists in water shares, for example the Sri Lankan *pangu* (Leach, 1980). It is important that equity is not confused with equality. Equality refers to conditions where all farmers are equal in the face of either abundance or shortage of water, regardless of landholding size (small/big), location (head/tail), and castes (the *dalits*/higher castes).

2.10 Factors Influencing Farmers' Level of Access to Water

This section of the thesis describes the factors identified in the literature that are likely to influence the farmers' levels of access to irrigation water. These are identified and described based on the literature as well as in the Nepalese context. The literature suggests that complex social, organisational, legal, technical, socio-political and cultural interactions influence farmers' levels of access to irrigation resources. Given the nature of the resource base, irrigation water in this case, a multidimensional approach is used to investigate farmers' levels of access to irrigation water. This thesis incorporates both user characteristics and resource characteristics into the model to understand the impact of different variables on access levels. Dimensions such as seasons, space (location), terrain and technology, socio-economic status, power relationships, political links, agronomical knowledge (crop-water requirement), participation, simplicity of governing rules and enforcing mechanisms are all considered. As discussed earlier in the thesis (Section 2.5), the variables described below represent different types of heterogeneities existing in rural Nepal which this thesis assumes to have implications on the households' ability to access water from the canal systems in rural Nepal.

2.10.1 Caste and Social Stratifications

Social stratification continues to be one of the most prominent features of social structures in many developing countries. In a broader sense, social stratification is conceived as the horizontal division of society into higher and lower social units (Murray, 1950). Stratification denotes differentiation of a given population into hierarchically superimposed classes. In the process of stratification, the dominant or hegemonic group allocated social position to individuals or groups depending on the superiority or inferiority of occupation that they undertake (Gisbert, 1973). In due course, the very social stratification became the essence of unequal distribution of rights, privileges, power, duties, responsibilities and other social values (Bhusan and Sachdeva, 2003).

Of many forms of social stratifications, the caste system presents the most complex, socially ingrained and religiously indoctrinated and orthodoxy differentiation of individuals into higher and lower social units, where occupation of a clan is treated as superior, equal or inferior, relative to one another, in socially important respects. The Hindu caste system is often conceived as a 'status system' based in a segmentary social structure at *the lineage level and below, and fissile in a different way at the level of endogamous and commensal groups* (Stevenson, 1954 p.23). Based on Hindu mythology, there are two kinds of status – secular and ritual, which are derived from different sources and socially manifested in different ways. The secular status of individuals within the groups, or sometimes the groups themselves are variables which are determined by such factors as occupation, skills, education, wealth, landholdings, and marriage outcomes. However, in contradiction to the secular status, the ritual status is derived from the relationships of individuals within a group or between groups, particularly with respect to a pattern of interactions based in myth, which themselves are assumptions based on purity and impurity, which scholars have dubbed 'Hindu Pollution Concept' (HPC) (Douglas, 2002). There are secular as well as religious interpretations of the idea that human life is sacred, based on religious scripts particularly the *Rig Vedas* which divides the Hindus into two dichotomous groups i.e. good sacredness and bad sacredness (Shrinivas, 1952; Milner, 1994).

The Nepalese society is divided into four mutually exclusive, exhaustive, endogamous, and hereditary and occupation specific *Vernas* (castes). These are *Brahmin*, *Chhetria*, *Baisya* and *Sudra*. However, some literature suggests that, in the beginning, only three castes existed, namely Brahmins, Chhetria, and Baisyas. Similarly, India was reported to have four castes in the beginning but later added another caste called ati-sudra (Deshpandey, 2000). The allocation of castes was based on the special assignments with which the clans or families were entrusted. The principle responsibility of the Brahmins was to act as *Guru* (teachers, purohit, pandits or priests) whose primary job was to perform religious functions. The Brahmins were considered religiously superior and possessed numerical supremacy over other castes and were ranked in the highest position in the caste hierarchy (Regmi, 1988). The main responsibility of the *Chhetria* was that of warrior and they were involved in governing and providing security to the state in the face of invasion. Thus even in the modern Hindu societies, the rulers (kings) are from the *Chhetria* caste. Interestingly, almost all of the national heroes of Nepal are from *Chhetria* castes. These have received the highest honours for military gallantry. Many *Chhetria* men are employed in the Nepalese, Indian and British armies. In the British army, they are popularly known as the *Gurkhas*. The responsibilities assigned to the *Baisyas* were of a commercial nature and they were involved in commercial activities of management and supply of food and other necessary goods to the palaces, civil servants, military men and other people (Poudel, 2000). The Sudras were assigned menial tasks such as tailoring, cobbling (working with leather) and as smiths (working with iron or ornaments). Since the Sudras undertook menial work they were ranked in the lowest position in the castes hierarchy. The Sudras are also called the occupational caste groups i.e. the *dalits* or untouchables.

As mentioned earlier, the principle upon which the entire caste system is based is the logic of religious purity and pollution (Hutton, 1946; Srinivas, 1952) and the tasks assigned to the *dalits* (*Sudras*) are considered to be ritually polluting to merit inclusion within the traditional *Verna* system and continue to face social exclusion. Although Nepal has committed to various international, legal and constitutional treaties, social discriminations are still evident in many sectors of the Nepalese society. Numerous studies in the past have shown that discriminations are extensive in the fields of caste, ethnicity and gender throughout numerous locations in Nepal (Dahal *et al.,* 2003; Bhattachan *et al.,* 2002; Subba *et al.,* 2002; FWLD, 2000).

An important feature of the caste system is that the *dalits* are considered to be 'untouchable' and they face a multitude of disadvantages in land endowment, socio-economic marginalisation, political participation and employment opportunities (Lawati, 2005). This practice systematically excludes the *dalits* from access to markets, particularly in dairy products. Pervasive landlessness amongst the *dalits* has meant that they have limited access to credit from local micro-finance schemes and banks, which are absolutely vital for initiating extra-farming activities including purchasing fertilisers and the credit needed for repairing sub-canals leading to their plots.

Also, the *dalits* are mostly *sukumbasi* (landless) or land-poor if they have any land, and live in the rural areas known as *khorias* (unproductive and rainfed areas) and public land. Understandably, this sector of the population represents a significant proportion of the population in poverty (NPC, 2002). Although efforts to alleviate poverty and to maintain the sustainable use of natural resources (irrigation in this case) through the involvement of local communities have demonstrated some success, the *dalits* and indigenous communities continue to face challenges, particularly because of landlessness and land poorness. The benefits from irrigation development accrue to landlords and land rich households, which are usually, but not always, from higher caste groups, while associated negative externalities are born by mostly landless and land-poor households. The problems of externality have come to greater prominence in recent years, particularly because of the concern about the link between the economy and the environment. Externality is defined as a third party or spill-over effect both intended and unintended, arising from the economic activities (production and/or consumption) of goods and services by individuals or firms on other individuals or firms for which no appropriate compensation is paid (Begg *et al.,* 2008). The problems of externality occur when the private costs or benefits to the producer or purchasers of goods and services are different from the total social costs or benefits incurred in the process of the production of goods or services (Coase, 1960). Externality can be both positive and negative. For example, loss of livestock to the canal and the effects of damp in houses and the surrounding area are commonly reported by the *dalit* households who are not necessarily benefiting from the canal. Furthermore, the opportunity costs associated with engagement in irrigational maintenance tasks are higher amongst landless and land poor people (Upasena and Abeygunawardena, 2009; Ray, 2002; Gonzalez-Alvarez *et al.,* 2006). For example, farmers with small amounts of land contribute towards cleaning the canal, but the benefits they obtain would be less compared to the amount of money they would earn if they undertook waged labour elsewhere. Aggregation of all these factors has meant that the social equity aspects of irrigation development are seriously questionable.

2.10.2 Size of the Landholding

In many agrarian societies, landholding is considered to be a vital asset for generating income and employment. In Nepal, the amount of land held also reflects the economic and socio-political status of the households in the community. The customary practice is that households with larger landholdings are respected, feared and often act as judiciary arbitrators in village settings. The rural areas of Nepal host almost 90 percent of the country's total population, where the quality and size of landholdings remains a crucial determinant of both status and power (Karki, 2002). Both the quality and quantity of landholding is considered critical for rural households to sustain livelihoods and a secure food supply. Nepal demonstrates a highly skewed land distribution. Evidence suggests that households with large landholdings have a higher amount of better quality *Khet* land which is productive and accessible to irrigation facilities, compared to the households with small landholdings (Seddon and Hussein, 2002). Land distribution also exhibits considerable gender differences, with households headed by men having almost double the landholdings of female-headed households. Equally important, a noticeably skewed distribution of landholdings can be observed among groups from different castes, as the landholders from higher castes have more than double the amount of *khet* and *pakho* lands (not irrigable) compared to farmers from *dalit* communities (Goyal *et al.*,2005).

It is well established that the incidence of poverty in Nepal is much higher amongst the landless and marginal farmers than amongst those with medium and larger landholdings (NPC, 2004; Karki and Seddon, 2003). This thesis uses the internationally accepted definition of poverty, which is 1.25 US dollar at 2005 purchasing-power parity (PPP) used by major international organisations such as the World Bank, the United Nations and the International Monetary Fund (IMF) (Ravallion *et al.*, 2009). The incidence of poverty amongst households with less than one hectare of land is about fifty percent (*ibid*) and this section of the population comprises more than two-thirds of the rural households in Nepal. The prevalence of higher incidences of poverty amongst the marginal farmers is attributed to lower access to agricultural inputs, including irrigation water, chemical fertilisers, high yielding varieties and credit arrangements. In Nepal, the rural households with large landholdings dominate the local power structures and influence government policies and programmes at the local as well as central level. These traditional elites who have control of large landholdings have maintained their dominance in society, legitimising their influence through the institutions in rural parts of Nepal (Brown and Kennedy, 2005).

This thesis assumes that the large landholders have more participation in irrigation governance, particularly in the AMIS and have better access to and appropriate more benefits from the irrigation canal. However, in development discourse participation has been an over-used and under-specified concept and its conceptualisation in the context of this thesis is important to bring "*clarity through specificity*" (Cohen and Uphoff, 1980 p.2). Literature on participatory development has formulated different models of participation depending on the degree of engagement in the management of natural resources and the capacity in which those engagements take place (Lilja and Ashby, 1999). The typology of participation is based on the assumption that differences in who makes the decisions will result in differences in what decisions are made. Although relatively old, Arnstein's (1969) "*ladder of participation*" has a contemporary relevance not least in the context of this thesis. The ladder of participation classifies the nature of participation into three categories; namely, citizen power, tokenism and non-participation. The citizen power remains at the top of the ladder in which the user group is empowered as they either take full control of development interventions or work in partnership with the external agency. Tokenism on the other hand represents situations where the users are only involved in consultation or are merely informed about the decisions taken by the external agencies involved in development interventions (World Bank, 1996b). Tokenism is characterised by "*functional participation*" (Rudqvist and Woodford-Berger, 1996) or passive participation, which is designed to meet project objectives at reduced costs. As such, tokenism represents situations in which the users do not have decision power and fall victim to the manipulation of the external agencies. The non-participation remains at the bottom of the participation ladder in which the users are mere passive recipients of the development interventions.

Similarly, Jules Pretty (1995) proposes a five tier model of participation based on the capacity in which the users participate in development interventions. Firstly, manipulative participation in which participation takes place in the form of representation through unelected board members with no real power for the local users. Secondly, passive participation which represents situation in which the users are informed of the decision already made without any consultation. Thirdly, participation by consultation involves a process where the external agencies define problems, gather information on project impacts and control analysis, whilst the users are only consulted by the external agencies and there is no mandatory obligation to take users views in consideration during interventions. Fourthly, the users are asked to take part in the project interventions so that the external agencies reduce project costs and meet project objectives which are pre-determined - a functional participation. Fifthly, participation can take place in a dynamic and interactive fashion in which the users in all aspects of development interventions; including problem identification, development of action plans and decision making. Sixthly, participation can also take place in the form of self- mobilisation in which the users participate by taking local initiatives independently and are involved in all stages of development interventions.

2.10.3 Location of landholding

Irrigation water demonstrates the inherent characteristics of a CPR, i.e. its competitive and non-exclusionary nature (Ostrom and Gardner, 1993) and it is usually managed by groups of individuals communally. At any time, there is a finite flow of water in the canal system, which is being accessed by multiple users. Withdrawal of water from an irrigation canal means that there is less water for others to use. Once an irrigation system is in operation, it is very difficult to exclude users from its benefits, particularly when property rights are not well defined. Also, the non-stationary nature of irrigation water and its demand at crucial times (for example, transplanting) poses added complexities. The heterogeneity in the spatial distribution of resource units gives rise to *assignment problems* (Ostrom *et al.*, 1994 p.11). The heterogeneous distribution of resources are characterised by a 'patchy' environment in which the patches may have significantly different levels of resource availability. For example, in common fisheries some locations 'hot-spots' have higher stocks while the 'cold spots' have very little stocks (McGoodwin, 1995). Similarly, the spatial distribution of water in the canal system demonstrates assignment problems, as the households with landholdings adjacent to the irrigation canal have direct access to water while the landholdings towards the tail end of the canal have indirect access. The farmers with landholdings at the head end of the canal naturally have locational advantages over the farmers with landholdings at the tail end of the canal. The spatial location of the landholding is assumed to have influence on the household access to irrigation water. Even the position in which the outlet is constructed in a plot will determine which landholdings will get the water next.

The natural locational advantage enjoyed by the farmers at the head end of the canal not only has differential economic outcomes but also has implications for collective outcomes, due to different levels of incentives among head and tail end farmers (Bardhan 1984; Ostrom, 1994; Johnson and Libecap, 1982). In the absence of appropriate institutional arrangements to design and implement property rights, and monitoring mechanisms for controlling fraud, many complex problems arise while managing local commons including irrigation systems.

2.10.4 Gender

A considerable body of feminist literature argues that there is a natural and essential connection between gender and nature, giving women an innate understanding of ecosystems and environmental protection (Diamond and Orenstein, 1990; Shiva, 1988; also see Mackenzie, 1995; Rocheleau *et al.*,1996; Schroeder and Suryanata, 1996). Others argue that it is the material practices that bring women closer to nature and which give them learned and practical knowledge of ecosystems (Agarwal, 1992; Warren, 1987). Many political ecologists have embraced a historical-materialist argument and focused on gender as one relationship through which access to and control over the distribution of natural resources is differentiated within societies (Carney, 1994; Fortmann, 1996; Freidberg, 2001; Gururani, 2002).

This thesis assumes that the WUA is often dominated by elites and traditional decision makers, which mostly include male members of the community. Women are often not included in the WUA committees which influence irrigation management decisions (Van Koppen, 2002). However, in many developing countries, including Nepal, a significant proportion of women engage in agricultural production and irrigation but are subordinated to males who control the production process and its outcomes (Safiliou, 1988). A study from South Asia reports that households with females as heads are often poorer than those with males and similar results were found in male-dominated irrigation systems studied in Pakistan, India and Sri Lanka (Hussain, 2005).

The Nepalese society is characterised by the dominance of the male not only in decision- making outside the household but also in household decision- making. The household heads who are usually male hold land disposal rights, control household income/expenditure and make decisions on behalf of the family members (Adhikari, 2003). The male members of the household also take part in meetings and village level discussions of public interest. Hence, male heads of households are more likely to be aware of and have knowledge about irrigation issues. The males are also the individuals who make the decisions on behalf of all family members and decide on the livelihood activities in the family (Thapa, 2009). Thus their decisions have major implications for the welfare of the entire family. Since the Nepalese society is male dominated, access to and control over productive resources such as land is dominated by males with no decision making powers accorded to women. The lack of decision making power provided to women has meant that their ability to influence policy making in irrigation governance is severely constrained and leads to a lower level of access to irrigation water (Valentine, 2007; Zwarteveen; 1997).

2.10.5 Human Capital: Agronomical Knowledge of the Local Farmers

Research shows that human capital such as farmers' agronomical knowledge has implications for the way in which irrigation water is used and the issue warrants some discussion, since it has implications for sustained head-tail inequalities in irrigation water (Samakande, 2002; Chambers, 1988). Although the government and donor agencies have made significant contributions in the construction and rehabilitation of many irrigation systems in Nepal, virtually no efforts have been made to educate farmers on the issue of on-farm water management. The high level of importance attached to the 'hardware' side of the irrigation management has overlooked the much needed 'software' side (Shivakoti and Bastakoti, 2006). The level of investment in irrigation infrastructure has not been supplemented by social initiatives from the WUAs to educate farmers and raise social awareness of the importance of scientific ways of using the water from the canals.

The lack of such training and awareness amongst the farmers about on-farm water management has meant that they are unable to design practical solutions to the problems of excessive water utilisation for agricultural purposes, which add to the already existing problems associated with water scarcity (Wolff and Stein, 2003; Abu-Zeid, 1979). The farmers also lack knowledge as to the amount of water required by particular types of crops and the frequency with which the crops need to be irrigated. The lack of proper management and planning by the WUA and the lack of awareness amongst farmers about the scientific procedures in using irrigation water have implications for water availability and water distribution (Wolff and Stein, 1999).

In rural farming communities, farmers commonly believe that changing water used for paddy irrigation leads to the production of better grain. Farmers at the head end often replace paddy plots with fresh water for a better quality harvest, being unaware of the salinity problems associated with excess irrigation. Water logging and salinity are two problems related to the productivity of land that often occur together. Previous studies have shown that salinity costs the world's farmers US$11 billion per year in lost income (Postel, 1999). The positive influence of farmers' agronomical knowledge and their reported level of access to water have huge implications for policy circles. Similarly serious implications follow for irrigation governance and ensuring equitable access to water as farmers are often following unscientific water appropriation practices based on blind faith. For example, the water replacement for paddy at the head end area with total disregard to the water shortage at the tail end could be avoided by educating the farmers. It is well recognised that increasing the knowledge of society and consumers is effective in agricultural water management (Pereira *et al.,* 2002). Also, access to information such as crop water requirement has an equity dimension as some members of the community are in a better position to know about such issues than the others. For example, educated farmers can read leaflets produced by the agencies managing irrigation systems, whilst those uneducated farmers may lack that opportunity.

2.10.6 Communal Social Capital: Level of Trust

The degree to which irrigators co-operate with each other is influenced by many factors, including social capital (Ostrom, 1990; Putnam *et al.,* 1993). Among other factors influencing the emergence of a co-operative solution, a 'continuity over time of relationship' between irrigators (Axelrod, 1984), 'efficacy of incentive mechanism' (Ullman-Margalit, 1978), 'social and political inequalities amongst individuals' (Boix and Posner, 1998) and 'group identity' (Akerlof and Kranton, 2002) remain commonly cited. Similar to other forms of capital (including natural, human and cultural), social capital is an important form of productive capital, enabling achievement of certain ends that would not be attainable in its absence.

Social capital is defined and measured in terms of social integration, individual interaction or generic sharing of social values such as "*participation in the local community, pro-action in social context, feelings of trust and safety, neighbourhood connections, connections with family and friends, tolerance of diversity, value of life and work connections*" (Woolcock and Narayan 2000, p.241).

Trust is an important form of social capital, not only at an interpersonal level but also at an organisational and government level, because it lubricates co-operation (Putnam, 1993; Levi, 1996). Kenneth Arrow argued that, *"-- virtually every commercial as well as non-commercial transaction has within it an element of trust; certainly any transactions conducted over a period of time. It can be plausibly argued that much of the economic backwardness in the world can be explained by lack of mutual confidence--"* (1972 p.172).

Similarly, highlighting the necessity of trust, Putnam *et al*. (1993) argues that, 'there can be no certainty in contract and hence no force to law and society and in the absence of trust, society is reduced to a state of semi-savagery'. In many societies, trust is considered an important form of moral resource (Hirschman, 1984). With increased trustworthiness, an individual not only enhances his/her credibility but also puts some form of moral pressure on others to become trustworthy. Equally important, by enhancing one's trustworthiness, individuals build up a reputation and by engaging in interaction, he/she takes on board other individuals to engage in mutually co-operative endeavours. It is assumed that a group composed of members with a high degree of trustworthiness on one another will be able to accomplish much more than a comparable group lacking that level of trustworthiness (Hirschman, 1984). Putnam *et al.* (1993) exemplifies the importance of trust in a farming community argues that "--*a farming community, where one farmer got his hay baled by another and where farm tools are extensively borrowed and lent, farmers' crop irrigated by lending him water during his turn, the social capital allows each farmer to get his work done with less physical capital in the form of tools and equipment---*" (Putnam *et al.,* 1993 p.167). In fact, trust helps to invigorate social interaction by establishing interdependence amongst individuals. It helps to establish a norm of reciprocity and inter-dependence in a network of civic engagement amongst individuals of groups. Indeed, a whole range of expectations and relationships arise in the presence of trust, as proponents of social capital argue "*Trust also plays a pivotal role for individual or group to abide by rules which in turn creates some kind of expectation that others will also follow the rules*" (*op.cit.* p.79).

2.10.7 Simplicity of Rules Governing Irrigation System

Oftentimes, management of natural resources requires appreciation of complexity and uncertainty inherent to the resource base in question (Lee 1993; Rolling and Wagemakers 1998). Also, the participation of different stakeholders is critical as "*success is more likely for collective action as the social learning process which takes place among different stakeholders*" (Pinkerton, 1994). Management of local natural resources and the actions of the users are regulated by a well developed set of rules (Ostrom, 1990). Rules are seen as the core of human actions, including that of managing natural resource bases such as irrigation systems. It is absolutely necessary for users to be acquainted with the rules and regulations governing their natural resources for them to comply with them fully.

The WUA can make stakeholders aware of the rules and regulations that govern their irrigation systems through different processes of interactive learning. The involvement of the WUA in organising social awareness regarding their irrigation system helps to 'enhance common knowledge, awareness and skills by thinking, discussing and acting together" (Borrini-Feyerabend *et al.,* 2000 p.12). Simplifying rules through public awareness not only helps in the understanding of the rules and regulations that guide the terms of farmers' compliance in resource management, but also fosters a high degree of commitment to a process of mutual learning in which irrigators agree to achieve collective outcomes (Wondolleck and Yaffee, 2000 p.132). In the co-managed irrigation systems, deliberations by the WUA creates an interface between local farmers and other agencies involved in managing irrigation systems through communications, collective consideration of issues and increased understanding of the rules and regulations. Simplifying rules through social deliberations:

"---- *allows people to discover latent public values that they have in common with others, and in the process to create new public values. Together, citizens begin to define targets of voluntary action, to identify what they value most about the community, and to uncover goals and commitments that transcend their narrower self-interests*" (Reich, 1985 p.1637).

2.10.8 Shape and Canal Gradients

This thesis assumes that that the physical characteristics, including the shape of the canal, influence farmers' access to water. Research in India has found very clear evidence that the physical status of the system has contributed to the water deprivation of the tail-enders (GoI, 2003). In Nepal, irrigation canals are of different shapes depending on the geographical/topographical locations in which they are based. Also, the shape of the canal depends on the distance between the water source and command area and the terrain through which the water flows in the canal to reach the command area. In many hilly areas, irrigation canals are extremely elongated and stretch along steep hill slopes. The longer the distance between the water source and command area, the more the canal will be elongated. The canals are located in very difficult terrain and are prone to damage by landslides, which are frequent in hilly areas. Also, frequent operation and maintenance is required to secure the undisturbed flow of the water in the canal. Plus the seepage rate through those canals running along the steep slopes is very high, which reduces the amount of canal reaching the tail ends (Higgins *et al.,* 1988). Since the irrigation systems in Nepal lack proper drainage facilities, the seepage not only creates water shortage at the tail end, but also causes water-logging and salinity problems in the field plots (Depeweg and Poudel, 2003; Perry and Hassan, 2000).

In Nepal, many irrigation systems in the mid-hills follow similar gradients to that of the source rivers which are feeding the canal systems. The construction of the canal with a gradient similar to that of the source river reduces construction costs because the canal systems do not require pumps and high bridges (Regmi, 2007). Instead, water finds its own course along the river gradient. In the mid-hills of Nepal, there are two types of irrigation system which include those flowing North to South and those that flow East to West or West to East. The canals flowing from North to South have steep gradients while the canals flowing in East to West have a milder gradient. The canals flowing in East to West mostly irrigate a flat river basin, and the canal maintenance efforts are lower and relatively easy (Benda-Beckmann, *et al.,* 2000). Therefore, the shape and the gradient of the canal are assumed to have implications for farmers' levels of access to irrigation water. A detailed description of the physical nature of the irrigation canals considered for this research is presented in Chapter Three.

2.10.9 Competitive Use of Irrigation Water

The demand for water has been increasing all over the world for agriculture and urban and industrial use. Nepal is no exception. However, water stress is felt worldwide, because of the increasing demand caused by population growth and a falling supply as a result of climate change. The Global Water Partnership concluded that "*On the one hand, the fundamental fear of food shortages encourages ever greater use of water resources for agriculture. On the other, there is a need to divert water from irrigated food production to other users and to protect the resource and the ecosystem. Many believe this conflict is one of the most critical problems to be tackled in the early 21st century*" (FAO, 2000, p.58).

Evidence across the world demonstrates that irrigation water supplies also provide water for many uses beyond crop production. Some of the areas where irrigation water has been needed include domestic use, fisheries, livestock use and for the wildlife habitat. Although the multiple use of water is good, it might create competition for water use particularly during times of water scarcity. Farmers tend to use water not only for agriculture purposes but also for house construction and brick factories which are in clear contradiction to agricultural use of irrigation water. This creates resentment amongst farmers who face water shortage for agriculture purposes.

This section of the thesis has identified the key issues in the literature pertinent to household access to irrigation water and these issues form the basis of the empirical enquiry in the analysis chapters later in the thesis (Chapters 4-6). The variables used include both household characteristics of the sample, communal characteristics and resource specific characteristics. The purpose of such description right at the outset is to provide readers with an opportunity to familiarise themselves with the context of the thesis. This will enable the reader to understand the socio-economical and cultural landscape in which the management of irrigation systems takes place in Nepal.

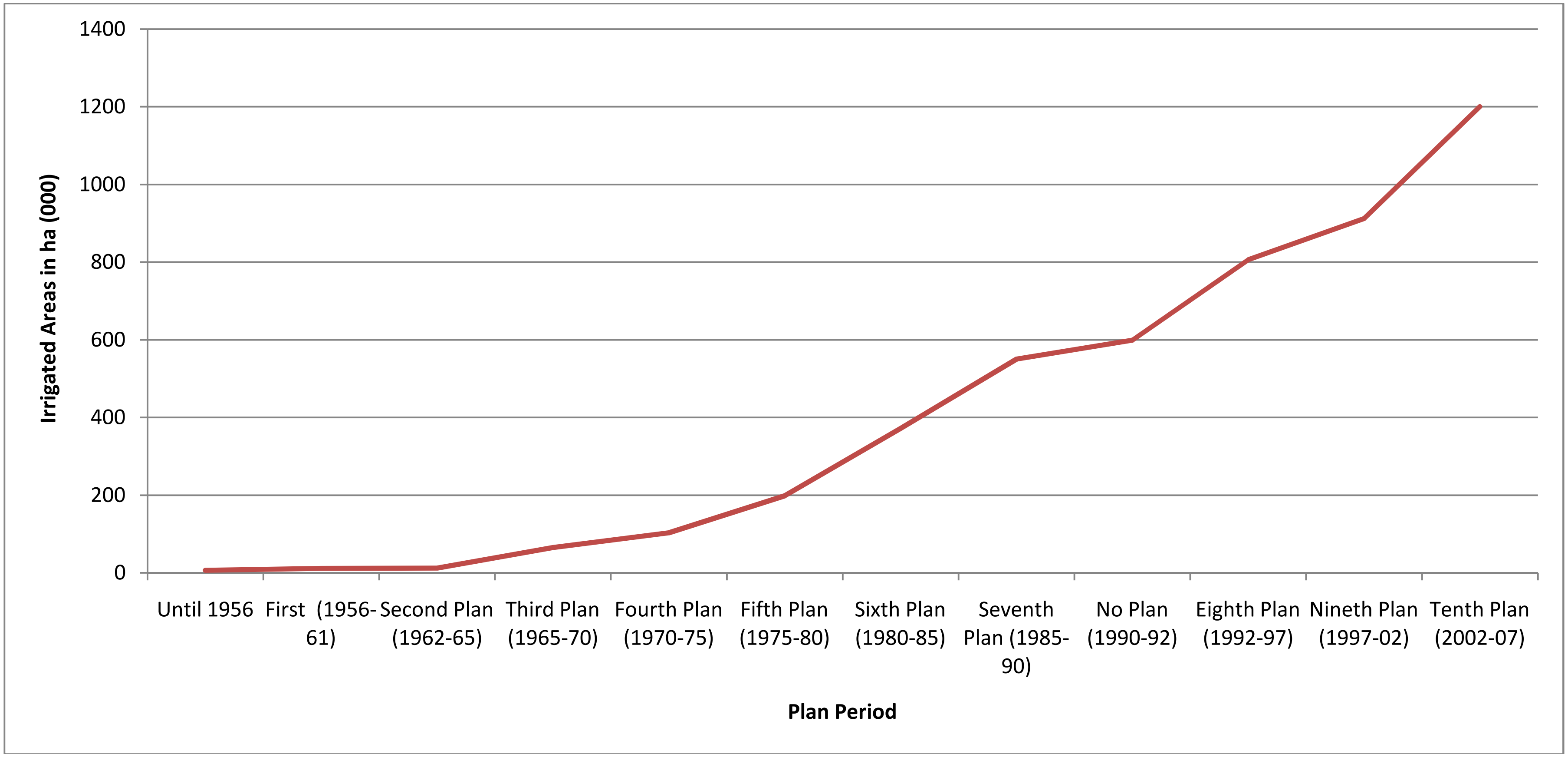
2.11 An Overview of Irrigation Policies in Nepal

This section of the thesis presents a brief discussion on the policy formulation and changes at national level. This is done to familiarise readers with the context within which this research took place.

Figure 2.2 below shows the expansion of irrigation facilities in different Five Year Development Plans in Nepal. It is clear that the irrigated land continues to grow steadily. Although Nepalese farmers have practised irrigated agriculture for a long time, the rapid increase in irrigation facilities did not start until 1956 when the planned development mechanisms called the Five Year Plans were introduced. Until 1956, Nepal's total irrigated land was just over 6000 Ha. Different policies have been designed and implemented for the development and maintenance of the irrigation systems in Nepal.

The emergence of water resource policies in Nepal dates back to the Civil Code of 1853 which was the first comprehensive statutory law in Nepal (Khanal, 1982). It established the rights of people concerning the use of water owing to their land being located in the irrigation system. Some specific provisions were made for the utilisation of water for irrigation. While the ownership of land within an irrigation system provided individual rights for the use of water, it also made provision that irrigation systems diverting water from the rivers would have prior rights and that new systems must get approval from the

Figure 2.2 Trend in cumulative Land Irrigated in Nepal 1956-2007



Sources: Five-Year Plan documents, HMG (1988), *Irrigation Master Plan, DoI, 2007* users of the irrigation system already in operation. The first attempt to make a specific law for the water sector was the Irrigation Act 1961. This was replaced by the comprehensive Canal, Electricity and Water Resources Act 1967 which introduced the concept of water tax and licensing for water use, although licensing was only implemented for the use of water in hydropower generation. After the introduction of the Basic Needs Program (BNP) in 1987, the working policy on irrigation development for the fulfilment of Basic Needs was formulated early in 1989. This was immediately followed by the promulgation of the Irrigation Regulations in April 1989, which placed emphasis on the greater collaboration of water users in all phases of irrigation projects; including planning, construction, operation and maintenance.

Water regulation in Nepal consists of customary rights and statutory laws. The previous centralised system of governance primarily satisfied the interests of ruling elites rather than those of the producers, traders and consumers. With the restoration of democracy during 1990 there has been a shift towards community participation and private sector involvement in decision-making. This has led to changes in the way government institutions operate and the role played by non-government institutions. In the wake of political changes in the country, the government has made many policy changes, with the Water Resources Act (1992) and Irrigation Policy (1992). The irrigation policy was further revised in 1997. The 1992 and 1997 irrigation policy laid clear emphasis on a participatory approach towards irrigation management. To this end, following the adaptation of the National Water Resources Strategy (NWRS) and the launch of a tenth Five-Year

Development Plan, the government brought out a new irrigation policy in 2003.

There are currently four policies, two acts and five regulations related to Nepal's water resources. Among them the acts, regulations and policies that are directly related to irrigation development and management are the Water Resources Act (WRA) 1992, Water Resource Regulation (WRR) 1993, Irrigation Regulation (IR) 1999, and Irrigation Policy (IP) 2003. Important aspects are briefly discussed below.

2.11.1 Water Resources Act 1992

The government of Nepal (at that time, HMG/N) promulgated the WRA 1992 on 17 December 1992 (HMG/N, 2001). As per Section 3 of the Act, ownership of water resources within the country remains with the state. Section Four specifies the rights to the use of water resources. Sub-section 4(1) states that no one can use the water resources without permission, as provisioned in Section 8. Everyone should obtain permission to access water resources except for drinking and domestic use, irrigation, water turbines, navigation, and water resources confined to private land [Sub-section 4(2)]. Sub-section 4(3) cautions that an individual or an organized institution should make careful use of water resources without harming the access of others. Section 5 has made provision for the Water Users' Organisation (WUO) to make use of water resources for collective benefits. WUOs have been recognised as autonomous bodies with perpetual succession (Section 6).

Section 7 of the Act has set the priority for water resource use in seven categories, such as drinking water and domestic use, irrigation, agricultural use like animal husbandry and fishery, cottage industry, industrial entrepreneurship and mining related use, water navigation, entertainment use, among others. Irrigation is placed second after drinking and domestic use of water resources, indicating the importance accorded to irrigation. The use of water resources for drinking and domestic purposes is only the smallest proportion of total consumption, so this prioritisation has least threat to irrigation.

As provisioned in the WRA 1992, the Government of Nepal (then HMG/N) could make agreements with domestic and foreign companies or organised institutions or persons for the use, development and expansion of services related to water resources (Section 12) and a contractor could fix and collect fees for services rendered on the basis of mutual agreement (Section 13). This provision opened new avenues to consider water resources as economic good. It enabled Agency Managed Irrigation Systems (AMIS) and Farmer Managed Irrigation System (FMIS) to sustain their irrigation systems through cost recovery, particularly operation and maintenance (O & M) costs.

2.11.2 Water Resource Regulations 1993

With the power given in Section 24 of WRA 1992, the government promulgated WRR 1993 on 17 August 1993. The WRR prescribed the formation and registration of the Water Users' Organisation (WUO), information to be furnished in the WUO constitution, and provision for the amendment of the constitution (Chapter Two of

WRR). The third chapter made provision for a nine member District Water Resource Committee authorised to sanction permission for water resource use. The committee is multidisciplinary, representing government and non-government administrative and water resources development and management related organisations so that discipline and other biases are minimised. Chapter Two of the WRR also defines the procedure for obtaining, renewing and selling or handing over of licences. The annual fee to be paid to the government by those who have obtained permission to use or provide services for irrigation or agricultural water use to others is nominal, but its rationale seems to promote and regulate judicious and beneficial use of water resources.

Chapter Four of the WRR has made provision for a Water Resource Utilisation Examination Committee to deal with water resource utilisation disputes. The Committee consists of representatives from the Ministry of Water Resources as chairperson, a representative from each of the District Development Committees of concerned districts and the Regional Offices of the National Planning Commission. In the event of disputes between more than two districts, the committee includes representatives from all District Development Committees concerned.

Provision for a Service Fee Fixation Committee and the amount of the service fee has been defined in Chapter Five of the regulation. The committee consists of three members, two persons designated by the government as Chairperson and Member Secretary and another person from among the water users, also designated by the government as a member. The Regulation would have been more transparent and representative if the member representing water users was elected or selected by the users themselves, instead of by government.

The sixth chapter describes the acquisition of houses and land for the purpose of water resource utilisation and provision of compensation for the acquisition. The Compensation Fixation Committee rightly includes the owner or his/her representative, whose fixed assets have been acquired for the water resource utilisation project. The last chapter describes miscellaneous aspects related to water resource utilisation, of which salient descriptions concern accidents, flow of information, and government authority to amend WRR Schedules as and when necessary.

2.11.3 Irrigation Regulations 1999

The government of Nepal has framed and enforced IR 1999 as per the WRA 1992, Section 24. The first amendment was made on 23 February 2004. Section 2(b) of the regulation clearly defines irrigation as the "means of the act of supplying water through structures on the field for agricultural use." By definition, the regulation prohibits other uses of irrigation water in the system, except for agricultural purposes.

Chapter Two of the regulation has made provision for: registration; election and dissolution of the Executive Committee; function, responsibility and rights; and renewal of the WUO. It also defines the procedures for registering the Users Coordination Organisation, establishing the O&M Fund, handover of the project, and joint management of the system. Section 26 describes the formation of a local level Irrigation Service Fee Fixation Committee, consisting of the chief of the District Irrigation Office (DIO) as chairperson, and a representative of the District Agriculture Development Office (DADO) and chairperson of the concerned WUA as members. This committee is responsible for determining the Irrigation Service Fee for turned over and jointly managed schemes only. Section 21 defines the priority bases for the distribution of water, in consultation with DADO. All these provide clear techno-legal guidance to WUOs for good governance.

2.11.4 Irrigation Policy 2003

In Nepal, irrigation systems developed to date are run-off-the-river types. They were mainly developed to supplement the water needs of paddy during the monsoon season. However, it has been realised that water scarcity is one of the important constraining factors for agricultural intensification and commercialisation. Thus, development of storage type irrigation systems was felt necessary to counter the problem of low flowing rivers in the winter and spring to make water available to irrigation systems year round. In this context, the Irrigation Policy- 1992 was amended twice, the first time in 1997 and the second time on 4th August 2003, with the main objectives of providing year round irrigation facilities to land suitable for irrigation by effective utilisation of the current water resources of the country, developing the institutional capability of water users for sustainable management of existing systems, and enhancing the knowledge, skill and institutional working capabilities of technical human resources, water users and non-government associations or organisations relating to the development of the irrigation sector.

This policy has emphasised the transfer of the irrigation system constructed by the government to the users, on the basis that a work plan and the possession and ownership of land and other infrastructures belonging to the system transferred, be provided to the users as per the prevailing law. It aims to strengthen the capability of local bodies and users associations to ensure their effective participation in the planning, construction and management of small and medium irrigation systems.

Similarly, the Tenth Plan's (2002-07) objective of awarding legal rights to the WUAs and Irrigation Division Offices to collect service fees is expected to address the paucity of funds for O&M. The Plan also intends to include user centered designs in the detailed planning of irrigation projects. It is the first time that user designs have been recognised in the government planning document.

2.11.5 Policy and Regulatory Directive for Irrigation Management

The review of national policies related to irrigation management shows that the government focus is on increased participation of users in the management of their systems. To this end, the aim is to transfer the management authority of all the government built systems to the users. These regulations also provide directives for: registration; election and dissolution of the Executive Committee; function, responsibility and rights; and renewal of the WUO. They also provide guidelines for the establishment of an O&M Fund, and fixation and collection of irrigation service fees. All these policies and regulatory directives influence institutional arrangements through a direct and indirect effect on the process of regulation formation at the irrigation system level.

Table 2.3 Summary of Salient Features of Irrigation Policies in Nepal

S.N.	Name of Act/Policy	Salient Features
1.	The Civil Code -1853	• the first comprehensive statutory law, which is a collection of administrative procedures and legal frameworks for interpreting civil and criminal matters, revenue collection, landlord and peasant relations, inter-caste disputes, and marriage and family laws • linked water usage rights to land ownership within the canal command area • provisioned 'prior appropriation rights' of existing irrigation canals over newly constructed canals
2	The Development Board Act -1956	• designed and implemented as one of the first policy measures under the First Five Year plan to provide guidance, streamline and increase the effectiveness of development interventions including irrigation • provided favourable environment for external donor to invest in Nepal's infrastructure development including irrigation
3.	Irrigation Act-1961	• laid the foundation for a legal framework specifically for irrigation • replaced by Canal Electricity & Water Resources Act 1967
4.	Canal, Electricity & Water Resources Act 1967	• replaced Irrigation Act 1961 • introduced the concept of water tax and licensing (only for hydropower generation)
5	Water Resource Act 1992	• states that the ownership of all water resources including irrigation rests on the State and its use should be permitted by the later (except drinking and domestic use, irrigation, water turbine, navigation and water use within private lands • individuals or an organised institution should make beneficial use of water resources, which should not jeopardise others' use of water particularly the use by the Water Users' Organisations (WUO) for irrigation purposes.

		• sets priority for water use in order of drinking and domestic use, irrigation, animal husbandry and fishery, cottage industry, industrial and mining related use, water navigation, entertainment and others • provisions with mutual agreements with between the Government of Nepal (HMG/N) and domestic and foreign nationals, companies or organised institutions to the use, development and expansion of services related to water resources • recognises water as an 'economic good' by granting authority to the contractors to fix and collect water fees. • enables AIMS and FMIS to sustain their irrigation systems through cost recovery mechanisms particularly the Operation and Maintenance (O & M) costs.
6.	Water Resource Regulation 1993	• provisions for the formation and registration of WUO • information to be furnished in the WUO constitution and provisions for necessary amendments • provisions for formation of a nine member District Water Resource Committee to sanction permissions for water resource utilisation at the district level • defines the procedures for obtaining, renewing and selling or handing over license • promotion and regulate judicious and beneficial use of water resources and pay water fee to the government for obtaining permission to provide services for irrigation or water use related to agriculture • provisions for a water Resource Utilisation Examination Committee to deal with water resource utilisation disputes • provisions for Service Fee Fixation Committee to determine amount of service fee from water users

		• empowers and designates Service Fee Fixation Committee to deal with compensation issues which are resulted from acquisitions of fixed assets during construction of water related enterprises
7.	Irrigation Regulation 1999	• defines irrigation as 'means of the act of supplying water through structures on the field for agricultural use' and prohibits other use of irrigation water in the system except for agricultural purposes • provides a clear techno-legal guide to WUOs for good governance by outlining procedures for registration, election and dissolve of WUO executive committee. • sets the remits of WUO including functions, responsibilities and rights and renewal of WUO licence • defines procedures for establishment of O & M Fund and delineate procedures and conditions for management transfer of irrigation systems to local users including the joint management
8.	Irrigation Policy 2003	• recognises the limitations of run-off-the-river type of irrigation systems and their inability to supply water all year around • priorities the development of storage type of irrigation for agricultural diversification, intensification and commercialisation • adds a greater emphasis in developing institutional capacity of water users for sustainable user of the irrigation resources and to enhance the knowledge, skills and technical capabilities of the human resources • strengthening the capabilities of WUOs and effective participation of users in planning, construction, and management of irrigation systems.

2.12 Access to Water under Different Property Right Regimes

This section builds the theoretical model of this thesis, done to set the scene for an empirical investigation of the impact of property rights regimes and distributional aspects of irrigation water in the later sections of this thesis. Given the definition of access provided in section 2.9 above, a condition where farmers' access to water should provide a reliable water supply, adequate for crop cultivation and equitable in water distribution, the farmers' level of access to irrigation water will be tested on the cumulative index of the above mentioned three constituent components of access.

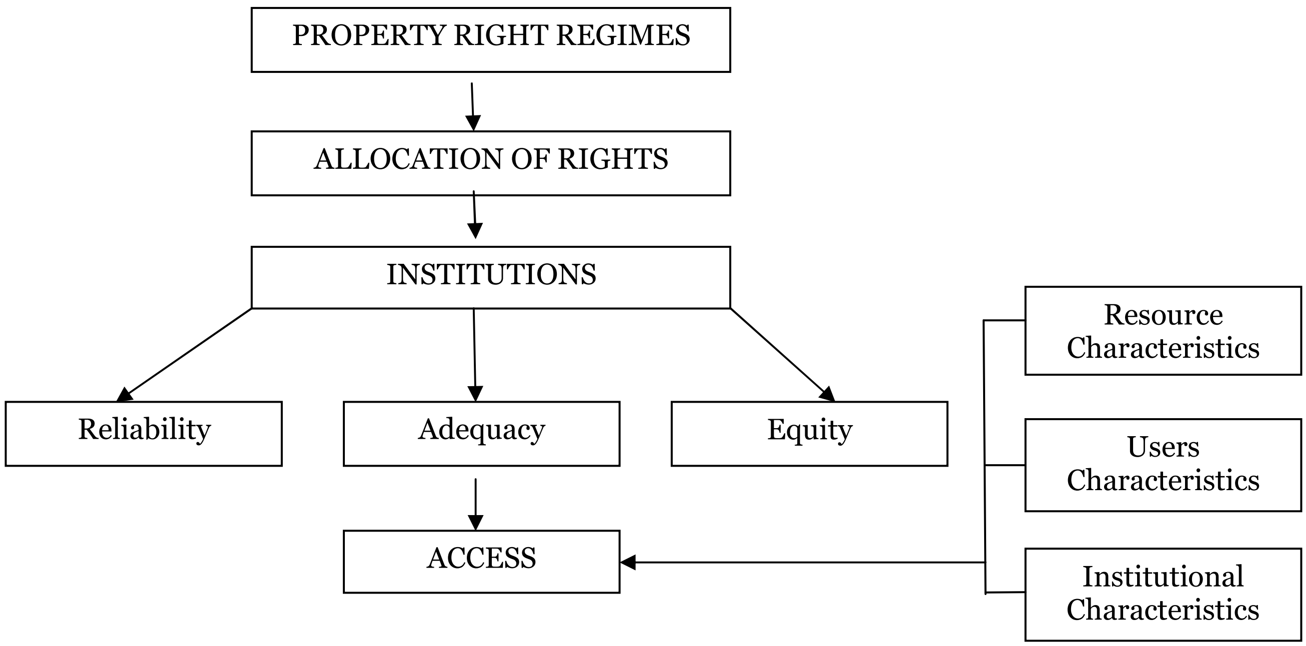
The management of irrigation systems is a complex phenomenon. Various users are involved in water appropriation from the canal's resources, and thus the management depends on how they (or their actions) are coordinated. The important point to note here is that users have tended to come together for collective arrangements and thus devise various alternative management options. The users have adopted various coordinated strategies for appropriation of resource units (Ostrom *et al.,* 1994). However, their coordinated strategies are influenced by the action arena where they operate together. The action arenas are affected by various factors, like the attributes of physical world, the community, and rules-in-use. The appropriators use rules to regulate their own relationships, various attributes of the physical world and the nature of the community where the action arena occurs. Therefore, in order to understand institutional issues it is important to analyse how the rules combine with the physical and community world to generate particular types of situation (Ostrom *et al.,* 1994).

The management of irrigation systems is also guided by various rules at the system level. It is noted that in community managed irrigation systems, farmers develop a wide range of rules to specify rights and responsibilities between them (Tang, 1992) and of greatest importance is that they enforce those rules without the involvement of external agencies. The situation is not same for all irrigation systems and the configuration of rules varies, depending on the mode of governance of the irrigation systems. In many irrigation systems, constructed and managed by state agencies, the rules at the system level were suggested by higher level offices, not necessarily developed by the users (Lam, 1998). It must be noted that the likelihood of rules being formulated at the system level may be guided by various policies at the national level as well. However, the situation might not be similar and other contextual variables may play a significant role.

In the Nepalese context, irrigation systems operate in diverse physical and community settings. The ecological diversity across hills/plain areas results in diverse physical attributes of the irrigation systems. Physical diversity represents not only the characteristics of resource systems, it also represents varying levels of external pressure in the form of market influences and commercialisation impulses. Similarly, the cultural and ethnic diversity in many parts of the country result in varied community settings and may have an influence on rule formation. Depending on the physical attributes and community attributes of the action arena, the rules-in-use and the process of rule formation may also vary. Tang (1992) noted variations in the rules of authorities and resulting appropriation activities between government-owned systems and farmer-owned systems.

The institutional structures which are designed and implemented to manage irrigation resources provide action situations where individuals associated with the irrigation activities interact. The theoretical framework proposed in this thesis will enable understanding of the influence of institutional arrangements and the physical characteristics of the irrigation systems on the nature of interactions amongst the farmers and their ability to access water from the canal systems. The theoretical framework used in this thesis has emanated from the literature review, particularly from the IAD framework proposed by Ostrom *et al.* (1994) and the interactive domain of irrigation governance proposed by Chambers (1988) has also guided fieldwork. All aspects of the research, including the questionnaire design, household survey, focus group discussions, key informant interviews, field notes and observations and documents analysis have been guided by the theoretical framework presented in the thesis.

Figure 2.3 A Theoretical Model of Thesis



2.13 Conclusions

Irrigation impinges on many aspects of human life in a myriad of complex ways. Natural resource bases, such as irrigation canals, help farmers relate to each other in many ways. The relationship amongst irrigators and that between the irrigation system and the farmers depends on whether or not they benefit from it. The property rights structures establish the farmers as stakeholders with relation to the irrigation canals. The property rights structures and institutional arrangements associated with a particular type of property rights regime, provides an action situation where farmers, irrigation bureaucracy and donor agencies relate to each other. This thesis argues that farmers' access to and control over water, and other irrigation infrastructures are functions of property rights structures designed to manage the irrigation systems. The nature of property rights also determines the pattern of use, benefit allocations, investment and negotiations associated with acquisition, allocation, water distribution, resource mobilisation and conflict resolutions in irrigation management. Also, studies on irrigation performance have been explicitly objective and are dominated by engineers and bureaucrats with disregard to the perspectives of the local farmers who rely heavily on and make use of irrigation resources to sustain their livelihoods. In fact, there has been a serious lack of research on the subjective measurement of access to irrigation water from the farmers' perspectives. In response to these concerns this thesis will draw on a comparative study of irrigation systems under different property rights regimes and will seek to illustrate the impact of property rights regimes on the subjective measurement of farmers' access to irrigation water.

CHAPTER THREE:

METHODOLOGY

3.1 Chapter Overview

This chapter returns to the research questions outlined in Chapter One and discusses their operationalisation. The rationale for the choice of research methodologies and criteria used for selecting research sites are explained and a detailed description of the sampling framework used for the household survey is given.The households are taken as the unit of analysis throughout the thesis. The procedures used for conducting focus group discussions and the process of secondary data collection are also described, as are the methods adopted for analysing qualitative and quantitative data, albeit briefly. Also, the chapter considers some ethical issues associated with this research. Finally, a brief description of the measurement of household access to water, based on the factors highlighted in the literature review is presented.

3.2 Introduction

The central phenomenon this thesis aims to explore is whether or not property rights regimes, which are designed and implemented for managing irrigation systems, affect the farmer's ability to access water. This thesis started with two high level research questions. Firstly, under which property rights structures do the farmers have the best access to irrigation water? Secondly, what roles do institutions play in enabling farmers to access irrigation water?

The literature reviewed in Chapter Two has provided a detailed exploration of both the high level research questions mentioned above. However, the existing literature only provides piecemeal information about the role of institutions in natural resource governance, particularly in irrigation management. Also, it is apparent from the reviewed literature that the role played by institutions in farmers' ability to access water from irrigation canals has rarely been explored in detail. The literature review presented in Chapter Two (Section 2.10) has identified the factors that are likely to influence farmers' level of access to irrigation water and these are identified and described based on the literature as well as in the Nepalese context. The literature suggests that a complex set of social, organisational, legal, technical and socio-political and cultural interactions influence farmers' level of access to irrigation resources. Both the theoretical as well as the contextual (based on the Nepalese context) have demonstrated a clear need for further empirical research in order to answer the following questions:

1a). Are the farmers from the *dalit* community benefiting equally from irrigation systems under different property rights regimes?

1b). Are marginal farmers benefiting equally from the surface irrigation systems governed by different property rights regimes?

1c). Under which property rights regimes do the 'tail-enders' have the best access to water from the canal system?

1d). Are the households headed by females benefiting equally from irrigation systems under different property rights regimes?

2a). Which institutions enable farmers to access water from the irrigation canals?

2b). What are the lessons that irrigation systems which are governed by different property rights structures can learn from each other to maximise their impact on farmers' abilities to access water?

As argued earlier in the literature review presented in Chapter Two (Section 2.10) a number of key factors are likely to influence household level of access to water from the irrigation canal systems in Nepal. Those factors which are assumed to have this influence are based in theoretical propositions and contextual premises (based on the Nepalese context). The first high level question attempts to investigate farmers' different levels of access to irrigation water in irrigation systems governed by different property rights structures. The second high level research question attempts to explore the complex set of institutional settings in which farmers interact and presents the varied perspectives or meanings that they hold in the irrigation systems governed by different property rights structures, seeking reasons why some irrigation systems are able to provide farmers with better access to water than others.

3.3. Why Case Studies?

The overarching aim of this research is to investigate the 'whys' and 'hows' of access to water, which demands an in-depth exploration of institutional mechanisms of water distribution. The case study method has proven the most appropriate, as it allows us to use a full range of strategies to gather evidence in sufficient detail to address the objectives and the associated research questions which were presented in Chapter One (Section 1.7.2) (Parajuli, 1999). The research objectives and the associated research questions demanded an investigation of the link between property rights and access to water, and processes in which these two variables interact within the given social settings. The case study approach tends to be "*holistic rather than dealing with an isolated factor*", which helps to unravel the complexities of the irrigation institutions, rural politics, socio-economic circumstances of the households and the physical nature of the irrigation canals (Denscombe, 2002 p.36). The need for a case study led approach has arisen for a number of reasons, which are outlined below.

Firstly, the nature of the research itself: the overarching aim of the thesis is to understand the nature of complex interactions amongst farmers and between farmers and the irrigation management committees in different institutional andenvironment settings. Secondly, the need for comparative case studies emanates from the nature of the research questions posited earlier, which aim to explore the implications of property rights regimes on farmers' abilities to access irrigation water. These questions demand extensive, holistic and in-depth descriptions of the ways in which farmers interact with each other in different institutional settings (Feagin *et al.,* 1991). Studies in the past reported that irrigation communities demonstrated an increasing level of sophistication and variation in all aspects of irrigation management, including physical design, water acquisition, allocation, drainage, resource mobilisation, decision making and conflict resolution (Uphoff, 1986; Hunt and Hunt, 1976; Coward, 1979).

Thirdly, the nature of the analytical framework used in the thesis also influences the decision to choose a case study approach. The Institutional Analysis and Development (IAD) Framework is used as an analytical framework throughout the thesis. The IAD framework analyses the course of action taken by individuals in different action situations. An action situation is conceived as *"a social space where individuals interact, exchange goods and services and engage in the appropriation and provision of activities, solve problems, or fight"* (Ostrom *et al.,* 1994 p.28). Both the research questions and the analytical framework attach significant importance to the contextual factors which need to be taken into consideration in measuring farmers' levels of access to irrigation water. Hence, this research required a method that allowed the collection of rich contextual materials: case study research places an emphasis on context as Robert Yin suggests: *"you would use the case study method because you deliberately wanted to cover contextual conditions- believing that they might be highly pertinent to your phenomenon of study"* (2003 p.13).

Fourthly, the immediate appeal for case studies also arises from the fact that the author had no control over either the actual interactions of the farmers and the institutional settings within which those interactions occurred. It is argued that the case study method is the most appropriate research method to fully capture farmers' interactions which cannot be controlled by the researchers and the institutional settings in which those interactions took place (Ostrom, 1990; Yercan *et al.,* 2004). There are thousands of irrigation systems in Nepal and it is impossible to consider such a large number within the scope of this research. Being selective was crucial in the choice of irrigation systems which reasonably represent those governed by different property rights regimes, and for this a case study approach was the most appropriate method of enquiry (Flyvbjerg, 2009). Furthermore, the author's aim was to focus on contemporary irrigation issues as opposed to historical events concerning access to irrigation water and level of access was to be investigated in natural and existing institutional settings. In order to undertake such research, a case study approach was the most appropriate (Bush and Opp, 1999).

Fifthly, a case study method is often suitable when the research "*relies on multiple sources of evidence*" (*op.cit*. p.14) and the case study method has a "*unique strength in its ability to deal with a full variety of evidence- documents, artefacts, interviews and observations*" (Yin, 2009 p.4). There is no doubt that there are multiple sources of evidence in this research-as the property rights structures pertinent to irrigation management have local (for FMIS) , regional and national (for JMIS and AMIS) dimensions. The nature of the research questions demand detailed information; the main sources of information were both local and national/regional. At the local level, the sources of information were local farmers, watchmen and the irrigation management committees, whilst at the regional and regional/national level the sources of information were irrigation bureaucrats, donor agencies, and irrigation engineers.

The conceptual and theoretical framework used in this thesis will highlight the dialectic and iterative interactions, (dis)continuity and interface between the life-worlds of local irrigators and government bureaucracies which are embedded in irrigation management in Nepal. This study goes beyond conventional investigations of confrontation within and amongst irrigators and takes on board irrigation bureaucracies which work in tandem with local irrigation institutions. The comparative study of three irrigation systems provides a fertile terrain of struggle where access to and control over irrigation infrastructure and other associated natural resource bases such as land and water, provides an arena of dynamic interactions, encounters, confrontations and negotiations between different social actors. In the quest to establish an actor perspective in agrarian development, Long and van der Ploeg posit that, "*thorough investigation of intervention practices enable us to understand emerging forms of interactions, procedures, practical strategies nature of discourse, cultural categories and stakeholder analysis*" (1989 p.226). This approach enables us to familiarise ourselves with a particular socio-economic context, agrarian relations and the natural resource bases, helping us to reformulate irrigation interventions from a more actor oriented perspective (Palumbo, 1987).

Once the decision on the application of a case study method to carry out the research was made, and given the nature of the research project, a comparative case study approach was selected. The comparative case study provides an opportunity for findings to be compared and contrasted with each other, allowing the *"distinguishing characteristics of cases to act as a spring board for theoretical reflection"* (Bryman, 2004, p.55). Whilst the advantages of the inclusion of multiple irrigation systems from each of the three property rights regimes considered in this research were recognised, there were some practical constraints. The logistics of undertaking a multi-site case study was hugely challenging, as the research had both time and budget constraints. A multi site case study would have had enormous budgetary implications and given the scope of this research, this was neither feasible nor practical. Considering these logistical and operational constraints, this research includes only one case from each of the three property rights regimes for in-depth and comprehensive study. The inclusion of multi sites case studies (three irrigation systems here) helped to broaden the coverage of this research. The variations in the context of the research sites provided a unique opportunity to examine whether interactions amongst farmers and access to water differed in irrigation systems governed by different property rights regimes. Through the use of multiple case studies, it was possible to gather different but rich contextual materials, which in turn greatly helped to expand the generalisability of the research findings and enhanced confidence in the overall outcomes of the research (De Vaus, 2002).

3.4 Criteria for Site Selected

This section describes the criteria used for selecting irrigation systems for case studies.

3.4.1 Different Types of Management Regimes

The over arching aim of this research is to compare irrigation systems that are being governed by different property rights regimes. Firstly, three such irrigation systems were selected. The Begnas Irrigation System (BIS) is an example of AMIS and is managed by government, while the Phalebas Irrigation System (PIS) is an example of FMIS and is managed by the local farmers. The Rainastar Irrigation System (RIS) is an example of a JMIS which is jointly managed by the government and local farmers. While other criteria used for selecting irrigation systems for in-depth case study attempt to show greater *similarities* amongst the irrigation systems, the management regime attempts to show the *differences* amongst them. In this way, it is possible to identify the impact of property rights structures on the household level of access to irrigation water.

3.4.2 Mid-hill Areas with Comparable Annual Rainfall and Temperature

In Nepal, a farmer's choice of crops depends on rainfall and temperature, which in turn depend on the geographical area. Demand for irrigation depends on the amount of rainfall, temperature and the type of crop growth. Crops such as paddy require a high amount of water for growth, whilst crops such as maize or potato require much smaller amounts of water. In order for a meaningful comparison to be made, the cropping pattern in the case study areas has to be similar; this in turn will determine the demand for irrigation. Areas with comparable annual rainfall and temperature are likely to have a similar cropping pattern. In all three areas considered for case study, farmers' choice of crops in different crop seasons was fairly comparable.

In many agrarian societies a wide range of socio-cultural factors such as traditional practices, local way of life and group identity influence farmers' choice of seeds, crop management and choice of crops (Jarvis *et al.,* 2000; Brush, 1995; Zimmerer, 1996; Gonzales, 2000; Thapa *et al.,* 2007). Also, other institutions such as land tenure, access to improved variety of seeds and size and the distribution of landholdings in the community also influence the choice of crops in rural agrarian societies. For example, in Ethiopia, a change in the land tenure system from communal to private ownership led to farmers using more sustainable land management practices including terracing, aforestation and using improved variety of crop seeds (Omiti *et al.,* 1999); access to land amongst a farming community in Mexico was to be a significant determinant of their preference for an improved variety of maize crop (Louette *et al.,* 1997). Whilst water availability was the major determinant of crop choice amongst the farmers in the research area for this thesis, other factors such as share cropping, market opportunities and households' cultural practices influenced the choice of crops. The crop sharer usually cultivated stable food crops such as paddy and maize whilst households with access to the local market cultivated cash crops like sugarcane, peanuts and vegetables. Households which brewed local liquors opted for millet as it was widely used for producing local liquors. The types of crops grown in the case study areas are presented in Table 3.1.

Table 3.1 Type of Crops Grown in Case Study Areas in Different Seasons

Seasons	Areas/Crop		
	Begnas Irrigation System (BIS)	**Phalebas Irrigation System (PIS)**	**Rainastar Irrigation System (RIS)**
Monsoon	paddy, maize,	paddy, maize	paddy, maize,
Winter	potato, millet, wheat, mustard, onion, garlic, sugarcane, legumes, rapeseeds	potato, millet wheat, buck wheat, mustard, spinach, barley, onion, garlic	peanuts, potato, wheat, mustard, spinach, onion, garlic, rapeseeds
Spring	spring paddy, spring onion	spring paddy, spring onion	spring paddy, spring onion

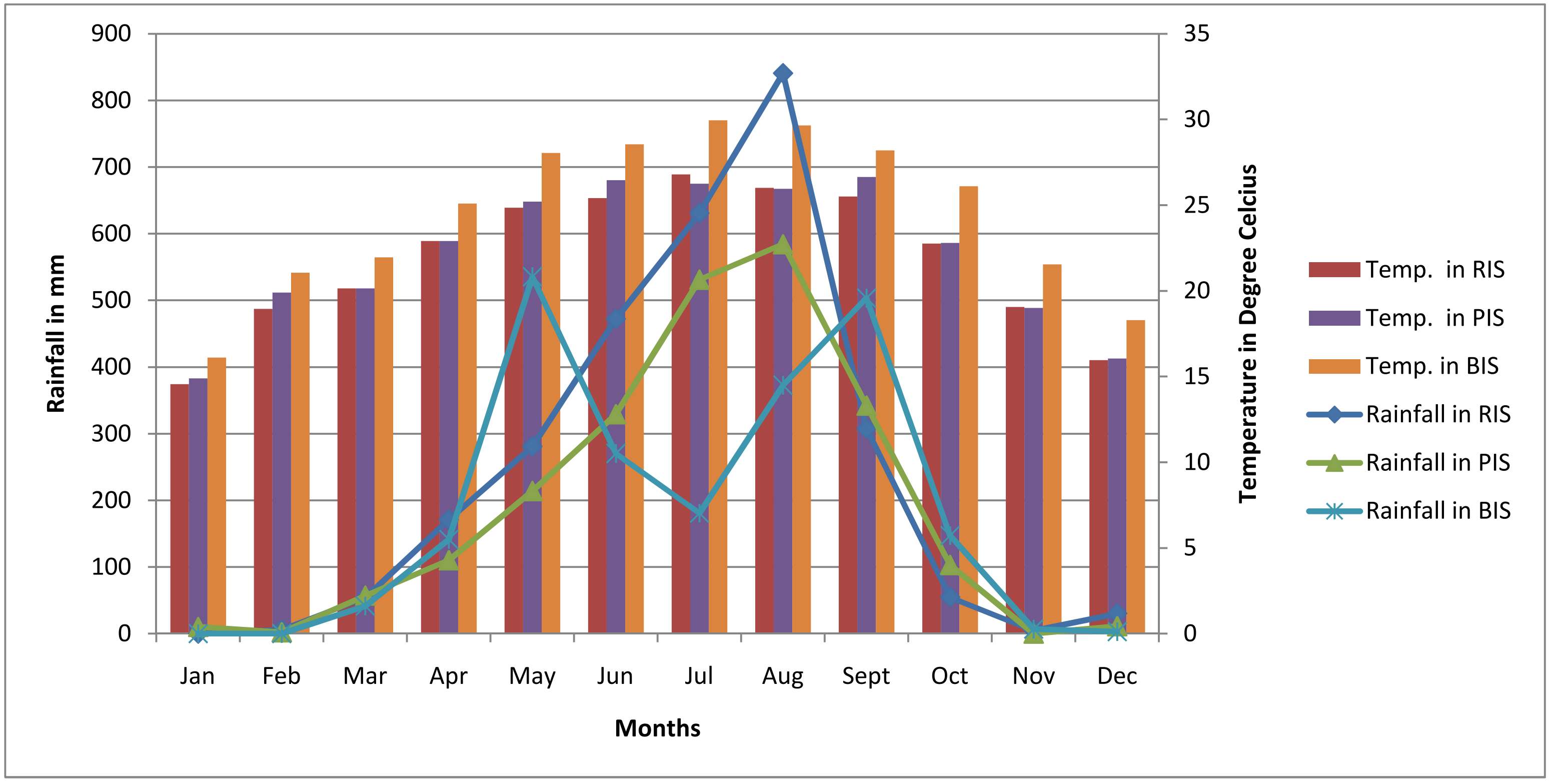
Source: Author's fieldwork (2007)

During the Monsoon season, farmers grow water intensive crops such as paddy, while during the winter they grow less water intensive crops such as wheat, mustard, potato, sugarcane, and other seasonal vegetables. Although these crops do not require intensive irrigation, but should be irrigated fairly regularly, the demand for water still remains high during this cropping season. The patterns of monthly rainfall and temperature in the case study areas selected are given in Figure 3.1.

3.4.3 Heterogeneous Communities

The management of natural resources to a large extent involves interactions of individuals and households along lines of ethnicity, gender, religion, wealth, caste (Agrawal and Gibson, 1999) and interest in the resource (Oliver and Marwell, 2001). The role of heterogeneity in the management of natural resources in general and irrigation in particular has already been explored in Chapter Two (Section 2.5). The structure and composition of community and group heterogeneity existing in the community has a wider implication in the management of natural resources. The degree of co-operation amongst farmers in managing their irrigation resources depends on the nature of communal composition. Although it is very difficult to find an irrigation system used by multiple households, which are homogenous in nature, the degree of heterogeneity varies greatly amongst communities. In order to make a meaningful comparison, cases must be selected which demonstrate a similar degree and nature of heterogeneity.

Figure 3.1 Average Monthly Temperatures and Rainfall in the Case Study Areas



DHM-Nepal (2008)

3.4.4 Local Rural Settings

The availability of 'exit options' for the local farmers depends to a great extent on their local settings. Exit options are defined as a range of employment opportunities outside the agricultural activities, such as employment opportunities in service sector, business and foreign employment. For example, farmers who live in areas located in close proximity to urban locations have greater exit options available to them than others who do not have access to urban settings. Access to markets in urban settings may reduce household dependency on agricultural activities, as they may have outside earning opportunities. In contrast, villages far from the market are more likely to be dependent on agricultural activities and irrigation resources as they lack alternate livelihood opportunity (Adhikari, 2003). It is equally plausible that if households have access to the local market, they may cultivate more cash crops and crops such as fruits and vegetables, which can readily be sold in the local market rather than crops with a long life cycle. The shift in crop preferences influences demand for water, which in turn affects household dependency on irrigation systems.

3.5 Descriptions of Case Study Sites

Criteria used for selecting irrigation systems for this research have been outlined in Section 3.4. These systems are located in the mid-hills and are in rural local settings. The farmers in these three irrigation systems have similar cropping patterns and the areas in which they are located have comparable average rainfall and temperature. All these factors influence the demand for water for irrigation.

In addition, the farming communities using water from the irrigation canal systems considered for this research are heterogeneous. Since the research aims to investigate the effect of property rights regimes on farmers' ability to access water from the irrigation canals, the irrigation systems considered for this study are governed by three different property rights regimes. Hence, three case study sites with reasonably comparable rural settings were selected for this research. The following section describes the systems considered for a detailed comparative case study.

3.5.1 Begnas Irrigation System (BIS)

The Begnas Irrigation System is an example of AMIS, and is located in the Lekhnath municipality of the Kaski district in western Nepal, which is about five kilometres south-east of the Pokhara valley. The canal system was constructed by the Government of Nepal (GoN) in 1984 with technical and financial support from the Asian Development Bank (ADB), was completed in 1988 and has remained under the management of the DoI. Table 3.2 presents some salient features of the three irrigation systems considered in the study. The AMIS makes use of a permanent headwork (water diversion structure) with sophisticated technologies to divert water from the southern end of the *Begnas Lake* to divert water into the canal system. The canal sought to provide irrigation facilities to a total command area of 580 Ha of land, to raise the economic standard of about 6000 members of the farming community (DoI, 2007). The actual area served by the canal remains much lower than the estimated 580 Ha land. The total length of the Begnas canal is 13.2 kilometres, including tertiary canals, which extend to serve triangular river basins with calcareous (limestone) sandy to sandy loam soils. The soil type found in the AMIS area contains a high concentration of limestone and requires high water application for crop production. The water diversion structures and gates installed in the canal systems are all permanent and modern. The majority of the canal command area consists of plain areas of terraces sloping south easterly and is formed by deposits from the *Seti* river and its associated tributaries. About sixty percent of the command area is moderately plain while the remaining forty percent is hilly. The total agricultural land of the Lekhnath municipality is 5305 Ha of which 580 Ha is served by the AMIS. The AMIS serves wards one, 12 and 13 which consist of plain, and wards 11 and 14 which consist of mixed of hilly and plain terrain. The wards are the smallest and lowest administrative units in Nepal and are not associated with hydrological boundaries. A number of wards combine to form V.D.Cs and municipalities. The Lekhnath Municipality is divided into 14 wards of which five are within the canal command area of the AMIS.

Photo 3.1 Headwork of AMIS

Photo 3.2 Cross Section of AMIS

Ever since it was constructed, the canal system has remained under agency management, primarily by the DoI with its technical and financial input. Recently, the DoI has constituted the Begnas Irrigation Management Committee

(BIMC), which is responsible for the day to day running of the canal system, which includes releasing water from the dam, organising operation and maintenance activities, conflict resolution and liaising with the DoI.

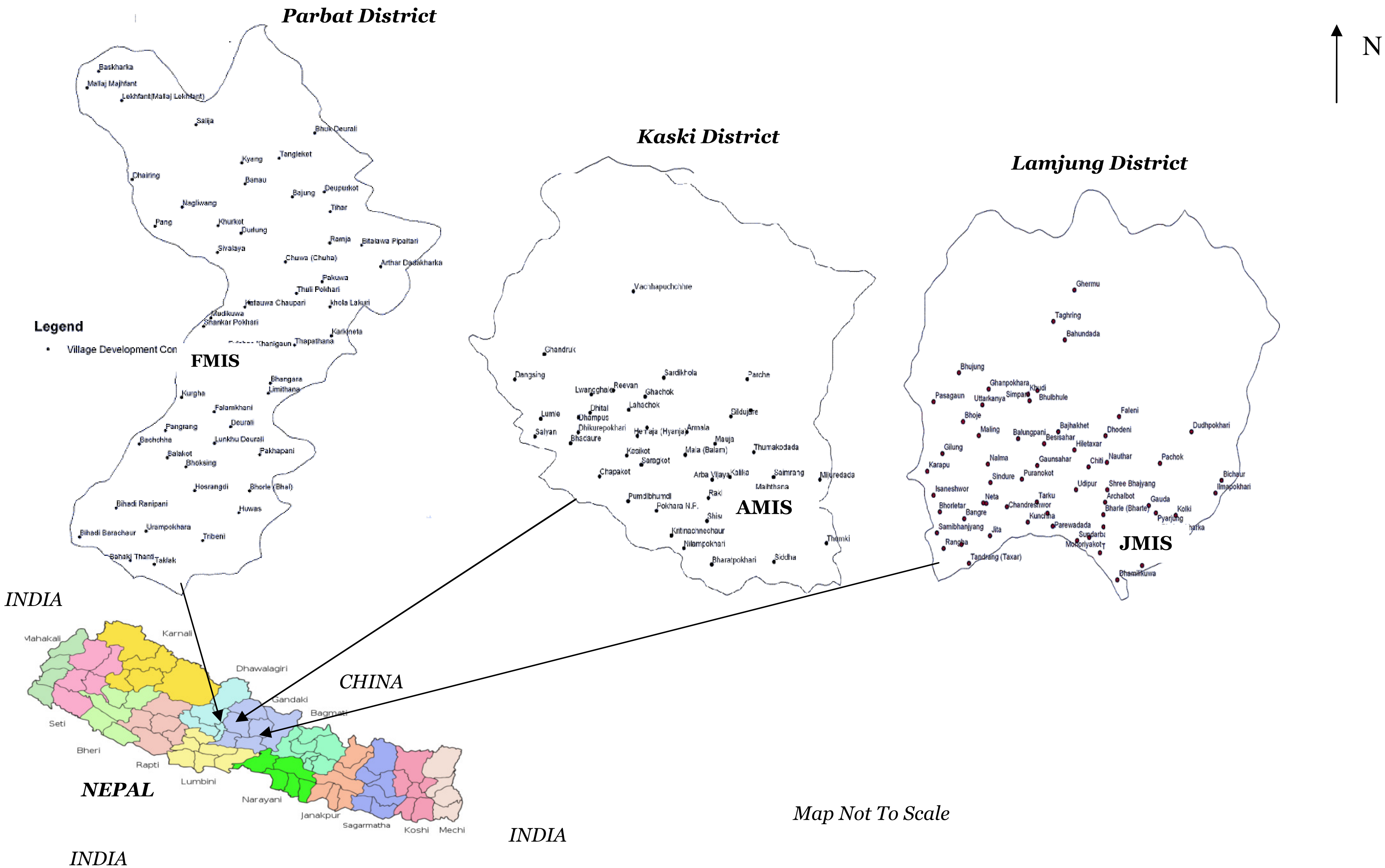
The BIMC consists of 19 members, of which four are represented from branch canals: BC-1; BC-2; BC-3; and BC-4. There are three members representing BC-5 in the BIMC. The branch committee consists of eleven members committee, including the president, vice-president, secretary, joint secretary, treasurer and six others. The canal system has five branches with their own branch canal committees. The DoI has employed three gate keepers, also called *Dhalepa*[3], to regulate the water supply in the canal system. One of the *Dhalepas* is permanently employed at the head end to look after the headwork, while the remaining two have been assigned responsibilities for taking care of the canal structures at the middle and lower part of the canal system.

[3] *Dhalepas* is Nepalese term used for watchmen. The *Dhalepas* patrol canal structures. In the AMIS, the *Dhalepas* are formally responsible to the Department of Irrigation (DOI), but in the JMIS and AMIS, they are responsible directly with the WUA or individual farmers on a daily basis.

Table 3.2 Some Salient Characteristics of the AMIS, FMIS and JMIS

Irrigation System	Water source and system characteristics	Area (Ha)	Date built	Management Type	WUA's Tenure
Phalebas Irrigation System (PIS)	Fed by a local seasonal stream. Mostly non-cement lined earthen canal, with temporary headwork.	341	1931	FMIS	3 Years
Begnas Irrigation System (BIS)	Fed by lake. Modern system with sophisticated infrastructure, cement lined and permanent headwork.	580	1988	AMIS	3 years but not renewed
Rainastar Irrigation System (RIS)	Fed by a perennial river. Semi-modern with permanent headwork.	850	1994	JMIS	3 years

Figure 3.2 Map of Nepal Showing the Districts locations of Case Study Sites



The demographic characteristics of the command area of the three irrigation systems are presented in Table 3.3. The canal command area is semi-urban, having a municipal status. The canal command area of the AMIS has access to roads and local market places and to the sub-metropolitan city of Pokhara, reached by modern means of transportation. Since the reorganisation of the Lekhnath area as a municipality, there has been a surge in development to its infrastructure. The Lekhnath municipality has a total of 216 km of road networks, of which 20 km is pitched, while 60 km and 136 km roads are gravelled and temporary and non-gravelled respectively. The local economy of the canal command area is agriculture based. About 87 percent of the population of the Lekhnath municipality are involved in agriculture while nine percent and four percent are involved in services and business respectively. Although the farming system in the canal command area is traditional, urbanisation and a surge of development have allowed the farmers to use mechanised farming, such as tractors for tillage. There is also a fishery research centre within the canal command area, which uses water from the canal system.

Table 3.3 Demographic Composition in the AMIS, FMIS and JMIS

Demographic Information	Number/Percentage					
	Phalebas area	Begnas area	Rainastar area			
			Bhalayakharka V.D.C.	Chaktratirtha V.D.C.	Dhamilikuwa V.D.C.	Rainastar area Total
Total Population	3308	41369	2,771	4,779	4,368	11,918
Male	1563 (47.2%)	19,475 (47.1%)	1,315 (47.4%)	2,200 (46%)	1,992 (45.6%)	5,507 (46.2%)
Female	1745 (52.8%)	21,894 (52.9%)	1,456 (52.6%)	2,579 (54%)	2,376 (54.4%)	6,411 (53.8%)
Annual Population Growth	4.6 %	2.9 %	1.4%	1.6%	2.1(%)	1.7 (%)
Total Number of Households	660	9362	580	1,004	948	2,532
Number of Households Served by the Canal	505 (76.5%)	4304 (45.9%)	180 (18.6%)	780 (77.7%)	748 (78.9%)	1,708 (67.4%)
Average Household Size	6.5	5.3	4.70	6.1	4.7	5.1
Population Density per Ha	8.7	4.7	Na	Na	Na	na

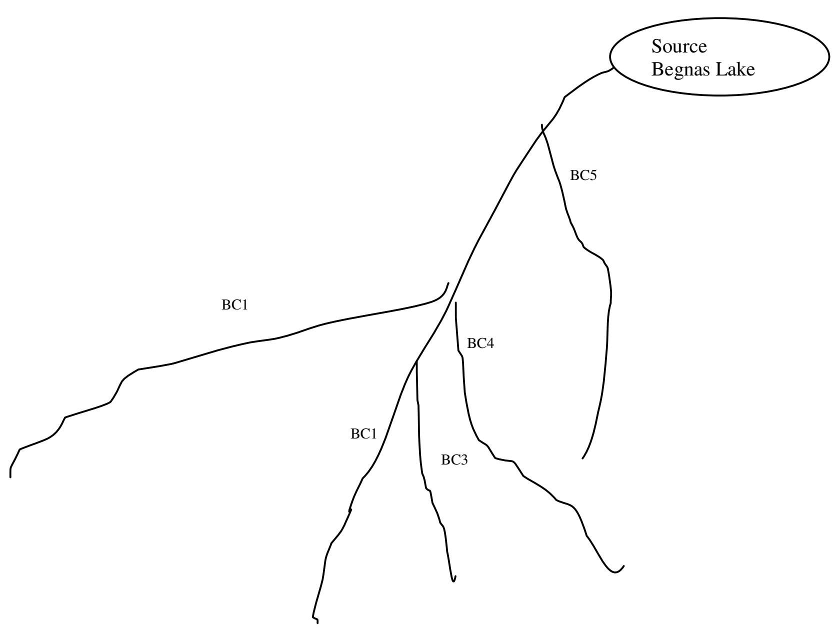
Source: CBS (2001) and LM (2000)

The physical characteristics of the three irrigation systems considered for this research are presented in Table 3.4. The Begnas irrigation canal is elongated, serving a command area of rugged terrain which makes O & M activities relatively difficult.

Table 3.4 Physical Nature of the Irrigation Systems

Physical Nature of the Irrigation Systems		
FMIS	**AMIS**	**JMIS**
Non-elongated longitudinally	Elongated longitudinally	C-shaped elongated longitudinally
Following through relatively plain areas	Flowing through steep area	Flowing though steep slopes
Relatively plain command area	Very undulating command area	Plateau like command area with sloppy edges on both sides

Figure 3.3 Schematic Diagram of Begnas Irrigation Canal and its Command Area



3.5.2 The Phalebas Irrigation System (PIS)

The Phalebas Irrigation System is an example of a FMIS which is managed by local farmers and is located in the Phalebas Devisthan V.D.C. of the Parbat district in western Nepal, about 30 km north-west of the Pokhara valley. Historically, the Phalebas area has had no access to irrigation water and the farmers depended on the Monsoon rainfall for crop cultivation. The farmers in the Phalebas area grew '*aga paddy*' which was low in both productivity and quality (PDDC, 2001). In 1926 a social worker and *Jimmawal*[4] named Bishe Pant envisaged constructing an irrigation canal using local resources and water from a local stream. A lack of financial resources, equipment and technical ability, coupled with a rugged topography, hampered the construction of the canal infrastructure (PDDC, 2001)

As a local social worker, Bishe Pant was determined to prove that the area of Phalebas could be self sustained for food by the construction of an irrigation canal. He started lobbying in the village and the initial financial contributions for the construction of the canal system were made by the villagers. Using the resources contributed by the local farmers, Bishe Pant enlisted local labourers of the Magar caste (also called *Ahuris*) from the *Rangkhani* village of neighbouring Baglung district for the construction of the irrigation system. The *Ahuris* from the village of *Rankhani* were renowned for their hard work and prowess as artisans. The local farmers joined Bishe Pant and participated enthusiastically, contributing voluntary labour for the canal construction and by donating food to feed the *Ahuris*. After relentless efforts over 11 years and

[4] Individuals with responsibilities of looking after land on behalf of the land owner

with the support of the local farmers, Bishe Pant was able to supply some water for irrigation in the Phalebas area in 1937. Ever since the construction of the Phalebas canal, it has been owned and managed by the beneficiary farmers (Pradhan, 1990; PDDC, 2001).

Some of the salient features of the FMIS are presented in Table 3.2. The FMIS provides irrigation facilities to 341 Ha of *tar*[5] land bounded by the Kali Gandaki river to the west, which is more than 130 meters lower, and to the south by the Lamaya stream, which is also a source of water feeding the system (PDDC, 2001). Given the nature of the landscape, the intake required has had to be constructed considerably higher upstream to divert water into the system.

Even today, the Phalebas Irrigation System makes use of a temporary headwork which is constructed by using locally available resources such as stone boulders, sandbags, tree branches and grassed soil (also called *Lapcha* or *Chapari*) to divert water from the seasonal stream named the *Lamaha Khola*. The temporary nature of the headwork means it is often prone to being washed away during the Monsoon season. The canal is elongated longitudinally along fractured hard rocks made of granite. These hard rocks have been holed and tunnelled by the *Ahuri* using chisel and hammers to divert the water.

[5] Elevated flat and dry land and usually bordered by rivers on both sides

Table 3.5 Caste/ethnic composition of the AMIS, FMIS and JMIS

Castes	**Area/ Percentage**					
				Rainastar		
	Phalebas area	**Begnas area**	**Bhalayakharka V.D.C.**	**Chaktratirtha V.D.C.**	**Dhamilikuwa V.D.C.**	**Rainastar area total**
Brahmins	41	38	32.5	27.2	30.8	29.4
Chhetriya	9	9	23.5	18.2	8.1	15.7
Dalits	6.9	13	11.4	21.1	28.3	21.6
Magar/Tamang	0.6	4	2.8	7.7	14.9	9.3
Gurung	0.7	13	26.8	5.6	4.4	10.1
Newar	17	3	0.6	3.9	6.9	4.3
Kumal	Na	Na	1.3	12.3	Na	5.2
Gharti/Bhujel	Na	Na	Na	2.1	2.3	1.7
Sanyasi	Na	Na	Na	1.3	2.2	1.3
Others	24.8	20	1.3	0.4	1.9	1.2
Total	100	100	100.0	100.0	100.0	100.0

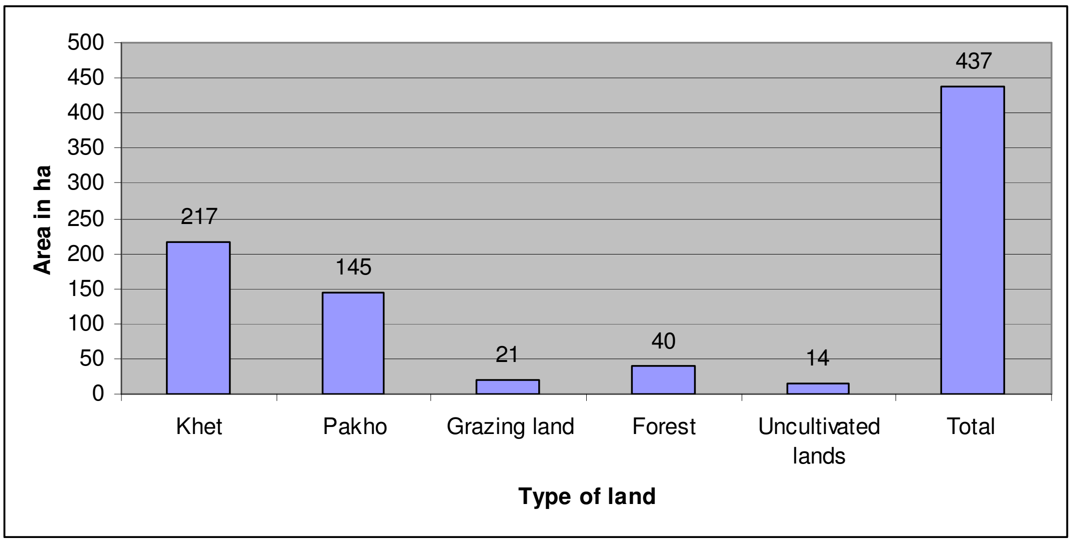
Photo 3.3 Water Source and Headwork of FMIS

Photo 3.4 Cross Section of FMIS

Tables 3.3 and 3.5 present the demographic composition of the Phalebas area. It is clear that the population of Phalebas is very heterogeneous. The total length of the canal system is 14 km, which includes 4 km of tertiary canal (distribution network) making a longitudinal arch across tar land with sandy

loam to sticky red soil, which has a high water requirement for crop production. The total area of Devisthan is 437 Ha of which 362 Ha is arable. Of the total arable land of 362 Ha, 217 Ha of land has irrigation facilities and 134 Ha are served by the Phalebas irrigation system, and the remaining 145 Ha are not irrigated. The Devisthan V.D.C. has 102.8 Ha of land under forest cover, of which 42.71 Ha is under community management (CBS, 2001; PDDC, 2001). The land types in the same VDC are presented in Figure 3.4.

Figure 3.4 Type of Land in Phalebas Area



Source: PDDC (2001)

Ever since the construction of the canal system, it has remained under the management of farmers with both technical and financial inputs. The irrigation system is managed by an elected body called Phalebas Irrigation Management Committee (PIMC), which is responsible for the day to day running of the canal water from the dam, organising operation and maintenance activities, conflict resolution and liaising with the DoI. The PIMC consists of 20 members, of which five are represented from each of the

Jogichaur, Dee-Kumalgaun, Satkuriya and Chaubiskuria branches. These branches have their own eleven member branch committee, of which five are represented in the PIMC. The branch committee consists of an eleven member committee including the president, vice-president, secretary, joint secretary, treasurer and six other members.

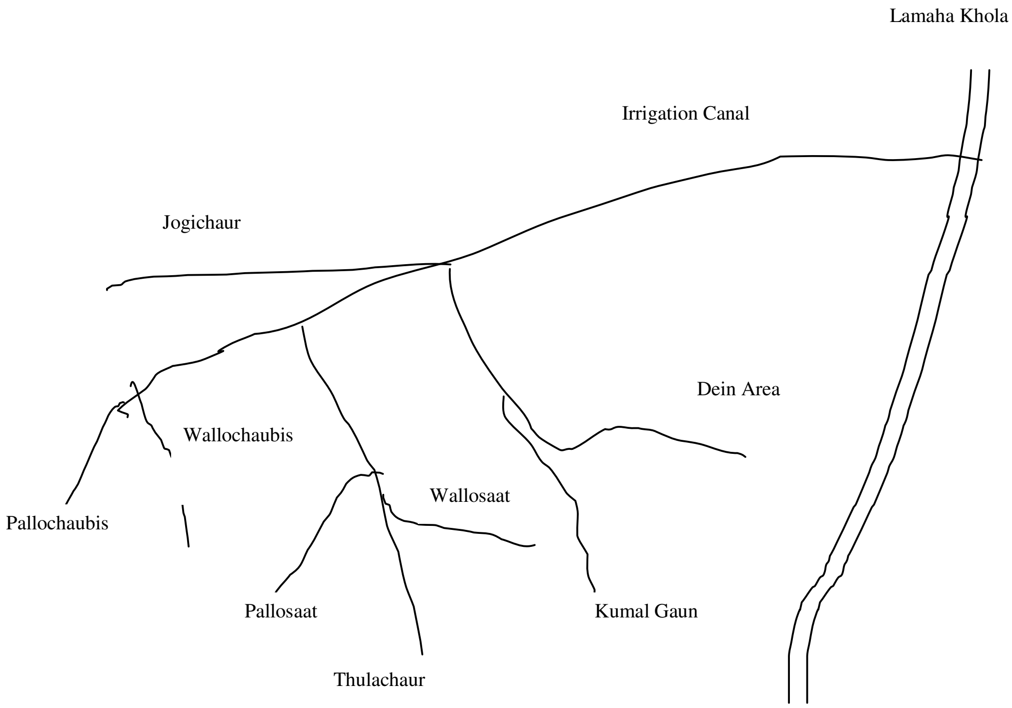
The PIMC has employed two gate watchmen, also called *Dhalepas,* to regulate the water supply in the canal system. The two *Dhalepas* have been assigned responsibilities for taking care of the canal structures across all sections including the headworks. The PIMC has employed a messenger called '*Katuwal'* of the *dalit* caste, who is remunerated with one *pathi* (about 4.5 kg) of food grains per household in all seasons after harvesting. For the purpose of informing the farmers of any meetings, operation and maintenance activities, the *Katuwal* stands on elevated land and blows his pipes (*Karnal*) and make the announcement four times facing each of the four directions. This mechanism of message delivery has proven to be extremely effective in informing the farmers about meetings and operation and maintenance activities (which the local farmers called '*chinna jane*').

The water diversion structures and proportioning weirs are all traditional, using locally available materials. In the FMIS, for the purpose of water distribution, the farmers use flow splinters, which help to divide the water volume into different secondary and tertiary canals, proportionate to the land area which the secondary and tertiary canals are irrigating. The wooden proportioning weirs, called *Gahak,* which are made of water resistant *simal* wood, are placed across the canal with sections cut to allow the water to flow through them. A detailed description of the Gahak is described in Chapter Six (Section 6.4.1).

The canal command area of the FMIS has a typical rural setting with no access to roads or modern means of transportation and urban markets. The nearest local market, called *Kusma bazaar,* which is also the headquarters of the Parbat district, is about three hours journey by foot. The local economy of the canal command area is primarily agriculture based, as about 94.5 percent of the population of Phalebas Devisthan V.D.C. has agriculture as its primary occupation while 2.3 percent and 3.2 are involved in business and services respectively (PDDC, 2001).

A schematic diagram of the FMIS is presented in Figure 3.5. The FMIS flows in an East-west direction. The canal is not elongated, and has a relatively flat river basin as its command area. It flows through a rough terrain which is prone to landslides, particularly during the Monsoon seasons.

Figure 3.5: Schematic Diagram of Phalebas Irrigation Canal and its Command Area



3.5.3 The Rainastar Irrigation System (RIS)

The Rainastar Irrigation System is an example of JMIS which is located in the south-eastern part of the Lamjung district. Covering three *tar* areas (Rainastar, Alkatar and Sahilitar), it is about 120 kilometres west of Kathmandu. The canal system was initiated by the Government of Nepal (GoN) in 1984 with the technical and financial support of the World Bank, UNDP and the ILO and was completed in 1996. The canal structure consists of an alternative permanent headwork without a dam. The dam uses some sophisticated technologies to divert back water after hitting steep cliffs on the bank of the *Chepe* river. The canal was envisaged to cover an aggregate area of 850 Ha of *Bhalayakharka*, *Chakratirtha* and *Dhamilikuwa* V.D.Cs, to raise the economic standard of 11,918 people residing in 1708 households. The actual area and the households served by the canal is much lower than initially estimated. The total length of the Rainastar irrigation canal is 21 km including tertiary canals which are longitudinally elongated sloping towards the south-west and forming a triangle. The canal system is fed by a perennial river named the *Chepe*, which flows in a south-westerly direction. The canal command area of the JMIS consists of *tar* land surrounded by the *Chepe* river in the south-eastern part, and surrounded by the perennial *Marsyangdi* river in the south-western part. The northern part of the canal command area is occupied by foothills of the local *Rainas danda* in the Mahabharat range. The canal command area is situated at an average elevation of 600 to 800 meters from sea level and consists of a mixture of undulating terraces and hillocks along the *Chepe* river valley. The soil types range from silt-clay loamy to sandy loamy soil, with low water holding capacities and requiring high water application for crop production. In the *Dhamilikuwa*, the soil is more fertile with better water holding capacity than the soil in *Chakratirtha* and *Bhalayakharka* where soils are mixed with gravel, boulders, sand and silt, which reduces the water holding capacity of the soil.

The diversion structures and gates installed in the canal system are permanent and modern but the farmers also make extensive use of their ad-hoc local technologies for water diversion, especially at the secondary and tertiary canal levels. The land under cultivation consists of unlevelled terraces with plots which have bunds to hold water for the cultivated crops. The area mainly consists of streams, gullies, terraced farmland and steep areas.

Photo 3.5 Headwork of JMIS

Photo 3.6 Canal Cross Section of JMIS

Immediately after the completion of the canal, it was managed by the Department of Irrigation (DoI) for a few years. But due to a high degree of enthusiasm from the local farmers to undertake the management responsibilities, the DoI transferred the canal to local management while retaining some of its responsibilities. Now, the canal system is managed jointly by a committee of 21 members called the Rainastar Irrigation Management Committee (RIMC). The RIMC consists of the chairpersons of 16 branch committees who are ex-officio members of the RIMC and an elected president, vice-president, secretary, treasurer and a representative of the DoI. The members of the RIMC have tenure of three years.

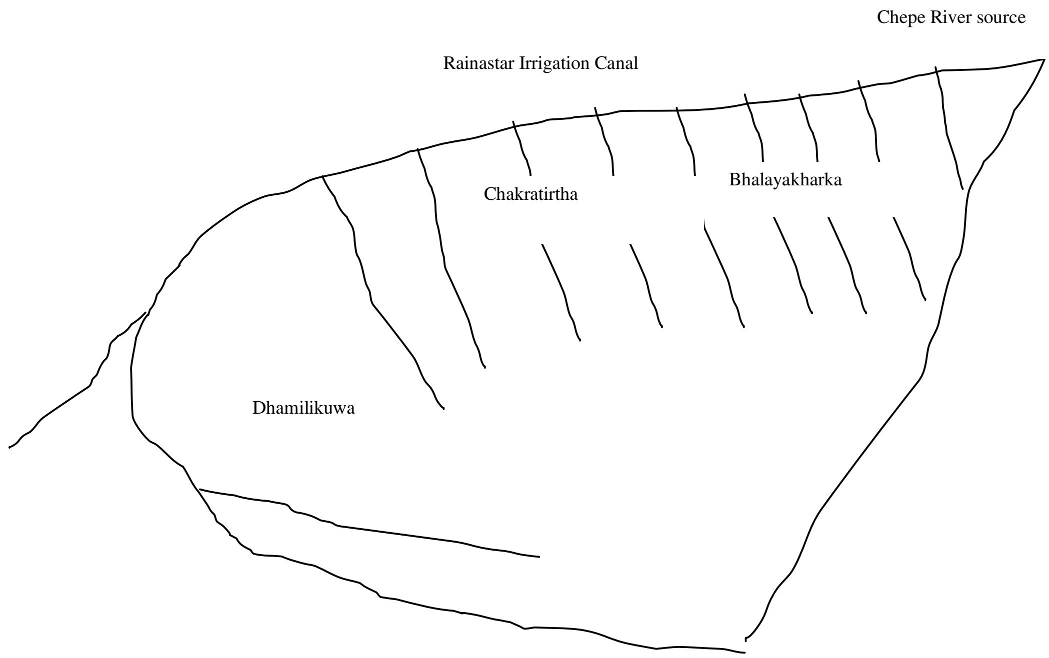
The minor O & M activities, conflict resolution and other minor activities are carried out under the juisdiction of the RMIC while the responsibilities for major O & M activities are carried out by the DoI. The canal command area has been divided into 16 blocks, each with its own 11 member block committee, responsible for the day to day running of the branch canal water in their respective blocks, organising operation and maintenance activities, conflict resolution and liaising with the RIMC.

The canal command area of the JMIS represents a typical rural setting with no access to roads or modern means of transportation. The nearest local market, *Baisjanghar* and the *Turture bazaar* in the neighbouring Tanahu district are situated just about half an hour and two hours walking distance respectively. The local economy of the canal command area was primarily agriculture based, with about 81.52 percent of the population of the canal command area of the JMIS engaged in agricultural activities. The farming system in the canal command area is traditional, with virtually no use of mechanised farming. Mostly the farmers use traditional methods of cultivation, like wooden ploughs and oxen for ploughing and tillage.

Generally, each block covers village settlements, but sometimes the block consists of a few village hamlets. In the JMIS, blocks 1-5 are situated at the head of the canal while blocks 6-11 are located in the middle section of the canal command area and blocks 12-16 at the tail end. The size of the block area ranges from 32 Ha to 80 Ha. Block 11, which comprises *Pakhetar* village, is the smallest block with a command area of 32 Ha and block 13 is made up of two villages, namely *Majha-hatiya* and *Naya Pauwa* villages is the largest block with a command area of 80 Ha. In general, the smaller blocks are situated at the head end and larger blocks at the tail end. It should be noted that the size of the block is not based on the location, but on the number of households and the command canal of the branch canal.

Figure 3.6 presents a schematic diagram of the JMIS. The physical shape of the Rainastar canal is C-shaped, elongated longitudinally and running along the steep slopes of the Rainastar hill. The canal command area of the JMIS is plateau-like flat land, sloping on both sides to the bed of the river Chepe on the eastern side and the Marshyangdi on the western side.

Figure 3.6 Schematic Diagram of Rainastar Irrigation Canal and its Command Area



3.6. Using Mixed Methods

Having selected three case study sites, data for this research were generated using multiple research methods, typical of the case study approach. The rationale for using a mixed methods approach was to reduce the likelihood of misinterpretation and to strengthen the data gathering and subsequent data analysis. The research makes use of between methods or across method triangulation rather than within-method triangulations (Tashakkori and Teddlie, 1998). Cross-method triangulation combines dissimilar methods to investigate the same conceptual phenomena and units of analysis (Flick, 2006; Miller and Gatta, 2006). There are a number of ways in which triangulations have been used to increase the validity and reliability of social science research which are highlighted below:

a) *Data triangulation*: Entails a process of gathering data through several sampling strategies so that samples are drawn from the same population at different points in time and social situations.
b) *Investigator triangulation:* Encompassess a research process in which more than one researcher in the field to gather and interpret data is used.
c) *Theoretical triangulation*: Represents a research process where more than one theoretical position in interpreting data is used.
d) *Methodological triangulation*: Refers to the use of more than one method for gathering data.
e) *Environmental triangulation*: Consists of a research process in which researchers make use of different environmental conditions such as locations, settings and times.

(Denzin, 1970 p.300)

This thesis has used a number of methods for gathering primary data which include a household survey, focus group discussions and key informant interviews (*methodological triangulation*). The methodological triangulation provided an opportunity to gain a better understanding of farmers' lives and the ways in which they experience them and express their life stories (Denzin and Lincoln, 2005). Furthermore, combining different methods made it possible to clarify views that farmers held in relation to their irrigation canal from several standpoints (Blumstein and Schwartz, 1983) and to verify their interpretation, based on what had been gathered simultaneously using various methods (Stake, 1995, Onwuegbuzie and Leech, 2005). By adopting such a strategy, the "*flaws of one method are often the strengths of another*" (Denzin, 1978 p.302).

The employment of a mixed methods approach was decided on the basis of research needs, relevance, feasibility, accessibility and availability of research materials (Yin, 2009; Creswell, 2009). The process of triangulation occurred throughout data gathering and data analysis, and the findings were combined by using both quantitative and qualitative methods, and inferences and conclusions drawn accordingly. Simultaneously, the central phenomenon was explored and verified by qualitative data (Creswell, 2003; Tashakkori and Creswell, 2007). Also, the research process involved investigator triangulation implicitly as data were generated by three individuals, including the author as a Principal Investigator (PI) and two Nepalese students as research assistants. Both of the research assistants were studying rural development in Nepal: one with a background in forestry and the other in agri-business. Both of the research assistants were knowledgeable about the farming system, literature on natural resource management and local livelihood practices. They also had excellent communication skills, which made my own contacts with the rural households extremely easy (Bailey, 1996).

The research assistants were given two days training in conducting fieldwork, including household survey and taking notes during the focus group discussions. The research assistants also took part in a questionnaire pre-testing exercise to familiarise themselves with the household survey. Every effort was made to ensure that the research assistants collected data to the highest standard.

Furthermore, data collection took place in different settings and different timings i.e. *environmental triangulation*. The household survey took place at different times of the day during the fieldwork. The time of the focus group discussions and key informant interviews varied in the different locations within the research sites. The timing of the focus group discussions and key informant interviews had to be adjusted to meet the needs of the research participants for their convenience and to maximise the number of individuals participating in these activities (Devereux and Hoddinott, 1993; Bryman, 2004). On some occasions, the focus group discussions and key informant interviews took place in the morning whilst on other occasions they were conducted during the day or even in the evenings depending upon the availability of and convenience for the research participants. All aspects of research design, data collection and data analysis used mixed methods concurrently, as presented in Figure 3.7 (page 206).

The various methods used for data collection included a household survey, semi-structured interviews and focus groups, observation, field notes and documentary analysis, all within the overall design of a case study. *Data triangulation,* in which data were derived from several sources from different stakeholders in different settings, (farmers, members of the WUA committee, local politicians, the elderly, women, *dalits*, irrigation bureaucrats, engineers, policy makers and experts in the field) was employed (Mason, 2002). By selecting different settings, the similarities and unique aspects of the concepts in the settings emerged (Denzin, 1978).

All of the key informant interviews and focus group discussions were recorded using a portable audio recorder after getting consent from the research participants. The recording of the key informant interviews and focus group discussions were transcribed immediately after each session to capture and remember key information. The author was involved in transcribing and translating the data, and both the transcription and translation were carried out in ways which captured everything that was being said and the contents of the respondents' replies were not edited. Since the transcription and translation were done in the field itself, it was possible to cross-check and clarify the contradictions arising from the interview notes with the translations. If there were any contradictions and inconsistencies in the content then they were immediately clarified through the local key informant interviewees. Since all the qualitative data were audio recorded and saved in the computer, it was easier to double check for contradictions and inconsistencies during data analysis as well, and if any contradictions or anomalies still remained, those were clarified through follow up calls to the WUAs and the local farmers in the research sites.

The following section presents a brief discussion on the various methods used for collection data for this research.

3.6.1 Focus Group Discussions (FGDs)

Although commonly adopted under different aegis in the past, in recent years Focus Group Discussions (FGDs) have re-emerged as a popular data collection method in social sciences. They have been used to explore specific issues, such as people's views and experiences of contraception (Barker and Rich, 1992), drink driving (Basch *et al.,*1989), nutrition (Crokett *et al.,*1990), mental health (Grunig, 1990), communication studies (Albrecht *et al.,*1995; Staley, 1990), education (Brotherson and Goldstein, 1992), politics (Delli-Capini and Williams, 1994), marketing (Greenbaum, 1993) and development studies (Bamberger, 2000; Cernea, 1991). The following section presents a critical appraisal of the FGD, including its strengths, limitations and the process through which those strengths have been consolidated and limitations overcome during the operationalisation of the research.

3.6.1.1 Strengths of Focus Group Discussions

The nature of the research questions demand a detailed understanding of the farmers' perceptions, thoughts, feelings and emotions and thorough exploration of their experience of irrigation systems, their farming activities and rural village politics and their expectations of the irrigation systems (Krueger, 1988a). Since very little was known about farmers' perceptions of irrigation systems, it was necessary to stimulate research participants to gain an in-depth picture. In order to obtain rich contextual data, the focus group is the best suited research method, as it helps to identify farmers' concerns and stimulate fresh ideas pertinent to irrigation issues. Catherine Hakim argues: *"focus group discussion is often used for exploratory research areas where relatively little is known"* (2000 p.38). The operational flexibility of focus group methods helped the author to adapt them to obtain the changing circumstances of the different settings (location, caste composition, timing and so on) in which those discussions took place.

The focus group discussion was also an efficient means of determining the language people used when thinking and talking about irrigation issues and the prevailing institutional settings (Krippendorf, 2004). This helped to provide concentrated amounts of rich data, in participants' own words, where the participants' interactions added richness to the data that might be missed in individual interviews or surveys and, more importantly, provided critical information in the development and interpretation of quantitative survey data and subsequent data analysis. Focus group discussions also provided an opportunity for the researcher to interact directly with participants, facilitating discussions, probing responses, posing follow up questions and clarifying any dubious and contentious issues (Stewart *et al.,* 2007; Foddy, 1993). Some of the contentious issues in this research included alleged corruption by the members of the WUA committee in the AMIS, non-payment of water levy by farmers in the JMIS and alleged vandalism of canal infrastructures in the FMIS. For example, one of the participants of a focus group discussion in the AMIS mentioned that he was reluctant to pay the water fee. When asked to provide reasons for being reluctant to pay the water fee, he said that on the one WUA had failed provide water regularly while on the other hand it was involved in misuse of the fund. This issue was probed during the focus group discussions and another participant who was a serving executive committee member of the WUA committee disclosed that some of the members of the WUA had misused the fund in the past and the WUA lacked a proper auditing of its financial activities. In this respect, focus group discussions also helped to facilitate the interpretation of the quantitative results and add depth to the responses obtained in the more structured survey (*ibid.*).

3.6.1.2 Limitations of Focus Group Discussions

However, despite all the above mentioned substantive and practical advantages, I had to be careful about some of the limitations to the focus group discussions. Some researchers have increasingly become critical of the value of focus group discussions as a way of generating data (Kitzinger, 1993; Wimmer and Dominick, 1997; Krueger, 1988a, b; Morgan, 2002). Some of the common criticisms of the focus group discussion as a research method which are reported in the literature include the following:

Firstly, the limited number of participants has meant that the data obtained from them begs questions on representativeness of the data and the generalisability of the research findings. Secondly, the interactions between participants and moderator and amongst participants, particularly the latter's' responses, were not independent of each other. This might skew their opinions and put the generalisability of the findings into question (Argyris, 1988). Thirdly, some participants of the focus group discussions were highly interactive, whilst some were hesitant to participate. Whilst active participation is encouraged, imbalanced participation in a focus group can skew not only the discussion but also the data generated and the subsequent analysis as Wimmer and Dominick (1997) argue:

"---*focus groups are not a good research methodology because of the potential influence of one or two respondents on the remaining members of the group. These critics say that a dominant respondent can negatively affect the outcome of the group and that group pressures may influence the comments made by individuals"* (p.461).

Fourthly, given the 'open ended' nature of the FGDs, there is a danger that the discussion might be lengthy and unrelated to the core research theme. Protracted and unrelated discussion leads to the generation of irrelevant data at the cost of genuine discussions on the research topic.

3.6.1.3 Operationalisation of Focus Group Discussions

The participants of the focus group discussions and were drawn from different categories to reflect the socio-economic heterogeneity of the community and to make the samples more representative. From the FMIS, all together 56 farmers were grouped into five categories with one from each of the five branches of the Phalebas canal. Detailed information on the number of participants and the different heterogeneities they represent is presented in Table 3.6. The first focus group discussion in the FMIS took place at a meeting place in the Sewa Kendra area within the Jogi Chaur branch. All together, 11 farmers participated in the meeting. There were three farmers from the head and the middle section and 5 from the tail end. Similarly, there were three farmers from large landholding categories whilst two and three farmers from medium and small landholding categories respectively. Of the total participants, nine were from higher caste groups and the remaining two belonged to the dalit castes. Two of the participants had agriculture as a secondary occupation whilst nine people took agriculture as a primary occupation. The participants had different educational qualifications as seven of them were illiterate and three farmers were educated to primary level. Only a small proportion of participants (two) were educated to college level. There were an equal number of male and female participants in the focus group discussions.

The second focus group discussion took place at the Tallo Khaula of Dee area branch within the FMIS where all together 20 people participated.

Table 3.6: Focus Group Discussions in the FMIS

Categories	Focus Group Discussions [Venue for Discussions] % (n)				
	Jogi Chaur ***[Sewa Kendra]***	**Dee Area** ***[Tallo Khaula]***	**Kumal Gaun** ***[Kumal Gaun]***	**Sat Kuriya** ***[Devi temple]***	**Chhaubis Kuriya** ***[Phalebas Bazaar]***
Gender					
Male	91 (10)	75 (15)	66.6 (4)	70 (7)	66.6 (6)
Female	9 (1)	25 (5)	33.3 (2)	30 (3)	33.3 (3)
Location					
Head end	27 (3)	35 (6)	33.3 (2)	30 (3)	22 (2)
Middle end	27 (3)	25 (5)	33.3 (2)	50 (5)	33.3 (3)
Tail end	46 (5)	45 (9)	33.3 (2)	20 (2)	44.7 (4)
Landholdings					
Larger	27 (3)	20 (4)	16.6 (1)	20 (2)	22 (2)
Medium	18 (2)	15 (3)	16.6 (1)	20 (2)	11 (1)
Small	55 (6)	65 (13)	66.6 (4)	60 (6)	66.6 (6)
Caste					
Higher caste	82 (9)	85 (17)	33.3 (2)	60 (6)	66.6 (6)
Dalits	18 (2)	15 (3)	66.6 (4)	40 (4)	33.3 (3)
Primary Occupation					
Agriculture	73 (7)	10 (2)	83.4 (5)	80 (8)	100 (9)
Non- agriculture	27 (3)	90 (18)	16.6 (1)	20 (2)	0 (0)
Level of Education					
Illiterate	46 (5)	60 (12)	83.4 (5)	60 (6)	44.7 (4)
Primary	27 (3)	35 (7)	16.6 (1)	30 (3)	22 (2)
College	27 (3)	5 (1)	0 (0)	10 (1)	33.3 (3)
Others					
Total	100 (11)	100 (20)	100 (6)	100 (10)	100 (9)

A significantly higher proportion of the participants (12 participants) were illiterate whilst remaining seven and one participants had education up to primary and college level respectively. There were 15 male and five female farmer participants in the focus group. A significantly higher proportion of farmers (nine) were tail-enders whilst the remaining five and six participants came from the middle and the head sections of the canal command area respectively. Similarly, a significantly higher proportion of farmers (13 in total) were small farmers, whilst farmers belonging to the large and medium landholding category were four and three respectively. A total of 17 participants belonged to higher castes while the remaining three participants were from the *dalit* castes. Also, an overwhelmingly high number of participants (18 in total) had agriculture as their primary occupation whilst the remaining two participants took agriculture as their secondary occupation.

The third focus group discussion was held at the village of Kumal Gaun of the Kuman Gaun branch within the FMIS where all together only six farmers participated in discussions, of which four were males and the remaining two were females. There were equal number of participants (two each) from the head end, middle end and tail end of the branch canal. Of the six participants, four were small landholders whilst the remaining participants (one each) belonged to medium and large landholding categories. Two participants were from higher castes whilst the remaining four participants belonged to the *dalit* castes. Also, none of the participants had a college level of education. The participants were either illiterate or had just primary level education. A majority of the participants were involved in agricultural activities whilst a small proportion of them had agriculture as secondary occupation.

Similarly, a focus group discussion was held at the Devi temple area of the village of Satkuriya, which is located within the FMIS. A total of 10 people participated in the discussions, of which seven were males while the remaining three were females. The participants of the Devi temple meeting were very heterogeneous. The number of participants from head, middle and tail end of the branch canal were three, five and two respectively. A majority of the participants (six) were small farmers and of the other four, two were from the medium and two were from the large landholding categories. All of the participants in Satkuria village had agriculture as their primary occupation. Also, there were six participants from higher castes and four from the *dalit* castes.

The final focus group discussions took place in the Phalebas Bazaar area of Chaubiskuriya branch within the FMIS, in which a total of nine farmers participated; six of which were male and three were female. Also, there were six participants from higher caste groups while remaining three participants belonged to the *dalit* castes. Six participants belonged to small landholding categories while two came from large landholding groups and only one from the medium landholding category. The number of participants from the head end, middle end and tail end of the branch canal were two, three and four respectively. Of the total participants, three were educated to college level and four farmers were illiterate. There were two participants with a primary level of education.

Similar focus group discussions were also held in the AMIS area with heterogeneous participants. All together, 59 farmers were grouped into five categories with one from each of the five branches of the AMIS. More detailed information on the number of participants and the different heterogeneities they represent is presented in Table 3.7. The first focus group meeting was held at the Dunge Patan area of BC-1 within the AMIS where a total of 12 farmers participated in the meeting, of which 10 were male and the remaining two were female. There were an equal number (four each) of farmers participating from the middle, head and tail end of the BC-1. A significant proportion of participants (seven) were small farmers while participants from the medium and large landholding categories were three and two respectively. Also, ten of the participating farmers were from higher castes while the remaining two belonged to the dalit castes. Similarly, agriculture was a primary occupation for nine participants and a secondary occupation for the remaining three.

The second focus group discussion was held at the Upallo Gagangauda area of the BC-2 in which 14 farmers participated in the discussions, of which 10 were male and the remaining four were female. Four farmers were head-enders while the remaining 10 farmers (five each) were from the middle and tail end of the branch canal. The numbers of participants from the large, medium and small landholding categories were as three, six and five respectively. The participants represented both higher and lower castes with 11 of them from the former and three from the latter caste group. Ten participants considered agriculture as their primary occupation, whilst the remaining four undertook non-agricultural activities as a primary occupation but undertook agriculture as secondary occupation.

Table 3.7: Focus Group Discussions in the AMIS

Categories	Focus Group Discussions [Venue for Discussions] % (N)				
	BC-1 ***[Dhunge Patan]***	**BC-2** ***[Upallo Gagangauda]***	**BC-3** ***[Sajha Bazaar]***	**BC-4** ***[Tallo Gagangauda]***	**BC-5** ***[Eklo Kuna]***
Gender					
Male	83 (10)	71 (10)	100 (13)	78 (7)	73 (8)
Female	17 (2)	29 (4)	0 (0)	22 (2)	27 (3)
Location					
Head end	33.3 (4)	29 (4)	30 (4)	33.3 (3)	36.5 (4)
Middle end	33.3 (4)	35.5 (5)	30 (4)	33.3 (3)	27 (3)
Tail end	33.3 (4)	35.5 (5)	40 (5)	33.3 (3)	36.5 (4)
Landholdings					
Larger	17 (2)	21.5 (3)	23 (3)	22 (2)	18 (2)
Medium	25 (3)	43 (6)	40 (4)	33.3 (3)	27 (3)
Small	58 (7)	35.5 (5)	37 (6)	44.7 (4)	65 (6)
Caste					
Higher caste	83 (10)	78.5 (11)	85 (11)	78 (7)	82 (9)
Dalits	17 (2)	21.5 (3)	15 (2)	22 (2)	18 (2)
Primary Occupation					
Agriculture	75 (9)	71 (10)	77 (10)	89 (8)	73 (8)
Non- agriculture	25 (3)	29 (4)	23 (3)	11 (1)	27 (3)
Level of Education					
Illiterate	25 (3)	29 (4)	23 (3)	22 (2)	18 (2)
Primary	41.7 (5)	42 (6)	37 (6)	44.7 (4)	36.5 (4)
College	33.3 (4)	29 (4)	40 (4)	33.3 (3)	45.5 (5)
Total	12 (100)	100 (14)	13 (100)	9 (100)	11 (100)

Similar focus group discussions were also held at Sajha Bazaar area of the BC-3 within the AMIS in which a total of 13 farmers participated. However, these focus group discussions were characterised by a complete absence of female participants. All of the participants were male; five were from the tail-end while the middle and the head end section of the branch canal were represented by four participants respectively. This group was also dominated by individuals from higher caste groups; 11 participants belonged to higher castes while only three came from *dalit* castes. The number of farmers belonging to large, medium and small landholding categories were three, four and six respectively. Ten participants undertook agriculture as their primary occupation and four as a secondary occupation.

The fourth focus group discussions were held at the Tallo Gagangauda area of the BC-4 from the AMIS in which a total of nine people participated, of which seven were male and two were female. Three farmers from each of the head, middle and tail end of the BC-4 participated in the focus group discussions. Similarly, the group was dominated by the farmers from the higher castes (seven) compared with the *dalit* castes (two). A majority of the participants (eight) undertook agriculture as their primary occupation while only one of them undertook it as a secondary occupation. The group was also very heterogeneous in terms of the participants' levels of education. Three participants were educated to college level while four of them had a primary level education. The remaining two were illiterate.

Similar focus group discussions were also held at the Eklo Kuna village of BC-5 in the AMIS in which 11 members of the local community participated.

Similar to other groups, this group was also highly heterogeneous. Eight participants were male while the remaining three were female. There were four individuals each participating from the head and the tail end of BC-5 while three were from the middle section of the branch canal. There were two farmers with a large landholding whilst three medium landholders and six small landholders. Two of the participants belonged to *dalit* castes whilst the remaining nine were farmers from higher caste groups.

Focus group discussions were held in the JIMS area too. All together, six focus group discussions were held in different blocks (branch canals) of the JMIS in which a total of 84 farmers participated. Detailed information on the number of participants and the different heterogeneities they represent is presented in Table 3.8. The first focus group discussions were held at the Borangkhola village of Block-1 from the JMIS in which a total of 11 people participated of which eight were male and three were female. Four farmers from each of the middle and tail end of the Block-1 participated in the focus group discussions while three participants were head-enders. Similarly, the group was dominated by the farmers from the higher castes (eight) whilst only three participants came from the *dalit* castes. A majority of the participants (eight) undertook agriculture as their primary occupation and only three as a secondary occupation. The group was also very heterogeneous in terms of level of education of the participants. Two participants were educated to college level while six of them completed primary education. The remaining three were illiterate.

Table 3.8: Focus Group Discussions in the JMIS

Categories	Focus Group Discussions [Venue for Discussions] % (n)					
	Block 1 ***[Borang Khola]***	**Block 4-5** ***[Satbise Bazaar]***	**Block 7** ***[Tinpiple]***	**Block 11** ***[Gaulitar]***	**Block 13** ***[Nayapauwa]***	**Block 16** ***[Thulo Bagaincha]***
Gender						
Male	72 (8)	73 (11)	59 (10)	50 (6)	66.6 (10)	64 (9)
Female	28 (3)	27 (4)	41 (7)	50 (6)	33.3 (5)	36 (5)
Location						
Head end	28 (3)	33.3 (5)	30 (5)	33.3 (4)	33.3 (5)	28 (4)
Middle end	36 (4)	33.3 (5)	35 (6)	33.3 (4)	33.3 (5)	36 (5)
Tail end	36 (4)	33.3 (5)	35 (6)	33.3 (4)	33.3 (5)	42 (6)
Landholdings						
Larger	18 (2)	20 (3)	24 (4)	25 (3)	27 (4)	21 (3)
Medium	28 (3)	33.3 (5)	35 (6)	33.3 (4)	27 (4)	21 (3)
Small	54 (6)	46.7 (7)	41 (7)	42 (5)	46 (7)	58 (8)
Caste						
Higher caste	72 (8)	80 (12)	76 (13)	66.6 (8)	66.6 (10)	72 (10)
Dalits	28 (3)	20 (3)	24 (4)	33.3 (4)	33.3 (5)	28 (4)
Primary Occupation						
Agriculture	72 (8)	73 (11)	70 (12)	84 (10)	80 (12)	72 (10)
Non- agriculture	28 (3)	27 (4)	30 (5)	16 (2)	20 (3)	28 (4)
Level of Education						
Illiterate	28 (3)	46.7 (7)	35 (6)	42 (5)	40 (6)	28 (4)
Primary	54 (6)	33.3 (5)	41 (7)	42 (5)	40 (6)	36 (5)
College	18 (2)	20 (3)	24 (4)	16 (2)	20 (3)	36 (5)
Total	100 (11)	100 (15)	100 (17)	100 (12)	100 (15)	100 (14)

The second focus group discussion in the JMIS took place at meeting place in the Satbise Bazaar of Chakratirtha VDC in which farmers from Block-4 and 5 participated in the discussions. All together, 15 farmers participated in the meeting. There were five participants from the head, the middle and the tail section of the blocks. Similarly, there were three farmers from large landholding categories whilst five and seven farmers from medium and small landholding categories respectively. Of the total participants, 13 were from the higher caste groups and the remaining four belonged to the *dalit* castes. Ten of the participants had agriculture as a secondary occupation whilst for seven of the participants agriculture was a primary occupation. The participants had different educational qualifications as seven of them were illiterate and five farmers had received primary education. Only a small proportion of participants (three) were educated to college level. There were 11 male participants and seven participants were female.

Similar focus group discussions were also held at the Tinpiple Bazaar area of the Block-7 within the JMIS in which a total of 17 farmers participated. However, this focus group discussion was characterised by a gender balance to a respectable degree. Ten participants were male whilst seven were female. The middle and the tail end sections of the branch canal were represented by six participants each, while five members were from head-enders. This group was also being dominated by individuals from higher caste groups with13 participants and only four from *dalit* castes. The number of farmers belonging to large, medium and small landholding categories was four, six and seven respectively. Twelve participants had agriculture as their primary occupation whilst five had it as a secondary occupation.

The fourth focus group discussions were held at the Gaulitar village area of the Block-11 from the JMIS in which there was a total of twelve farmers with equal participation of both male and female. Six participants were male and six were female. Also, there was equal representation from head, middle and tail sections of the canal with four farmers from each respectively. Similarly, the group had a significantly higher proportion of farmers from higher castes; with eight compared to only four from the *dalit* castes. A majority of the participants (ten) were involved in agriculture as a primary occupation whilst only two of them as a secondary occupation. The group was also very heterogeneous in terms of participants' level of education. Two participants were educated to college level while five of them had received a primary education. The remaining five were illiterate.

Similar focus group discussions were also held at Nayapauwa area of Block 13 and Thulobagaincha area of Block 16 from the JMIS. Similar to other groups, the participants of these focus group discussions were also highly heterogeneous and represented the socio-economically diverse communities. The details on the number of participants from different categories of heterogeneities are presented in Table 3.8.

Firstly, in order to encapsulate the heterogeneous nature of the irrigation communities, careful consideration was given to ensuring that an adequate sample was selected from several subgroups (e.g. gender, age, level of education, size of landholding, location and caste/ethnicity). These subgroups were developed based on the heterogeneities existing in the rural communities of the research sites as mentioned in Chapter Two (Section 2.5 and Section 2.10). This was achieved by sampling purposively. The idea of purposive sampling is to increase internal generalisation or trustworthiness of data as opposed to external generalisation (Gomm *et al.,* 2000, Kemper *et al.,* 2003). Purposive sampling not only helped capture community heterogeneity but also to gather rich data, including both typical and atypical cases (Patton, 1990; Lofland and Lofland, 2006). This helped in garnering information on the farmers' needs, expectations, degrees of engagement in and dependence on irrigation resources through gaining access to the farmers' natural, cultural and social world (McCracken, 1988; Gomm *et al.,* 2000). The selection of atypical cases also gave opportunity to learn more from their stories (Stake, 1995). It is clear from Tables 3.6-3.8 that the participants of the FGD represented heterogeneous communities, including participants from each of different location, caste/ethnicity, landholding size, educational level, occupation and gender.

Secondly, the level of interactions amongst the participants of the focus group discussions and the discussion between the participants and the moderator, has an immense bearing not just on the interactions themselves but also for the quality of the data generated (Gilbert, 2008). Whilst almost all the focus group discussions were conducted reasonably smoothly, some of them were clearly challenging. Some of the problems encountered during the focus group discussions include dominant and hesitant members of the group, private conversation and whispering, and discussion becoming lengthy and unrelated to the topic. In order to overcome these problems a number of strategies were used. Firstly, the role of moderator was absolutely critical in managing the focus group discussions (Puchta and Potter, 2004; Stewart *et al.,* 2007). The author recognised the importance of having a group moderator and took on this role for the focus group discussions by demonstrating excellent interpersonal and communication skills, and showing a genuine interest in all the participants. As a moderator, the author understood his role and acted as a neutral moderator rather than participating actively in the discussion as this was likely to influence the interactions and responses (Bryman, 2008). The author demonstrated both passion and patience in moderating and listening to the views and sometimes uncomfortable remarks expressed by the participants of the discussions. The moderator's role was to act as facilitator but also to intervene if the discussions were inappropriate.

Whilst a majority of the focus groups were balanced in terms of individual contribution to the discussions, some of the groups comprised of more dominant members than others; resulting in some hesitant participants. This is something that I had anticipated as rural Nepalese society is very hierarchical in which some members of the community dominant others. For example, crop-sharers would be reluctant to criticise landlords, women are dominated by men and people from lower castes are dominated by individuals from higher caste groups. For instance, a landlord from a higher caste group threatened a landless *dalit* farmer, who has leased-in a small piece of land from him, to stop leasing him land from next year when he criticised him for stealing water from the canal. Whilst a level playing field was provided to all the participants in the focus group discussions, it should be taken in relative terms as some members have remained oppressed in their locality for decades if not centuries. The issue of heterogeneities and power relationships amongst the farmers in rural Nepal in relation to their irrigation resources have been already discussed in detail in Chapter Two (Sections 2.5 and 2.7).

It was necessary that all the members of the groups participated in the discussions as failure to do so would jeopardise the quality of data (Kitzinger, 1994). The reluctant members were gently drawn into discussions by directing questions at them. When directing questions at the reluctant members of the group, care was taken not to intimidate them but to encourage them to participate in the discussions freely and actively. In order to manage the dominant members of the group, their contribution was acknowledged and other group members were asked what they thought about the dominant members' contribution. Also, a direct eye contact was avoided with dominant members of the group as it might affect the impartiality of the moderator. At times, when the members were clearly dominating and driving the discussions to irrelevant topics, they were asked in an "*assertive*" manner to be quiet and allow other members to speak and contribute to the discussions (Gilbert, 2008). If any participants still hesitated in expressing themselves, their concerns were followed up after the FGD in one to one interviews.

Thirdly, to keep discussions on track and make them relevant to the research theme, the moderator guided them around the topic managing some dominating and strongly opinionated participants. Topic guides pertinent to the research questions were prepared and used for guiding and fostering discussion, which made both the discussions and the data obtained manageable and minimised lengthy and unrelated conversation prevailing during the FGDs. Topic guides used for focus group discussions are presented in Table 3.13. These encompassed all aspects of irrigation management, including the physical conditions of canal infrastructure, collective actions, O & M activities, water distribution, water levy collection, revenue regeneration, sanctions and conflict resolution, water use and irrigation scheduling, WUA committees and so forth. The use of topic guides for the focus group discussions was both practical and helpful in understanding farmers' perceptions, difficulties and challenges faced in managing their canal systems. Questions were asked as to how they litigated with the district and regional irrigation authorities for such things as budgets and technical expertise. The FGDs helped with the understanding of the range of knowledge, attitudes, and practices, including the logic of water distribution and the identification of vulnerable groups in water distribution. Other general aspects of block level discussions also applied for these FGDs. They were convened to raise awareness amongst the irrigators on the wider issues of irrigation management, and to discuss in broad terms the objectives of the research itself. This helped in gathering useful information pertinent to the research questions and solicited feedback on the kinds of information that the study could usefully provide to actors in irrigation management, thus improving the livelihoods of vulnerable groups in the area and their access to irrigation water.

The FGDs were held at the branch/block level. Blocks are administrative units in irrigation governance, which are primarily responsible for the management of the canal networks, and occasionally of the main canal. Each block or branch consists of a number of hamlets, which can be ethnically diverse, mixed or homogenous, depending on settlement patterns. In general, hamlets in the plot areas are mixed. In order to obtain individual perceptions, FGDs were conducted in heterogeneous settings (both in income, social status, ethnicity and spatial location of landholdings), and both men and women were encouraged to participate fully and contribute actively to the discussion. This helped to capture the gender dimensions and capitalise on the experiences of women.

Open ended questions pertinent to irrigation governance, including conflict resolution, water distribution, fee payment and so on were put to the members who took part in FGDs. The groups provided a unique opportunity to understand the perceptions of community members on a number of issues, including the functioning of block committees, roles and responsibilities of farmers, water charges, water distribution, conflict resolution, and management of communal funds, and their awareness of and participation in irrigation management.

The rationale for undertaking focus group discussions was to gather farmers' perspectives on the performance of their irrigation systems and the ways in which they interacted with each other in relation to their irrigation systems. Crucially, it was believed that the data collected through focus group discussions would help shed light on the differences in levels of access to irrigation water from systems governed by different property rights regimes. Although there are no set research questions that the focus group discussions sought to answer, it is hoped that the data generated through focus group discussions will be helpful in explaining the differences in the level of access to irrigation water across different levels of heterogeneity considered for this research. Crucially, the focus group discussions aimed to define the access threshold described in this chapter (Section 3.9).

3.6.2 Key Informant Interviews (KIIs)

Key Informant Interviews (KIIs) are qualitative interviews with people who are aware of what is going on in the community (Denzin and Lincoln, 2005). The following section presents a critical review of key informant interviews, including its strengths, limitations and the process through which those strengths were consolidated and limitations overcome during the operationalisation of the research.

3.6.2.1 Advantages of Key Informant Interviews

Through key informants interviews, the aim was to gather respondents' "*personal feelings, opinions, and behaviours*" (Seidler, 1974 p.817), but informants generalise "*about patterns of behaviour, after summarizing either observed (actual) or expected (prescribed) individual relations associated with canal related activities"* (*op. cit.* p.817). By conducting in-depth interviews, it was possible to analyse not only farmers' attitudes and behaviour, particularly in relation to their irrigation canals, but also the long term experiences and expectations concerning the canal, including the canal management committees.

In rural Nepal, particularly in the research sites, a majority of farmers have agriculture as their primary occupation. Whilst a small proportion of respondents were also involved in non-agricultural activities, such as businesses, cottage industries and services, they were also involved in agricultural activities to supplement their income and vice-versa. In rural Nepal it is very common for individuals with jobs in the business and service sectors to also undertake some agricultural activities (Adhikari *et al.,* 2004). Therefore, the majority of the farmers who took part in the key informant interviews were primarily farmers. The inclusion of individuals with agriculture as a secondary occupation in the focus group discussions helped to shed light on their views pertinent to the irrigation issues in the villages. There was no distinction made between people undertaking agricultural activities as a primary occupation and those as a secondary occupation.

Importantly, key informant interviews were used to elicit and provide a platform for local farmers, including the *dalits*, women and uneducated people, to share their experiences and have their voices heard (Ungar, 2003; Creswell, 2009), which is one of the desired objectives of social policy. Furthermore, they helped to explain divergent, unexpected and immature or incomplete results, as well as unseen contextual factors (Jick, 1979) during analysis and interpretation. In this regard, the key informant interviews worked in adjunct to other methods rather than as alternatives to them, providing additional evidence of efficacy (Cook and Payne, 2002). In fact, it could be argued that the qualitative methods in this study were found to be "*the glue that cements the interpretation of multi-method results*" (Jick in Miles and Humberman, 1994 p.42).

Furthermore, through key informant interviews, it was possible to gather in-depth knowledge on the socio-economic world of the people and the process in which their interactions with each other take place. It is believed that such information is more likely to be generated and understood through in-depth key informant interviews, which seek viewpoints of participants (Gomm, 2004). The key informant interviews in this study were found to be useful to supplement, validate, explain, illuminate and reinterpret quantitative data (Miles and Huberman, 1994). In some cases, the results of the statistical analysis using quantitative data were insignificant but during the triangulation process the qualitative data strongly indicated otherwise. The richness of the qualitative data helped to describe both the practical and policy significance of the results despite being statistically insignificant. More information on these aspects of analysis are presented in Chapter Four and Chapter Five.

Inaudible and silenced voices and relatively unknown topics (canal shape, canal gradient, vandalism and neglect of infrastructures and social and economic needs) were explored and explained through the qualitative approach, which helped with the understanding of many of the social relationships and tacit knowledge of the participants' social world (Ungar, 2003).

3.6.2.2 Limitations of Key Informant Interviews

Like any other research methods, the key informant interviews have some significant drawbacks. It should be pointed out that both informant bias and random error can taint informant reports. Firstly, the information provided by an individuals taking part in the in-depth interview may vary significantly depending on socio-economic position within the community and organisational role in irrigation related activities (Seidler, 1974). For example, the views of the irrigation engineers may systematically vary from those of the farmers because their organisational roles influence their interpretations of events and evaluations of irrigation performance. In addition, other more idiosyncratic sources of error may contaminate informant reports, especially retrospective accounts (Salancik and Meindl, 1984, Schwenk, 1985). Informant reports suffer from individual memory failure, or the inaccurate recall of past events (Golden, 1992), as well as from memory distortion (Nutt, 1986; Kumar *et al.,* 1993). Secondly, information might be distorted on purpose or from hindsight bias, attribution bias, subconscious attempts to maintain self-esteem, or impression management (Huber and Power, 1985). Also, there is the risk of their being little correspondence between informant reports and actual events.

With due acknowledgment of the limitations of key informant interviews, and following a set of eligibility questions that verified key informants were selected from a pool of individuals who had firsthand knowledge of irrigation issues in local settings and could provide complete and in-depth information, which would not be available through other means.

3.6.2.3 Operationalisation of Key Informant Interviews

At the irrigation system level, all together ten individuals from each of the AMIS and the JMIS and twelve from the FMIS were selected for the key informant interviews. In order to make the sample more representative of the community in all the three irrigation systems, individuals were selected from a range of heterogeneity dimensions including gender, location, size of landholding, caste, education and primary occupation. The detailed characteristics of the sample for Key Informants' Interviews are presented in Table 3.9.

Semi structured interviews were held with key informants including the *dalit* leaders, women leaders, local landlords, teachers, the *Dhalepas* from different landholding categories, at both head end, middle and tail end of the canal structures, past chairmen and incumbent chairmen of the three irrigation systems. The *Dhalpas* are paid staff who are usually from the local area and have a wealth of information about the local areas. Their assignments include opening and closing water gates and reporting to the block committees in the JMIS and the FMIS amongst others, theft of water, and any physical damage to canal infrastructures (in the case of the AMIS, they are responsible to the DoI. The *Dhalepas* have superior knowledge about the informal institutions that influence the accessibility of irrigation water and cooperation between households for the collective management of the irrigation canal. They also have knowledge about water theft, and different methods adopted by potential fraudsters to steal water from the irrigation canal. The perspectives of *Dhalepas* are important in designing policy interventions to tackle fraud, repair canal infrastructures and so on.

The Executive Director of the Farmers Managed Irrigation Promotion Trust (FMIPT) was also interviewed to get his perspective on the devolution of irrigation governance to local communities in Nepal. These key informants were asked questions pertinent to irrigation governance, funding mechanisms, and issues related to devolution of irrigation management to local farmers. Since these activities were associated with bureaucracies, it was anticipated that this would be time consuming. In order to avoid bureaucratic hassles and for the smooth running of the key informants' interviews, every effort was made to establish contact with the individuals who could help in identifying the key informants at a local level.

For the majority of the respondents, agriculture was their primary occupation whilst some respondents were also involved in non-agricultural activities such as business, cottage industries and services. It should be pointed out that even though respondents were involved in non-agricultural activities as their primary occupations, they were also involved in agricultural activities to supplement their income and vice-versa. In rural Nepal, it is very common for individuals with jobs in business and the service sectors to undertake some agricultural activities. Also, the majority of the respondents were illiterate, which is not uncommon, as the level of education still remains very low in rural areas in Nepal. Whilst it was relatively easy to interview educated farmers, it was challenging to interview farmers with little or no education and to put probing questions to them. This is because the people with little or no education were unfamiliar with activities such as key informant interviews and the terminologies used during the course of interviews, were suspicious of the objectives of the study and were fearful of making mistakes and giving incorrect answers during the interviews. However, in order to include illiterate participants, every effort was made to listen to and learn from their experiences.

The rationale for undertaking key informant interviews was to gather qualitative information on farmers' perspectives on the performance of their irrigation systems and the ways in which they interacted with each other in relation to to their irrigation systems. Crucially, it is believed that the data collected through key informant interviews will help to shed light on the differences in farmers' levels of access to irrigation water from those systems governed by different property rights regimes. The data collected through the key informant interviews will address the second big issue raised in this thesis, i.e. the role of institutions in enabling farmers' to access irrigation water. It is hoped that the data generated through the key informant interviews will be helpful in explaining the differences in the level of access to irrigation water across all levels of heterogeneity considered for this research.

The participants of the key informant interviews were drawn from different categories to reflect the socio-economic heterogeneity of the community and to make the sample more representative. From the FMIS, all together 12 individuals were interviewed whilst ten key informants were interviewed from each of the AMIS and the JMIS. Detailed information on the number of participants and the different heterogeneities they represent are presented in Table 3.9 It is important to maintain the quality of the data which was collected through multiple methods. In order to maintain consistency in the nature and the quality of the data collected, they were cross-checked at the transcription/translation stage. The contents of the focus group discussions and key informant interviews were cross examined in a number of ways. Firstly, by physically listening to the recordings made during the interviews. Secondly, they were cross-checked during the translation and transcription stages; if any inconsistencies and contradictions were identified they were clarified immediately through the local farmers, including key informant interviewees and the participants of the focus group discussions. Thirdly, the data was cross-checked during the data analysis process which used thematic matrices as provided in Section 3.8.1 (Table 3.13). Some of the remaining contradictions were clarified through follow up calls to the WUAs and the local farmers. Whilst consistency in data is an important issue, the contradictions which came about were not discarded but were either clarified or taken on board by providing sufficient evidence to accommodate different viewpoints expressed by the farmers and inferences are reached and conclusions drawn chiefly from the primary data generated during the course of the research.

Table 3.9 Key Informant Interviews in the three irrigation systems

Categories	**Key Informants**		
Gender	**JMIS** **% (n)**	**AMIS** **% (n)**	**FMIS** **% (n)**
Male	90 (9)	60 (6)	50 (6)
Female	20 (2)	40 (4)	50 (6)
Location			
Head end	30 (3)	30 (3)	33.3 (4)
Middle end	30 (3)	30 (3)	33.3 (4)
Tail end	40 (4)	40 (4)	33.3 (4)
Landholdings			
Larger	30 (3)	30 (3)	33.3 (4)
Medium	30 (3)	30 (3)	33.3 (4)
Small	40 (4)	40 (4)	33.3 (4)
Caste			
Higher caste	70 (7)	70 (7)	66.6 (8)
Dalits	30 (3)	30 (3)	33.3 (4)
Primary Occupation			
Agriculture	80 (8)	70 (7)	75 (9)
Non- agriculture	20 (2)	30 (3)	25 (3)
Level of Education			
Illiterate	40 (4)	30 (3)	58 (7)
Primary	40 (4)	40 (4)	25 (3)
College	20 (2)	30 (3)	17 (2)
Total	10 (100)	10 (100)	12 (100)

3.6.3 Household Survey

Surveys have been widely applied in research strategy, aiming to gather data in order to map the social world of the subjects (Sturgis, 2008). Social surveys are carried out to gather statistical information about the attributes, attitudes and actions of a population by administering standardised questions to some of its members (Buckingham and Saunders, 2004). The necessity of using surveys for this research came from the research questions themselves, particularly questions 1a, b,c and d, which sought to investigate and compare the benefits received by small farmers, the *dalits* and tail-enders. All the above mentioned research questions have a strong empirical focus, requiring wide ranging and inclusive data in order to view the '*phenomenon',* i.e. their level of engagement in and amount of benefits derived from irrigation systems both inclusively and comprehensively (Sapsford, 2007). However, both costs and time factors were clearly constraints for conducting comprehensive the survey and sampling was clearly a viable option for this research. Since, the administration of the research questionnaires was carried out by the author, it was relatively inexpensive. The survey method also provided a unique opportunity to sample households, which could relate to the characteristics of the population from which the sample was drawn. The survey method was very flexible for generating data, particularly the descriptive statistics critical to making statistical inferences from sample to population. In other words, by using the sample it was possible to make statistical inferences from respondents to the wider population through generalisation (Buckingham and Saunders, 2004). Equally important, the use of a survey helped to collect statistical data with greater precision by standardising the questionnaire design and maintaining uniformity, while executing the survey questions. The statistical data collected through the survey method was useful in investigating *"causal process, to develop and test hypothesis on associations and relationships between the variables"* (Hakim, 2000 p.76). The aim of the thesis was to compare the irrigation systems governed by different property rights regimes. The standardisation and uniformity of the survey greatly assisted the collection of similar data from different irrigation systems, which could then be interpreted comparatively (Denscombe, 2006). By using a rigorous stratified random sampling procedure, a more representative sample was collected, which in turn helped to increase reliability through the application of standardised stimuli to the participants and minimising participants' subjectivity (Hakim, 2000). The sampling procedure is described in detail in Section 3.6.3.2.

However, some practical difficulties were encountered during the household survey. Firstly, given the heterogeneous nature of the irrigation communities, it was a huge challenge to collect a truly representative sample (Fink, 2003), but care was taken, through stratified random sampling, to make the sample as representative as possible. The method of stratified random sampling involves dividing the population into small groups called strata, where groups are formed based on their members sharing a specific characteristic. A random sample from each stratum is taken, in a number proportional to its size when compared to the population (Lohr, 2010). The strata consisted of various categories which are based on the socio-economic heterogeneities existing in the rural communities in Nepal. The heterogeneities considered for the purpose of selecting sample for this research include variables such as caste, gender, location of landholding and size of landholding. The households were divided into higher and lower castes. Similarly, the strata along the dimension of location of landholding were head end, middle end and the tail end depending on the location of household's landholding within the canal command area. Along the gender dimension, households were stratified into two categories i.e. male-headed and female-headed households depending on who the head of the household was. The head of the household was on the one who made major decisions on behalf of other members of the household such as financial matters, marriage and participation in local politics including irrigation related activities. Also, the households were divided into three categories based on the household's amount of landholding. A detailed classification of households based on the size of landholding is provided Chapter Three (Section 3.6.3.2). The criteria used for dividing into different landholding categories are presented in Table 3.11. These subsets of the strata are then pooled to form a random sample. The stratification of samples ensures that a correct proportion of households is surveyed from each category of the population, whilst randomness ensures that every household has a similar chance of being included in the survey (Levy and Lemeshow, 2008).

Another practical dilemma that was faced during the fieldwork was that it was physically impossible to directly observe respondents' activities in order to independently validate survey responses. Data collection, particularly through survey and key informant interviews, involved gathering verbal responses to the questions and respondents' recollections of the events in retrospect might not have always been very accurate, partly because people forget events that took place in distant past (Buckingham and Saunders, 2004). Similarly, since the survey used a structured questionnaire seeking objective answers to the research questions, it did not necessarily gather the in-depth and quality information which is normally obtained through key informant interviews and focus group discussions. This is one of the problems generally associated with household surveys and the shortcoming was addressed through triangulation.

3.6.3.1 Questionnaire Design

In order to carry out the household survey, a questionnaire was designed to gather information concerning irrigation governance from the household respondents. As mentioned earlier, the management of irrigation systems involves multiple activities including O & M activities, conflict resolution, water acquisition and budget allocation. The irrigation management process was broken down into different themes to investigate the multifaceted aspects of irrigation governance. In particular, issues such as landholdings, location, agricultural production systems, operational and maintenance of irrigation infrastructure, household involvement and awareness in irrigation policy issues, water harvesting and distribution and utilisation of costs were to be investigated through the household survey, focus group discussions and expert interviews. As argued in Section 2.10, these issues encompass the factors identified through the literature review and with consideration to the Nepalese context which are likely to influence farmers' level of access to irrigation water. These issues have also informed the research objectives and research question which this thesis aims to address. Issues covered in the household survey also seek to capture the multi-dimensional nature of irrigation governance in Nepal, which influence the farmers' levels of access to irrigation water.

The questionnaire was piloted in a randomly selected village outside the sample frame. It was believed that the responses to the pilot would result in the revision of questions not relevant to the research questions. The piloting also helped the researcher to identify and remove some questions from the existing questionnaire that were irrelevant and problematic to the local context. The administration of the pre-tested and reformatted questionnaire was carried out with the household heads. The household remains the unit of analysis in this thesis.

However, there are some limitations related to the household survey which need elaboration. Although households have become common sampling units in social research and the household heads are consulted for the survey, their usefulness has been questioned. Firstly, the conventional definitions of 'household headship' have been criticised (Rosenhouse, 1989) and policy implications from research findings where the research subjects were households heads have been questioned (Buvinic and Gupta, 1997; Bruce and Lloyd, 1997). Secondly, although the administration of a questionnaire to the household head is considered to be less constraining in a practical sense, it raises many methodological concerns. The definitions of both the terms 'household' and 'head of household' demonstrate variations as different countries use them in different ways. The term 'head of household' is rather ambiguous when the assignment of headship is left to the judgment of household members. The extent to which the views of the household head represent those of the other members of the household is open to debate. The attributes associated with the household headship are subjective and depend on the interpretations of the household members. Also, the term 'head of household' is not neutral , but is often loaded with additional meanings which reflect a traditional conceptualisation of the household as an undifferentiated unit in patriarchal societies with no reflection of internal conflicts in the distribution of resources (Folbre, 1990). Deshingkar *et al.* (2003b), in their study of livelihood options in India, contend that excessive focus on the household head can ignore important experiences of other members of the household. In many instances, the assumption that the household head is aware of and shares other members' experiences leads to an over simplification of complex issues, which can jeopardise the quality of data and consequently leads to misleading findings.

Notwithstanding these methodological dilemmas, it has become common practice to administer questionnaires to the household head. The extent to which the response of the household head represents that of other members depends on several factors such as their authority in and contribution to the household. The response of the household head is determined largely by factors shared by the entire household. The rationale for administrating this survey questionnaire to the household head is that in the research sites they generally hold land disposal rights, control the household income/expenditure and make decisions on behalf of family members. The household head also takes part in meetings and village level discussions concerning public interests. He/she is more likely to be aware and have knowledge of irrigation issues. In general, households are headed by men, though in some cases by female members who are either widows or women whose husbands have left for foreign lands to seek employment. In the latter case, where the male is not available, women carry out almost all the work customarily assigned to men. In the absence of parents, households are headed by the eldest son in the family who performs all the responsibilities that generally fall to the parents. The household head responding to this questionnaire is also the person who makes the decisions on behalf of all family members and decides on the livelihood activities in the family. Thus his/her decisions have major implications for the welfare of entire family members. Households headed by females are expected to provide great insights into equity aspects and the trickle down effects of irrigation interventions. Jazairy *et al.* (1992) maintains that households, which are headed by females suffer triple disadvantages: the burden of poverty; gender discrimination; and absence of support. These households are characterised by lower average earnings, fewer assets, and less access to remunerative occupations and productive resources such as land, capital and technology. They are also characterised by low level of education, restricted access to land and credit from the banks and local co-operatives (Agarwal, 1994; Morris and Meyer, 1993; Stash and Hannum, 2001).

3.6.3.2 Sampling Strategy

Since this study is associated with the institutional analysis of household access to irrigation water at the local level, households were the operational sampling units in research design. The main focus of this research is to investigate the role of property rights structures on farmers' ability to access irrigation water resources. In order to explore irrigation issues, it is necessary to understand the rules, regulations and other formal and information institutional arrangements designed and implemented at the local setting. Distributional mechanisms of irrigation water and contributions towards the operation and maintenance of the irrigation infrastructure need to be investigated in order to understand irrigation governance in Nepal. As highlighted in Chapter Two, the level of dependency of households on irrigation water depends on various factors such as size of landholdings and their spatial location, availability of alternative irrigation facilities (such as private *kulo*), and crop share-in/out practices. The household level of contribution towards system maintenance is determined by how much they are benefiting from irrigation water *per se*. For example, relatively better off households with larger landholdings have a higher stake in irrigation water and appear to get involved and have much better access to irrigation governance than households with smaller landholdings.

Similarly, as outlined in the literature review presented in Chapter Two, households with landholdings adjacent to irrigation canals have direct access to water, while the landholdings towards the tail end of the canal networks have indirect access. The spatial location of the landholding is assumed to have influence on the household ability to access irrigation water. Even the position in which the outlet is constructed in a plot will determine the landholdings to next get the water. For this reason, informal institutions such as mutual co-ordination, understanding, trust and so on, are critical for irrigation governance, and these are also included in the questionnaire designed for the household survey.

In order to assess a household's access to and requirement for irrigation water, the households covered by the sample frame were categorised into three different landholding groups, i.e. large landholdings, medium landholdings and small landholdings. However, dividing the households into the above mentioned three categories was not an easy task. Similar to other farming communities in Nepal, farmers of the canal command areas of Phalebas, Rainastar and Begnas irrigation systems are involved with diverse income generating activities to sustain their livelihoods. Adhikari (2004) noted that it is extremely difficult to categorise households into different groups based on their household income and landholding. This would be arbitrary and pose methodological flaws for the sampling process. A number of scholars have applied a wealth ranking exercise to sample populations into different income groups. For example, Fox (1983) and Richards *et al.* (1999) have applied similar methods to categorise sample households into different categories through the Participatory Rural Appraisal (PRA) process. The criteria applied by Fox (1983) and Richards *et al.* (1999) are presented in Table 3.10

Table 3.10 Households Types Based on Size of Landholdings

Households Category	Size of Landholdings (Ha)	Mean Landholdings (Ha)
Poor	0- 0.25	0.15
Middle	0.28-0.75	0.51
Rich	0.78-4.25	1.33

Source: Fox (1983) and Richards *et al.* (1999)

Adhikari (2004) comments that the above categorisation of households should be understood in relative terms, as most households sampled represent rural farmers who are mostly marginal farmers with very few employment opportunities other than agriculture and income from the communally managed resources such as forestry. There are no big landlords in the case study sites considered for this research.

While the literature suggests that household asset attributes like landholdings have implications in access to irrigation water (Shah *et al.,* 2000), the argument suggesting access to irrigation water depends solely on the size of landholding is often seen to be implausible. Also, the irrigators' entitlement and what they receive is not always the same. Furthermore, access to irrigation water based on landholding alone is considered to be incomplete and does not necessarily reflect other attributes of the local settings. The wave of agricultural modernisation and change in the size of landholdings has changed the scenario that landholdings and water acquisitions are directly proportional (Nicolson, 1984). This thesis argues that the size of the landholding is only one factor which influences household access to water and an over-emphasis on the land size ignores other influencing factors. In response, this thesis uses other factors across different heterogeneities described in Chapter Two (Section 2.10) to investigate the household level of access to water from irrigation canals which are governed by different property rights regimes.

Given the above mentioned evidence on the number of factors that are likely to influence farmers' access to water, the survey questionnaire was designed and operationalised with great care to obtain a representative and unbiased sample for analysis. The sample was selected in stages to pinpoint the locations where interviews are to be conducted and to choose the households efficiently. The research design contains stratified random sampling in such a way that the sample is spread over geographic sub-areas (throughout the canal command area, i.e. from the head end, the middle and tail end of the canal) and population sub- groups including caste, size of landholding, gender and income level. In order to keep costs to a manageable level, a survey map was prepared to conduct the household survey by making use of the clusters of households. Careful attention was paid to avoid the sample being overly clustered because of the damaging effects on reliability. Complexity of household survey design means that standard errors (SE) estimated on the basis of a simple random sample design will not reflect the true variance in the survey estimates. Statisticians argue that over clustering can lead to a substantial increase in standard errors if the community is relatively homogenous.

In order to capture spatial and caste/ethnic hierarchy, households were randomly selected on a proportional basis from different locations, landholdings and castes from each ward of the VDCs served by the irrigation canals. The sample households included only private landholdings. There were no leasehold lands in the research sites but share cropping was a common practice amongst the farmers.

The households were categorised into three landholding groups: small, medium and large landholders, based on the area of irrigation land available to them (Richards *et al.,* 1999; Fox, 1983). The average landholding in the mid-hills of Nepal is 0.77 Ha (lower than the national average of 0.96 Ha). However, the average landholding size in the research area was 0.9 Ha. The categorisation of households into different groups in the thesis reflects the size of the average landholding at both the local areas (case study sites) and national level. Table 3.11 presents the criteria used for categorising into three different landholding categories. This research considers farmers with less than half the average landholding in research sites (0-0.45 Ha) as 'small', while those with landholdings above the national average (>0.96 Ha) are considered as 'large' landholdings. In Nepal, the households with less than half the national average landholding size are considered to be marginal farmers (Sharma and Chhetry 1996). Farmers with landholdings above half the local average and below the national average (0.45-0.96 Ha) are considered 'medium'. In rural Nepal, the amount of private landholding reflects household economic and socio-political status, as households with larger landholdings are respected, have greater authority and often act in village judicial arbitration. It is plausible that the households with large landholdings who enjoy socio-economic dominance in village settings can influence access to irrigation water.

Table 3.11 Criterion for Categorising Households

Households Category (based on size of landholding)	**Size of Landholdings in (Ha/*Ropani*)**
Small/Marginal	0-0.45Ha (0-9 *Ropani*)
Medium	0.45-0.96 Ha (9-19 *Ropani*)
Large	>0.96 Ha (>19 *Ropani*)

The framework applied for surveying households is unique because it covers the entire canal command area from the head to the tail ends and transcends both hydrological and political boundaries. In the JMIS the canal command area stretches over all three V.D.Cs namely Dhanilikuwa, Chakratirtha and Bhalayakharka. Table 3.12 presents the different wards of the three V.D.Cs/municipality served by the irrigation canals considered for this research.

Table 3.12 V.D.Cs/Municipality wards served by the Irrigation canals

Irrigation System	VDC/Municipality	Wards served by canal
Rainastar	Bhalayakharka	1, 2 and 3.
	Chakratirtha	1, 2, 3, 6, 7, 8 and 9
	Dhamilikuwa	1, 2, 3, 4, 5, 6 and 8
Phalebas	Devisthan	1, 2, 3, 4, 5, 6 and 7
Begnas	Lekhnath	1, 11, 12, 13 and 14

Every effort was made to include households from all the wards from all three irrigation systems considered for data collection, although not all wards of the VDCs and municipality are served by the irrigation canal systems. Nonetheless, some irrigators are living in wards not served by the canal but have landholdings down the canal where their plots are being irrigated. In order to avoid a systematic exclusion of households who use water from the canal systems, irrespective of their location, all the households whose fields were served by the canal systems were considered in the sampling framework.

The command area of the JMIS is divided into sixteen blocks; while the area of the AMIS is divided into five branches (BC1- BC5) depending on which branch of the canal irrigates the area concerned. In the case of the FMIS there are four branches (Jogichaur, Kumalgaun, Satkuriya and Chaubiskuriya). These blocks and branches have their own level of committees which are responsible for the day to day running of the canal in their respective areas, ensuring release of water from neighbouring branches, conflict resolution and liaising with RIMC/PIMC/BIMC if necessary. The criterion used for constituting block size is often the area served by the irrigation canal and the number of households within that area. In the Phalebas and Begnas areas, data on different categories of household were rare. In the absence of secondary data on the number of households in different wards in the FMIS and the AMIS, snowball sampling methods were used for sampling households. The difficulties associated with locating respondents meant that the preference for the snowball sampling method was both desirable and inevitable. This approach made use of the local informants, including the members of the management committee who participated during the WUA meetings, gathering information on the number of households in each of the small, medium and larger landholding categories, and while in the JMIS area, secondary sources of data were used to calculate the number of households in each category. It should be noted that, whilst snowball sampling techniques can dramatically lower research costs, this comes at the expense of introducing bias, as the technique itself reduces the likelihood that the sample will represent a good cross section of the population. To minimise bias, a number of local farmers were asked initially about the number of households in different wards. However, their estimations were cross checked with other farmers to confirm the tentative assumptions as valid on the number of the households in each landholding category at ward level. For the purpose of this research, a total of 249 households was considered. This allowed some margin for the non-respondents to ensure the generation of sufficient numbers of respondents for analysis. The margin for non-respondents was taken as 12 households, four for each of the three systems surveyed. The details of the households in each ward and the number of households sampled in each of the landholding categories are given in Appendices 3a-3d.

The computation of the total number of households in each landholding category warrants some explanation here. The total number of households in each ward of the municipality/V.D.C within the canal command areas of all three irrigation systems considered for this research was taken from secondary sources. The total number of households in each ward as a percentage of the total number of irrigating households was computed. The proportion of households in each landholding category in the different wards of the V.D.Cs and municipality was gathered from a variety of sources. In the case of the JMIS, a secondary data source was used, while in the case of the AMIS and the FMIS, the knowledge of key informants was utilised to compute the percentage of households in each landholding category in each ward served by the canal. All together a total of 249 households with 83 households from each of the three irrigation systems considered for this research were surveyed. Given the nature of the study, the only difference was the property rights structure governing the irrigation systems and for any meaningful comparison it was critical to select other reasonably similar variables including the sample size.

In order to determine the number of households to be surveyed from each ward, the proportion of households located in the ward was taken as a base line figure. For example, in ward number one in the Lekhnath municipality, there are in total1204 irrigating households. This accounts for 27.9 percent of the total households using irrigation water in the entire canal command area. The same percentage of households was computed from the 83 households allocated for the AMIS which are 23.15 households. Then using the key informants' knowledge, the percentage of households in each category of landholdings was determined. In the case of ward one of the Lekhnatha municipality, 70 percent of irrigator households are small landholders,while the percentage of households in the medium and the large landholding categories in the same ward were 20 and 10 percent respectively. To determine the exact number of households to be surveyed from each landholding category, the same percentages -70 percent for small landholdings, 20 percent and 10 percent of medium and large landholdings respectively from the allocated total of 23.15 households were computed out. Since the number of households cannot be a fraction, they were rounded off to the nearest whole number to get the exact number of households to be surveyed. For example, for the small landholdings in ward one of the Lekhnath municipality, the figure was 70 percent of 23.15, which is 16 when rounded to the nearest zero decimal place. For medium and larger landholdings in the same ward it was 5 and 2 households respectively after rounding off to the nearest zero decimal place.

3.6.4 Participant Observations

The institutional analysis of irrigation systems demanded an exploration of the social environment in which local farmers live, in order to get a first hand insight into their culture and how they maintained their rural livelihoods. Since the overarching aim of the thesis was to compare and contrast institutional settings in which farmers' interactions occurred, it was important to understand the local context in which the irrigation systems functioned (Jorgensen, 1989). In order to understand the local settings and the symbolism of the world in which the farmers lived and operated their irrigation canals, participant observation was considered as one form of data generation technique. The choice of participant observation came about only after gaining access and reasonable confidence in building up rapport with local people and understanding the local context (Waddington, 2004). This was important for a researcher who was external to the real world of the local farmers and needing to understand their social world and the process of irrigation governance. These issues were more likely to be understood through such an approach (Gomm, 2004). The qualitative approach to investigating the social world of the local farmers necessitated spending a significant amount of time immersed in the culture of participants (Creswell, 2007).

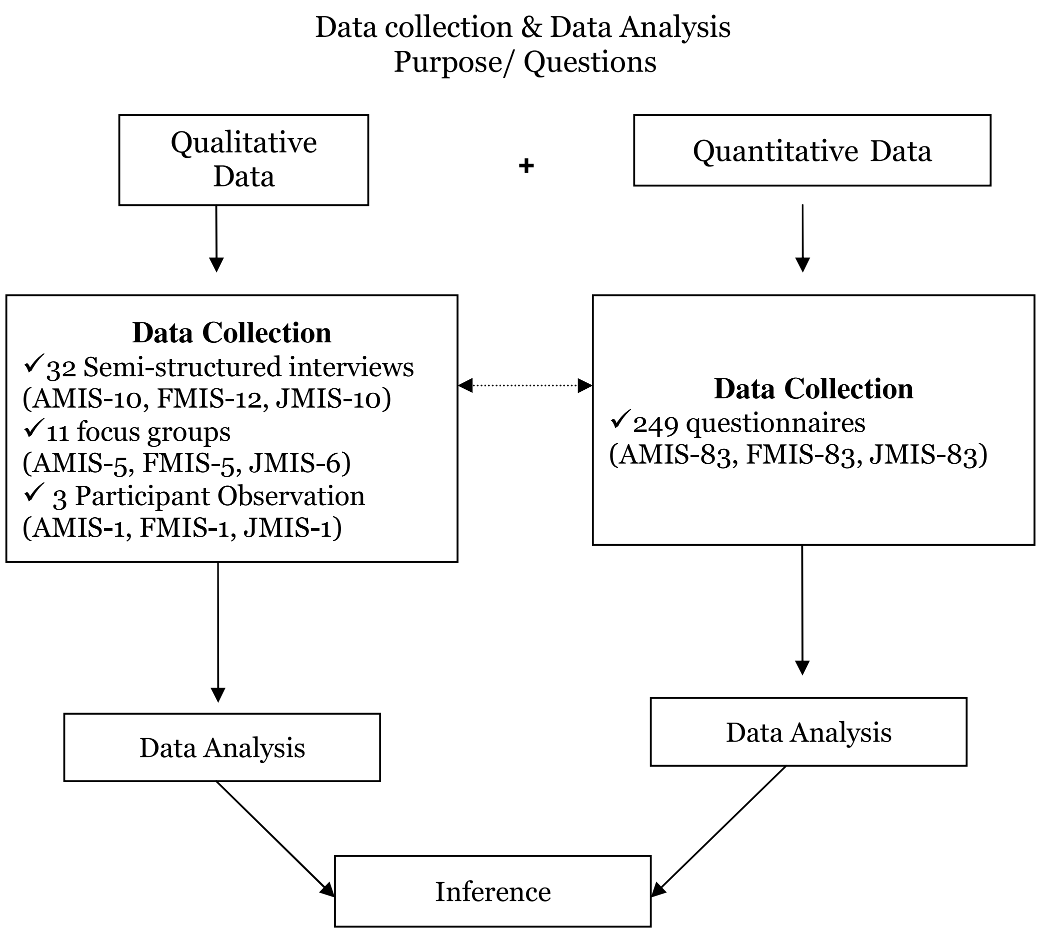
Although the method was time consuming, the unstructured and flexible nature of participant observation made it the most appropriate method by which to understand the context in which farmers organised their activities, including involvement in irrigation management. The case study method used in this research included multiple strategies for data collection, and participant observation could be easily used in combination with other methods applied to undertake the research for this thesis. The aim of the fieldwork was to gather in depth and contextual data on patterns of interaction amongst the farmers in their natural settings, for which it was necessary to understand the ways farmers negotiated their water rights, their experience of irrigation systems and developed meanings and associations within the irrigation communities (Fielding and Thomas, 2008).

Participant observation was useful in investigating small units of study, such as executive committee meetings, which encompassed small groups of local farmers whose interactions were relatively easy to observe (Smith and Berg, 1987). During the course of participant observation, numerous executive committee meetings from each of the three irrigation systems considered for the research were observed. The rationale behind observing these meetings was to understand the working mechanisms of the executive committees, the dominating and submissive members, their attitudes and their associated characteristics, which in turn could shed light on the farmers' long term perspectives about their irrigation systems. Furthermore, by using participant observation, it was possible to identify rules influencing farmers' actions and interactions in local settings, discern patterns of interaction and problematic issues (Cassell *et al.,* 2006).

Despite the above mentioned advantages of participant observation, numerous disadvantages were experienced in using it as a data collection strategy. Firstly, participant observation alone was not sufficiently robust to explore the issue this thesis intended to study (Atkinson and Hammersley, 1994). In response to this short-coming, participation observation was used in combination with other research methods, like focus group discussion, survey and key informant interviews. Secondly, as an observer, the author had less control of the situation. This methodological weakness proved beneficial for the research, as there was a necessity to minimise 'observer effects' and record the activities in their natural settings devoid of external influences. Throughout the process of participant observation, every effort was made to participate in the activities of the local farmers, but the participation was more in the role of observer than participant. This approach to participant observation was adopted to avoid influencing or manipulating the activities of local farmers and to maintain objectivity during the research process (Bersson, 1978). Thirdly, numerous studies have questioned the generalisibility of findings from participant observation (Fielding and Thomas, 2008; Jorgensen, 1989). Since participant observation was used in *"adjunct to other methods rather than as alternative to them, it helped to enhance and complement findings from other methods and provided evidence of methodological efficaciousnes*s" (Cook and Payne, 2002 p.23). Fourthly, the use of participant observation is not suitable for studying a larger and heterogeneous group (Tedlock, 1991) although since the attempt was to observe small group of individuals, i.e. executive committee members of irrigation systems, the use of participant observation was preferred. In order to keep a good record of the observation, field notes were recorded on various issues discussed and patterns of interaction during their meetings after each round of observation and before engaging in further interaction so that full descriptions of interactions were recorded before they were lost

(Emerson *et al.,* 1995). It helped to ensure that the general character and the order of the event remained intact.

Figure 3.7 Concurrent Mixed Methods Design



3.6.5 Regional/ District Level data and Documentary Analysis

Most of the data generated for irrigation policy at a regional/district level were collected using secondary sources by reviewing policy documents and project reports. Key publications were requested from the district development committees, municipality publications and publications from the DoI. WUAs were asked for any relevant documentary data. These secondary sources helped to familiarise the author with irrigation issues both at local and regional levels. In particular, the documentary analysis was relied upon in investigating the irrigation issues at the local level. Chapter Six contains description of the data gathered from documentary analysis, using the records compiled by the WUAs to understand water distribution rules in the three irrigation systems considered for this research.

3.7 Research Ethics

This section describes some of the ethical dimensions of this research both from theoretical and practical viewpoints.

3.7.1 Some Ethical Considerations

This research has been carried out following all ethical aspects and codes of conduct. Ethical responsibilities towards research participants were derived from the research ethical guidelines of the British Sociological Association (BSA) which includes voluntary participation, no harm, confidentiality, anonymity, or privacy, which is commonly referred to as "informed consent" (BSA, 2004). Participants in interviews and focus groups were informed about the purpose and nature of the study, including its time period, anticipated benefits and confirmation that all information would be confidential. It was made clear that the participants would not be harmed in any way either by providing data or by declining to take part in the study. The participation of the research subjects was entirely on a voluntary basis and the subjects were free to opt out of the interview or group discussions if they chose to do so (Shaw, 2003). Participants were offered the choice and assured that they were free not to answer questions which made them feel uncomfortable talking about or reporting and that they could decline to participate in the research at any time (as happened in a few cases).

As mentioned in this chapter in Section 3.6, two research assistants were employed for the purpose of fieldwork for this research. Since the author was not familiar with the two research sites, namely Phalebas and Begnas areas, the experience of the research assistants and their knowledge of the local area were very useful in terms of arranging the logistics. The research assistants were involved in various activities including arranging logistics, conducting household survey and taking notes during focus group discussions. Whilst the research assistants proved to be useful, I was aware of a number of limitations their direct involvement could pose for the quality of the data gathered, particularly in the household survey due to inter-interview variability (Bryman, 2008; Oppenheim, 1992; Fowler and Mangione, 1990). The quality of data obtained through the household survey and interviews depends on the quality of interviewing, which is difficult to standardise due to interviewers interactions (Martin, 1983; Gilbert, 2008).

Previous studies on inter-interviewer variations in social research have found a number of factors which contributed towards such variations (Groves, 1989; Dillman, 2000; Dillman *et al.,* 2009; Goyder, 1987; Groves *et al.,* 1992; Groves and Couper, 1998). Firstly, the inconsistencies can result from difference in administering questions such as difference in words and intonations and a different style and extent of probing to assist respondents during the survey (Matveev, 2002; Groves; 1989; de Vaus, 2002). Secondly, the demographic characteristics of interviewers and their background, which in turn influences the interviewers expectations from respondents and latter's uneasiness in answering questions, may determine the responses obtained (Bradburn and Sudman, 1979; Bradburn *et al.,* 2004; Lord *et al.,* 2005). The expectations of the interviewers might influence the respondents to modify their responses in their desire for social desirability (Heeb and Gmel, 2001). In other words, the respondents might shape their responses to suit what they believe the interviewers will find more acceptable. Thirdly, although in varying degrees, "Social Attributes" and the demographic characteristics of the interviewers such as sexual orientation, caste, race, age, education, political beliefs and social status are reported to have influence on the quality of the data obtained (Fowler and Magione, 1990; Edward and Berk, 1993; Hox *et al.,* 2002).

Fourthly, the "Social Distance" model (Johnson *et al.,* 2000) of interviewer variations argues that respondents provide truthful answers if they share some common personal characteristics with interviewers due to emotional attachment, comfort and sense of friendship (Cantania *et al.,* 1996) In contrast, existence of more social distance between the interviewer and the respondents will become increasingly reluctant to provide true answers to sensitive questions such as sexual activities, criminal activities and abuses. For example, female interviewers were able to obtain a more accurate data in research in sensitive topics such as AIDS, contraception, fertility and physical and sexual abuse as the respondents were more willing to disclose such sensitive and personal information to them (Axinn, 1991; Groves and Fultz, 1985; Dailey and Claus, 2001).

A number of procedures were followed in order to bring about uniformity in conduct of the household surveys, interviews and to maintain the quality of the data collected by minimising the influence of research assistants. Firstly, the questionnaires were designed carefully by removing ambiguities and maintaining closed ended questions (Fowler and Mangione, 1990; Bryman, 2008). Secondly, both the research assistants were given standardised training in note taking and conducting a household survey (Gwartney, 2007). The research assistants also took part in a questionnaire pre-testing exercise to familiarise themselves with the household survey. Thirdly, the research assistants shared common research interests with the PI which helped to minimise disciplinary conflicts (Echtner and Jamal, 1997; Stern, 1994). Fourthly, the allocation of households to be surveyed was randomised which helped to minimise any systematic human errors during the survey (Choi and Comstock, 1975). Fifthly, the performance of the research assistants was reviewed continuously to ensure that the data were collected in a consistent way throughout the fieldwork. This is because variations in the ways in which questionnaires are administered can exert an impact on replies which would have implication on the quality of the data generated (Schuman and Presser, 1981).

Contact information of the lead researcher and research assistants was also provided. Confidentiality of data provided by participants or gathered from documents, observation and informal interviews with others were respected and participants were assured of such confidentiality by signing confidentiality declaration forms (Arksey and Knight, 1999). All participants and locations were given in the form of pseudonyms when analysing the data. All the data, including transcriptions, tapes and other recorded materials, were stored securely to maintain confidentiality throughout the research process.

In some of the irrigation systems, accessing financial details of the WUA was very difficult and impractical for two reasons. Firstly, it contained personal and sensitive information about the local farmers, and the WUA was not comfortable with distributing these to external researchers without their consent. Personal information such as individual and household loans, land registration details and details of any sanctions imposed were present in the WUA records, which were considered highly confidential and not released. Secondly, the WUA particularly in the AMIS had not audited its financial reports, and it found this uncomfortable to disclose. In Nepalese culture, farmers particularly in rural areas find it uncomfortable to disclose the family's financial affairs to someone outside. Since the researcher was clearly an outsider to the farmers, there were instances, particularly when individuals were aware of their financial situation, in which they expressed embarrassment and discomfort if they let a researcher, an outsider, invade their privacy. Also, the disclosure of farmers' financial details to an outside researcher was more likely to damage confidentiality and the relationships amongst the WUA, DoI and the farmers. These issues were adequately addressed throughout the research process by keeping such information highly confidential.

Informal and casual conversations with the research participants, which were used to kick start the focus group discussions, contained information which did not have implications for the welfare and confidentiality of the participants. These conversations were also stored during data compilation and logging of data, fieldwork or during observation (Lofland and Lofland, 2006) to be analysed at a later stage of the research. The farmers' anonymity and confidentiality were ensured throughout the research process. Participants were not harmed or distressed as the result of participating in the research (Hayes and Devaney, 2004). Sensitive personal data were collected only in accordance with research purposes and in the favour of public interest, as opposed to individual interest.

3.7.2 Ethical Approval

The individual interviews in this study were conducted in private settings where the author, as an outsider, constantly needed permission from gatekeepers for each stage of the study. Permission to access official records and WUA files was obtained through relevant gatekeepers, either in social settings or from the DoI.

In October 2007, the DoI in Kathmandu and the Western Regional Irrigation Directorate (WRID) in Pokhara were contacted for permission to undertake fieldwork. Upon receiving authorisation from the DoI, an official letter of ethical approval was sent to the WUA and the WRID on 18th October 2007. Prompt responses were received to undertake the research.

The research activities associated with this thesis involved human participants in all aspects. The fieldwork included a household survey, focus group discussions and key informant interviews. In order to comply with the University of York's ethical requirements, ethical approval was obtained from the Humanities and Social Sciences Ethics Committee of the University of York, which is responsible for ethical standards for research carried out in the Department of Social Policy and Social Work at the University of York. The fieldwork for this research took place over a period of four months between October and January 2007.

3.7.3 Gaining Access

It was critical to gain access to the world of local farmers in order to gather evidence. Based on their experience with naturalistic research, Lofland and Lofland (1984) believe that researchers are more likely to be successful gaining access to situations if they make use of contacts that can help remove barriers to entrance. After receiving official ethical approval from the DoI and the WUAs, the objectives of the study and data collection process were explained to the WRID and the presidents of all the three WUAs. The contacts and rapport established with the staff at the WRID and the presidents of the WUAs were crucial in gaining access to the local farmers. The duration of fieldwork was about five months. The available time for fieldwork was divided equally in the three irrigation systems. In all three systems, both formal and informal interviews were conducted alongside checking WUA records. In Nepal, personal and social life is shaped by gender roles and the social space of women is not generally accorded consideration. Given the social and cultural values attached to women's participation in social space, there was limited access to female participants and a structured schedule had to be followed when interviewing females.

Initially, difficulties were faced in persuading the WUA that key informant interviews should be held with some stakeholders. A sample of key questions was provided. Upon receiving the sample research questionnaire and detailed modality of the research operation, the DoI gave permission to conduct the fieldwork.

Use was made of Silverman's four principle ways to maintain and enhance access in the field during the course of work (Silverman, 2005). Firstly, *impression management,* which required considerable awareness of the setting and stakeholders' or participants' culture in order to present oneself in a positive manner were critical for collective data free of biases. Secondly, *obtaining 'bottom-up' access,* in which access was not regarded as a one-time permission, meant it was gained, for example, by the DoI for all settings. Thirdly, a non–judgmental approach to the farmers, institutions, policies, systems, programmes, staff and clients was adopted. Fourthly, *feedback* was offered to the farmers and the members of the WUA committees for sharing their invaluable knowledge and experience and being part of the research. Fifthly, gaining the trust of all farmers, WUA members and the DoI was the only way to gain access to certain participants and also to some of the information. Thus, relationships based on trust, respect and commitment to maintaining the privacy of participants were considered a key factor to entering the participants' world (Fontana and Frey, 2005). In addition to this, when gaining access to the settings and participants, key informants were identified who had access to official records and contact with the local farmers. This saved time and limited the likelihood of mistakes when logging data and during fieldwork.

3.8 Methods of Analysis

3.8.1 Analysing Qualitative Data

The qualitative data which were in audio format were transcribed and translated, and then uploaded into *Atlas-ti* software for analysis. The uploaded transcripts were read thoroughly and all the meaningful data from the transcripts were abstracted for data categorisation. An *a priori* coding method was used to code the transcripts of the qualitative interviews. The preference for *a priori* coding came from institutional analysis literature, particularly those associated with the management of natural resources (Ostrom, 1990; North, 1990; Bandaragoda, 2000; Lam, 1998). There is a well established argument in natural resource management literature, which suggests that institutions set the ground rules for resource use and establish the incentives, information, and compulsions that guide economic outcomes. Institutions are considered to have "organised and established procedures" which set out the rules of the game in the society that its members are expected to observe (Jepperson, 1991 p.145). Douglas North argues that institutions are "humanly devised constraints that shape human action" (1990 p.3). Previous studies on irrigation management have focused on issues such as the physical condition of canals, water levy collection, conflict resolution, collective action and so on (Hilton, 1992; Ostrom, 1990 also see Lam, 1998; Tang, 1992). The issues investigated in this research were established prior to the analysis based on the literature on nature resource management. The thematic codings used were informed by the above mentioned studies. The issues involved in thematic coding used in the data analysis are presented in Table 3.13. This research investigated aspects of irrigation management such as history, organisational configurations, governance modalities, water distribution, physical infrastructure of canals, contributions towards canal maintenance and conflict resolution using qualitative methods. Hence, a deductive approach was adopted to analyse qualitative data where "all decisions on variables, their measurement, and coding rules were made before the observation began" (Neuendorf, 2002, p.11). However, some additional categories were introduced and given the nature and scope of this research, revisions were made on the existing themes mentioned in the literature to tighten up the categories and maximise mutual exclusivity and exhaustiveness of those categories (Weber, 1990).

Also, thematic coding templates (matrices) on the above mentioned issues were created, resulting in a matrix of seven thematic templates for both the KII and FGD, maintaining numeric identifiers for each transcript in order to track the source of information and allow for retrieval of verbatim and paraphrased quotes. Each coding included categories comprising "groups of words with similar meaning or connotations" (Weber, 1990 p.37). The coding categories were "mutually exclusive *and exhaustive*" (GAO, 1996, p.20). The process of data abstraction and reduction involved pulling quotations onto the respective templates in the *Atlas-ti* software. Data analysis involved looking for similarities and differences in general thematic areas by using the matrices and coding templates to retrieve and compare information, resulting in a textual summary of findings.

There is a danger that researcher bias might influence the nature and quality of findings, depending on what information is retained and what is deleted during the process of data coding and abstraction. This is commonly understood as selection bias (Collier and Mahoney, 1996) where data are distorted to achieve the intended results. This might cause distortion and misinterpretation of the meaning intended by an interviewee during the process of transcription and data abstraction, which could translate and feed in as invalid and unreliable information, altering and distorting the findings and subsequent conclusions. In order to avoid selection biases, a check list was prepared and used for undertaking thematic analysis. The themes check list included issues such as the history of the irrigation canals, organisational configurations, governance modalities, water distribution, physical infrastructure of canals, contributions towards canal maintenance and conflict resolution. The use of such a check list helped to make both data analysis and research findings more systematic, rigorous and reflective (Miller and Dingwall, 1997). By adopting *a priori* coding and using a thematic analysis, it was possible to combine and catalogue related patterns of words, phrases and communications and any subsequent sub-themes emerging out of such data. Sometimes the data demonstrated divergent patterns and rival explanations, which were handled with great care through cross examination rather than totally disregarding them. The cross examination of divergent patterns helped to ensure coherence in data analysis and fitted different ideas and components together in a meaningful way (Leininger, 1985). This helped to enhance the credibility of the data analysis and the inference drawn from it (Patton, 2002). Selection bias leads to seriously erroneous inferences being drawn from the investigation. No effort was spared to minimise such selection bias throughout the research process. Data was constantly cross-checked to maintain consistency in both its quality and process of analysis. Table 3.13 presents the themes covered during the qualitative research undertaken for this research.

Table 3.13: *A Priori* Coding and Issues Covered in Qualitative Research

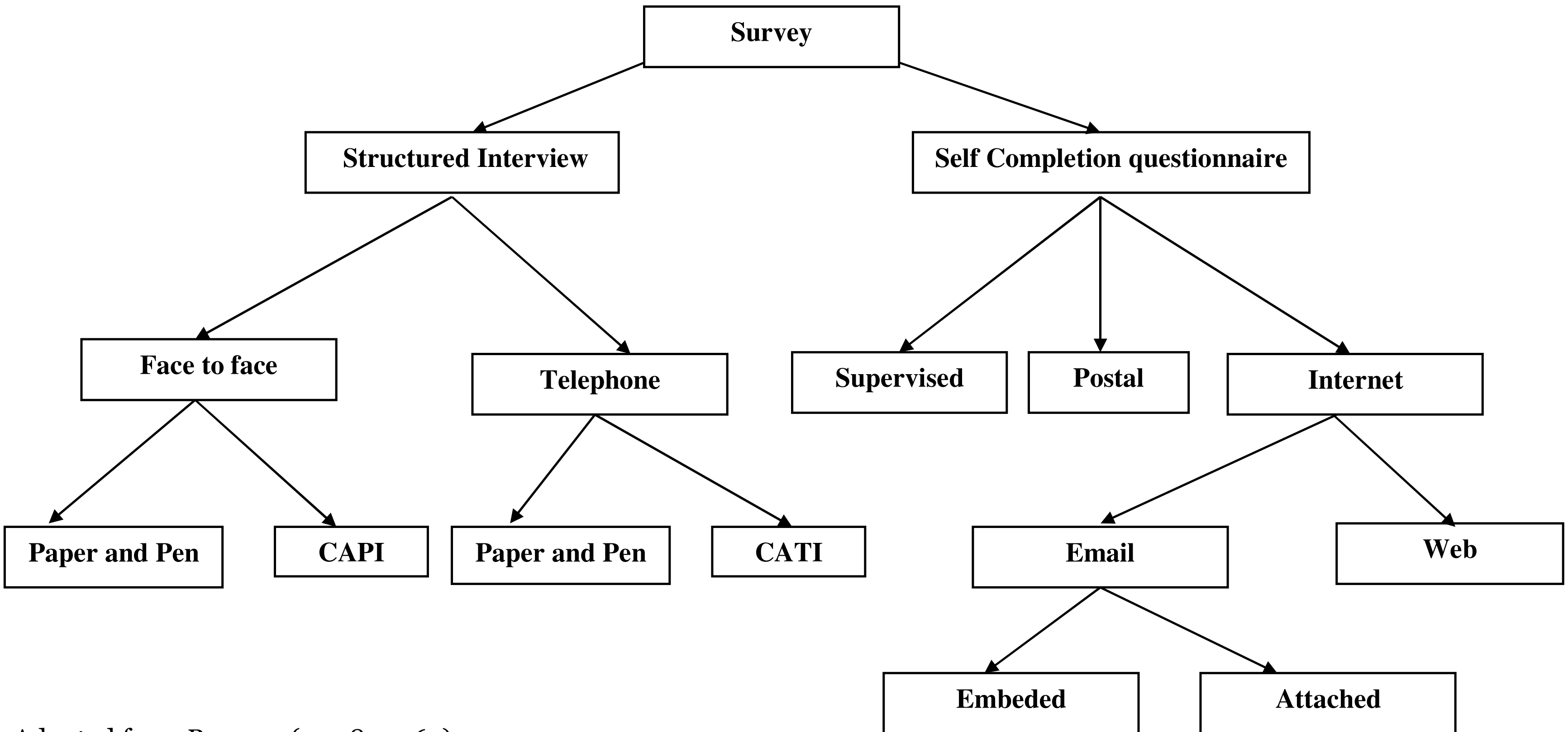
SN	Themes	Major Issues Covered
1	Historical context	Initial idea on the construction of canal, initial funders/contributors, designing
2	Physical Condition of Canal	Physical nature of canal, vandalism, standard of canal maintenance,
3	Water Levy Collection	Rate of water fee, mechanism and efficiency in fee collection, maintenance of account, allocation of fund raised, resource distribution between main canal and branch canal, deposit to the DoI
4	Conflict Resolution	Existence of water related conflicts, mechanism of conflict resolution, complaining irregularities, compliance and sanctions, water thefts
5	Operation and Maintenance	Farmers participation in operation and maintenance, rules of participation, penalty/sanctions, level of contributions
6	Performance of WUA	Accountability to farmers, relationship between farmers and WUA, advocacy work by WUA to educate farmers,
7	Transparency of the WUA	Financial transparency, account maintenance,
8	Formation of WUA	Formation of WUA, constitutions, election, composition, branch committee and main WUA committee, gender/caste and locational representations

3.8.2 Analysing Quantitative Data

Although there is a burgeoning literature on survey methods, the administration of the survey questionnaire was one of the most challenging tasks during the research process. A wide range of survey methods including postal survey, telephone survey, email survey and online survey are advocated in the literature. Some of the commonly practiced survey methods in social research are presented in Figure 3.8.

Although the advantages of self-completion questionnaire survey over costs and time (Bryman, 2008) are well known, it was not an option for this research as most of the household heads to which the survey questionnaires were administered were illiterate and innumerate. Also, the poor postal services in the rural part of Nepal with post taking an exceptionally long time or being unreliable has meant that postal survey was also not a feasible option for this research. There were no internet services available in the research sites, which mean it was not an option either.

Figure 3.8: Some commonly used survey administration techniques



Adopted from Bryman (2008 p. 167)

In light of the above mentioned constraints, the survey in this research took place in the form of structured interviews where the interviewers asked questions to respondents and their responses were recorded in the questionnaires.

Although time consuming, the structured interview was the most preferred method of household survey for this research for a number of reasons. Firstly, the problems associated with literacy and numeracy levels of the rural households had to be considered for the survey. Secondly, although the three case study sites were situated in three different geographical locations, the households were not very dispersed within the canal command areas making the survey less time consuming. Thirdly, the face to face structured interviews had the added advantage for being synchronous communication in time and space (Opdenakker, 2006). The aim of this research was to investigate farmers' experience of the irrigation canals which needed to take advantage of social cues such as voice, intonation and body language amongst others. These social cues helped make the survey process more of a social-emotional conversation (Kiesler *et al.,* 1985) by increasing interdependence between the interviewer and interviewees (Straus and McGrath, 1994). Fourthly, the face to face structured interviews during the household survey helped to minimise "social desirability" biases which was critical for understanding issues such as water thefts, negative attitudes towards the WUA and canal vandalism. These activities were more likely to be under-reported in other survey format such as postal or web-based surveys (Sudman and Bradburn, 1982; Shuy, 2002). In order to generate high quality and consistent data, the nature of the research was explained to the respondents and they were asked to provide answers truthfully without being influenced by the presence of interviewers (Emans, 1986). Fifthly, face to face structured interviews also helped to standardise the survey process (Martin1983; Gilbert, 2008).

The survey questionnaires were paper based where answers were filled in the questionnaire itself rather than using a computer as there was no electricity in the research sites. Also, since the rural farmers had never seen a laptop, the use of such equipment would have been distracting from the actual research process, which the author wanted to avoid. Whilst the household survey was paper based, all the key informant interviews and focus group discussions were digitally tape-recorded after obtaining consent from the interviewees using Sony ICD-UX200 Digital Voice Recorder. The importance of a tape recorder during the fieldwork is lucidly highlighted by Patton (2002) "*as a good hammer is essential to fine carpentry, a good tape recorder is indispensable to fine fieldwork*" (p 380). Along with improving the quality of recording, the use of digital recording for recording focus group discussions and key informant interviews helped to naturalise the research experience not only during the fieldwork but also after the fieldwork, particularly during transcribing and analysing the tapes (Ashmore and Reed, 2000). The recording helped to retain the data digitally, which then could be easily saved on a computer and transported safely. Through the use of a digital recording device, it was possible to maintain a "*report of the interview, in anecdotal form, including gestures, facial expressions, questions, and remarks of the interviewer*" (Bryman 2008 p. 202). The "talk-in-interaction" (Learner, 1996 p.303; Ten Have, 1999 p.21) recorded helped to document and archive data which are subtle, nuanced and highly sensitive in a structured, normative and accountable fashion by keeping "order at all points" (Sacks, 1995 p.22). Unlike recording by cassette tape, the use of digital recording helped to minimise noises such as the tape hiss which enhanced listening and the transcription of even the softly spoken words. The improvement in quality of the data recorded helped to reduce the risk of lost data and results in faster, less expensive and more accurate transcription (Stockdale, 2002). The advantages of digitally recording the interviews and focus group discussions are highlighted by Pomerantz and Fehr (1997 p.70):

a) "Certain features of the details of actions in interaction are not recoverable in any other way."
b) "A recording makes it possible to play and replay the interaction, which is important both for transcribing and for developing an analysis."
c) "A recording makes it possible to check a particular analysis against the materials, in all their detail, that were used to produce the analysis."
d) "A recording makes it possible to return to an interaction with new analytic interests."

The digitally recorded interviews were saved in multiple external hard drives to ensure that they are not lost, stolen or infected with computer viruses. The recorded interviews were transcribed in the field itself. Whilst research assistants helped in carrying out household surveys, all the interviews were transcribed by the author. The author was aware that the transcription of the data is the beginning of the data analysis procedure and therefore data were transcribed into highly detailed minutes with every audible sound in their recording. This was important as this research concerns the detailed understanding of farmers' perceptions about the quality of the irrigation services as transcripts should represent "*tape recordings of naturally occurring interactions*" (Hutchby and Wooffitt, 1997 p.73). During the transcription process even non-verbal interactions such as silence, sighs, laughter, posture and gestures were noted because these might influence the underlying meanings in social research (Downe-Wamboldt, 1992). The importance of such non-verbal interactions is highlighted by Watzlawick *et al.* (1967) "*the nature of a relationship is contingent upon the punctuation of the communicational sequences between the communicants*" (p.59).

The importance of language in constructing and describing the social world is widely recognised (Stanley and Wise, 1993; Atkinson, 1990; Holstein and Gubrium, 1995; also see Hammersley, 1993 & 1995; Ladd, 2003; Duranti, 2003). In describing the importance in understanding the social world, Michele Barrett (1992) has argued *"researchers have accepted to varying degrees the view that meaning is constructed in rather than expressed by language*" (p.203). Therefore, the process of translation is not a neutral exercise (Bradby, 2002; Duranti, 2003). In order to reduce the degree of power relations between the researchers and the research subjects on the ground of language, a common language was used for all aspects of the fieldwork. As such Nepalese language was the medium in which all the fieldwork including household survey, focus group discussions and key informant interviews were conducted. Although the household survey questionnaires were prepared in English, they were translated in Nepalese during the actual administration. As suggested by Hansen (1987) the translation component was critical in all aspects of the research process including developing data collection instruments (designing questionnaire and topic guides), the data collection process (questionnaire administration, conduct of focus group and key informant interview) and data analysis (data transcription and translation). Although the author is a Nepalese national and the fieldwork for this research took place in Nepal, there were many aspects including my naivety and little knowledge of local cultural practices and idiomatic differences which constantly presented a challenge. However, for reliability and validity of data and research findings, it was important to understand the irrigation issues from another cultural perspective (Tripp-Reimer and Dougherty, 1985; Mackenzie, 1994). This is because Nepalese was the main language spoken in rural parts of Nepal including the research sites. Also, both the research assistants were bilingual with fluency in both Nepalese and English. The digitally recorded interviews were transcribed in Nepalese in the field itself. The rationale for transcribing the qualitative data in the field itself was that the researcher could clarify immediately with the local farmers if the transcribed texts maintained the same cultural meanings embedded in linguistic expression (Simon, 1996) and correct immediately if any discrepancies and distortions had taken place.

For the purpose of translation, "The Brislin model" of cross cultural translation was used as to achieve the equivalence between two different languages i.e. Nepalese and English (Brislin, 1970). The Brislin model of translation suggests that a bilingual person should translate the data from its source language (Nepalese in this case) to the target language (English in this case). The process of translating the data from source language to target language is called "forward translation" (Jones *et al.,* 2001). After the completion of the forward translation, another bilingual person back translates the documents from the target language to source language which is called "backward translation" (Munday, 2001; Groot *et al.,* 1994). However, the back translation is done by blinding the second translator to the original data. This is done to maintain the equivalency of the translated data which is important for reliability and validity of research. Both the translated versions of the data are then compared for accuracy in which questionable items are identified and translated further by the translators until the meaning of translated data is mutually agreed by them.

Since the PI was bilingual with fluency in both English and Nepali, he acted as the first bilingual translator throughout all the translations and transcriptions activities associated with this research. This was done also to minimise the research costs as translators are very expensive in Nepal. The PI was in a position to take this responsibility partly because he had some work experience in translating Nepalese to English and vice versa before starting his graduate studies at the University of York. The second translator was a professional translator from Kathmandu (Nepal) with more than ten years of experience in translation related activities.

The adoption of the Brislin model of data transcription included the following steps:

Step 1: First bilingual translator (the PI) forward translated the original data (Nepalese version 1) into the target language (English version 1)

Step 2: Second bilingual translator back translated forward translated data (English version 1) into source language (Nepalese version 2) without prior knowledge of the source data (Nepalese version 1)

Step 3: The back translated data (Nepalese version 2) was compared with original data (Nepalese version 1) to identify any discrepancies

Step 4: Both translators produced mutually agreed version of qualitative data (English version 2)

Step 5: The English version 2 was used for the final analysis but if any confusion arose, then the prior versions were also consulted as and when needed.

After the completion of the household survey, all the returned questionnaires were thoroughly checked to ensure that expectations on data characteristics and quality were met. Data from all the completed questionnaires were entered in SPSS for analysis, while missing responses were discarded. The dataset was tidied and thoroughly double checked for any inconsistencies and discrepancies such as missing cases, because data discrepancies can alter the findings (Pallant, 2007).

After preparing a complete dataset, general descriptive analysis was undertaken, for example, univariate analysis such as percentages and diagrams and some appropriate measures relating to central tendencies and variability, like distribution and histograms, were carried out. In addition, bivariate analyses were also undertaken to uncover whether different variables are auto correlated or related. This helped in undertaking t-tests, chi-square tests, anova and regressions to establish the relationship of the different variables to household level of access to irrigation water.

Non-parametric tests, such as chi-square, were carried out to find associations between the categorical (nominal and ordinal) variables. T-tests and Anova tests were carried out to find the mean differences between different group categories of farmers. When carrying out regression analysis, checks were made for multicollinearity. In all the statistical tests, $p=0.05$ (95% confidence interval) were considered statistically significant. Moreover, to enable the reader to use his/her own judgement about which finding was most important, the p value, coefficients and sample size were presented for each test, including regression analysis, presented in Chapter Five.

3.9 Measuring Access to Water

This section follows on from the discussion on the conceptualisation of access to water under different property rights regimes presented in Chapter Two (Sections 2.9 and 2.11). It describes the approach taken in the thesis to measure and quantify household level of access to irrigation water. In order to measure household this, a cumulative index is created by combining three constituent components of access, namely reliability, adequacy and equity. The computation of the three dependent variables Reliability (R), Adequacy (A) and Equity (E) warrant some explanation. Respondents were asked if the water delivered by the irrigation systems was reliable, equitable and adequate in different cropping seasons. Although the survey was carried out in 2007, respondents were asked for their long term concerns about their irrigation systems. They were explicitly warned not to base their response on one sporadic event but to take overall performance of the irrigation system into account. As a result, the research findings reflect the overall performance of the irrigation systems in delivering irrigation water to farmers in the three aspects of access mentioned above. While the variables adequacy and reliability capture system characteristics to deliver adequate and reliable water to the farmers, equity represents an institutional mechanism for water distribution.

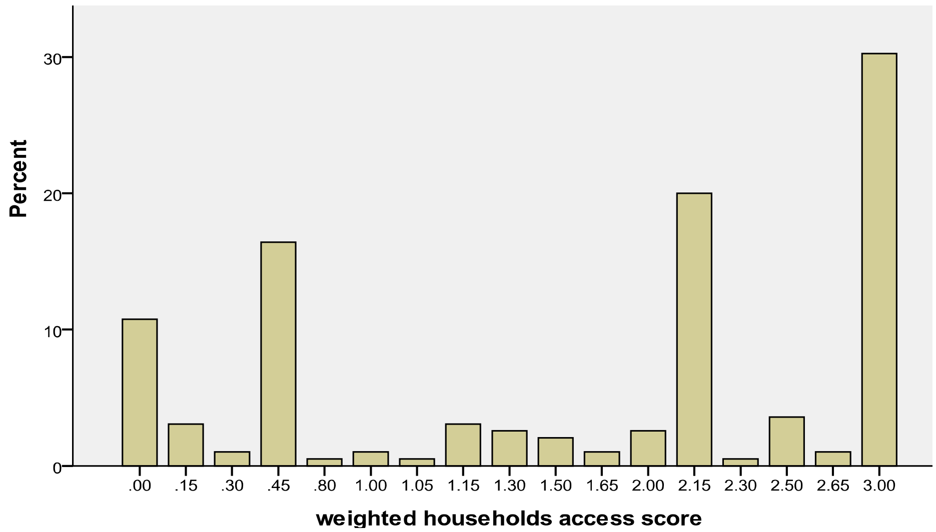
In Nepal, the water availability in the canal systems varies greatly, with the Monsoon season being water abundant, compared to Winter and Spring seasons which are characterised by limited and scare water supplies respectively. The Monsoon season ranges from June to mid September, when almost 80 percent of the annual rainfall occurs. It is imperative to understand that the importance of water to the farming households varies greatly in different seasons. In order to capture this variability, different weightings have been given to responses in different seasons. Based on field observations and views obtained from the participants of the focus group discussions, the weighting factors of 0.15, 0.35 and 0.50 were assigned for the Monsoon, Winter and Spring seasons respectively. The participants of the focus group discussions were asked to give marks out of a hundred for their level of dependency on the canal for irrigation during different cropping seasons. The average marks given by the farmers were 15, 35 and 50 percent for Monsoon, Winter and Spring respectively. The assigned weighting factors for different cropping seasons reflect farmers' dependency on canal resources for crop cultivation. The lower weighting factor for the Monsoon season reflects that farmers do not rely much on water from the canal for irrigation. Instead the

Monsoon rainfall provides water for crop cultivation. But the scant rainfall in Winter and virtually non-existent rainfall in the Spring have meant that farmers depend highly on the canal for obtaining irrigation water. Therefore, higher weighting factors are assigned to the Winter and Spring seasons. The dichotomous (binary) responses for the three variables, i.e. reliability, adequacy and equity, in all three cropping seasons were weighted and added together to compute a continuous variable ranging from 0 to 3.

The quantitative data in this thesis come from a small sample size of 199 households. In order to make the analysis logical and accurate, the data had to be reduced to a format that enabled maximum analysis with minimum loss of information (Searle, 2005). There are no simple solutions to this problem. In order to divide the dependent variable into reasonably valid and reliable categorisations which reflect the farmers' experiences of irrigation water in terms of access, households were divided into two categories, i.e. those having strong access to water and those having weak access.

The next stage was to reduce the individual scores into manageable groups. However, as Bryman and Cramer argue, one of the main sources of concern with collapsing data is that the "*choice of cut-off points is bound to be arbitrary and will have a direct impact on the results obtained, suggesting that it may be better to employ a fairly systematic procedure like quartiles as a means of collapsing cases*" (1994 p.178). The distribution of the weighted access score was produced and is presented in Figure 3.9.

Figure 3.9 Distributions of Access Score in the Sample



Searle (2005) points out that there are three issues that need to be taken into consideration while deciding the cut-off points. Firstly, the scores need to be arranged in a way, which create a valid categorisation of the access scores within the population. Secondly, in order to ensure that the sample is representative of the population and to maintain a high degree of generalisability, care must be taken to ensure that there are sufficient numbers of cases within each category. Thirdly, a scientific approach with a clear practical and/or theoretical rationale should be used to ensure that that the methodology is reliable.

In order to maintain the reliability and validity of the study, the dependent variable, i.e. level of access, was created by dividing households into two categories i.e. strong access (access score >1.735) and weak access (access score ≤1.734). This was partly informed by the discussions held with the farmers during the PRA process. The majority of the farmers insisted that if they have a good water supply throughout the year in all the three measures of access as defined in the thesis, they are able to grow up to five crops a year. However, they reported that if they do not have good access to irrigation water, then they can only cultivate one crop in a year. Furthermore, there was a common consensus amongst the farmers during the PRA process that at least they should have an average access score for them to grow two crops a year, which is critical for their household food security. Therefore, an overall mean access score is taken as the boundary for the strong-weak divisions. A mean access score of 1.73, which is just over half of the maximum value of 3 indicates water availability which is considered to be enough for cultivating two crops in year. However, it has to be said that these methods are not exhaustive but were considered as providing a reasonable variation in terms of addressing the three main issues of validity, reliability and generalisability.

3.10 Some Reflections on the Positionality of this Research

The interactions and their dynamics between the researchers and those being researched have become a topical issue both in qualitative and quantitative research. The proliferation of literature in social sciences have increasingly argued that the positionality of the researchers have implications in many aspects of research process including the epistemological foundation, methodological choice, findings and ethical considerations (Greenbank, 2003; Ganga and Scott, 2006). Therefore, researchers are increasingly called to recognise "*their own positionality*" (Moser, 2008 p. 384) to explore the "politics of position" (Smith, 1993 p.305) and to examine it reflexively (Rose, 1997). The positionality of the researchers has been defined as their place in space (Rose, 1997) in terms of how their values, interests, past experience, background (such as race, ethnicity, education, and sex) influence the way in which they relate to the research participants (Greenbank, 2003; Holliday, 2002; Denzin and Lincoln, 2003), which in turn determines both the validity and reliability of the data collected and the research findings. The commonalities such as cultural, linguistic, ethnic, national and religious and political beliefs shared by the researchers with their research subjects affords researchers a degree of proximity between them (Ganga and Scott, 2006), which influences the socio-psychological dynamics of the research. Therefore, the researchers' reflection on the research process is critical in maintaining the neutrality and universality of the knowledge produced (Pile, 1991; Thrift, 1996; McDowell, 1992). For example, Rosen (1998) highlights the importance of positionality in the creation of knowledge:

"A person's knowledge can only exist by virtue of a vast range of past experiences which have been lived through, often with the most intense feelings. These experiences, including textual experiences (books, lectures, lessons, conversation, etc), we have been taught to disguise so that our utterances are made to seem as though they emerge from no particular place or time or person but from the fount of knowledge itself" (p.30).

The following section of this thesis is devoted to my reflection in conducting this research on the distributional aspects of irrigation interventions in Nepal. This is important because a researcher's biographical profile can sometimes determine the selection of research topic as Burgess (1984) argues:

"While some [researchers] become interested in an area of study through reading other people's work, this is only one part of the story, for the biography of the individual researcher has a part to play." (p.210)

Whilst the academic and policy importance of this research is described in Chapter One, the much needed encouragement came from my own personal experience in Nepalese society in general and in relation to irrigation canal in particular. Because of my shared ethnic background and personal experience with some of the participants of this research, I intend to reflect on them in the following section of the thesis.

Firstly, as with many children in rural Nepal, I learnt to swim in the canal when I was a child. Secondly, as a son of a rural farmer, I was involved in farming including participating in O & M activities and diverting water from the canal. It is fair to say that the water acquisition from the canal was not always an easy task and it was characterised by bullying, verbal abuse and on many occasions being physically manhandled. Thirdly, I undertook my undergraduate dissertation research in a jointly managed irrigation canal in Nepal, which further enhanced my interest in canal politics. Fourthly, perhaps more importantly, I come from the most marginalised community in Nepal, commonly called the *dalits* (untouchables) with landholding at the tail end of the canal. A growing body of literature demonstrates that social scientists studying minority groups have faced a mounting pressure to re-examine their concepts and methods and to change their relationships with the people they study (Moore, 1973; Zinn, 1979). Some scholars such as Montero (1977) argue that the research techniques used in studying ethnic minority community should gear towards sensitising the investigators to the actual nature of community and its members. It is argued that "*researcher's gender, age, prestige, expertise or ethnic identity may limit or determine what he or she can accomplish*" (Wax, 1979 p.583). In line with my background, it is important to detail the research process, particularly the qualitative interviews undertaken as a part of fieldwork for this research.

Whilst the preference for conducting fieldwork in Nepal was primarily based on the policy relevance for this research, the much-needed impetus to do so came from a logistics viewpoint. I am a Nepalese citizen and conducting fieldwork in Nepal had many advantages including my own established network in Nepal, my past experience and the knowledge of local language. However, returning to Nepal to conduct fieldwork posed several dilemmas for me. Firstly, since my home was in Nepal, returning to Nepal for fieldwork was returning "home". However, I was aware that I had to make a clear distinction between "field" and "home" and considered Nepal, at least for the purpose of research, a field rather than home (Sultana, 2007). Moreover, whilst I was born and raised in a rural village, I attended school and college in Kathmandu, the capital city of Nepal. This meant my social connection to my village of birth was rather weak. The field sites for this research were typical rural villages, which provided me different socio-economic context for conducting fieldwork. Nonetheless, because of my family ties to rural area, the settings were somewhat familiar to me. Also, I come from a *dalit* community and I share a common ethnic background with many of my research participants. The importance of shared cultural knowledge with research participants in influencing the social dynamics during the fieldwork is highlighted by Bousetta (1997):

"During data collection, for example, an ethnic background can be very helpful. Ethnic researchers can have privileged relations with immigrant

groups, which can facilitate access to the field. Similar advantages arise from familiarity with the languages and the physical space of the researched group. On the other hand, such closeness between a researcher and his/her subject can also harm the research process" (p.5).

It is important to highlight that reseachers' shared background and life experience plays an important role in their understanding and interpretation of what they observe (Berger and Luckmann, 1966). Many qualitative researchers such as Denzin (1989) argue that "*interpretive research begins and ends with the biography and self of the researcher*" (p.12). This is because when researchers understand, interpret and describe any research issues from research participants with a shared background, they are "*staying close to the phenomena*" (Jungck, 1996 p. 166). As such the awareness of researcher's own "*biases, blind spots, and cognitive limitations presents a high priority for knowledge generation*" (Brown, 1996 p.20).

Whilst certain degree of researcher bias and subjectivity are inevitable in social research, objectivity and value-neutrality are considered important criteria for the credibility of research methods, and reliability and validity of research findings (Mehra, 2002). As a member of the *dalit* community, to some extent, I had some prior knowledge and preunderstanding of many aspects of *dalit* communities including their knowledge, insights, social status, socio-economic disadvantages and caste-based discriminations faced by them (Gummesson, 2000). The possession of prior knowledge of the context of the research was critical both during research design and research operation. My prior knowledge of the research context together with literature reviewed helped me to generate research questions, which are theoretically informed and also have strong contextual basis. Whilst it is recognised that in gravity flow system of irrigation, tail-enders suffer locational disadvantages in water appropriation (Bardhan 1984, Ostrom, 1994; Johnson and Libecap, 1982), the research idea about the role of property right structures in determining the level of access to water came about from my prior knowledge of the policy context of irrigation governance in Nepal.

The valuable prior knowledge about the cultural aspects and power structures in the rural communities and the hardship experienced by the members of *dalit* communities enabled me to operationalise research demonstrating sensitivity to their culture, norms and traditions. Also, my familiarity with the rurality of the research sites enabled me to make use of local colloquial terms and draw on my own personal experience in asking questions and interviewing (Nielsen and Repstad, 1993). This was critical in following up on replies and observations to obtain in-depth information pertinent to irrigation issues (Coghlan and Brannick, 2005). For example, because of shared ethnicity, I was able to share my own personal experience of caste-based discriminations in my community with the members of *dalit* community in the research sites, which encouraged the research participants belonging to the *dalit* community to share their own experience during interviews and focus group discussions. Furthermore, my shared ethnic background and prior knowledge about the research subjects allowed me to see social reality from a different "lens" by allowing me to ask questions and gather information which others could not.

I was able to capitalise on my prior knowledge of the community and local networks to establish a good rapport with the research participants in maintaining "*synergy, commitment and balance needed to operate as an insider researcher*" (Gorinski and Ferguson, 1997 p.22). My prior knowledge of the *dalit* community and the rural settings helped me to maintain "*trustworthiness, commitment, familiarity, credibility and accessibility*" with the research context and research participants and to communicate with research subjects effectively (Coghlan and Brannick, 2005 p.63). A shared ethnic background and established network provided me with an opportunity to acquire '*understanding in use*' rather than '*reconstructed understanding*' (Adler and Adler, 1987 cited in Coghlan and Brannick, 2005 p.47)

Also, the rurality of the communities considered for this research characterised by pre-dominantly agricultural activities meant that the timing of the fieldwork was critical for maximising their participation in the research process (Punch, 2005; Groves, 1998; Reimer, 1977). In Nepal, generally the farmers are busy in agricultural activities throughout the year except during the festivals and the time period between harvesting of maize crop and monsoon paddy. The fieldwork took place between October and January 2007, which is the period immediately after harvesting maize and before harvesting monsoon paddy. The two most important Hindu festivals, *Dashain* (Dashara) and *Tihar* (Diwali), also fall during this period in which farmers were relatively free and could participate in the research process.

Whilst the possession of such prior knowledge of the research context and the research subjects, particularly the farmers from the *dalit* community was helpful in accessing information, it also presented a challenge to me in a number of ways. In particular, because of my prior knowledge, there was always a danger that I might assume too much about the research subjects and fail to probe enough due to prior assumptions such as backwardness of and discriminations against the *dalit* communities (Coghlan and Brannick, 2005; Ferguson and Ferguson, 2001). As Valentine and Valentine (1970) argue, contrary to an insider, an external researcher's background will enable the research topic to be investigated from a thoroughly objective viewpoint and *"this influences the kind of data and the quality of understanding that emerges"* (p.403).

However, whilst a shared ethnic and cultural background particularly with the members of *dalit* community might locate me with the research participants, the "native" at the same time made me the "other" because of my privileged background, particularly my education and experience in the UK (Lal, 1996). Nevertheless, in material and symbolic terms I was acutely aware of my educational privilege compared to the research participants. Although I appeared an insider because of my shared ethnicity with many of the research participants (Gilbert, 1994; Mullings, 1999), my privileged educational background made me somewhat more of an outsider than an insider creating "*diversity in proximity*" (Ganga and Scott, 2006 p.2).

The members of the *dalit* communities who participated in my research were excited and were eager to help me in whatever way possible. I was often complimented for my academic accomplishments despite coming from a disadvantaged socio-economic and ethnic background. I was aware that "*neutrality of the researcher and the power relations involved in the research process*" are critical for collecting unbiased data (Madge *et al.*, 1997 p. 87). Because of my educational background and experience of the western world (UK), the farmers often assumed that I was wealthy and powerful man. Farmers in the rural village often assumed that researchers are superior to them because of their intellectual ability and they had the responsibility to provide answers to the questions which they were being asked, especially if they were not very personal (Tiwari, 2007; Moser, 1993; Fraenkel and Wallen, 1990).

The issue of power relations between the researchers and their research participants have been widely discussed in the literature (Piquemal, 2001; Crigger *et al.,* 2001; Goodwin *et al.*, 2000; Erber and Fiske, 1984; Meara and Schmidt, 1991). A growing body of literature suggests that the research process is characterised by a "*relative powerlessness of the subject vis-à-vis the researcher*" (LaRossa *et al.*, 1981 p.306) and existence of an inherent structural imbalance of power between them gives rise to potential ethical questions in research process (Brownlee, 1996; Geyer, 1994; Schank and Skovholt, 1997). It is argued that individually perceived power hierarchies, which are often rooted in historical factors such as racism, colonialism, sexism and casteism provide a backdrop to power relations between researchers and their subjects (Harding, 1991; Piquemal, 2001; Morawski, 1997; IDSN, 2009). Such historically rooted power differences provide individuals in positions of power the opportunity to "*engage in thoughts and behaviour, which attempts to maintain their position of authority*" (Richeson and Ambady, 2003 p.177). In the context of this research, such power imbalances between the researcher and research participants emanated from historical social factors and their personality traits. Firstly, whilst in general the research participants were helpful in answering my queries, at times some farmers' acted in ways that demonstrated they are more powerful than the researcher partly because they were the source of information (Kiegelmann, 1996; Cohen *et al.*, 2007). For example, during focus group discussions in the AMIS, when the issue of alleged financial irregularities taking place in the WUA was being discussed some of the participants were reluctant to provide information on the misuse of public funds. One of the participants went as far as suggesting that issues pertinent to local village sphere, which could be resolved at the village level, should not be reported to external researchers as the latter lacked both authority and ability to intervene. Such attitudes demonstrate a clear unwillingness to share information by some farmers participating in the research. Whilst the farmers demonstrated self-protective behaviour to minimise community intrusion by an external researcher (Singer, 1993; Shalala, 2000); however, by withholding information on important issues such as misuse of public funds and lack of accountability of the WUA, the research participants were not only protecting the corrupt WUA officials but also denying themselves an opportunity to rectify past mistakes and move in a positive direction with greater transparency and accountability within the WUA (Johnson *et al*, 2002; Ostrom, *et al*, 1994). Although such attitudes to external researchers cannot be generalised to all the research participants, they still provide evidence of different power relations between the researchers and the research participants.

Secondly, the power relations between the researchers and their research participants can confound with socio-cultural group status partly to maintain existing social stratification (Jost and Banaji, 1994; Operario *et al.*, 1998). Such power differences, which are rooted in socio-cultural factors, form the basis for cognitive biases of powerful individuals participating in research process, which serve to maintain their dominance in the society in general and the focus group discussions in particular (Sidanius and Pratto, 1993; Lather, 1988; Edwards, 1990; Stanley and Wise, 1990). Whilst in general the research participants treated me with great respect even though I am from the *dalit* caste group, some participants attempted to show their caste hegemony during the focus group discussions. For example, dominance of farmers belonging to higher castes was clearly visible during the focus group discussions, which took place in Tinpiple village in the JMIS, as some farmers went to suggest that "*dalits* would complain about everything when they find a *dalit* researcher, why cannot they so with WUA or researchers from higher castes". Such remarks from farmers belonging to the higher castes simply disregarded the ability of the *dalit* farmers. Furthermore, by making such remarks during focus group discussions, the farmers from higher castes were being judgemental about the ability of the *dalit* farmers and the researcher, which are based on stereotypes (Fazio *et al.,* 1995; Richeson and Ambady, 2003). Scholars such as Levkoff *et al.* (1998) suggest that such stereotypical attitudes towards the *dalits* could emanate from a mismatch between the assumptions held by the researcher and the research participants, particularly those belonging to the higher castes.

Thirdly, this research involved interviews and interactions with some prominent key informants such as bureaucrats in the DoI and local politicians who were more powerful than the researcher. Whilst in general most of the key informants responded positively to my queries, some key informants particularly those associated with the AMIS and the JMIS were reluctant to provide information. Interviewing local farmers was relatively easier compared to some senior bureaucrats at the DoI as Eyben (2004) suggest "*interactions is easier at lower echelons but there is less preparedness to take an interest in the substance of the research as more and more senior staff members become involved in the research*" (p.4). Firstly, it was difficult to negotiate appointment with senior bureaucrats working in the DoI partly due to existence of different "gatekeepers" (Mander, 1992 p.1461) and "key masters" (Campbell, 2006 p.97) within the bureaucratic hierarchy in the DoI. Secondly, even after gaining access to the 'core of the DoI', there was a prevalence of various forms of denials, particularly on the issues related to the performance of the AMIS and the JMIS. When asked about the poor performance of irrigation systems managed by the DoI, the bureaucrats attempted to cover their backs by quickly mentioning that "*the views expressed are those of the individual farmers and do not represent those of the WUA and the DoI*" (Douglas, 1986 p.19). In one instance during the interview a key informant, who is a senior engineer at the DoI, went on to say that *"if you ask the farmers how much water is enough for them, you will soon discover that no amount of water is enough for them--- do not listen to them--- they will drive you crazy".*

Similarly, as this research used farmers' perceptions in measuring the level of access to irrigation water; which immediately put me at odds with the irrigation bureaucrats; they constantly made efforts to hide key information regarding the performance of the DoI and the WUA. Cohen (2001) argues that the existence of power relations between the researchers and their subjects provides grounds for various forms of denial, which are extremely difficult to overcome particularly when they are built into the organisational and institutional structures. It should be mentioned that existence of such power differences between the researchers and research participants provides grounds for deniability, which in turn provides opportunity for the "*deferral of responsibilities*" towards the farmers by the DoI (Eyben, 2004 p.5). The attitudes of the DoI staff members towards local farmers provided a clear indication of power differences between them, which was reflected during key informant interviews.

Also, the power relations between the researchers and officials have implications in their ability to access secondary data (Hakim, 1982; Sanmartin and Ross, 2006; Scott *et al.,* 2006). Despite gaining formal permission from the DoI in Kathmandu, some staff members at the DIO in the Lamjung district, where the JMIS is situated, appeared to be suspicious about the research. The DIO staff members were very reluctant to provide me access to project documents related to the JMIS. Obviously, the staff members at the DIO were the 'gatekeepers' who had access to some of the important secondary data which this research needed to obtain. The power relation between the researcher and the staff members at the DIO clearly presented a challenge during the fieldwork. However, once I explained the aims, objectives and benefits of my research, the staff members at the DIO reluctantly provided me access to project documents related to the JMIS.

However, in order to maintain a neutral position throughout the fieldwork, I adopted a number of steps. Firstly, I constructed my role as a researcher with well-defined scope and boundaries. However, these were flexible enough to increase my adaptability depending upon the circumstances during the fieldwork. I was an outsider researcher, whose aim was to collect unbiased data and maintain neutrality throughout the research process. Ashforth *et al.* (2000) argue that a clearly defined role and flexible boundaries enable a researcher to maintain his/her dual role as an external researcher as well as a member of the community which is being studied. The boundaries were pliable spatially and temporally. The flexibility and permeability of the role constructed enabled transition from one role to another. For example, my affiliation to the *dalit* community enabled me to build a rapport with the members of the *dalit* community and obtain even personal information pertinent to irrigation issues. Also, because of a clearly defined role, I could assume physically one role (a member of a *dalit* community) and psychologically and behaviourally assume another role (a neutral researcher). Even though I demonstrated a friendly attitude towards the research participants, I never lost sight of the aims and objectives of my research and worked diligently to maintain neutrality and generate unbiased data.

A growing body of literature on research methodology asserts that some distance between the researcher and the people who are being researched should be maintained to provide a "*fully external and rigorous observation of* *social phenomenon and the neutrality of scientific language is the only way to approach social reality*" (Beltrán and Alonso, 2005 p.5). Therefore, consistent with the dominance of positivism in social research, as a researcher, I needed to be close to my research subjects to build up rapport and to generate much needed data. However, at the same time I kept a certain distance to maintain objectivity and neutrality during the research process. I never attended dinner at the research participants' houses either after the interview or otherwise despite being invited, as having dinner is perceived as being too close in Nepalese culture where the risk of losing neutrality was high. Instead, I shared tea with them at the local tea shops at my own expense. This approach had a number of advantages. Firstly, it is a customary practice for local people in rural Nepal to assemble in local tea shops to discuss issues of local interests informally and I could use this opportunity to build rapport with the local people. Also, having a cup of tea together instead of having dinner at their houses is considered as being "*close but not too close*" (Welsh *et al.*, 2008 p.1854) to the research participants. Secondly, paying for tea was a way of thanking the research participants for the time they gave me to discuss issues related to irrigation. Also, paying myself for tea means that I was not expecting anything from the local farmers apart from honest answers to hone my understanding of the irrigation related issues in their communities. Thirdly, I neither accepted gifts from the research participants nor gave them any gifts as this is likely to influence the social dynamics between the researcher and the participants. Fourthly, despite being asked what I could do to their villages, I did not promise anything that I could not deliver. Instead I told them that this is an independent study for my PhD degree and the findings would be shared to the local farmers and the policy makers, which might help to change irrigation policies in the future. Fifthly, I took necessary care in generating "*situated research*" (Atkinson, 2005 p.51) to understand the irrigation issues from the perspectives of the farmers, which is not influenced by my affiliation to the *dalit* community, which was being researched. In doing so, I distanced myself from my own 'ethnic affiliation and prejudices' (McKinley, 2005). The respondents were informed at the outset of the interviews that our shared ethnic background should not influence the way they responded to my questions. The respondents were assured that the information they provided would be strictly confidential and that they should respond to the questions in a free and impartial manner without any worry of being punished for their opinions.

3.11 Conclusions

This chapter has described the research methodology used in this research. It has briefly revisited the research questions and highlighted the need for a distinct research methodology in order to answer the research questions. Given the nature and the scope of the study, a case study approach was deemed to be the best approach to investigating the issues raised and the research questions posited in Chapter One. The case study involved triangulation of data obtained through mixed methods. The mixed method approach adopted in this thesis has applied a number of data collection methods including a household survey, focus group discussions, key informant interviews, participant observations and documentary analysis. The chapter has highlighted the advantages and limitations of each of the general methods used in the thesis and explained how these were applied during the course of the fieldwork.

Whilst the choice of a sound research method was critical, the choice of case study sites was equally important in answering the research questions. The chapter has explained the rationale for choosing the three irrigation systems considered for this research. The selection of case study was done in light of a number of factors, including comparable precipitation and temperature, rural settings, similar cropping patterns, heterogeneous settings and different property rights structures.

The chapter has described the socio-economic situations and demographic patterns of the case study sites in order to familiarise readers with the context within which this research took place. Furthermore the ethical considerations have been highlighted. Since the research involved human subjects, it was absolutely critical to demonstrate a clear adherence to the research ethics. Finally, the chapter has explained the data analysis methods used in the research.

CHAPTER FOUR:

HOUSEHOLDS CHARACTERISTICS AND ACCESS TO IRRIGATION WATER: A COMPARATIVE STUDY OF THREE IRRIGATION SYSTEMS

4.1 Chapter Overview

The relationship between socio-economic heterogeneity and distributional implications of natural resource management is becoming a growing concern amongst both academics and policy makers alike. This chapter uses both households' socio-economic characteristics and resource specific features, which are assumed to have influence on household ability to access water from the irrigation canals. The analysis is based on a household survey from the mid-hills of the Nepal to investigate households' level of access to irrigation water from canal systems, which are governed by different property right regimes. Depending on the nature of the variables, simple statistical tests such as the Chi-square test, ANOVA and t-tests were carried out to answer research questions presented in Chapter One. The analysis of field data suggests that households with different socio-economic capability have different level of access to irrigation water. However, farmers along these heterogeneities have different levels of access to water in irrigation systems governed by different property right regimes with farmers in the FMIS performing significantly better than those served by the AMIS and the JMIS. This chapter argues that property rights on natural resources need to be combined with social goals for equity for the sustainable management of irrigation resources.

4.2 Endogenous Variables: Basic Description of Communal Characteristics

This section describes the characteristics of the sample, community characteristics and resource specific characteristics. Variables are identified through the literature review presented in Chapter Two, which are assumed to have implications on farmers' capabilities to access water. The exercise carried out in this chapter will help to design the model for regression analysis in Chapter Five.

4.2.1 Caste and Access to Irrigation Water

Nepalese society is dominated by caste hierarchy. The *dalits* who occupy the lowest position in the caste hierarchy face a multitude of segregations including subordination, untouchability and socio-economic discrimination. In order to understand the association between caste and farmers' access to water, the respondents were asked if they faced caste based discrimination in general and specifically in relation to water appropriation from the canal system. Table 4.1 shows the proportion of farmers who reported to have experienced caste based discrimination in general and caste based discrimination particularly in relation to water appropriation in the sample households.

However, the results show remarkable differences in caste discrimination, particularly in relation to irrigation related activities amongst the three irrigation systems considered for this research. None of the farmers from the lower castes (the *dalits*) in the FMIS area, who reported having faced caste based discrimination in their communities reported discrimination during water appropriation from the canal. Neither did farmers from the *dalit* castes in the FMIS area who did not report facing caste based discriminations in their community, report such discrimination during water appropriation.

It is interesting to note that the caste based discrimination took place in the opposite direction in the FMIS area. The data shows that a significant proportion of farmers from higher caste groups who reported having faced caste based discrimination generally in their community, also reported it during water appropriation. About 40 percent of the farmers belonging to higher caste groups who reported having faced caste based discrimination in their community generally, also reported it during water appropriation, while the remaining 60 percent did not.

Despite being a semi-urban area, caste based discrimination, particularly during water appropriation, is generally high in the AMIS area. Although none of the farmers belonging to the *dalit* caste reported discrimination generally in the AMIS, all reported it during water appropriation.

Table 4.1 General Caste based Discriminations and Caste based Discrimination related to Water Distribution as Reported by Farmers

Caste Based Discrimination	Irrigation Systems												Over all caste based discriminations in water appropriations	
	FMIS				AMIS				JMIS					
	General % (n)		Water specific % (n)		General % (n)		Water specific % (n)		General % (n)		Water specific % (n)			
	Dalits	Higher castes	Dalits	Higher castes	Dalits	Higher castes	Dalits	Higher castes	Dalits	Higher castes	Dalits	Higher castes	Yes % (n)	No % (n)
Yes	81.8 (9)	8.9 (5)	0 (0)	3.6 (2)	0 (0)	3.3 (2)	100 (3)	1.7 (1)	61.5 (8)	19.6 (11)	38.5 (5)	22.2 (12)	36.8 (73)	3.8 (7)
No	18.2 (2)	91.1 (51)	100 (11)	96.4 54)	100 (3)	96.7 (58)	0 (0)	98.3 (59)	38.5 (5)	80.4 (45)	61.5 (8)	77.8 (44)	63.2 (126)	96.2 (192)
Total	100 (11)	100 (56)	100 (11)	100 (56)	100 (3)	100 (60)	100 (3)	100 (60)	100 (13)	100 (56)	100 (13)	100 (56)	100 (199)	100(199)
Pearson Chi-square = 36.768 D.F. = 1 P-value <0.001														

However, none of the farmers from higher castes reported to facing caste based discrimination generally nor during water appropriation. Of the farmers from higher castes in the AMIS reporting experiences of caste based discriminations, 1.7 percent also reported discrimination during water appropriation, while the remaining 98.3 percent did not make such reports. It illustrates that the *dalit* households in the AMIS continue to face caste related discrimination in water appropriation, which has serious implications for social inclusion in the management of the AMIS and ultimately a profound implication on access to productive resources such as irrigation water. One of the objectives of this research was to investigate under which property rights regime farmers belonging to the *dalit* castes have better access to water. The data demonstrate that, for these farmers, there is a clear link between discrimination on the basis of caste in general and on the basis of caste in water related issues including water appropriation from the canal system in the AMIS.

Similarly, a significant proportion of farmers belonging to the *dalit* caste in the JMIS who reported caste based discrimination also felt discriminated against during water appropriation from the canal system. Data demonstrate that 61.5 percent of the farmers from the *dalit* castes who did not report to have faced caste based discrimination generally, reported it whilst appropriating water from the canal system, while 38 percent of the *dalit* farmers reported caste discrimination generally also reported it specifically when appropriating water from the canal system. Equally important, a significant proportion of farmers from the higher castes who experienced caste related discrimination also reported it during water appropriation from the canal system.

Overall in the sample, 39 percent of the farmers who reported facing caste based discrimination in their society generally also reported it while appropriating water from the canal system. Similarly, a significantly higher proportion of farmers (63.2 percent) who reported not having experienced caste based discrimination generally, also reported facing caste based discrimination.

Table 4.1 presents results of the Chi-square test between the irrigation systems and caste based discrimination in water appropriation from the canal. The results of the Chi-square test indicate that there is a statistically significant association between the irrigation systems and caste based discrimination in water appropriation. The system level comparison of caste based discrimination in water appropriation shows a clear difference. The implantation of an egalitarian approach to water distribution in the FMIS has meant that perhaps the *dalit* farmers in the FMIS have a sense of being more empowered and report less caste based discrimination in water appropriation (as described in Chapter Six later). This has a significant effect on the welfare of the lower caste people who depend on marginal land for sustaining their livelihoods.

Table 4.2 shows the level of access to irrigation water by different caste groups in the three irrigation systems considered for this research. In the FMIS, the *dalit* households appear to have better access to water than the higher caste farmers in the same irrigation system. The percentage of farmers reporting strong access to irrigation water in the FMIS is 90.9 and 82.1 from the *dalits* and higher castes respectively. However, the proportion of the *dalit* farmers reporting strong access to water in the AMIS and the JMIS is rather low when compared to people from higher castes. The definition of strong and weak access to water in the context of this thesis has been provided in Chapter Three (Section 3.9). Strong access to water is the level of access as reported by the farmers with an access score value more than the mean access score (access score >1.735), while weak access is considered as the level of access with an access score less than 1.735. The mean access score is the level of access to water, which is enough to grow at least two crops a year essential for household food security. The proportion farmers in the AMIS in both castes reporting a weak access to water is substantially higher as compared to the farmers in the FMIS and JMIS. Only a third of the *dalit* households in the AMIS reported having strong access to water, while 61.5 percent and 90.9 percent from the JMIS and the FMIS reported strong access respectively. The Chi-square test results presented in Table 4.2 indicate that caste based discrimination, particularly in relation to irrigation issues, has statistically significant association with the level of access to water.

Table 4.2 Level of Access to Water by Castes in Different Irrigation Systems

Level of Access to Irrigation Water	Irrigation Systems								Households reporting caste cased discriminations by system types		
	FMIS % (n)		AMIS % (n)		JMIS % (n)		Overall % (n)				
	Higher castes	***Dalits***	**Higher castes**	***Dalits***	**Higher castes**	***Dalits***	**Higher castes**	***Dalits***	**FMIS % (n)**	**AMIS % (n)**	**JMIS % (n)**
A strong access	82.1 (46)	90.9 (10)	21.7 (13)	33.3 (1)	76.8 (43)	61.5 (8)	59.3 (102)	70.4 (19)	83.6 (56)	22.2 (14)	73.9 (51)
A weak access	17.9 (10)	9.1 (1)	78.3 (50)	66.7 (2)	23.2 (13)	38.5 (5)	40.7 (70)	29.6 (8)	16.4 (11)	77.8 (49)	26.1 (18)
Total	100 (56)	100 (11)	100 (60)	100 (3)	100 (56)	100 (13)	100 (172)	100 (27)	100 (67)	100 (63)	100 (69)

Pearson Chi-square= 58.910
D.F.= 2
P-Value <0.001

4.2.2 Size of Landholding and Access to Water

Table 4.3 shows the landholding by different households in the three irrigation systems under consideration. The categorisation of households has been discussed in Chapter Three (Section 3.6.3.2). Whilst the classification of households into various categories would suggest inherent differences in the size of landholdings amongst the households in those categories, the differences in landholding across other heterogeneities also appear to be marked. Firstly, in the FMIS, while there are no apparent differences in the holdings of farmers in different locations, the difference between types of farmers is striking. On average, the larger landholders have more than five times the land of small landholders. As mentioned earlier, landholding not only reflects economic power but also social status and privileged position in the rural communities in Nepal. Whilst the amount of landholding symbolises socio-economic power in rural Nepal, the quality of the land determines the actual economic gains from agricultural practices. Generally the *Khet* land is considered to be better than *Pakho* for crop production. The large farmers not only have a significant amount of land, but it is also better quality. The larger farmers have a higher amount of productive *Khet* land as well as *Pakho,* compared to medium or small landholders. In the same system, the male-headed households have a higher amount of land than female-headed households, and they also have access to more of the better quality *Khet* land compared to households headed by females. The unequal distribution of land can also be observed amongst different caste groups. Farmers from higher castes have almost twice the amount of landholdings than those from lower caste groups.

Table 4.3 Households Categories and landholdings

Households Categories	Types of Land in *Ropani*								
	FMIS			AMIS			JMIS		
	Khet	Pakho	Total	Khet	Pakho	Total	Khet	Pakho	Total
Large	15.3	7.4	22.7	20.5	5.0	25.6	15.2	11.2	26.4
Medium	10.1	1.9	12.0	10.1	2.0	12.1	8.5	4.6	12.8
Small	4.3	0.5	4.8	3.5	0.2	3.7	2.3	2.3	4.6
Male HH	8.0	2.2	10.2	8.6	1.7	10.3	9.9	6.7	16.8
Female HH	5.9	2.0	7.9	3.5	0.1	3.6	6.1	5.2	11.3
Head end	10.7	3.6	14.3	3.7	0.6	4.3	9.2	3.3	12.5
Middle end	6.7	2.2	8.9	9.2	1.2	10.4	7.5	2.5	10.0
Tail end	7.1	1.8	8.9	7.4	1.7	9.2	5.9	9.6	15.4
Higher castes	8.0	2.3	10.3	7.8	1.4	9.2	10.6	7.1	17.8
Dalits HH	5.3	1.2	6.5	1.0	0.7	1.7	3.4	4.0	7.4
Over all	7.6	2.1	9.7	7.5	1.3	8.8	9.3	6.6	14.3

Secondly, in the AMIS, unlike the FMIS, the distribution of landholdings along the spatial scale is quite distinct. The farmers at the tail end of the main canal in the AMIS area have larger landholdings than the farmers at the head end. However, the farmers at the tail end of the canal have poor access to water as compared to farmers at the head end. This has serious implications for food production, not only at the household level but also for the entire system, as the large swath of land at the tail end lacks good access to irrigation water. In the same system, landholdings are distributed very unequally amongst the farmers belonging to different caste groups. Farmers from higher castes groups hold almost five fold the amount of land than that of the lower castes, and also have access to better quality *Khet* land than the farmers belonging to lower caste groups. Generally, the farmers belonging to the *dalit* castes have marginal landholdings, which are often located in unproductive areas called the *Khoriya*. These *Pakho* landholdings are difficult to irrigate, while also requiring a high water application for crop production, owing to their unproductive nature.

A two-sample independent t-test was used to determine whether there was a gender difference in the distribution of land. The t-test shows that on average, farmers from households headed by men had access to larger landholdings (Mean=12.35 *Ropani*, S.D. = 12.39, N=156), than female-headed households (Mean= 7.57 *Ropani*, S.D. =5.64, N=43).

This difference was statistically significant t (154.25) = 3.859, $p<0.05$, and also represented a medium sized effect (Eta-squared=0.083).[6]

Similarly, the t-test shows that on average, farmers from higher castes had access to larger landholdings (Mean=12.35 *Ropani*, S.D. = 11.94, N=172) than farmers from lower castes (*dalit*) (Mean= 6.41 *Ropani*, S.D. =5.56, N=27). This difference was also statistically significant t (71.527) = -4.227, $p<0.05$ and represented a medium sized effect (Eta-squared=0.07).

Table 4.4 Small Farmers and Access to Water in the Three Irrigation Systems

Level of Access to Irrigation Water	Irrigation System/ Marginal Farmers		
	FMIS % (n)	**AMIS % (n)**	**JMIS % (n)**
A strong access	76.2 (32)	15.2 (6)	61.9 (13)
A weak access	23.8 (10)	84.6 (33)	38.1 (8)
Total	100 (42)	100 (39)	100 (21)
Pearson Chi-square= 31.407 D.F.= 2 P-Value <0.001			

Table 4.4 shows comparative access levels of farmers belonging to small landholding categories in the three different irrigation systems. The data clearly demonstrate that the small farmers in the FMIS have better access to irrigation water than their counterparts in the AMIS or JMIS. On average, 76.2 percent of the marginal farmers in the FMIS reported having strong access to irrigation water, while just 15.24 percent and 61.9 percent of the

[6] Cohen's d, also called Eta-squared is commonly used to indicate the standardized different between two means and often used in reporting results of t-test and ANOVA. Cohen (1988) suggests that in the behavioural sciences, an effect size of 0.2 indicates a small effect, 0.5 a medium effect, and >0.8 a large effect.

marginal farmers in the AMIS and the JMIS respectively, made this same report. The Chi-square result indicates that there is an association between the level of access and irrigation systems for marginal farmers and the association is statistically significant at $p<0.001$ level.

Table 4.5 shows an average access score of the marginal farmers in three different irrigation systems. On average, the marginal farmers in the FMIS reported higher access scores (2.02) than their counterparts in the AMIS (0.84) and the JMIS (1.54).

Table 4.5 Average Access Score of Famers with Small Landholding

Marginal Farmers	N	Mean	Std. Deviation	Std. Error	Min.	Max.
small farmers in FMIS	41	2.0268	.51504	.08044	.80	3.00
small farmers in AMIS	39	.8372	.99159	.15878	.00	3.00
small farmers in JMIS	20	1.8975	1.34228	.30014	.00	3.00
Total	100	1.5370	1.07188	.10719	.00	3.00

A one way between-group analysis of variance (ANOVA) test was conducted to determine the statistical significance of the household level of access to irrigation water as measured by the access score. The marginal farmers were divided according to the type of system that served them (Group 1: marginal farmers in the FMIS; Group 2: marginal farmers in the AMIS; Group 3: marginal farmers in the JMIS). The results are presented in Table 4.6.

Table 4.6 ANOVA Results for Access Score of Marginal Farmers in the Three Irrigation Systems

	Sum of Squares	d.f	Mean Square	F	Sig.
Between Groups	31.537	2	15.768	18.606	.000
Within Groups	82.206	97	.847		
Total	113.743	99			

The ANOVA results indicate a statistically significant difference between the groups at the $p<0.001$ level in the access score for the three groups of marginal farmers: $F(2, 97) = 18.606$, $p<0.001$. Although the difference in access scores between the groups appears small, those small differences do indicate a greater significance, as the value of access scores ranges between 0 and 3 where a small difference could indicate huge significance in practical terms. The effect size, calculated using eta squared was 0.28, which is considered to be large statistically (Cohen, 1988).

Table 4.7 Multiple Comparison of Access Score of Small Landholders in Three Irrigation Systems

(I) Small farmers	(J) Small farmers	Mean Difference (I-J)	Std. Error	Sig.
small farmers in FMIS	small farmers in AMIS	1.18965*	.20591	.000
	small farmers in JMIS	.12933	.25109	.864
small farmers in AMIS	small farmers in FMIS	-1.18965*	.20591	.000
	small farmers in JMIS	-1.06032*	.25319	.000
small farmers in JMIS	small farmers in FMIS	-.12933	.25109	.864
	small farmers in AMIS	1.06032*	.25319	.000

The multiple comparisons of the access scores of marginal farmers in the three irrigation systems are presented in Table 4.7. While there is no significant difference between the access scores of marginal farmers in the FMIS and the JMIS, the difference between the marginal farmers in the AMIS and their counter parts in the FMIS and the JMIS is statistically significant. First, the small landholders in the FMIS are compared with their counterparts in the AMIS and the JMIS. It was found that the marginal farmers in the FMIS are significantly different from their counterparts in the AMIS, but have statistically non-significant difference with marginal farmers in the JMIS at $p<0.001$ level. When compared with marginal farmers in the FMIS and the JMIS, the marginal farmers in the AMIS, the difference in access score was found to be statistically significant at $p< 0.001$ level. Also, when the marginal farmers in the JMIS were compared with their counterparts in FMIS, the difference was not statistically significant but comparison with their counterparts in the AMIS showed a statistically significant difference at $p<0.001$ level.

As argued in Chapter Two, socially and economically dominant groups have greater access to and control over productive capitals such as landholdings, while the landless and small landholders depend on the larger landholders for their livelihoods. Some of the informal practices of patron-client relationships include the practices of *Haliya* and *Balighare*.[7] The farmers with small

[7] The term '*haliya*' denotes a form of agricultural bonded labour practice in Nepal. The haliya system is organised on a short term contract where a ploughman ploughs his masters' plots as debt payments. Generally *haliyas* are from the background of the 'low caste' and ethnic community. Although the haliya system has been abolished officially by the Government of Nepal in September 2008, it is still widely prevalent all over the country, but is more common in Baitadi, Bajhang, Bajura, Dadeldhura, Darchula, Gorkha, Mustang, Myagdi, Parbat, Baglung and Gulmi districts (INSEC, 1994). Also, the baalighare system is an age old practice of labour arrangements where the bonded labourer or the ploughmen or tailors are paid annually in the form of grain for their work for their masters from higher castes.

landholdings face multiple problems in securing their livelihoods and depend on credits from various formal and informal sources. The dependency of landless and small landholders on larger landholders is often mediated through patron-client relationships and other forms of informal credit relationships.

4.2.3 Location of Landholding and Access to Water

The farmers at the head end of the canal systems are often fuelled by a deep rooted mentality that they should have natural priority rights to irrigation water owing to their location, as demonstrated by the following quotation from a key informant interview:

> "---*There is no such thing in irrigation management where tail-enders should be prioritised at the expense of the head-enders. Head-enders should naturally enjoy priority as the water flows through our area. How could you think that we will stand on the canal side and watch water flowing down when we do not have enough water in our own field---?*"
>
> (Male, 56 years, head-ender in AMIS)

The natural locational advantage enjoyed by the farmers at the head end of the canal not only has differential economic outcomes but also implications for collective outcomes, owing to different levels of incentives among head and tail end farmers (Bardhan 1984, Ostrom, 1994; Johnson and Libecap, 1982). In the absence of appropriate institutional arrangements to design, and implement property rights, and monitoring mechanisms for controlling defrauding many complex problems arise while managing local commons, including irrigation systems.

Table 4.8 presents the access score, and the number of hours irrigation water is used annually in different locations in the three irrigation systems considered for this research. A clear pattern in the access score of different households can be observed both across the landholding locations and the irrigation systems. The access score has a minimum value of 0 and a maximum value of 3. Households with higher access scores have better access to irrigation water. In the FMIS, head-enders have access scores of 1.9, while middle and tail-enders have average access scores of 1.9 and 2.3 respectively. In fact, the tail-enders in the FMIS appear to have better access to irrigation water compared to middle and head-enders. This is partly because of water distribution rules implemented in the FMIS, which will be described in detail in Chapter Six.

Table 4.8 Household Irrigation Access Score and Total Number of Hours Irrigation Water Applied by Landholding Locations

System Type	Location	Average Access Score	Total Number of hours irrigation water used
FMIS	Head	1.9	692.79
	Middle	1.9	361.97
	Tail	2.3	116.73
AMIS	Head	1.7	997.60
	Middle	0.8	519.38
	Tail	0.5	382.42
JMIS	Head	2.7	3190.0
	Middle	2.6	1629.38
	Tail	0.6	1092.27

A one way between-group analysis of variance (ANOVA) test was conducted to find out the statistical significance of the level of access to irrigation water as measured by the access scores. The marginal farmers were divided according to the type of systems that serve them. (Group 1: head-enders; Group 2: middle-enders; Group 3: tail-enders). The results are presented in Table 4.9.

Table 4.9 ANOVA Results for Access Score of Landholding Locations in Phalebas

	Sum of Squares	**d.f**	**Mean Square**	**F**	**Sig.**
Between Groups	1.570	2	.785	3.958	.024
Within Groups	12.495	63	.198		
Total	14.065	65			

ANOVA results indicate a statistically significant difference between the groups at the p<0.05 level in the access scores for the three group landholding locations: F (2, 63) = 3.958, p<0.05). The effect size, which is calculated using Eta squared, was 0.11 and is considered to be of medium significance statistically (Cohen, 1988). Table 4.10 presents the outputs from multiple comparisons.

Table 4.10 Multiple Comparison of Access Score by Landholding Group in the FMIS

(I) Location of majority of household's landholdings with reference to main canal	**(J) Location of majority of household's landholdings with reference to main canal**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**
		Lower Bound	Upper Bound	Lower Bound
head end	middle end	.03875	.15745	.967
	tail end	-.32750	.17952	.170
middle end	Head end	-.03875	.15745	.967
	tail end	-.36625(*)	.13173	.019
tail end	Head end	.32750	.17952	.170
	middle end	.36625(*)	.13173	.019

It is interesting to note that the head and tail-enders do not differ significantly from each other in the FMIS. First, the mean access score of the head-ender is compared with the middle and tail-enders and have not been found to be significantly different from each other ($p<0.05$). The comparison of the middle-enders group with head and tail-enders groups shows the difference between middle and tail-enders to be statistically significant at ($p<0.05$) level, while the difference between middle-enders and head-enders was not statistically significant. Similarly, when comparing tail-enders with middle-enders, the difference between them was also found to be statistically significant ($p<0.05$), while the difference between tail-enders and head-enders was not. Similarly, as mentioned in Table 4.8, in the AMIS, head-enders have access scores of 1.7 while the middle and tail-enders have average access scores of 0.8 and 0.5 respectively. It is clear that the farmers at the head end of the AMIS have higher average access scores compared to the landholdings in the middle and tail end of the canal system.

Table 4.11 ANOVA Results for Access Score of Landholding Locations in AMIS

	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	9.617	2	4.809	4.910	.011
Within Groups	57.779	59	.979		
Total	67.396	61			

In order to determine the access scores of famers located in different locations, an ANOVA test is carried out. The ANOVA results indicate a statistically significant difference between the groups at the $p<0.001$ level in the access score for the three groups of landholding locations: $F (2, 59) =$

4.809, $p<0.05$) as presented in Table 4.11. The effect size, calculated using Eta squared, was 0.14 which is considered to be large statistically (Cohen, 1988).

Table 4.12 presents the outputs from multiple comparisons. The output consists of 95% confidence intervals for all differences between the underlying true means for weighted access scores of pairs of landholdings situated in different locations. It is very interesting to note that the mean access scores of head-enders differ significantly from that of both tail and middle-enders. First, the mean access scores of the head-enders are compared with those of the middle and tail-enders and they are found to be significantly different from each other at $p<0.05$ level. The comparison of the middle-enders group with the head-enders indicates a statistically significant difference at $p<0.05$ level, while the difference between the middle-enders and tail-enders is not statistically significant at $p<0.05$ level. Similarly, when comparing the tail-enders with the head-enders, the difference between them is found to be statistically different ($p<0.05$), while the difference between tail-enders and middle-enders was not statistically significant.

Table 4.12 Multiple Comparison of Access Score by Landholding Groups in AMIS

(I) Location of majority of household's landholdings with reference to main canal	(J) Location of majority of household's landholdings with reference to main canal	Mean Difference (I-J)	Std. Error	Sig.
		Lower Bound	Upper Bound	Lower Bound
head end	middle end	.88250(*)	.36456	.048
	tail end	1.16375(*)	.37247	.008
middle end	Head end	-.88250(*)	.36456	.048
	tail end	.28125	.27528	.566
tail end	Head end	-1.16375(*)	.37247	.008
	middle end	-.28125	.27528	.566

Similarly, in the JMIS, head-enders have an average access score of 2.7 while for middle and tail-enders scores are 2.6 and 0.6 respectively. In fact, a very low access score of farmers in the tail end of the JMIS shows an enduring problem of head-tail inequality. The ANOVA results indicate a statistically significant difference between the groups at the $p<0.001$ level in the access scores for the three groups of landholding locations: $F(2, 63) = 32.553$, $p<0.01$). The effect size, calculated using Eta squared, was 0.50 which is considered to be large statistically (Cohen, 1988).

Table 4.13 presents the outputs from multiple comparisons in the JMIS. Although the head-enders do not differ significantly from middle-enders, the difference between head-enders and tail-enders was significant at $p<0.05$ level. Similarly, although the comparison of the middle-enders group with the head-enders did not indicate a statistically significant difference at $p<0.05$ level, the difference between the middle-enders and tail-enders *was* statistically significant at $p<0.05$ level. Similarly, when comparing tail-enders with the head-enders and middle-enders, the difference between them was found to be statistically different ($p<0.05$).

Table 4.13 Multiple Comparison of Access Score by Landholding Groups in JMIS

(I) Location of majority of household's landholdings with reference to main canal	(J) Location of majority of household's landholdings with reference to main canal	Mean Difference (I-J)	Std. Error	Sig.
		Lower Bound	Upper Bound	Lower Bound
head end	middle end	.11688	.24366	.881
	tail end	2.14500(*)	.29787	.000
middle end	Head end	-.11688	.24366	.881
	tail end	2.02813(*)	.27391	.000
tail end	Head end	-2.14500(*)	.29787	.000
	middle end	-2.02813(*)	.27391	.000

All of the discussions and statistical analyses show that head-tail inequality continues to be a major concern in the distribution of water resources in the Nepalese irrigation system. As will be clear from later discussions, head-enders often appear to free ride at the expense of the contributions made by other farmers, mainly those from the tail ends of the canal system. However, the irrigation systems differ in terms of catering for the needs of the tail end farmers. Table 4.14 presents the household level of access to water based on location in different irrigation systems. In the FMIS, 80 percent of the head-enders reported having a strong access to water while 50 percent and 90 percent of their counterparts did so in the AMIS and the JMIS respectively. A considerably higher proportion (100 percent) of tail-enders in the FMIS reported having a strong access to irrigation water compared to just 8.3 percent in the AMIS and 20 percent in the JMIS. The Chi-square results indicate a statistically significant association between the landholding locations and levels of access to irrigation water.

The data indicate that a clear pattern of access to water exists amongst the farmers in three different locations along the main canal. In both the AMIS and the JMIS, the proportion of farmers reporting strong access to water decreases from head end to the tail end. Interestingly in the FMIS, the proportion of farmers who report a strong access to water is higher at the tail ends than the head ends. This shows that the FMIS have been able to minimise head-tail inequalities while the other two systems still suffer from these problems.

Table 4.14 Household Level of Access to Irrigation Water by Locations

Level of Access to Irrigation Water	Irrigation Systems/Locations								
	FMIS % (n)			AMIS % (n)			JMIS % (n)		
	Head end	Middle end	Tail end	Head end	Middle end	Tail end	Head end	Middle end	Tail end
A strong access	80 (8)	70 (28)	100 (17)	50 (5)	17.2 (5)	8.3 (2)	90 (18)	88.2 (30)	20 (3)
A weak access	20 (2)	30 (12)	0 (0)	50 (5)	82.8 (24)	91.7 (22)	10 (2)	11.8 (4)	80 (12)
Total	100 (10)	100 (40)	100 (17)	100 (10)	100 (29)	100 (24)	100 (20)	100 (34)	100 (15)
Pearson Chi-square= 8.913 D.F. = 2 P-value = 0.01									

Table 4.15 Tail-enders and Level of Access to Irrigation Water in the Three Irrigation Systems

Level of Access to Irrigation Water	Irrigation System			
	FMIS % (n)	AMIS % (n)	JMIS % (n)	Total % (n)
A weak access	24.4 (10)	83.3 (30)	48.3 (14)	50.9 (54)
A strong access	75.6 (31)	16.7 (6)	51.7 (15)	49.1 (52)
Total	100 (41)	100 (36)	100 (29)	100 (106)
Pearson Chi-square= 26.762 D.F.= 2 P-Value <0.001				

Table 4.15 presents the level of access to irrigation specifically among the tail-enders of the three irrigation systems considered in this research. A significantly higher proportion of tail end farmers in the FMIS reported strong access to irrigation compared to their counterparts in the AMIS and the JMIS. In the FMIS, 75.6 percent of the tail-enders reported strong access to irrigation water compared to just 16.7 and 51.7 percent from the AMIS and the JMIS respectively. The results of the Chi-square test indicate an association between the system type and access to irrigation for tail-enders at p< 0.001 level.

Whilst the chi-square results just indicate the relationship of the association between two categorical variables (tail-enders in the three irrigation systems and level of access to irrigation water in this case), ANOVA tests show if the mean of a continuous variable (access score in this case) differs significantly amongst different categories of farmers. One of the research objectives was to investigate the role of property rights regimes in the 'tail-enders' ability to access water from the canal system, as stated in research question 1c in

Chapter One. In order to answer this research question, an ANOVA test was carried out to compare the average access score of the tail-enders in the three irrigation systems, which tail-enders is presented in Table 4.16. On average, the tail-enders in the FMIS system have a weighted access score of 2.0 while the average access score of tail-enders in the AMIS and the JMIS are 0.69 and 1.46 respectively. The access score of tail-enders in the FMIS was almost three times that of the tail-enders in the AMIS and 1.2 times their counterparts in the JMIS. This indicates that the FMIS has been successful in internalising the problems associated with head-tail inequalities in the system through appropriate institutional arrangements (explored in Chapter Six).

Table 4.16 Access Score of Tail-enders in the Three Irrigation Systems

Farmers' Categories	N	Mean	Std. Deviation
tail end farmers in FMIS	40	2.0238	.51253
tail end farmers in AMIS	35	.6943	.98098
tail end farmers in JMIS	28	1.6429	1.34479
Total	103	1.4684	1.11124

An ANOVA test was conducted to compare the mean access score of farmers at the tail end of the three irrigation systems considered for the study. The results of the ANOVA test are presented in Table 4.17.

Table 4.17 ANOVA results for Access Score of Tail-enders in the Three Irrigation Systems

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	37.056	2	18.528	16.887	.000
Within Groups	209.560	191	1.097		
Total	246.616	193			

The ANOVA results indicate a statistically significant difference between the groups (Group 1: tail-enders in FMIS; Group 2: tail-enders in AMIS); Group 3: tail-enders in the JMIS) (at the $p<0.001$ level in the access score for the three groups of landholding locations: $F (2, 191) = 16.88, p<0.01$). The effect size, calculated using Eta squared, was 0.15 which is considered to be large statistically (Cohen, 1988).

Table 4.18 Multiple Comparisons of Access Score of Tail-enders in the Three Irrigation Systems

(I) tail end farmers in different irrigation systems with reference to main canal	(J) tail end farmers in different irrigation systems with reference to main canal	Mean Difference (I-J)	Std. Error	Sig.
		Lower Bound	Upper Bound	Lower Bound
tail end farmers in FMIS	tail end farmers in AMIS	1.32946(*)	.22175	.000
	tail end farmers in JMIS	.38089	.23607	.245
tail end farmers in AMIS	tail end farmers in FMIS	-1.32946(*)	.22175	.000
	tail end farmers in JMIS	-.94857(*)	.24292	.000
tail end farmers in JMIS	tail end farmers in FMIS	-.38089	.23607	.245
	tail end farmers in AMIS	.94857(*)	.24292	.000

Table 4.18 presents the outputs from multiple comparisons of mean access scores of tail-enders in the three irrigation systems. Firstly, the tail-enders in the FMIS are compared with their counterparts in the AMIS and the JMIS. While the difference in the mean of tail-enders in the FMIS is statistically significant with tail-enders those in the AMIS at $p<0.05$ level, the difference between the FMIS and the JMIS is not statistically significant. However, when the mean access scores of the tail-enders in the AMIS are compared with those of their counterparts in the FMIS and the JMIS, they are found to be statistically significant with each other at $p<0.05$ level. Similarly, when

comparing the mean of tail-enders in the JMIS with that of the tail-enders in the FMIS the difference was not statistically significant, while the difference between tail-enders in the JMIS and the AMIS was found to be statistically significant at $p<0.05$ level.

From Table 4.19, it is clear that a significantly higher proportion of tail-enders in the AMIS and the JMIS reported having faced institutional disadvantages over water appropriation compared to tail-enders in the FMIS. In this thesis, institutional disadvantage has been defined as discrimination against some farmers that have been incorporated into structures, processes and procedures of the irrigation organisation either because of prejudice or because of failure to take into account their particular needs (Reskin, 1998). The institutional disadvantages in irrigation management occur because of the collective failure of irrigation organisations to provide appropriate service relating to the particular needs of some farmers (Pager and Shepherd, 2008). Such institutional discrimination is often observed in processes, attitudes and behaviour which amount to discrimination through unwitting prejudice, ignorance and thoughtlessness that disadvantage some farmers over others (Pandey *et al.*, 2006).

When asked if they faced institutional disadvantages during water appropriations, more than a third of the replies from tail-enders from the AMIS and the JMIS were positive compared to just under fifteen percent in the FMIS.

Table 4.19 Tail-enders and Institutional Disadvantages in Water Appropriation in the Three Irrigation Systems

Institutional Disadvantages	Irrigation System			
	FMIS % (n)	AMIS % (n)	JMIS % (n)	Total % (n)
Yes	12.2 (5)	38.9 (14)	34.8 (8)	27 (27)
No	87.5 (36)	61.1 (22)	65.2 (15)	73 (73)
Total	100 (41)	100 (36)	100 (23)	100 (100)
Pearson Chi-square= 7.848 D.F.= 2 P-Value <0.05				

4.2.4 Farmers' Agronomical Knowledge and Access to Irrigation Water

Research shows that farmers' agronomical knowledge has implications for the way in which irrigation water is used and the issue warrants some discussion since it has implications for sustained head-tail inequalities in access to irrigation water (Samakande, 2002; Chambers, 1988). The implications of farmers' agronomical knowledge on irrigation practices in rural Nepal have been discussed in Chapter Two (Section 2.10.5). It is assumed that if the farmers have some agronomical knowledge, particularly the water requirements of different crops in different stages of their development, then the farmers can make appropriate decisions as to how much water is needed for the crops at their particular stage of development and how frequently the crops should be irrigated. In many irrigation systems in Nepal, the WUAs have initiated some social initiatives to educate farmers and raise social awareness of the importance of scientific ways of using the water from the canal. Respondents were asked a series of questions whether farmers had gained any agronomical knowledge from the WUA, particularly in irrigation applications and if they had followed any guidelines issued by their WUAs while irrigating crops.

Table 4.20 presents the results of a Chi-square test between farmers' agronomical knowledge and irrigation system.

Table 4.20 Farmers' Self-reported Agronomical Knowledge within the three Irrigation Systems

Farmers agronomical knowledge	Irrigation System			
	FMIS % (n)	**AMIS % (n)**	**JMIS % (n)**	**Total % (n)**
Yes	88.1 (59)	61.9 (39)	72.5 (50)	74.4 (148)
No	11.9 (8)	38.1 (24)	27.5 (19)	25.6 (51)
Total	100 (67)	100 (63)	100 (69)	100 (199)
Pearson Chi-square= 11.855 D.F.= 2 P-Value <<0.003				

A significant proportion of the farmers in the FMIS reported having agronomical knowledge, i.e. knowledge about crop-water requirements, compared with farmers in the AMIS and the JMIS. This is partly because the irrigation management committee in the FMIS has put lot of emphasis on enhancing farmers' awareness about crop-water requirements, to avoid wasteful use of water.

In the FMIS, 88.1 percent of farmers reported having received information on crop-water requirements, compared to just 61.9 percent in the AMIS and 72.5 percent in the JMIS. When asked if the farmers use water according to crop-water requirements, a significant proportion of farmers in the FMIS reported that they do, while the proportion of farmers using water according to crop-water requirements is considerably lower in the AMIS and the JMIS, as shown in Table 4.21.

Table 4.21 Farmers Using Water According to Crop-water Requirement in the Three Irrigation Systems

Irrigation practices according to crop-water requirements	**Irrigation System**			
	FMIS % (n)	**AMIS % (n)**	**JMIS % (n)**	**Total % (n)**
Yes	96.9 (62)	52.5 (32)	53.6 (37)	67.5 (131)
No	3.1 (2)	47.5 (29)	46.4 (32)	32.5 (63)
Total	100 (64)	100 (61)	100 (69)	100 (194)
Pearson Chi-square= 37.5372 D.F.= 2 P-Value <0.01				

There is a burgeoning literature on various types and sources of knowledge and their application in the management of natural resources (Olsson and Folke, 2001; Cash *et al.*, 2003; Reid *et al.*, 2006; Fabricius *et al.*, 2006; Gustavsen, 2004). The types of knowledge widely discussed in the literature range from traditional or indigenous to scientific which might be informal, such as lay, tacit and implicit knowledge (Polanyi, 1997; Fazey *et al.*, 2005, 2006) and knowledge embedded in cultural and communal norms (Berkes, 1993; Healey, 1993; Becker and Ghimire, 2003) to those generated through a formal process such as scientific research (Gunderson *et al.,* 1995; Turnbull, 1997; Pullin and Knight, 2001; Fazey *et al.*, 2004). Also, there is an increasing recognition that western scientific knowledge alone is not adequate for dealing with the full complexity of human-environment interactions (Nabhan 1997; Johannes, 1998; Olsson and Folke, 2001). Furthermore, there is a wider acceptance of the need in integrating scientific knowledge with traditional and indigenous knowledge to adequately deal with such environmental complexities (Raymond *et al.*, 2010). The integration of scientific knowledge and local knowledge presents a specific process in which co-generation of knowledge takes place, which is based on mutual learning between scientific communities and indigenous communities (Schon, 1983; Reason and Bradbury, 2001). Several studies have documented how indigenous communities have interacted with their natural environment in dynamic ways for a sustainable management of natural resources (Ruddle and Johannes, 1985; McNeely and Pitt, 1985). For example, fishing communities in Sweden have used their local ecological knowledge to manage their fish stock at a sustainable level (Olsson and Folke, 2001); the co-learning of the dynamics of wetland between the managers and cattle grazers in Australia has helped to conserve wetland ecosystems (Raymond *et al.,* 2010); indigenous knowledge about rainfall and water availability has helped local farmers in the Himalayan region of Nepal to select crop types (Chhetri, 2007).

In rural farming communities, the farmers believe that changing water in the paddy plots leads to the production of better quality grain (Tabuchi, 2004). Farmers at the head end of the canal, particularly those in the AMIS and the JMIS, often replaced paddy plots with fresh water, with the expectation of a better quality harvest, often being unaware of the salinity problems associated with excess irrigation. The farmers in the local areas believed that in order to harvest better quality grains, water in the paddy plots should be replaced every other day. Although farmers lack skills to conduct scientific experiments, the indigenous knowledge about the link between the quality of grains and water replacement frequency in the paddy plot has come about from years of experience by the rural farmers. Based on years of experience, an elderly farmer from the JMIS area said:

> "*We were able to replace water in the paddy plots last year and we were able to have the best harvest- grains full of fragrance, both the paddy field and kitchen were smelling nicely, this year we experienced one of the worst forms of water scarcity and could not replace water in the paddy plots, the quality of harvest is not very good-I probably will exchange these grains for better ones even if I make some financial loss*"
>
> (Male, 67, JMIS)

However, I was not able to find any studies with scientific evidence supporting the claim that changing water frequently and having extra water tables in the field plots leads to the production of better quality grain in the paddy plants. It is definitely an issue that needs further investigation. In fact, as Gadgil and Berkes (1991) argue indigenous resource management may not always make ecological sense and may even be maladaptive in some situations. The farmers in the rural villages who are mostly uneducated and lack even basic knowledge of agronomy, appear to relate changing the water table frequently to the production of better quality paddy grain, based on their dogmatic beliefs rather than from any pragmatic rationale. This is partly because of lack of training and education available to the farmers. The positive influence of farmers' agronomical knowledge and their reported level of access to water have a huge implication for policy decisions.

In Nepal, while investment in the irrigation infrastructure is impressive, little effort has been made to educate farmers and raise social awareness regarding irrigation enterprise. This has serious implications for irrigation governance and ensuring equitable access to water, as farmers are often following unscientific water appropriation practices based on blind faith. For example, replacing water for paddy at the head end area with total disregard to the water shortage at the tail end could be avoided with some efforts to educate the farmers.

Table 4.22 shows the farmers' conformity to the rules in using water according to crop-water requirements. In the FMIS, an incredibly higher proportion of farmers reported conforming to the rules of irrigation water distribution than those from the AMIS and the JMIS. On average, 97 percent of the farmers in the FMIS reported to have stopped using water after their turn was over, while just 37.1 percent and 52.5 percent of farmers from the AMIS and the JMIS respectively reported to have done so. Overall, 63 percent of farmers reported having stopped irrigation immediately after their turn, while 37 percent of farmers reported that they continued applying irrigation water even after their turn was over.

However, self-reported responses on sensitive issues such as illegal activities including water thefts and non-conformity to rules should not be taken at their face value as respondents do not always tell the truth and when they do tell the truth, they do not tell the whole truth whilst sometimes they tell more than the truth (Silverman, 2005). A growing body of literature suggest that there is a tendency to overreport socially desirable behaviours and underreport socially undesirable behaviours (Phillips and Clancy, 1972; Wyner, 1980; Kalton and Schuman, 1982; also see Takalkar *et al.*, 1993; Morten *et al.*, 2010). According to Crowne and Marlowe (1964) individual's personality trait, which feeds into a strong desire to command a great social approval in his/her conduct, presents a huge challenge for obtaining unbiased responses. Behaviours such as health promotion, voting, giving to charities, participating in communal activities, political connection, social status and attending religious activities are considered socially desirable in many societies (Cahalan 1968; Presser and Stinson, 1998) and such socially desirable activities are frequently overreported in research. Such socially desirable activities contribute towards enhancing personal social status of the respondents, which appear to be highly overreported in development research (Leonard *et al.*, 2010; Shneiderman, 2009). However, behaviours such as drug and alcohol abuse, sexual behaviour, involvements in criminal activities, bullying and thefts are considered socially undesirable activities, which often appear to be underreported by respondents (Aquilino 1994; Warnecke *et al.*, 1997; Johnson and Fendrich, 2002; Kim and Hill, 2002; Meston *et al.*, 1998). Oksenberg and Cannell (1977) argue that respondents may not always report incidents truthfully, particularly those events which are perceived as "*embarrassing, sensitive in nature, threatening, or divergent from one's self-image, it is likely to either not to be reported at all or to be distorted in a desirable direction*" (p.327).

Farmers disclosing their involvement in breaking rules and those self-reporting involvements in water thefts should be interpreted cautiously. This is probably due to the fear of being reported to the WUA. Also, farmers in the rural villages do not want to disclose their own personal negative conducts such as involvement in water thefts that might tarnish their image in the village.

Overreporting of socially desirable issues and underreporting of issues which respondents consider socially undesirable have implications on the reliability of data and validity of the entire research which may impair the results of survey research and policy capturing of the results (Karp and Brockington, 2005; Herbert *et al.*, 1995; Arnold and Feldman, 1981; also see Brookhouse *et al.*, 1986; Mazen, 1990). In order to overcome problems of overreporting and underreporting especially of sensitive issues such as water thefts a number of steps were adopted. Firstly, the questionnaire was carefully designed with inclusion of mostly questions seeking factual answers. It is argued that with factual questions that seek to obtain true values for the information sought from the respondents, in principle, can be cross-checked from some other sources (Kalton and Schuman, 1982). For example, self-reported incidence of water thefts and non-compliance to the rules can be cross-checked against the data compiled by the WUA. The cross-checking for biases can also be done through data triangulations. The qualitative analysis presented later in the thesis in Chapter Five and Chapter Six indicate that both the AMIS and the JMIS are characterised by a high level of non-compliance to the rules, whilst the level of non-conformity to the rules was relatively less in the FMIS. However, it is important to recognise that not all the factual questions can be verified from other sources. Secondly, the questionnaire was pre-tested in community outside of the research sites to identify any social desirability biases. Such biases can be superficially gauged through the degree of unease which respondents feel in responding to survey questions. During the questionnaire pre-testing exercise, particular attention was paid to respondents' physical reactions to questions such as excitement, unease, facial muscle moment and counter questioning from the respondents (Booth-Kewley *et al.*, 1992). The pre-testing of the questionnaire before conducting actual survey helped to identify if certain category of respondents behaved and responded differently when presented with research questions (Davies *et al.*, 1998). This technique of identifying social desirability biases has been widely used by many past and present social scientists (Edwards, 1953; Crowne-Marlowe, 1960; Paulhus, 1991).

Whilst a detailed discussion on the ethical aspects of this research is presented in Chapter Three (Section 3.7.1), this section briefly highlights legal and ethical aspects of investing illegal activities. Researching farmers' involvement in water thefts presented some ethical conundrums for me because it had potential legal implications (Fitzgerald and Hamilton, 1996, 1997; Moore, 1993). During the course of my field research, I became aware of the individuals who reported their involvement in occasional water thefts. Whilst I was acutely aware that such activities were not socially desirable, I was not judgemental about the individuals engaged in such activities to maintain research objectivity and neutrality (Crotty, 1995). Being judgemental about such socially undesirable activities by the farmers would likely have introduced bias in my research (Tetlock *et al.*, 1996). The introduction of normative judgements based on assumed notion of legality and morality because of reported illegal activities by the research participants can give rise to a complex psychological pressure which could change the dynamics of the relation between the researcher and the research subjects (Hamilton, 1980; Tetlock, 1991). In order to avoid pre-assumptions about the research participants, I did not characterise farmers as bad or immoral just because they were involved in water thefts. Moreover, as an outsider researcher, my sole purpose was to objectively study the prevalence of water thefts and non-conformity to the irrigation governing rules.

Studies in the illegal activities such as drug dealings are usually characterised by involvement of undercover researchers because of their highly sensitive nature and risk involved (Dunlap and Johnson, 1998; Johnson *et al.*, 1991). The researchers assume hidden identities and mix with the research subjects under a pseudo name to penetrate into their core to gain access and the cooperation (Fettermen, 1989; Barrett, 1984; Werner and Schoepfle, 1987). In doing so, the undercover researchers build extensive friendship, offer incentives such as favours and assume their roles to disguise themselves from their true identity (Marx, 1988; Williams, 1996). In fact, if the undercover researchers assume native identity and lose sight of the purpose of doing so, they can get involved in illegal and unethical practices themselves using their friendship and loyalty with the criminal groups (Farkas, 1986).

In the case of this study, the issue of water thefts was more of an undesirable social behaviour rather than a serious criminal activity. For there was no formal statutory law against it, only local rules and sanctions implemented by

WUA. Moreover, my familiarity with the lives of rural farmers was sufficient enough to establish friendship and gain access to the research subjects. I followed the ethical guidelines issued by the British Sociological Association (BSA, 2004). The BSA's ethical guidelines consist of aspects such as voluntary participation, no harm, confidentiality, anonymity, or privacy, which is commonly referred to as "informed consent". I adhered to the ethical guidelines issued by the BSA throughout the research process to protect and assist the research participants and to maximise positive aspects of their research participation (Barratt *et al.*, 2006). The issue of confidentiality and anonymity had a particular resonance at times when illegal aspects of water appropriation was investigated and remained an integral part to the whole research process (Ritchie and Lewis, 2003; Smyth and Williamson, 2004). The research participants were assured that their identity would be anonymised (Oliver, 2003; Gregory, 2003) giving them assurance that they will not be harmed as consequence of participating in the research. Whilst as a researcher I had a duty to report on the research findings to wider audiences, the identity of the research participants were concealed. Since I personally signed the confidentiality form, I was legally responsible for any breach of confidentiality.

Table 4.22 Farmers Stop Irrigating Immediately after Receiving Amount of Water Required for Crops

Farmers conforming to water application according to crop-water requirement	Irrigation System			
	FMIS % (n)	AMIS % (n)	JMIS % (n)	Total % (n)
Yes	97 (64)	37.1 (23)	52.5 (32)	63 (119)
No	3 (2)	62.9 (39)	47.5 (25)	37 (70)
Total	100 (66)	100 (62)	100 (61)	100 (189)
Pearson Chi-square = 53.405 D.F. = 2 p-value <0.001				

As argued earlier, the attitude of head-enders in relation to water utilisation determines the water availability for down-stream farmers. From Table 4.23 it is clear that the head-enders in the FMIS appear to have observed water distribution rules more closely than the head-enders in the AMIS and the JMIS systems. Farmers' failure to comply with the water distribution rules as prescribed in the constitutions has a number of implications for water distribution. Firstly, they use water wastefully, which creates greater soil salinity, reducing soil productivity. Secondly, they create an artificial water scarcity for the downstream farmers.

The qualitative data gathered during fieldwork indicated a number of reasons for farmers' failures to adhere to the water distribution rules. The main reasons, as laid out by the WUA, include uncertainty in water delivery, bad relationships with neighbouring farmers, and deliberate attempts to stock pile water tables in the fields. A significant disparity in the proportion of farmers adhering to the rules of water distribution can be observed both across the types of system and the location within the system, as shown in Table 4.23. Overall, 53.3 percent households reported having violated water distribution rules, while 14.8 percent of the respondents reported having faced uncertainty in water delivery, and 16.5 percent made deliberate attempts to stock-pile water tables in the field plots. Similarly, a small proportion of farmers (1.1 percent) reported having bad relationships with neighbouring farmers in relation to water appropriation. It should be mentioned that in rural agrarian societies, the bad relations amongst the neighbouring farmers can arise from other historical factors such as land encroachments and crop thefts, especially the green vegetables and fodder. The soured relationship amongst the farmers can also arise from financial matters and issues related to marriage. Water related conflicts are one of the many factors which can contribute towards the bad relationships between the farmers. However, since this thesis is concerned with irrigation management, it investigated only the water related factors contributing to conflicts amongst the farmers rather than other historical factors.

Also, a stark difference in conforming to rules regarding water appropriation can be observed amongst farmers in different locations. Overall, a significant proportion of the head-enders reported having violated rules of water distribution compared to middle and tail-enders. Only 51.4 percent of the head-enders reported to have followed rules compared to 72.4 percent and 59.2 percent of middle and tail-enders respectively. The results of the Chi-square test indicate that there is an association between violation of water distribution rules and the location of the landholdings. Also, there is an association between the location of the landholding and farmers' adherence to the water distribution rules amongst the farmers within the AMIS and the JMIS. Also, the difference amongst the head-enders in the three irrigation systems is statistically significant (Chi-square= 12.841; df.=2; p=0.002). A significantly higher proportion of the head-enders in the FMIS reported having followed rules of water distribution compared to their counterparts in the AMIS and the JMIS. About 90 percent of the head-enders from the FMIS reported having conformed to the rules of water distribution, compared to 52.9 percent and 10 percent from the JMIS and the AMIS respectively.

Similarly, the results of the Chi-square test indicate that a significantly higher proportion of middle-enders and tail-enders in the FMIS reported having conformed to the water distribution rules while appropriating water from the canal. Amongst the middle-enders, about 97.5 percent of farmers from the FMIS reported having conformed to the rules of water distribution compared to 50 percent and 60 percent from the AMIS and the JMIS respectively. Also, a significantly higher proportion of tail-enders (100 percent) from the FMIS reported having conformed to the water distribution rules compared to just 34.8 percent and 50 percent of tail-enders from the AMIS and JMIS respectively.

It is clear from Table 4.23 that uncertainty concerning water delivery and deliberate attempts to stock pile the water table in the fields remain a primary cause of rule violations in the irrigation systems. Results from Chi-square tests are not statistically significant. The head-enders in the AMIS and the JMIS reported having a greater concern with water security and acted irresponsibly at the cost of the tail-enders. About 40 percent of the head-enders in the AMIS violated the rules of water distribution because of uncertainty in water delivery by the canal system, while none of the head-enders from the JMIS and the FMIS violated rules for this reason. Similarly, about 50 percent of the head-enders in the AMIS violated water distribution rules deliberately to stock pile water in the fields and 42.1 percent of the head-enders in the JMIS did so for the same reason, while none of the head-enders in FMIS reported having made deliberate attempts to stock pile water tables in the fields. These results indicate that farmers in the JMIS and AMIS are more involved in rule violations during water distribution compared to the farmers in the FMIS.

Table 4.23 Reasons for not conforming to the Rules in Water Distribution by Location

Irrigation System	Locations	Reasons for non-rule confirmations						
		Water uncertainty % (n)	Extra water table % (n)	Bad-relation with neighbour % (n)	Other % (n)	Rule Conformed % (n)	Rule not conformed % (n)	Total % (n)
FMIS	Head end[a]	0 (0)	0 (0)	11.1 (1)	0 (0)	90 (9)	10 (1)	100 (10)
	Middle end[b]	0 (0)	0 (0)	0 (0)	0 (0)	97.5 (39)	2.5 (1)	100 (40)
	Tail end[c]	0 (0)	0 (0)	0 (0)	7.7 (1)	100 (16)	0 (0)	100 (16)
AMIS	Head end[a]	40 (4)	50 (5)	0 (0)	0 (0)	10 (1)	90 (9)	100 (10)
	Middle end[b]	25.9 (7)	14.8 (4)	0 (0)	3.7 (1)	50 (14)	50 (14)	100 (28)
	Tail end[c]	40.9 (9)	13.6 (3)	4.5 (1)	0 (0)	34.8 (8)	65.2 (15)	100 (23)
JMIS	Head end[a]	0 (0)	42.1 (8)	0 (0)	5.3 (1)	52.9 (9)	47.1 (8)	100 (17)
	Middle end[b]	9.7 (3)	25.8 (8)	0 (0)	0 (0)	60 (18)	40 (12)	100 (30)
	Tail end[c]	33.3 (4)	16.7 (2)	0 (0)	0 (0)	50 (5)	50 (5)	100 (10)
	Head end	10.5 (4)	34.2 (13)	2.6 (1)	2.6 (1)	51.4 (19)	48.6 (18)	100 (37)
Overall[d]	Middle end	10.3 (10)	12.4 (12)	0 (0)	1.6 (1)	72.4 (71)	27.6 (27)	100 (98)
	Tail end	27.7 (13)	10.6 (5)	2.1 (1)	2.1 (1)	59.2 (29)	40.8 (20)	100 (49)
Total		14.8 (27)	16.5 (30)	1.1 (2)	1.6 (3)	64.7 (119)	53.3 (65)	100 (184)

[a] Chi-square= 12.841
d.f.= 2
p-value= 0.002

[b]Chi-square=21.975
d.f.=2
p-value=0.001

[c]Chi-square=17.053
d.f.=2
p-value=0.001

[d]Chi-square=6.114
d.f.=2
p-value =.047

Table 4.24 Agency Responsible for Raising Awareness about Crop Water Requirement

Agency for creating awareness about crop water requirement	Irrigation System			
	FMIS % (n)	AMIS % (n)	JMIS % (n)	Total % (n)
WUA	13. 4 (9)	0 (0)	1.4 (1)	5 (10)
Practical experience	77.6 (52)	58.7 (37)	56.5 (39)	64.3 (128)
NA	9 (6)	41.3 (26)	42 (29)	30.7 (61)
Total	100 (67)	100 (63)	100 (69)	100 (199)
Pearson Chi-square= 32.65 D.F.= 4 P-Value <0.001				

Table 4.24 shows the different ways the farmers obtain information about crop-water requirements, which is crucial in changing their attitudes to stock piling water tables in the paddy plots. The crop-water requirement is the amount of water reasonably considered sufficient for the growth and development of a cultivated crop in a particular season. An overwhelming proportion of farmers have gained some practical knowledge on crop water requirements. On average, 77.6 percent of farmers in the FMIS reported having gained practical knowledge regarding crop water requirement, while 58.7 percent and 56.5 percent did so through practical experience in the AMIS and the JMIS respectively. However, the difference is striking regarding the involvement of the WUA in raising farmers' awareness of crop water requirements in the three irrigation systems considered for this study. While 13.4 percent of the farmers in the FMIS reported that they received information on crop-water requirements from WUA, only 1.4 did so from the JMIS and none from the AMIS. The positive role played by the WUA in the FMIS seems to have raised awareness amongst the farmers, particularly those

from the head-ends, to make optimum use of irrigation water and to avoid problems of water-logging and soil salinity owing to over irrigation. However, both the JMIS and the AMIS suffered greatly from over-use of irrigation water, particularly by the head-enders, and the WUAs in the both systems have not made sufficient efforts to raise awareness amongst the farmers regarding optimal use of water.

4.2.5 Gender and Access to Irrigation Water

As discussed in Chapter Two (Section 2.10.4) and in Chapter Three (Section 3.6.3.1), the Nepalese society is still male dominated, as are access to and control over productive resources such as land. Table 4.25 shows household land endowments and gender. It is clear that male-headed households have higher amounts of both *Khet* and *Pakho* lands compared to female-headed households. On average, male-headed households have 8.9 *Ropani* and 3.7 *Ropani* of *Khet* and *Pakho* lands respectively, compared to 5.2 *Ropani* and 2.3 *Ropani* of *Khet* and *Pakho* lands respectively. The disparities in landholdings particularly for *Khet* land owned by female-headed households, have implications for access to irrigation water as *Khet* lands are more productive and have better access to irrigation facilities than *Pakho* lands. Both male and female-headed households in the AMIS have lower access scores, compared to the households in the FMIS and JMIS. The female-headed households in the AMIS have significantly lower access scores compared their counterparts in the FMIS and JMIS.

Table 4.25 Households Landholding and Access Score by Gender in the Three Irrigation Systems

Households Gender	Amount of Landholdings in *Ropani*			Access Score in Different Irrigation Systems			
				FMIS	AMIS	JMIS	Overall
	***Khet* land**	***Pakho* land**	**Total land**				
Male	8.9	3.7	12.6	2.1	0.9	2.3	1.8
Female	5.2	2.3	7.5	2.0	0.8	1.9	1.6
Total	8.1	3.4	11.5	2.0	0.8	2.2	1.7

A one way between –group analysis of variance (ANOVA) test was conducted to determine the statistical significance of the level of access to irrigation water as measured by the access score. The results of ANOVA are presented in Table 4.26.

Table 4.26 ANOVA Results for Access Score of Landholding Locations

	Sum of Squares	d.f	Mean Square	F	Sig.
Between Groups	11.184	2	5.592	5.267	.009
Within Groups	41.405	39	1.062		
Total	52.589	41			

The ANOVA results indicate a statistically significant difference between the groups at the $p<0.05$ level in the access scores for female-headed households in the three irrigation systems: $F (2, 39) = 5.267$, $p<0.05$). The effect size, which is calculated using Eta squared, was 0.61 - considered to be large statistically (Cohen, 1988).

One of the research objectives was to investigate the role of property rights regimes in female-headed households' ability to access water from the canal systems, as stated in research question (1d) in Chapter One. In order to answer this research question, an ANOVA test was carried out to compare the average access scores of the female-headed households in the three irrigation systems. For a multiple comparison, the female-headed households were divided into three groups according to the type of irrigation systems they were served by, (Group 1: females in FMIS; Group 2: females in AMIS; Group 3: females in JMIS). Table 4.27 presents the outputs from multiple comparisons.

Table 4.27 Multiple Comparison of Access Score by Females in the Three Irrigation Systems

(I) female-headed households	(J) female-headed households	Mean Difference (I-J)	Std. Error	Sig.
female-headed in FMIS	Female-headed in AMIS	1.14762*	.38290	.013
	female-headed in JMIS	.12564	.39044	.945
Female-headed in AMIS	female-headed in FMIS	-1.14762*	.38290	.013
	female-headed in JMIS	-1.02198*	.39686	.036
female-headed in JMIS	female-headed in FMIS	-.12564	.39044	.945
	female-headed in AMIS	1.02198*	.39686	.036

It is interesting to note that the mean access scores of the female-headed households in the AMIS are statistically significant compared with the female-headed households in the FMIS and the JMIS. The mean access score of the female-headed households in the AMIS was compared with their counterparts in the JMIS and FMIS and the difference between them was found to be statistically significant at $p<0.05$ level. However, the difference in the mean access score of the female-headed households in the FMIS and their counterparts in the JMIS was not found to be statistically significant at $p<0.05$ level.

Table 4.28 shows household levels of access to irrigation by gender in the different irrigation systems. From Table 4.28 it is clear that a higher proportion of households headed by males reported having strong access to water, compared to the households headed by females. In the FMIS, 80.4 percent of the male-headed households reported having strong access to canal water, while 75 percent of female-headed households reported have done so. The remaining 19.6 percent of the male-headed households and 25 percent of female-headed households reported having weak access to irrigation water. Similarly, in the JMIS, 76.8 percent and 61.5 percent of male and female-headed households respectively reported having strong access to irrigation water, while the remaining 23.2 percent and 28.5 percent of male-headed and female-headed households respectively reported having weak access to irrigation water.

Table 4.28 Level of Access to Irrigation Water by Gender in the Three Irrigation Systems

Gender	**Level of Access to Irrigation Water in different irrigation systems**							
	FMIS		**AMIS**		**JMIS**		**Total**	
	Strong	**Weak**	**Strong**	**Weak**	**Strong**	**Weak**	**Strong**	**Weak**
Male	80.4 (41)	19.6 (10)	20.4 (10)	79.6 (39)	76.8 (43)	23.2 (13)	76.8 (43)	23.2 (13)
Female	75 (12)	25 (4)	14.3 (2)	85.7 (12)	61.5 (8)	38.5 (5)	61.5 (8)	38.5 (5)
	Chi-square = 1.147 D.F. = 1 P-value = .284							

However, the proportion of the farmers who reported having weak access to irrigation remained significantly higher in the AMIS. On average, only 20.4 percent of male-headed households reported to having strong access to irrigation water while 14.3 percent of female-headed households reported having done so. The remaining 79.6 percent of male-headed households and 85.7 percent of female-headed households respectively reported having weak access to irrigation water. Although the differences in the level of access to irrigation water between male and female-headed households are not statistically significant, the gender implications of access to irrigation water is common to all the three irrigation systems. Although the gender difference in the level of access to irrigation water within the different irrigation systems is statistically non-significant, the differences do have some serious practical significance, as described in Chapter Two (Section 2.10.4). Despite being statistically non significant, the gender implications of access to irrigation water still remains a critical issue and needs some further explanation (Zwarteveen, 1997; van Koppen and Hussain, 2007). It will be clear from the discussion later in the thesis, particularly the evidence from the qualitative data,that both the causes and consequences of gender implication of irrigation are too important to ignore just because the results of the Chi-square test are statistically non-significant. The statistically non-significant results might have occurred owing to the small sample size included in this research. Indeed the gender implications of irrigation governance and access to water have some serious "practical" significance. The gender implications of access to irrigation can be attributed to the Nepalese social context, in which women in rural areas are confined to household activities while men play a dominant role in many spheres of village life, including irrigation issues. Women's confinement to household activities has meant that their knowledge of events of public interest is limited and they often lag behind in participating in them.

However, when the level of access to irrigation of the female-headed households is compared across the three irrigation systems, the difference is statistically significant.

Table 4.29 Level of Access to Irrigation by Female-headed Households in the Three Irrigation Systems

Level of Access to Water	**Gender/Irrigation System**		
	Female in FMIS % (n)	**Female in AMIS % (n)**	**Female in JMIS % (n)**
A strong access	75 (12)	14.3 (2)	61.5 (8)
A weak access	25 (4)	85.7 (12)	38.5 (5)
Total	100 (16)	100 (14)	100 (13)
Pearson Chi-square= 11.818 D.F.= 2 P-Value =0.003			

Table 4.29 shows that a significant proportion of female-headed households in the FMIS (75 percent) reported having strong access to irrigation water compared to just 25 percent and 61.5 per of their counterparts in the AMIS and JMIS respectively. The results of the Chi-square test indicate that these differences are statistically significant.

Table 4.30 shows the level of participation of women in the WUAs in different irrigation systems. It is clear that an overwhelming proportion of women in all three systems do not participate in the WUAs. In the FMIS, only 37.5 percent of the female-headed households reported that women participate in the WUAs compared to 11.4 percent and 69.2 percent in the AMIS and the JMIS irrigation systems respectively. The lower level of participation of women in the WUAs, particularly in the AMIS, conforms to the construction of gendered space in irrigation management.

Table 4.30 Participation of Women in WUA in the Three Irrigation Systems

Participation in WUA	**Gender/ Irrigation System**		
	FMIS (%)	**AMIS (%)**	**JMIS (%)**
Yes	37.5 (6)	11.4 (2)	69.2 (9)
No	62.5 (10)	84.6 (11)	30.8 (4)
Total	100 (16)	100 (13)	100 (13)
Pearson Chi-square= 7.917 D.F.= 2 P-Value <0.019			

Perhaps this not particularly surprising, as in developing countries men are traditionally seen as the family bread-winners, while women are home makers and nurturers (Narayan *et al.,* 2000a). However, this is not to say that women are always confined to nurturing and home-making roles. In fact many women, particularly from poorer households, work outside the home to sustain their livelihoods while still responsible for their traditional household roles. Women also tend to be responsible for farming family plots, which are also major sources of nutrition for the households, although they generally have the least influence in decision making within the household or outside it in the wider community (Narayan *et al.,* 2000b; Soussan, 1998; Turton, 2000; UNDP, 2000). The gender differentiation has serious implications on power distribution and knowledge dissemination, which in turns affects environmental governance and resource utilisation for power distribution (Gibson-Graham, 1994; Kobayashi, 1994; McDowell, 1999).

The qualitative data also confirms the low levels of women's participation in WUAs. An elderly farmer from the AMIS area who participated in a focus group discussion argued:

> *"Today for the focus group discussions the participation of women is very low because, we did not have time to inform them---"*
>
> (Male, 45, AMIS)

In response to the researcher's curiosity about the low attendance of women participants in the focus group discussions, a respondent replied:

> *"Well, its nearly lunch time and women are busy in the kitchen preparing lunch for the family and doing other households activities. After the meeting we can have lunch and go to the office, and women have got to go the field for paddy harvesting"*
>
> (Male, 46, AMIS)

Although some women participated in the focus group discussions, they remained quiet and did not participate fully. On asking a woman why she was so quiet during the focus group discussion in the Begnas area, she contended that:

> *"--Well, in our village as a woman, it is rude to argue against men through our independent viewpoints—you know men are talking and sharing their views--- anyway I will be ridiculed for my viewpoints, once you interviewers go away*."
>
> (Female, 32, AMIS)

The reasons for the low level of participation of women in the focus group discussions could be attributed to the socio-cultural context of the Nepalese society and local power structures (Giri, 2009), which acted as barriers to participation of women in both irrigation management and in this research (Agarwal, 2001a; Lama and Buchy, 2002; Gupte, 2004; Agrawal and Gupta, 2005). Factors such as gender, caste, wealth, age, education as well as individual status in the society provide the context in which a highly gendered role in community participation is constructed (NPC and UNICEF, 1996; Agarwal, 2001b). In Nepal, individual and household participation in activities that are outside the households are highly gendered. It is almost customary practice in rural parts of Nepal that men participate in activities outside the house including participating in local development activities and village politics, whilst women often assume role of nurturing and are confined to activities inside the households (Thapa, 2001; Elmhirst and Resurreccion, 2008). Since the farmers in the rural villages had to juggle around with different things such as working in the field, herding cattle, fetching water from local wells, collecting fodder for cattle; the timing of the focus group discussions was critical for maximising their participation. As such, the research design and timing of fieldwork were set to maximise the level of participation of both men and women. In fact, before conducting focus group discussions, the local farmers including many women were consulted to fix the location and timing of the focus group discussions so that they can come and participate. Generally, women in rural Nepal also have high workload particularly during mornings and evenings (IFAD, 1999) which means they do not have adequate time for village meetings (Lama and Buchy 2002). Furthermore, village men often disapprove and discourage women's participation in local politics and the public sphere on the basis of perceived gendered roles and behaviours (Agarwal, 2000; Lama and Buchy, 2002). The prevalence of gender stereotypes in patriarchal societies which define the role of women as wives and mothers where their primary responsibilities are caring and nurturing make them stereotypically inferior and helpless (Liddle and Joshi, 1986; Segal, 1987; Barrett, 1980) and by doing so the patriarchal societies exacerbate their oppression against women (Walby, 1989).

With such characterisation of women's role in the rural parts of Nepal, the women are preoccupied with household activities such as cooking, collecting fodder for cattle and cleaning during the mornings and the evenings, and chances of them participating in key informant interviews and the focus group discussions are minimal at those times. However, women have some free time during the day in which they could to participate in research processes. In order to maximise their participation in the research process, most of the key informant interviews and focus group discussions were held during the daytime when women were free. Also, interviewing women alone is also a culturally sensitive issue in Nepal and demonstrates power relations as (1989b) argues that "*it cannot be assumed that gender-free information is obtained in interviews*" (p.116). Whilst interviewing men through building rapport was relatively straightforward and socially acceptable, development of such rapport with women was highly undesirable due to cultural sensitivity (Oakley, 1981). Because of prevalence of cultural sensitivity and power relations between the male interviewer (author) and female interviewees, the female participants were contacted prior to conducting interviews to make sure that they were not alone at home and the timing for interview is good for them (Finch, 1984). Accordingly, women were interviewed when there were other members present in the household, although other members neither took part in the interview nor stood alongside the women who were being interviewed. As mentioned earlier in Chapter Three (Section 3.10), the timing of the fieldwork was deliberately chosen at the time when women were relatively free because of the festive period and time-off from agricultural activities.

Whilst timing of the research activities are likely to affect participation, it should be acknowledged that the research design might also have had implications on the low level of participation of women during the focus group discussions (Yin, 2009; Kobayashi, 1994; Scheyvens and Leslie, 2000). For example, on some of the questions included in the survey questionnaire, particularly the ones related to farmers' personal and financial matters, the research participant either refused or lacked the ability to respond, making such information inaccessible to the researcher (Williams, 1978; Kenney, 2006). This is because the information regarding household's financial matters were generally controlled by men and it was considered to be highly impolite for women to share such information with an external researcher, especially male researcher, without consulting their husband or adult son

(Finley and Wright, 1994; Blumberg, 1988). Furthermore, usually female participants of the focus group discussions found it incredibly awkward to talk about issues in which men were alleged to have involved in corruptions and water thefts (Connell and Messerschmidt, 2005; Cox *et al.*, 1990; Billingsley, 1972). Many feminist researchers, particularly working in patriarchal communities have questioned the validity and reliability of mixed focus group discussions as an unbiased source of data (Jowett and O'Toole, in press; Agarwal, 2000; Bennett, 2005; Barbour and Kitzinger, 1999; Kitzinger, 1994).

This research endeavoured to provide a level playing field for both men and women in terms of their participation in the focus group discussions. However, it should be acknowledged that given the historically patriarchal Nepalese society where certain activities including participating in activities outside the household and public discussions are highly gendered and the level playing field provided by this research perhaps was not perfectly level. Nonetheless, this research adopted various strategies to encourage women to participate more in the focus group discussions. If men were dominating the conversation, as a moderator, I respectfully thanked the men who had spoken and suggested that it would be great to hear from some of the women present as well. At the times when women seemed to be participating less, I tried to make eye contact with women and even asked them direct questions individually to foster their participation during the discussions. However, in cases where the gender imbalance in the composition as well as participation of focus groups was acute, further steps were taken to address such imbalances. For example, the focus group discussions, which were characterised by a high degree of gender imbalance and minimal participation of women, were reconducted with only female participants. The informal atmosphere of the women only focus group discussions enabled the participants to speak more freely about not only irrigation issues but also issues that they had concern about in their locality, which they were unable to talk about in mixed focus groups. Such technique of designing female only focus groups is also being advocated by Madriz (2000) to enable women to freely share their experience without being intimidated and fearful.

It is clear that the male-headed households show higher levels of participation in WUAs than female-headed households. Also, similar differences can be observed in the frequency of household contact with the members of the WUA to discuss their concerns regarding irrigation issues. During the WUA meetings, farmers pass their concerns to the designated WUA member in their locality who represents their interests. Table 4.31 shows household levels of communication with the members of the WUA by gender.

Table 4.31 Households with a Frequent Communication with the WUA by Gender in the Three Irrigation Systems

Gender	Frequent Communication with WUA		
	YES % (n)	NO % (n)	Total % (n)
Male	42.8 (65)	57.2 (87)	100 (152)
Female	24.4 (10)	75.6 (31)	100 (41)
Overall	38.9 (75)	61.1 (118)	100 (193)
Chi-square= 4.588 D.F. = 1 P-value = .032			

Overall, 38.9 percent of the sample households reported having communication on a regular basis (frequently) with the WUA member, while

61.1 percent did not. A gender difference can be observed in establishing communication between the farmers and the WUA member. In the sample households, 42.8 percent of the male-headed households reported having communication on a regular basis with the WUA members, while just 24.4 percent of the female-headed households did so. An overwhelming proportion of the female-headed households did not seem to have frequent communications with the WUA members.

4.2.6 Participation in Operation and Maintenance (O & M) Activities

The three irrigation systems considered in the study are situated in the hilly region with difficult terrain and regular operation and maintenance are required for regular and unconstrained water supplies in the canal systems. In Nepal, whilst community participation in the management of irrigation systems are encouraged, both government and beneficiaries have well defined roles to play in terms of contribution towards O & M activities. Generally, irrigators' contributions towards canal maintenance are expected in all types of irrigation systems. However, the degree of government involvement in O & M activities depends on the level of commitment, as specified in WUA constitutions. In the FMIS, all O & M activities are carried out at the community level by the users themselves with a minimum or no involvement on the part of the DoI, while in the AMIS, a minimum commitment is expected from the users and the DoI undertakes almost all the O & M activities. In the case of the JMIS, the situation is rather different. According to the WUA constitution of the JMIS, major O & M activities are carried out with the support of the DoI, while minor O & M activities are carried out by the users themselves. It should be pointed out that the notion of 'major' and 'minor' remains very vague and has different interpretations[8]. In general, clearing of massive landslides or major repairs of headwork are considered 'major' O & M activities, while regular canal cleaning activities are considered as minor O & M activities.

Table 4.32 Farmers' Belief about Agency Responsible for O & M Activities in the Three Irrigation Systems

Contribution of different stakeholders in the canal systems	**Irrigation Systems**		
	FMIS % (n)	**AMIS % (n)**	**JMIS % (n)**
Local Farmers	93.8 (61)	76.3 (45)	71.6 (48)
Department of Irrigation	6.2 (4)	23.7 (14)	28.4 (19)
Total	100 (65)	100 (59)	100 (67)
Chi-square= 11.452 D.F. = 2 P-value = .003			

Table 4.32 shows that a significantly higher proportion of local farmers in the FMIS believed the O & M activities to be their responsibility as compared to farmers in the AMIS and the JMIS. A considerably higher proportion of farmers (about 93.8 percent) in the FMIS considered that operation and maintenance activities were their responsibility, compared to 76.3 and 71.6 percent of the farmers in the AMIS and in the JMIS respectively. A small proportion (6.2 percent) of the farmers in the FMIS believed that the DoI

[8] The Operation and Maintenance (O & M) activities were classified as major and minor by the DoI depending on the complexity of the tasks. Generally tasks such as repairing headwork and clearing landslides which needed technical expertise and financial contributions from the DoI were considered as major O & M activities whilst tasks such as day-to-day- operation and canal cleaning were considered as minor O & M activities.

should carry out all the O & M activities, compared to 23.7 percent and 28.4 percent of farmers reporting in the AMIS and the JMIS respectively.

Farmers' sense of responsibility for contributing towards O & M activities starts right from the outset of the construction of the irrigation canal systems. The sense of ownership of the canal remains higher amongst farmers who contributed towards the construction of the canal. In the case of the FMIS, the local farmers had made considerable sacrifices in constructing the canal infrastructures and a strong sense of both pride and responsibility prevails amongst them as demonstrated by the following quotation from a participant of a key informant interview:

> "---*Look, this canal has been constructed with a great deal of sacrifices from the local farmers. every drop of water flowing in the canal is our sweat and our ancestors' sweat-- we worked all day--- every day for months and years to bring water to the Phalebas area—this was not an easy task to bring water to the Phalebas area—We feel proud and blessed to have this canal----the canal is a life line of every villager—and it is our responsibilities to keep the spirit of our ancestors who dug the canal high---!"*
>
> (Male, 85 years, FMIS)

Table 4.33 presents what farmers considered their contributions at the initial stage of the canal constructions. In the FMIS, 95.5 percent of farmers made compulsory labour contributions during the construction of the canal, while only 55.6 percent did so in the JMIS. Since the AMIS was constructed with the financial and technical aid of external agencies and the DoI, none of the farmers contributed towards the construction of the canal system.

Table 4.33 Nature of Contribution During the Construction of the Three Irrigation Systems

Irrigation System	Compulsory nature of participation during Construction		
	Compulsory % (n)	**Voluntary % (n)**	**Total % (n)**
FMIS	95.5 (64)	4.5 (3)	100 (67)
AMIS	0 (0)	100 (63)	100 (63)
JMIS	55.6 (35)	44.4 (28)	100 (63)
Chi-square =1.193 D.F. = 2 P-value= .000			

As discussed earlier, the degree to which the farmers are willing to contribute towards O & M activities of the irrigation infrastructure is determined by their expected pay off from collective action. Both the canal infrastructures and the water resources in the irrigation canal resemble the provision of public goods, which provide benefits to the community members. However, the significant costs associated with excluding some members of the community has meant that it is very difficult to exclude farmers from reaping benefits from the canal systems. Therefore, the potential to free ride is both real and common, particularly in irrigation systems where proper institutional arrangements are absent or weakly enforced. Poteete and Ostrom (2003) argue that even amidst heterogeneous communities, homogeneity in interests such as economics, communities might be able to build strong foundations for collective activities. Similarly, the availability of exit options (alternative employment opportunities) among the users also influences collective efforts towards the management of many CPRs, including irrigation systems. In Nepalese community forests for example, the lower level of exit options amongst the users is associated with a higher level of collective action (Adhikari and Lovett, 2006).

Table 4.34 Household Member Participating in O & M Activities in the Three Irrigation Systems

Member participating in O & M activities	Irrigation Systems		
	FMIS % (n)	**AMIS % (n)**	**JMIS % (n)**
Men	36.4 (24)	31.7 (20)	56.1 (37)
Women	60.6 (40)	55.6 (35)	40.9 (27)
Children	1.5 (1)	6.3 (4)	1.5 (1)
None	1.5 (1)	6.3 (4)	1.5 (1)
Total	100 (66)	100 (63)	100 (66)
Chi-square=14.344 D.F. = 6 P-value = .026			

Table 4.34 shows the member of the farming households who reported to have participated in the O & M activities in the irrigation canals considered for this research. About 36.4 percent of households in the FMIS had adult males participating in O & M activities compared to 31.7 percent from the AMIS and 56.1 percent from the JMIS. It is interesting to note that some households send children to participate in O & M activities, as this would reduce households' costs. While the practice of sending children for O & M

activities was common to all the three irrigation systems, it was more conspicuous in the AMIS. On average, 6.3 percent of the households in Begnas systems reported sending children for O & M activities, while 1.5 percent of households did so in both the FMIS and JMIS. While the participation of every member of the community is a good endeavour, children's participation in a difficult terrain not only endangers their welfare but does not necessarily compensate the labour input of the adult male labourer.

Table 4.35 shows the number of households who appropriate water from the canal systems despite their reluctance to contribute to the O & M activities.

Table 4.35 Water appropriation by households despite reluctance to participate in O & M activities in the three irrigation systems

Appropriate water but unwilling to participate in O & M activities	Irrigation Systems		
	FMIS % (n)	AMIS % (n)	JMIS % (n)
Yes	41.8 (28)	54 (34)	76.8 (53)
No	58.2 (39)	46 (29)	23.2 (16)
Total	100 (67)	100 (63)	100 (69)
Chi-square= 17.642 D.F. = 2 P-value = .000			

In many rural parts of Nepal a number of sanctioning mechanisms are commonly used by the WUA managing the irrigation systems to ensure that the farmers comply with the rules governing their irrigation resources. However, the degree to which the farmers comply with the rules depends not only on the nature of the sanctions, but also on the strictness with which those sactions are imposed. The sanctions imposed for fraudulent activities, including non-compliance in participating in O & M activities and stealing water from the canal, were severe in the FMIS, whilst those implemented in the JMIS and the AMIS were both light and weakly enforced. Since the sanctions imposed in the JMIS and the AMIS were weakly enforced, the proportion of farmers complying with the rules was significantly less in those irrigation systems. The proportion of farmers appropriating water despite their reluctance to participate in O & M activities in the AMIS and JMIS is 54 percent and 76.8 percent respectively. The proportion of farmers complying with the rules in the FMIS was significantly higher in the FMIS as only 41.8 percent of the farmers reported that they appropriated water from the canal despite their reluctance to participate in O & M activities. However, despite the existence of strict sanctioning mechanism in the FMIS, a significantly higher proportion of farmers reported to have appropriated water despite their reluctance to participate in O & M activities. Nonetheless, the proportion of farmers appropriating water despite reluctance to participate in O & M activities still remains lower in the FMIS compared to the farmers in the AMIS and the JMIS.

4.2.7 Households Participation in WUA and Access to Water

Table 4.36 presents the proportion of farmers participating in WUA committees in different systems and the *dalit* castes.

Table 4.36 Household with Participation in WUA by the *Dalits* in the Three Irrigation Systems

Households' Participation in WUA	Dalit/Irrigation Systems		
	***Dalits* in FMIS % (n)**	***Dalits* in AMIS % (n)**	***Dalits* in JMIS % (n)**
Yes	100 (11)	66.7 (2)	100 (13)
No	0 (0)	33.3 (1)	0 (0)
Total	100 (11)	100 (3)	100 (13)
Chi-square =8.308 D.F. = 2 P-value= .016			

It is evident that a significantly larger proportion of the households from the *dalit* caste groups from the FMIS and the JMIS have better participation in WUA activities compared to their counterparts in the AMIS. All the respondents belonging to the *dalit* caste groups in the FMIS and the JMIS reported having participated in the WUA's monthly meeting compared to 66.7 percent from the AMIS.

Table 4.37 shows the level of household participation in the WUA in the three irrigation systems and landholding types. It is evident that farmers with larger landholdings dominate the WUA, with 76.5 percent of farmers from larger landholding groups reporting representation in the WUA compared to 73.9 percent and 58.8 percent of medium and small landholding categories respectively. However, on cursory inspection of the level of participation by household, a clear difference becomes apparent. In the FMIS, small landholders have excellent representation on the WUA committee.

Table 4.37 Households with Participation in WUA by Size of Landholding in the Three Irrigation Systems

Landholding category	Household Participation in WUA meetings							
	FMIS %(n)		AMIS %(n)		JMIS %(n)		Overall %(n)	
	Yes	No	Yes	No	Yes	No	Yes	No
Large	85.7 (12)	14.3 (2)	88.9 (8)	11.1 (1)	67.9 (19)	32.1 (9)	76.5 (39)	23.5 (12)
Medium	90.9 (10)	9.1 (1)	60 (9)	40 (6)	75 (15)	25 (5)	73.9 (34)	26.1 (12)
Small	78.6 (33)	21.4 (9)	48.7 (19)	51.3 (20)	38.1 (8)	61.9 (13)	58.8 (60)	41.2 (42)
	Chi-square = 6.129 D.F. = 2 P-value= .047							

On average, 78.6 percent of the farmers from the small landholding category reported having participated in the WUA, compared to 85.7 percent from the large landholding category and 90.9 percent from the medium landholding category. However, the participation of farmers with small and medium landholding in the AMIS was very low compared to their counterparts with large landholdings. In the AMIS, only 48.7 percent of small landholders and 60 percent of medium landholders reported having participated in the WUA committee compared to 88.9 percent of farmers with large landholdings. Similarly, the participation of farmers with small landholdings remains very low in the JMIS compared with their counterparts in the FMIS and AMIS. In the JMIS only 38.1 percent of farmers with small landholdings reported participating in the WUA committee compared to 75 percent and 67.9 percent of farmers from the medium and large landholding categories.

Table 4.38 shows the proportion of farmers in different locations and their level of participation in the WUA.

Table 4.38 Household Participation in WUA by Landholding Location in the Three Irrigation Systems

Location	Household Participation in WUA meetings							
	FMIS %(n)		**AMIS % (n)**		**JMIS % (n)**		**Overall % (n)**	
	Yes	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
Head end	80 (8)	20 (2)	40 (4)	60 (6)	40 (8)	60 (12)	50 (20)	50 (20)
Middle end	80 (32)	20 (8)	58.6 (17)	41.4 (12)	70.6 (24)	29.4 (10)	70.9 (73)	29.1 (30)
Tail end	88.2 (15)	11.8 (2)	37.5 (9)	62.5 (15)	66.7 (10)	33.3 (5)	71.4 (40)	28.6 (16)
	Chi-square = 6.405 D.F. = 2 P-value= .041							

Overall, a greater proportion of tail-enders reported participating in the WUA compared to farmers at the middle and head ends of the canal systems. On an average, 71.4 percent of tail-enders reported participating in the WUA, compared to 70.9 percent and 50 percent of middle and head-enders. Equally important, the different level of participation of farmers with landholdings in different locations along the canal systems becomes clear. In the FMIS, about 80 percent of farmers with landholdings located at the head end and middle end reported participating in the WUA committee. The difference between them is small compared to that of the farmers in the AMIS and the JMIS. In the Begnas area, the participation of farmers in general was low, where only 37.5 percent and 40 percent of the tail-enders and head-enders respectively, reported having participated in the WUA committee. Also, the farmers with landholdings at the middle of the canal system reported having a lower level of participation in the WUA committee, at about 58.6 percent. Similarly the head-enders in the JMIS had a lower level of participation in their WUA committee compared to farmers in the middle and tail end of the canal system. In the JMIS only 40 percent of tail-enders reported participating in the WUA committee compared to 70.6 percent of middle-enders and 66.7 percent of tail-enders. The differences between the levels of participation of farmers with landholdings at the different locations are statistically significant. A lower level of participation of the head-enders in the WUA committee of the JMIS could be due to the fact that the WUA office was located at the tail end area, and they often reported finding it inconvenient to attend scheduled meetings.

Table 4.39 shows the members of the family participating in the WUA meetings. From earlier in Section 4.2.6, the existence of gender bias was evident in the level of participation in O & M activities, with a significantly higher proportion of women participating in O & M activities. However, the participation of women in the WUA committee was consistently lower than the level of participation of men in all three irrigation systems. However, the difference in the level of participation of both men and women in the WUA committee in the FMIS was lower than that of the JMIS and the AMIS.

In the FMIS, 72.7 percent of male-headed households reported having participated in the WUA, compared to 21.2 percent of women and 1.5 percent of children. Similarly, the difference in the level of participation in the WUA amongst male and female-headed households was greater in the AMIS compared to both the JMIS and the FMIS. In the AMIS, 61.7 percent of male-headed households reported having participated in the WUA, compared to just 5 percent of female-headed households.

Table 4.39 Household Member Participating WUA Committee in the Three Irrigation Systems

Member participating in WUA activities	Irrigation Systems		
	FMIS %(n)	AMIS %(n)	JMIS %(n)
Men	72.7 (48)	61.7 (37)	73.5 (50)
Women	21.2 (14)	5.0 (3)	20.6 (14)
Children	1.5 (1)	0 (0)	0 (0)
None	4.5 (3)	33.3 (2)	5.9 (4)
Total	100 (66)	100 (60)	100 (68)
Chi-square= 32.859 D.F. = 6 P-value = .000			

In the same system, 33.3 percent of the respondents reported not having participated in the WUA at all, which is considered high. Similarly in the JMIS, 73.5 percent of male-headed households reported having participated in the WUA compared to just 20.6 percent of female-headed households. About 5.9 percent of respondents reported that they did not have any participation in the WUA committee.

The lower level of participation from female-headed households in the WUA compared to male-headed households can be explained by the level of effort that the WUA makes to ensure inclusivity in the WUA committee. Table 4.40 shows the proportion of respondents who believe that the WUA committee in their area is making efforts to increase women's participation in the activities of the WUA.

Table 4.40 Reported level of WUA's Effort for Gender Inclusion in the Three Irrigation Systems

WUA's Efforts to ensure Gender Inclusion	Irrigation Systems		
	FMIS % (n)	AMIS % (n)	JMIS % (n)
Yes	13.4 (9)	3.2 (2)	27.3 (18)
No	86.6 (58)	96.8 (60)	72.7 (48)
Total	100 (67)	100 (62)	100 (66)
Chi-square= 14.769 D.F. = 2 P-value = .001			

In the FMIS, 13.4 percent of farmers reported that their WUA was making genuine efforts for gender inclusion compared to just 3.2 percent of farmers in the AMIS. In the JMIS, 27.3 percent of farmers believed that their WUA was making genuine efforts for gender inclusion in their WUA's activities.

Table 4.41 shows the level of participation reported by the farmers in the three irrigation systems considered for the study. During the household survey, the farmers were asked to rank their level of engagement with irrigation issues in general. It is clear that the majority of the farmers reported having occasional participation in the irrigation issues in all the three irrigation systems. However, the differences in the proportion of farmers reported to have a strong participation in irrigation governance is higher in JMIS and the FMIS compared to the AMIS. In the FMIS, 23.9 percent of the farmers reported strong participation in irrigation governance, while 62.7 percent and 11.9 percent of the farmers reported that their level of participation was occasional and not often, respectively. Only a small proportion (1.5 percent) of farmers reported that they did not participate in irrigation governance.

Table 4.41 Household level of Participation in Irrigation Governance in the Three Irrigation Systems

Participation in Irrigation Governance	**System Systems**		
	FMIS % (n)	**AMIS % (n)**	**JMIS % (n)**
Strong participation	23.9 (16)	11.1 (7)	28.4 (19)
Occasional participation	62.7 (42)	38.1 (24)	47.8 (32)
Not often	11.9 (8)	31.7 (20)	19.4 (13)
Hardly ever	1.5 (1)	19 (12)	4.5 (3)
Total	100 (67)	100 (63)	100 (67)
Chi-square= 29.067 D.F. = 6 P-value = .000			

However, the proportion of farmers reported to have a strong participation in irrigation governance is very low in the JMIS, where only 11.1 percent of the farmers reported strong participation in irrigation governance. In the same system, 38.1 percent and 31.7 percent of the farmers reported that their level of participation was occasional or not often. A higher proportion (19 percent) reported that they hardly ever participated in irrigation governance. Similarly, in the JMIS, about 28.4 percent of farmers reported strong participation in irrigation governance, while 47.8 percent of them reported occasional participation. About 19.4 percent of the respondents from the same system did not participate often in irrigation governance, while a small proportion (4.5 percent) reported having hardly ever participated in irrigation governance. Table 4.42 shows different stages of household participation in relation to irrigation issues.

Table 4.42 Stage of household Participation in Irrigation Governance in the Three Irrigation Systems

Stage of Participation	**Irrigation Systems**		
	FMIS % (n)	**AMIS % (n)**	**JMIS % (n)**
Planning & Decision makings	62.1 (41)	39.3 (24)	58.5 (38)
Benefit sharing	37.9 (25)	60.7 (37)	41.5 (27)
Total	100 (66)	100 (61)	100 (65)
Chi-square= 7.530 D.F. = 2 P-value = .023			

The respondents were asked if their participation related to planning and decision making or did they engage with irrigation issues only in relation to sharing water from the canal. It is clear that a higher proportion of farmers in the FMIS reported having participated at the decision making level through their involvement in planning and decision making, compared to both the AMIS and the JMIS. The proportion of respondents reported to have been involved in planning and decision making remains at about 62.1 percent in the FMIS compared to 39.3 percent in the AMIS and 58.5 percent in the JMIS.

4.2.8 Communal Rules for Controlling Defrauding

As mentioned earlier, in the absence of appropriate institutional arrangements, the problems of free-riding and fraud become endemic, which greatly hinders collective action. In many communities of irrigators, communal rules have been devised for controlling water theft. Some of the rules include financial sanctions, restricted use of water, additional contribution towards O & M activities and temporary suspension of memberships. Table 4.43 presents information on the existence of communal rules for controlling water defrauding and vandalising of irrigation infrastructures, as reported by the farmers.

Table 4.43 Existence of Communal Sanctioning Mechanisms for Defrauders in the Three Irrigation Systems

Existence of Communal Sanctioning for Defrauders	**Irrigation Systems**			
	FMIS % (n)	**AMIS % (n)**	**JMIS % (n)**	**Overall % (n)**
Yes	95.5 (64)	31.7 (20)	62.3 (43)	63.8 (127)
No	4.5 (3)	68.3 (43)	37.3 (26)	36.2 (72)
Total	100 (67)	100 (63)	100 (69)	100 (199)
Chi-square= 57.298 D.F. = 2 P-value = 0.005				

In the FMIS, 95.5 percent of the farmers reported the existence of communal sanctioning mechanisms compared to 62.3 percent in the JMIS and just 31.7 percent from the AMIS. In many village level organisations, what is written in the constitution and what is being implemented in practice are two different things. Often it is the case that rules are not implemented as prescribed in the WUA constitutions. The degree to which the rules are implemented appears to be associated with farmers' involvement in irrigation management and also the presence of sanctioning mechanisms (Ostrom, 1990).

Table 4.44 Rules Implemented as Described in the Constitution in the Three Irrigation Systems

Rules Implemented as per Constitution	Irrigation Systems			
	FMIS % (n)	AMIS % (n)	JMIS % (n)	Overall % (n)
Yes	92.5 (62)	31.7 (20)	60.9 (42)	62.3 (124)
No	6.0 (4)	66.7 (42)	37.7 (26)	36.2 (72)
Do not know	1.5 (1)	1.6 (1)	1.4 (1)	1.5 (3)
	100 (67)	100 (63)	100 (69)	100 (199)
Chi-square= 52.423 D.F. = 4 P-value = .000				

Table 4.44 shows the proportion of farmers reporting the implementation of rules as written in the WUA constitutions. About 92.5 percent of the respondents in the FMIS reported that rules were implemented as prescribed in the constitution. However, only 60.9 percent and 37.7 percent of the farmers in the JMIS and AMIS respectively, reported having done so. A small proportion of respondents in all three irrigation systems reported that they do not know whether communal rules are imposed on defrauders as prescribed in the constitution. About 1.5 percent of farmers in the FMIS reported that they did not know if communal rules imposed on water defrauders were as

prescribed in the constitutions, while 1.6 and 1.4 percent from the AMIS and the JMIS respectively reported this.

Table 4.45 show the various types of reported sanctions which are imposed in the irrigation communities for farmers involved in water defrauding and for those vandalising canal infrastructures.

Table 4.45 Nature of Sanctions Imposed on Defrauders in the Three Irrigation Systems

Nature of Sanctions imposed on water defrauders	**Irrigation Systems**			
	FMIS % (n)	**AMIS % (n)**	**JMIS % (n)**	**Overall % (n)**
Financial sanctions	53.7 (36)	39.7 (25)	53.6 (37)	49.2 (98)
Restricted use	1.5 (1)	0 (0)	0 (0)	0.5 (1)
membership suspension	37.3 (25)	0(0)	4.3 (3)	14.1 (28)
NA	7.5 (5)	60.3 (38)	42.0 (29)	36.2 (72)
Total	100 (67)	100 (63)	100 (67)	100 (199)
Chi-square= 68.976 D.F. = 6 P-value = .000				

For example, in the FMIS area a series of graduated sanctions are imposed depending on the nature of infractions and the damage they cause. For the first infraction, the defrauders are fined NRs. 100, while fines imposed on second and third time defrauders are NRs. 250 and NRs. 500, respectively. While financial sanctions were the most common form of sanctions, other forms were also commonly reported. Restricted use of the resource, in this case obviously irrigation water, and in rare cases temporary suspension of membership were practised. However, most of the minor incidents of defrauding were resolved at the local level. In the FMIS, the WUA has fully implemented graduated sanctions compared to both the AMIS and the JMIS. Financial sanctions remained the most common form imposed on the defrauders in all three irrigation systems considered for this research. About 53.7 percent of the farmers from the FMIS reported that financial sanctions were commonly practised while 39.7 percent and 53.6 percent of the farmers reported that financial sanctions were the most common form of sanctions for defrauders in the AMIS and the FMIS respectively. Interestingly, the WUA president in the AMIS was not in favour of financial sanctions, and he argued:

> "--- *we have not imposed any sanctions to the defrauders or otherwise— although I am aware that there are sanctioning provisions in the constitutions. But in my view it is not appropriate to imposed financial sanctions because it penalises the entire household. The mistakes are made by an individual but the fine imposed will be paid from the household's income which will have a negative impact on already poorer households who are struggling to meet their daily needs---"*
>
> (Male, 44, President of the AMIS)

Amongst other forms of sanctions, the WUA in the FMIS also imposed restricted use of the water resources for irrigators while in serious and repeated cases, the defrauders might be temporarily excluded from the general membership. Almost 38 percent of respondents reported that in serious and repeated cases of defrauding, the WUA did temporarily suspend the memberships of the defrauders. But in both the AMIS and the JMIS neither restricted use nor temporary suspension of members was practised. Also, farmers perceived that compliance with the rules is ensured by not only by the nature of the sanctions but also their strengths and the degree of implementation.

Table 4.46 shows that in general the sanctions imposed remained of a moderate nature, with farmers in the FMIS reported heavier sanctions, while many farmers in the AMIS and the JMIS reported either no sanctions imposed or light sanctions if they were imposed at all.

Table 4.46 Severity of Sanctions Imposed on Defrauders in the Three Irrigation Systems

Severity of Sanctions Imposed	**Irrigation Systems**			
	FMIS % (n)	**AMIS % (n)**	**JMIS % (n)**	**Overall**
Light	1.5 (1)	12.7 (8)	13.0 (9)	9.0 (18)
Moderate	70.1 (47)	27.0 (17)	46.4 (32)	48.2 (96)
Heavy	16.4 (11)	0 (0)	0 (0)	5.5 (11)
NA	11.9 (8)	60.3 (38)	40.6 (28)	37.2 (74)
Total	100 (67)	100 (63)	100 (69)	100 (199)
Chi-square= 38.294 D.F. = 4 P-value = .000				

Around 13 percent of farmers in the JMIS reported that the sanctions imposed on defrauders were light, compared to just 1.5 per of respondents in the FMIS and 12.7 percent in the AMIS. Similarly, a significantly higher proportion of farmers in all systems reported having imposed moderate levels of sanctions in the FMIS. In the FMIS, 70.1 percent of farmers reported moderate sanctions, compared to 27 percent in the AMIS and 46.4 percent in the JMIS. While none of the farmers felt that the sanctions imposed on defrauders in the AMIS and the JMIS were heavy, 16.4 percent in the FMIS considered the sanctions strong.

The results of the Chi-square test which is presented in Table 4.47 indicate that there is an association between the severity of communal sanctions and the prevalence of water theft in the irrigation systems. Although the association is not statistically significant, farmers naturally will not be prepared to take the risk of getting fined if the rules are strictly enforced. It is, therefore, plausible to suggest that there will be fewer incidences of water theft in irrigation systems where heavy penalties are imposed on farmers who break water distribution regulations. Farmers become reluctant to get involved in water fraud if the fines when they are caught and found guilty of misconduct are high.

Table 4.47 shows farmers' responses on the severity of communal sanctions and incidences of water theft in the irrigation systems considered for this study.

Table 4.47 Relationship between Severity of Communal Sanctions and Prevalence of Water thefts in the Three Irrigation Systems

Severity of sanctions	**Prevalence of Water Theft**	
	YES % (n)	**NO % (n)**
Light/No sanctions	68.9 (62)	31.1 (28)
Moderate	56.7 (51)	43.3 (39)
Heavy	36.4 (4)	63.6 (7)
Total	61.3 (117)	38.7 (74)
Chi-square = 5.880 D.F. = 2 P-value= .053		

There is an association between the severity of sanctions and incidents of water theft. Although the overall problem of water theft (61.3 percent) still remains high and continues to be an issue, as the severity of sanctions increases, incidents of water theft decrease. A significantly higher proportion of farmers (68.7 percent) who reported that the fines imposed were light or no fine was imposed, also reported prevalence of water theft in their community. Also, 56.7 percent and 36.4 percent of farmers who reported moderate and heavy sanctions imposed on defrauders, reported having problems with water theft in their communities, respectively.

4.2.9 Communal Social Capital and Access to Irrigation Water

As mentioned in Chapter Two, the level of trust amongst farmers has a great significance to the way they co-operate with each other. In developing countries, particularly in rural communities, factors such as trust and co-operation are considered vital aspects of village life which not only impact on farmers' abilities to engage in irrigation management but also in other spheres of social life in the rural villages.

In order to assess farmers' perspectives on how they evaluate the level of trust in their neighbouring farmers, it was asked how they perceived this level of trust in relation to irrigation water. The results are present in Table 4.48, which shows that an overwhelming proportion of farmers in the FMIS reported to have a high level of trust in one another, while an overwhelming proportion of farmers in the AMIS reported having a low level of trust in one another. In the Begnas area, 61.2 percent of the farmers reported having a high level of trust, while the remaining 31.3 percent and 7.5 percent of farmers in the same system reported having a modest and low level of trust respectively. Similarly, in the Begnas area only 9.5 percent of the farmers reported to having a high level of trust, while the remaining 63.3 percent and 30.2 percent of the farmers reported having a modest and low level of trust, respectively. In the JMIS, 28.4 percent of farmers reported having a high level of trust, while the remaining 58.2 percent and 13.4 percent of the farmers report having a modest and low level of trust, respectively.

Table 4.48 Self-reported Level of Trust amongst Irrigators in the Three Irrigation Systems

Level of Trust amongst Irrigators	Irrigation Systems		
	FMIS % (n)	AMIS % (n)	JMIS % (n)
High Level of Trust	61.2 (41)	9.5 (6)	28.4 (19)
Modest Level of Trust	31.3 (21)	60.3 (38)	58.2 (39)
Low Level of Trust	7.5 (5)	30.2 (19)	13.4 (9)
Total	100 (67)	100 (63)	100 (67)
Chi-square= 44.270 D.F. = 4 P-value = .000			

Table 4.49 shows that there is an association between the level of trust as reported by the farmers and their level of access to irrigation water.

Table 4.49 Household Level of Access to Irrigation water and Level of Trust amongst the Farmers in the Three Irrigation Systems

Level of Access to Irrigation Water	Level of Trust amongst Irrigators		
	High % (n)	Modest % (n)	Low % (n)
A strong access	83.3 (55)	58.2 (57)	24.2 (8)
A weak access	16.7 (11)	41.8 (41)	75.8 (25)
Total	100 (66)	100 (98)	100 (33)
Chi-square= 32.884 D.F. = 2 P-value = .000			

In general, a higher proportion of farmers who reported having a high level of trust amongst them also reported strong access to irrigation water, while those reporting low levels of trust reported weak access to irrigation water. About 83.3 percent of farmers who reported a high level of trust also reported strong access to irrigation water, while the remaining 16.7 percent reported weak access to irrigation water. Similarly, 58.2 percent of farmers reporting a modest level of trust reported strong access to water, while the remaining 41.8 percent reported weak access to water. Perhaps not surprisingly, a significant proportion of farmers who reported having a low level of trust also reported weak access to irrigation water. About 75.8 percent of farmers reporting a low level of trust appear to have weak access to irrigation water, while only 24.2 percent of them reported strong access to irrigation water. A higher level of mutual trust facilitates the process of establishing 'social norms', where community members follow the rules of the community (Ostrom, 1994).

Table 4.50 shows the level of trust in each of the irrigation systems considered, and the prevalence of water theft. While in general, the problem of water theft remains common to all three irrigation systems, there remains a continuum of incidence of water thefts remaining high at the lower level of trust and decreasing as the level of trust among farmers increases. The farmers who reported a high level of trust within the community also reported a lower incidence of water thefts in their area. It appears that low levels of trust amongst the farmers are associated with a higher incidence of water theft.

In the FMIS, 43.9 percent of farmers who reported a high level of trust also reported prevalence of water theft in their area compared to 61.9 percent and 80 percent of farmers reporting a modest and a low level of trust, respectively.

The proportion of farmers reporting prevalence of water theft remains high in the AMIS.

Table 4.50 Level of Trust and Water Thefts in the Three Irrigation Systems

Irrigation Systems	Level of Trust	Prevalence of Water Theft		
		YES % (n)	NO % (n)	Total % (n)
FMIS	High	43.9 (18)	56.1 (26)	100 (41)
	Modest	61.9 (13)	38.1 (8)	100 (21)
	Low	80 (4)	20 (1)	100 (5)
AMIS	High	83.3 (5)	16.7 (1)	100 (6)
	Modest	75.7 (28)	24.3 (9)	100 (37)
	Low	89.5 (17)	10.5 (2)	100 (19)
JMIS	High	16.7 (2)	83.3 (10)	100 (12)
	Modest	48.7 (19)	51.3 (20)	100 (39)
	Low	100 (9)	0 (0)	100 (9)
Overall *	High	42.4 (25)	57.6 (34)	100 (59)
	Modest	61.9 (60)	38.1 (37)	100 (97)
	Low	90.9 (30)	9.1 (3)	100 (33)
	*Chi-square= 21.012 D.F. = 2 P-value = .000			

Of the farmers who reported a high level of trust, 83.3 percent reported having encountered problems with water theft compared to 75.7 percent and 89.5 percent reporting modest and low levels of trust, reporting problems of water thefts, respectively. Similarly, in the JMIS, 100 percent of farmers who reported a low level of trust also reported having experienced problems of water theft in their communities, compared to 48.7 percent of farmers with modest levels of trust and 16.7 percent of farmers with a high level of trust in their communities.

4.2.10 Simplicity of Rules and Access to Irrigation Water

The importance of simple rules for irrigation governance has been discussed in Chapter Two (Section 2.10.7). Simple rules for the management of irrigation systems are both easy to implement and follow, while complex rules are difficult to follow for uneducated farmers in rural Nepal. If the farmers are aware of the rationale behind the rules implemented, they can either support them or contest them. In order to raise awareness about irrigation systems and the rules governing them, the WUAs spend considerable amounts of their resources. However, the WUAs in some irrigation systems make greater efforts in raising awareness amongst the farmers than others.

Table 4.51 Simplicity of Irrigation Governing Rules in the Three Irrigation Systems

Simplicity of Irrigation Governing Rules	Irrigation Systems			
	FMIS % (n)	AMIS % (n)	JMIS % (n)	Overall % (n)
Simple/easy to understand	95.5 (64)	27 (17)	49.3 (34)	57.8 (115)
Complex/Difficult to understand	4.5 (3)	73 (46)	50.7 (35)	22.1 (44)
Total	100 (67)	100 (63)	100 (69)	100 (199)
Chi-square= 77.430 D.F. = 2 P-value = .000				

Respondents were asked how easy they found the rules governing the irrigation systems to understand. The results are presented in Table 4.51, which shows that the level of farmers' engagement in irrigation governance influences their level of understanding of the rules imposed. In the FMIS area, 95.5 percent of the farmers reported that they found their rules to be simple and easy to understand, while the remaining 4.5 percent reported the rules to be complex and difficult to understand. Similarly, about 49.3 percent of the farmers in the JMIS area reported the rules to be simple and easy to understand while remaining 50.7 percent reported them to be complex and difficult to understand. However, a significant proportion of farmers in the AMIS area reported that their irrigation governing rules were overtly complex and hence difficult to understand. In the AMIS, 73 percent of the respondents reported that the irrigation governing rules are complex and difficult to understand compared to just 27 percent, who reported that the irrigation governing rules were simple and easy to understand. The results of the Chi-square test indicate that there is a statistically significant association in the reported simplicity of irrigation governing rules among the three systems considered for this research.

As such, the farmers have different levels of participation in the management of irrigation system and they also do so in different capacities. The level of farmers' participation in irrigation management of the three irrigation systems considered in this research can be described using Arnstein's (1969) "*ladder of participation*". The ladder of participation classifies the nature of participation into three categories; namely citizen power, tokenism and non-participation. In the FMIS, farmers have a full control of their irrigation systems where decisions are made at the local level by the users themselves. In the JMIS, the participation of the water users was merely consultations in which the DoI was not legally obliged to consider the outcomes of those consultations in its decision making. Therefore, the nature of farmers' participation in the JMIS was merely tokenism in which the participation was a functional participation to reduce operation costs (Rudqvist and Woodford-Berger, 1996). As such, the farmers in the FMIS did not have decision-making power and fell victim to the manipulation of the external agencies. However, in the AMIS, farmers did not participate in decision making and remained at the bottom of the participation ladder in which they were passive recipients of the development interventions.

Table 4.52 shows the relationship between the simplicity of rules governing irrigation systems and the extent of their implementation as prescribed in the constitutions. It is clear that farmers who reported that the rules governing their irrigation systems were simple also reported that the rules were implemented as prescribed in the constitutions. An overwhelming proportion of farmers (87.5 percent) in the FMIS area who reported that their irrigation governing rules were simple also reported that the rules were implemented as prescribed in the constitution, while only 33.3 percent of the farmers reporting complex rules reported that the rules were implemented as prescribed in the constitution.

In the AMIS area, although the proportion of farmers reporting irrigation governing rules to be simple was less than both the FMIS and the JMIS areas, a higher proportion of farmers reporting simple rules also reported rules being implemented as prescribed in the constitution.

Table 4.52 Relationships between Simplicity of Rules and Implementation in the Three Irrigation Systems

Irrigation System	Simplicity of Irrigation Governing Rules	Rules implemented as prescribed in WUA Constitution		
		Yes % (n)	No % (n)	Total % (n)
FMIS	Simple	87.5 (56)	12.5 (8)	100 (64)
	Complex	33.3 (1)	66.7 (2)	100 (3)
	Total	85.1 (57)	14.9 (10)	100 (67)
AMIS	Simple	52.9 (9)	47.1 (8)	100 (17)
	Complex	0 (0)	100 (46)	100 (46)
	Total	52.9 (9)	100 (46)	100 (63)
JMIS	Simple	64.7 (22)	35.3 (12)	100 (34)
	Complex	8.6 (3)	91.4 (32)	100 (35)
	Total	36.2 (25)	63.8 (44)	100 (69)
Overall *	Simple	75.7 (87)	24.3 (24)	100 (115)
	Complex	4.8 (4)	95.2 (80)	100 (84)
	Total	45.7 (91)	54.3 (108)	100 (199)
	*Chi-square= 98.297 D.F. = 1 P-value = .000			

About 52.9 percent of farmers in the Begnas area who reported that their irrigation governing rules were simple also reported that the rules were implemented as prescribed in the constitution, while none of the farmers reporting irrigation governing rules as complex reported that the rules were implemented as stated in the constitution. In the Rainastar area, a significantly higher proportion of farmers (64.7 percent) who reported their irrigation governing rules to be simple also reported that the rules were implemented as prescribed in the constitution, while only 8.6 percent of

farmers reporting their irrigation governing rules to be simple also reported that the rules were implemented as prescribed in the constitution.

Table 4.53 shows the relationship between the simplicity of irrigation governing rules and the incidence of water theft. It is clear that a reasonably high proportion of farmers who reported that the rules governing their irrigation systems were complex also reported incidence of water theft in their areas, in all the three irrigation system. The WUA themselves are aware of the importance of keeping irrigators informed of the rules and regulations that govern their irrigation systems. Whilst the need for raising awareness amongst the local farmers is acknowledged by the technicians, the WUA and local farmers themselves, cooperation is lacking.

Table 4.53 Relationships between Simplicity of Irrigation Governing Rules and Incidence of Water Thefts in the Three Irrigation Systems

Simplicity of irrigation governing rules	**Prevalence of Water Thefts in Different Systems**							
	FMIS % (n)		**AMIS % (n)**		**JMIS % (n)**		**Overall % (n)**	
	Yes	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
Simple	50.0 (32)	50.0 (32)	100.0 (17)	0 (0)	28.1 (9)	71.9 (23)	51.3 (58)	48.7 (55)
Complex	100.0 (3)	0 (0)	73.3 (33)	26.7 (12)	76.7 (23)	23.3 (7)	75.6 (59)	24.4 (19)
Total	52.2 (35)	47.8 (32)	80.6 (50)	19.4 (12)	51.6 (32)	48.4 (30)	61.3 (117)	38.7 (74)
Chi-Square= 14.859 D.F.= 1 P-value =000								

The difficulties in maintaining cooperation amongst the technicians, the WUA and the irrigators can be attributed to the lack of awareness among the farmers. If they do not know the rules and regulations that govern their irrigation systems, it is difficult for them to judge their own behaviour.

4.3 Conclusions

This chapter has investigated whether there are relationships between different variables, both household, socio-economic, communal characteristics and resource specific features, and farmers' capabilities to access irrigation water. Simple statistical tests (Chi-square tests, ANOVA test and t-tests) have been carried out. The results of different statistical tests indicate that farmers in the FMIS have better access to irrigation water compared to those in the AMIS and the JMIS, under the measure of access defined in the thesis.

Caste remains an important factor in rural communities in Nepal. In the FMIS, a higher proportion of *dalit* farmers reported having faced caste based discrimination. However, none of the *dalit* farmers reported having faced caste based discriminations in irrigation-related activities. A similar pattern was observed in the JMIS, but the proportion of *dalit* farmers reporting caste based discrimination in irrigation governance still remains. Caste based discrimination, as reported by the *dalit* farmers, indicates that discrimination is rampant in the AMIS. The *dalit* farmers consistently reported a weak level of access to irrigation water compared to higher castes in all three irrigation systems, but the difference between the systems is very clear. In the FMIS, the difference is very low whilst in both the AMIS and JMIS the difference is much greater. Caste based discrimination is not only linked to access to water but also to landholding. The data show that the higher caste groups also have access to more productive *Khet* lands with good irrigation facilities, whilst the *dalits* have the less productive *Pakho* and *Khoriya* lands and cultivate in non-productive lands with little or no access to water.

The inclusiveness in irrigation governance in the FMIS has meant that marginal farmers have better access to irrigation water compared to their counterparts in the AMIS and the JMIS. On average, the marginal farmers in FMIS have higher average access scores than their counterparts in the AMIS and JMIS.

The location of the landholdings along the main canal continues to be an important factor in farmers' capabilities to access water from the irrigation systems. Whilst head-enders have enjoyed locational advantages, tail-enders continue to face disadvantages in accessing water in all three irrigation systems. However, the differences in the head-tail inequalities are more conspicuous in the AMIS and JMIS compared to the FMIS. The comparison amongst the tail-enders in the three irrigation systems shows that the tail-enders in the FMIS have better access to irrigation water compared to their counterparts in the JMIS and AMIS.

Farmers' agronomical knowledge helps to reduce inequalities in water distribution. In the FMIS, the WUA has invested considerable time and resources in educating farmers about crop-water requirements to reduce wasteful use of water, whilst the WUA in the AMIS and JMIS were indifferent to this issue and the head-enders in these two systems have used water in very inefficient ways.

In rural Nepal, the society is very patriarchal and the effects of gender on access to water are glaring. The female-headed households have less access to irrigation water compared to the households headed by men. The traditional roles of nurturing and undertaking household tasks assigned to females have meant that their participation in debates and deliberations in irrigation governance is significantly lower than that of men. However, women's contributions were significantly higher in operation and maintenance activities compared to that of the men. The male-headed households have productive landholdings with better access to irrigation water compared to female-headed households. Also, the gender gap between the systems was significant. The WUA in the FMIS was very inclusive in gender dimension compared to the WUA in the AMIS and JMIS. Consequently, female-headed households in the FMIS have higher levels of access to irrigation water compared to their counterparts in the AMIS and the JMIS.

The higher level of involvement in irrigation governance in the FMIS has meant that the bond between them is high and there is consequently a higher propensity to be involved in collective action, whilst the interferences of external agencies and unclear distribution of responsibilities between the WUA and the DoI in the JMIS and AMIS has meant that an environment of mistrust and disengagement with irrigation issues were high. This has serious implications in the performance of those two irrigation systems and a consequent effect on farmers' level of access to irrigation water.

The presence of sanctions for defrauders and their implementation by local irrigators help to ensure compliance. In the FMIS, the farmers have been able to imbed those sanctions in the governance of their irrigation systems, while a weak implementation of the sanctions in the AMIS and the JMIS has meant that water theft and canal vandalism was acute in those systems.

CHAPTER FIVE:

DETERMINANTS OF HOUSEHOLD ACCESS TO IRRIGATION WATER: RESULTS AND DISCUSSIONS

5.1 Chapter Overview

This chapter follows the literature review presented in Chapter Two (Section 2.10) and the statistical tests carried out in Chapter Four. It presents the results of statistical analysis to determine factors influencing household access to irrigation water. For the purpose of this analysis, a statistical model for household access to irrigation water has been built using variables which include household socio-economic characteristics, communal characteristics of irrigators and resource specific characteristics of the irrigation system. The model constructed for the statistical analysis in this chapter is based on the findings in Chapter Four. A detailed treatment of the three components of access, i.e. reliability, adequacy and equity, has been described in Chapter Two (Section 2.9) and Chapter Three (Section 3.9). Chapter Five is broadly divided into two main sections, the first of which describes variables used for building the model to explain the factors influencing household access to water. It also presents the results of the statistical analysis. The second section of this chapter presents the discussions on the findings from the statistical tests. The data used to estimate household level of access to irrigation water come from the household survey. The chapter also uses qualitative data gathered through key informant interviews and focus group discussions, to illustrate and explain the findings from the regression analysis reported in the first section of this chapter. Access to and control over irrigation water is inherently associated with both household socio-economic status and resource specific characteristics to describe the findings from statistical analysis. A clear pattern of access to and control over irrigation water is reported. Results from the analysis indicate that the features associated with the FMIS have a positive influence on marginal and poorer farmers in their abilities to access water from irrigation canals, whilst the features particularly associated with the AMIS have negative effects on marginal farmers' ability to access water from the canal system. The chapter concludes that the characteristics associated with the FMIS provide conducive environments for the marginal farmers in accessing irrigation water while those associated with the AMIS and the JMIS constrain their capabilities in accessing water from the canal systems. The statistical tests carried out in Chapter Four uncovered the variables associated with access to irrigation water. The statistical analysis carried out in the same chapter has also led to further statistical analysis, carried out in this chapter. It should be pointed out that the variables considered in this chapter have been taken from the findings in Chapter Four.

5.2 Modelling Household Access to Irrigation Water

In order to understand the relationship between different physical and socio-economic variables and access to irrigation water, a multiple logistic regression model has been developed. The computation of household level of access to irrigation water has been described in detail in Chapter Three (Section 3.9). The regression analysis was carried out to predict the probability of strong access to irrigation water by farmers in households with different socio-economic characteristics and who are served by irrigation systems governed by different property rights structures. The regression analysis is a statistical technique which is used to measure the predictive power of independent variables to determine the value of a dependent variable. The multiple logistic regression method is used to predict a categorical outcome (dependant variable) from a combination of a number of explanatory (independent) variables. Since the dependent variable consists of two discrete and mutually exclusive categories, i.e. strong access and weak access, logistic regression analysis was the most suitable method of quantitative analysis. Furthermore, the suitability of the logistic regression technique is also considered on the grounds of “flexibility”, as this technique is free from restrictions compared to many other regression techniques. For example, binary logistic regression technique has no assumptions on the linear relationship between independent variables and can be used in any mix of dichotomous, discrete and continuous predictor (independent) variables (Tabachnick and Fidell, 2007).

The logistic regression readily allows each variable in the analysis to be described in terms of its strength of contribution to the outcome, the odds of reporting a strong access to irrigation water and the direction in which this contribution is made, that is whether the odds increase or decrease the likelihood of farmers’ reporting strong access to irrigation water (Hair *et al* 2006). In probability terms, the two outcomes can be represented by the following equation:

$$\text{Odds} = P(Y=1)/1-P(Y=1) \qquad \text{-----------------} \; (5.1)$$

Where Y=1 is the probability of households reporting strong access to water and 1-Y is the probability of households not reporting strong access to water (i.e. probability of reporting weak access to water).

It is assumed that access to irrigation water is the function of both socio-economic and physical characteristics of the resource base. By taking the natural logarithm of the odds that Y=1, as the dependent variable, the relationship between the dependent variable and the independent variables can be represented by the following equation:

$$\text{Logit}\ (Y) = \infty + \beta_1 X_1 + \beta_2 X_2 + \text{-------} + \beta_n X_n + \dot{\varepsilon}. \text{ -----------------} \ (5.2)$$

Where, Y in the left hand side of the equation 5.2 is the logit of the probability of reporting strong access to water by the respondent Y. The left hand side of model contains a set of *n*th explanatory variables X, a constant, ∞ and an error term, $\dot{\varepsilon}$.

To make the equation 5.2 simple and to express the parameters in terms of the odds, we need to exponentiate logit (Y) as Odds (Y=1) = $e^{\text{logit}\ (Y)}$. This results in the following equation:

$$\text{Odds}\ (Y=1) = e^{\ln[\text{odds}(Y=1)]}$$

$$= e^{(\infty + \beta_1 X_1 + \beta_2 X_2 + \text{-------} + \beta_n X_n} \text{ ------------} \ (5.3)$$

A change of one unit of an independent variable (X) multiplies the odds by e^{β} which can then be converted back to the probability that (Y=1) by the following equation:

$$P(Y=1) = e^{(\infty + \beta_1 X_1 + \beta_2 X_2 + \text{-------} + \beta_n X_n)} / 1 + e^{(\infty + \beta_1 X_1 + \beta_2 X_2 + \text{-------} + \beta_n X_n)} + \dot{\varepsilon}. \text{ -------} \quad (5.4)$$

The values of odds ratios inform us of the household level of access to irrigation water influenced by independent variables. The dependent variable (Y) has two possible values, 1 and 0 which represent strong and weak access respectively.

5.3 Determinants of Household Level of Access to Irrigation Water

5.3.1 Variable Definitions and Regression Equation

A detailed description of the variables and their association with the irrigation issues has been presented more broadly in the literature review in Chapter Two. This section describes the independent variables used in constructing the model to measure household access to irrigation water.

The description of the fourteen independent explanatory variables which are assumed to influence household level of access to irrigation water and the sign of their expected relationship with the level of access to irrigation water is presented in Table 5.1. The findings from Chapter Four demonstrated that household socio-economic characteristics and physical characteristics of the irrigation resource bases are associated with the level of access to irrigation water.

The fourteen explanatory variables which are used to build the regression model can be grouped into three separate categories. Variables such as the physical condition (PHYCOND), nature of the source feeding the system

(SOURCE) and the direction of flow of the canal (GRAD) are physical characteristics of the irrigation systems, while variables such as location of landholdings such as head-enders (LOCH) and tail-enders (LOCT) represent the physical position of landholdings in the canal command area.

Other variables, such as the type of farmer, such as small landholders (FARS) and landholders (FARL), represent the economic characteristic of the household. The household's social and institutional characteristics are represented by the household's caste group (CASTE), farmers' agronomical knowledge (AGROKN), simplicity of irrigation governing rules (RULES), gender of the household head (HHSEX) and level of trust amongst the farmers, i.e. high level of trust (TRUSTH) and low level of trust (TRUSTL). Thus the model accommodates multidimensional characteristics of irrigation governance.

Table 5.1 Definition of Explanatory Variables

Variables	Explanations	Expected sign of Relationship
XCESS	Dummy for access to water (1=a strong access, 0=otherwise	Dependent variable
PHYCOND	Dummy for physical nature of the canal system (1=cement lined, 0=otherwise)	+
RULES	Dummy for simplicity of rules (1=simple, 0=otherwise)	+
TRUSTH	Dummy for higher level of trust (1=higher, 0=otherwise)	+
TRUSTL	Dummy for lower level of trust (1=lower, 0=otherwise)	-
CASTE	Dummy for castes (1=*Dalits*, 0=otherwise)	-
HHSEX	Dummy for gender (1=male, 0=otherwise)	+
LOCH	Dummy for landholding location at the head end of the canal (1=tail end, 0=otherwise)	+
LOCT	Dummy for landholding location at the tail end of the canal (1=tail end , 0=otherwise)	-
AGROKN	Dummy for farmers agronomical knowledge used as a proxy for WUA engagement in educating farmers regarding water application (1= knowing crop-water requirement, 0=otherwise	+
FARL	Dummy for Large farmers (1=large, 0=otherwise)	+
FARS	Dummy for Small farmers (1=small, 0=otherwise)	-
GRAD	Dummy for Canal flowing in East-West direction (1=EW flow, 0= otherwise	?
SHAPE	Dummy for Shape of the Canal (1= elongated with outlets at multiple distant locations, 0=otherwise)	-
SOURCE	Dummy for source feeding irrigation system (1=perennial river, 0=otherwise)	+

Based on the variables described above, the thesis model was constructed in Chapter Two (Section 2.11). A modified IAD Framework described in Chapter One (Section 1.9) has been used as the theoretical framework for this thesis. The IAD Framework advocates that both policy process and policy outcomes are assumed to be affected by four major variables which include communal attributes of resource users, physical characteristics of the resources, interactions amongst the users and the institutional setup which govern those interactions (Ostrom, *et al.,* 1994). The theoretical model constructed to measure household access to water argues that this access is influenced by the institutional arrangements which are designed and implemented to govern irrigation systems. The theoretical model of this thesis is presented in Chapter Two (Figure 2.3), which illustrates that various attributes of the physical world and the communal characteristics have implications on the households' access to irrigation water. Furthermore, the institutional arrangements which are designed and implemented to govern irrigation systems provide the necessary action arena where farmers operate together to contribute towards and appropriate benefits from irrigation canal systems. Therefore, in order to understand the institutional issues, it is important to analyse how rules combine with the physical and community world to generate particular types of situations which determine household access to water from the canal system.

The model constructed for the purpose of this thesis is tested using the following regression equation:

$$XCESS = \beta_0 + \beta_1 PHYCOND + \beta_2 RULES + \beta_3 TRUSTH + \beta_4 TRUSTL + \beta_5 CASTE + \beta_6 HHSEX + \beta_7 LOCH + \beta_8 LOCT + \beta_9 AGROKN + \beta_{10} FARL + \beta_{11} FARS + \beta_{12} NSGRAD + \beta_{13} WATFED + \beta_{14} SHAPE + e \quad \text{------------------} (5.5)$$

Where, XCESS is a dummy variable measuring household level of access to irrigation water. The dependent variable, XCESS, has two values, 1 and 0, which represent strong and weak access to irrigation water, respectively. The β_0 is the intercept of the regression equation and $\beta_{1-} \beta_{14}$ are the parameters of the regression model that describe the directions and the strengths of the relationship between the dependent variables and the independent variables. The notation 'e' is an independent, normally distributed error term with zero mean, which represents the random and unexplained error in the model.

PHYCOND is a dummy variable and refers to nature of the physical condition of the canal, with value 1 denoting cement lined canals and value 0 representing non-cement lined canals. Similarly, RULES is a dummy variable representing the simplicity of irrigation governing rules. The variable RULES was created through the household survey, by asking the respondents if they thought the irrigation rules governing their system were simple or not. The level of trust amongst the irrigators is assumed to influence household level of access to irrigation water. In order to gauge communal social capital, i.e. the level of trust amongst the farming communities, the respondents were asked if they considered their level of trust with fellow irrigators as low, medium or high. The variables TRUSTH and TRUSTL refer to a high and low level of trust, respectively. Both TRUSTH and TRUSTL are dummy variables with values 1 and 0, where 1 represents high and low level of trust while 0 otherwise. Similarly, HHSEX and CASTE are dummy variables representing the gender and the caste of the household head. Their values are 1 and 0, which represent male and female for HHSEX and higher and lower castes, respectively.

Similarly, the location of the landholding is a critical factor in determining the level of access to water in gravity flow irrigation systems. The landholdings were placed into three categories, namely head end, middle end and tail-end depending on the location of the landholding in the canal command area. Both variables, LOCH and LOCL are dummy variables denoting landholdings located at the head and tail-ends respectively. Both LOCH and LOCT have values 1 and 0 which denote head-enders and otherwise for LOCH and tail-enders and otherwise for LOCT. As mentioned in Chapter Three (Section 3.6.3.2), households in the sample were divided into three categories, namely small, medium and large landholdings. The variables FARS and FARL are dummy variables and refer to small and large landholders, respectively. Similarly, variables SOURCE and SHAPE are also dummy variables. SOURCE refers to the nature of the water source feeding the canal and has two values, 1 and 0 which represent permanent and perennial and seasonal sources of water feeding the canal, respectively. The shape of the canal is assumed to influence household access to water. The dummy variable SHAPE refers to the shape of the canal and has two values 1 and 0 which represent an elongated canal with outlets at distant and multiple locations while 0 represents a non-elongated canal with outlets at closer locations. Similarly, GRAD is a dummy variable with values 1 and 0, which represent a canal flowing in a north-south direction and those flowing in east-west or west-east directions respectively.

5.3.2 Results

The conceptualisation of household access to irrigation has been described in Chapter Two (Section 2.9) and Chapter Three (Section 3.9). The respondents were asked about their perception of the reliability of their canal system in delivering water in all the three cropping seasons. Also, the respondents were asked if the water they receive for crop production is adequate and whether or not they think the water in their irrigation system is distributed equitably. A detailed description of the computation of strong and weak access has been presented earlier in Chapter Three (Section 3.9).The results of the logistic regression for household level of access to irrigation are presented in Table 5.2.

The model tested performs well with a pseudo R^2 of 0.38 and an acceptable significance level of 95 percent confidence interval. The odds ratio column in Table 5.2 shows the impact of each variable in the model on the likelihood of households having strong access to irrigation water relative to those having weak access to water when all other variables in the model are held constant. The odds ratios measure how the odds of households reporting a strong access to water i.e. a strong access which is coded as 1 compared with those reporting that the household has weak access to water i.e. a weak access coded as 0. For categorical variables, an odds ratio greater than 1 shows the factor by which the odds of having strong access to irrigation water for cases in which one category of the variable exceed the odds for those in the reference category.

Table 5.2 Logistic regression model to explain factors influencing the odds of having 'a strong access to irrigation water'

Predictor	B	SE β	Wald's χ2	Df	p-value	e^{β} (odds ratio)
Constant	1.130	.899	1.580	1	.209	.323
Physical conditions of canal	**-1.774**	**.595**	**8.888**	**1**	**.003*****	**.170**
Rules governing irrigation system	.062	.544	.013	1	.910	1.063
High Level of trust amongst farmers	.554	.509	1.187	1	.276	1.740
Lower Level of trust amongst farmers	**1.278**	**.603**	**4.495**	**1**	**.034****	**.278**
Caste (*Dalits*)	-.203	.567	.129	1	.720	.816
Gender	.217	.483	.203	1	.652	1.243
Landholding location at head end	.828	.645	1.648	1	.199	2.289
Landholding location at tail end	**-.949**	**.481**	**3.891**	**1**	**.049****	**.387**
Farmers agronomical knowledge	.504	.499	1.017	1	.313	1.655
Small farmers	**-.970**	**.489**	**3.934**	**1**	**.047****	**.379**
Large farmers	.942	.540	3.043	1	.081	2.564
				1		**3.804**
Source feeding irrigation system	**1.336**	**.521**	**6.589**		**.010****	
Gradient of the Canal (EW-direction)	**2.331**	**.658**	**12.534**	**1**	**.028*****	**.280**
Shape of the Canal	**-4.409**	**1.271**	**12.043**	**1**	**.001*****	**.012**

***$p<0.01$ ** $p<0.05$, *$p<0.1$, Chi-square=2.860, df =8, Cox & Snell R^2=0.382; Nagelker R^2= 0.516

The results from the regression analysis indicate that the physical condition of the canal has a negative association with the odds of having strong access to water from the irrigation systems, and it is statistically significant. The results indicate that the odds of farmers having strong access to water are significantly decreased by being served by canals which are cement lined. Other physical characteristics of the canal have a significant influence on the household level of access to irrigation water from the canal. The odd of having strong access to irrigation water is increased by being served by canals flowing in an east-west direction. Also, the odds of having strong access to water are significantly influenced by canals with outlets at numerous distant locations. This is partly because, if the canal has outlets at numerous distant locations, it is very hard to monitor the activities of the farmers and it is characterised by rampant water theft. This situation is particularly conspicuous in canals where there is lack of strong WUA and absence of or weak enforcement of sanctions for water defrauders.

As the model predicts, other socio-economic characteristics of households are also significantly influencing their level of access to water from the canal systems. The results from the regression analysis indicate that the odds of having strong access to irrigation are significantly decreased by being at the tail end of the canal. Similarly, odds of reporting strong access to water are significantly reduced by having a small landholding size. A low level of trust amongst the households also decreases significantly, the odds of having strong access to water.

However, as the model predicts, variables such as caste, gender, head end location, large landholding, high level of trust and farmers agronomical knowledge have statistically non-significant effects on the household level of access to water. It should be pointed out that although some of these variables have statistically non-significant results; this is not to say that they do not have practical significance in real life. Those variables which have practical significance despite being statistically non-significant are discussed in the section below.

5.3.3 Discussions

The following section presents the findings from the regression analysis. The discussions on the findings are presented in the order of the physical condition of the canal systems and household socio-economic position within the community, in relation to their access to water from the irrigation canals.

5.3.3.1 Physical Conditions of Canal and Access to Irrigation Water

5.3.3.1.1 Canal Lining

Although the advantages of cement lining canals are well acknowledged, those come about at substantial cost (Snell, 2001; Meijer *et al.,* 2006). It is reported that cement lining a canal reduces water loss through seepage, promotes smooth flow of water and increases the command area by not only reducing hydraulic roughness but also depositions and sedimentations, avoids waterlogging and reduces maintenance costs in the long term. Furthermore, by cement lining the canals, the growth of weeds is controlled and the channel beds and banks are stabilised (Khair *et al.,* 1991). However, cement lined canals are not only expensive, but are also prone to high seepage losses, particularly in older concrete lined canals with deteriorated joints and frost heave or settled sections (Hill, 2000; Zhu, 1991).

This is particularly significant in terms of policy, as huge amounts of resources are invested in the cement lining for canals, both in the construction of new canals and rehabilitating of old systems. These are rather unusual results because of the fact that the purpose of cement lining the canals is to reduce seepage and facilitate unconstrained flow of water in the canals, which in turn will help to reduce head and tail inequalities. However, the cement lined canals clearly did not achieve these objectives. Instead, data from qualitative interviews with participants explaining that when cement lined canals are damaged by aquatic crabs it is a problem that is both difficult to identify and is very costly to repair (much less of an issue in canals that are not cement lined).

Also, in many rural parts of Nepal, particularly in the hilly region, it is common practice to grow big trees along the canal edge. This is done so that the canal is protected from landslides by the tree roots, as the terrains are fragile and prone to frequent landslides. However, root penetration beneath the canal bed and the canal cross section ruptures the cement lining leaving cracks in the canal cross section, which causes severe deterioration in the canal infrastructures, leading to a high level of water seepage. This in turn leads to increased head and tail inequality, while at the same time increases salinity problems at the head end due to water seepage. While the government is investing a considerable amount of money in the rehabilitation of cement lined canals and making considerable efforts in constructing new cement lined canals, the results support the idea that costly cemented irrigation infrastructures neither guarantee water and nor necessarily enhance farmers' levels of access to irrigation systems. Instead, non-cement lined canals, if well maintained in a timely fashion, can ensure water reliability and higher access to water from irrigation systems and help to reduce head and tail inequalities.

5.3.3.1.2 Water Source

As mentioned in Section 5.3.2, the regression results indicate that the nature of the water source feeding the canal system appears to influence household levels of access to irrigation water positively and the relationship is statistically significant. The nature of the water source feeding the irrigation canal system has the greatest impact in the model. Thus, it is imperative that the efforts to construct irrigation canals should consider the water availability at source, particularly during the autumn and spring.

5.3.3.1.3 Canal Gradient/ Shape and Access to Irrigation Water

Similarly, the farmers who are being served by canals flowing in an east-west direction are likely to report strong access to irrigation, compared to farmers who are being served by canals which are flowing in a north-south direction.

As mentioned in Chapter Two (Section 2.10.8), the canals flowing in a north-south direction have steep gradients and flow through difficult terrain. These canals are generally long, elongated, prone to landslides and in need of frequent operation and maintenance for a smooth flow of water in the canal. However, the canals which flow in an east-west direction have mild gradients and flow through command areas which are flat river basins. This being the case, maintenance efforts are lower and relatively easy. The shape of the canal was reported to have implications in the way the water is distributed in the irrigation systems. Farmers reported that irrigation canals which are long, elongated and with outlets at numerous places have a higher degree of inequalities in water distribution. The farmers reported that the existence of numerous outlets along the elongated canals not only allows defrauders to tamper with the canal infrastructure to appropriate more than their fair share of water but also makes it extremely difficult to monitor the situation. However, short, non-elongated canals with less outlets and outlets spanning a shorter distance along the canal, help to distribute water more equitably as a *Dhalepa* in the JMIS said:

> *"—this canal has the shape of the Nile river; it stretches long and far along the rugged terrain—can you see the landslides at numerous places,-- look here is one, you will find plenty of landslides damaging the canal--.– Look these damages are made by the defrauders illegally—to be honest we need at least ten Dhalepas to monitor the activities of the farmers, but there are just three of us, it takes almost a whole day to travel along the canal—it is almost impossible to keep an eye on everybody's activities----"*
>
> (Male 42, Tail end *Dhalepa*, from the JMIS)

In such irrigation systems, farmers find it difficult to tamper with the canal infrastructures as it is easy for the WUA to monitor them. Therefore, the shape and the gradients of the canals have implications for farmers' levels of access to irrigation water.

5.3.3.2 Location of Landholding and Access to Irrigation Water

Similarly, the differences between the tail-enders and farmers in other locations (middle and head-end) in terms of access to water are statistically significant. This finding is consistent with earlier findings (Jahromi and

Feyen, 2001; Ostrom and Gardner, 1993). In fact, water inequality faced by the tail-enders continues to present a major challenge in irrigation governance in Nepal. The irrigation canals in the mid-hills are constructed in difficult terrain and are prone to landslides, particularly during the Monsoon season. Also, farmers at the head end have a spatial advantage in appropriating more water. The farmers at the head end of the canal systems are often fuelled with a deeply rooted mentality because of their locations, that they should have priority over the natural rights to irrigation water:

> *"---Do you expect me to stand and watch water flowing down the canal while my crops wilt? The whole thing about prioritising the tail end has become very political. The tail-enders in Dhamilikuwa area think that they have political connections and can influence the irrigation issues. ---we head-enders were the first ones to compromise during canal construction, you see. We sacrificed our land--. Almost my entire cultivable land has been dissected by the canal--I lost my chickens and livestock in the canal--- my baby fell in the canal and nearly died—nobody compensates me—Is it not natural that the head-enders should get the water first? They can transport water by air if they want, but how can I see water draining down while my crops wilt---?"*
>
> (Male, 43, JMIS head-ender)

The natural locational disadvantages faced by the farmers at the tail-end of the canal not only has differential economic outcomes but also has implications for collective action, owing to different levels of incentives among head and tail end farmers. The tail-enders, particularly in the JMIS, have lost the sense of belonging to the irrigation community. The perceptions of the farmers to both the WUA and the head-enders were, in general, not very positive as demonstrated by the following quote:

> *"---Yes of course, they are interfering with the water. They say 'we are located at the head end, what can you do about it?' The consequences of their negligence and reckless behaviour should be assessed and we should have a serious debate about them—their field is over-flooded while our crops are failing due to lack of water. We have been let down by the WUA. Who cares about tail-enders, anyway? ----Tail-enders always have suffered water austerity, while the head-enders enjoy plenty. Well, with a heavy heart, I must say ----this is the irony of this canal---"*
>
> (Woman, 44 from tail end of JMIS)

Similarly, in the Begnas system, the locational advantage of water appropriation was being enjoyed by the farmers with landholdings located at the head end of the canal. In fact, the severity of neglect of the irrigation canal was more pronounced at the head end of the Begnas canal than any of the canals considered in this study. In the Begnas system, the hegemony of the head-enders could be conceived not only by a single dimension, although water appropriation was clearly the most significant. The cumulative effect of the neglect on the part of head-enders has led to a massive extent of canal deterioration. Apart from drilling canal banks to appropriate more water from the canal unlawfully, the head-enders have used canals for a number of other purposes, including, amongst other things, drawing water for household use (washing clothes and utensils and feeding animals), making puddles at the head end for children to swim and buffaloes to bath, and dumping household waste:

> *"---Well, the story is very long--- but the main problems arise from the irresponsible behaviour of the head-enders. --- head-enders are the ones who benefit the most from the canal--- they are the ones who are not contributing in the operation and maintenance (Jhara) regularly—the canal is dirty and filled with debris, it has become a dumping site (for the head-enders) --- they dump everything in the canal—households waste, fallen banana trees—dead and rotten chickens, dead bullocks—everything—you name it—irregularities emanate from the head end of this canal ---"*
>
> (Head end *Dhalepa*, AMIS)

In both the JMIS and AMIS, whilst water shortages at the tail end of the canal were an immediate impact resulting from the activities of the head-enders, the farmers at the tail and middle sections of the command area alleged that the filthy water in the canal was also damaging standing vegetables and reducing the fertility and quality of the soil in their fields:

> *"---You can see polythene bags and other garbage including the trunk of a banana tree, tree stem flowing in the canal water. This would not only damage the standing vegetable crops, but would also destroy the fertility of the soil---"*
>
> (Male, 35 WUA member, AMIS)

Farmers at the middle section of the Begnas canal also related some of the most agonising situations they faced as a result of the negligence of the head-enders. Although the middle section of the canal has a more adequate and reliable water supply compared to the tail-end, they are at a particular disadvantage when it comes to bearing the costs of cleaning and removing silts from canal beds and banks. This was highlighted by the experiences of a farmer in the middle section of canal command area:

> *"---We are in a fix—We work hard in cleaning the canal and wait a long time for our turn to irrigate, but when the water arrives it becomes a bitter pill to swallow-- If we use the canal water, it damages soil and crops and if we don't use it our crops would wither away without irrigation---".*
>
> (Female, 41, middle end, AMIS)

The WUA in the Begnas canal had assigned the head-enders to carry out operation and maintenance activities in their sections of the canal, but the head-enders had failed to do so. Their indifference to cleaning and maintaining the canal was vivid, as there was a swath of lotus plants and other noxious weeds growing in the canal cross sections, creating a number of problems in the canal irrigation. Firstly, it obstructed a smooth flow of water in the canal. Secondly, the plant growth in the canal increased evapo-transpiration, causing water losses from the canal (Unal *et al.,* 2004). Thirdly, and perhaps most importantly, the plant growth destroyed the canal infrastructure, as the plant roots penetrated into the canal bank and broke the cement linings and other reinforced concrete (RCC) structures, resulting in increased water seepage. The dead parts of plants got deposited on the canal bed, which further reduced the canal surface area.

5.3.3.3 Level of Trust and Access to Irrigation Water

Similarly, according to the model, communal social capital such as level of trust influences household access to irrigation water. A clarification is needed as to whether high social capital (trust) leads to better access to water or vice versa. It might be the case that the absence of trust creates conflict, making maintenance of field channels and control structure difficult, which decreases the system's ability to provide water to the farmers efficiently. Water theft is common under these circumstances, which might have led farmers to report weak access to the resource (Uphoff and Wijayaratna, 2000). Alternatively, weak access to the water resource, which can be unreliable and inequitably distributed or both, can cause resentment amongst irrigators, particularly those who do not get their fair share, and who lose their confidence in collective action and report a low level of trust. In fact, the level of trust among the irrigators is positively associated with collective action, which is necessary for canal operation and maintenance (Seabright, 1993). This finding is consistent with earlier studies (Lam, 1998; Ostrom, 1990). Trust is the foundation of cognitive social capital, which has been argued to be an important factor in the institutional and economic development of both the community and the country (Knack and Keefer, 1997). Generalised interpersonal trust plays a crucial role in determining the outcomes of socio-economic interactions. Trust as social capital facilitates exchanges and interactions amongst individuals and groups of farmers without the necessity for strict enforcement of rules and reduces transaction costs in doing so (Zak and Knack, 2001).

The farmers particularly in the AMIS and the JMIS reported that the irrigation issue was highly politicised. As irrigation is used for political purposes, there is a high degree of mistrust amongst the irrigating households. As mentioned in Chapter Four (Section 4.2.9), a higher proportion of farmers in the FMIS reported having a higher level of trust within their community, compared to the farmers in the AMIS and the JMIS. The watchman (*Dhalepa*) in the Begnas irrigation system said:

> *"---there is a real crisis of confidence and cooperation here amongst the farmers. The whole irrigation issue is heavily politicised. They do not cooperate with the WUA. They can't do a good job and pull legs of individuals who are attempting to change things for the good. This canal is not a boon for weak farmers but a curse to be honest. The canal breeds conflicts ---."*
>
> (Male 42, Tail end *Dhalepa*, from the JMIS)

Similar sentiments were echoed by the farmers, particularly at the tail end of the JMIS. The farmers reported that understanding of the irrigation governing rules is necessary but not sufficient to ensure the maintenance of the canal infrastructure and fair distribution of water resources. Along with an understanding of rules, the relationships amongst the farmers and between farmers and the WUA should be healthy and sound. The WUA should be trustworthy in generating compliance with the rules they hope to implement for the betterment of the management of the irrigation systems. A culture of trust amongst the stakeholders is thought to be essential for ensuring equitable water distribution amongst farmers across different heterogeneities. The treasurer of the block committee located at the tail end of the JMIS argued that:

> "---*There is such a high level of mistrust not only between the farmers but also between farmers and the WUA-- neither the WUA committee nor irrigators work cooperatively---people have such negative attitudes to prove who is more powerful--. It is about taking revenge by being uncooperative with each other or even with the WUA --. Irrigation and local politics are inseparable, once you get politics sorted, things will ease out otherwise this lingering continues--."*
>
> (Treasure of JMIS, tail-ender)

Transparency in both the financial and operational aspects of the WUA are critical in nurturing the much needed trust between the WUA and the farmers. Whilst the FMIS had a proper financial audit, unfortunately the WUAs in the JMIS and the AMIS lacked proper accounting. A considerable number of local farmers and the watchmen alike in the Rainastar and Begnas irrigation systems have questioned the conduct of some of the WUA members, as a *Dhalepa* from the JMIS said:

> "--- *There are allegations of fraud within the WUA —some individuals with large landholdings and higher caste group misused NRs. 44,000.*

The incumbent WUA committee is making attempts to recover the sum but I doubt if it will be possible to do so. Neither the DoI have looked at the incidences of fund misuses nor the farmers questioned the WUA---"

(*Dhalepa*, 43, head end, JMIS)

Similar incidents of financial irregularities were repeatedly mentioned by the local farmers in the AMIS:

"---*The accountability of the previous committee is embarrassing. Looks like the people in the committee completely forgot what WUA stands for. They have neither submitted account details nor do they audit their transactions. We do not have a clue about their income and expenditure, how much they raised from local farmers, what they did with the money. It has surfaced that a total of NRs. 71,000, which is about six hundred seventeen pounds, was used for personal purposes.*[9] *When we enquired about the money, the treasurer and president told us that they did not make personal use of the sum. This is a gross neglect of public money---".*

(Male, 43 President of AMIS)

5.3.3.4 Size of Landholdings and Access to Irrigation Water

The odds of having strong access to irrigation is significantly reduced for farmers with small landholdings compared to the farmers in the medium landholding category. The disadvantages in water use endured by the small

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9 According to the Central Bank of Nepal, the Exchange Rate is £1= NRs. 115.88 on 22 January 2011 (Central Bank of Nepal, 2011).

farmers are reported to be most conspicuous in the AMIS and the JMIS, compared to the FMIS. The participants of the key informant interviews repeatedly mentioned the dominance of the large farmers in the management of the irrigation system in the BIS:

> *"---Right from the beginning, the large landholders have assumed that the primary beneficiary of the canal should be them. And they have been enjoying the hegemony with regards to both water use and irrigation management. And they are the ones who created this mess and unsystematic cultur, a culture of neglect in the irrigation governance---."*
>
> (Male, 45 from AMIS tail-ender)

The irrigation systems continue to be the heart of village level politics, where the irrigation issues are being used by the large and powerful farmers for their political gains rather than the benefits of the marginal farmers. As a participant of a key informant interview expressed:

> "---*Some selfish people with myopic thinking took the issue of irrigation lightly. For them irrigation was politics more than anything else. Irrigation is in fact life for marginal farmers. The large landholders and head end farmers designed the rules to suit their needs without considering the needs of the marginal and tail end farmers---"*
>
> (Male, 43, President of AMIS)

The degree to which farmers can influence irrigation governance is also closely related to their landholdings, positions in the society and locations, amongst other things. The farmers, particularly in the AMIS and the JMIS, consistently report that neither the needs of the farmers are treated equally nor are they equally represented in the management of irrigation systems. The influence of small farmers and tail-enders was reported to be very weak. As a farmer from the middle section of the Begnas system, who participated in the key informant interview argued:

> *"---The influence of small farmers is negligible in irrigation governance. It is not yet in people's consciousness that irrigation is a common property that each and every member has equal rights and responsibilities---"*
>
> (Male, 52, middle section of AMIS)

This further highlights the dominance of the farmers with large landholdings over the small farmers in irrigation governance and water acquisitions. However, the experts' views expressed during the key informant interviews indicated a stark difference in the irrigation systems in relation to the influence of both irrigation governance and water acquisition:

"--- Either you look at it from a management perspective or water acquisition point of view, it is the large landholders and more powerful people who always enjoy the hegemony over irrigation systems. They might have a brilliant system but marginal farmers are often neglected. ---It's a pity that neither the government has brought any package programme for the marginal farmers nor the WUA is sensitive towards this---"

(Male, 34, Irrigation Expert)

Larger landholders in the AMIS also reported being more reluctant in undertaking their fair share of operation and maintenance activities. As a participant of the focus group discussion said:

> *"---The farmers with larger landholdings are not only reluctant to take part in but also procrastinate the most during operation and maintenance activities --- because marginal farmers are uneducated, ignorant and innocent but are hard working, and large landholders and influential farmers manipulate them (make them dance at their finger tips)---"*
>
> (Female, 25, AMIS)

Similar viewpoints were also expressed by both farmers and watchman alike in the JMIS, as demonstrated by the *Dhalepa*s participating in key informant interviews in the following quotation:

> *"---Yes, there are farmers with as much as 150 Ropanis of landholdings—also there is evidence that the same farmers have not paid the water levy --. The large landholders intentionally ignore rules and obstruct reforming rules too.—the larger farmers frequently defraud from irrigation governing rules—often stealing water from the canal---they lease out land and ignore irrigation----"*
>
> (Male, 39, Tail end *Dhalepa*, JMIS)

In the FMIS, the local farmers participated in all aspects of irrigation governance including design, installation and the decision making process on the location and size of water division structures (the *Gahaks*). As described later in Chapter Six (Section 6.4.1.5), equal participation of local farmers, irrespective of their social status, landholdings and location, provides them with assurance about equitable water distribution and enhances their engagement with irrigation issues. The installation of proportional weirs enables farmers to derive their fair share of water while also making water availability more predictable. Rules are strictly enforced and farmers failing to comply with them are sanctioned, which has helped to ensure more equitable water distribution amongst the farmers. These sentiments were echoed by farmers during the focus group discussions:

> *"--- there isn't any notion of head-tail in this system—we do not identify ourselves as head or tail-enders. We might be in different locations; our landholdings might be in different locations but for irrigation purposes we have no locational discrepancies.—we have transplantation in the head end as well at the Gandaki bank at the tail end at the same time---"*
>
> (Male, 46, Tail end farmer, FMIS)

The imposing of strict sanctions on defrauders in the FMIS has meant that water is more likely to be equitably distributed amongst the farmers. A participant of the focus group discussion from the FMIS argued:

> *"--- If an individual takes water just to moisten soil on their potatoes – even for a short while during anothers turn, it is a clearly a misuse of water--, this will impact on other farmers crops and particularly the small farmers will be badly affected by this type of defrauding activity----*

no one can acquire water illegally. Small farmers should not be victimised as the results of water thefts by large farmers---"

(Female, 39, tail-ender, FMIS)

The roles of local religious beliefs have been used by farmers in the FMIS, where they have capitalised on local religious beliefs in the management of the irrigation system. The WUA of the FMIS has built a temple in close proximity to the head end to avoid any unnecessary intrusions and tampering in the canal headwork, as temples are considered sacred in Nepal. Such sentiments were echoed by elder members of the community, as an elderly farmer who participated in a key informant interview said:

"--- In ancient times, the location of the headwork was considered a haunted place full of demons' souls and we have constructed a Kali temple, the Goddess who fought against demons----- the local people have a great respect for the Goddess Kali and they do not tamper with the headworks as they fear that their tampering will not please the Goddess and the canal will not function well---."

(Male, 85, local elderly in FMIS)

5.3.3.5 Simplicity of Irrigation Governing Rules and Access to Irrigation Water

Although the result was statistically non-significant, farmers who reported that the rules governing their irrigation systems were simple and easy to understand were more likely to have strong access to water than those who reported their irrigation governing rules to be complex and difficult to understand. Despite the statistically non-significant results, the simplicity of irrigation governing rules has some practical significance. The WUA in the FMIS had made significant investments in educating farmers about their irrigation governing rules, making it easier for farmers to interpret the rules and follow them, while the farmers in the AMIS and JMIS reported that their irrigation governing rules were complex and difficult to understand. This is partly because the WUA did not make any effort to educate farmers. The farmers in the AMIS and the JMIS repeatedly reported that they know that whether their actions are wrong or right. A participant of the focus group discussion from the JMIS argued:

> *"---I doubt if a lot of people here even know the irrigation related rules--- this is the outcome of a sheer lack of public awareness—neither the WUA committee nor irrigators work cooperatively---people have such negative attitudes to prove who is more powerful---".*
>
> (Male, 46, Treasurer of the JMIS)

Similar views were expressed by the irrigation engineer working in the local area, who participated in a key informant interview:

> "*---Constructing irrigation canals is not the only thing, the issue at stake is developing the farmers' capability to manage the systems ----. Farmers are not being educated on this front—this is not a problem of the present—evidence of the past also shows similar stuff--. We have not sought for ways to sustain the irrigation system for a long time. Lack of public awareness has resulted in a gross negligence of huge investment,*

> *billions in fact---systems are not maintained and repaired regularly--. Neither the government nor the locals can sustain their system alone---".*
>
> (Male, 32 irrigation engineer, JMIS)

Funding has remained a critical issue for undertaking an awareness raising campaign. The funding made available from the government agency is hardly sufficient to clean the canal, let alone raise public awareness. A lack of funding for raising social awareness amongst the farmers in terms of using water scientifically was repeatedly mentioned by the participants of the focus group discussions, as a *Dhalepa* from JMIS argued:

> *"---well, the financial support from Department of Irrigation is so little that it is hardly enough to do basic repairs on the canal, how can we campaign for public awareness? Where do we get the money from---?"*
>
> (Male, 43, *Dhalepa*, JMIS)

5.3.3.6 Gender/Caste and Access to Irrigation Water

Although statistically non- significant, the results show that gender and caste have negative influences, whilst location at the head end of the canal appears to have a positive influence on the farmers' level of access to irrigation water. These results have practical significance despite being statistically insignificant and warrant some discussion.

The model predicts a number of factors influencing household access to water in the sample as a whole rather than making any comparisons according to systems. This is partly because of the very small number of cases in some of the categories. Although caste and gender appear to have non-significant effects on the household level of access to water, the analysis presented in Chapters Four and Five demonstrate clear differences according to system, in household level of access to water, particularly for the *dalits* and female-headed households. Results in Chapter Four (Sections 5.3.1 and 5.3.5) on the systemwise comparison clearly demonstrate that a higher proportion of farmers from the *dalits* and female-headed households in the FMIS have strong access to water compared to their counterparts in the JMIS and the AMIS. Despite statistically non-significant overall results, the egalitarian rules (discussed in Chapter Six) implemented in the FMIS to include the *dalits* and women in all aspects of irrigation governance, suggests that they are more likely to have strong access to water compared with their counterparts in the JMIS and the FMIS. Small landholdings, coupled with lower level of access to irrigation water, further marginalise the *dalit* households.

In general, women have a very low level of involvement in the entire decision making process of the WUA. Women's absence from WUA decision-making means that they have little contribution to the development of distributional rules (Agarwal, 1997). Also, in rural Nepal, in general males have higher education levels than females and it might be the case that better educated farmers have better earning opportunities outside farming and farming activities may be less attractive to them, while women who do not have such options are bound to agricultural activities and weak access to water hinders their chances of getting out of poverty. This finding is similar to that of Gunatilake (1998), who observes that education of female family members is negatively related to income from local commons in the tropical biosphere reserves in Sri Lanka. Higher educational levels may also be associated with greater opportunity costs for labour (Yanggen and Reardon, 2001). This is probably the reason that farmers with better daily wage rates were reluctant to participate in the O & M activities and instead preferred to send women and children to carry out these activities, as the daily wage rate is very low. Farmers' low level of access to water indicates the inability of the system to deliver water to farmers in times of need, with their consequent inability to benefit from irrigation infrastructures.

Despite the statistically non-significant results, the farmers' agronomical knowledge also has some practical significance and warrants some discussion, since it has implications for sustained head-tail inequalities in irrigation governance. The issue of farmers using excessive water with the intention of producing better quality grain was already discussed in Chapter Four (Section 4.2.4). The positive influence of farmers' agronomical knowledge and their reported level of access to water have huge implications for policy makers. In Nepal, while investment in irrigation infrastructure is impressive, little effort has been made to educate farmers and raise social awareness. This has serious implications for irrigation governance and ensuring equitable access to water, as farmers are often following unscientific water appropriation practices, based on blind faith. For example, the water replacement for paddy at the head end of the canal, with total disregard for the water shortage at the tail end, could be avoided with some effort to educate the farmers.

5.4 Conclusions

This Chapter has sought to understand the relationship between household social-economic characteristic and the characteristics of the irrigation resources and access to irrigation water. Household access to irrigation has been investigated by building a regression model. The results clearly indicate differences in access to water by households in different categories of heterogeneities. In addition to household characteristics, those of the resource bases themselves appear to be critical in determining household access to irrigation water. The households with landholdings located at the tail end of the canal have been consistently disadvantaged in all three aspects of access. Although this result is not entirely surprising, given the nature of gravity flow irrigation, the farmers' perceptions about irrigation systems under different property rights regimes is quite astonishing. Clearly, as the qualitative data suggest, marginalisation of the tail-enders both in access to water and access to irrigation governance is greater in the government managed system (AMIS) and jointly managed system (JMIS), compared to farmers managed system (FMIS).

Similarly, the level of trust amongst farmers remains a critical factor in household access to irrigation water. Higher levels of trust amongst farmers have meant that long-term co-operative outcomes were more likely than individual short-term benefits in lower levels of trust. The qualitative data clearly demonstrated that the level of trust amongst the farmers in the FMIS was considerably higher than the farmers in the AMIS and the JMIS. Farmers in the FMIS engaged in collective outcomes, while the farmers in the AMIS and the JMIS lacked communal spirit in managing their system and ensuring better access to water.

The better access to water by the larger landholders' relative to the marginal farmers appears to be a function of the way the WUAs have been institutionalised. The composition of the WUAs is generally dominated by large landholders and farmers from higher castes groups. The rules devised by the WUA appear to be biased towards meeting the needs of larger landholders. However, the degree to which larger landholders dominate both water acquisition and irrigation governance greatly depends upon the property rights regime managing the canal system. The dominating roles played by larger landholders are significant in the AMIS and the JMIS, while the FMIS appears to be more inclusive both in terms of representation in the WUA and water appropriation. This is particularly because of the inclusive nature of the WUA in the FMIS and the strict sanctions for defrauders, but in the JMIS and the AMIS, the WUA was not inclusive, nor were sanctions strictly enforced, which had left loopholes for the larger farmers to exploit at the cost of the marginal farmers.

In addition to household characteristics, the specific features of the resource base also have implications for household access to irrigation water. The results of the statistical analysis show that an irrigation system fed by a perennial source provides farmers with better access to water compared with localised and seasonal streams. Also, the results show that non-cement lined canals serve farmers better than those that are not cement lined. Whilst it is not suggested that the canals should not be cement plastered, it does beg the question whether enormous investments in cement lining canals is justified at the present level of access to the canals considered in this study. In Nepal, most of the farmer managed irrigation systems are simple in design and construction, with non-cement banks, while the government managed and jointly managed irrigation systems are mostly sophisticated in their design and construction, with cement lined banks. These results show that for farmers to have better access to water, the management of the irrigation resource is more critical than the physical structure of the canal systems. The farmers also reported that the rules governing FMIS were simple and easy to understand, while the rules governing AMIS and JMIS were overly complicated and difficult to understand and follow. This is partly owing to the involvement of the Department of Irrigation, whose activities are guided by the national framework which is very complex for local farmers to understand and adhere to.

CHAPTER SIX:

A QUALITATIVE STUDY OF WATER DISTRIBUTION INSTITUTIONS IN THREE IRRIGATION SYSTEMS

6.1 Chapter Overview

By now, the extent of difference in household level of access to irrigation water in the three irrigation systems is clear. The thesis has addressed the first high level research question presented in Chapter One (Section 1.8.1) "Under which property rights structures do the farmers have the best access to irrigation water?" However, there is a clear need for further analysis to establish why such differences exist. In order to understand the causes of the differences in household level of access to irrigation water, the role of institutions in facilitating this access is critical. This chapter attempts to address the second high level research question presented in Chapter One (Section 1.8.2): "What roles do institutions play in enabling farmers' to access irrigation water*?*"

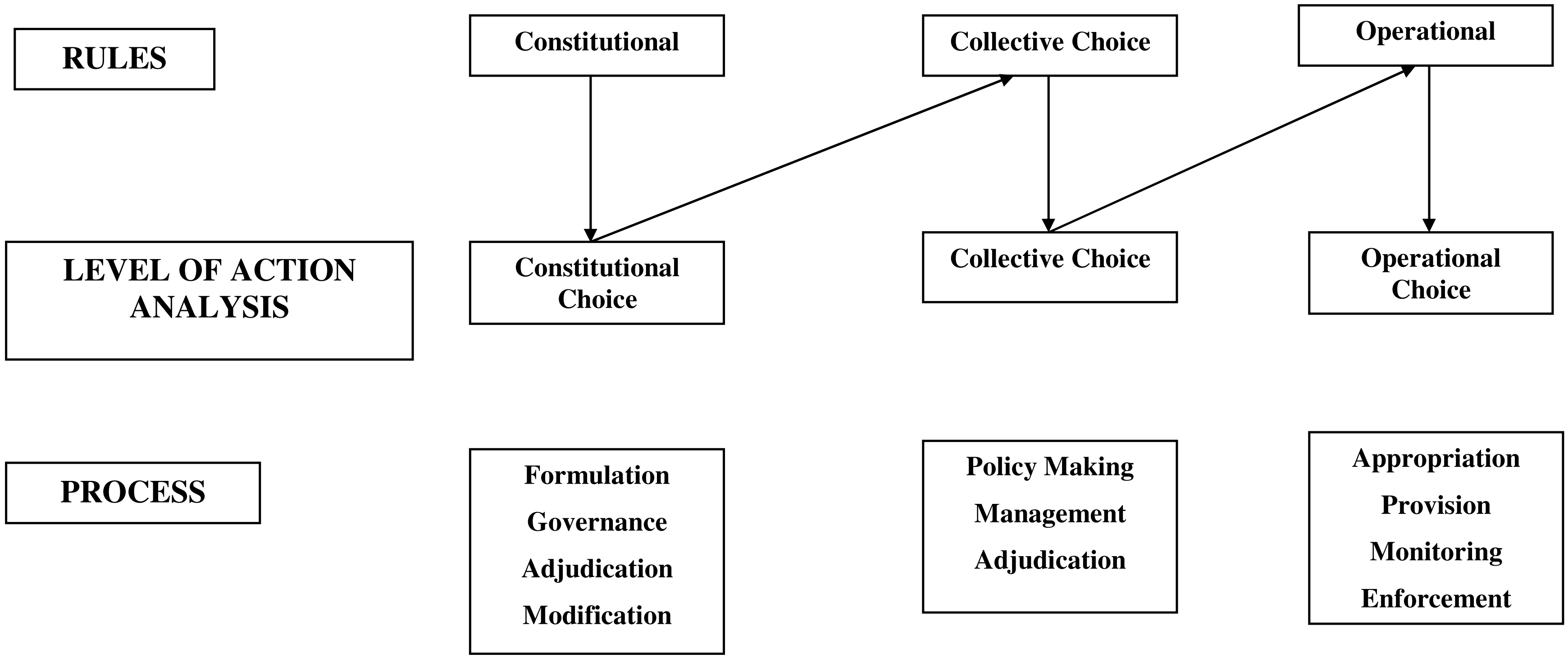
In this chapter, a comparative institutional analysis of the water distributions in the three irrigation systems considered for this research is carried out. The aim of this chapter is twofold. Firstly, it revisits the analytical framework, i.e. the IAD Framework, used in this thesis which was described in Chapter One (Section 1.10) to enhance our understanding of irrigation issues at the institutional level. In doing so, it provides a deeper understanding of the characteristics and operational mechanisms of the rules governing these three irrigation systems. Furthermore, it is hoped that a detailed description of the institutional arrangements, which are designed and implemented in the distribution of irrigation water in the three irrigation systems, will shed light on the discrepancies in household level of access to water from the irrigation systems. Secondly, based on the detailed analysis of the rules governing the irrigation system in general and water distribution in particular, the chapter aims to identify some of the institutions which enable farmers to access water from the canal systems as stated in research question (2a): "What are the enabling institutions for farmers to access water from the irrigation canals?" It is hoped that the identification of the enabling institutions will shed light on the on the research question (2b): "What are the lessons that irrigation systems governed by different property rights structures can learn from each other to maximise their impact on farmers' abilities to access water?"

6.2 Institutional Analysis of Irrigation Governance Using IAD Framework

As mentioned in Chapter One (Section 1.10), the IAD Framework is used as the analytical framework for institutional analysis of irrigation systems considered for this research. Ostrom (1990) argues that the rules governing CPRs should be studied at three levels, namely operational rules, collective choice rules and constitutional choice rules, because cumulatively they affect actions taken and outcomes achieved in any socio-economic interactions. The same order is followed in describing the rules in use in the three irrigation systems considered for this research. The following section describes the interactions amongst farmers in carrying out different irrigation management related activities at the three levels and how activities at one level affect the activities at other levels. The following section describes basic institutional characteristics of water distribution in the three irrigation systems considered for this research.

When viewed through the IAD framework, irrigation management encompasses a collection of actors who operate in the "*action arena*" (Ostrom, 1990 p. 52), guided by formal rules which are codified in laws, policies and regulations and by informal rules which are based on social norms of reciprocity and community based cultural exchange (Imperial, 1999). The IAD framework "*emphasizes the effect of both formal and informal institutions and their effect on outcomes amongst actors in public organisation and collective groups*" (Heikkila and Issett, 2006 p.3). Furthermore, the IAD framework provides a unique opportunity for analysing decision making at multiple theoretical levels: Operational choice, collective choice and constitutional choice. The multiple levels of analysis help to diagnose different sets of rules and processes affecting the outcomes of irrigation interventions, as rules at one level interact with rules and actions at other levels. The usefulness of the IAD framework for multiple levels of policy analysis is presented in Figure 6.1. Kiser and Ostrom (1982) argue that the above mentioned "*three level institutions are nested, with rules at the higher level impacting the production and governances of rules at the lower levels*" (cited in Hardy and Koontz, 2009 p.396).

Figure 6.1 Multiple Actions and Outcomes in IAD Framework



Source: Ostrom (1990 p.53)

6.2.1 Operation Level Rules

The operational rules delineate the conditions that farmers are required to meet in order to make legitimate use of the irrigation facilities. Additionally, the operational rules directly affect day to day decisions in terms of delineating appropriators, the time and place of resource appropriation, information sharing or withholding, and sanctions for any rule infringements (Ostrom, 1990 p.52).

The operational activities in irrigation management include management actions such as issuing membership, communication, co-ordinating and performing O & M activities, conducting education and outreach campaigns, awareness raising activities, collecting water levies, maintaining financial audits and so on (Small and Svendsen, 1990; Nijman, 1992). The following section briefly discusses the details for the operational rules designed and implemented in the three irrigation systems considered for this research.

6.2.1.1 Boundary Rules

The boundary rules dictate the membership of the irrigation systems, and the members are recognised as the legitimate users of the irrigation infrastructure, including the water. These rules are essentially access rights, whereby all defined users have a right to enter the system as per the specified rules and withdraw their entitlement of water.

The constitutions of the both the JMIS and the FMIS explicitly state that farmers with landholdings and crop-sharers within the canal command area are eligible for membership. However, in the AMIS, the clarity of membership has been questioned on many occasions. The constitution itself does not explicitly explain the scope of the irrigation enterprise in terms of its members. The constitution reads *"all the beneficiary individuals residing in the canal command area shall be granted membership"* (AMIS Constitution, 2008). Similar view points were expressed by the president of the WUA of AMIS:

> *"--- All the individuals using water from the canal, whether for irrigation, washing or cleaning are members of the canal system. The membership should not be confined to only individuals using the canal for irrigation purposes---".*
>
> (Male, 43, WUA President, AMIS)

Whilst the President's view was to treat every individual residing within the command area equally, irrespective of water use for agricultural purposes, water use by other farmers and contractors for non-agricultural activities, such as the construction of houses and the local fishery, has put added pressure on the available resources. It is important to point out that use of the canal water by individuals who do not hold landholdings within the command area, are not members of the WUA and are not obliged to contribute towards O & M activities, was found to be problematic by many local farmers, particularly those with landholdings at the tail end of the canal. A considerable number of participants of the focus group discussion echoed these sentiments:

> *"---Contractors build houses and divert water for preparing cement, plastering walls and preparing mud, whilst we struggle to irrigate our crop--- they make money using water from the canal whilst we struggle for our livelihoods---they (contractors) neither pay money to the WUA*

nor contribute towards the O & M activities---the canal is for irrigation not for house construction, isn't it?"

(Male, 54, AMIS tail end)

In addition to the problem of a clearly defined boundary for WUA membership in terms of using canal water, the flexibility of transferring the water share amongst the irrigators was repeatedly mentioned by the farmers. The farmers in the FMIS who hold water rights can transfer their share of the water to other farmers without explicit permission from the PIMC. The flexibility of transferring the water share amongst the households was repeatedly mentioned by the farmers in the FMIS:

"--- when I struggled for water last year, I could borrow water from the other side through my neighbour's plot--- yes it was fairly easy----. I will also lend water to my neighbour if he struggles in the future--, you have to reciprocate positively—door swings both the way---"

(Female, 34, FMIS middle section)

However, the farmers in the JMIS reported that they have to consult their WUA, who must authorise any transfer of water share as a farmer from JMIS argued:

"---I have been struggling to get water since past few seasons---my land is located in a slightly elevated area and initially they had told me that the DoI would install a siphon but they didn't.—there is a possibility of channelling water to my plots but it has to be through my neighbour's

field--- he said he might help me but only if the WUA gets involved------ I think he is expecting some financial compensation from the WUA for the loss of his land—who would want to destroy their property (land) at no compensation anyway---"

(Male, 64, Middle Section, JMIS)

Similar views were echoed by the farmers in the AMIS, as a key informant interviewee said:

"---Well I have been complaining to the WUA for a sakha (tertiary canal) for years---- I think it's the fourth WUA committee which still has not considered my situation seriously--we are small farmers--- we are not powerful--- we don't have connections--, they say an engineer has to come from the DoI but they came hundreds of times--, my heart breaks when I see green lush crops in other's field while my land remains barren---!"

(Female, 42, AMIS)

Similarly, in the FMIS area, the WUA memberships are only distributed to the farmers after the payment of membership fees. It is absolutely essential that individual households have membership in order to have their concerns heard and interventions made by the WUA over any issues concerning irrigation, including conflict resolution:

"---last year, Indre (name changed) got into bitter dispute with his farmers from Kumal Gaun, regarding water from the canal. I think there was a brawl too – umm--obviously whilst we sympathised with Indre we

couldn't help him as he didn't have the receipt for payment of the membership fee. I think police from the district headquarters got involved in the case –It's a pity that the WUA couldn't get involved even though it was an irrigation related issue but without membership we can't intervene---"

(Female, 49, Treasurer, FMIS)

However, both in the AMIS and the JMIS areas, payment of membership fee was not a pre-condition for acquiring membership. This probably explains the fact that the WUA in the FMIS have been able to raise 100 percent of the membership fees, whereas these have been overdue in the AMIS and JMIS areas. The issue of non-payment of the WUA membership fee and the annual water levy was mentioned by farmers participating in the focus group discussions:

"---The issue of fee collection is something that the DoI has been nagging us about for years--- we have to pressurise the farmers to pay the water fee on time--. Records from my file show less than 60 percent of the farmers in my block have paid their water fee--whilst we accept we have not been successful in ensuring water to all the farmers throughout the year----Fee collection is very poor and patchy---"

(Male, 50, Block 14 President, JMIS)

6.2.1.2 Input Rules

Input rules stipulate the obligatory aspects expected of the irrigators in return for withdrawing water from the canal system. Tang (1989) articulated four major types of input that irrigators are expected to contribute, which include regular water fees, labour contribution for regular operation and maintenance, emergency repairs and contribution towards capital investment. It will be clear from discussions later in the chapter that the input rules designed and practiced in the FMIS were consistent with Tang's findings, whilst both the AMIS and the JMIS did not have consistent arrangements for input rules. Furthermore, the allocation of responsibilities between the DoI and WUA were not clear in the AMIS and the JMIS. Similarly, the allocation of labour contributions for O & M activities was not on the basis of proportionality in the latter two systems. The contributions were made both in cash and kind terms. In the past, the allocation of water shares was based on the contribution made during construction; however, a recent amendment to the constitution has changed the rules for water allocation and currently water distribution takes place in proportion to the household landholdings.

In the area, two types of water charges are levied. Firstly, a general membership fee (*sadasya shulka*) at a flat rate of NRs 5, NRs. 10 and NRs. 50 is levied from each member, irrespective of landholdings and their locations in the FMIS, the JMIS and the AMIS areas respectively. In the FMIS all the beneficiary farmers were expected to pay their water service fee by mid-April. Failure to do this would lead to sanctions with an additional 5 percent of the total up until mid-May and 10 percent until mid June. If it is still unpaid, then sanctions are imposed according to the provision of the WUA constitution. In extreme cases, the individual might be banned from using water from the canal if the fee is not paid. These measures were not taken by both the RIMC and the BIMC.

Secondly, a water service fee (*sewa shulka*) at a rate of NRs 3, NRs. 10 and NRs. 10 per *Ropani* of cultivated land was levied from the farmers in the FMIS, the AMIS and the JMIS, respectively. However, despite this constitutional provision, a variable user fee was levied and in the JMIS areas farmers reported that in some of the blocks farmers paid NRs 20-22 per *Ropani* as annual water service fees. It should be mentioned that there is no data on the exact number of farmers who reported variable water fee. Nonetheless the participants of the key informant interviews repeatedly mentioned the prevalence of an inconsistency in the collection of water fees in the JMIS:

> *"---The water fee is not consistently applied. I was asked to pay NRs. 220 for 10 Ropani land which is NRs. 22 per Ropani of land, while my cousin paid NRs. for 10 Ropani land. The treasurer of the block committee told me that we have to pay for our kharbari (uncultivated land) too and I have to pay a water fee for a plot of land that I do not use irrigation water for---"*
>
> (Male, 34, JMIS)

Furthermore, the WUA managing the irrigation systems under the AMIS and the JMIS were required to deposit a proportion of their income obtained from the revenues with the DoI. The BIMC was legally obliged to contribute 30 percent of its revenue to the treasury of the DoI, while keeping the remaining 70 percent by the PIMC. Similarly, in the JMIS, the RIMC contributed 20 percent of its gross revenue to the DoI whilst keeping 80 percent for itself. Provision was made that 50 percent of the generated revenue (after deduction for a contribution to the DoI) was allowed to be kept with the Block Committees, while the remaining 50 percent was transferred to the main WUA committee of the RIMC. However, since the PIMC was autonomous, it was not legally required to make any financial contribution to the DoI, as a key informant interviewee said:

> *"--This is our canal and we collect the water fee and use it for the betterment of the canal. The WUA has its own savings bank account and we have been keeping some money in that account-- the interest rate is quite good too, obviously all the money including the interest from the savings is farmers' money. The most important thing is that we do not have to give any money to the DoI. We collect the fee; we manage it as to our needs---"*
>
> (Female, 49, Treasurer, FMIS)

In the FMIS, the temporary nature of the headwork and the canal traversing a landslide prone area, has meant that regular O & M activities are required. Usually the PIMC carries out a walk along the canal to identify any urgent O & M activities, and all farmers are called upon to carry out these activities. Whilst the O & M activities in the AMIS were all carried out by the DoI, the major O & M activities in the JMIS canal were done the by the DoI and minor work was carried out by the WUA. Serious concerns were raised by the farmers participating in the focus group discussions and the key informant interviewees, about the lack of co-ordination between the DoI and the WUA:

> *"---Our frustration is about not getting enough help from the DoI whenever we need help from them. Firstly, the DoI takes an awfully long time to respond. We need help at the beginning of the monsoon in May for major O & M activities but the DoI's help doesn't arrive until late*

July. By this time it's too late. What's the point of medicine after patient's death? Secondly, the overseers come, they just talk with the big people here, they do not talk with us, we know our problems regarding the canal, just walking along the canal does not solve the local problems associated with the canal---"

(Male, 34, *Dhalepa* from JMIS)

6.2.1.3 Allocation Rules

While the boundary rules provide conditions that individuals are required to meet in order to join the resource system, the allocation rules stipulate actual mechanisms for members to claim their rights and withdraw water from the appropriate resource, i.e. water distribution. In Nepal, a wide range of mechanisms are practiced for water allocation, including fixed proportion, fixed time slots and fixed orders. The allocation procedures depend on various factors including, size of landholdings, spatial location, crop-water requirement, individuals' water share and government discretion, amongst others. The detail procedures for water distribution both at the branch canal and at plots levels are described in Section 6.4.

6.2.1.4 Penalty Rules

In the absence of penalty rules, the individuals have little or no incentive to follow allocation or input rules, which increases incidence of free riding. The penalty rules restrict irrigators from defrauding, which helps to ensure rule compliance. Similar to the allocations and input rules, the penalty rules might take several different forms, including fines in cash, incarceration, restricted use and temporary loss of all appropriation rights. However, incarceration is least likely to be practiced in many irrigation systems including the irrigation systems considered in this study, partly because of the fact that it requires the involvement of lawsuits and can often be very costly. A single penalty rule is highly unlikely to ensure compliance and a combination of rules is commonly practiced in Nepal, which include fines in cash, restricted use of water and withdrawal of membership, as discussed in Chapter Four (Section 4.2.8). The penalty rules help to ensure rule compliance and maintain cooperation, to achieve collective outcomes while managing the irrigation system.

In the FMIS area, a series of graduated sanctions is imposed, depending on the nature of infractions and the damage they cause. For the first infraction, the defrauders are fined NRs. 100, while fines imposed on second and third time defrauders are NRs. 250 and NRs. 500, respectively. In the cases of severe and repeated fraud, the PIMC can temporarily suspend the individual's water rights. The strict nature of sanctions imposed on the defrauders was vividly described by the farmers in the FMIS, as the President of the PIMC said:

> *"---We have evidence of fining some defrauders NRs. 5000. A farmer from the head-end caused severe damage to the irrigation infrastructure as he attempted to transport wooden logs through the canal water. It was a serious breach of the rules and he made a mockery of the rules. I think the sanction the WUA imposed on him rightly reflects the seriousness of the offence---"*
>
> (Male, 45, President of FMIS)

It is often the case that if a farmer is found to be involved in water theft, his/her next access slots will be suspended temporarily. However, despite being written in the constitutions of the JMIS and the AMIS, such graduated sanctions were seldom implemented. These issues were raised by the farmers who participated in the focus group discussion:

> *"---There is nothing in the canal--, the gates are tampered with and broken, the canal linings are damaged, they use all sort of local tools to steal water kuto/ kadalo (spade), ghan (hammer) gaichi (pick axe) and even gals (crowbar) to bore holes in the canal lining to steal water. The most worrying thing is that nobody gets sanctioned. They just get away with it---"*
>
> (Female, 24, AMIS)

Similar sentiments were echoed by the farmers in the JMIS, as participants of a key informant interview said:

> *"---Only god knows the rules in Nepal, who cares about the rules and regulations in this area? ---People, especially the powerful individuals, do what they prefer, the rules are not for them, rules are for us, the poor and powerless. The powerful farmers do not pay a water fee, add more tertiary canals, steal water, you name them this irrigation system resembles a travesty of Justice ---"*
>
> (Male, 34, dalit from JMIS)

It should be noted that the operational level rules are neither self –generating nor self enforcing (Ostrom, 1990) and their effective implementation depends on the existence of the rule enforcers, the number of users and the degree of co-ordination between them. The importance of co-ordination and communication between the WUA and the farmers and between the farmers themselves, were highlighted by the participants of the focus group discussions:

> *"---At the end of the day rules are effective as long as they are implemented effectively. Rules themselves are meaningless unless they are implemented adequately and monitored--- and this is what is lacking in this irrigation system---"*
>
> (Male 56, JMIS)

It should be pointed out that while it may be relatively easy to enforce operational level rules in systems with fewer members, it is quite difficult to enforce them with large a large number of members, owing to higher transaction costs for monitoring and sanctioning (Tang, 1989).

6.2.2 Collective Choice Rules

The collective choice rules are applied by the users, the officials and external authorities in designing and implementing operational rules which govern their natural resources. Collective choice rules are better designed for tackling '*collective choice problems*'. The collective choice rules guide the operational choice of how a resource is to be used or how collective work should be carried out (Ostrom, 1990). In irrigation management, collective choice activities include policy making, management, and adjudication of policy decisions (Hardy and Koontz, 2009). The collective choice activities help to improve the flow of information between the stakeholders, which in turn can result in more co-ordinated management efforts (Imperial, 2005). The decisions on irrigation management are affected by the collective choice rules, which establish who has the right to participate and the modalities of doing so. Given the complex nature of irrigation management, all stakeholders in irrigation governance, including farmers, WUA and the DoI, often spend considerable time and effort on collective choice activities, which include creating comprehensive irrigation management action plans, formation of technical and financial committees, assigning different individuals to different tasks, drafting action plans for mitigating contingencies and designing and implementing other operational rules. However, the 'non-self-generating' and 'non- self-enforcing' nature of the operational rules has meant that in the absence of external coercive agents, users are more likely to refrain from enforcing them, in order to maximise their own utilities, causing *free-rider* problems (Ostrom, 1990).

In order to overcome free rider problems, the PIMC has successfully designed collective choice rules aiming to formulate, modify and enforce operational rules and provide users with incentives to maintain collective endeavours and exercise mutual self-restraint while using the resources. The collective choice rules are institutions encompassing collectively chosen rules, procedures and principles that enable users to respond to changes in operation rules, resolve conflicts and sustain productive relationships amongst users, through monitoring and sanctions against rule violations. This helps to overcome three basic problems of:

supply; credible commitment; and mutual monitoring, which are often nested hierarchically (Ostrom, 1990).

In order to deal with the *problem of institutional supply*, the PIMC has designed workable sets of rules, procedures and sanctions regarding irrigation management, water harvesting and controlling fraudulent activities. Constitutional provision empowers the PMIC and the WUA members, providing them with the necessary mandate to amend operational rules, fix water charges (both water tax and membership fees) and to utilise surplus funds for irrigation related or other community development work within the canal command area.

A large body of literature documents that religion has an important influence on the socio-economic behaviour of individuals including family, marriage, women's role within and outside the family, education, income, natural resource conservation and so on (Rappaport, 1979; Taylor, 2005; Durkheim, 1995; Ramachandran and Blakeslee, 1998; Lehrer, 2004; Harris, 1971; Posey and Balee, 1989; Sharma, 1999). A symbiotic relationship exists between nature and culture which is based on religious beliefs. Indeed, for many people around the world, religious beliefs are central to their culture and provide natural codes for human-nature interactions in terms of how individuals should behave when dealing with natural resources (Ranger, 1999). Similar to many parts of Africa (Sibanda, 2000), in rural parts of Nepal the presence of temples encourage individuals to have beliefs in god and affirm that religion is at least "fairly important" in their lives (Myers, 2000 p.285). As such, temples are considered holy shrines in Hindu mythology and the general tidiness in and around the temple is considered to be very important for receiving blessings from the god. It is believed that general tidiness in and around the holy shrines, such as temples, and honest behaviours help to enhance people's spirituality by maintaining purity in the individual's mind and body (Rappaport, 1999). In order to create purity in mind and body and to gain divinity, individuals visit temples to worship and pay their homage to the gods. Such activities are accompanied by religious beliefs which affect basic patterns of individual and group behaviours (Stevens, 2010). It is also a common practice to visit temples for marriages as paying homage to such holy shrines provides blessings for a happy and prosperous conjugal life (Waite and Lehrer, 2009). This is because religious activities associated with temples and holy shrines are considered to be helpful in fostering positive attitudes amongst individuals and reinforcing the cultural values of wider society and to foster a sense of community (Bocock, 1974; Verdy and Grosch, 1994). The WUA in the FMIS have used the local belief system associated with religion and temples for the management of the irrigation system.

In fact, a branch committee of FMIS also intends to build a temple in close proximity to the head end to avoid unnecessary intrusion, as temples are considered sacred in Nepal. In Nepal there is a religious belief that the area in and around the temple should be kept clean and any acts of dishonesty should not be carried out in and around that area. The construction of a temple is to reinforce this belief, and deter farmers from tampering with the outlets and obtaining water fraudulently.

In order to overcome the *problem of credible commitment*, rules are put in place to raise awareness amongst the users that long term net benefits of collective engagement are substantially higher than the net benefits gained by short term dominant individual strategies (Ostrom, 1990). Users are urged to demonstrate long term commitment to following rules, and maintaining self restraint. Similarly, in the FMIS, the arduous task of *mutual monitoring* is achieved through the employment of watchman, called *Dhalepas*. Two *Dhalepas* are employed by the PIMC on a salary basis, with the first one assigned responsibilities for looking after the upper half of the canal (head end) and the second one for the lower half of the canal. Along with observation, the watchmen also contribute towards the system operation and maintenance. While the *Dhalepas* are instrumental in monitoring users' activities, the users themselves are very watchful and have the right to file petitions against any suspected fraudulent activities with the PIMC. There were three *Dhalepas* in the JMIS areas, each responsible for head, middle and tail sections of the command area. Two of the *Dhalepas* were remunerated by the DoI; the other's salary was paid by the RIMC. Similarly, the AMIS had three *Dhalepas* who were employed by the DoI. Their salaries were paid by the DoI instead of the BIMC.

The successful design and implementation of the above mentioned collective choice rules has helped to achieve positive collective outcomes through mutually imposed, self-financed and binding contracts, limiting users' resource consumption activities.

6.2.3 Constitutional Choice Rules

The constitutional choice rules affect activities such as formulation, governance and adjudication, and modification of constitution level activities in irrigation management, by legitimising them. These rules involve establishing who should participate in collective choice activities and in what capacity (Ostrom, 1990 p.53).

In irrigation governance, some of the constitutional level activities are the formation of the WUAs and the transfer of irrigation management to local users. The process of forming WUAs, including elections, composition, rights, responsibilities and tenure were carried out at constitutional level. The executive committees of the WUAs are mandated in running their irrigation systems. Similarly, the transfer of irrigation systems by the DoI to the local users involves significant changes at the constitutional level, including formation of WUAs, definition of their scope, levy collection, financial and technical contributions to O & M activities, among others. Once formed, the WUAs become functional and develop their own collective choice rules for making operational rules. It is important to note that these three levels of rules may not always be mutually exclusive, though they may exhibit elements of specific activity at different levels. Some farmers are involved in different capacities in the management of the irrigation system and can assume other roles at the same time. For example, a farmer can be a member of the WUA committee, an irrigator and a liaison officer between the WUA and the DoI. Therefore, the above mentioned three levels of rules and activities guided by them affect the action taken, and outcomes obtained in different settings can help illuminate differences in institutional arrangements and outcomes achieved across different cases (Kiser and Ostrom, 1982).

6.3 Working Rules and Operating Principles of Water Distributions

Taking a qualitative and institutional approach, this section of the thesis describes the mechanisms developed and followed for distributing irrigation water by the local farmers in the three irrigation systems considered for this research. Firstly, this section highlights the context within which water distribution takes place in these three irrigation systems. Secondly, it describes the water distribution rules as practiced by the farmers in the three systems. In this section of the thesis, the water distribution rules are presented in as much detail as possible. Presentation will be very simple and descriptive.

6.3.1 Water Distributions: The Context

In the case study sites selected for this research, as elsewhere in Nepal, the demand for water is influenced by localised conditions which are both natural and man-made. The factors which influence the need for water include: the nature of distribution arrangements; the nature of the source water; the number of branch canals (outlets); the type of crops and their water requirements; and the topographical features of the command area. As mentioned in Chapter Three (Table 3.1) the farmers in the three irrigation systems have more or less similar cropping patterns. The farmers grow highly water intensive crops such as monsoon paddy (*barkhe dhan*) and spring paddy (*chaite dhan*) during the Monsoon and spring seasons respectively. However, during the winter, the farmers grow less water intensive crops such as wheat, mustard, potato, sugarcane, and other seasonal vegetables. Although these crops do not require intensive irrigation, they still need to be irrigated fairly regularly, which means the demand for water remains high even during the winter.

Table 6.1 Crops and their growing periods in research sites with irrigation requirements

SN	Crops	Planting Month	Weekly Irrigation Frequency	Harvesting Month
1	Monsoon paddy	June-July	3 times	October-November
2	Spring paddy	February-March	3 times	June-July
3	Wheat	November-December	3 times per cropping season	March-April
4	Vegetables	All year around	5 times	All year around
5	Potato	November-December	3 times per cropping season	March-April
6	Mustard	September-October	Not practiced	February-March
7	Millet	September	Not practiced	October-November
8	Maize(summer)	April-May	Not practiced	June-July
9	Maize(winter)	October-November	Not practiced	April-May

Source: Author's fieldwork (2007)

The FMIS has a temporary nature of water supply, whilst the JMIS derives water from a perennial source. The AMIS is fed by a lake from where the water diversion has been restricted, particularly during the Winter and Spring, owing to its sensitive ecological importance. Accordingly, in the FMIS and the JMIS, the spring season is characterised by a high degree of water stressed conditions, both in the source and the irrigation canal. However, the JMIS has an abundant water supply from the source throughout all three cropping seasons.

Although the JMIS is fed by a perennial source of water, the sheer number of outlets in the canal and the rugged topographical area through which the canal runs has made water distribution a complex task for the WUA. The existence of several gorges, a difficult terrain and a larger number of outlets increase conveyance loss through evapo-transpiration and seepage. Furthermore, water theft has also been reported to be one of the most serious problems in the JMIS area, as farmers repeatedly reported:

> *"---Well they say we have rotational distribution----but where is the rotational distribution if people use water as they wish? --- Who is there to monitor and impose sanctions against these sorts of fraudulent activities? This system has been plagued by a series of systematic management failures--. If you ask me, I would say water is not the problem in this canal, there is plenty of water but management is the problem. I am afraid I have more questions than answers for you regarding water distribution in this canal system---"*
>
> (Male, 39, *Dhalepa*, Middle end, JMIS)

The problems associated with water distribution in the JMIS are also echoed by the members of the WUA:

> *"--- What can you do if people do not feel ashamed of their improper and illegal activities? ---no sense of collective and communal spirit – mostly people on the upper section of the canal divert water from the outlets*

when they should have been closed---- it is a matter of utter shame that despite almost the entire Chepe river is diverted into the canal system at the head end but we have not been able to deliver adequate water at the tail end---."

(Male, 53, Treasurer of RIMC)

Similarly, the water source for the AMIS is a lake in which water should not be drawn to below a critical level, owing to the sensitive ecological landscape in which the canal is situated. Both the DoI and the WUA has been advised that the canal system should maintain a certain level of water in the lake when drawing water for irrigation purposes. This is done with due consideration for the important physical and ecological role played by the lake. The lake is also a tourist attraction with recreational boating, which means a certain level of water has to be constantly maintained. It should be pointed out that the tourism sector is also an important business that contributes significantly towards the local economy. Many farmers also own lodges and pursue boating as a secondary occupation at the head end of the canal.

Similarly, in the AMIS, a local fishery was in operation at the head-end section of the canal. The fishery was in direct conflict with the WUA, as it drew water from the irrigation canal. The conflict was particularly conspicuous during winter and spring , as water shortage in the canal is glaring and the demand for water is high both for fishery and irrigation activities. While the fishery has helped to achieve multiple use of the water and has increased the livelihood security of some farmers, it also has limited water availability in the canal, as the water is diverted from the canal to the fishery.

Similarly, the command area of the AMIS is witnessing an unprecedented level of urbanisation in recent years. The process of urbanisation has brought about many changes in terms of land use in the Lakhanath municipality areas. A considerable number of farmers, particularly those with landholdings on the edge of the municipality and with access to highways, carried out land-plotting for housing development. The contractors involved in the housing development also drew water from the irrigation canal, which further reduced the volume of water available for irrigation. The management of the fisheries, the house contractors and local farmers were in constant conflict as they all competed for water, as a farmer who participated in the focus group discussion argued:

> "---*There is a fishery right at the canal mouth just drawing water from the canal. They are making loads of money at the expense of us (farmers) who have to pay the costs of water shortage in the canal ---- they even do not pay a water fee and we have to— Do you think that this is fair? They sell their fish to the tourists at a high price or take them to Pokhara, what do we get? No water for irrigation! Brilliant!! I appreciate water is a natural and notational resource but this fishery has literally privatised it-- It is bad for the local farmers. This is unfortunate for us---!"*
>
> (Male, 47, Tail end AMIS)

At the same time, farmers also tended to use water for preparing mud-loaf for brick production. Some farmers, particularly in the AMIS, showed their concern about the use of irrigation water for other than agricultural purposes, as it is in direct conflict with agricultural activities. In fact, the Irrigation Regulation 1999 clearly defines irrigation as "*the means of the act of supplying water through structures on the field for agricultural use*" (DoI, 1999). By definition, the Irrigation Regulation 1999 clearly prohibits other uses of irrigation water in the system, except for agricultural purposes, and clearly this was not the case in the AMIS.

6.3.2 Water Distribution in the FMIS before Monsoon Season

The initial land preparation for sowing paddy grain to grow seedlings marks the beginning of agricultural activities in Nepal. Right from the onset of land tillage the farmers need water in the fields and the role of irrigation is immediately felt. The growing of saplings takes place during the month of Baisakh (April-May) before the arrival of the Monsoon rain, and water demands are to be met through the application of irrigation water in the fields.

During this time, each branch committee of the FMIS calls upon all the farmers in its canal sub-section to submit an application concerning their preferred land tillage date and sowing grain for growing saplings. The application is sought by the WUA branch committees during the month of April every year. Upon receiving applications from the farmers, the branch committee convenes a meeting in early May to deliberate on the applications. The branch committee deliberates the water schedules, drawing up the first draft for paddy transplantation, with due consideration for water availability at the source, in the main and branch canals, and also the predicted arrival of the Monsoon rainfall.

In the mean time, the main WUA Committee (*mul-samiti*) calls upon all farmers to participate in O & M activities for the smooth delivery of water throughout the canal system. During paddy transplanting periods, the farmers get their share of water just for the plots where transplantation is planned, irrespective of their total irrigable land. Then based on the schedules designed and implemented by the branch committees, individual farmers make arrangements for the transplantation, including labour, bullocks, plough, and seedlings.

The first draft of the irrigation schedule is then circulated among the local farmers. The branch committee also seeks farmers' comments on the first draft by the end of May each year. If the allocated timings suit the farmers and no concern is raised, then the branch committee finalises and implements the drafted irrigation schedules for sapling preparation and paddy transplantation. However, if the allocated time slots are not suitable for the farmers, those concerned negotiate with their neighbours.

6.3.3 Water Distribution During the Monsoon Season

The Monsoon paddy growing season starts from mid- Ashad (end of June) and ends in the month of Mangsir (November-December). In the FMIS, all the branch canals draw water from the main canal simultaneously, without any rotational distribution at the branch levels. The available water in the canal is divided amongst the different branches with designated proportioning weirs called Gahaks. The Gahaks help to ration the available water amongst different branch canals, and a detailed description is presented later in chapter Six (Section 6.1). The proportioning weirs are constructed at the bifurcation of the branch canal from the main canal. The size of the proportioning weirs depends on the command area for which the particular branch delivers water for irrigation. In general, for every hectare of command area, one inch of cross section incision is made on the wooden structure to let water flow into the branch canal from the main canal. For example, a branch canal designed to deliver water for a command area of 32 Ha of land will have 32 inches of cross sectional incision in the Gahaks. The water distribution mechanism adopted in the FMIS during the Monsoon season is presented in Table 6.2.

Table 6.2 Irrigation Cycle in the FMIS during Monsoon Season

Branch Name	Turn	Command Area in Ha	hours one cycle	Weekly Calendar
Chaubiskuriya	1	81	40	7am (Sunday)-11pm (Monday)
Jogichaur	2	79	39	11pm (Monday)-2pm (Wednesday)
Dee Area	3	37	18	2 pm (Wednesday)-6am (Thursday
Kumal Gaun	4	62	30	6am (Thursday)-12pm (Friday)
Saatkuriya	5	82	41	12pm (Friday)-7am (Sunday)

Similarly, the WUA of the JMIS holds its meeting before the start of the Monsoon season to discuss water distribution issues and prepare a schedule for the season. The meeting is also attended by the representatives of each block. The meeting generally takes place during the month of Jestha (May-June) every year before the start of the Monsoon paddy cultivation. The WUA records show that a schedule was agreed upon for the Monsoon season in 2007, during the time of my field work, which is given in Table 6.3.

Whilst the FMIS practise a continuous flow of water distribution during the Monsoon seasons, the JMIS adopt a rotational distribution during the same season. The entire command area of the JMIS has been divided into sixteen blocks. It should be made clear that the demarcation of the blocks does not resemble any political, geographical or administrative division adopted by the Government of Nepal. Instead, the blocks are demarcated as the administrative units only for the purpose of irrigation governance. Each block has its own block committee, comprising 11 members. Blocks are divided on the basis of the number of households and size of the command area in the section of the canal command area.

In order to deliver water to the blocks, water gates (outlets) are installed along the main canal to let the water flow off the canal into the branch canals.

Table 6.3 Branch Level Water Schedules during Monsoon Season in the JMIS

Branch Name (Block)	Village Name	Turn	Command Area in Ha	Hours in one cycle	Weekly Calendar
Block 1	Borankhola	1	25	21	6am (Sunday)-3am (Monday)
Block 9	Syaauli Bazaar	1	46	21	6am (Sunday)-3am (Monday)
Block 2	Phant	2	54	21	3am(Monday)-12am (Tuesday)
Block 10	Bisuralgaun	2	65	21	3am (Monday)-12am (Tuesday)
Block 3	Bhalayakharka	3	47	21	12am (Tuesday)-9pm (Tuesday)
Block 11	Pakhetar	3	32	21	12am (Tuesday)-9pm (Tuesday)
Block 4	Timure	4	56	21	9pm (Tuesday)-6pm (Wednesday)
Block 12	Saatghare	4	53	21	9pm (Tuesday)- 6pm (Wednesday)
Block 5	Saatbise	5	64	21	6pm (Wednesday)- 3pm (Thursday)
Block 13	Hatiya-Pauwa	5	80	21	6pm (Wednesday)- 3pm (Thursday)
Block 6	Alkatar	6	67	21	3pm (Thursday)-12pm (Friday)
Block 14	Panchbhai Chautara	6	55	21	3pm (Thursday)-12pm (Friday)
Block 7	Tinpiple	7	73	21	12pm (Friday)-9am (Saturday)
Block 15	Parajuligaun	7	50	21	12pm (Friday)-9am (Saturday)
Block 8	Kumalgaun	8	58	21	9am (Saturday)-6am (Sunday)
Block 16	Garambesi	8	75	21	9am (Saturday)-6am (Sunday)

In the JMIS, a water distribution schedule is implemented when all the farming households complete paddy transplantation. Accordingly, the rotational water distribution schedule begins from mid-Asadh (end of June). The distribution schedule comprises eight time slots for a total of sixteen blocks. According to the distribution arrangement, each time slot has duration of twenty one hours. In any one time slot, two blocks draw water from the main canal while the remaining fourteen outlets remain closed. In general, the blocks from the head end and middle section are paired up, while blocks from the middle section are paired up with blocks from the tail end of the canal command area. The first cycle of the schedule begins from 6 a.m. on Sunday morning, in which block 1 (located in the head section) and block 9 (located in the middle section) irrigate their paddy fields for a period of twenty one hours until 3am on the following day, when the *Dhalepa* closes the rotating heads of blocks 1 and 9 and opens the rotating heads of blocks 2 and 10, closing all other outlets for the next twenty one hours. These two blocks (blocks 2 and 10) divert water from the main canal for a period twenty one hours starting from 3 am on Monday to mid-night on Tuesday, when the *Dhalepas* close the rotating heads of these two branch canals, opening outlets 3 and 11. This is the weekly cycle for distributing water which is presented in Table 6.3 above.

The distribution cycle repeats itself at 6am on Sunday the following week. The same schedule is adopted until the paddy is harvested, during the month of Mangsir (November-December). From the schedule, it is clear that water is allocated on a timed rotational basis at the block level. However, the allocated duration for the branch did not reflect the size of the command area. Every branch draws water for duration of 21 hours on a weekly schedule. Whatever may be the logic and rationale for the water distribution at the branch level, the water distribution in the JMIS is inequitable. Firstly, the time slots allocated for different branches do not correspond to their entitlements, as the distribution does not correspond to the command area for which the branch canal is supplying water. For example, according to the currently practiced water distribution schedule, Block 13, with 80 Ha of command area, is getting water for a period of twenty one hours, and Block 11, with a command area of only 32 Ha, is also getting water for same period of time, which clearly indicates inequitable water distribution.

Also, the water distribution at the branch level does not follow any contiguity in the JMIS. Whilst the pattern of water distribution appears regular, it is bound to create some complications in water distribution. According to the schedule, the pairing up of outlets from different locations leaving the outlets in between, provides farmers with real temptation to steal water, particularly during times when farmers need more water, for example during paddy flowering periods. The lack of a sufficient monitoring and sanctioning mechanism has meant that water theft is a persistent problem in the JMIS. The farmers in the *Tinpiple* village, which is located in the middle section of the canal command area, expressed the following viewpoints during a focus group discussion:

"--- *Ram Kumal [name changed] in Kumal Gaun in* Block -8 *broke the outlets unlawfully and diverted water for almost a month. What was the WUA Doing? Where did the Dhalepas go? The Dhalepas are paid by both the WUA and DoI, did they do their job properly?*

> *This is just an example; there are plenty of incidents where farmers have unlawfully appropriated water from the canal. ---Individuals who are caught red hand stealing water and vandalising canal infrastructure are not penalised - --?"*
>
> (Female, 50, middle section, JMIS)

Similar to other two irrigation systems (FMIS and JMIS) considered in this study, the Monsoon paddy growing periods remains the same in the command area of the AMIS. The water schedule comes into effect after the completion of paddy transplantation by all the beneficiary farmers in the canal command area. During the Monsoon season the water in the Begnas canal is divided amongst the branch canals according to the canal command area which the particular branch is delivering water to. There was no timed rotation practiced in the AMIS. Instead the DoI provisioned for a continuous supply of water in all the branch canals. The water allocation in the AMIS is given the Table 6.4. According to the current water distribution provisions, all the four branch canals appropriate water simultaneously. The DoI had provisioned that the Branch Canal 1 (BC-1) which supply water to the *Sainik Basti* area appropriated 50 percent of the total canal flow, while BC-2 which delivered water to the village of *Satmuhane*. The BC-2 appropriated only 15 percent of the total canal flow. Similarly, the allocation for BC-3 which delivered water to the village called *Kholako Chheu* which was allocated 17.5 percent of the canal flow whilst BC-4 which delivered water to the village of *Rajako Chautara* was also entitled 17.5 percent of the total canal flow.

Table 6.4 Branch Level Water Schedules in the AMIS during Monsoon Season

Branch Name	**Turn**	**Volume proportion in % of total canal release (A)**	**Command Area in Ha**	**Volume Entitled as % of total canal release (E)**	**Difference (A-E) in %**	**hours in one cycle**
Sainik Basti (BC1)	1	50	200	34	+ 16	Continuous
Satmuhane (BC2)	1	15	180	31	-16	Continuous
Kholako Chheu (BC3)	1	17.5	60	10	+7.5	Continuous
Rajako Chautara (BC4)	1	17.5	140	25	-7.5	Continuous

The canal command area of BC-1 is 200 Ha while the canal command area of BC-2 is 180 Ha. Similarly, the canal command area of BC-3 and BC-4 was 60 Ha and 140 Ha respectively. The current water allocation arrangements made by the DoI are clearly not equitable as the water allocations at the branch level do not correspond to their water entitlements. In other words, the farmers do not get their fair share of the total canal flow given time slots allocated for them for irrigation. Table 6.4 presents the discrepancies between water diverted and the actual amount of water entitled in different branch canals in the AMIS. For example, the current distribution arrangement allows BC-1 to divert 50 percent of the total volume of water flowing in the canal whereas its entitlement based on proportionality is only 34 percent of the canal flow. Clearly, this is an over-appropriation of water by 16 percent more than its legitimate entitlement. Similarly, according to current water distribution arrangements, the allocated share of water for BC-2 is 16 percent less than its entitlements based on proportionality. Also, BC-3 is over-appropriating 7.5 percent more water than its legal entitlements while BC-4 is under-appropriating 7.5 percent of its legal entitlements.

The local farmers, especially at the tail end of the canal, expressed a strong dissatisfaction over the current branch level water distribution arranged by the DoI; as a farmer said:

> *"---These are highly qualified individuals working at the DoI but they just do not seem to grasps the local settings--. The water distribution schedules are prepared based on the experience of the Terai (southern plains) whereas our local topography and soils are totally different. They have an allocated water flow of 6 cusec per Ropani of land in our*

branch—this is the estimation for terai paddy. Given the type of soil in this area we need almost 18 cusec water flow per Ropani in the area. I am an agronomist and I clearly see that the new engineers and overseers lack knowledge about the local settings—we request technical assistance, but it takes an unusually long time to get the responses. They just walk along the canal bank and estimate the budget and walk away--. Do not get me wrong---, but I do think that they are concerned more with their daily allowances than helping farmers prosper—after all they are not from the local area anyway---".

(Male, 39 years, an agronomist and farmer, AMIS)

The *Dhalepas* in the AMIS are employed by the DoI and have responsibility for opening and closing the gates of the branch canals. They also ensure that farmers adhere to the current water distribution rules. However, the *Dhalepas* are increasingly under threat from unruly local residents, particularly the local youths, who are coercing them to release water as needed by the farmers:

"--- Well, you have come to interview me but after a while those local boys come and pressurise me to release water---. Look at this scar! Some drunken guys from BC-1 attacked me a few months ago. They manhandled me, punched me and pushed me in canal because I did not release the water according to their demands --- of course I cannot release water as those thugs wish. This is quite a challenging job. Sometimes farmers come to divert water with knife and naked khukuri—this can be scary and traumatising--. You go to the canal with other tools like kuto and kodalo not khukuri-----. Sometimes farmers are not happy

with the DoI and they vent their anger on us, Dhalepa. We do not make the decision with regards to the canal-- We just follow their instructions"

(Male, 45, *Dhalepa*, AMIS)

6.3.4 Water Distribution during the Winter Season

As mentioned earlier, the way in which water is allocated to different branches within the irrigation canals changes with the seasons. This is because the amount of water available differs with different cropping seasons, as do the crops grown and their water requirements. As mentioned earlier in Chapter Three (Table 3.2), all the three case study sites had similar cropping patterns and the farmers grew wheat and mustard as the main winter crops. Some farmers also grow spring onions, onions, potatoes and other leafy vegetables. Whilst the demand for water remains high (although less intensive than for paddy), the water in the canal is reduced drastically and careful planning is required in the water distribution.

The water supply in the FMIS during the winter season is very low and considering these fluctuations in water availability, the WUA in the FMIS has adopted rotational water distribution into the different branch canals. Every year, between November and February, the farmers use a particular type of rotational distribution method for allocating water to different branches. The water rotation in different canals during this time period is known locally as '*paanch-paalo*. In these methods of rotational distribution, each branch acquires water for a duration of 12 hours before handing over to the next branch. The individual who is the last to be irrigating in the branch canal informs the first irrigator of the next branch that it is his turn to divert the water to his branch canal, which is known locally as '*paani pharkaune*'. If the individual who is irrigating fails to inform the farmers of the branch canal to whom the water is to be transferred and over-appropriates water, then the farmer concerned will be sanctioned by the WUA. There are five branches in the FMIS area, which means that each branch can divert water for a duration of 12 hours and the cycle repeats itself every one and half days (i.e. every sixty hours). The detailed rotation duration and different branches in the FMIS are presented in Table 6.5.

Table 6.5 Irrigation Cycle in FMIS during Winter Seasons

Branch Name	**Turn**	**Command Area in Ha**	**Hours in a cycle**	**Weekly Calendar**
Chaubiskuriya	1	34	12	7am (Sunday -7pm (Sunday)
Jogichaur	2	32	12	7pm (Sunday)-7am (Monday)
Dee Area	3	14	12	7am (Monday)-7pm (Monday)
Kumal Gaun	4	26	12	7pm (Monday)-7am (Tuesday)
Saatkuriya	5	36	12	7am (Tuesday)-7pm (Tuesday)

The FMIS consists of five major branch canals, which are *Chaubiskuriya*, Jogi Chaur, Dee Area, Kumal Gaun and Saatkuriya. The rotating schedules for each branch are listed in Table 6.5. During the winter season, the *Chaubiskuriya* branch uses the water first, and their turn begins at 7 am on the first Sunday of the month when the irrigation schedule commences. The *Chaubiskuriya* branch draws water for a duration of twelve hours before handing over to the *Jogi chaur* branch at 7 pm on the same day. The last irrigators of the Chaubiskuriya alert the first irrigator of the Jogi Chaur branch to divert water into the canal. According to local practice, a reminder is given about fifteen minutes prior to the end of the time allocated to the last farmer of the *Chaubiskuriya* branch. A similar pattern is followed with the other branches. It is the duty of the farmers to let other farmers know their timing for diverting water into their branch canals, and failure to do so, as well as any overuse of irrigation water, results in sanctions being imposed on them by the WUA. The WUA of the FMIS enforces the rules very strictly and there is a high degree of compliance. The farmers are expected to adhere to the rules or face sanctions. The farmers interviewed believed that both the costs and benefits from the canal have been shared proportionately by farmers of different categories, as one farmer said:

> *"---Although we may not have abundant water during Winter and Spring, we do know when the water will be made available to us---- we get water as per our entitlements which is based on cultivated lands--- we share the burden of water scarcity--- we share the joy of having plenty of water---"*
>
> (Female, 59, tail-ender, FMIS)

It should be noted that the farmers in the FMIS have been following the same schedule for the last fourteen years, and it is considered a stable water scheduling mechanism. The current water distribution schedule was decided through a lottery system about fourteen years ago, and farmers see no need for revising the schedules. The farmers in the FMIS repeatedly expressed their satisfaction with the water distribution mechanisms in the FMIS, as a participant in the focus group discussion said:

> *"---Well there is no need for revising the water distribution schedule, the farmers are satisfied; they are happy and the WUA is happy too with how things are working here--- it's working for everybody---"*
>
> (Male, 45, FMIS)

It should also be pointed out that there are no legal obligations for the farmers to stick to the same rotation pattern. These arrangements are more for convenience and consistency rather than legally binding. If the local farmers feel the need for change in the rotation pattern in the distribution of water resource, it can be done through deliberations by the PIMC, which is the committee managing the irrigation resources in the Phalebas area.

The water schedule which is implemented by the WUA in the JMIS canal during the winter and spring is presented in Table 6.6. The farmers reported that the head-tail inequalities increased as the water in the canal reduced during winter and spring. Whilst the inequalities can be attributed to the reduced volume of water in the canal, they are exacerbated by the nature of the water distribution schedule implemented by the WUA in the JMIS. According to the schedule, the first three blocks, namely 1, 2 and 3, get water all the time throughout the week, while other branches get water just once a week. The rotating heads of the outlets of branch canals delivering water to the fields plots in blocks 4-7 are opened, keeping other outlets closed (except the first three outlets) for a period of twenty four hours on Sunday.

Table 6.6 Branch Level Water Schedules during Winter and Spring season in the JMIS

Branch Name (Block Numbe	Village Name	Turn	Command Area in Ha	hours in one cycle	Weekly Calendar	Water Availability
Block 1	Borangkhola	All the time	25	No cycle	24 hours a day	Abundant
Block 2	Phant	All the time	46	No cycle	24 hours a day	Abundant
Block 3	Bhalayakharka	All the time	54	No cycle	24 hours a day	Abundant
Block 4	Timure	Every Sunday	65	24 hours	24 hours on Every Sunday	Enough
Block 5	Saatbise	Every Sunday	47	24 hours	24 hours on Every Sunday	Enough
Block 6	Alkatar	Every Sunday	32	24 hours	24 hours on Every Sunday	Enough
Block 7	Tinpiple	Every Sunday	56	24 hours	24 hours on Every Sunday	Enough
Block 8	*Kumalgaun*	Every Monday	53	24 hours	24 hours on Every Monday	Enough
Block 9	Syaauli Bazaar	Every Monday	64	24 hours	24 hours on Every Monday	Limited
Block 10	Bisuralgaun	Every Monday	80	24 hours	24 hours on Every Monday	Limited
Block 11	Pakhetar	Every Monday	67	24 hours	24 hours on Every Monday	Limited
Block 12	Saateghar	Every Monday	55	24 hours	24 hours on Every Monday	Limited
Block 13	Hatiya-pauwa	Every Tuesday	73	24 hours	24 hours on Every Tuesday	Scarce
Block 14	Panchbhai Chautara	Every Tuesday	50	24 hours	24 hours on Every Tuesday	Scarce
Block 15	Parajuli Gaun	Every Tuesday	58	24 hours	24 hours on Every Tuesday	Severely scarce
Block 16	Garambesi	Every Tuesday	75	24 hours	24 hours on Every Tuesday	Severely scarce

The *Dhalepas* working in the JMIS reported that on Monday they opened the rotating heads of the outlet canals of blocks 8-12 inclusive, while other outlets (except the first three blocks) remained closed for period of twenty four hours. Again on Tuesday morning, the *Dhalepas* opened the outlet gates of blocks 13-16, leaving other gates closed (except the first three gates). Similar to the water schedule implemented during the Monsoon season, that implemented during the winter and spring appeared to distribute water on the basis of proportionality. Clearly, the duration of the time slots allocated for the larger blocks is the same as that of the smaller blocks. Also, the first three blocks located at the head end of the canal command area received water all the time, while the remaining blocks appropriated water just once a week.

Inequalities occurred because the nature of the scheduling was echoed by the farmers. The availability of water in their field plots, particularly the ones located at the tail end of the canal, was being heavily affected by the nature of the water distribution mechanism implemented in the JMIS. The majority of the farmers reported that the water availability in the first three blocks in the JMIS was abundant, while the water availability in the middle section was reported to be just sufficient. Similarly, as one went down the canal command area, the water availability reduced significantly, with farmers at the tail end of the canal reporting water availability as limited and scarce. The qualitative data indicated that that while the tail-enders (famers from blocks 15 and 16) contributed more towards operation and maintenance activities, the water available to them was very scarce and they risked crop failures. The problems associated with inequitable water distribution in the JMIS were echoed by the farmers, as a key informant argued:

"--- Lets not talk about irrigation water for us! --- The WUA only comes and asks for our labour contributions during O & M activities. Last year the seeds on the paddy plot bed got roasted and I had to cultivate green lentil instead. Life remains the same for us—we used to look at the cloud coverage to plan our paddy transplantation in the past and we do the same even these days ---!"

(Male 28, tail end from JMIS)

Other farmers also echoed similar sentiments with regards to water in the canal in the JMIS:

"--- Well, we did not receive any water from the canal last season and I had to graze my cattle on the transplanted paddy crops as we lacked water-- plots dried up due to lack of water ---Plants completely wilted turning yellow ----it was pretty miserable for us---".

(Female, 43, Tail end, JMIS)

The DoI in collaboration with the WUA of the AMIS had a separate arrangement for winter cropping. The water distribution mechanism during the winter is presented in Table 6.7.

Table 6.7 Branch Level Water Schedules in the AMIS during Winter Season

Branch Name	Turn	Command Area in Ha	Hours per week	Weekly Calendar
Sainik Basti (BC1)	1	200	48	6am (Saturday)-6am (Monday)
Satmuhane (BC2)	2	180	48	6am (Monday) – 6am (Wed)
Kholako Chheu (BC3)	3	60	48	6am (Wed) – 6am (Friday)
Rajako Chautara (BC4)	4	157	48	6am (Friday)- 6am (Sunday)

Unlike during the Monsoon season, the DoI has adopted timed rotational water distribution at the branch canal level. The preference for a timed rotation to continuous irrigation water flow in the branch canal results from the reduced level of water in the source lake. As mentioned earlier, the lake is ecologically so sensitive that a certain level of water has to be constantly maintained.

The winter schedule comes into effect in the third week of November, when the farmers finish cultivating their winter crops. Every branch canal diverts water for a period of 48 hours, irrespective of the command area and water needs. The irrigation schedule starts from the head end of the canal as BC-1, delivering water to the *Sainik Basti* area. The *Sainik Basti area* diverts water from 6 am on Saturday until 6 am on Monday, when all the gates of other branch canals are kept closed. When the turn of the *Sainik Basti* area ends at 6 am on Monday, the gates of the BC-2, which delivers water to the village of *Satmuhane,* are opened and the other three gates kept closed. The village of *Satmuhane* receives water for of the next 48 hours until 6 am on Wednesday. When the village's turn ends, the water is diverted towards BC-3 to provide water to the village of *Kholako Chheu* for next 48 hours until 6 am on Friday. The village of *Kholako Chheu* is at the far tail-end of the canal and farmers reported that a significant proportion of water in the canal was lost through seepage and evapo-transpiration. The farmers from the village of *Kholako Chheu* reported that whilst water loss due to evapo-transpiration was a concern for them, water loss owing to seepage posed the greatest threat to the water security for the cultivated crops. When the turn of the village of *Satmuhane* comes to an end at 6 am on Friday, the gates of BC-4 are opened to release water for the village of *Rajako Chautara,* whilst the other three gates remain closed for next 48 hours when the water is diverted to BC-1 at 6 am on Monday.

6.3.5 Distributions during Spring Season

Similar to the distribution mechanism for winter crops, the WUA of the FMIS has a separate water distribution mechanism for the spring. By nature, the water demand for spring paddy is high, but the water supply both in the canal and the source is very low during the spring. High demand and low supply has meant that the competition for water is very high during the spring. In order to cope with the water shortage, the farmers have to grow spring paddy under a carefully designed water distribution mechanism. The water distribution schedule implemented in the FMIS during the spring is presented in Table 6.8.

Table 6.8 Irrigation Cycle in FMIS During Spring

Branch Name	Turn	Command Area in Ha	Hours in one cycle	Weekly Calendar
Satkuriya	1	34	36	7am (Sunday) -7pm (Monday)
Kumalgaun	2	32	36	7pm (Monday)-7am (Wednesday)
Dee Area	3	14	36	7am (Wednesday)-7pm (Thursday)
Jogichaur	4	26	36	7pm (Thursday)-7am (Saturday)
Chaubiskuriya	5	36	36	7am (Saturday)-7pm (Sunday)

During the spring, the farmers undergo even more stringent water scheduling, which is known locally as the *tin paalo*. During the *tin paalo* system, each branch canal gets water for a period of 36 hours, i.e. two days and one night continuously, after which the water is diverted to the next branch. Firstly, the village of *Satkuriya* diverts water for a period of 36 hours starting from 7 am on Sunday, and its turn for irrigation ends at 7 pm on the Monday. At this time the farmer who is diverting water from the canal is expected to inform the farmer from the Village of *Kumalgaun*. The process is repeated for the village of Dee Area and Jogichaur. The village of *Chaubiskuriya*, which diverts water first during the winter under the *panch paalo* system, diverts water last during the spring season. When the turn for diverting water for the village of *Chaubiskuriya* ends at 7 pm on Sunday of the following week, the cycle repeats itself for the rest of the spring until the paddy is harvested.

It is important to point out that the water distribution cycles during the *panch paalo* and the *tin paalo* are in reverse order. In the *paancho paalo*, the *Chaubiskuriya* branch gets the water first during the winter, while it gets the water last during the *tin paalo* during the spring, as the Chairman of the WUA argued:

> *"---we have to make everybody satisfied with the distribution rules. Of course there is no magic formula to make everybody satisfied. But there are ways in which we can make things work for everybody in the village. I think, if some branch is getting the first priority in one season, then it should compromise in the next seasons for water appropriation---since the last fourteen years, the water rotation begins with Chaubiskuriya first during the winter seasons and it diverts water last during the Spring seasons---"*
>
> (Male, 45, President of FMIS)

The farmers in the FMIS believed that the entire irrigation management, including the water distribution, is guided by a spirit of fairness, as an elderly farmer who participated in a focused group discussion said:

> *"---Although there may be head and tail ends in physical sense of the terms—but in practical terms there is nothing called head ends and tail ends in this canal. But in our system we have paddy transplantation at the head end areas and also at the extreme tail end areas ---- right at the bank of the Kaali Gandaki—this is the beauty of the Phalebas canal!—And this has been possible only because all the members believe and act with true spirit of fairness and justice---"*
>
> (Female, 50 from Tail end, FMIS)

In the JMIS, the schedule which is implemented during the winter is also continued through the spring. The water distribution schedule implemented in the JMIS in spring is presented in Table 6.6. It should be pointed out that the farmers in the JMIS areas cultivate less water intensive crops, such as potato, wheat and mustard, during the winter while more water intensive crops, such as spring paddy, are grown during the spring. The water schedules designed for the winter reflect less water demanding situations. The schedule is not adjusted to meet this increased demand for water. Therefore, the WUA's efforts to meet the increased demand during the spring with water distribution designed for the winter do not necessarily reflect the demand for water in the field.

Considering the decreased water supply, the WUA in the AMIS has designed water schedules on an ad-hoc basis. During this period, the farmers in need of water make a request to the WUA chairperson. Upon receiving such requests, the chairperson of the WUA, in consultation with DoI staff, gives instruction to the *Dhalepa* to release the gates of the canal to allow the flow of water into the canal from the source lake. The pattern of water distribution in the AMIS is presented in Table 6.9 below.

In fact there is no regular pattern in water distribution during the spring in the AMIS and a considerable degree of variation exists in water distribution. In the AMIS, allocation of water is based on need rather than entitlement. Unless there is a special case, water is usually, but not always, released every Saturday for farmers to irrigate their plots. It is therefore not surprising that the water appropriation by the farmers is often reported to be inadequate, irrespective of locations and branches.

Table 6.9 Branch Level Water Schedules in the AMIS during Spring Season

Branch Name	Turn	Volume Proportion	Command Area in Ha	hours in one cycle	Weekly Calendar
Sainik Basti (BC1)	Variables	Not proportional to command area	200	As per need (often inadequate)	Every Saturday
Satmuhane (BC2)	Variables	Not proportional to command area	180	As per need (often inadequate)	Every Saturday
Kholako Chheu (BC3)	Variables	Not proportional to command area	60	As per need (often inadequate)	Every Saturday
Rajako Chautara (BC4)	Variables	Not proportional to command area	140	As per need (often inadequate)	Every Saturday

The inability of the AMIS to meet the increased demand for water owing to a decrease in water supply, has meant that apart from a few farmers at the head end of the canal, an overwhelming proportion of the farmers reported that water was severely constrained during the spring. Whilst the water shortage in the AMIS could partly be associated with the nature of the water source, the water distribution arrangements implemented by the WUA also contributed to a growing disparity in water appropriation by the farmers. The lack of a proper and regular pattern of water distribution during the spring has added to the already existing head-tail inequalities in water appropriation. A growing number of farmers in the AMIS repeatedly argued that the pattern of water distribution was equally responsible for the inequitable access to irrigation water, as a participant in a focus group discussion argued:

> "--- *if the nature of the water source is to be held responsible for severe water shortages in the system, why do head-enders have good access to water, even during the driest period of the year?*

Should not the water shortage equally affect all the farmers within the system? Water itself doesn't discriminate between head and tail-enders, does it? Water flows where it is directed. The WUA is perhaps attempting to pass on the blame to the physical nature of the canal, but it is quite clear that the WUA is weak at the institutional level and the tail-enders suffer from their inabilities. People can't be both witch and witch doctor at the same time!"

(Male, 34, AMIS)

6.4 Water Distribution Technology in the Irrigation Systems

The following section describes the water division technologies used in the three irrigation systems considered for this research.

6.4.1 Use of Traditional Technology for Water Distribution in the FMIS

The core process of irrigation practice includes control, allocation and distribution of water and making water available to farmers to apply for crop growing. Water control structures provoke a particular type of water allocation and distribution practice (Pradhan, 1996). Parajuli (1999) argues that the irrigation technologies employed shape operational characteristics, which in turn strongly influence equity, operational flexibility and organisational development.

In the FMIS, farmers have designed and installed traditional proportional weirs using locally available resources. The proportional weirs, called '*Gahak*' are hydraulic structures made of timber with notches of uniform depth cut into them. The flow splinters (*Gahak*) which are placed across the direction of flow of water in the canal and divide water volumes into different secondary and tertiary canals which are proportionate to the land area they are irrigating. The *Gahak* are made of wood from the *simal* tree, which is water resistant with high durability. The widths of the notches in the *Gahak* represent the farmers' water entitlements (water share) in a particular branch.

Photo 6.1 The Structure of the Gahak

To ensure that equity in water distribution is maintained, farmers in the FMIS area have used a traditional pressure normalisation technique. For the purpose of pressure normalisation, simple wooden structures or obstructions made of blocks consisting of a combination of iron rods and cement are constructed across the flow of water to break its speed and hence normalise water pressure and maintain the level crest on the canal bed. It is important to point out that, owing to hydraulic characteristics, the water pressure decreases as it travels further down the canal and in absence of speed breakers, the net total flow of water through outlets at the head end are always more than their counterparts at the tail end, despite their equal sizes. However, the use of a pressure normalisation technique forbids hydraulic flexibility to exceed by unity.[10] The control of hydraulic flexibility at less than unity level helps to maintain uniform flow fluctuation rates in both parent and branch canals when water supply to the parent canal increases.

Furthermore, the use of the *Gahaks,* coupled with the pressure normalisation technique has some additional advantages. First, it helps to distribute the final products of irrigation efforts, i.e. water, equitably according to the farmer's share. Second, it helps to internalise the externalities created by the oversupply of water, particularly during the Monsoon. The *Gahak* system helps to dissipate externalities equally among the farmers, and avoid the flooding of terrace bunds used for cultivation, as any fluctuations in water supply to the parent canal has equal impacts on branch canals. Thirdly, the fixed structures of the *Gahak* have meant that a frequent adjustment of outlets by operational staff and farmers are not required and help maintain equity at lower transaction costs. Also, by using the *Gahak*, illegal water appropriations through tampering with the water division structures are minimised, as they are fixed and inflexible. It is the farmers who are required to manage their water share at secondary canal level.

However, at the tertiary canal level, the use of ad-hoc adjustment of water distribution has meant that farmers exercise more flexibility in terms of actual

[10] It is defined as the rate of change of flow in the parent and branching canals.

water use and can and do exchange turns for irrigation, particularly during periods of water scarcity.

6.10 Branch, Command Area and Size of the *Gahaks* in the FMIS

Branch Name		**Command Area in Ha**	**Size of Gahak in Inches**
Jogichaur		32	32
Dee-area		14	14
Kumal Gaun		26	26
Saatkuriya	Thulachaur	6	6
	Wallosaat	18	18
	Pallosaat	12	12
Chaubiskuriya	Wallochaubis	18	18
	Pallochaubis	16	16

6.4.2 Open Close Type of Water Distribution Technology in JMIS and AMIS

The involvement of external agencies equipped with financial resources and technical expertise, has meant that both the AMIS and the JMIS were characterised by sophisticated and modern water division technologies. Photos 6.2 and 6.3 show the types of water division structures used in the AMIS and JMIS respectively.

In the AMIS, the DoI has installed Open-Close slot gates, whilst in the JMIS, gates with Open-Close rotating heads are installed. Both the slot gates and rotating heads consist of bifurcated metallic hydraulic structures, fitted with open-close devices which are placed on the canal. These structures divide water into two or more parts. The mechanical nature of the equipment has meant that these structures have required frequent opening and closing manually.

Photo 6.2 Open-Close Slot Gates in AMIS

Photo 6.3 Open-Close Rotating Gates in JMIS

Although these structures appear sophisticated and efficient, farmers have struggled to operate the rotating water gates, because they are jammed with rust. This has resulted from the lack of proper maintenance of the canal infrastructure. Farmers in the rural villages lacked knowledge about the size of the rotating head and their water entitlements. Often those farmers who were powerful and had influence used more water than they were entitled to at the expense of weak, smaller farmers and tail-enders. The nature of water division structures and their characteristics are given in Table 6.11.

Table 6.11 Characteristics of Water Division Structures used in Nepal

Type of Water Division Structures	Characteristics
Open-Close	• Simple bifurcated hydraulic structures fitted with open-close device • Divide water into two or more parts • Frequent open/close requirement • Used at tertiary canal and farm level • Share only benefits but not risks associated with excessive Water
Ad-hoc Adjustment	• Simple open cut (turnout) • Adjustment through either altering turnout size/shape of hydraulic head • Divide water into two or more parts • Great human artisanship requirement for adjustment • Used at main and branch canal level • Share only benefit but not risks associated with excessive water
Fixed Proportional	• Simple orifice or weirs • Divide water into two or more parts proportional to water share • Usually made of wooden timber • Consists of multiple notches with uniform depth • Used at main and branch canal • Share both benefits and risks associated with excessive water

6.5 Findings from Qualitative Institutional Analysis

Based on the qualitative data obtained from key informant interviews, focus group discussions, documentary analysis and field notes, this section highlights the main themes emerging from the institutional analysis of the irrigation governing rules in general and rules for water distribution in particular, which are designed and implemented in the three irrigation systems considered for this research.

It is clear that the PIMC is mandated by the WUA and the FMIS is autonomous, both in operational activities and financial transactions. The PIMC controls the irrigation infrastructure and water flow in the system. The autonomous nature of the PIMC has meant that the DoI does not interfere in its affairs. Increased autonomy has helped the PIMC readjust the water flow depending on the availability of water in the canal. The autonomous nature of the FMIS has ensured that decisions made are by the farmers for the farmers. A number of farmers in the FMIS reported that the autonomous control of the resources, both financial and canal infrastructure has provided them with a sense of ownership of the irrigation resource. Table 6.12 presents the summary of the institutional analysis of the AMIS, the FMIS and the JMIS, considered for this research.

The farmers in the FMIS reported emotional attachment to the canal system. An elderly farmer who participated in the key informant interview said:

> "---*Look, this canal has been constructed with a great deal of sacrifices from the local farmers. The people of Phalebas have sweated a lot for the*

canal— every drop of water flowing in the canal is our sweat and our ancestors' sweats-- we worked all day--- every day for months and years to bring water to the Phalebas area- We feel proud and blessed to have this canal----the canal is a life line of every villager—and it is our responsibility to keep the spirit of our ancestors who dug the canal high---. This canal is run by the local farmers for the local farmers---!"

(Male, 85 years, FMIS)

Table 6.12 Summary of Findings of Institutional Analysis

Institutional	**Principles**	**Irrigation Systems**		
		AMIS	**FMIS**	**JMIS**
Autonomy		NO	YES	PARTIAL
Contiguity		NO	YES	NO
Proportionality	**Rights**	NO	YES	NO
	Duties	NO	YES	NO
Uniformity	**Techniques**	NO	YES	NO
	Right	NO	YES	NO
Transparency		NO	YES	NO
Monitoring		NO	YES	PARTIAL
Graduated Sanctions		NO	YES	NO
Farmers' Participation		MINIMAL	FULL	PARTIAL

Albeit partial control of the AMIS is given to the farmers and the BIMC has been instituted in recent years, in effect, the DoI controls the irrigation infrastructure and its operational activities. The water distribution is directed by agency staff. In essence, the government directs and controls not just the operation of the WUA but also the water distribution, making the WUA non-autonomous. The local users have minimal involvement in the management of their irrigation system. A number of farmers from the AMIS reported remarkably contrasting views regarding their irrigation canal, as a local farmer who participated in the focus group discussion said:

> *"---We do not know who controls this irrigation system. We have a puppet WUA which appears to work to please the DoI and their political agents. The WUA should work for the local farmers not the hakims (bureaucrats) in the headquarters, don't you think so? Too much politics flows in the canal, there should be water flowing in the canal, not politics! Look, to be honest, our views are not respected here, we are poor small farmers. Who bothers to listen to us? We are not big people, you see! We also have the right to be heard by the WUA and the DoI. If they can come to collect a water levy from us, why can't they come to discuss issues related to the irrigation system? They should come and talk to us and we will tell them what we need---"*
>
> (Male, 43, AMIS)

Similarly, although the management of the irrigation system has been devolved to local users in the JMIS, their participation is only partial. The WUA in the JMIS works in collaboration with the DoI, particularly in relation to major O & M activities which require technical support. Since the RIMC works in collaboration with the DoI, it has some input into operational activities, but the final decisions regarding the canal system, including both financial and structural changes, have to be approved by the DoI. This has made the RIMC more of a semi-autonomous entity than completely independent. The lack of ownership in the management of the irrigation canal in the JMIS was noted by local farmers, as a key interviewee said:

> *"---There is a crisis of identity between the WUA and the DoI in this system. The tussle between DoI and the WUA has resulted in a chaotic situation here. Come mid-June, they will be looking at each other as to who should do the O&M activities. The WUA thinks the DoI should provide financial and technical resources for the O & M activities but the DoI thinks it is the responsibility of the local farmers to carry out the O & M activities. What is a major O & M activity is also not clear. What is major to WUA is not major to the DoI. We do not feel in charge of our own canal. This is a real shame but what to do---"*
>
> (Male 55, Ex-Chairman of RIMC)

It is argued that the lack of a sense of ownership of the irrigation resource amongst the farmers has serious implications for much needed collective action in managing the irrigation system in general and carrying out O & M activities in particular. The data indicated that the FMIS demonstrated a greater degree of not only autonomy but also financial flexibility, including revenue generation, fixing and collection of the water levy and the spending pattern. The 'bottom up' approach adopted in the FMIS helped to foster collective goals rather than the pursuit of self-centred individual goals amongst the irrigators. In contrast, failure to provide financial and operational autonomy and a 'top-down' approach of irrigation governance adopted in the AMIS and JMIS gave very little incentive to the local farmers (Hilton, 1992). The autonomous nature of the FMIS provided opportunities to identify, assess and prioritise the needs of the local farmers and give a prompt response to any problem. The non-autonomous nature of the JMIS and the AMIS has meant that the farmers have lacked the authority to identify, assess and prioritise their needs. The DoI assumed the role of priority setting for local farmers, often failing to consult the local farmers and imposing its own agenda over them. The persistent communication gap between the local farmers and the DoI lengthened the response time in combating any contingencies related to the irrigation system.

6.5.1 Contiguity in Water Distributions

It is clear that all the farmers in the FMIS appropriate water with the same frequency, and the water distribution takes place continuously during the Monsoon season. However, during periods of water scarcity, a timed rotational distribution is practised. At the field channel levels, irrigation takes place upwards from the tail-ends of branch canals during the winter and downward from the head end during the spring. This not only makes water distribution a conspicuous activity but also helps to ensure the reliability of water supply in the FMIS.

The contiguous order in the water distribution, particularly during periods of water scarcity is fundamental not just for water conservation but also in achieving collective outcomes. The contiguous nature of water scheduling in the

FMIS has a number of advantages. First, the farmers in the FMIS prioritised tail-enders by allowing them to irrigate first. In this way, the farmers were able to mitigate the risk of crop failure at the tail-end owing to lack of water. Second, the progression of movement of water upward in the canal, starting from the tail-end, on the one hand made farmers aware of their turn for irrigation and on the on the minimised chances of water theft. Third, contiguous water application during rotational distribution concentrated irrigation activities in one branch, which made the entire irrigation process a more visible public event and farmers could observe each others' activities. This helped to deter fraudulent water appropriation. Fourth, the contiguity principles were easy for farmers to understand and follow.

Farmers in both the AMIS and the JMIS do not appropriate water with the same frequency. Even when there is a continuous supply of water, farmers struggle to operate the rotating water gates because they are jammed with rust. This is the result of a lack of proper maintenance of the canal infrastructure. The farmers in the rural villages lacked knowledge about the size of the rotating head and their water entitlements. Often powerful farmers who have greater influence, use more water than they are entitled to at the expense of weak, smaller farmers and the tail-enders. Farmers neither use water with same frequency nor is the distribution according to landholdings under cultivation. Although farmers practice a timed rotation method of water distribution, this does not reflect equity in the distribution of water. Farmers in the AMIS and the JMIS had not followed any ordered pattern in the distribution of water. The movement of water along the canal was "*zigzag*" lacking any contiguity. However, both in the AMIS and JMIS, the lack of contiguity in irrigation made the rules complicated, as water scheduling followed a "*zigzag*" pattern which left abundant opportunity for water theft. The farmers in the JMIS and the AMIS appropriated water with variable frequencies and the lack of knowledge on the size of the rotating heads at the outlet meant that farmers were not aware if they appropriated water as per their entitlements.

6.5.2 Proportionality in Distribution of Rights and Duties

6.5.2.1 Proportionality of Distribution of Rights

As mentioned earlier in Chapter Six (Section 6.7.1), all the farmers in the FMIS receive water with the same frequency, although with different time slots proportional to the amount of land cultivated, irrespective of landholdings and their locations. However, the water distribution in the AMIS and the JMIS did not take into account the principle of proportionality, i.e. water entitlements were not according to the amount of irrigable and cultivated lands. As a result, head-tail inequalities were rampant, both in the AMIS and the JMIS. Also, the distributional mechanisms adopted provided loopholes for farmers to exploit in using water unlawfully at the costs of the other farmers, particularly the tail-enders.

6.5.2.2 Proportionality of Distribution Duties

The qualitative data indicate that in the FMIS, all users are expected to contribute their fair share of labour for O & M activities and to pay the water levies according to the landholdings using canal water for irrigation. However, in the AMIS, the O & M activities are not performed on the basis of proportionality. Small, marginal farmers and those from the lower castes tend to be active in O & M activities whilst larger and better off farmers do not contribute their fair share.

The response of the DoI towards canal maintenance has been slow and inadequate, having an enormous impact on the water distribution in the canal system.

Similarly, in the JMIS, the contributions made by the local farmers is not commensurate with the benefits they derive from the canal, i.e. the participation in O & M activities does not take place according to the principles of proportionality. Small, marginal, tail-enders and farmers from the *dalit* castes contribute more towards O & M activities compared to larger and better off farmers. The DoI take responsibility for any *'major'* O & M activities while *'minor'* O & M activities are to be carried out by the user farmers. However, the understanding of '*major*' and '*minor*' activities is not clearly defined and often misinterpreted. This has led to high expectations of local farmers from the DoI and vice versa.

6.5.3 Uniformity in the Distributions of Water Rights, Duties and Techniques

6.5.3.1 Uniformity in Distributions of Water Rights and Duties

Similarly, uniformity in water appropriation remains a critical factor in enhancing farmers' access to water. In the FMIS, the farmers receive water with the same frequency, and in the case of farmers being convincingly in need of more water, they are able to negotiate with their neighbours and the WUA for further allowances. This must be approved by the WUA and the farmers assured that everyone will be provided with similar opportunities if needs are felt. However, in both the AMIS and the JMIS, farmers receive water with variable frequency. Although in principle, farmers' water rights corresponded to the size of landholdings under cultivation, there was clear evidence of inequalities in water distribution. The head-tail inequalities, and inequalities across landholdings and castes were obvious.

Uniformity in water distribution takes place in two ways, namely frequency and water distribution technology. Uniformity in water distribution in the FMIS helps to bring a basic commonality amongst the farmers and contributes towards achieving equitable distribution of irrigation water. It also helps to minimise suspicion amongst farmers regarding their water appropriation, because everybody in the system is irrigating with the same frequency. Also, uniformity in water distribution technology helps to achieve equitable water distribution amongst the farmers, as described later in Chapter Six (Section 6.6.3.2). The farmers in the FMIS irrigated with the same frequency in all three cropping seasons, whilst the farmers in the AMIS and the JMIS irrigated with variable frequencies. Whilst it is true that different crops have different water requirements, the farmers in the AMIS and the JMIS areas had more or less similar cropping patterns but dissimilar frequency in water appropriation. This raised doubts over the activities of the farmers who were irrigating more frequently than those who did not get water with the same frequency. Also, the farmers in the FMIS had installed *Gahaks* in their entire system, which brought uniformity in water distribution, while in the AMIS and the JMIS farmers used variable methods. The *ad-hoc* adjustment at the outlets in the AMIS and the JMIS left real opportunities for some farmers to appropriate water disproportionately.

The proportionality principles both in rights and duties appear to be the most important factors in ensuring equitable water distribution. The water distribution in the FMIS conformed to the proportionality principles on which the allocations of water rights were based. The water distribution was proportionate to farmers' cultivated land. There was more or less a single water to land ratio in the FMIS while the water distribution did not take place on proportional basis in either the AMIS or the JMIS. The water scheduling designed and implemented in the AMIS and the JMIS did not conform to proportionality principles. Consequently, some farmers appropriated more water than they were entitled to, while others did not get their fair share of water. Similarly, the O& M responsibilities were not proportionally distributed amongst the farmers in the AMIS and JMIS, while they were distributed proportionately amongst the farmers in the FMIS. The proportionate distribution of both rights and accompanying duties amongst the farmers helped to achieve fairness amongst them, which in turn helped to achieve collective goals.

6.5.3.2 Uniformity in Water Distribution Techniques

The technological adaptations used in the FMIS were exercised uniformly in all outlets ensure fair distribution of water proportional to the amount of cultivated lands. The use of similar technology, i.e. the *Gahaks,* in water division at the outlet levels helped to reduce conflict among the farmers, as all the branches got their fair share. Although the canal infrastructures in the AMIS and the JMIS had sophisticated equipment such as rotation gates, the water was not distributed in an equitable manner. The farmers also lacked knowledge on operating the rotating heads of the gates. The rotating gates were rusty and jammed, owing to lack of regular maintenance.

The proportionality principles both in rights and duties appeared to be the most important factors in ensuring equitable water distribution. The water distribution in the FMIS conformed to the proportionality principles on which the allocations of water rights were based. Water distribution was proportionate to farmers' cultivated land. There was more or less a single water to land ratio in the FMIS, while distribution did not take place on a proportional basis in either the AMIS or the JMIS. The water schedule designed and implemented in the AMIS and the JMIS did not conform to proportionality principles. Consequently, some farmers appropriated more water than their entitlement, while others did not get their fair share of water. Similarly, the O & M responsibilities were not proportionately distributed amongst the farmers in the AMIS and JMIS, while they were amongst the farmers in the FMIS. Proportionate distribution of both rights and accompanying duties amongst the farmers helped to achieve fairness and foster collective goals.

6.5.4. Transparency in Irrigation Governance

An equally important factor, which is critical for ensuring good governance in the management of irrigation, is that of transparency. Transparency in both financial and operational terms helped to establish a healthy relationship and build trust amongst the members of the WUA committees and the irrigators. The absence of transparency would create mistrust and reduce much needed social capital in irrigation management. Allocation and the rules for water use were known to all users in the FMIS. Also, an adequate monitoring mechanism was put in place in the FMIS and helped to ensure compliance to the rules. In the FMIS, the WUA had a regular audit of its accounts and financial transactions and its operational activities, while such arrangements were absent in the AMIS and the JMIS. A level of trust amongst the farmers in the FMIS in their WUA committee members was significantly higher than that of the farmers in the AMIS and the JMIS. A high level of trust and faith in their WUA provided farmers in the FMIS with incentives to participate in irrigation related activities.

However, the farmers in both the AMIS and the JMIS did not understand the water allocation principles fully and did not adhere to the proposed allocation principles. There was absence of an adequate monitoring mechanism for infringement of rules. The WUA had poor accountability and there was no transparency in the financial operation of the WUA because of the absence of proper financial auditing.

6.5.5 Regularity in Water Distributions

For the last 14 years, the PIMC has been practising the same routine for water distribution (although the routine varies within the branch) and the use of *'tinpalo'* and *'pachpalo'* to ensure regularity and uniformity in water distribution. More importantly, in each branch canal, the farmers always irrigate from the tail end, which means they have a robust and regular water distribution mechanism both at the branch canal level and at the field plot level. However, in the AMIS and the JMIS, the WUA didn't follow a regular pattern in water distribution at either level. The irregular pattern of water distribution made water availability unreliable for the farmers. Also, the distribution pattern practised by the farmers in the JMIS was not the most effective or efficient use of water. Opening few outlets at the head and tail-end omitting the outlets in the middle sections, provided plenty of loopholes for farmers to use water unlawfully.

6.5.6 Monitoring Farmers' Irrigation Related Activities

It is important to point out that an appropriate monitoring mechanism helps to ensure that the 'rules of the game' are followed appropriately and sanctions are imposed to penalise fraudsters, which in turn helps ensure 'best practice' in the management of irrigation systems. The farmers in the FMIS had appropriate monitoring mechanisms for '*keeping track'* of each other regarding irrigation related activities. The monitoring was done through the *Dhalepas* and the *katuwal*. The monitors were independent and credible in their operation and were neither coerced nor intimidated. Along with monitoring of farmers, the WUA was scrutinised for its operation to ensure transparency.

Although *Dhalepas* were present both in the AMIS and the JMIS, they were assumed to have responsibility to the DoI rather than the local WUA. Neither the individuals nor the WUA were properly monitored. *Dhalepas* were often coerced and intimidated during their activities. A lack of monitoring of users left plenty of loopholes for farmers to free ride and steal water, while absence of accountability in the WUA resulted in financial irregularities and ineffective governance. The *Dhalepas* employed by the DoI assumed they were answerable to the DoI rather than the WUA and conflicts of interests were common. The *Dhalepas* were intimidated to release water for the use of powerful and abusive farmers.

The independence and integrity of the *Dhalepas* were pushed aside. Neither the activities of the defrauding farmers nor of the WUA committee were monitored properly, which resulted in accountability in the WUA and financial irregularities and ineffective governance.

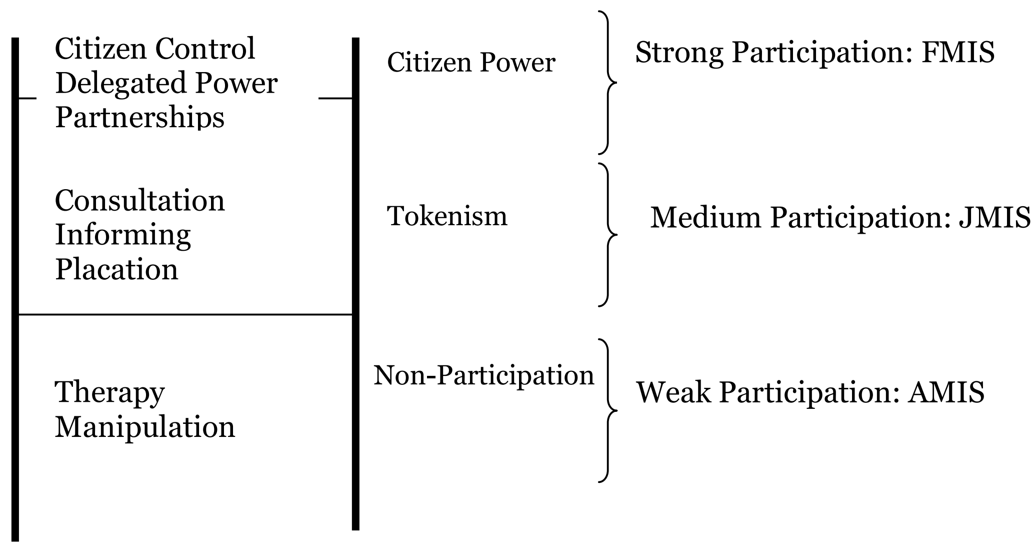
6.5.7 Graduated Sanctions

A sanctioning mechanism also remains crucial for ensuring good governance in irrigation management. In the FMIS, the WUA have developed and implemented a range of sanctioning mechanisms which were commensurate with the gravity of the offences in irrigation related activities. Although they had been written into the constitution, sanctions were not implemented effectively in either the AMIS or the JMIS. Individuals vandalising canal infrastructures and water defrauders were not punished according to the gravity of the offence. This made it too easy for farmers to get away with canal vandalism and water defrauding.

6.5.8 Farmers' Participation

The importance of user participation in the management of natural resources including irrigation resources, have been increasingly recognised by national and international policy circles (Mark *et al.*, 2009; Hilton, 1992). Whilst the typologies of participation have already been presented in Chapter Two (Section 2.10.2), those models of participation have relevance in explaining the nature of farmers' participation with the irrigation issues and the capacity in which farmers interact with the irrigation bureaucracy, particularly with the DoI. Figure 6.2 presents the nature of participation of the farmers in the management of their irrigation system considered for this research using Arnstein's (1969) ladder of participation.

Figure 6.2: Level of Participation in the three irrigation systems using a ladder of participation



Of the three irrigation systems considered in this study, the level of participation of the irrigators in the management of the AMIS was the least, which was almost non-existence. In Arnstein's ladder of participation, the participation of farmers in the AMIS was at the lower end of the ladder. This is because the DoI played a dominant role in managing all aspects of the canal system in the AMIS and the farmers had little participation in the development efforts of their irrigation canal system. Even though the local farmers were consulted at times, those consultations were manipulative and therapeutic (Rafter, 1984) and characterised by complete dominance of the DoI (Lam, 1998). When the DoI made visits to the canal area for a *run-through* along the canal to identify damages in infrastructures and budget estimations for repairing such damages, the farmers only took the officials around the canal and did not have the opportunity to take part in the interventions that followed. As such the farmers in the AMIS lacked a sense of ownership of their irrigation system because of the failure on DoI's part to involve them in decision-making pertinent to their irrigation system (Adnan *et al.*, 1992; Duyne, 1998). A sense of frustration amongst the farmers because of the dominance of the DoI in canal management was frequently expressed by the local farmers, as one of them said:

> *"---Because we are poor small farmers, our views are not respected here, Who bothers listening to us? We are not big people, you see! We also have right to be heard from the WUA and the DoI---"*
>
> (Male 43, AMIS)

In the AMIS, the DoI not only controlled the WUA and O & M activities, it also controlled water distribution through its agency staff. In this sense, the farmers in the AMIS appeared to be only the passive recipients of irrigation interventions as the government directs and controls not just the operation of the WUA but also the water distribution. The local users have minimal involvement in the management of their irrigation system. Also, as the AMIS was non-autonomous, the farmers' level of engagement in the management of irrigation was passive and manipulative where the DoI played an exclusive role in decision-making. The nominal participation (White, 1996) of the farmers in the AMIS did not provide a platform for them to be heard and their viewpoints to be considered in making decisions on the irrigation system.

Whilst the level of farmers' participation in the JMIS was higher than the one present in the AMIS, the nature of participation was piecemeal in which their participation was only during the consultations without any power to influence the decisions and interventions, which followed such consultations. The participation of farmers in the JMIS took place in the form of functional participation (Pretty, 1995). The functional participation of farmers in the management of the irrigation system played an instrumental role as it enabled the DoI to meet project objectives, and most importantly reduce operation costs. For example, farmers in the JMIS were required to contribute towards O & M activities compulsorily to reduce canal operation costs by the DoI. The farmers in the JMIS, particularly, the tail-enders repeatedly mentioned a lack of collaboration between the DoI and the WUA, as one farmer said:

> *"--- Lets not talk about irrigation water for us! --- The DoI doesn't care if we get water or not. They come and ask for our labour contribution during Operation and Maintenance activities---"*
>
> (Male 28, JMIS)

Although the farmers were consulted in problem identification such as spotting damage to infrastructures, they were not involved in making decisions and/or allocating budget nor did the DoI have mandatory obligations to integrate farmers' views in decision-making. A lack of mandatory obligations by the DoI to incorporate outcomes of the consultations has meant that farmers' participation was a mere tokenism rather than a genuine participation as one farmer from the middle section of the JMIS said:

"Overseers come, they just talk big things with the big people here, they neither talk with us nor we hear what they talk about with the big people --- we know our problems regarding the canal, just talking big things with big people alone does not solve the local problems associated with the canal---"

(Male, 39, JMIS)

However, the level of farmers' participations in the FMIS can be considered to remain on the top of the "ladder of participation" as proposed by Arnstein (1969). The autonomous nature of the FMIS has meant that farmers had operational independence both in O & M activities and financial transactions. The farmers had full control of their irrigation infrastructure in terms of its management, including water distribution. The autonomous nature of the FMIS also provided the WUA, which was responsible for managing the canal on a day-to-day basis, with a favourable environment free from any interference from the DoI. All the decisions related to irrigation issues are made at the local level with full participation of the beneficiary farmers. Also, the farmers' participation was highly interactive as they were involved in all aspects of problem identification, policy formulation and decision-making. Such level of autonomy provided the local farmers a sense of ownership of the canal resources as an elderly female said:

"---this is our canal and we manage it. We collect water fee and use it for the betterment of the canal, basically we are the in-charge here! We collect the fee; we manage it as our needs---"

(Female, 49, FMIS)

The *five-tier* model of participation proposed by Pretty (1995) can be used to understand and explain the nature of farmers' participation in the management of the three irrigation systems considered for this study.

The AMIS was characterised by minimal involvement of the local farmers in the management of their irrigation system. Government bureaucracy through the DoI heavily influenced all the aspects of the AMIS. Whilst the participation of the local farmers was encouraged in the JMIS, participation was partial and piecemeal. The level of farmers' participation in the management of the AMIS was very weak. The DoI played an exclusive role in making decisions regarding all aspects of irrigation systems including construction, O & M activities and budget allocations. In the AMIS, the WUA responsible for liaising with the DoI was unelected and did not demonstrate accountability towards the farmers. There is a burgeoning literature on unelected leadership and lack of accountability in development discourses (Blair, 2000; Haas, 2004; Benner *et al*., 2004; Bäckstrand, 2006).

Table 6.13 presents the characteristic of participation of local farmers in the management of their irrigation system using typologies of participation proposed by Pretty (1995). The Pretty's five-tier model of participation used to understand the different degree of farmers' involvement in the management of irrigation systems was different in the three irrigation systems considered for this research.

Table 6.13 Characteristics of Participation in the three irrigation systems

Type	**Characteristics**	
Manipulative Participation	No decision power on users, unelected representation	Weak Participation: AMIS
Passive Participation	Lack of user engagement, unilateral decision making by external agency	
Participation by consultation	A mere consultation with users, non-mandatory incorporation of consultation during decision making	Medium Participation: JMIS
Functional participation	Users participation to only to reduce costs and meet pre-determined project objectives	
Interactive participation	A dynamic and holistic participation of users in all stages of project, including problem identification, assessment and decision making	Strong Participation: FMIS
Self-mobilisation	Users participate through their own initiatives Independently in all aspects of project	

Adapted with modifications from Pretty (1995).

The unaccountability of the WUA coupled with unilateral decision-making by the DoI has meant the nature of farmers' participation in the AMIS was manipulative where the WUA operated just to please the DoI rather than contributing towards local development. Also, a lack of proper user engagements in the management of irrigation canal in the AMIS has meant that the farmers are passive recipient of development interventions. Although the DoI had both financial resources and technical expertise, a lack of institutional arrangement to consult and empower farmers has contributed towards such a low level of participation (Huppert, 2008). The farmers in the AMIS repeatedly expressed such lack of consultations by the DoI, as a local farmer said:

> "---*The water distribution schedules are prepared based on the experience of the Terai (southern plains) whereas our local topography and soils are totally different. ---And this* is the consequence of a lack of consultation with the local farmers---"
>
> (Male, 39, AMIS)

Whilst the level of farmers' participation in the JMIS was higher than the AMIS, such participations were mere consultations with the users rather than genuine participation. In the JMIS, the local farmers contributed towards minor O & M activities, whilst the DoI carried out the major O & M activities. However, both farmers and the DoI differently interpreted the notions of major and minor O & M activities. As a result, there was an apparent mismatch between each other's expectations and contributions in the management of the irrigation system.

Also, the DoI did not have mandatory obligations to respond to the issues raised during the consultations with the farmers. The professional hegemony enjoyed by the DoI staff enabled them to make unilateral decision without being accountable to the farmers. Although the farmers in the JMIS participated in the O & M activities, such participation had a number of functional roles as describe by Pretty (1995). Firstly, farmers' involvement in the O & M activities has helped to reduce operational costs by the DoI. Secondly, such functional participation enabled the DoI to achieve per-determined project goals at lower costs (Inocencio *et al.*, 2005; Cornish and Perry, 2005).

The FMIS demonstrated a high degree of farmer participation in the management of the irrigation system. The farmers were involved in all aspects, including O & M activities, sanctions, construction, levy collection and so on. The farmers in the FMIS had a real sense of ownership of their irrigation resources. Also, the WUA was more inclusive in the FMIS, with representation of dalits, women, tail-enders and marginal farmers, whilst the WUA in the AMIS and JMIS was characterised by hegemony of the large and powerful farmers. The level of participation demonstrated by the farmers in the FMIS was strong and interactive. The farmers in the FMIS were involved in all the stages of irrigation management including problem identification, assessment of the local needs and decision makings regarding their irrigation system (Korten, 1980; Uphoff, 1986). The nature of farmers' participation was in line with the Participatory Irrigation Management (PIM) proposed by the World Bank, one of the major donors in funding a large number of irrigation systems in many developing countries (World Bank, 1996). The farmers in the

FMIS were involved in '*all aspects*' including information sharing, with WUA, joint assessment of problems and shared decision-making (World Bank, 2007); and in '*all stages*' including construction, supervision and financing, O & M activities, and monitoring and evaluation of the system (Renault *et al.,* 2007). The autonomous nature of the WUA managing the FMIS has meant that the farmers could involve at '*all levels'* including both tertiary, secondary and main system level (Svendsen *et al.*, 2000).

6.6 Conclusions

This chapter has sought to provide a bigger picture of the issues concerning irrigation governance in Nepal by presenting a qualitative institutional analysis. The IAD framework is used to understand the details of water distribution arrangements in the three irrigation systems considered for this research. By using the IAD framework, it has been possible to investigate the complex action situations which comprised of both natural and socio-economic conditions in which the interactions amongst the farmers and between farmers, and irrigation bureaucracy occurred. Those action situations are influenced by various factors such as attributes of the physical world, attributes of community, and rules-in-use. The interactions at all three levels: operational, collective choice and constitutional choice; are influenced by the rules in use which appropriators use for ordering their own relationships with regards to the irrigation system. All the irrigation related activities including, O & M activities, water appropriation, payment of water levy, sanctions, formation and composition of the WUA and water distribution, are guided by the institutional structures designed and implemented for the governance of the irrigation systems. The institutional analysis carried out in this chapter has demonstrated that the institutional setup differ amongst irrigation systems governed by different property right structures; the nature of interactions amongst the farmers also vary considerably.

The irrigation systems governed by different property rights structures have designed and implemented different sets of water distribution arrangements, both at the intra-branch canal and inter-branch canal levels. The results show that farmers use different rules in different cropping seasons. This is done to cope with different levels of water availability and water requirements of the crops. However, some irrigation systems are more flexible and consistent in re-adjusting the distribution pattern within the canal command area than others. The comparative study of institutional arrangements in the three irrigation systems indicates that the FMIS was autonomous from the DoI in its operation and governance, whilst the JMIS and the AMIS were to a large extent controlled by the DoI. The AMIS was more dependent on the DoI than the JMIS. The involvement of the DoI in the management of AMIS has interfered in the water distribution, while its involvement in the management of the canal has created confusion over the roles of the WUA and the DoI. The expectations and misunderstandings of each other's responsibilities has meant that co-ordination has become very difficult in both in the AMIS and the JMIS, whilst the autonomous nature of the FMIS has made it flexible and easy to organise irrigation related activities.

Contiguity and uniformity in water application remain important features for successful irrigation governance. The contiguity (pattern) and uniformity (similar frequency) in water application help to ensure predictability in water supply and in generating a critical mass in organising operation and maintenance activities. The farmers in the FMIS always applied water from the tail-end of the branch canal, following both uniformity and contiguity patterns. In doing so, the farmers have prioritised the needs of the most vulnerable group of farmers for accessing irrigation water. Apart from ensuring provision of water at the tail-ends, the contiguity pattern makes water supply more reliable and predictable. The reliability and predictability in water supply informs farmers of the timing and duration of their allocated share. However, both in the AMIS and the JMIS the irrigation pattern lacked contiguity. The absence of contiguity in the application of irrigation water not only makes water availability unreliable and unpredictable but also increases opportunistic behaviour amongst the irrigators. In turn, this aggravated head-tail inequalities and inequalities in water appropriation across other heterogeneities.

The notion of proportionality both in rights and duties appears to play a crucial role not only for ensuring farmers' water allocation but also fulfilment of designated responsibilities. The proportionality principles in rights and duties and their strict enforcement has helped to maintain the canal systems in the FMIS area, whilst the lack of a strong mechanism in the enforcement of this principle has led to weak participation and often inequitable contribution to irrigation related activities resulting in poor conditions in the canal systems both in the AMIS and JMIS areas. The physical conditions of the canals have also influenced farmers' abilities to appropriate their rightful claim to water.

Transparency, monitoring and graduated sanctions complement each other. For the WUA, transparency both in financial and operational activities is critical in securing farmers' support in successful management of the canal system. Monitoring helps to ensure transparency from the WUA as well as the farmers. The ability to monitor each other's activities helps to remove '*clouds of doubts'* and '*a climate of mistrust'* between farmers and the WUA and amongst the farmers themselves. The prevalence of sanctions and their strict enforcement help to reduce fraudulent activities in irrigation management. The sanctions help to ensure accepted norms of behaviour, both from the WUA and the farmers, in their conduct in irrigation management. However, graduated sanctions have been successfully designed and implemented in some irrigation systems, whilst in others they have not been strictly enforced. Availability and enforcement of sanctions in the FMIS have meant that fraudulent activities have been minimised, including water theft and vandalism of canal infrastructures, using a "tough love" approach. Lack of both a proper monitoring mechanism and also of sanctions in the AMIS and JMIS have meant that destruction of the canal infrastructure and incidence of water theft were rampant.

CHAPTER SEVEN:

CONCLUSIONS, POLICY IMPLICATIONS AND FUTURE RESEARCH DIRECTIONS

7.1 Chapter Overview

This chapter draws together the main findings of this research in order to address the research objectives and answer the research questions set out in Chapter One. In doing so, it revisits the research objectives and the associated research questions and discusses some policy implications of the research findings. It also sheds light on the importance of institutions in understanding water distribution and irrigation governance in general. This thesis has attempted to illustrate the distributive aspects of irrigation water under different property rights regimes through an institutional analysis of water distribution mechanisms in three irrigation systems in Nepal. In-depth and comparative analysis of three irrigation systems which are governed by different property rights regimes have been carried out. This chapter draws some conclusions based on the analysis and results presented in the previous chapters. It also highlights the contribution to knowledge made by this thesis and describes the direction of future research for exploring distributional implications of irrigation management and the role of institutions in achieving the equity goals of irrigation interventions.

7.2 Introduction

Water as a valuable natural resource contributes to our lives in a myriad of complex ways, including providing water for irrigation and industrial purposes, sustaining complex ecosystems (Petts, 1998; Saleth and Dinar, 2004) and sustaining livelihoods of many rural poor in developing countries (Lipton, 2007; Reardon and Vosti, 1995). Irrigation water is vital to the livelihood strategies of many vulnerable people in these countries, but water resources have faced fierce pressures owing to increasing demand and constrained supply. The demand on water is increasing daily, owing to the need for expansion of agricultural activities to meet the food demand of increasing populations and rapid urbanisation. But water on a daily basis becomes more scarce owing to deterioration in both quality and quantity because of the effects of climate change and over-exploitation.

Irrigation continues to remain the single most important sector for water consumption with 70 percent taking place in the agricultural sector worldwide and more than 96 percent in Nepal (WECS, 2001). In order to manage irrigation systems, different institutional arrangements are designed and implemented all over the world and Nepal is no exception. Nepalese irrigation systems are managed by three types of property rights regimes, which are characterised by distinct sets of institutional arrangements.

Firstly, historical evidence vis-à-vis present trends show Nepal's rich portrayal of farmers' engagement in the management of irrigation canals which have become commonly known as the FMIS. The FMIS continue to occupy a prominent position in agricultural development in Nepal as they are the highest contributors towards the gross irrigated agricultural practices. Currently the FMIS contribute up to 70 per cent of total irrigated land

(Pradhan, 2000). The role of FMIS is critical in the hilly areas since as much as 90 percent of irrigated areas derive water from them as compared to about 70 percent in the Terai (Pradhan, 2005). Many FMIS are designed, constructed and managed by local farmers using locally available resources and traditional technologies. Mostly, the canal linings are run-of-the- river diversions where the headworks are made of mud (Chappari), stones and wooden logs/leaves (Jhikra) and the canal linings are not cement plastered. The temporary headwork and non-plastered canal linings are prone to damage by heavy flooding during the monsoon seasons and require frequent maintenance and repairs. Also, the management aspects of the FMIS are devolved to local users associations called Water Users Association (WUAs). The local WUAs are governed by an elected body (usually elected for a period of two years) and make rules and regulations regarding water distribution, water allocation, expansions and maintenance. Since the management of FMIS is a collective enterprise availability of water and its equitable distribution remains critical for the function of both irrigation infrastructure and the management committees.

Secondly, whilst the FMIS have been operating in Nepal since historic time, it was not until the inception of a planned development in mid-1950s that Nepal witnessed a surge in the development of irrigation infrastructures through the involvement of the government and external agencies. The irrigation systems, which are designed, constructed and managed either by the government or external agencies, are commonly known as the AMIS. Since many AMIS have a huge construction and maintenance budget, they are usually large in size and technologically robust. They have permanent headworks and the canal linings are cement plastered. The management of AMIS is done through the DoI which is an auxiliary body of the Government of Nepal solely responsible for the development of irrigation infrastructures in Nepal.

Thirdly, some irrigation systems are jointly managed by the beneficiary farmers and the government or an external agency. These irrigation systems are commonly called Jointly Managed Irrigation Systems (JMIS). The design and construction of the JMIS is carried out by the DoI, which also manages the canals for first few years of their operation. The DoI or the external agency involved in the management of canals also invests significant amounts of its resources in the development of communal capacity for the management of the irrigation systems. The management of the canals are handed to the beneficiary farmers when the farmers are capable and willing to undertake the management responsibilities. In the JMIS, the government carries out the major O & M activities while the farmers contribute towards minor O & M activities.

In Nepal, as elsewhere in many developing countries, irrigation has been advocated as a vehicle for poverty reduction and substantial investments have been made in this sector by both national government and international donor organisations. While the expansion of irrigation infrastructures is good and should be welcomed, the distributional aspects of irrigation development have rarely been explored. Equally, despite a major policy shift in irrigation management from government to local users, its impact has not been adequately assessed, especially from the perspectives of the local farmers. In response to these problems, this research has carried out an in-depth and comparative institutional analysis of irrigation management in the mid-hills of Nepal. The thesis has considered various stakeholders who have an interest in irrigation governance and has considered the benefit appropriation by farmers with different capacities. In particular, this thesis has aimed to demonstrate the level of access to irrigation water by the marginal and weak farmers in rural Nepal. The level of access to irrigation water by small landholders, dalits, tail-enders and female-headed households in the three irrigation systems which are governed by different property rights regimes has been investigated. The thesis also has looked at the institutional arrangements of irrigation governance in general and water distribution in particular in different irrigation systems governed by three different property rights regimes. The aim of the comparative institutional analysis was to identify institutional barriers and how they have influenced the level of benefit appropriation from irrigation resources, particularly by weak and marginal farmers.

These three irrigation systems, which are governed by three different property rights regimes, were selected for an in-depth case study. In addition to property rights regimes, the thesis aimed to investigate the role of institutions in farmers' abilities to access water. The data generated for this study come from a range of sources, both primary and secondary. The primary data were generated in a number of ways, including a household survey, focused group discussions and key informant interviews. The secondary data included government publications, reviews, and project appraisal reports.

The government has formulated a plethora of policy interventions which essentially sought to hand over management responsibilities to the local irrigation communities in one form or another under the aegis of 'Irrigation Management Transfer (IMT)'. The Water Resource Act (WRA) of 1992 paved the way for transferring irrigation management responsibilities to local users, and was followed by The Irrigation Regulation of 1999 and the amended Irrigation Policy of 2003, both advocating increasing performance and enhancing cost recovery from the irrigation systems. The involvement of communities in the management of natural resources, including irrigation systems, were considered solutions to problems such as information asymmetries, incentive incompatibility, lack of effective monitoring and maintenance, which were endemic to state management (Ostrom and Gardner, 1993).

Although there are compelling theoretical arguments for and in support of transferring irrigation systems to local users, and the impetus for doing so is strong, the distributional implications of policy change need to be considered. I am in no way advocating centralisation of natural resource management, but arguing that the IMT should not be taken at face value as a panacea for the problems associated with many agency managed irrigation systems. The assumption that the transfer of management roles to local users automatically leads to an equitable distribution of the resource bases should be scrutinised. In fact, evidence has demonstrated that the objectives of many projects involving management transfer to local users, such as resource productivity, equity, poverty alleviation and organisational and environmental sustainability, have not been met (Meinzen-Dick and Knox, 1999; World Bank, 1996a).

It is hoped that the policy lessons drawn from this research could be useful for the government, particularly the DoI and the irrigation communities at large. Since the inception of the planned development in the mid-1950s, the Government of Nepal has assumed a central role in all spheres of national development, including the management of its natural resources, including irrigation. The necessity for centralized management of the natural resources has emanated from the prevalence of market failure, particularly positive and negative externalities and the strategic importance of the natural resource bases in order to avoid '*the tragedy of the commons*' (Hardin, 1968; Yugandhar and Raju, 1992; Rasmussen and Meinzen-Dick, 1995). Until the 1990s, the irrigation systems in Nepal, particularly those managed by the government, suffered from related problems including low performance, deteriorating physical infrastructures and low cost recovery. The following section describes the main findings of this research. Each research objective and its associated questions are addressed in turn.

7.3 Main Findings and Policy Implications

1. Under which property rights structures do the farmers have the best access to irrigation water?

a. Are the farmers from the *dalit* community benefiting equally from irrigation systems under different property rights regimes?
b. Are marginal farmers benefiting equally from the surface irrigation systems governed by different property rights regimes?
c. Under which property rights regimes do the 'tail-enders' have the best access to water from the canal system?

d. Are the female-headed households benefiting equally from irrigation systems under different property rights regimes?

In order to answer the above mentioned research questions, an in-depth comparative case study of three irrigation systems governed by three different property rights regimes was carried out. The data for this research came from a number of sources, including focus group discussions, key informant interviews, household survey and documentary analysis.

A total of 249 households (83 from each of the systems) were surveyed for the quantitative analysis. However, only 199 valid responses were used in the final analysis as 51 questionnaires were discarded as they were incomplete. The main criterion used for the categorisation was the area of land owned by the household. There was no leasehold land in the research sites, whilst share-cropping was commonly practised. In order to capture spatial and caste/ethnic hierarchy, households were randomly selected on a proportional basis from different locations, landholdings and castes in each ward of the Village Development Committee (VDC) served by the irrigation canals. Private landholding reflects the economic and socio-political status of a household. Those with larger landholdings are respected, have greater authority and often take part in village judicial arbitration. Households were categorised into three landholding groups: small, medium and large landholders, based on the area of irrigation land available to them (Richards *et al.*, 1999; Fox, 1983). In order to capture spatial and caste/ethnic hierarchy and socio-economic heterogeneities, households were randomly selected on a proportional basis from different locations, landholdings and castes from each ward of the Village Development Committee (VDC) served by the irrigation canals.

Although overall, the regression model presented in Chapter Five indicated statistically non-significant results in predicting odds of strong access to water by caste, the comparison of the *dalit* households in the three irrigation systems presented in Chapter Four (Section 4.2.1) shows that a significantly higher proportion of the *dalit* households in the FMIS reported strong access to water compared to their counterparts in the AMIS and the JMIS. Therefore, caste continues to be an important factor in the distribution of irrigation water. Households belonging to the *dalit* communities are socially, economically and politically excluded and have no say over policy decisions that affect their lives. In Nepal, neither land reforms nor irrigation interventions have been pro-*dalit* (Bhattarai, 2003; Wily *et al.* 2008). Customarily, caste status was associated with differential access to resources such as landholdings (Seddon, 1987; Cameron, 1998). As mentioned in Chapter Two (Section 2.10.1), households from higher caste groups have access to greater and more productive landholdings, while the *dalit* households have very little access to more productive parcels of land. Farming by the *dalit* households takes place primarily in unproductive and barren landholdings called *khoriya* which are usually situated at the edge of the village locality. These landholdings are not generally preferred by higher caste groups as they are not very productive and give less return for investment. The level of access to water by the *dalit* households is weak, partly because *dalit* households reside at the edge of the village, are often secluded from the normal communal activities and have landholdings at the tail-end of the canal.

The *dalits* have fewer landholdings which are unproductive and they also have weak access to irrigation water. This creates *double jeopardy* for the most deprived and vulnerable members of Nepalese society and further reinforces already existing inequalities. However, comparative study of the three irrigation systems clearly demonstratesd that the *dalit* households in the FMIS have better access to water than their counterparts in the AMIS and the JMIS. The institutional structures designed and implemented in the FMIS are egalitarian and based on democratic values and the principle of proportionality. Lack of such democratic decision making in the AMIS and the JMIS, supported by existing structures of authority, reinforces already existing caste exclusion. Unlike in the FMIS, both the JMIS and the AMIS have not implemented proportionality principles in the issues of irrigation governance. The current institutional arrangements in the AMIS and the JMIS maintain status quo rather than breaking barriers, and farmers from the *dalit* communities do not benefit as much as they should. Therefore, in the absence of a more egalitarian management regime, households from the *dalit* communities are more likely to lose out from irrigation development than those from the higher caste groups. It can be argued that if the status quo is maintained and inflexibility towards social transformation, including resource governance, is continued, a wave of disenfranchisement and disincentive for collective action prevail. This, in turn, leads to fraud, non-compliance with rules, non-maintenance of canals and so on, ultimately leading to what Hardin called "*the tragedy of the commons*" (Hardin, 1968). Political dominance of non-*dalit* elites over the *dalits* and other indigenous caste groups has meant that the latter's influence over local natural resource governance is very feeble.

The livelihoods of more than 1.3 billion small farmers in the developing world critically depend on agriculture and its associated activities (Dixon *et al.,* 2001). Small landholders are vulnerable to food insecurity owing to low productivity and small or negligible landholdings in their dispositions (Tiwary, 2005). Numerous studies have shown that irrigation plays a crucial role not only in enhancing food security but also lifting people out of poverty (Angood *et al.,* 2002; Brabban *et al.,* 2004; Hussain, 2007). Thus it is necessary to ensure water security for the marginal farmers, but distributional implications of the irrigation infrastructure have not been explored in greater detail. In many instances, the benefits from the irrigation developments have gone to the rich and large landholders, who own the irrigable and most fertile lowlands. The poor, who are often either landless or have only a small patch of non-irrigated upland, are deprived of the benefits accruing from investment in irrigation, which mostly come from the national treasury or international grants and loan assistance.

Although the overall regression model presented in Chapter Five predicts a statistically non-significant result, the large landholding is positively associated with strong access to water. A higher proportion of farmers with larger landholdings reported having strong access to irrigation compared to farmers in the medium and small landholding categories, as described in Chapter Four (Section 4.2.2). The small landholding is negatively associated with strong access to water and the difference is statistically significant, as shown by the regression model presented in Chapter Five (Section 5.3.1). Equally important, a cross-system comparison in Chapter Four (Section 4.2.2) indicates that a higher proportion of small landholders in the FMIS reported having strong access to water compared to their counterparts in the AMIS and the JMIS.

Also, whilst it is understandable that larger farmers require more water than small farmers because of the large amount of land at their disposal, but for them to have strong access to water whilst small farmers struggle for this access raises serious questions about the current water allocation procedures. Also, because of the egalitarian institutional arrangements implemented in the FMIS as described in Chapter Six, the small farmers have strong access to water compared to their counterparts in the AMIS and the JMIS. These findings are interesting, since the government invests massively in the expansion of irrigation facilities in Nepal to improve the livelihoods of the rural poor. It begs the question is the current distribution of benefits from irrigation equitable, as the level of access to irrigation water by the marginal farmers is less than their larger landholding counterparts. This creates a vicious circle, where more and more small farmers, particularly those whose livelihoods depend on agricultural activities will be trapped in poverty and insecure livelihoods.

The results of the statistical analysis indicate that head-tail inequalities continue to be a major concern in irrigation systems in Nepal. Although the head-enders enjoy their locational advantages in all the three irrigation systems, the tail-enders in the FMIS have better access to irrigation water than their counterparts in the AMIS and the JMIS. A clear asymmetry between head and tail-enders exists. However, the WUA in the FMIS designed and put in place appropriate institutional arrangements to internalise this issue. Firstly, the farmers in the FMIS always irrigate from the tail-end both in the main canal and also at the branch canal level. The contiguity in water application has also helped to ensure water at the tail-end. The sanctions and their strict enforcement have deterred the head-enders from demonstrating opportunistic behaviour in water appropriation. However, in the AMIS and the JMIS, the lack of appropriate sanctioning mechanisms and weak enforcement of the rules and non-contiguity in water application have further increased already existing asymmetries between the head and the tail-enders. Both in the AMIS and the JMIS, the head-enders often perceive water to be 'easily available' leaving a tendency to appropriate more than their entitlement or more than the amount necessary for crop growth. Also, the head-enders have not made any particular effort to block leakages, assuming that such leakages are the problems of the downstream farmers. Unless the headwork is damaged or there is a major leakage which massively reduces the water availability to the head-enders, they make no efforts to control them. The cumulative impact of such a level of indifference by the head-enders has serious consequences for the tail-enders (Bromley *et al.,* 1980; Moore, 1980, Skold *et al.,* 1984; Wade, 1988). Absence of an appropriate sanctioning mechanism for such ignorant and indifferent attitudes to the problems, which could jeopardise collective outcomes, has meant that the needs of the tail-enders have been consistently ignored in both the AMIS and the JMIS.

Also, the presence of a permanent headwork both in the JMIS and the AMIS has meant the head-enders are less dependent on the tail-enders to keep the systems running smoothly. As long as the headwork is functional and the head-enders can appropriate water, their propensity to co-operate with the tail-enders is very low and an '*up-canal monopoly*' in water use has been rampant (Price, 1995). However, in the FMIS, the temporary nature of the headwork needs regular repair and this is necessary even for the head-enders, as lack of maintenance of the temporary headwork will seriously jeopardise their water availability as much it does to the tail-enders. The interdependence between the head and tail-enders in the FMIS has led farmers to cooperate with each other, irrespective of their location along the canal. Unfortunately, the head-enders in the AMIS and the JMIS do not have to take this factor into consideration in appropriating water from the canal.

It is equally important to rethink the strategies adopted by the government in cement lining the canals to enhance their performance, partly because this has not improved despite high investment. Cement lining can reduce the interdependence amongst farmers to co-operate with each other and work collectively. Furthermore, the cement lined canals, once damaged by tree roots growing along the canal bank and also the presence of aquatic crabs, suffers greater seepage and exacerbates head and tail inequalities. Seepage increases water salinity and reduces soil productivity in the land located at the head end section of the canal command area. I am not suggesting that the canal systems should not have permanent headworks or always have temporary headwork, or that canals should not be cement lined, but my aim is to raise awareness about the factors which deter the head-enders from participating in collective action and to highlight the necessity for appropriate institutions to be put in place to rectify the activities of the head-enders.

The results from the statistical analysis demonstrate that gender is negatively associated with access to water from the canal. The level of access to irrigation water amongst female-headed households in different irrigation systems which are governed by different property rights regimes is statistically significant. A significantly higher proportion of female-headed households in the FMIS reported having strong access to irrigation water compared to their counterparts in the AMIS and the JMIS, as presented in Chapter Four (Section 4.2.5). The analysis presented in this thesis indicates growing gender differences in access to and control over irrigation water. In fact it is almost a ritual for women to participate in the more laborious operation and maintenance activities, whilst men dominate the decision making in the WUA. Women's contribution in the non-decision making sphere of agricultural activities such as weeding, seedling preparation, transporting manure, harvesting, participating in cleaning the canal and so on continues to be significant in Nepal. However, the assumption that the women will automatically hold water rights and appropriate benefits indirectly through the males, particularly their husbands, and that the latter will represent women's issues well in irrigation governance are driven by stereotypical beliefs which needs rethinking if women are to benefit from irrigation and be lifted out of poverty (Agarwal, 1994; Zwarteveen, 1997). Although, generally the participation of women in the WUA is low in all the three irrigation systems considered for this study, women's level of access to water and their participation in the management of the irrigation system was significantly higher in the FMIS compared to both the AMIS and the JMIS. Women's better access to irrigation water in the FMIS can be attributed to the robust institutional mechanisms designed and implemented, compared to the institutional arrangements in the AMIS and the JMIS.

Similarly, farmers' agronomical knowledge helps to reduce wasteful use of water. Household perception of access to water is being influenced by level of agricultural knowledge. For example, it is common to assume that greater water application ensures higher crop yields amongst the farmers, who lack even some basic knowledge of crop-water requirements. And those farmers both waste water and are more likely to over-appropriate it, creating water shortages for the tail-enders. Too much water application also increases soil salinity and reduces soil productivity in the long term. Therefore, it is imperative that the WUAs should invest their resources in launching awareness raising campaigns to educate farmers about the appropriate use of water. This will help farmers to change their attitudes towards the environment and enhance their knowledge not only on the impact of agriculture in the environment but also the consequences of their activities in over-appropriating irrigation water from the canals.

It should be pointed out that the WUA in the FMIS has implemented some awareness raising activities like "door-to-door" visits and through local women's groups, while such activities were absent both in the AMIS and the JMIS. In fact the WUA in the FMIS allocated a budget for awareness raising campaigns and the programme is considered an essential part of WUA's annual programmes. Interestingly the WUA in the FMIS has utilised local beliefs such as the construction of a *Kali* temple to ensure the canal infrastructures are not tampered with and water flow is not obstructed.

This research also highlights the importance of social capital for enhancing collective action in managing irrigation resource bases. It has revealed that communities with a high level of trust tend to have strong access to water, while low levels of access are associated with low levels of trust. Trustworthiness amongst individuals and between households helps to establish a bond between individuals managing natural resources. Both interpersonal and inter-household trust provide much needed impetus to build up confidence in promoting co-operation and solving collective action problems (Coleman, 1990; Putnam *et al.*,1993). However, it has to be stressed that absence of trust creates conflict, making difficulties in the maintenance of field channels and control structures, which in turn make water delivery unreliable, inadequate and inequitable or all three, and water theft is common under these circumstances, which might have led farmers to report weak access to the resource (Uphoff and Wijayaratna, 2000). Alternatively, weak access to water can cause resentment amongst irrigators and those who do not get their fair share lose their confidence in collective action and hence report a low level of trust. Therefore, these findings are indicative rather than definitive in terms of causality between social capital and access to irrigation water and a further research is needed to ascertain whether a high social capital (trust) leads to better access to water or vice versa. Nonetheless, the notion of trust and its understanding remains a critical factor for channelling information, establishing social norms and raising expectations and fulfilling obligations in building institutions for managing natural resources including irrigation resources (Coleman, 1990). These in turn foster collective actions for minimising defrauding activities which have major implications for the maintenance of and ensuring unconstrained flow of water in the canal.

It should be mentioned that it is not just the trust amongst the neighbouring farmers that is important in irrigation governance, trust between the farmers and the WUA also remains critical as through trust, the later is able to gain support and loyalty from the entire rural community to achieve their collective objectives of managing irrigation systems. Hence, trust not only boosts the morale of the WUA, but also empowers local farmers to believe in and show a high degree of engagement in collective action whilst at the same time demanding responsiveness from the WUA (La Porta *et al.,* 1996). Previous studies also have shown that the level of trust among the irrigators is positively associated with collective actions, which are necessary for canal operation and maintenance (Seabright, 1993; Lam, 1998; Ostrom, 1990). The comparative study of the three irrigation systems considered here indicates that a significantly higher proportion of farmers in the FMIS reported a higher level of trust with regards to the irrigation issues amongst themselves and stronger access to water compared to the farmers in the AMIS and the JMIS.

Similarly, this research also has highlighted the influence of the physical characteristics of the irrigation canal systems on household level of access to irrigation water. In fact there has been a long standing argument on the physical-environmental factors in shaping, limiting or determining various forms of group-shared behaviour (Berry, 1976; Dunlap and Catton, 1983). Perhaps two of the most interesting findings of the thesis are the impact of canal gradients and the shape of the canal on household's level of access to irrigation water. The pattern of infrastructural development in Nepal such as roads, irrigation canals and electricity lines all follow river gradients. While the canal construction costs may be reduced by following river gradients during the construction of the canals, the operation and maintenance tasks become laborious once the canals come into operation. The canals flowing in east-west or west-east directions have mild gradients and require less operation and maintenance while those flowing in north-south direction have steep gradients and require more operation and maintenance activities (Regmi, 2007). Both the AMIS and JMIS have deep high gradients with steep slopes and canals are prone to landslides necessitating a regular operation and maintenance of the canals. However, farmers in those two systems namely the AMIS and the JMIS had a level of low social capital (low level of trust) amongst each other not least in organising collective actions for canal maintenance. Whilst the physical nature of canal demanded high level of collective action, the community's failure to organise such collective actions had serious implications water availability and ultimately in the household level of access to irrigation water.

Also, another important factor influencing household access to water is the shape of the irrigation canal. The regression analysis in Chapter Five (Section 5.3) demonstrated that the odds significantly decreased on being served by a canals which are elongated and with a number outlets at multiple and distant locations. In the mid-hills areas in Nepal, the elongated canals transcend across difficult geographical terrains which make them prone to landslides and need regular operation and maintenance. Also, outlets at the numerous and distant locations make it incredibly difficult for the WUA and other farmers to monitor the activities of the farmers. In the absence of proper monitoring mechanisms and well implemented sanctions imposed on the defrauders, farmers in such canals are often involved in water defrauding which have serious implications for water particularly at the tail end. It has to be mentioned that the costs for monitoring such elongated canals with numerous outlets and distant locations are also significantly high (Easter, 2000).

Whilst the differences in the level of household level of access to water have been demonstrated in Chapter Four and Chapter Six, the reasons for such discrepancies were explored in Chapter Six through an institutional analysis of the governance structure and water distribution mechanisms designed and implemented in the three irrigation systems considered for this research.

2. What roles do institutions play in enabling farmers' to access irrigation water?

a) *What are the enabling institutions for farmers to access water from the irrigation canals?*

b) *What are the lessons that irrigation systems governed by different property rights structures can learn from each other to maximise their impact on farmers' abilities to access water?*

There is a growing awareness that institutions play a critical role in the process of irrigation development (Coward, 1980; Shivakoti *et al.,* 2005; Ostrom; 1990). In fact, policy debates in natural resource management has circled around *"getting the prices right to getting the property rights right to getting the institutions right"* (Williamson, 1994 p.3). With a due acknowledgement of this policy debate, this thesis has carried out an in depth comparative institutional analysis of the water distributions in the three irrigation systems. The rationale for doing so was to identify some of the 'enabling institutional' arrangements embedded within the FMIS which enhance farmers' ability to access water.

Nepal, with its rich hydraulic civilisation and abundant irrigation systems which are governed by different property right regimes provided a fertile terrain to undertake a comparative study of the irrigation institutions. Institutions are considered as humanly designed arrangements which either facilitate or constraint human interactions. As such, institutions represent a set of ordered relationship amongst individuals, which define their rights, acknowledge the rights of others, privilege, forbearance and responsibilities which in turn provide action situations and determine the incentive environment behavioural conditions for human interactions (Ostrom, 1990).

The thesis has made use of a modified "Institutional Analysis and Development (IAD) Framework" to compare water distribution rules across the three irrigation systems more systematically. The theoretical model proposed in this thesis argues that the access to irrigation water from the irrigation canal is affected by four major variables. These variables include the following (a) attributes of the physical world, (b) attributes of the community within which actors are embedded, (c) rules that create incentives and constraints for certain actions, and (d) interactions with other individuals.

By applying a modified IAD framework the thesis has *"emphasised the effect of both formal and informal institutions and their effect on outcomes amongst actors in public organisation and collective groups"* (Heikkila and Issett, 2006 p.3). Furthermore, the IAD framework provided a unique opportunity for analysing decision making at multiple theoretical levels: Operational choice, collective choice and constitutional choice. The multiple levels of analysis help to diagnose different sets of rules and processes affecting the outcomes of irrigation interventions as rules in one level interact with rules and actions other levels. Kiser and Ostrom (1982) argue that the above mentioned "*three levels institutions are nested, with rules at the higher level impacting the production and governances of rules at the lower levels*" (cited in Hardy and Koontz, 2009 p.396).

Given the complex socio-environmental context in which the three irrigation systems operate, it is useful to recast the IAD framework in terms that captures not only the resource specific characteristics, communal characteristics and institutional features but also the exogenous variables that are useful in designing irrigation policy in Nepal. Whilst the original IAD framework has the historical emphasis on the production and appropriation of CPRs, a modification of the original IAD framework has enabled this research to specifically include exogenous aspects such as social capital (level of trust), human capital (agronomical knowledge of farmers), simplicity of irrigation governing rules and competitive use of water resources. The modified IAD framework is presented in Figure 7.1. The theoretical propositions on those exogenous variables are presented in Chapter Two (section 2.10), whilst the empirical verifications have been presented throughout the analysis chapters of this thesis (Chapters Four-Six).

The findings of the comparative study of three irrigation systems indicate that the design principles of the FMIS were more robust and egalitarian compared to the AMIS and the JMIS. This thesis neither prescribes nor advocates for '*a one size fits all*' model of irrigation management in Nepal. In fact, the thesis recognises the challenges posed by the complex socio-ecological systems within which the irrigation systems function. Furthermore, irrigation systems should be studied with a due consideration of the geographical terrains in which they are located and the institutional structures which are designed and implemented for their management. However, some general design principles which have worked well in the FMIS can be tried and tested in other irrigation systems too. The enabling institutions designed and implemented at the FMIS can indeed help towards achieving greater equity in the distribution of benefits from the irrigation. Whilst the irrigation management transfer programme is being vigorously persuaded by the Government of Nepal in recent years, the transfer should not be done without developing proper institutional arrangements.

The findings of the institutional analysis described in Chapter Six (Section 6.7) has attempted to identify "enabling institutions" to enhance access to water for marginal and vulnerable farmers. The purpose of the institutional analysis was to seek answers to research question (2a) and the "institutional lessons" that the irrigation systems can learn from each other i.e. research question (2b). These institutions are referred to as "enabling institutions" because they are egalitarian, fair and conducive for enhancing households' access to water particularly the marginal farmers, women, tail-enders and the farmers from *dalit* community.

The following section briefly revisits the findings of the institutional analysis in identifying the "enabling institutions" for enhancing farmers' access to irrigation water.

Autonomy: In the FMIS the irrigation community has a full control over the irrigation infrastructure and the flow of water in the canal whilst in the AMIS the irrigation system was run with a tight fist of the DoI without any autonomous rights granted to local users. Albeit some efforts were made to make the JMIS autonomous, the decisions were heavily reliant on and influenced by the DoI.

Contiguity: Water distribution in the FMIS takes places in a contiguous fashion where water moves from one landholding to another in a succession from tail end to the head end without moving back and forth whilst there was no contiguity in water distribution in both the AMIS and JMIS.

Proportionality: In the FMIS, both rights and duties are distributed in accordance to the principle of proportionality. All the farmers get water as per their entitlements and no one can over-appropriate more water than their legal entitlements. Also household contributions towards O & M are according to the amount of land under irrigation. However, such proportionality principles neither existed nor were implemented in the JMIS and the AMIS.

Uniformity: All farmers in the FMIS use water uniformly with same frequency (uniform rights) and with similar techniques. However both in the AMIS and JMIS no such uniformity in water distribution was practiced.

Regularity: All the farmers in the FMIS distribute water in the same way in every same season. However, such regularity in water distribution was absent in both AMIS and the JMIS. If needed, adjustments are made with regularity in every season in the FMIS. For example adjustment from the Monsoon to Winter and Winter to Spring are carried out similarly every year.

Transparencies: All the farmers in the FMIS are aware of the rules, their nature and have the capacity to conform to the rules. The analysis indicated that farmers in the AMIS and the JMIS lacked knowledge on the irrigation governing rules. This could be due to the proactive roles played by the WUA in the FMIS in organising social awareness regarding their irrigation system help to "*enhance common knowledge, awareness and skills by thinking, discussing and acting together*" (Borrini-Feyerabend *et al.,*2000 p.12). Simplifying rules through public awareness not only helps in understanding of the rules and regulations that guide the terms of resource management compliance by farmers, but also fosters a high degree of commitment to a process of mutual learning in which irrigators agree to achieve collective outcomes (Wondolleck and Yaffee, 2000 p.132). However, the WUA in the AMIS and JMIS did not make sufficient effort to raise social awareness amongst the farmers regarding irrigation issues.

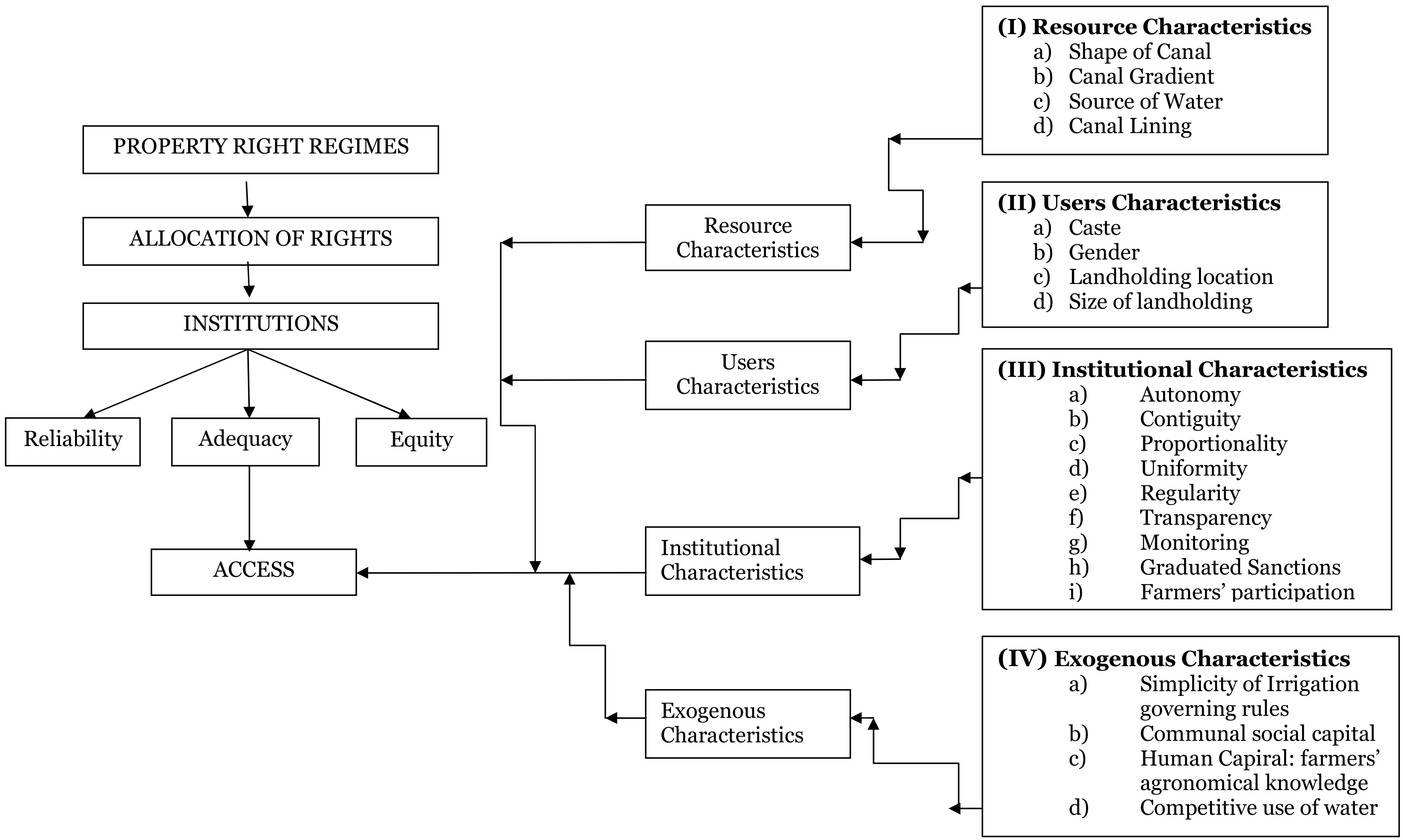
Monitoring: In the FMIS, both the WUA and individual farmers can keep track of each others' irrigation related activities both by themselves and also through the employment of water guards to ensure credible commitments are made and rules are adhered to. A proper monitoring mechanism is designed and implemented to ensure conformity to the irrigation governing rules including water distribution and contribution towards O & M activities. However, no such rules were presented in the AMIS and although some monitoring mechanisms were put in place in the JMIS, they were weakly enforced.

Graduated Sanctions: The WUA in the FMIS enforced rules and regulations, which were designed and implemented to govern irrigation system very strictly to ensure that farmers all conform to the rules and any infringements of the rules resulted in tough sanctions being imposed on the defrauders. However, both in the AMIS and the JMIS sanctions were rarely present and if implemented were weakly enforced and were not graduated and did not reflect the gravity of the defrauding caused.

Farmers' Participation: The governance structure of the WUA in the FMIS has enabled farmers to show an active participation in the management of their irrigation system whilst the governance structures of the JMIS and the AMIS were such that the farmers had little opportunity to participate in the management of their irrigation systems. Also, both the AMIS and the JMIS were characterised by heavy involvement of the DoI which did not necessarily understand the concerns of the local farmers.

Based on the analysis presented in the thesis, Figure 7.1 presents the modified model of the thesis with variables that this thesis has identified which have an affect in the household level of access to water from theirrigation canal systems.

Figure 7.1 Modified Theoretical Model of Thesis



The following section describes the policy lessons that the irrigation systems can learn from each other based on the findings of this research.

It is commonly believed that one of the key requirements in promoting users participation in managing an irrigation system is to devolve decision-making power so that the available water resource can be shared most efficiently and equitably (Fisher, 2000). The WUA should be autonomous both in terms of financial and administrative capabilities to make their activities more effective and more accountable to the local farmers and to maximise the impacts of irrigation development.

The operation of the WUA should be monitored through auditing of its financial and administrative responsibilities to ensure greater accountability and transparency are maintained. This will help to enhance to effectiveness and responsiveness of the WUA and make them answerable to the farmers. The monitoring should be for both the farmers and the WUA committee members to ensure their compliance to the rules of irrigation governance. In case of rules infringements, the sanctions must be applied to both the WUA committee and the farmers. The sanctions should be graduated and their severity should reflect the gravity of the offence. These findings are consistent with previous studies which suggest that irrigation organisations are shaped by variables such as the concentration of authority, structuring of activity, accountability and responsiveness (Uphoff, 1991).

Similarly, both rights and responsibilities should be based on the principle of proportionality. A greater share of benefits should be equated to a greater share of the responsibilities. Farmers' willingness to engage in and contribute towards the irrigation resources depends on their perceived long term benefits from them and sense of interdependence and mutual benefits from the natural resource as a result of involving in collective actions. The presence of well crafted and properly implemented sets of credible, simple and well understood and property enforced rules provide positive incentives for farmers to believe in and contribute towards the collection actions in managing irrigation systems (Regmi, 2007).

The water distribution should be uniform both in techniques and rights. Water should be divided amongst the farmers using similar technology which is critical to assure farmers that all the farmers in the system are using the similar technology and no one is using excessive water by tampering with gates and outlets. Although for different durations, the farmers should receive water with similar frequency. The duration of irrigation should reflect farmer's water rights based on the principles of proportionality. If the distribution of costs and benefits are based on the principle of proportionality then comments like "*he has irrigated five times this week but I just irrigated once or twice*" would be less likely to arise. Uniformity in irrigation frequency removes any clouds of doubts that some farmers might be having more water as they are using water more frequent that the others.

Another important lesson to be drawn from this study is the contiguity in the water application. The water availability can be made more predictable and reliable if water distribution takes place following a contiguous fashion as it avoids confusion over water scheduling and the movement of water in the canal. The water distribution scheduling practiced in both the JMIS and the AMIS were a discontiguous which moved water randomly back and forth in different locations of the canals which provided a real opportunity for farmers to tamper with water distribution particularly during the water scarcity period in those systems. Water applications at the tail ends and head ends leaving the middle section without water tempted farmers from the middle section to appropriate water by tampering with irrigation infrastructures such as unwarranted opening of gates in the canals. However, the farmers in the FMIS followed contiguity in water distribution where irrigation took place from the tail end with scheduling moving progressively upward in the canal. This ensured water for the most vulnerable groups i.e. tail-enders in the FMIS but in both the JMIS and the AMIS, the tail-enders faced consistent disadvantages.

7.4 Contributions to the Knowledge Made by This Thesis

This thesis has contributed to the knowledge primarily in three ways. Firstly, the thesis has made efforts to combine two types of research methodologies namely the qualitative and quantitative methods in irrigation research. The mixed methodology approach taken in this research has helped to draw a range of inferences from the research findings through methodological triangulation. Also, the methodological contribution made by this thesis is the use of subjective measure of access to irrigation water. Secondly, this thesis has made some important theoretical contributions in determining the factors that influence household access to irrigation water. Thirdly, the thesis has questioned the current thinking on irrigation management transfer and has initiated a policy debate on the effectiveness of such a policy shift. The following section presents a brief discussion on the contributions made by this thesis.

7.4.1 Methodological Contributions

7.4.1.1 Methodological Triangulation in Irrigation Research

While methodological triangulations have been used in sociological research, the studies of irrigation institutions have felt a dearth of methodological synthesis. Anthropological studies on irrigation have been overtly qualitative (Pradhan, 1991; Price, 1995; Wittfogel, 1956), while quantitative treatments of irrigation have failed to capture qualitative side of farmers' livelihoods which depends on irrigation water. Furthermore the quantitative treatments of irrigation have been treated mostly as exclusive domain of engineering, agronomy and economics (Wilson, 2008; Howell, 2001; Carruthers and Clark, 1981). However, studies of irrigation should not be reduced to a mere act of hydraulic engineering (Kelly, 1983) or price determination (Johansson, 2000) or agronomical calculations (Lascano, 2000).

The development of irrigation has been heralded as one of the most important achievements in human civilisation. This is because irrigation has helped human beings to grow crops to feed themselves. Initially, the development of irrigation represented a sophisticated development as water is diverted from its source through complex networks of canal to grow crop in distant places. The important nature of irrigation to human beings has made it an increasingly important economic good. In the past, irrigation has been treated as an exclusive domain of engineering. The treatment of irrigation issues explicitly from only one discipline has led to studying irrigation from a narrow defined methodology. The inferences drawn from such studies are one-dimensional and findings are restrictive in their generalisations. In response to these criticisms there is a growing recognition that studies of irrigation should be carried out with *"specialist knowledge of management and techniques which should be supplanted and influenced by detail local knowledge and by insights from other relevant disciplines including sociology, social anthropology and/or political science"* (Bottral, 1981 p.3). Recognising the importance of mixed method research, this thesis has used both qualitative and quantitative approaches to investigate the research problem posited in Chapter One. The use of multiple methods of data generation, which includes focus group discussions, key informant interviews and household survey, enabled the author to cross-check if the findings are consistent, rigorous and unbounded by any particular methodological approach. It is hoped that the methodological triangulation in irrigation research will make the findings more robust and recommendations made from such research more convincing and adaptable to the policy makers involved in irrigation development not in Nepal but also in other parts of the world.

7.4.1.2 Subjective Measure of Access to Water

Previous comparative studies on irrigation have mainly been characterised by macro level project appraisal studies, which tend to have an overwhelmingly technical focus (Laitos, 1986; Pradhan et al., 1988; Renault et al., 2007). At best, such research is undertaken to appease the donor agencies to secure funding for irrigation development. Some of the previous studies have carried out comparative study of the performance of the FMIS and the AMIS in Nepal, which mostly focused on performance measures (Lam, 1998; Shivakoti et al., 2005). The performance measures have been undertaken following technical procedures and not surprisingly have technical outcomes laden with technical jargon which the local farmers found very difficult to understand. As a consequence, the local farmers often have a considerable antagonism towards the technical individuals involved in irrigation enterprise as the former often felt water inadequate and poor performance of the system, while the latter would press on water abundance based on technical measures. Indeed in Nepal, the management of irrigation resources, particularly ones with involvement of external agencies have been characterised with the hegemony of technocrats and bureaucratic with no or little say by the local users (Lam, 1998). The technocratic hegemony has been characterised by objectivity in measuring performance of irrigation systems (Gorantiwar and Smout, 2005; Bastiaanssen and Bos, 1999). Whilst objectivity in measuring the performance of irrigation systems is necessary, it is not sufficient to measure irrigation performance from the perceptions of the local farmers. Also, the objective measure of irrigation performance rarely contributed towards empowering local farmers in measuring the performance of their irrigation systems. Engineers might measure how much water has reached the tail end of the canal and give an excellent performance rating for an irrigation system but they often ignore the fact that water flows through a range of socio-economic terrain. As a result, an overtly objective measurement of performance of the irrigation canal has obscured the 'perceptive' measure of access and led a systematic failure to incorporate farmers' perceptions in assessing their level of access to irrigation water. This thesis has attempted to rectify this.

7.4.2 Theoretical Contributions

This thesis has clearly demonstrated the fallacy of the current policy thinking in irrigation management which has become 'distributional blind'. The statistical analysis carried out in this research has highlighted the need for distributional aspects to be taking into consideration in any irrigation interventions. The results of the statistical analysis presented in Chapters Four and Five highlight that vulnerable farmers such as dalits, women, tail-enders and small farmers continue to face disadvantages in accessing irrigation water. However, these vulnerable farmers have a relatively better chance of engaging in irrigation governance in general and having a strong access to irrigation water in particular in the FMIS compared to their counterparts in the AMIS and the JMIS. The egalitarian governance approach adopted by the FMIS has helped to ensure that the most vulnerable farmers do not face any disadvantages in appropriating benefits from irrigation canals. The design principles of the FMIS could be replicated and tested in other irrigation systems to ensure that the some of the distributive aspects of irrigation interventions illustrated in this thesis can be addressed.

While it may not be totally surprising to see head and tail inequalities in gravity flow irrigation systems, the level of difference on the level of access to irrigation water amongst the farmers who are being served by irrigation systems governed by different property right regimes is very striking. Also, the higher amount of benefit appropriations by male-headed households, high caste households and large farmers and their dominance in irrigation governance begs questions on the efficacy of the reforms in the irrigation sector. The reform strategies to overcome these endemic problems through Irrigation Management Transfer (IMT) have not still been able to look at the distributive aspects of irrigation interventions.

Taking property rights as a theoretical premise, this thesis has demonstrated that institutions play a pivotal role in enhancing or constraining farmers' level of access to irrigation water. The institutional arrangements designed and implemented in the FMIS, which is a Farmers Managed Irrigation System are more conducive in terms of enhancing farmers' level of access to irrigation water compared to the institutional arrangements implemented in the AMIS and the JMIS which are Agency and Jointly Managed Irrigation Systems respectively. This thesis has identified some of the institutional arrangements which are found to be more '*farmer friendly*' in terms of enhancing their ability to access water from the canal systems. These institutions include autonomy of the systems, contiguity of water distribution, proportionality of rights and duties, uniformity in water distribution and water distribution techniques, development of a proper monitoring mechanism and graduated sanctions for to control defrauding and to ensure compliance to the rules governing irrigation systems.

Apart from socio-economic factors influencing household level of access to water, some of the other research findings from this thesis are worth mentioning particularly the role of social capital (trust) and the shape of the canal and its gradient in ensuring a better access to irrigation water. The results of statistical analysis reported in Chapter Four (Section 4.2.9) and Chapter Five (Section 5.3) indicated that households with a low level of trust with other farmers are significantly less likely to report a strong access to water while those with high level of trust are more likely to report a strong access to irrigation water. The absence of trust amongst the farmers and between farmers and the WUA can give rise to conflicts in the management of irrigation systems. Because of the conflicts amongst the farmers, there is little co-operation in maintaining field channels and control structure, which in turn makes water delivery not only unreliable but also inadequate. In the absence of trust amongst the farmers, and water theft is common which fuels water related conflicts.

Similarly, the shapes of the canals and their gradients have a significant influence on household access to irrigation water. The pattern of infrastructural development in Nepal such as roads, irrigation canals and electricity lines follow river gradients. While the canal construction costs may be reduced by following river gradients during the construction of the canals, the operation and maintenance tasks become laborious once the canal comes into operation. The canals flowing in east-west or west-east direction have mild gradients and require less operation and maintenance while those flowing in north-south direction have steep gradients and require more O & M activities. This will have an impact on farmers' ability to access water from the canal systems.

Also, the thesis demonstrates that the shape of the canal also have implications in the way the water is distributed in the irrigation systems. Farmers reported that irrigation canals which are long, elongated and with outlets at numerous places have higher degrees of inequalities in water distribution. The farmers reported that existence of numerous outlets at multiple locations along the elongated canals makes it extremely difficult to monitor farmers' canal related activities and the monitoring activities become costly. In the absence of a proper monitoring mechanism, the defrauders find it easier to tamper with the canal infrastructures to appropriate more water than their entitlements. However, in irrigation canals which are both short and non-elongated and have a fewer number of outlets, where the outlets are located at a close distance along the canal, makes farmers' canal related activities more visible and easy to monitor. The relative ease in monitoring farmers' canal related activities reduces the chances of tampering with the canal infrastructures. As a result, there will be fewer incidences of water thefts and infrastructural vandalism, which helps to distribute water more equitably. In such irrigation systems farmers find it difficult to tamper with the canal infrastructures as it is easy to monitor by the WUA.

7.4.3 Contributions to Policy Debates in Irrigation Management

The IMT has been persuaded by many governments around the world and Nepal is no exception to it. The logic and rationale for the transfer is to benefit farmers by improving efficiency and reliability of water supply through the participation of the beneficiary farmers in the decision making process. However, while the intention of the IMT sounds good and performance might temporarily improve, the assumption that the IMT is the panacea to the chronically underperforming irrigation systems begs questions. The transferred irrigation systems do not operate in a vacuum and the transfer should be persuaded only after the development of sufficient communal capacity so that the community can manage the handed resources. The institutional set up should be studied carefully and modified gradually if necessary before the transfer of the irrigation systems. The unequal level of access to irrigation water and distribution of the benefits of irrigation in general are institutional problems. These institutional problems should be resolved as institutions guide users' activities which in turn will determine the long term sustainability of the irrigation systems. Similarly, the transfer process should be preceded by a clear delineation of the scope and the boundaries of the users and the agency involved in the management of the irrigation systems. A clear delineation of rights and responsibilities of all the stakeholders would reduce confusions as to who should do what and when.

7.5. Policy Recommendations and Future Directions for Research

The current water distributions mechanisms in the two irrigation systems namely the AMIS and the JMIS, continue to reinforce traditional social and economic hierarchies prevalent in rural Nepal. The IMT strategies and the institutional rules which are currently implemented do not take into account the distributional aspects of irrigation interventions. This study recommends that the marginal farmers such as women, the *dalits*, small landholders and tail-enders should be given adequate representation in the management of irrigation systems which would give a voice to the less powerful and facilitate more impartial rules. The water distribution should follow a contiguous pattern during irrigation which will help to reduce the water loss and defrauding activities. The use of uniform techniques and frequency in the distribution of water from the canal resource would help to enhance equitable distribution of irrigation water. Similarly, rights and duties associated with the irrigation activities should be divided proportionally amongst the farmers to ensure that the contribution of the farmers in O & M activities.

Research in the future should focus on the effects of institutions on the trickle down effects of irrigation interventions. Along with property right structures, research in the irrigation sector should consider the institutional arrangements incorporating all aspects of the rules governing irrigation systems, water distributions and responsibilities towards operation and maintenance activities.

7.6 Strategies for Disseminating Research Findings

The dissemination of research findings is absolutely critical for policy changes to bring about the necessary shifts in policy thinking in irrigation sector in Nepal. To this end, the dissemination strategy involves interactions with local farmers and government policy makers. Firstly, I intend to organise end user networks within, and across, case study sites, which will involve the respective WUAs as coordinators and the respective DIO of the district in which the three irrigation systems considered for this research. Secondly, I am planning to organise local dissemination activities such as presentations and workshops in every case study area to raise awareness about the distributional implications of irrigation water and importance of institutions for the successful management of irrigation resources. Thirdly, I will establish strong links between the WUAs, DoI and the National Federation of Irrigation Water Users' Association (NFIWUA) in Kathmandu to highlight the importance of research findings and the lessons which can be learnt from the findings. A workshop is planned to this end in which local researchers, academicians, government officials, professionals and NGO members working on community-based natural resource management will be invited to attend. I will also disseminate the results through IUCN/Nepal, NFIWUA, Nepal Water Conservation Foundation (NWCF), Farmers Managed Irrigation Systems Promotion Trust (FMISPT) and other organizations working on water issues in Nepal. Fourthly, I will disseminate my research through the publication of a number of research papers in academic journals. Fifthly, I will also create a website (to be hosted by the NFIWUA in Kathmandu) to disseminate research findings and provide reports in downloadable form.

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APPENDICES

Appendix 1:

Appendix 1a: Commonly used internal and external performance parameters, their definitions and indicators (Wahaj, 2001)

	irrigation system and its deliveries conform to prior expectations of its users (Rao, 1993).	• Temporal coefficient of variation of the ratio of actual water delivery to demand[2]:	$P_D = 1/R \sum_R cv_T (Q_D / Q_R)$ Where CV_T (Q_D/Q_R) = Temporal Coefficient of Variation Q_D/Q_R for a specific location in a region R over a time period T Q_D/Q_R = water delivered/ water required
Efficiency	• Conservation of water recourses in the delivery process or the prevention of over deliver (Molden and Gates, 1990)	• Ratio of water required to water actually delivered: • Conveyance Efficiency: • Distribution Efficiency: • Field Application Efficiency: • Overall Project Efficiency:	$P_F = 1/T \sum_T 1/R \sum (Q_R / Q_D)$ Where Q_R/Q_D = water required/ water delivered to a region R in time T Total water supplied by the conveyance system / Total inflow into the conveyance system Total water delivery to field / Total inflow into the delivery system Crop irrigation water requirement / Water delivery to the field Crop irrigation water requirement / Total inflow
Productivity	• Output per unit of means of production (land and water)	• Yield per unit of land: • Yield per unit of water: • Output/unit of cropped area: • Output per unit of water supply: • Output per unit of water consumed:	Kg/ha Kg/m^3 $/ha $/ m^3 $/ m^3

[1] When rice is considered deep percolation and seepage losses are added to crop demand.
[2] Delivery Performance Ratio is also used as an equity indicator (Murray-Rust and Snellen, 1993)
[3] These two indicators are referred to as the 'dependability' indicators by Molden and Gates (1990) and Bos *et al.* (1994).

Performance Parameter	Definition	Indicator	
Adequacy	• Amount of water delivered to versus amount of water required. • Amount of water delivered to adequately fulfil crop water requirement (Molden and Gates, 1990). • Measure of the degree to which delivery meets soil-plant-water requirements (Murray-Rust and Snellen, 1993).	• Relative Water Supply: • Relative Irrigation Supply: • Ratio of actual water delivery to demand:	Water supply (irrigation water + rainfall) / Crop demand[1] (crop evapotranspiration) Irrigation water supply (irrigation water) / Irrigation water demand (crop evapotranspiration – rainfall) $P_A = 1/T \sum_T \left(1/R \sum_R Q_D / Q_R \right)$ Where Q_D/Q_R = water delivered/ water required to a region R in time T
Equity	• Spatial uniformity of the ratio of the delivered amount to the required amount (Molden and Gates, 1990) • An expression of the share for each individual or group that is considered fair by all system members (Murray-Rust and Snellen, 1993).	• Coefficient of variation of Delivery Performance Ratio: • Modified Inter-quartile Ratio: • Spatial Coefficient of Variation of the ratio of actual water delivery to demand:	CV (DPR) Ratio of average depth of water received by the land in the best quarter, to the average depth of water received in the poorest quarter of land $P_E = 1/T \sum_T CV_R (Q_D / Q_R)$ Where CV_R (Q_D/Q_R) = Spatial Coefficient of Variation Q_D/Q_R for a specific time over a region R Q_D/Q_R = water delivered/ water required to a region R in time T
Reliability	• An expression of confidence by the irrigation system to deliver water as promised (Murray-Rust and Snellen, 1993). • The degree to which the	• Delivery Performance Ratio[2]: • The ratio of actual to the intended duration of water delivery[3]:	Actual discharge / Target discharge or Actual Volume / Target Volume Actual duration of water delivery / Intended duration of water delivery

Appendix 1b: Literature on Irrigation Performance Measurement

Researchers	Performance Measure
Abernethy (1986)	Equity, regularity, reliability and durability
Chambers (1988)	Productivity, equity and stability.
Uphoff (1988) and Steiner (1991)	Productivity, equity, harmony, environmental sustainability and economic sustainability or cost effectiveness
Abernethy (1989)	Productivity, equity, profitability, sustainability and quality of life.
Plusquellec *et al.* (1990)	Water availability, water use efficiencies (conveyance, field application and overall efficiencies), equity of water distribution, cropping intensity and crop yields and project economic rates of return.
Molden and Gates (1990)	Adequacy, efficiency, dependability and equity at different levels in the water delivery systems.
Goldsmith and Makin (1991)	Adequacy, equity, reliability, productivity and equity.
Makin *et al.* (1991)	Water delivery performance parameters such as actual versus targeted water supply along with equity, reliability and adequacy
El-Awad *et al.* (1991)	Adequacy, water losses (distribution efficiency), equity, cost (annual operating cost of system per unit area), water users convenience and durability
Kaushal *et al.* (1992)	Productivity, equity and adequacy.
Mujumdar and Vedula (1992)	Reliability (matching water release from the reservoir in particular period with total irrigation requirement of all the crops in that period), resiliency (likelihood of the system recovery from a failure once a failure occurs) and productivity.
Bos *et al.* (1994)	Water supply performance (conveyance indicators, maintenance indicators, utility of water supplied, and equity), agricultural performance (area indicators and production indicators) and economic, social and environmental performance (economic viability, social viability and environmental sustainability and drainage)
Purkey and Wallender (1994)	Water supply and deliveries, water conveyance, on-farm irrigation and the environmental sustainability
Meinzen-Dick (1995)	Timeliness of irrigation (cumulative deficit in water deliveries over the crop season and cumulative excess in water deliveries over the crop season)
Oad and Sampath (1995)	Adequacy, dependability (reliability and predictability) and the equity
Kalu *et al.* (1995)	Productivity (agronomic efficiency-the total quantity of crop production under irrigated agriculture and economic efficiency-the total net benefits) and equity
Makadho (1996)	Adequacy, equity and timeliness
Small and Rimal (1996)	Productivity (conveyance efficiency, physical productivity of water, physical productivity of land, economic productivity of water) and equity.
Bos (1997)	40 multidisciplinary performance indicators, which cover water delivery, water use efficiency, maintenance, sustainability of irrigation, environmental aspects, socio-economic and management
Sarma and Rao (1997)	Water supply–requirement ratio, irrigation intensity, crop productivity and change in cropping pattern
Makombe *et al.* (1998)	Deviation of actual water supply from the desired supply as measured by the crop water requirement adjusted with the effective rainfall (how accurately the water management system is achieving the desired supply).

Appendix- 2

Household Survey Questionnaire

THE UNIVERSITY OF YORK

Department of social policy and social work

Doctoral Student: Mr.Bishnu Pariyar

Questionnaire

Conducted at:
Phalebas Irrigation System (FMIS)
Begnas Irrigation System (AMIS)
Rainastar Irrigation System (JMIS)

Date of Survey: 26/10/2007-27/12/2007

Type of Survey: Rural Household Survey
Number of Respondents: 249

Language translated to: Nepali

Namaste!

I am conducting a research on institutional aspects of irrigation governance in Nepal. For the purpose of this research, the Phalebas, Begnas and Rainastar Irrigation Systems have been selected for conducting household survey. This research is solely for academic purpose and all your responses will remain confidential. We will try our best to share the results of our research with you once it is completed. We will be extremely grateful if you agree to collaborate with us and give some of your time to answer a set of questions we have. The questions are designed to help us understand how irrigation systems are managed and irrigation water distributed. We thank you for your time and eagerly hope for your cooperation.

Would you like to participate in the interview?

yes ☐ → Proceed to question A

no ☐

Researcher: Bishnu Pariyar
Date of Interview:
Household Head Name:

Interviewer:
Village/Ward

Age...... Caste.......

A. DEMOGRAPHIC INFORMATION

Q. 1a. Please read out and fill the following household information

S.N.	HH Members	Age (Yr)	Sex (M/F)	Education No. of School Yr.	Occupation Code
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Occupation Code:

Agriculture = 1 Business = 2 Public Service = 3 Private Service = 4
Cottage Industry = 5 Agriculture + Business = 6 Agriculture + Service = 7
Wage Labour = 8 Other = 10 (Please Specify...)

B. LANDHOLDINGS, TENURE AND PRODUCTION SYSTEM

Q 2a What type and how much Land you have got?

SN	Type of Land*	Amount of Land (*Ropani*)
A	Khet Bari	
B	Pakho Bari	
C	Khar Bari	

* NB: arranged in terms of productivity

Q 3a Please fill the table below to the best of your knowledge to inform us about the agricultural activities/ output for major crops

Activities	Crop1	Crop2	Crop3	Crop4	Crop5
Name of Crop (most important first)					
Method of Irrigation water distribution *					

Farmers using HYV for this crop					
Farmers using chemical fertilizer/pesticides					
Max. yield (Muri/Rp.) Min Yield (Muri/Rp)					
Average Yield (Muri/Rp)					
Fraction of Crops marketed (%)					
Rainfed based yield (Muri/Rp)					

* Mode of irrigation Distribution:
1.= continuous flow 2. rotation 3. demand 4. request 5. others

Q 4a State the location of majority of landholding with respect to main and outlet canals

Canal Reference	Location		
	Head End	Middle End	Tail End
Main Canal			
Outlet Canal			

Q.5a. Did you do Adhiya or tyahu last year?

1. Yes 2. No

If yes to Q 5a. go to Q. 6a. If No Go to Q. 7a

Q. 6a How was the production cost shared?

Production factors	production cost sharing	
	By Land Owner (prop./amount)	By land Cultivator ((prop./amount)
Seeds/Siblings		
Labour Cost		
Manure		
Time/ money in Irrigation O & M*		

* it is not clear that, whether landlord or the crop sharer contribute towards O & M activities as conditions for access to water

Q. 7a what are the major crops you have produced in the past year and annual income from selling agricultural products?

SN	Unit	Total Production	Unit Sold	Unit Price (Rs)	Total Income (Rs)
1	Rice				
2	Maize				
3	Millet				
4	Wheat/ Legumes				
5	Mustard				
6	Barley				
7	Fruits				
8	Potato/ Vegetables				
9	Peanuts				
10	Others				

Q. 8a How long the field crop production can meet your household food demand?

1. < 3 months 2. 3. to 6 months 3. 6 to 9 months 4. 9 to 12 months 5. > than 12 months

Q. 9a Did you have enough food for your family before irrigation canal operated?

1. Yes 2. No

Q.10a Do you have enough food for your family after irrigation canal operated?

1. Yes 2. No

C. NATURAL RESOURCE MANAGEMENT AND UTILISATION

Q.1c What is the total area irrigated, and fallow, in *Ropani* during each cropping seasons #

Area/Season*	Spring		Monsoon		Winter		Area Irrigated by Pvt. Kulo (Indicate S/M/W)
	Khet	Pakho	Khet	Pakho	Khet	Pakho	
Irrigated area (*Ropani*)							
Unirrigated area (*Ropani*)							

Q.2c Tick as appropriate to inform us about your experience of water appropriation from irrigation canal

Reliability (wt. 1/3)						Adequacy (wt. 1/3)						Equity (wt. 1/3)					
Seasons						Season						Season					
Monsoon		Winter		Spring		Monsoon		Winter		Spring		Monsoon		Winter		Spring	
Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No

* Seasons: Monsoon- June 1- October 31; Winter- November 1- January 31; Spring- February- May 31
# those area which were pakho before irrigation canal construction, should be treated as pakho

Q.3c Please tick, which location does majority of your landholdings are located and put appropriate number below to indicate the characteristics of water availability

Characteristics of water availability (Put number from below marked by * below)	Location (Indicate your location as Head end, Middle end or Tail end (--------)		
	Monsoon	Spring	Winter

* 1= abundant 2= limited 3= scare 4= non-existence 5= do not know

Q.4c Approximately, how many hours do you irrigate your field using water from the irrigation canal

Type of	Length of time irrigation in different

Land /Season*	seasons (in Hours)*		
	Monsoon	Spring	Winter
Khet			
Pakho			

* if days/per week, change them to total hours in particular season

Q.5c How the irrigation water is distributed?

1. Family size/equity 2. Land size 3. According to the labour contribution during construction 4. Equal time irrespective of 1, 2 and 3

Q6c Are you satisfied with the existing distribution process?

1. Yes 2. No

Q7c. Do you use water for supplementary irrigation (During the wet season)?

1. Yes 2. No

Q8c If no, to Q3e, why not

Q9c. Do you feel you share of water you current get is fair in the scheme?

1. Yes 2. No

Q10c. If no to Q6e what do you think is the reason for the inequality?

1. Ethnicity 2. Gender 3. Political Power
4) Religion 5. Crop Type 6. amount and location of land
7.Others/Specify ---

Q11c. If there is inequality, which groups of people get more?

Q12c. If there is inequality, which groups of people get less?

Q13c. If you get less, do you believe this is reasonable?

1. Yes 2. No

Q14c. If no, what measures do you take in response?

1. Become Reluctant to participate in operation and maintenance
2. Try to over use water in my turn
3. Align with my likes in order to bring about equality
4. Other / specify --

Q15c. Do you get irrigation water if you are reluctant to participate in maintenance?

1. Yes 2. No

Q16c. Do you know about crop water requirement?

1. Yes 2. No

Q17c. If yes to Q16c, do you use crop water requirement rates for watering your fields?

1. Yes 2. No

Q18c. If yes, to Q16c. who gives you the rate?

Q19c. If yes to Q 16c, do you always stop watering when the rate is met even if the usual time given to watering turn is yet to get?

1. Yes 2. No

Q20c If no to Q 19c, why don't you stop at the given rate?

1. There is water uncertainty 2. I prefer to have some extra water table in my plot

3. Bad relationship with next plot & wants to give him/her less water 4. Other (please specify)

Q21c. Are there special considerations for crop-type and stage of growth during water allocation?

1. Yes 2. No

Q22c. If No to Q21c, what happens when somebody is convincingly in higher need of water for his/her field?

1. Can do nothing until his/her term is up 2. Can contact water controlling body in terms of emergency and get water
3. Can negotiate with the fellow irrigator of that turn and get water
4. Other/specify ---

Q23c. Do you pay any water use fees?

1. Yes 2. No

Q24c If yes to Q23c, How much do you have to pay (fees) for harvesting water from the irrigational canal annually?

NRs. ------------

Q25c. Is the fee paid towards the contribution of O &M costs?

1. Yes 2. No

Q26c. If No to Q25c, What are the fee collected used for?

1. Fee to Dhalpa 2. fee to irrigation officials 3. Operation and Maintenance
4. members of water users association

Q27c. Who determines who should get the water after you irrigated?

1. RIMC/AIMC/BIMC 2. Plot Comm. 3. Yourself 4. Your Neighbour 5. It's been following conventionally

Q28c. Do you have flexibility on as to which direction you want to put the outlet in your field plot?

1. Yes 2. No

Q29c If you have two different owners' land next to your plot, do you have preference as to whom you want to let have water?

1. Yes 2. No

Q30c Is your relatives' plot next to yours?

1. Yes 2. No

Q31c. If No to Q30c, what determines the as to who should get water after your plot?

1. Good social relation 2. financial incentives 3. party politics

Q32 c. Have you got alternative source irrigation, such as private kilos?

1. Yes 2. No

Q33c. what type of water division structures you are currently using?
1. Open-Close 2. Ad-hoc Adjustment 3. Fixed Proportion

Q34c. What type of water distribution methods is used?

1. Continuous to every user in proportion to land area or share

2. Continuous or rotational delivery of water to every user in proportion to land area, land type and crop

3. Continuous to certain Sections of irrigated area in proportion to land area or share and timed rotation within the Section

4. On demand, based on crop water need

D. OPERATION AND MAINTENANCE

Q1d. Did your household participate in the construction of the irrigation schemes?

1. Yes 2. No

Q2d. If yes to Q1d, How many person-days of labour did your households contribute (approx.)

Q3d. If yes to Q1d, Was it mandatory for the households to contribute towards canal construction to get water later?

1. Yes 2.No

Q4d. If No to Q3d. Why not?

Q5d. Does your household participate in Operation and Maintenance activities?

1. Yes 2. No

Q6d If yes to Q5d., Where do you participate in Operation and Maintenance?

1. On the network canal leading to my plot 2. On the main canal 3. On the diversion dam 4. All of the above

Q7d. If No to Q5d, why not

Q8d. Besides regular labour contributions by appropriators, are there specialized staff or workers to undertake maintenance

1. No 2. Yes, all are appropriators 3. Yes all are non-appropriators

4. Yes, some are appropriators; some are non-appropriators 5. Do not know

Q9d. Does there appear to be any insurance mechanism available to the appropriators related to variability of water appropriation from the irrigation canal?

1. Yes 2. No 3. No that I am aware of

E. SYSTEM CHARACTERISTICS

Q1e. Does the system has permanent headwork?

1. Yes 2. No

Q2e. If No to Q1e, What materials do you use for temporary headwork?

Q3e Is the main system canal lined?

1. Yes 2. No

Q4e Is the outlet canal lined?

1. Yes 2. No

Q5e Did the authority give your plot pipes for water appropriation?

1. Yes 2. No

Q6e. How well are the physical conditions of the appropriation resource base maintained?

1. Well maintained- excellent working order
2. Moderately well maintained- good working order
3. Some resource deterioration occurring due to insufficient maintenance
4. Badly maintained- not in good working order

Q7e How frequently does the main canal structure get damaged in a year?

1. once 2. twice 3. 3-4 times 5. More than 5 times

Q8e How does the outlet canal get damaged in a year

1. once 2. twice 3. 3-4 times 5. More than 5 times

Q9e. Do you think that the irrigation infrastructures have degraded over the years?

1. Yes 2. No

Q10e, if Yes to Q. 9e, What are the problems with the infrastructure?

1. Siltation in the canal
2. Canal destroyed by natural disasters like landslides/floods
3. Breakage of the water gates
4. Breakage of the cement lining to steal water
5. Weak bund and sluice

Q11e, what are the reasons for lack of maintenance/revival efforts

1. Villagers do not have authority to take up repairs & DoI is not taking up repairs
2. The repair is beyond the capacity (financial/technical) of the community members
3. The canal structure is multi-village, so cooperation is difficult
4. Repairing damage is the responsibility of the DoI

Q12e Please give the details of the improvements/repairs done in the last 3 years

Repair/Maintenance	Contributing Agents	
	Farmers	DoI
Headwork		
Main canal structure		
Distribution network		
Sluice and Gates		

Q13e Please give the details of the contributing organisations for improvements/repairs done in the last 3 years

Repair/Maintenance	Agents making financial contribution	
	Farmers	DoI
Headwork		
Main canal structure including		
Distribution network		
Sluice and Gates		
Disilting the canal		
Eviction of Encroachment		

F. CONFLITC RESOLUTION

Q1f. Have you had any conflicts with fellow irrigator(s) with regards to water appropriation?

1. Yes 2.No

Q2f. What do you think is/are the main cause/s of conflict in your scheme?

1. Water allocation 2. Water distribution 3. Land redistribution 4. water theft
5. Others/Specify --

Q3f. Is there a problem of water theft in your fields?

1a. Yes 2. No

Q4f. If yes to Q50e, which groups of people steal do you think (know)?

Q5f. If yes to Q3f, at what time does the stealing take place?

1. At day time 2. At night time 3. Any time

Q6f. What hostile activities are there among the community members resulting from conflict over irrigation production?

1. ____
____

2. ____
____

3. ____
____

4. ____
____

5. ____
____

Q7f. If yes to Q3f, what is done in cases of water distribution defaults? ---------
----

Q8f. Does the community have a system of rule for controlling water distribution default?

1. Yes 2. No

Q9f If yes to Q8f, what does the rule say?

Q10f. Keeping in mind the rules in this system has evolved/adopted to govern the activities it has organised, classify these rules according to the following scale:

1. Simple, easily understood
2. Relatively complex, can be understood through learning and experience
3. Very complex, difficult to understand
4. I know nothing about the rules

Q11f. If yes to Q8f, do you believe the rule is enforced in the way formulated?

1. Yes 2. No

Q.12f. If no to Q11f, what are the weaknesses? Please, list down in order of importance
1. ____
2. ____
3. ____
4. ____
5. ____

Q13f The Enforcement of the rules in this organisation (system) is primarily undertaken by:

1. Members of the organisation (RIMC/AIMC/BIMC)
2. Plot Comm. 3. Members and external officials 4. external officials only 5. None

Q14f. How would you characterize the levels of mutual trust amongst appropriators

1. moderate to high levels of trust (e.g. Oral promises given high credence)
2. modest levels of trust (e.g. Oral promises are used but appropriators may be uncertain about performance)
3. low level of trust

Q15f characteristics of usual behaviours of the members of the groups with respect to local operational level rules in use related to the appropriation process from the irrigation systems

1. Almost all members follow the rules
2. Most members follow the rules
3. About half of the members follow the rules
4. Most members do not follow the rules
5. Almost all members do not follow the rules

6. Do not know 7 NA

Q16f. Estimate the number households in your plot area
1. less than 25 2. 25-50 3. 51-100 4. 101- 200 5. 201-500
6. 501- 1000

Q17f Can fines be imposed on appropriators for breaking rules related to the appropriation and/or maintenance of this resource?

1. Yes 2. No

Q18f, if Yes to Q17f mention the severity of fines

1. Light 2. Moderate 3. Heavy

Q19f Please mention the nature of fine imposed,

1. Cash 2. Restricted use 3. exclusion from membership

Q20f. Is there a gradation of social, physical, and official sanctions that varies with the severity of rule violations?

1. Yes, considerable range of sanctions are imposed depending on type of rule infractions
2. Yes, moderate range of sanctions are imposed depending on type of rule infractions
3. Yes, limited range of sanctions are imposed depending on type of rule infractions
4. No, little or no variation on sanctions
5. No rules, no sanctions

G. HOUSEHOLD AWARENESS/ PARTICIPATION/ POLICY ISSUES/ IN IRRIGATION RESOURCE MANAGEMENT

Q1g Is there water users' association (WUAs)?

1. Yes 2. No

Q2g If yes to Q1g, When was the water group and executive committee formed

(BS---)

Q 3g. When was community members started involving in the irrigation management

(BS------)

Q4g Who is empowered to formulate and implement rules and regulations for water use and management decisions?

1. DoI 2. WUAs 3. NGOs working in Irrigation sector

Q5g What do you think are the roles of the various social and economic groups in the WUA

1. Roles of Social Groups (caste based):

----

2. Roles of Economic Groups (rich and poor)

Q6g What are the problems faced by the WUA?

Q7g Do those problems, have implications on increasing access to irrigation water?

1. Yes 2. No

Q8g. Does any members of your households participate in users' annual/ monthly assembly?

1. Yes 2. No

Q9g Does your household has the right to participate in the management of irrigation system?

1. yes de jure 2. yes de facto 3. No my household exercises neither de jure or de facto rights 4. No but my household have de jure rights

Q. 10g Are any women members from your household represented in users committee?

1a. Yes 2. No

Q.11g How do you evaluate the performance of users committee?

1. Highly satisfactory 2. Satisfactory 3. Neutral 4. Not satisfied

Q. 12g. At what stage do you and your family members participate in organisation activities?

1. Planning and decision-making 2. Implementation 3. Benefit sharing 5. Evaluation

Q.13g. How do you evaluate the rate of your and family members participation in Water User Group?

1. Strong participation 2. Occasional participation 3. Not very often 4. Hardly ever

Q.14g. How do you know when to divert irrigation water to the field?

1. Attending committee meeting 2. Informed by committee members
3. Informed by neighbours 4. WUG assembly

Q15g Does your households use water from canal for alternative purpose?

1. Yes 2. No

Q16g if Yes to Q15g ,What purpose is the water from the canal being used? E.g. Water mills
----

Q17g Is your households being consistent disadvantage in appropriating water from the canal system?
1. Yes 2. No

Q18g, if Yes to Q17g, why do you think you are being consistently disadvantaged?

Q19g Please Mention the sources of Revenue

Sources of Revenue	Amount in Last Year the last 3 years	
Government		
Household Levy		
Charitable Donation		

Q20g Are monetary fees collected by the concern irrigation authorities?

1. Yes and regularly collected 2. yes and some fees collected 3. yes, only insignificant or no fee collected

Q21g If yes to Q20g, Do the fee collected is being used for Operation and maintenance costs of the irrigation system

1. Yes 2. NO

Q22g. If yes to Q21g, Do the fees collected cover operation and maintenance costs of the irrigation system?

1. Yes fully 2. Yes just partly 3. No

Q23g If fees collected, what agency assesses/determines the fees?

1. RIMC/AIMC/BIMC 2. external officials only

Q24g If fees collected, what agency collects the fees?

1. RIMC/AIMC/BIMC 2. external officials only

Q25g. Is there a direct relationship between the fee collection and water appropriation?

1. Yes 2.No

Q26g How are the fund collected being maintained? FGD

Q27g How much time you need to spend annually in following WUG obligatory activities?

SN	Activities	Time Spent (days) in a Year	Remarks
1	Irrigation canal cleaning		
2.	WUG meetings		

Q28g. Is there any direct cash incur to your household annually for communicating, information gathering and travelling for irrigation related activities? If yes, what are the tentative direct cash expenses?

(NRs------------)

Q29g. What amount (User Group membership fee) you have to pay annually as a member of Water User Group?

1. Pay (NRs. ---------) 2. Do not need to pay

Q30g. Do you hire any paid labour beside your family members in involving irrigation canal maintenance activities?

Number-------------------

Q31g. What is the hired labour rate per day? (NRs--------------)

Q32g. Who in your family involve in WUG meetings?

1. Men 2. Women 3. Children

Q33g. Who in your family involve in Irrigation Cleaning Programmes?

1. Men 2. Women 3. Children

Q34g what are the advantages and disadvantages of membership of the Water Users Group?

SN	Advantages of Membership	Disadvantage of Membership
1		
2		
3		
4		
5		
6		
7		

8		
9		
10		
11		

Q.35g What is your perception regarding equity issue in irrigation canal?

Equity Issues	Y/N	How
Are you relatively satisfied with existing institutional arrangements?		
How you ever been disadvantaged by institutional arrangements?		
Is allocation of membership rights in organisation fair?		
Has distribution of resources and wealth change?		
Are costs and benefits of resource management base on individual's ability to pay?		
Others (please specify)		

Q36g Did you lose any asset of your own because of irrigation canal construction?

1. Yes 2. No

Q37g If Yes to Q 36g, what did you lose?

1. Grazing land 2. Cultivated land 3. Residential house and place
4. Others, specify

Q38g If yes to Q36g, what was your response to your loss?

1. Opposed the construction 2. I accepted my loss assuming the future benefit
3. Internally opposed; however I eventually yielded in as I didn't have the power
4. Others, specify --

Q39g is there a frequent contact and communication between people in this location and the irrigation officials in an administrative centre?

1. Yes 2. No

Q40g Did your household have a say over the location of outlet in the main canal?

1. Yes 2. No

Q41g Are you satisfied with the location of the outlet in the main canal?

1. Yes 2. No

Q42g If No to Q41g, why not?

Q43g Did your household have a say over the choice of the water distribution technology?

1. Yes 2. No

Q44g If yes to Q43g, Are you satisfied with the type of technology current being used for water division at the outlet?

1. Yes 2. No

Q18g if No to Q44g why not?

H. Miscellaneous

Q 1.h. Are you or your members are associated/participated in any village development organisation?

1. Yes 2. No

Q2h. if yes please provide the following information?

SN.	Name of Organisation	Type*	Nature of Work**	No Involved		Position held	Remarks
				M	F		
1							
2							
3							
4							
5							
6							

* Local informal =1 Local formal = 2, Government = 3 NGO=5, INGO=5
** Saving and credits= 1 Conservation=2 Agriculture/ livestock product=3, Women's organisation=4, Village Co-operative=5, others=6 (specify)

Q.3h Do you need credit for your livelihood activities?

1. Yes 2. No

Q4h If yes to Q3h, yes, where do you for credit?

1. Bank 2. Land lord 3. Neighbour 4. Relatives 5. Co-operatives
6. others (please specify)

Q5h) How does WUG investing surplus fund (if any) various community development activities?

Q6h What are the trends in employment opportunities in the past 10 years in your area?

SN.	Nature of Employment	Increase	Decrease
1	Agricultural based employment		
2	Cottage industry based opportunities		
3	Government		
4	Non-government		
5	Private Sector		

6	Others		

Q 7h.Do you feel you being discriminated on the ground of castes
1. Yes 2. No

Q8h If Yes to Q7h, Are you being discriminated in irrigation water on Caste grounds?

1. Yes 2. No

Q9h Are you affiliated to any political party?

1. Yes 2. No

Q10h. Do you take part regularly in political meetings?

1. Yes 2. No

Q11h If no to Q10h why not?

1. Not invited 2. Not interested 3. Not getting information

Q12h Which party has the majority in your area?

1a. Nepali Congress 2. CPN-UML 3. CPN-M, 4. RPP

Q13h. Which party the does the VDC Chairman belongs?

1. Nepali Congress 2. CPN-UML 3. CPN-M, 4. RPP

Q14h Does the VDC Chairman take initiatives in negotiating water right on your behalf?

1. Yes 2. No

Q15h Do you think local politics influence in irrigation management?

1. Yes 2. No

Q16h Do you think you are being discriminated in irrigation on political background?

1. Yes 2. No

Q17h Do you have any suggestions regarding the improvement of existing (specially equity aspects) of irrigation canal development? How irrigation canal can be made more profitable and sustainable?

-------------THANK YOU VERY MUCH FOR YOUR RESPONSES-----------

Appendix 3

Appendix 3a: Sample size in the BIS (Lekhnath Municipality)

Ward No.	Households		% of total HH			Households to be Surveyed	Total Number of households surveyed		
	Total	% of Total	Small	Medium	Large		Small	Medium	Large
1	1204 Total irrigators[4304]	27.9	842.8 (70)	240.8(20)	120.4 (10)	23.15	16	5	2
11	795	18.4	651.9 (82)	95.4 (12)	47.7 (6)	15.27	12	2	1
12	922	21.4	737.6 (80)	138.3(15)	46.1(5)	17.76	14	2	1
13	922	21.4	829.8 (90)	64.54 (7)	27.66 (3)	17.76	15	1	1
14	462	10.7	346.5 (75)	46.2 (10)	69.3 (15)	8.87	6	1	1

The percent of households in each category were obtained from the knowledge of the local informants in the area.

Appendix 3b: Sample size in the PIS (Phalebas Devisthan VDC)

Ward No.	Households		Total Households n (%)			Households to be Surveyed	Total Number of households surveyed		
	Total	% of Total	Small	Medium	Large		Small	Medium	Large
1	60 (t number irrigator =50	11.8	52 (86)	6 (10)	2 (4)	10	8	1	1
2	60	11.8	54 (90)	5 (8)	1 (2)	10	8	1	1
3	85	16.8	80 (94)	4 (5)	1 (1)	14	12	1	1
4	60	11.8	54 (90)	5 (8)	1 (2)	10	8	1	1
5	78	15.4	56 (71)	19 (24)	3 (5)	13	9	3	1
6	82	16.2	66 (80)	13 (16)	3 (4)	13	10	2	1
7	80	15.8	72 (90)	4 (5)	4 (5)	13	10	2	1

The percent of households in each category were obtained from the knowledge of the local informants in the area.

Appendix 3c: Sample size in the RIS (Dhamilikuwa and Bhalayakharka VDC)

Ward (Dhamilikuwa VDC)	Households		Number of Households N (%)			Households to be Surveyed	Total Number of households surveyed (rounded to the nearest decimal place)		
	Total number of households	% of Total	Small	Medium	Large		Small	Medium	Large
1	101 (748)	13.5	37(37)	35 (35)	29(28)	5	2	1	1
2	110	14.7	41(37)	39(35)	40(28)	5	2	2	1
3	124	16.5	46(37)	43(35)	35(28)	6	3	2	1
4	97	12.9	36(37)	34(35)	27(28)	5	2	2	1
5	95	12.7	35(37)	33(35)	27(28)	4	2	1	1
6	104	13.9	38(37)	36(35)	30(28)	5	2	2	1
8	105	14.0	39(37)	37(35)	29(28)	5	2	2	1
Bhalayakharka VDC									
1	60 (180)	11.1	16 (27)	31(52)	13(21)	1	0	1	0
3	60	11.1	16 (27)	31(52)	13(21)	1	0	1	0
4	60	11.1	16 (27)	31(52	13(21)	1	0	1	0

Appendix 3d: Sample size in the RIS (Chakratirtha VDC)

Ward No. (Chakratirtha VDC)	Households		Number of Households N (%)			Households to be Surveyed	Total Number of households surveyed		
	Total	% of Total	Small	Medium	Large		Small	Medium	Large
1	112 (780)	14.3	19(17)	77(69)	16 (14)	5	1	3	1
2	180	23.2	31(17)	124 (69)	25 (14)	5	2	2	1
5	128	16.4	22(17)	88 (69)	18 (14)	7	1	4	2
6	88	11.3	15(17)	61 (69)	12 (14)	5	1	3	1
7	112	14.2	19 (17)	77 (69)	16 (14)	7	1	4	2
8	112	14.2	19(17)	77 (69)	16 (14)	7	1	4	2
9	48	6.5	8(17)	33 (69)	7 (14)	2	0	2	1

The percent of households in each landholding category in Dhamilikuwa VDC is obtained from Feasibility studies of Rainastar Irrigation Project, Lamjung and Attrauli-Puttar Irrigation Project, Tanahun, Department of Irrigation and for Bhalayakharka VDC, Due to the lack of data, we use average of Dhamilkuwa and Chakratirtha V.D.C to calculate the number of households in different categories of landholdings.