Fostering a climate-resilient agri-food sector: Untangling and understanding Ukraine's post-Soviet hurdle

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Abstract

Recently, the United Nations announced that the annual average concentration of atmospheric carbon would pass 400 ppm and scientists warned that catastrophic climate change would be unavoidable. Three facets to addressing climate change exist: lessening impacts through greenhouse gas reduction, adapting to impacts that cannot be avoided and improving capacity by developing sustainably. Experts argue that fostering climate-resilient development pathways integrate all three facets thereby providing the strongest response through a triple-win. Yet typically each aspect has been treated as a distinct response and studied separately. As such, insufficient research exists about the process of building resilience and the possible interactions between each of the facets. This research examined Ukraine's agri-food sector to begin to fill this large gap in understanding how to build climate-resilience. A case study approach works best when aiming to understand context-dependent processes such as development pathways. Systems methodology provided a framework for understanding possible interactions. All three facets of addressing climate change were integrated into a single process by modifying the Sustainable Livelihoods Framework (SLF) to include planned adaptation and mitigation. The SLF was then used to create a semi-structured plan for interviewing farmers and stakeholders. An iterative participant-driven approach including grounded theory and Q method allowed for multiple perspectives to be considered and allowed for exploration of an under researched topic. The research finding revealed that factors such as corruption, land tenancy, trust and a perceived inability to work together function as barriers to building resilience. Moreover, learning from both international and domestic projects helped to build resilience. The development of agricultural cooperatives within Ukraine has the potential to create a cycle of improved social networks and learning, thereby enhancing climate-resilience. These findings complement other studies that highlight the importance of addressing non-climate issues in order to foster climate-resilience.

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Author's Declaration

I declare that the work contained in this thesis is my own. I declare that the work contained in this thesis has not been previously been presented for an award at this University or any other University. All sources are acknowledged as references.

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Chapter 1. Introduction

Climate Change Adaptation, Mitigation and Sustainable Development

As the UN announced that the annual average concentration of atmospheric carbon would pass 400 ppm, scientists warned that catastrophic climate change would soon be unavoidable (Moss and Scheer, 2015; Vaughan, 2015). Now more than ever, the global community needs to act quickly to mitigate climate change through a reduction in emissions and enhancement of carbon sinks, and to adapt to the change in climate that will inevitably happen.

Typically adaptation and mitigation have been studied separately by different research communities using distinct approaches; mitigation research has focussed predominantly on economic and technical issues, while adaptation research has focussed on place specific, local issues (Klein et al., 2007). In addition to mitigation and adaptation, a third category for addressing climate change involves improving capacity through sustainable development (Klein et al., 2005). However, by applying discrete categories instead of recognising the continuity between each policy action this distinction obscures interactions and shared opportunities. This thesis endeavours to better understand the interactions between adaptation, mitigation and sustainable development (AMS) through a case study of Ukraine's agri-food sector.

Synergies, trade-offs and unexpected consequences exist between adaptation, mitigation, economic goals and environmental goals (Denton et al., 2014; Klein et al., 2007). The Intergovernmental Panel on Climate Change (IPCC) 2007 defines a synergy as 'the interaction of adaptation and mitigation so that their combined effect is greater than the sum of their effects if implemented separately' (Klein et al., 2007). For example, many energy efficiency strategies contribute to both mitigation and adaptation (Shaw et al., 2014). Insulating homes reduces emissions by conserving energy and helps occupants to adapt to heatwaves by keeping homes cooler. Similarly, planting trees in urban areas reduces the heat island effect, while also enhancing carbon sinks (Klein et al., 2005). The IPCC report describes a trade-off as 'a balancing of adaptation and mitigation when it is not possible to carry out both activities fully at the same time' (Klein et al., 2007). A trade-off could be any development option that helps with climate adaptation, but creates emissions during construction. Trade-offs can be direct, immediate and clear, but in practice they can also be indirect, delayed and happen at another location (Moser, 2012). The neutrality of the term trade-off can obscure potentially negative consequences particularly when the benefit lost or item 'traded' has a high value for an individual or one specific group (Hirsch et al., 2010). A trade-off has the potential to increase existing inequalities; therefore, attention must be paid to both the potential winners and losers of climate action.

The negative consequences of these interactions have also been described as maladaptation. Barnett and O'Neill (2010) defined maladaptation as 'action taken ostensibly to avoid or reduce vulnerability to climate change that impacts adversely on, or increases the vulnerability of other systems, sectors or social groups' (p.211). The five types of maladaptation are adaptation actions

that increase greenhouse gas emissions; increase the vulnerability of one group in order to meet the needs of another group or sector; have high economic, social, or environmental costs relative to alternatives; reduce incentives to adapt and lead to path dependent responses decreasing future flexibility (Barnett and O'Neill, 2010).

Researching adaptation and mitigation together provides a means to understand these interactions and develop policies that take advantage of positive synergies while minimising any negative consequences (Denton et al., 2014; Klein et al., 2007). Some argue that mitigation should be viewed as a subset of adaptation, since mitigation is an adaptive act aimed at reducing the cause of climate change (Biesbroek et al., 2009; Pelling and Manuel-Navarrete, 2011).

The concepts of adaptive and mitigative capacity, defined as the ability to adapt or mitigate respectively, provide another link between the two responses. Yohe (2001) was the first to suggest that the same set of characteristics responsible for adaptive capacity also help to determine the mitigative response to climate change. At the core, capacity is determined by the resources available and the ability to use the resources effectively (Brooks and Adger, 2005). Since the ability to use resources varies by context, the concept of capacity is not easily generalized from one context to the next (Engle, 2011). Nonetheless, the determinants of adaptive and mitigative capacity include: clear market rules and effectiveness of government regulation (institutions); economic wealth (financial capital); technology and infrastructure (physical capital); information, knowledge and skills (human capital); and group membership and trust (social capital) (Klein et al., 2005; Yohe, 2001). Many have proposed the concept of response capacity as more appropriate because of the shared determinants, thereby encapsulating adaptation, mitigation and sustainable development (Burch and Robinson, 2007; Tompkins and Adger, 2005; Winkler et al., 2007). In this instance, a response is understood as any action to manage environmental change recognising the restrictions imposed by environmental, economic, social contexts and the trajectories of the underlying development pathway (Burch, 2009; Burch and Robinson, 2007; Tompkins and Adger, 2005; Winkler et al., 2007). Thus response capacity incorporates and integrates adaptation, mitigation and sustainable development.

The 2014 report from the Intergovernmental Panel on Climate Change devoted a chapter to the idea of researching and addressing adaptation, mitigation and sustainable development together. They argue for sustainable development to be the ultimate aim; mitigation as the way to keep climate change impacts moderate rather than extreme; adaptation as a response strategy to cope with impacts that cannot be avoided; and development pathways provide contexts that shape choices and actions (Denton et al., 2014). The chapter stressed the importance of immediate progression toward climate-resilient pathways, defined as 'development trajectories that combine adaptation and mitigation with effective institutions to realize the goal of sustainable development' (Denton et al., 2014, p. 1106). Specifically, climate-resilient pathways are viewed as:

> *Iterative, continually evolving processes for managing change within complex socio-ecological systems; taking necessary steps to reduce vulnerabilities to climate change*

impacts in the context of development needs and resources, building capacity to increase the options available for vulnerability reduction and coping with unexpected threats; monitoring the effectiveness of vulnerability reduction efforts; and revising risk reduction responses on the basis of continuous learning. As such, climate-resilient pathways include two main categories of responses:

• Actions to reduce human-induced climate change and its impacts, including both mitigation and adaptation toward achieving sustainable development

• Actions to ensure that effective institutions, strategies, and choices for risk management will be identified, implemented, and sustained as an integrated part of achieving sustainable development. (Denton et al., 2014, p. 1106)

The concept of climate-resilient pathways has origins in resilience and adaptive management literature (see: Lee, 1995). The resilience concept first came from studying ecosystems, but was later expanded to describe socio-ecological systems (Folke, 2006; Holling, 1973). Resilience has multiple levels of meaning, consequences in interpretation and more than one definition (Carpenter et al., 2001). While previous perspectives assumed stability, resilience highlights non-linear dynamics, feedbacks, uncertainty, varying rates of change, and interactions across temporal and spatial scales (Folke, 2006). The initial definition of resilience was to bounce back to a previous state after disturbance, but in many cases this type of resilience can preserve a maladaptive system such as poverty traps, dictatorships or short-term stability at expense of future generations (Carpenter et al., 2001; Holling and Gunderson, 2001; Holling et al., 2001). In order to avoid maladaptation, the presence of mechanisms that facilitate experimentation, novelty and discovery are necessary to allow for the infiltration of new technology (Carpenter et al., 2001; Tompkins and Adger, 2005; Yohe, 2001). Therefore, Nelson et al. (2007) provide a more comprehensive definition of resilience: 'the amount of change a system can undergo and still retain the same function and structure while maintaining options to develop'. While earlier adaptation work centred on actors and reducing vulnerability of specific groups, the resilience approach uses a dynamic systems view focused on building capacity and thus maintains the flexibility needed to deal with uncertainty (Nelson et al., 2007). The vulnerability approach has another drawback in the negative connotation of describing people as vulnerable rather than having less capacity (Engle, 2011; Miller et al., 2010).

The definition of vulnerability and the relationship between resilience and vulnerability varies throughout the literature.[1] O'Brien et al. (2007) identified two distinct views of vulnerability in the climate change literature with completely different framings of the problem of climate change.

[1] In a review of the literature Gilberto (2006) found the relationship between vulnerability and resilience to vary from vulnerability being the opposite of resilience to resilience being one of the components of vulnerability.

‘Outcome vulnerability’ views the problem as two linearly related variables: vulnerability decreases when climate impacts are reduced by adaptation or mitigation, while, ‘contextual vulnerability’ views vulnerability to be a product of the interactions between climate and the political, institutional, economic and social context (O'Brien et al., 2007). While, many have used a more contextual view of vulnerability by defining it as the combination of the risks that households and communities are exposed to and their ability to use assets (capacity) to cope with these risks (FAO, 2013), others argue that the social processes producing vulnerability to climate change still do not receive adequate research attention (Bassett and Fogelman, 2013). Miller et al. (2010) argue that the strength of the resilience approach is with identifying interactions, while the vulnerability approach highlights historical and political economic processes; however, the two approaches have increasingly converged in the literature. Arguably a resilience approach can consider historical and political economic processes even if this has not been true of past research.

Similar to this shift from reducing vulnerability to enhancing resilience, development work has shifted from a material perspective to a social perspective focussing on enhancing the capacity of individual livelihoods (FAO, 2013). Climate change adaptation has been largely influenced by development work, since adapting to climate change does not differ greatly from adaptation to any other natural or social shock (Klein, 2007). For the first time, the IPCC 2014 report also included a chapter pertaining to sustainable livelihoods. The report stressed the importance of addressing inequalities in promoting climate-resilient development pathways via a sustainable livelihoods approach (Olsson et al., 2014). A livelihood described as how one makes a living, can be said to be sustainable when it enhances the assets on which it depends, recovers from stress and shocks, does not negatively affect other livelihoods and provides for future generations (Chambers and Conway, 1991). The sustainable livelihood framework (SLF) highlights the following: people live within a context of risks, shocks, trends and seasonal changes; they have assets or capitals to draw upon to fulfil livelihood strategies; context, formal and informal institutions and processes influence access to assets; all these factors influence livelihood activities and finally livelihood activities secure specific outcomes (Bingen, 2000; Brocklesby and Fisher, 2003; DFID, 1999).

Due to contextual shocks and stresses, livelihood strategies temporarily use ‘coping strategies’ as a short term answer, but then return to prior livelihood strategies once recovery has happened, while climate change, globalization and political problems require longer term adaptation strategies (De Haan, 2000). Scoones (2009) argues that livelihoods research has largely ignored the longer-term problem of climate change and only deals with shocks, while Hahn et al. (2009) contend that the SLF deals with adaptive capacity to climate change to a limited extent only. Regardless of how the framework has been used in past research, the five capitals in the asset pentagon along with the processes and institutions that influence access to capitals inform response capacity; moreover, by adding planned adaptation and climate change mitigation as an explicit outcome livelihoods work can give a more holistic approach to understanding the entire process of AMS as shown in figure 1.

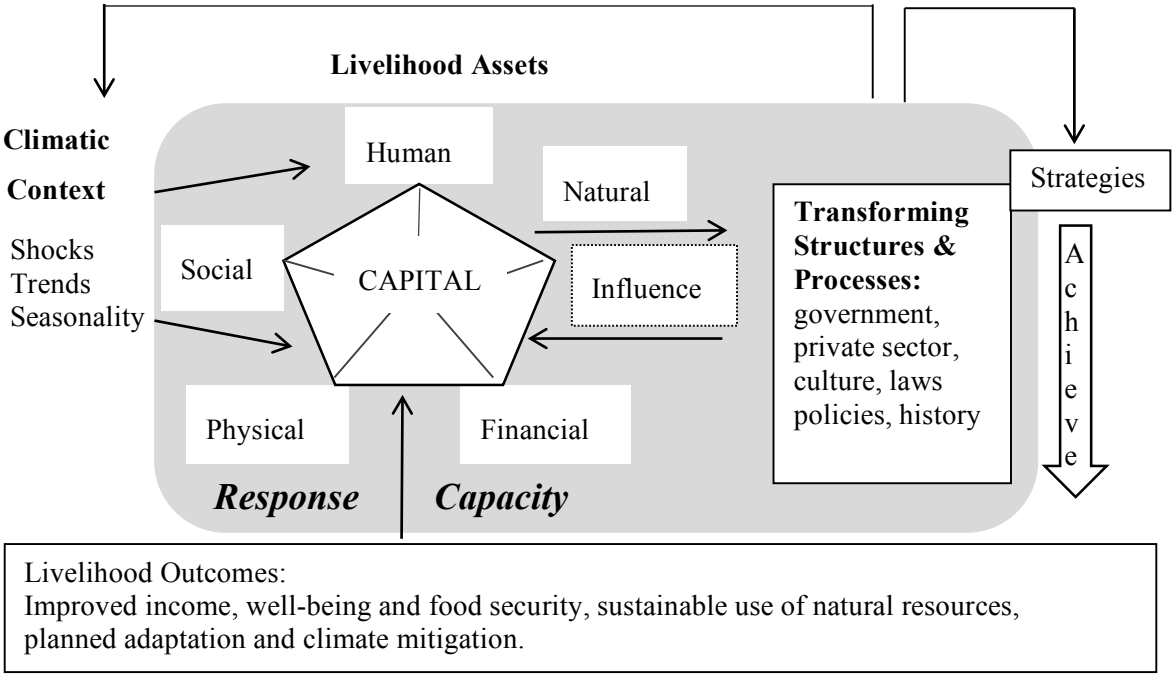

Figure 1. Sustainable Livelihood Framework.
Adapted from Sustainable Livelihoods Guidance Sheet (DFID, 1999). Author has modified framework to include planned adaptation and climate mitigation. Vulnerability context has been changed to climatic/ecological context to avoid the ambiguity surrounding the definition of vulnerability. The area in grey indicates response capacity. Transforming structures and processes can also be viewed as the social, poltical and economic context. The SLF evaluates how context influences access to livelihood assets or capitals which are used to fulfil livelihood strategies that ultimately lead to outcomes. Arrows denote influence and not causation.

Agri-Food Sector and Climate change

The agri-food sector provides a particularly stimulating case for an integrated study of climate change adaptation, mitigation and sustainable development. Due to projected increases in world population, caloric intake and meat consumption, global food production will need to make a 'quantum jump'(FAO, 2006). A daunting challenge in itself, but at the same time food production needs to also adjust to climatic extremes and reduce greenhouse gas emissions and environmental impacts (Smith, 2013).

Agriculture contributes significantly to climate change, generating 10-12% of global anthropogenic emissions (Robertson et al., 2000; Verchot, 2007). Moreover, the agricultural sector is the largest global contributor to emissions of non-carbon dioxide greenhouse gases, accounting for approximately 50 percent of global anthropogenic methane emissions from livestock and rice cultivation and 80 percent of nitrous oxide emissions from fertilizer use and manure management (Rosenzweig and Tubiello, 2007; Smith et al., 2008; U. S. EPA, 2012). While the world's soils provide a much larger carbon pool than the atmosphere and vegetation (Smith et al., 2009), projections of increased production reveal an increase in emissions from agricultural soil by 35

percent by 2030 (U. S. EPA, 2012). However, the potential also exists to sequester large amounts of carbon through agricultural practices that improve cropland and grazing land management and restoration of degraded lands (Smith et al., 2009; Smith et al., 2008). In summary, the mitigation potential of agriculture arises from an enhancement of removals of greenhouse gases; a reduction of emissions through management of land and livestock; and reduction of indirect emissions from machinery, irrigation pumps, transport and fertilizer production (FAO, 2016; Smith et al., 2014). Thus, efficiency improvements and a strategic reduction of inputs provide a cost-effective means towards climate change mitigation (Smith and Olesen, 2010). In addition, soil carbon sequestration will be most effective in the first couple of decades of implementation and can therefore fill a gap while new energy technologies are developed (Smith, 2004). As more time passes the carbon in the soil reaches equilibrium, so from 20 to 100 years the carbon sequestration potential becomes minimal (Freibauer et al., 2004). Moreover, the changes to land management practices must be permanent to maintain carbon sequestration (Freibauer et al., 2004).

In terms of adaptation, since food production has always been dependent on climatic conditions, producers have some experience adapting to change. How well individual producers adapt has direct consequences on their livelihoods, while on a larger scale the ability of major producers to adapt has consequences for global food security. Unfavourable climatic conditions continue to be a key cause of food insecurity, as evident recently when climate extremes impacting the production of major producers contributed to a spike in food prices (Porter et al., 2014). Various projections demonstrate that climate change will have mostly negative effects on food security including: availability, access, stability of supply and utilisation of food (FAO, 2003; Glantz et al., 2009).

Potential positive changes include[2], an extended growing season and expansion of crops to northern latitudes (Porter et al., 2014). However, producers will still need to adapt to seize these opportunities (Fay et al., 2009). Furthermore, a change in mean temperature and precipitation does not pose as big a risk as increases in variability and climate extremes including: heatwaves; seasonal changes in temperature; reduced snow cover protecting crops from winter freeze; changes in hydrology due to an increase in frequency and intensity of droughts, flooding from intense rainfall events and seasonal changes in timing of rainfall (Min et al., 2011; Rosenzweig et al., 2002). These changes will have many biophysical and socio-economic consequences including: physiological effects on the quality and quantity of crops, pasture and livestock; changes in the quantity and quality of land, soil and water; changes in weed and pest problems; declines in yields and food quality; fluctuations in market prices; changes in global trade; increases in hunger risk and food insecurity; migration and conflict (FAO, 2007).

Some trade-offs will need to be made in the agri-food sector. For instance, land cannot be completely dedicated to conservation and mitigation efforts while also growing crops. More

[2] Fertilization from additional CO_2 in the atmosphere has not been included as a potential benefit because models show that any increase in yields will be offset by yield losses due to atmospheric ozone and climate change (Porter, Xie et al. 2014).

efficient production through ‘sustainable intensification’ offers one possible strategy by ensuring the supply of safe, nutritious food from the same area of land, while maintaining the health of natural resources (Smith, 2013). Part of this strategy would be to seize upon the many synergies or ‘triple-win’ measures present in agriculture. These measures adapt, mitigate and provide non-climate benefits such as improved yields and sustainable resource use. Triple-win measures in agriculture include: diversification of crop rotation, prevention of nutrient leaching from soils, conservation of soil moisture, restoration of organic soils and improved land management (Glantz et al., 2009; Smith and Olesen, 2010). While these measures have many benefits, who benefits and the timing of benefits in practice are not as well understood. Refer to Table 1 for a more thorough, but not exhaustive, list of AMS strategies in agriculture.

Integrating AMS strategies into sector policies allows for a more efficient and effective use of money and human resources by seizing opportunities that have multiple benefits (Ahmad, 2009; Klein et al., 2005; Pelling, 2010). Despite the clear advantage, climate policy integration has received insufficient research attention to inform policy decisions (Adelle and Russel, 2013). Early research on integration viewed adaptation and mitigation as complementary measures using a cost-benefit analysis to determine the optimal mix of the two responses (Bosello, 2005; Bosello et al., 2010, 2011; Hope et al., 1993). Research in climate policy mainstreaming and integration remains predominantly conceptual and exploratory identifying the potential with little work revealing what happens in practice (Chia et al., 2016; Chuku, 2010; Kok et al., 2008; Matocha et al., 2012). Thus while the IPCC 2014 report determined a high-level of consensus for the concept of climate-resilient pathways, the report also acknowledged that scant evidence supports this claim, since many aspects of sustainable development, climate change adaptation and mitigation have not been studied empirically (Denton et al., 2014).

Table 1. AMS strategies in agriculture with potential outcomes.

Adapted from Freibauer et al. (2004) and supplemented with other sources including: Bullock (1992), Reckling et al. (2014); Smith and Olesen (2010) and Smith and Wollenberg (2012).

Measure	**Adaptation**	**Mitigation**	**Other benefits/costs**
Improved or New Irrigation	-Cope with drought and seasonal changes in precipitation	- Increase or decrease in energy demand depending on systems - Possible increase in soil C storage	-Improved yields -Water conservation (upgraded system)
			-Increased competition for water (new irrigation)
Afforestation, Reforestation, Agroforestry	-Shade provides protection for crops -Reduced run-off during heavy precipitation events	-Increase soil Carbon storage on newly planted land, but future management can reduce C storage	-Diversified income -Habitat/biodiversity improvement -Reduced erosion
			-Loss of agricultural land
Use of cover crops	-Reduced or increased soil moisture depends on weather	-Increase soil Carbon storage	-Improved weed control and beneficial insects
			-Can increase or decrease disease risk
			-Can suppress growth of other species of plants (allelopathy)
Improved crop rotations/fallow	-Improved water infiltration due to soil structure - Improved water holding capacity	-Increase soil Carbon storage	-Higher yields -Improved soil structure and fertility -Improved pest management -Risk management via diversification
Use of legumes in crop rotation	-Potential for improved water infiltration and soil moisture holding capacity	-Reduced emissions through a reduction in fertilizer use	-Reduced costs for fertilizer inputs -Improved yields
			-Reduced grain production
Efficient fertilizer use: organic fertilizer, legumes, green manure, compost and animal manure	-Potential for improved water infiltration and soil moisture holding capacity	-Reduced nitrogen and methane emissions	-Higher yields through increased soil fertility
Incorporation of residues	-Increased water holding capacity	-Increase soil Carbon storage	-Higher yields from improved soil fertility
			-Loss of animal feed
Reduced/zero tillage	-Increased water holding capacity (Potential for water-logging under wetter conditions)	-Increase soil Carbon storage	-Improved yields -Potential for lower yields in short-term -Weed management leads to increased labour or herbicide control -Nitrous oxide emissions can increase due to anaerobic soils

Ukraine's Significance

Ukraine's agri-food sector was chosen as a case due to Ukraine's importance in agricultural production, the still unmet potential of agricultural production, the high variability of yields related to climatic events, the mitigation potential due to continued operation of inefficient Soviet systems and finally the considerable environmental and socio-economic challenges facing the country.

Due to a Soviet legacy, Ukraine faces many socio-economic and environmental problems independent of climate change. For instance, the country ranks 78th out of 186 countries according to the Human Development Index placing it well behind other countries in the region (UNDP, 2013). Moreover, local governance structures do not have clear mandates or division of responsibility within the current policy frameworks (UNDP, 2013).

According to estimates, Ukraine is potentially capable of feeding 300 to 350 million people (Ministry of Foreign Affairs of Ukraine, 2010). The FAO (2002) determined Ukraine to have the largest exploitable yield gap, the difference between actual and potentially obtainable yields, of any country in the world. Current yield statistics still indicate considerable potential for increased production of barley, maize and wheat if Ukrainian yields reduce the gap with the EU and the U.S averages (Meyers and Goychuk, 2015). Moreover, production has not remained robust during times of drought indicating potential difficulties with future climate change adaptation. According to estimates, climate variability accounts for 20-50% loss of winter crops and 35-75% loss of summer crops in Ukraine (Adamenko and Prokopenko, 2011). Simelton et al. (2012), found Ukraine along with other middle-income transition countries to have the highest agricultural vulnerability to drought. Furthermore, fluctuations in food production due to climate extremes in agriculturally important countries, along with the implementation of export quotas as a domestic policy response, played a role in recent spikes in global food prices (Porter, 2014). Ukraine is one country that responded to climate extremes in such a manner.

In terms of climate change mitigation, Ukraine is the sixth largest per capita greenhouse gas emitter and uses over three times more energy per unit of GDP than the average among OECD countries (UNDP, 2013; World Bank Group, 2015). This inefficiency, however, provides an opportunity for emission reduction projects to be completed relatively inexpensively. Ukraine has benefited from the Joint Implementation (JI) offsetting scheme within the Kyoto Protocol. JI allows countries to invest in emission reduction projects in host countries. Ukraine has 251 registered projects and has issued 60% of the emission reduction units making it the leading host country in the scheme (Anja Kollmuss et al., 2015).

Aims, objectives and thesis structure

This chapter reviewed the literature pertaining to the integration of response capacity, adaptation, mitigation, sustainable development; the concept of climate-resilient development pathways and

the potential benefits of using an integrated approach. The thesis aims to understand sustainability, climate change adaptation and mitigation within the context of the current development pathway to reveal insights that can contribute towards fostering a climate-resilient development pathway. The approach adopted here answers a call from the IPCC for more context specific case studies integrating AMS (Denton et al., 2014). Using Ukraine's agri-food sector as a case study provides both context specific results and also provides insights as to the potential gains from using an integrated approach.

While synergies and trade-offs have been identified on paper, research has not addressed what happens in practice or provided a clear understanding of implications for equitable development (Denton et al., 2014; Ürge-Vorsatz and Tirado Herrero, 2012). Similarly, the determinants of capacity have been ascertained, but the process of capacity to action is not well understood. Specifically, how to develop capacity to seize opportunities and overcome constraints to action needs research (Klein et al., 2005; Sathaye et al., 2007). Therefore, the three objectives of this research relate to understanding three dynamic properties of AMS: synergies, trade-offs and the link between capacity building and climate action. The first objective is to understand how to seize synergies by identifying shared barriers and mutual opportunities. The second objective is to understand how to develop capacity to address climate change. In order to meet these two objectives, adapting, mitigating and developing sustainably (AMS) are viewed as a single process commencing with response capacity. Adaptation, mitigation and sustainable development become distinct responses to climate change at the outcome stage of the modified SLF. This approach applies the emerging argument that adaptation, mitigation and sustainable development should not be viewed as distinct responses (Biesbroek et al., 2009; Pelling and Manuel-Navarrete, 2011). The third objective is to identify and understand potential negative consequences of how trade-offs occur in practice and how maladaptive strategies arise. This objective will be met by operating at more than one scale and considering the perspectives of multiple stakeholders gained through interviews and observation.

Furthermore, this research follows the interpretivist paradigm in order to understand multiple perspectives. The interpretative paradigm holds the view that people's interpretation of social reality differs according to historical and social context (Higgs, 2001); moreover, acknowledging multiple socially constructed realities provides a more equitable approach since it allows for all 'voices' to be heard (Creswell, 2013; Guba and Lincoln, 1989).

Chapter 2 provides an overview of how methods are both compatible with a systems methodology and maintain a participant-driven research approach. The compatibility of methods and how they integrate across each chapter is also explained.

Chapter 3 clarifies why Ukraine was chosen as the case study country. As well, it presents an overview of Ukraine's agricultural and climate change mitigation potential, indicators of national capacity, current socio-economic, political and environmental challenges, and historical context.

Data Chapters 4-6

Each of the data chapters uses an integrated approach, engages with multiple stakeholders and operates at more than one scale. The work follows a participant-driven method with a predominant focus on the objective of determining how to seize positive synergies and how developing capacity links to climate response. Achieving the third objective of understanding trade-offs and maladaptation is largely a consequence of working across several scales in the research.

Chapter 4 draws upon interviews from stakeholders dealing with different aspects of climate change, agriculture and/or rural development. While stakeholders at the national, local and farm-level were interviewed, this chapter concentrates on issues affecting the entire nation. Using grounded theory to code the data, the same barriers and bridges were found to influence adaptation, mitigation and sustainable development/capacity building. These findings indicate that the key areas requiring attention are not directly related to climate change, but rather targeted capacity-building has the potential to deliver a triple-win.

Chapter 5 applies the modified SLF to the successful implementation of one particular strategy: a cooperative. By viewing the cooperative as a livelihood strategy with the potential for AMS outcomes, this chapter concentrates on understanding the potential synergies from capacity building. The work focuses on the changes involving social capital quality and quantity as the cooperative developed since those changes were deemed central to AMS. Specifically, this chapter endeavours to understand how social capital went from a barrier to addressing climate change to an instrumental factor in achieving multiple livelihood outcomes including planned adaptation.

Chapter 6 examines a particular triple-win technique, crop rotation, because it emerged as a topic of considerable disagreement amongst stakeholders despite being an approach with many benefits. By using Q methodology, perspectives could be clarified to reveal why crop rotation was not consistently implemented. While this chapter intended to meet the first objective by revealing barriers to crop rotation implementation, it also meets the third objective by demonstrating a trade-off farmers currently make in the short-term.

Chapter 7 first summarises results and then compares this case study with other studies integrating AMS. The chapter ends with the main conclusions from this work and potential areas for future research.

Chapter 2 Methodology

Introduction

This chapter explains how the Sustainable Livelihood Framework (SLF), grounded theory, Q method and political ecology were integrated, how each method fits with a systems methodology and how the methods complement each other by mitigating weaknesses. Chapters 4 through 6 each have a methods section providing more detail of how methods were applied. The purpose of this chapter is to justify the methodological choices made and to demonstrate consistency in philosophical stance and methodological approach. First, an explanation of systems methodology provides the groundwork for understanding the rationale and strengths of this methodology.

Systems Methodology

In the literature the systems methodology has also been called general systems theory, systems paradigm or systems thinking (Boulding, 1956; Checkland, 1981; Checkland, 1976; Kornai, 2002). This work follows a systems methodology within the interpretivist paradigm. 'Systems thinking' influences the research approach and methods used, thus fulfilling the role of a methodology. For these reasons, the term 'systems methodology' will be used for this study. Moreover, the systems methodology provides a holistic framework to organise the knowledge gained from multiple disciplines perspectives and scales, and the historical, social and political context (Berkes et al., 2003; Halsnaes et al., 2007; Meadows, 2009).

Systems methodology accommodates the interpretivist paradigm in recognising that people continually negotiate their interpretations of the world around them (Checkland, 1981) . The researcher must also acknowledge assumptions and how personal, cultural and historical background shape interpretations[3] (Addison, 1999; Creswell, 2013; Gasson, 2003). Systems methodology involves recognising that the environment cannot be controlled and acknowledging that system boundaries change and interact with other systems (Bell and Morse, 2008). A distinction must also be made between 'soft' and 'hard' systems. Soft systems apply to systems with poorly defined problems such as social systems (Checkland, 1999). While hard systems can be controlled and engineered, soft systems must first be understood to then be improved or modified (Checkland, 1981).

In soft system methodology, the system does not apply to the world, but rather to an organised process of inquiry into the world (Checkland, 1999). For instance, a systematic way to engage multiple perspectives provides insights, opportunities for reflection and equitable action (Hirsch et al., 2010). Therefore, from a systems perspective, participatory methods yield better information for understanding and addressing issues, since these methods lead to understanding of stakeholder interpretations of the system from 'on the ground' experiences (Pritchard Jr. and Sanderson, 2001).

[3] Refer to appendix 1 for the researcher's reflective journal.

In some manner, systems need to be simplified to be understandable, but not in a reductionist matter. Instead clarity can be accomplished by addressing the issue from different scales or conceptual levels; such as, national, regional, local and household level (Mesarovic et al., 2003). In this research, each chapter has a different focal point: national issues; the cooperative as a strategy; and the technique of crop rotation.

Several methods meet the needs of a systems methodology as the focus is not solely on structure, but means understanding relationships, patterns, processes, context and feedback loops (Capra, 2005; von Bertalanffy, 1971). The goal of this research was to capture dynamics and changes in processes over time; therefore, qualitative methods were determined to be the better option within a systems methodology (Kornai, 2002; Patton, 1990). Moreover, qualitative methods allow for a more complex understanding, enable the incorporation of multiple-perspectives and identify variables that cannot easily be measured (Creswell, 2013; Denzin and Lincoln, 2000).

In summary, this study views a systems methodology as a systematic way to incorporate multiple perspectives and scales to understand processes within the context they occur. In this research, the Sustainable Livelihood Framework provides a heuristic device for the system under study. Each chapter explores the system from a different conceptual level, while the chosen methods allow for multiple perspectives and problem definition from the participants themselves.

Methods

The following sections explain how the SLF, grounded theory, Q method and political ecology were applied in this study. These methods maintain a participant driven approach and accommodate a systems methodology as summarised in table 2 and described in the following sections.

Table 2. Methods employed in research and how they fit with a systems methodology and participant-driven approach.

Method/Approach	Participant-driven	Systems Methodology
Sustainable Livelihood Framework	Generate open-ended questions for semi-structured interview	Heuristic device (soft-system)
Grounded Theory	Constant comparison between data collection and analysis. Open to new directions in research depending on participant responses.	Process oriented by gerund coding. Sensitive to context.
Q method	Direct statements from interviews used in concourse generation.	Isolates factors so not reductionist.
Political Ecology	Multi-perspective Ethnographic data collection	Analysis of economic, historical and political factors. Multi-scale

Sustainable Livelihood Framework

The sustainable livelihood framework was derived from participatory approaches building on experience of past system-oriented work (FAO, 2013). Sustainable livelihoods stress participatory methods where community members develop indicators that provide insights into processes at each conceptual level (Bossel, 2001). While livelihoods models are typically applied to household level, this framework can also be used at different scales (Pelling, 2010; Scoones, 1998). In this study, the SLF was used to generate questions that worked across scales and related to capital access, outcomes, successes and failures (see tables 3 and 4). The SLF consists of a two-pronged approach to understanding household livelihood strategies: 1) acquire knowledge about the access community members have to the five forms of capital (natural, social, human, physical, financial) and 2) explore the environmental, historical and political context and institutional processes and structures (May et al., 2009; Scoones, 1998). Livelihood strategies produce outcomes that included planned adaptation and mitigation in the modified SLF. As such the modified SLF also served as a heuristic device to capture the AMS process at multiple scales (see: figure 1, chapter 1).

Table 3. Questions posed to stakeholders in Ukraine.

Category	**Question**
Adaptation	How well has the agri-food sector managed during past extreme climate events? (floods, drought, frost/winter kill due to reduced snow pack and insulation, extreme heat, seasonal changes)
Mitigation	What opportunities exist to mitigate climate change? Where or how can mitigation occur in the agri-food sector or in rural communities?
Adaptation or Mitigation	What positive opportunities and negative impacts will climate change bring to Ukraine's agri-food sector?
Capacity/Context	What are the biggest challenges to the agri-food sector in Ukraine or what do you view as policy priorities or development priorities for the agri-food sector in Ukraine?
Context	What are the biggest environmental concerns (natural resource use)? Which are the easiest to address? How can they be addressed?

Table 4. Questions posed to farmers.

Category	Question
Adaptation	How have you handled climate variability in the past (drought, heavy precipitation, frost kill, seasonal variability, extreme heat)? (Could things have been easier with access to certain forms of capital?) Did anything else go wrong? What if the event happened three years in a row? How would you change your practice? What drawbacks/impacts would that change have on your livelihood? What would you need to help in long-term planning?
Mitigation	What changes have you made to improve efficiency in your work (fuel, animal feed, yields/input? Why did you make these changes (did something in particular make you see the need)? When did you make these improvements? Have you ever postponed these changes? If so, why did you have to postpone making improvements? Did you have as much improvement as anticipated? Did you see any unexpected improvements?
Capacity	*Human Capital* Where do you access information that is important to your livelihood or business? How available is the information? Has the ability to access information changed over time? What would you like information on? *Social Capital* Are you a part of any other formal farming groups? (Do any exist that you have chosen not to join?) What help do these groups provide? What local services do you use? Are they easy to access? *Natural Capital* How productive are the soils? Has this been changing over time? How have you been able to increase the productivity of resources? How are your fields/crops impacted by outside users? *Physical Capital* How would you describe the state of transport infrastructure and services, communications, and energy supplies? Have you seen changes over time? How has this supported or hindered families income or livelihood? Do you have any equipment that you use to bring in extra income? *Financial Capital* What is your main income source? Do you have other sources of income? Other members of your household? Does anyone work outside of the region? In what years did you have good income and what happened then? What happened/caused bad years? How is the household doing currently with the level of income?

Grounded Theory

Attention to processes and context is one of the principal tenets of grounded theory research. Rather than a method, grounded theory has been described as a style of doing qualitative analysis with distinct features embracing: theoretical sampling; concurrent data collection and analysis; and constant comparison of data to data, data to concepts and concepts with theoretical categories (Charmaz, 2005, 2006; Laws and McLeod, 2004; Strauss, 1987). Grounded theory maintains a participant-driven approach by aiming to discover key issues from participants in the field, seeking differing perspectives and using an iterative approach with flexible data collection procedures (Charmaz, 1995; Charmaz, 2000; Glaser and Holton, 2004; Oreszczyn, 2000). In practice, this translates to using broad, open-ended questions to encourage unanticipated explanations to emerge, while follow-up discussion stimulates detailed information on the topic (Charmaz, 2006). Follow-up questions explored context, processes and structure.

Q Method

Stephenson (1953) developed Q method for the field of psychology. Often described as a collaboration tool, Q method can create a more neutral interview setting for posing potentially contentious statements and issues (Brannstrom, 2011; Dryzek, 1990). Q method does not provide a percentage of the population that adheres to one idea, but rather provides clarity of multiple perspectives by systematically identifying discourses (Dryzek and Niemeyer, 2008). Moreover, the factor analysis component of Q method works well with systems methodology since it isolates factors in multivariate phenomena without being reductionist (von Bertalanffy, 1971). The first step of this method is to develop 'the concourse' through interviews, observation, media reports and a review of the literature (Van Exel and de Graaf, 2005). The concourse consists of the range of opinions surrounding a topic and from the concourse a list of statements can be generated for the Q sort. In chapter 6, the concourse was developed solely from statements from participant interviews. Interviewees sorted the statements into a quasi-normal distribution from least agree to most agree and factor analysis generated well-defined discourses. Short interviews via email were conducted after the sorting, providing details, context and ultimately a better understanding of the emerging factors. Consequently, this method helps to uncover how and why perspectives diverge.

Political Ecology

Similar to Q method, political ecology explains and resolves the consequences of ideas about environmental change as much as explaining the change itself (Robbins, 2011). The interdisciplinary approach of political ecology emerged from the field of political economy and thus maintains a focus on the link between the distribution of power and productive activity, while also including an analysis of environmental relationships (Berkes et al., 2003; Greenberg and Park, 1994). Political ecology differs from most other approaches and complies with systems methodology since it includes economic, historical and political analysis; involves multiple scales and perspectives from ethnographic data; and contends with discourse analysis and the relationship between power and knowledge (Berkes et al., 2003; Bryant and Bailey, 1997; Muldavin, 2008).

In terms of discourse analysis, the broad aim of political ecology has been to uncover counter-narratives to those dominating policies or academic debates about the causes of environmental problems (Benjaminsen et al., 2010). In particular, discourse analysis and the relationship between power and knowledge have been influenced by the work of Foucault. Flyvbjerg and Richardson (2002) describe a Foucauldian approach as using context-based case studies and a theoretical analysis of power; exploring the relationship between power and knowledge; viewing language as conflict rather than debate and applying the insights gained to bring about change. Foucault asserted a more complex idea of power and power relations. First, Foucault maintained that the state was secondary to local regional powers and these powers must be understood in historical and geographical context (Foucault, 2012). While Foucault argued that power exists in interactions between people when one wants to influence the action of others, he also maintained that people understand their actions and why they do them, but are not always aware of the consequences or larger impacts (Dreyfus, 1982; Hindess, 1996). Foucault also stressed that power relations had narrowly focused only on domination and repression ignoring other potential relationships; furthermore, if the possibility of resistance does not exist there are no relations of power (Foucault, 1987; Foucault, 1989). Finally, Foucault argues that power ensures that things get done and should not be only considered in a negative light (Foucault, 2012).

Integration of Methods

The discovery of new ideas from the constant comparison process provided new opportunities when initial research plans did not come to fruition, highlighting an additional benefit of the grounded theory approach (see appendix 2 for details of how the research plan changed). Figure 2 shows how Grounded theory and other methods were integrated throughout the research process. In chapter 4 the grounded theory process eventually led to the integration of post-Soviet literature since coding revealed themes related to a Soviet legacy. Memo writing in the field resulted in two participant driven outcomes that were examined further in chapters 5 and 6. Chapter 5 examines the changes in social capital and returned to the modified SLF to examine the development process of a dairy cooperative. When crop rotation emerged as a contentious topic with considerable disagreement, Q method was used to examine the disagreements, as Q method has been shown to be particularly valuable when applied to complex and controversial issues (Addams and Proops, 2000; Barry and Proops, 1999). Finally, a political ecology lens was used in the final synthesis and analysis of results.

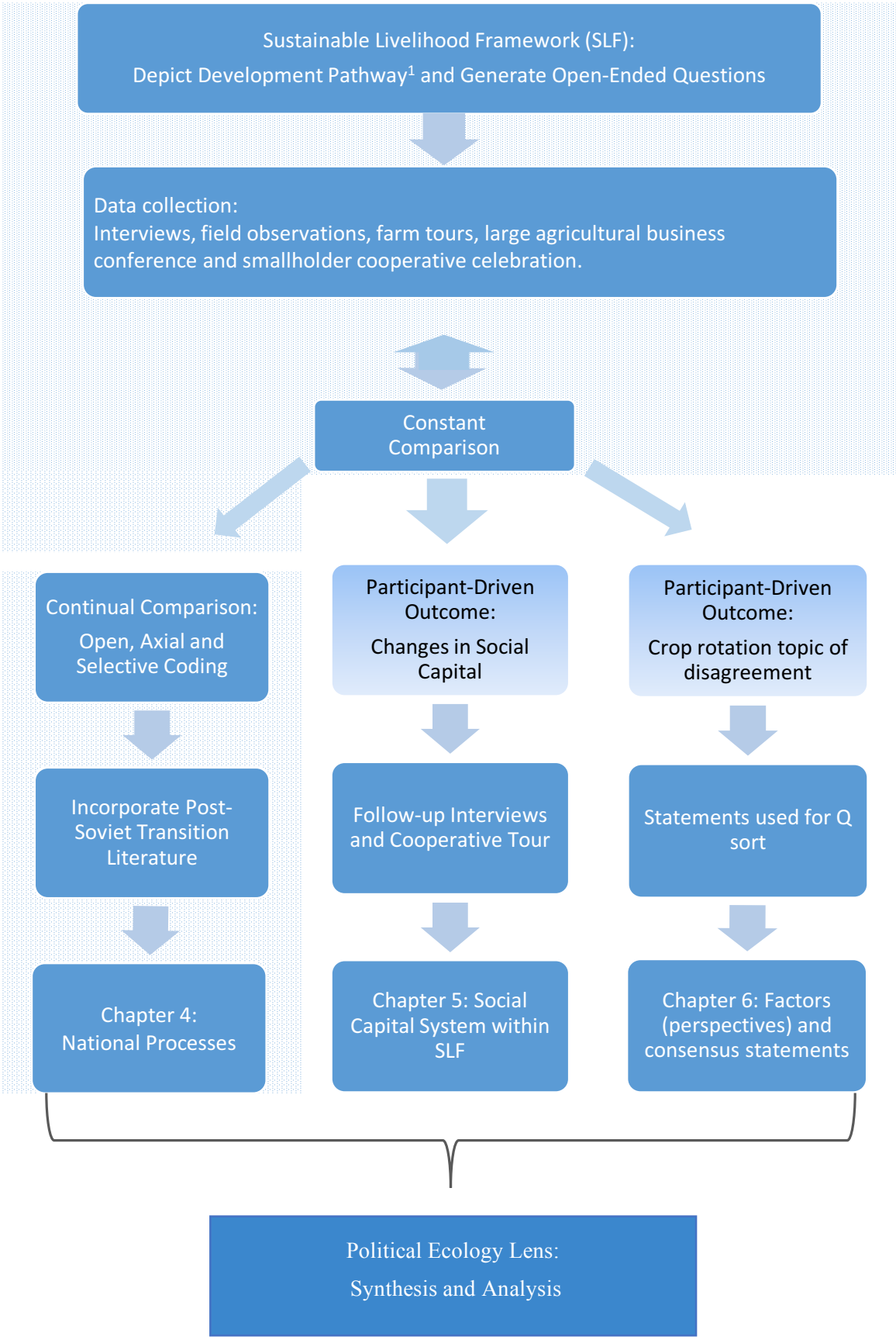

Figure 2. Research design.

[1] Adaptation, mitigation and sustainable development were considered to be a single process addressing climate change through resilience building. They were differentiated as three different objectives at the outcome stage of the process. Shaded area indicates where grounded theory was used for collection and analysis.

The methods used are also complementary in respect to addressing weaknesses as shown in table 5. While political ecology strongly focuses on historical context, the SLF often does not lead to consideration of historical factors. For example, people who have historically experienced problematic external interventions might not be receptive to new interventions (Adato and Meinzen-Dick, 2002). Since grounded theory does not use prior theories from the literature, it has been argued that it runs the risk of re-discovering previous findings (Thornberg, 2012). Using the SLF to generate questions and political ecology to synthesise the results helps to counter this concern. Q method often finds unanticipated similarities among individual attitudes; thus supplementing grounded theory well (Addams, 2000). Moreover, integrating grounded theory and Q method with a political ecology approach can address criticisms against political ecology. In particular, Vayda and Walters (1999) stressed the use of open questions in environmental research and not assuming political influences or having a political bias prior to conducting research. By using open-ended questions in interviews prior to building the concourse this bias was reduced. In addition, all statements on the subject including those that are not political were included in the concourse to account for apolitical influences. Finally, political ecology has often used a chain of explanation when in reality multiple levels act more like networks of influence (Robbins, 2008). Q methodology does not reduce a complex subject into a linear explanation, but maintains the complexity of influences versus claiming direct causes.

Table 5. Role methods play in addressing weaknesses.

The second column indicates criticisms of the methods listed in the first column, while the third column explains shows how these criticisms were addressed by the methods listed in the last column.

Critiqued Method	**Criticism**	**Mitigating Role**	**Supporting Method(s)**
Sustainable Livelihood Framework (SLF)	Misses global processes, historical influences and power relations	Predominantly focus on global processes, historical and power relations	Political Ecology
Grounded Theory	Risks 'reinventing the wheel'	Used to guide interviews	SLF
		Used to interpret results	Political Ecology
Political Ecology	Misses apolitical influences	Open coding process includes apolitical terms	Grounded Theory
		Apolitical statements included in sort	Q method
	Leads to a linear/causative interpretation	Explanations are influences not causes and relationships are not linear	Q method

Concluding Remarks

Understanding and solving climate change requires a holistic and interdisciplinary approach such as a systems methodology (Schneider, 1977). Moreover, agriculture and climate change are socio-ecological systems characterized by interactions between power relations and justice, resource use and management, and feedbacks across multiple scales (Fischer et al., 2015). The methods selected for this study address each of these characteristics. Thinking of the problem as systems within systems helps to make the study manageable without being reductionist. For instance, a system may be a region, a community, a household, an economic sector, a business, a population group, or ecological system (Brooks and Adger, 2005). Chapter 4 considers broad issues affecting climate change in the agri-food sector in Ukraine, chapter 5 considers the system to be a dairy cooperative in Ukraine's south, while chapter 6 examines how the political economic systems interacts and affects crop-rotation. Finally, the understanding of environmental issues varies according to differing perspectives, and social systems and power relations influence these perspectives (Hirsch et al., 2010). In chapter 7, a Foucauldian political ecology approach engages with these perspectives to reach a greater understanding of each of these sub-systems.

The next chapter describes the context of Ukraine's agri-food sector by using the SLF as a guide. Moreover, in order to support political ecology analysis considerable attention is given to the history of agriculture in Ukraine.

Chapter 3. The Pathway of Ukraine's Agri-Food Sector

Introduction

Since the aim of this study is to understand how to foster a climate-resilient development pathway, the ideal candidate country for this case would have two key features: appreciable potential and considerable sustainability challenges impeding that potential. The purpose of this chapter is to provide contextual information about Ukraine's agri-food sector. As will be established in this chapter, Ukraine's agri-food sector satisfies the qualities for both an intrinsic and instrumental case (Stake, 2005). Due to Ukraine's agricultural importance, findings even when just limited to the context of Ukraine have intrinsic value; however, the potential synergies, the unmet potential and numerous challenges provide a case that is instrumental in understanding the broader issues surrounding climate-resilience.

Methodology and Outline

This chapter consists of a literature review of journal articles, technical documents and historical reports. Over the course of this research, Ukraine has experienced considerable political turmoil including the Maidan revolution, subsequent fall of the Yanukovych government, annexation of Crimea by Russia and a continuing war in eastern Ukraine. Data collection occurred prior to the Maidan revolution with the exception of the Q sort procedure in Chapter 6. This chapter has been updated in an attempt to capture some of the ongoing reforms in Ukraine. In addition, personal communication with a land reform expert in Ukraine supplements the information gathered from literature reviews.

A brief introduction provides the key features justifying Ukraine as a case study, while the remainder of the chapter broadly follows the SLF in providing information pertaining to challenges and opportunities for fostering a climate-resilient development pathway. First, the climate context is discussed: including shocks, trends and seasonality from both past events and predictive climate models. The next section addresses current livelihood practices by discussing farm structures and crops produced. Then an examination of national indicators for the five capitals provides an idea of capacity as well as socio-economic, environmental/natural resources challenges in Ukraine. Following that, the historical changes that have influenced Ukrainian agriculture will be described. Finally, adaptation and mitigation outcomes will be discussed.

Overview of Ukraine's Potential and Challenges

Ukraine, often called the breadbasket of Europe, has one-third of the world stock of black fertile soil (chernozem) and a favourable temperature and moisture regime for growing a variety of crops (Fileccia et al., 2014). Ukraine is the second largest country in Europe with 70% of that land being arable (41.5 million hectares) compared to approximately 45% arable land in the EU (Arkadiusz, 2014; Dolgilevich, 1997; Fileccia et al., 2014; The World Bank, 2010; Thuroczy, 2009). Location

also serves Ukraine well. Ukraine means borderland, aptly named due to its location on the south-eastern edge of Europe, closely neighbouring Asia and the Mediterranean and with the Black Sea coast to the south (Subtelny, 1988). Therefore, Ukraine's 19 ports (5 in Crimea) are well positioned to export to key markets including the EU, Northern Africa and the Middle East (Morton et al., 2005; OECD, 2003; Thuroczy, 2009). Also due to location, most of Ukraine has a moderate-continental type climate, except for the almost sub-tropical climate of the southern coast of Crimea (UNFCCC, 1998). This enables Ukraine to grow a range of crops and produce ranging from winter wheat and spring barley to melons and grapes. The nations natural riches are largely due to the ecoregions in Ukraine: forest, forest-steppe, steppe, mountain, and both freshwater and saltwater systems.

Transitioning to a market economy has slowed the achievement of Ukraine's agricultural production potential. After Ukraine achieved independence, fallow land increased fivefold, forage crops decreased by nearly 40 percent, livestock production plummeted and agricultural GDP contracted by 51 percent (Karacsonyi, 2010; Lindeman, 2004; Shuker, 2004; Thuroczy, 2009). However, conditions have improved, and since 2000, production has been increasing (Karacsonyi, 2010). Agribusiness has become one of the most promising and thriving sectors of Ukraine's economy and further gains could serve to drive the rest of the economy (Karacsonyi, 2010; Shuker, 2004; Williams, 2011). Currently agriculture accounts for about 20% of the country's employment and at 14% of Ukraine's gross domestic product, agriculture's share of GDP is much higher than in Europe's other major agricultural producers (Arkadiusz, 2014; WDI, 2015).

Ukraine's economy can also benefit from attracting foreign investment for climate mitigation projects. While Ukraine has benefited from the JI scheme, Ukraine has low motivation to act due to unambitious commitments under the Kyoto Protocol. The baseline year for Ukraine under the Kyoto Protocol was 1990 and the reduction target called for stabilising emissions at 1990 levels by 2012 (UNFCCC, 2008). Ukraine received Assigned Amount Units (AAUs) based on these targets (Aldrich and Koerner, 2012). Since the baseline is one year prior to the collapse of the Soviet Union and the subsequent economic breakdown, Ukraine had an abundance of AAUs which remained in effect post-2012. AAUs could be traded to other countries, which helped lower costs of emission reductions. Money earned from selling AAUs went into the Green Investment Scheme, but often those projects did not contribute to additional emission reductions (Aldrich and Koerner, 2012).

Ukraine faces many challenges independent of climate change that contribute to the vulnerability context. The unstable political situation and crisis in eastern Ukraine continues to cause problems and create risks for Ukraine's economy (World Bank Group, 2015). High levels of corruption have become an enduring problem in Ukraine. According to Transparency International (2015), Ukraine's transparency score of 27 out of a possible 100 has been relatively consistent over the last 5 years and places Ukraine 130/168 in the country rankings. As per Gwartney and Lawson (2015), Ukraine also ranks in the 128th position and amongst the least free countries for economic freedom

based on the size of government, legal structure, freedom to trade internationally and regulation of credit, labour and business. However, many reforms have very recently occurred including new anti-corruption legislation, better-targeted assistance to the poor, strengthening of regulatory framework and harmonization of banking practices with EU norms (World Bank Group, 2016).

Climate Context: Shocks, trends and seasonality

In terms of establishing climate context, it is worthwhile to look at historical and recent climate events. Droughts have increased in frequency and intensity and have recently started to influence even the typically wet northern Polesye region (Adamenko and Prokopenko, 2011). Correlation analysis conducted for the period covering 2000 to 2012 found increasing temperatures and decreasing precipitation to limit summer productivity in the steppe and forest steppe zones (Movchan and Kostyuchenko, 2015). However, drought is not the only potentially detrimental change affecting crop production. The timing and intensity of precipitation events is also of concern. In Ukraine, snow pack is essential for protecting winter crops from frost damage and for providing moisture for crop development through the spring melt (Romanov, 2011). An example of multiple climate events affecting production happened in 1890. Crops were affected first by an unusually dry autumn, then strong winds removed snow cover during an extremely cold winter, a rapid snow melt in the spring did not provide the necessary soil moisture for early development and finally a meteorological drought occurred in the late spring and summer (Dronin and Kirilenko, 2012).

In terms of climate models, Parry et al. (2007) predicated a slight beneficial affect for Ukraine. However, Alcamo (2007) argued that earlier models related to averages over large areas, while they found that an increase in severe droughts could lead to significant reductions in local crop production. Indeed, models for both north western and south eastern Ukraine demonstrated water deficits in the summer due to increasing temperatures, corresponding increases in evapotranspiration and decreasing precipitation (Dronin and Kirilenko, 2012; S. Fischer et al., 2014). While earlier models predicted that eastern Europe would have an increase in growing season due to fewer days of frost (Tebaldi et al., 2006), more recent models indicate that Ukraine will experience a decrease in growing season of 10 or more days due to summer water deficits (Bär et al., 2015). Increases in growing seasons and as well as potential yields have been demonstrated for the Carpathian Mountains where significant agricultural production is not feasible (Bär et al., 2015; Sutton et al., 2008).

At the same time, several models indicate an increase in frequency and magnitude of extreme precipitation events. Roudier et al. (2016) found that flood magnitudes will increase significantly for Ukraine. In south western Ukraine, Croitoru et al. (2013) observed an increase in heavy and extremely heavy precipitation days. Moreover,Gaál et al. (2014) found drying in the summer, but increases for all precipitation indices in the winter for the Carpathian basin indicating an increase likelihood of flash floods.

Seasonality and precipitation variability causes considerable volatility in production as will be explained in the outcome section of this chapter. While drought is the dominant concern, timing of precipitation, intensity of events, snow-pack also play an important part in yields realised. The next section discusses current livelihood practices in terms of farm structure and crops produced.

Livelihoods: Current farm structures and crop production

Farm Structures

Ukrainian citizens possess the following four types of agricultural land: (1) plots of land around their homes, (2) small household plots near villages, given to families residing in the closest village, (3) dacha plots or summer homes typically owned by urban families, and (4) land shares given to members of the former collectives and local residents (Morton et al, 2005). The land can either be cultivated by the "owner" or leased to another farmer or business. An estimated 6 to 7 million Ukrainian citizens choose to cultivate small land plots; moreover, 37.1 percent of Ukrainian households raise cattle, poultry or bee hives (East Agri, 2005; Morton et al., 2005). However, many opt to lease land to agricultural businesses.

Ukrainian statistics identify three types of farms: agricultural enterprises or agri-holdings from 1 000 to 100 000 hectares or more, private farms of 100-500 hectares and household plots of typically 1-2 hectares (Karacsonyi, 2010). Small individual farms and household plots produce most of the agricultural output in Ukraine due to the sheer number of individual farmers (Karacsonyi, 2010; Thuroczy, 2009).

In general, agricultural enterprises are getting larger (Karacsonyi, 2010). Between 2005 and 2011, the number of farms over 3000 ha increased by 35 percent mostly due to a reduction of farms ranging from 500 to 2000 hectares (Meyers and Goychuk, 2015). The large agricultural enterprises tend to be vertically and/or horizontally integrated businesses, managed by agribusiness professionals and often owned by investors from other industries (EBRD and FAO, 2008).

Farm Production

In Ukraine and globally, there has been a noticeable move away from cereal production to oil seed crops such as sunflower, rapeseed and soybean (EBRD and FAO, 2008). Oil crop production has experienced the fastest growth in Ukrainian agriculture compared to other crops (Karacsonyi, 2010). The land area used to cultivate sunflower has more than doubled since 1985; moreover, it was the only crop that had increased production during the 1990s (Karacsonyi, 2010; Shuker, 2004; Thuroczy, 2009). Ukraine became the top exporter of sunflower in 2012 and increased exports by almost 40 percent between 2013 and 2014 (McFerron, 2014; Ministry of Foreign Affairs of Ukraine, 2012). Rapeseed production increased 60 times in five years and has replaced sugar-beet and flax in the north and in the forest-steppe (Karacsonyi, 2010). The area sown with soy increased from 31,000 hectares in 1998 to more than 700,000 hectares in 2006 (Thuroczy, 2009).

Despite declines in production and shifts to oil crops, Ukraine produces 3-4 percent of global grain production and belongs to the top 15 wheat producing countries (Karacsonyi, 2010). Forecasts for wheat production for the 2016/2017 season predict a decrease from the year previous due to fall dryness reducing area sown; however yields are forecast to be at their highest level in 26 years (Lindeman, 2016a, 2016b) Barley is the next most common crop since fields with crops damaged by frost are frequently reseeded with spring barley (Lindeman, 2004; Thuroczy, 2009). The third most important crop in Ukraine is maize. Ukraine was the world's largest exporter of maize in 2006/2007 producing 5 million tonnes (Thuroczy, 2009). While cultivated lands producing maize quadrupled between 2002 and 2013, maize has decreased over the past two years due to falling prices (Lindeman, 2016a). Rye continues to be an important crop in the northern region of Ukraine with exports to neighbouring countries (Karacsonyi, 2010).

On average people in Ukraine consume 132 kilograms of potatoes per person each year (Shuker, 2004). The area sown with potatoes has consistently been around 1.5 million hectares (Karacsonyi, 2010). Households produce 98 percent of the potatoes in Ukraine and most vegetables and some fruits are grown for personal consumption with surplus production sold on the local market (Karacsonyi, 2010; Shuker, 2004). Livestock production, animal feed, sugar beet and high valued crops such as fruit and wine declined the most in production. The volume of fruit, grape and wine produced in Ukraine is half of what it was in the 1980s (Karacsonyi, 2010). Sugar beet production has decreased due to its inability to compete with sugar cane and the improved profitability of grains and oilseeds (Karacsonyi, 2010; Lindeman, 2004). This decline, particularly in large-scale production, caused social and economic problems in rural areas since sugar beet is a labour intensive crop (Karacsonyi, 2010; Lindeman, 2004). Animal feed production had one of the steepest declines due to a drop in meat production (Karacsonyi, 2010). Cattle production has not been profitable since independence (Galperina, 2014). By 2009, cattle stocks were less than a quarter of what they were in the early 1990s, and Ukraine had 60 percent fewer pigs (Karacsonyi, 2010; Thuroczy, 2009). Poultry production has now recovered after experiencing a 40 percent drop by 2001 (Thuroczy, 2009). Sheep and goats are raised only near Odessa, Crimea and the Carpathian Mountains, but their stocks declined in the 1990s, stabilized in the 2000s and experienced some growth in the late 2000s (Karacsonyi, 2010). Access to capitals influences farm structure and production, the next section reviews indicators for the five types of capitals with the SLF.

SLF Capital Indices

This section reviews the challenges and opportunities facing a sustainable future in Ukraine and the potential response capacity by examining indicators for each form of capital within the SLF.

Financial Capital

Ukraine's national poverty rate is 24% with rural areas experiencing poverty rates twice that of urban areas (UNDP, 2013). Many living in rural areas depend on subsistence farming, while those

employed in agriculture receive half the wage compared to other sectors (Karacsonyi, 2010; Shuker, 2004). In addition, women working in agriculture, on average, receive a salary 89.3% of that of men working in the sector (UNDP, 2015).

For businesses, Ukraine's agri-food sector has a risky lending environment due to: the inability to use land as collateral because of the land sale moratorium, unpredictable government policies and ineffective law enforcement (Krasnozhon, 2013; Morton et al., 2005; Shuker, 2004). High interest rates at commercial banks and lending terms that do not fit the needs of small farmer's add an additional challenge to gaining necessary financing (Morton et al., 2005). However, large farms can receive financial support from the concessional credit programme and agri-holdings are able to attract foreign investment (Arkadiusz, 2014; EBRD and FAO, 2008; Thuroczy, 2009).

Physical Capital

Physical capital can be divided into two broad categories: 1) capital specific to the agri-food sector such as crop inputs, technology, and handling, storage and food processing infrastructure and 2) general infrastructure for the rural population. Historically, collective and state farms provided for all services in rural areas including infrastructure, social and cultural activities (East Agri, 2005). Ukraine's agri-holdings are often the only source of investment in rural areas; however, agri-holdings pay taxes to cities where headquarters are located thus reducing funds available for rural infrastructure (Arkadiusz, 2014). Local administrators do not have the budget needed to maintain facilities: according to some estimates budgets only cover the costs of 1-3 percent of necessary maintenance (East Agri, 2005). Many homes in rural Ukraine lack key infrastructure including running water, safe drinking water and sewers (East Agri, 2005; UNDP, 2015). Moreover, the number of villages reachable via paved roads declined from 1500 to 560 within 10 years (East Agri, 2005).

The inability to access financial capital has resulted in a decrease in input use and continued use of obsolete machinery[4] (East Agri, 2005). The inputs consumed by owners of private household plots are very small: 5.1 percent purchased seeds, 3.8 percent purchased fertilizers and 0.4 purchased pesticides (Morton et al., 2005). In addition, approximately 40 percent of tractors are 15 years or older and machinery replacement occurs at $1/10^{th}$ the rate it did during Soviet times (East Agri, 2005; Morton et al., 2005).

Construction and maintenance of irrigation systems ceased after independence leading to: inefficiencies, water loss and a decrease in irrigated land (Gumeniuk et al., 2010; The World Bank, 2007). According to FAO (2010), an estimated 5 million hectares would benefit from irrigation. Before Ukraine's independence irrigation systems covered approximately 3 million hectare, but by

[4] In interviews, one farmer said that one benefit of Soviet machinery was the ease with which it could be fixed. While more modern machinery does not break down as often, when it does break down it can take days for parts to arrive and even more time for the subsequent repair to be completed.

2004 the area of land covered by irrigation declined by 50 per cent and only 370 thousand hectares were irrigated (FAO, 2010; Gumeniuk et al., 2010).

Ukraine has invested in ports, but millions need to be invested to improve economic and energy efficiency of grain handling and storage systems that were established in the 1970s (EBRD and FAO, 2008). Despite some companies purchasing grain hoppers along transport routes, the country still lacks storage facilities which forces producers to sell even when prices are low (EBRD and FAO, 2008; Lindeman, 2004).

Human Capital

Human capital captures the capability of individuals to work as determined by health, education and demographics. By all measures, the rural areas of Ukraine have poor human capital. Ukraine experienced the greatest decline in population after the collapse of the Soviet Union and currently Ukraine is one of the fastest aging and depopulating countries in Europe (Thuroczy, 2009; World Bank Group, 2015). At 31.9%, the current share of the rural population is high compared to other European countries; however, the rural population decreased by as much as 15.9% since independence due to declining living standards, lower life expectancy and migration to urban areas (Arkadiusz, 2014, Ryabchenko, 2013). Adult death rates for men are among the highest in the world largely due to cardiovascular disease, high smoking rates and alcohol consumption (The World Bank Group, 2015). While the millennial development goals for maternal health, child mortality and education have been met, the goal for HIV/AIDS and Tuberculosis remain a significant concern (UNDP, 2013). Moreover, out of pocket expenses for health care amount to 40.5% of total expenses in Ukraine compared to 16.6% for the EU (Rechel et al., 2013). Finally, food security, particularly nutrition, has become a concern in rural areas. Rural households in Ukraine spend 70 percent of their income on food while household in developed countries spend 15-25 percent of their income on food (East Agri, 2005; R. Morton et al., 2005).

Ukraine benefits from a highly educated work force (UNDP, 2013). However, similar to healthcare, the education system in Ukraine remains underfunded (Rechel et al., 2013). Higher education and research centres are needed to spur innovation and leadership in Ukrainian agriculture (Grueninger and von Cramon, 2008). In addition, financing for sciences is ten times lower in Ukraine compared to developed countries, so many scientists move abroad seeking better working circumstances (O'Donnell et al., 2007).

Government is currently addressing some of the challenges related to human capital such as low internal labour mobility, high informal employment and a mismatch of skills to employment needs (World Bank Group, 2015). As well, the international community provided assistance in testing different models of advisory services in Ukraine and then began implementing extension services as a result of these tests (Morton et al, 2005). Until the allocation of 2 million USD in 2007, the financing necessary to establish extension services was not available (The World Bank, 2007). Extension services are now receiving funding from state and local budgets; moreover, further

development of extension services has become a priority in order to inform citizens of changes to land and agricultural policies (Kalna-Dubinyuk and Poplavska, 2014).

Social Capital

As in the case of human capital, social capital is less tangible than the other forms of capital. While human capital exists within individuals, social capital exists in the informal and formal relationships between individuals (Portes, 1998). Trust is also considered necessary for the development of social capital (Fukuyama, 1995). In terms of trust, generally Ukrainian citizens have the greatest trust in relatives and friends and the least in politicians and institutions; therefore, they tend to have high self-reliance with some dependence on relatives, but less dependence on friends and networks (Sapsford and Abbott, 2006).

Unfortunately, Ukraine provides an example of what is considered to be the dark-side of social capital, since social networks are used to maintain corrupt practices and a thriving informal economy (Rose-Ackerman, 2001). Moreover, UNDP (2013) identified problems with social exclusion in Ukraine with critical levels of exclusion in rural areas affecting access to education, health care, social care and proper housing. The drive for individualism and memory of past experiences with collective farming prevents farmers from joining cooperatives even when membership clearly provides benefits (EBRD, 2002). Forming a network of agricultural extension services could also serve to improve social infrastructure (Kalna-Dubinyuk and Poplavska, 2014).

Natural Capital

In terms of natural capital, Ukrainians benefit from living in one of the richest countries in Europe; however, Ukraine also happens to be one of the most polluted countries in the area (UNDP, 2013). Ukraine covers less than six percent of Europe, but has approximately 35 percent of Europe's biological diversity (O'Donnell et al., 2007). Ukraine has considerable freshwater and saltwater habitat: 96 per cent of Ukraine's 22,000 rivers drain into the Black Sea or Sea of Azov; while the remainder flow to the Baltic Sea (Chemonics International Inc., 2001; The World Bank, 2007). Ukraine's forests are largely located in the northern flat region named Polessia, the Carpathian Mountains and the Crimean Mountains (Gumeniuk et al., 2010). Polessia has mixed coniferous and broadleaf forests along with many diverse wetlands that support rare plant species (Chemonics International Inc., 2001; Kolomytsev, 2011). For instance, Polessia has most of Ukraine's 1.4 million hectares of peatlands (Michael Succow Foundation, 2009). In the west of the country, the Carpathian Mountains have 20 percent of Ukraine's forests and has been recognised by UNESCO as an area of global significance (Chemonics International Inc., 2001; Keeton and Crow, 2009). Crimea, in southern Ukraine, has a more Mediterranean type climate and dry mountain forests (Chemonics International Inc., 2001; Synyakevych et al., 2009).

Deforestation, the draining of wetlands and peat harvesting allowed for substantial areas of Polissia to be converted to agriculture. However, most agriculture takes place in the Steppe zone, where more than 80% of all land is cultivated, followed by central Ukraine's Forest-Steppe zone (Gumeniuk et al., 2010; Kolomytsev, 2011). Both regions have climate and soils well suited for

agriculture. The Steppe region has a greater presence of chernozems; however, droughts occur more frequently in the Steppe zone compared to the Forest–Steppe (Birmili et al., 2008). Almost all native vegetation has been removed for agriculture in these two zones (Birmili et al., 2008; Chemonics International Inc., 2001). Prior to the introduction of agriculture, broadleaf forests and open grasslands dominated the landscape in the Forest-Steppe zone, while the Steppe zone was predominantly grassland (Chemonics International Inc., 2001).

Unfortunately, these ecosystems do not have adequate protection. Currently, protected areas make up 5.6% of the land in Ukraine compared to the international average of 10% (UNDP, 2013). Historically, agriculture has been responsible for most habitat destruction through deforestation and wetland drainage (Chemonics International Inc., 2001). Agricultural practices cause 35-40 percent of environmental degradation in Ukraine (The World Bank, 2007). Natural resources in Ukraine; such as, forests and soils continue to be exhausted from over exploitation. However, Ukraine also endures considerable environmental contamination due to industry, mining and the Chernobyl disaster.

The 1986 Chernobyl catastrophe mostly affected the Polessia region. In Ukraine, 200 thousand people from more than 2,000 settlements were relocated outside the exclusion zone (Kravchenko, 2005). Radioactive Iodine was the biggest concern immediately following the accident; however, long-term contamination from Strontium-90 (^{90}Sr) and Caesium-137 (^{137}Cs) continues to be an expensive legacy from Chernobyl. According to the Nuclear Energy Agency (2002), 8.4 million hectares of agricultural land require some countermeasures due to ^{137}Cs contamination. Countermeasures include monitoring, fertilizing, special cultivation practices and radio-caesium absorbing tablets as a supplement to animal feed. However, difficulties arise even with the help of remediation. Many farmers cannot afford the expense of additional inputs and the stigma from Chernobyl hinders sales (New Agriculturist, 2005; The World Bank, 2007; World Health Organization, 2005). Regardless the long half-life of ^{137}Cs means that remediation will be necessary for another 50 years in the areas currently farmed; in addition, remediation will be necessary once barred areas are brought back into agricultural production (Fesenko et al., 2006). While the consumption of agricultural food contaminated with ^{137}Cs constitutes the main risk to human health, a hydro-geological study of the exclusion zone concluded that ^{90}Sr could contaminate drinking water at some point within the next 100 years (Nuclear Energy Agency, 2002).

Environmental contamination is not limited to radio-nuclides from Chernobyl. While pesticide use has decreased since independence, pesticide contamination still affects agricultural lands (The World Bank, 2007). Storage of obsolete pesticides in flood-prone areas also carries a major environmental risk since flood waters could spread the contamination over a wide territory (UNDP, 2013). Eutrophication of the Black Sea and pollution of freshwater bodies caused by fertilizers and pesticide runoff, improper manure management, and under-treated sewage and industrial waste has become a problem again after experiencing some relief due to economic decline in the late 1990s

(Chemonics International Inc., 2001; The World Bank, 2007). In addition, dams and heavy regulation of river flows have caused increases in underground water levels and altered the ability of rivers to filter contaminants (Chemonics International Inc., 2001; O'Donnell et al., 2007). Ukraine has a persistent water deficit in terms of quantity and quality, particularly for potable water (Bagin et al., 2003).

Agriculture soil and water conservation depend on healthy forests (The World Bank, 2007). Forested lands amount to 10 million ha or approximately 16% of Ukraine: three times less than that of western Europe (43.2 percent) and below the optimal level of forests needed to fulfil ecosystem services (20-22 percent) (Gumeniuk et al., 2010; O'Donnell et al., 2007; UNFCCC, 1998). From the 1950s through to the late 1990s, 440,00 ha of shelterbelts were created through afforestation projects (Dolgilevich, 1997). However, when lands were divided after independence, many trees in shelterbelts were cut for wood (Fedorchenko, 2008b). As well, half of the forests in the Carpathian Mountains have been logged (Kravchenko, 2005). Landsat-based research revealed that illegal logging accounts for as much timber harvesting as documented logging (Kuemmerle et al., 2009). In addition to deforestation much of the native forests in the Carpathians have been changed into spruce monocultures resulting in large windfalls of young stands, erosion and siltation of the Black River reservoir and flooding of farmlands (Chemonics International Inc., 2001; Keeton and Crow, 2009).

For centuries agriculture in Ukraine has been responsible for decreasing soil fertility; for example, chernozem virgin top soil contains around 10 percent of soil organic matter, but cultivated lands now have 3-6 percent (Alioshyn et al., 2003; Shikula, 1997). Ukraine does still have rich productive soils. For instance, Ukraine's chernozems with humus content from 3 to 7% and with thickness of humus layer of 130 - 150 cm occupy more than 10% of Ukraine and the Grey Forest soils in the Forest-Steppe zone and the Chestnut soils in the Steppe zone have high fertility covering a significant portion of the country (UNFCCC, 1998). However, according to estimates more than 500 million tonnes of soil are lost from arable lands due to erosion annually (Fileccia et al., 2014). Dust storms originating from agricultural fields are common in Ukraine affecting chernozem soils the most (Birmili et al., 2008; Dolgilevich, 1997; Kassam and Friedrich, 2009). Additional problems with agricultural soils include: nutrient depletion, compaction from oversized machinery, salinization of irrigated fields and alkalinization (Alioshyn et al., 2003; Gumeniuk et al., 2010; Karacsonyi, 2010; The World Bank, 1992, 2007).

History of Agriculture in Ukraine

The historian Subtelny (1988, pg 5) articulates Ukraine's story best, "if nature has been generous to Ukraine, history has not." This next section describes the history of Soviet agriculture to elucidate why the transition to a market economy has been so difficult.

Forced Collectivisation

The history of collectivisation differs in western and eastern Ukraine. From 1654 until the Second World War, with the exception of a brief period of independence, western Ukraine was ruled by Poles and Austrians and eastern Ukraine was ruled by Russians. Collectivisation began in the late 1920's in the east and in the late 1940's in the west of Ukraine (Subtelny, 1988).

Prior to collectivisation, the peasant class were given approximately 12 million hectares of land through the Bolshevik Agrarian Programme in eastern Ukraine. However, corruption was rampant, taxes were regressive and most of the profits went to middle-men (Krawchenko, 1985a). Peasant uprisings began to break out as strong Ukrainian nationalist sentiments grew among the rural population. Historians view Stalin's programme of collectivisation in Ukraine as not only a way to provide grain for needed industrialization, but also a means to destroy the nationalist movement within Ukraine (Krawchenko, 1986; Mace, 1986a).

The communal approach to agriculture logically happened in the Russian north because of the poorer soils and harsher climates, while individual farming was widespread in Ukraine (Subtelny, 1988). In 1929, the collectivisation programme became compulsory, since after two years under the voluntary programme collectives only farmed 3.7% of Ukraine's arable land (Krawchenko, 1986). Moscow was to control all work that was formally under the control of local authorities in Ukraine including crop selection, soil improvement strategies and research objectives (Manning, 1953a) Collectivisation happened in several stages in eastern Ukraine: increased economic pressure on Kurkuls (rich peasants), the destruction of Kurkuls as a class, the artificial famine and finally an increase in punishment from the police.

The definition of a Kurkul varied, but typically they owned 10-15 acres of land and several cows, horses and probably sheep, but ultimately a Kurkul had more to do with an attitude of resistance to collectivisation (Krawchenko, 1986; Subtelny, 1988). At the start of collectivisation public uprisings were common and the army were called in to settle the villages (Subtelny, 1988). The government depicted the kurkuls as exploiters and blood suckers, while in reality they achieved their status through hard-work and efficiency (Subtelny, 1988). Kurkuls were divided into three groups and dealt with according to how they were labelled. Those who actively resisted collectivisation were executed or sent to prison camps, the wealthiest peasants were deported to remote parts of the Soviet Union, while the remainder were ordered to leave their district (Krawchenko, 1986; Manning, 1953a). The objective was to control rural uprisings by removing the leaders of village life who also happened to be the most productive farmers (Mace, 1986a).

The artificial famine ensured the control of the remainder of the rural population. Grain quotas would be impossible to meet for several reasons: 1) planting schedules were decided in Moscow without the knowledge of local conditions, 2) machine tractor stations were staffed by workers from outside of Ukraine, 3) party activists headed the collective farms and planted inappropriate crops, 4) farms did not contribute to quotas based on crop yield but according to sown area which was later changed to size of farm and 5) grain spoiled due to a poor transport system (Manning,

1953a; Subtelny, 1988). Ukrainian communists warned Moscow about the disastrous results of collectivisation, but despite the warnings Stalin raised Ukraine's grain quotas in 1932 by 44%. (Mace, 1986a; Subtelny, 1988) Peasants were not allowed to keep any of their own harvest and the sale of grain was illegal in regions that had not met their quotas (Maksudov, 1986).

Exact number of deaths due to the famine are not known but range from 4 to 7 million (Krawchenko, 1985b; Mace, 1986b; Maksudov, 1986; Manning, 1953b). Several steps taken by the Soviet regime helped to hide the exact death toll. Physicians were not permitted to list hunger as the cause of death, so deaths during the famine were recorded using symptoms of starvation like weakness and diarrhoea (Manning, 1953a). Soviet censorship prevented foreign correspondents from reporting on the famine (Manning, 1953b). Finally, the 1937 census was determined to be the work of subversives because too few people were found by census takers. The results were destroyed and supervising officials were shot to death (Krawchenko, 1985b; Mace, 1986b; Maksudov, 1986; Subtelny, 1988). The 1939 census was just a short summary and the results were not published (Mace, 1986b).

By the 1940s almost all of eastern Ukraine's peasants were members of collective farms and the traditional mode of life had been destroyed (Manning, 1953a; Subtelny, 1988). In western Ukraine, mass collectivisation began in 1948. The process was important for political reasons, but the west was not ready economically for collectivisation (Marples, 1992a). Western Ukraine did not endure a famine, but those that did not join kolkhozy (collective farms) were sentenced to hard labour and the kurkul class was attacked (Marples, 1992a). Peasants resisted by slaughtering livestock rather than turning property over to collective farms (Marples, 1992b). An armed struggle occurred when the weakened Ukrainian Insurgent Army and guerrilla forces retaliated against collective farms into the 1950's (Marples, 1992b; Subtelny, 1988). In spite of the resistance, collectivisation was effectively complete in western Ukraine by 1951 with 1.5 million peasant households belonging to collective farms (Marples, 1992c; Subtelny, 1988).

Soviet Restructuring

The Khrushchev period also had a significant impact on Ukrainian agriculture. Khrushchev's biggest impact was in the agricultural sector and he criticized Stalin for not being more knowledgeable about the practicalities of agriculture (Volin, 1959). He involved himself in technical details such as crop rotations and planting techniques and wanted other party officials to follow his lead (Karcz, 1966; McCauley, 1976) . Khrushchev and Stalin both believed in the superiority of large farms. Khrushchev merged collective farms and transformed many of the collectives (kolkhozy) into state farms (sovkhozy) (Volin, 1959). The state owns and operates sovkhozy with paid labour in the same manner as they would have run a Soviet factory. Machine tractor stations were viewed as a second boss, competing with the role of collectives, and as part of decentralization the equipment was sold to the collectives (McCauley, 1976; Volin, 1959). The sovkhozes end up with more advanced machinery compared to kolkhozes (Karacsonyi, 2010). In

addition, Moscow was no longer responsible for planning crops instead collectives were put in charge of most decisions (Volin, 1959).

Along with restructuring, Khruschev infused considerable funding into agriculture through increased pay to peasants and investments in machinery and fertilizers (McCauley, 1976; Volin, 1959; Wadekin, 1969). Krushchev's belief in the superiority of maize caused one of the largest changes to agriculture in Ukraine. By expanding grain production in the east, land in Ukraine was freed up to grow maize (Desai, 1992; Karcz, 1966; McCauley, 1976; Volin, 1959). While Soviet agriculture has been criticized for inefficiency and environmental degradation, under Khrushchev grassland crop rotation and the planting of shelter belts were established as good practices (McCauley, 1976).

Nonetheless, Clarke (1968) describes Soviet agriculture as being in disarray due to frequent reorganisation during the Khrushchev period. Overall Soviet agricultural policy caused distrust of government among the rural population when promised solutions didn't deliver (Karcz, 1966). More specifically, changes implemented after Khrushchev left included: reduction of production targets, increased investments to improve irrigation, drainage and machinery, and removal of restrictions on the size of private plots and personal livestock ownership (Clarke, 1968). As a result of these changes, millions of Ukrainians were cultivating crops on small land parcels even before the fall of the Soviet Union (Karacsonyi, 2010).

Agriculture transition: 1991 – 2012

The State Committee of Ukraine on Land Resources was established to implement land reform by transferring land from state to collective private ownership (Fedorchenko, 2008b). State-owned farms were privatized by partitioning each farm's land and non-land assets into land and property shares and then distributing shares equally to farm managers, employees, and retirees (Krasnozhon, 2015). Land shares given to each of the 7 million new 'land-owners' varied depending on farm size and number of employees, but on average amounted to 4 ha per person (Arkadiusz, 2014; Leonid A. Krasnozhon, 2015). Vouchers issued by the government for each land share had to be claimed by citizens and then exchanged for certificates. The certificates were a temporary title and thus had to be exchanged for a permanent deed by the 31st of December 1996 (Arkadiusz, 2014; Leonid A. Krasnozhon, 2015). Certificates technically allowed for land and property shares to be leased, bequest or sold; however, in 1992 the state imposed a land sale moratorium (Krasnozhon, 2015). While the state permitted the leasing of land, certificates did not have the necessary information for a rental contract such as the location of the land parcel, while a deed did contain this information (Krasnozhon, 2015). By the end of 2012, title deeds had been issued to 6.4 million people (Arkadiusz, 2014). A much simpler process involved the division of 2.6 million hectares of state and local government owned 'reserve' lands into small plots for 7 million rural residents (Arkadiusz, 2014). By late 2012, 74% of all agricultural land in Ukraine was technically privately owned (Arkadiusz, 2014).

Up until further reforms in 1999, collective agricultural enterprises (CAE) were the dominant form of farm organization. CAE operated as an employee-owned corporation based on shared, undivided ownership of land and assets and were subsidized by the state (Krasnozhon, 2015). In 1998 CAEs reported 1.23 billion USD in losses with most farms unable to keep up loan repayments (Krasnozhon, 2015). The 1999 reforms renewed the land-sale moratorium and ordered the reorganization of the CAEs into either sole proprietorships (SP) or employee-owned corporate farms (EOC) (Krasnozhon, 2015).

The History of Not Establishing a Land Market

The Soviet past created both technical and social challenges in creating a land market. For instance, in 1917 land was declared people's property and any records associated with a land market such as a cadastre, maps and accurate spatial references were destroyed. The land cadastre was renewed in 1968 but only at the republic level and not with any details even as basic as land use (Yanov and Fedorchenko, 2007). Establishment of a land register and cadastre was costly and required considerable technical and legal expertise not available in a country with a Soviet background (Yanov and Fedorchenko, 2007). The World Bank assisted with technical expertise and loans to complete an electronic cadaster for all of Ukraine making it the largest cadastral map in Europe and improving transparency for future land deals (The World Bank, 2013).

In terms of social challenges, the final reform of lifting the land sale moratorium has been a difficult change for many stakeholders to accept. For instance, throughout the 1990s collective farm interests formed an influential lobby and stalled reforms in agriculture because of the competition land privatization would bring (EBRD, 2002). A 2003 survey found that 44 percent of farmers were against a land market and 39 percent worried that a small group of people would purchase all the agricultural land (Fedorchenko and Yanov, 2010; R. Morton et al., 2005). Moreover, some academics argue that privatization of land is unconstitutional in Ukraine (Fedorchenko, 2008a). Finally, many rural landholders feel that life was better with the collective system (Fedorchenko and Yanov, 2010). This attitude has to do largely with the current state of rural infrastructure. In Soviet times, subsidies for rural development were implemented via collective farms, but after independence local budgets and administrators were not prepared for the responsibility of maintaining rural infrastructure (Fedorchenko, 2008b).

However, many argue that the ban on land sales prevents rural business development, economic growth and job creation (Crane and Larrabee, 2007). For instance, the land sale moratorium prevents farmers from using the land as collateral for loans (Fedorchenko and Yanov, 2010; Shuker, 2004). Moreover, a restriction on land sales has left approximately 20 percent of agricultural land not in use (East Agri, 2005; Fedorchenko, 2008b). While the land can be passed along through inheritance, according to Fedorchenko, 100,000 landowners do not have heirs (Personal Communication, 19/02/2011). At the same time, agri-holdings have used land contracts to attract investments while leaving the land idle (Meyers and Goychuk, 2015).

Moreover, even with the land sale moratorium the lack of transparency has permitted an illegal market for agricultural land (Nemchynov, 2011) For instance, in the last decade, ownership transfers occurred for an estimated 20 percent of agricultural land (Krasnozhon and Peregon, 2011). Hostile competitors have increasingly been able to take over existing businesses due to problems with lease renewals (Arkadiusz, 2014).

Regardless, most did not agree with lifting the land sale moratorium during Yanukovych's term in government due to a high level of distrust among the citizenry towards the government at that time (Fedorchenko, Director of My Land, Personal Communication,19/09/2011). Once the market became open to everyone, it was suspected by some that powerful interests with political connections would be able to get access to land and sell it to make a profit (Fedorchenko, Director of My Land, Personal Communication,19/09/2011 and Lehr, CEO Lehr Agrar, Personal Communication 15/09/2011).[5] The land sale moratorium has been renewed prior to each deadline with the last renewal extending the deadline until the 1st January 2017 (USUBC, 2015). Lifting the land sale moratorium has been declared a policy priority by the current government (Kyiv Post, 2016).

Development, Adaptation and Mitigation Outcomes

In terms of agricultural production, adaptation and mitigation Ukraine continues to have unmet potential. Considering the level of policy uncertainty and unfavourable political and economic conditions, farmers in Ukraine have managed well and large improvements in production have been made on a few farms (Meyers and Goychuk, 2015). Nonetheless, barley, wheat and maize yields in Ukraine are approximately half of the yields achieved in the EU and yields of Ukraine's major crops vary more than those of the EU and the U.S. (Meyers and Goychuk, 2015).

Yields have been particularly impacted by climate variability since the majority of farmers in Ukraine do not apply techniques that can help alleviate climate variability (OECD, 2003). For instance, wheat production varies considerably depending on weather, particularly precipitation. From 2000-2012, an average of 5.8 million hectares had been harvested with a bumper harvest of over 20 million tons in 2008; however, during the 2003 drought, 2.45 million hectares were harvested producing 10 million tons of output (Karacsonyi, 2010; Thuroczy, 2009). While a warmer climate in the north of Ukraine could favour agriculture, experience indicates a lack of capacity for seizing new opportunities (Fay et al., 2009). Moreover, declining productivity with increasing aridity in southern Ukraine could cause a loss of human capital as skilled farmers opt to change livelihoods (Lioubimtseva et al., 2013). While expansion of irrigation could ease some of the consequence, reduced groundwater recharge threatens the water supply for irrigation and due to high evapotranspiration losses irrigation consumes water making it unavailable for other uses including ecosystem services (Bär et al., 2015; Falloon and Betts, 2010).

[5] See appendix 3 for a description of problems in building climate-resilience during Yanukovych's term.

An assessment of Joint Implementation projects found that Ukraine's potential to mitigate climate change had not been seized. Ukraine's rules for guaranteeing environmental integrity were not consistently applied; as a result, the environmental integrity of issued emission reduction units were of questionable to low integrity (Kollmuss et al., 2015). Moreover, both Ukraine and Russia registered many projects retrospectively with no possible additionality for emission reductions as the commitment period came to an end in 2012 (Kollmuss et al., 2015). Finally, reports from Ukraine indicated preferential treatment for a few companies and unnecessarily slow processing for others (Kollmuss et al., 2015). Kollmuss et al. (2015) concluded that the countries with significant AAU surpluses had JI projects with lower environmental integrity.

Summary

Ukraine has significant and unmet agricultural production potential, as well as the opportunity to contribute to climate change mitigation by attracting foreign investment. This chapter reviewed the challenges associated with the transition and the current political economic context of Ukraine. In addition, the history of instability and change to Ukrainian agriculture contributes to an understanding of the current situation and the potential barriers to improvements. Models indicate that extreme precipitation events, in particular drought, will increase in frequency and intensity in Ukraine. A review of recent climate events indicate farmers have difficulty adapting to these changes.

The next three chapters examine many of the issues outlined in this chapter by analysing stakeholder interviews. Chapter 4 considers the shared barriers and bridges between capacity building, adaptation and mitigation for Ukraine's agri-food sector. Chapter 5 appraises how social capital transforms from a barrier to becoming a bridge for fostering climate-resilience. Finally, chapter 6 examines how many of the factors outlined in this chapter contribute to the abandonment of crop rotation.

Chapter 4. Change and transition: the climate of Ukraine's agri-food sector

Preface

Adaptive and mitigative capacity have been proposed to share many of the same determinants (Burch and Robinson, 2007; Tompkins and Adger, 2005). This chapter drew from interviews of stakeholders dealing with a variety of aspects related to climate change, agriculture and/or rural development to understand the common challenges and opportunities. The results highlight key issues related to a post-Soviet context that must be addressed at the national scale in order to foster climate resilience. It therefore addresses the first objective of ascertaining ways to seize synergies through identifying shared barriers and bridges. This chapter has been written in the style of Climate Policy and was published online in November 2014. The paper is available at http://www.tandfonline.com/doi/abs/10.1080/14693062.2014.979131.

Abstract

The agri-food sector has contributed significantly to climate change, but has an important role to play in climate change mitigation and adaptation. The agri-food sector has many potential win-win-win strategies that benefit mitigation and adaptation, and also deliver gains in rural income and land management. Post-Soviet transition economies provide a good model for understanding some of the barriers to adaptation and mitigation in the agri-food sector, due to their significant unmet agricultural potential combined with inefficient energy use. Ukraine is used as a case study to explore the barriers and bridges to addressing climate change in a post-Soviet state. A variety of stakeholders and farmers were interviewed about mitigation and adaptation and the current response capacity. Grounded theory analysis revealed themes that are perceived to function as barriers including: pandering, oligarchs and market interventions; corruption and transparency; and survival, freedom and law enforcement. Foreign involvement and investment emerged as a bridge to overcoming these barriers. The results indicate that significant progress in climate mitigation and adaptation in the agri-food sector in Ukraine will only be achieved if some of the wider political and social issues facing the country can be addressed.

Key words: adaptation, agri-food sector, mitigative capacity, post-Soviet, transition economy

Introduction

Providing sufficient food for a growing population, under increasingly frequent climatic extremes, currently stands as one of the biggest global challenges (Nelson et al., 2010). At the same time, the agri-food sector plays an important role in climate change mitigation. Agriculture accounts for the majority of global anthropogenic methane and nitrous oxide emissions and agricultural lands can function as either a sink or source for carbon dioxide (Smith et al., 2008). Food production must be more sustainable and resilient to mitigate and adapt to climate change.

Measures that mitigate climate change enhance sinks or reduce sources of greenhouse gases, while adaptation measures help to better withstand these changes (IPCC, 2001). While defined and deemed to be two separate responses to climate change, adaptation and mitigation have many links (Klein et al., 2007). First, the capacity to adapt or mitigate have common determinants, and when combined, can be termed response capacity (Burch and Robinson, 2007; Tompkins and Adger, 2005). Capacity does not convert directly to action, since decisions about resource allocation determine how and if response capacity is applied to adaptation or mitigation (Adger and Barnett, 2009; Winkler et al., 2007). Second, certain strategies involve trade-offs between adaptation and mitigation, while other strategies address both adaptation and mitigation (Klein et al., 2007). The agri-food sector has many potential win-win-win options that can deliver mitigation, adaptation and also provide auxiliary benefits such as improved land management (Glantz et al., 2009; Rosenzweig and Tubiello, 2007; Sutton et al., 2008). For example, measures that increase the carbon content of soils, such as conservation tillage, mitigate climate change by sequestering carbon, adapt to droughts by improving the ability of soils to retain water, while improving fertility and reducing soil erosion (Glantz et al., 2009; Lal, 2004; Rosenzweig and Tubiello, 2007). While synergies are apparent, Moser (2012) warns that trade-offs may not be immediately evident, since the trade-off may be made at another location or by another group.
Researching adaptation, mitigation and response capacity together delivers specific benefits for informing policy: i) it uncovers approaches that improve response capacity and serve as no-regret options ii) it reveals strategies that will lead to both adaption and mitigation and iii) it has the potential to expose trade-offs.

This study aims to identify barriers to climate change capacity building, adaptation and mitigation in Ukraine's agri-food sector, uncover processes that allow these barriers to continue and pinpoint bridges that might overcome these barriers. By applying an integrated framework, it is anticipated that common barriers will emerge revealing priority areas. Therefore, this study has a focus on the first two anticipated policy benefits of this framework.

This framework was applied to Ukraine's agri-food sector for several reasons:

1) Integration: The agri-food sector has many potential synergies.
2) Adaptation: Ukraine is an agriculturally important country, but has unmet potential with yields very dependent on climatic conditions (Adamenk and Prokopenko, 2011; FAO, 2002).
3) Mitigation: Ukraine has a high mitigation potential due to inefficiencies.[6] Emissions reductions can be made economically and Ukraine hosts the most Joint Implementation (JI) projects (UNEP, 2013).

[6] Ukraine emits 7,483 metric tons of CO2 per $ 1 million of GDP compared to the world average of 846 and the European average of 640 (Buzogány, 2013).

4) Capacity: Transition economies have less response capacity compared to developed countries.

Consequently, Ukraine's agri-food sector serves as both an intrinsic and instrumental case study as described by Stake (2005). As an important global player in agricultural production and climate change mitigation, findings from this study have significant intrinsic importance. It is instrumental because some findings could be applicable to other former Soviet Union (FSU) states and Ukraine's agri-food sector has the features necessary to test an integrated framework.

Climate policy in the FSU has not attracted as much research attention as in developing countries (Korppoo and Gassan-Zade, 2014). The weak emission reductions under Kyoto and the regions JI projects has been examined (Evans et al., 2000; Fankhauser and Lavric, 2003; Golub et al., 2009; Sabonis-Helf, 2003). Previous studies mention an unstable business environment and bureaucracy as barriers to foreign investment for mitigation projects, but they do not explore the barriers (Garbuzova and Madlener, 2012). Attention has also focused on the challenges of transition in Ukraine influencing forest policy reform (Nijnik, 2004; Nordberg, 2007; Torniainen et al., 2006). However, agricultural sector reforms in Ukraine have been more drastic compared to the forest sector (Soloviy and Cubbage, 2007), necessitating specific consideration be paid to agriculture. Adaptation has received less attention. Research has explored the strength of written policy in Ukraine, but policy is often not implemented (Maas et al., 2011; Sutton et al., 2008). Since other problems are perceived as more urgent in the FSU, implementing adaptation does not receive strong support among stakeholders, while developing institutional capability does receive backing (Bizikova et al., 2014). Much of the existing research in the FSU uses multi-country case studies, while this research contributes to the existing literature by offering an in-depth integrated exploration of one country's agricultural sector involving diverse stakeholders. Moreover, it empirically tests an integrated framework for the analysis of climate change barriers and bridges.

The remainder of this article is structured as follows. Section 2 provides more background literature specific to climate change in Ukraine and the FSU. Section 3 details methodology and approach, section 4 first describes barriers and then discusses foreign involvement as a bridge and section 5 has conclusions.

Background

The inefficient systems still operating in the FSU provide benefits to investors using the Kyoto Protocol's JI framework, since large reductions in emissions can be made at lower costs (Cornillie and Fankhauser, 2004). JI allows countries to invest in projects that mitigate climate change in host countries and the FSU hosts the majority of projects (UNEP, 2013). However, due to weak international commitments Ukraine has low motivation to act. The baseline year for Ukraine under the Kyoto Protocol is 1990 and the reduction target called for stabilising emissions at 1990 levels by 2012 (UNFCCC, 2008). Ukraine received Assigned Amount Units (AAUs) based on these targets (Aldrich and Koerner, 2012). Since the baseline is one year prior to the collapse of the

Soviet Union, a year with high economic activity that Ukraine has never regained, Ukraine has an abundance of AAUs which remain in effect post-2012. AAUs can be traded to other countries which help lower costs of emission reductions. Money earned from selling AAUs goes into the Green Investment Scheme, but often these projects do not contribute to additional emission reductions (Aldrich and Koerner, 2012).

In relation to adaptation and capacity, agricultural production was adversely affected by the collapse of communism (The World Bank, 2007). Improving agricultural production in these countries would ease the global food crisis and benefit their development (Lioubimtseva and Henebry, 2012). In particular, Ukraine is an agriculturally important country since it is responsible for 3-4 per cent of global grain production and in the top 15 wheat-producing countries (Karacsonyi, 2010; Shuker, 2004). The FAO (2002) determined Ukraine to have the largest exploitable yield gap (difference between actual and obtainable yields) of any country in the world.

Some climate projections indicate potential for Ukrainian agriculture to benefit from warmer temperatures; however, producers will need to adapt to new conditions to seize opportunities (Fay et al., 2009). During years of drought Ukraine's agricultural output decreased substantially and climate fluctuations caused losses up to 50% and 75% for winter and summer crops respectively, but experts believe that with proper investment production could better withstand fluctuations (Adamenko and Prokopenko, 2011; Grueninger and von Cramon, 2008; Karacsonyi, 2010). Investments need to be made soon, since climate projections forecast increased droughts in Ukraine (Falloon and Betts, 2010). Moreover, during years of poor production, Ukraine has added to instability in global food supplies by imposing export restrictions and driving up food prices[7] (Olearchyk, 2011).

Methodology and Approach

The process of adaptation and mitigation can be separated into two phases: capacity building and climate action (adaptation and mitigation). For this study, response capacity was defined as the ability to access resources, specifically the five types of capital: social, human, natural, physical and financial capital (Brooks and Adger, 2005). A barrier either reduces capacity by limiting access to one of the capitals or prevents the mobilization of resources to adapt or mitigate, and a bridge overcomes these problems.

Given the integration of capacity, adaptation and mitigation and interest in the post-Soviet context, case study research offered the best approach because it allows for in-depth exploration of many variables, and can provide new insights when clear boundaries do not exist between subject and context (Yin, 1981, 2009). While this case study examines national issues, processes at the national scale limit the options available at the local level and vulnerability resides in individuals

[7] As noted by one reviewer, commodity traders play a larger part in global price volatility. However, respondents did not mention this issue during interviews.

not countries (Adger et al., 2005; Brooks et al., 2005). How national processes impact the capacity of farmers and businesses was of interest. Since local context can also vary and the local impacts arising from national issues need to be understood, stakeholders and farmers in Khersons'ka, an oblast in Ukraine's south were interviewed in addition to environmental and agricultural experts in Ukraine's capital Kyiv. Ukraine's south was chosen because it is historically prone to drought and according to projections it will face the greatest impacts from climate change due to an increase in droughts.[8]

Experts in adaptation and mitigation have differing backgrounds and the opinion of farmers was anticipated to vary according to type of farm, so a purposive sampling strategy was used to gain a variety of perspectives from various stakeholders in Kyiv and in Khersons'ka. Twenty-three interviews were done in Kyiv and twenty-three interviews in Khersons'ka. See table 6 for a description of participants.

Table 6. Description of participants from this study.

Location	Number of interviewees	Affiliation/Role
Kyiv	5	Agricultural business (2 agri-holdings)
	6	Agricultural non-governmental organisation
	2	Environmental non-governmental organisation
	1	Non-profit rural development group
	3	International development agency
	2	Other international agricultural agency
	3	Researchers
	1	Policy-maker
Khersons'ka	5	Private farmers (mid-sized farms)
	5	Small-holder farmers
	3	Farming association leaders (also farmers)
	2	Agricultural support groups
	1	Head of a state farm
	2	Researchers
	5	Regional or village administrators

Snowballing was used in Khersons'ka, and to a lesser extent in Kyiv, since most of the groups were identified prior to interviews. Interviewees varied in expertise, so open-ended questions administered in a semi-structured format ensured that research remained flexible and participant driven. National and regional stakeholders were questioned about adaptation, mitigation, and the most pressing social and environmental issues for the country and region respectively. Farmers were asked about access to capitals to understand capacity, adapting to climate variability, efficiency measures and soil improvements (see chapter 2, tables 3 and 4). Interviews were

[8] Khersons'ka was also chosen to balance the pro-west views of Kyiv as it is considered to be part of the east politically. However, the 'east-west divide' in Ukraine is not easily defined. Interviewees were more pro-West than anticipated.

conducted in the spring and summer of 2012. A number of interviews were conducted in English, translators provided simultaneous translation for those conducted in Ukrainian and all interviews were recorded after interviewees granted verbal permission. Stakeholder interviews took between 30 minutes to 1 hour, while interviews of farmers took from 45 minutes to 4 hours.

A grounded theory approach was used in data analysis as it places great importance on how the contextual setting influences processes (Charmaz, 2005; Laws and McLeod, 2004). Grounded theory involves constant comparison during collection and analysis (Charmaz, 2006). Therefore, memos were written to note themes using a contact summary template shortly after each interview (see Miles and Huberman, 1994). Coding of transcripts was done using Max QDA software. The first phase involved open coding of each line using gerunds and in-vivo codes (see Charmaz, 2006). Codes were then sorted into structural categories based on: themes that emerged from contact summaries, categories that emerged during coding and finally responses to particular questions such as mitigating and adapting. The categories were then examined to see if commonalities existed between each of them that would provide a better explanation of processes. Categories were merged to form two main categories central to the study that explained barriers and bridges.

Glaser and Holton (2004) argue that an extensive literature review should not occur prior to data analysis. In this study, a review of climate change literature informed the idea of capacity and questions about access to capitals. As explained by Heath (2006) relevant literature only becomes known as the study proceeds. While climate change is a complex problem, it is not entirely unique, so similarities can be drawn from research in other areas. Coding of transcripts revealed categories relating directly to the challenges of the post-Soviet transition process. Therefore, post-Soviet literature provides further explanation and was integrated into the constant comparative analysis as described by Glaser and Horton (2004). In addition, technical reports provide corroboration of the perspective provided by stakeholder interviews.

Results

By relating codes to each other, two central categories emerged:

1) Post-Soviet challenges were perceived to be barriers to addressing climate change.
2) Foreign involvement was perceived to be a bridge for overcoming barriers.

In effect, transitioning from a post-Soviet state, capacity building, adapting and mitigating were perceived to have common barriers and foreign involvement was viewed as a bridge. Each theme cuts across all aspects of climate change by drawing from a diversity of respondents with varying expertise. As a function of looking for the most frequent codes during analysis, this study predominantly found areas of agreement among the various stakeholders. In general, responses from producers and businesses provided insight about capacity building, farming associations about adaptation, and environmental and development groups about mitigation. Respondents viewed

these issues to be a function of post-Soviet problems. As a consequence of incorporating post-Soviet literature with interviews each theme has two parts: the first part of the theme comes from post-Soviet literature and the second part from interviews.

Barriers in a post-Soviet country: relinquishing change and transition

The climate change barriers identified fit into the following categories: i) pandering, oligarchs and market interventions, ii) corruption and transparency, and iii) survival, freedom and law enforcement. Table 7 provides an overview of climate change projects discussed by participants, corresponding barriers and how they relate to capacity, adaptation and mitigation.

Table 7. Overview of projects and corresponding barriers discussed.

* While farmers and business were questioned about access to five types of capital, national issues impacted financial capital predominantly.

Project	Capacity*	Adaptation	Mitigation	Barrier (Theme)
Shelterbelt /windbreak Crop Rotation Soil Passport Cover Crops	Improved Soils (Natural Capital)	Improved Soils (Drought resistance)	Carbon sequestration	Corruption and Transparency Survival, Freedom and Law Enforcement
Crop Insurance	Reduced losses from crop damage (Financial Capital)	Mediate risk from weather related crop losses	Not applicable	Pandering, Oligarchs and Market Interventions
Support Payments	Reduced losses from crop damage (Financial Capital)	Assist producers during difficult years	Not applicable	Corruption and Transparency
Biogas / Green Energy	Potential for extra income (Financial Capital)	Not applicable	Reduced emissions	Pandering, Oligarchs and Market Interventions
Energy Efficiency (Transport, fuel efficiency and processing)	Potential Cost Savings (Financial Capital)	Not applicable	Reduced emissions	Pandering, Oligarchs and Market Interventions Corruption and Transparency

Pandering, oligarchs and market interventions: political displays, lobbying and breaking the market

The cases raised by respondents in this theme differed depending on their background and experience: support payments were mentioned for adaptation (crop insurance) by some agricultural groups, low food prices for capacity building by producers and low energy prices for mitigation projects by environmental groups. These examples are the result of two different processes: low

prices and direct compensation appeal to a wide voter base and help a poor population, but oligarchs lobby government to receive the greatest benefit.

Pandering applies to fiscal decisions that appeal to many voters, but potentially have long-term negative impacts.[9] A respondent involved in establishing crop insurance programmes in Ukraine viewed support payments as an example of this barrier as evident in the following quote:

> *"The government has found money to pay the farmers directly to cover damages. This makes it more difficult to convince farmers to buy insurance because they (farmers) hope that the government will help them." (Interviewee 6)*

While the government had finances available for support payments, it was not able to provide financial support for establishing crop insurance programmes.[10] Even in the absence of climate change, crop insurance can provide a way of coping with weather risk and a strategy for climate change adaptation for mid-sized farms (Smit and Skinner, 2002).

Pandering is viewed to play a part in market interventions as well. As one mid-sized producer explained:

> *"All years were good until this one. Not in terms of weather, but the state did everything to break the market… the problem is that we have elections this year and they (politicians) are trying to show they are working well, so they fight against producers to decrease the price for food." (Interviewee 18)*

In interviews, producers remarked that they benefitted during years with poor yields due to better prices. Better prices help producers accumulate financial capital necessary for building capacity or at least mediate the financial effect of reduced yields. According to producers in Khersons'ka, the drought-prone climate means every fourth or fifth year can be difficult for production. Many producers have been able to adapt to this difficult climate and expressed that difficult markets cause more problems.

In years with poorer harvests export quotas have been used to keep prices low for consumers. Quotas were imposed in 2005, 2006, 2007 and 2010. Williams (2011) estimated that Ukrainian farmers lost approximately $ 2 billion in 2010/2011.

[9] Populism is the term used in some of the post-Soviet literature to explain this phenomenon. It has been described as the new negative term in Ukraine replacing nationalism (Kuzio, 2010). Attention has focused on social populism in advance of elections including market interventions (Aslund, 2005; Kuzio, 2010) with a goal to appeal to the common people through a soviet socialist tradition (Bugaric, 2008; Riabchuk, 2008). Populism is not necessarily negative and therefore has been replaced with pandering.

[10] The government finding money or suddenly having money for subsidies, but not financing preventive programmes was often mentioned. This is not to say that support payments should be eliminated.

The official reason provided for export quotas were weaker harvests due to drought (Cramon and Raiser, 2006; Olearchyk, 2011). However, commercial enterprises with government ties obtained quotas to sell back to exporters at a profit (Crane and Larrabee, 2007; Williams, 2011). In particular, Khlib Investbud, a partly state owned company received the most quotas (Nikolov, 2011; Olearchyk, 2011). A respondent from a farming association explains the role of oligarchs in export restrictions:

> *"Three or four years ago Ukraine had a huge harvest of Barley so Ukraine started to export a lot. Large farms (with livestock) owned by businesses and rich oligarchs have connections with deputies and political pull. They wanted to keep Barley cheap for feed. That is why restrictions appeared. So farmers stopped growing it because of the low price. Ukraine has a small stock, but most likely they (oligarchs) will lobby for the stock to be used." (Interviewee 10)*

Currently, export quotas appear to be a national strategy for adapting to weaker harvests. However, it reduces the capacity of producers and the impact does not stop there. Fearing a food crisis, the World Bank implored countries to refrain from limiting exports[11] (Olearchyk, 2010).

Energy markets encounter similar difficulties. For instance, electricity was a need provided by the state in the Soviet Union, while prices have increased since independence; subsidies still cover most of the costs (Dodonov et al., 2004) . Consumers lack motivation to conserve energy because of low energy prices (IEA, 2013; Park, 2011). As described by a respondent working in rural development:

> *"In the last 4 years Ukraine has had the (higher) European price for natural gas and this pushed efficiency. Ukraine has the cheapest electricity in the world. When the price for electricity is higher than people (consumers) will think about saving money for electricity." (Interviewee 12)*

Moreover the heavy regulation of energy markets prevents expansion of renewable energy. State entities control most of the energy production and inefficiency results from the lack of competition (IEA, 2012, 2013). The complicated bureaucracy of the energy market was an additional barrier identified by a rural development worker:

> *"The market in electricity is very regulated with a monopoly of participators. The green tariff is just for approval, but the owner of the power line is a separate company and they don't want other competitors in their system…a license is needed and technical condition must be met, so it is a lot of documents." (Interviewee 12)*

[11] Countries outside of the FSU have also imposed export quotas. The issues leading to export quotas in Ukraine, such as the involvement of oligarchs, are perceived by respondents to be a post-Soviet problem.

Energy markets have a two-way connection to agriculture, since agricultural facilities both use and can provide energy. For instance, methane emission from new large livestock facilities was mentioned as a problem in interviews and the recent development of biogas projects as a solution. While Ukraine has a relatively high rate for feed-in tariffs (Trypolska, 2012), a tariff does not exist for biogas and barriers prevent market access. As explained by a respondent from a farming association:

> *"Bio-fuels have potential and some businesses have begun to work in this sphere, but some problems exist. No legal base exists for after energy is produced, so there are problems with how to get it into the system."(Interviewee 17)*

Food and energy prices are kept artificially low to win favour with voters. This however reduces the capacity of producers in the case of food, while removing motivations for energy efficiency measures. In addition, corrupt elements limit market access for food and green energy producers.

Corruption and transparency: making unofficial payments and going astray

The situations with markets are just one example of corruption. Most interviewees mentioned corruption, paying unofficial payments or lack of transparency as either a barrier to capacity building, adaptation or mitigation. Corruption causes problems when enforcing soil conservation measures as noted in this response from a rural development worker:

> *"Right now it just seems like there is so much corruption in the country, you can just talk to the right people or give them money and it will slide unfortunately."(Interviewee 7)*

This particular quote related to crop rotation rules. An interviewee from a large-agriholding also said that the company paid officials instead of following the crop rotation rules. In Ukraine, unofficial payments cost firms an average 2 per cent of total sales (EBRD, 2002). The need to make unofficial payments, not only when breaking rules, but as a matter of doing business reduces financial capital and capacity.

While some producers hope to receive support payments, these funds often fail to make it to needed recipients. Smallholders in particular value support payments since crop insurance is not available or appropriate for them. Interviewees in Khersons'ka stated that aid money did not make it to any recipients in the region. As illustrated in the following two quotes, lack of transparency in calculating aid money and the failure of money to make it to recipients were also mentioned by respondents in Kyiv:

> *"I think there is also a political reason because we don't know exactly what the procedure [is] for this money dividing between the producers. What are the real damages? We don't have a clear methodology." (Interviewee 6)*

> *"They (politicians) said some government aid [was] issued but most of it got lost somewhere along the way."(Interviewee 7)*

Lack of transparency also affects climate change mitigation. Two tracks exist for JI projects. The JI Supervisory Committee approves projects and issues credits under Track 2, while under Track 1 host parties approve projects, verify emission reductions, and issue credits (Carbon Market Watch, 2012). Ukraine has opted to use the Track 1 scheme. Interviewees expressed concerns about this decision citing transparency issues. International observers share these concerns and question the authenticity of credits (Alessi et al., 2011; Carbon Market Watch, 2012). Meanwhile, the need to make unofficial payments slows valid mitigation projects. As explained by a development worker:

> *"Seventy to eighty per cent of JI projects are not realised because they need approval nationally. To get approval in a timely manner you need to make some unofficial payments otherwise it takes a year or more." (Interviewee 12)*

From the perspective of interviewees corruption continues to be the most pressing issue in Ukraine. Lack of transparency hampers mitigation projects and limits the capacity of producers. The next theme explores the difficulties with law enforcement in Ukraine and moves from looking at citizens as victims of corruption to how ordinary citizens maintain corrupt practices.

Survival, freedom and law enforcement: stepping over the rules

Values, lack of trust and survival behaviour sustains corrupt practices making law enforcement difficult in Ukraine. This hinders attempts to conserve natural resources such as soil quality and forest buffers. Corruption has become an institution in Ukraine and well-established practices are difficult to change. For instance, a policy-maker made the following comment:

> *"A lot of people, (it is) kind of part of the national mentality to step over the rules... How is it possible to use money for fighting corruption if country is corrupt from very bottom to very high? It is not a phenomenon of today it is since Soviet time. Of course maybe in Soviet times it was less evident, but it was… It is the same in many countries of the former Soviet Union." (Interviewee 3)*

Rule breaking often happens out of necessity to survive. A few interviewees stated that in some ways it was better during Soviet times because people had more of what they needed. Unfortunately, short-term survival skills often cause long-term problems particularly when managing natural resources. As noted by the leader of a regional farming group:

> *"Huge problem (illegal deforestation of shelterbelts/windbreaks) because people use trees for fuel to heat homes…maybe some laws but no one does anything to protect. People use a trick to logging trees. They use fire to burn weeds which kills trees then it is fine to cut down the trees because they are dead." (Interviewee 19)*

Windbreaks provide many benefits from reducing soil erosion to addressing climate change. Small-scale deforestation leads to cumulative impacts and in this case the perpetrators are trying to meet basic needs.

While people comment about greater security during Soviet times, a lack of trust in government and a high value for freedom arise due to memories of Soviet control and influence rule breaking as well. A leader of a farming association in Kyiv and a producer in Khersonsk'ka address each of these issues respectively:

> *"Farmers don't trust state workers in Ukraine and it is again because of Soviet times. Our farmers don't like people from government, they don't like any inspectors, any standardization, any certification, any controls." (Interviewee 8)*

> *"Poland is too organised and divided. In Ukraine you have freedom to develop. The only problem is the leaders. They don't have a long-term agenda. Ukraine is better than Poland in terms of freedom and possibilities." (Interviewee 20)*

As well, if the rules are deemed illegitimate or not well planned then legislation has very little impact. For example a respondent from a farming association noted:

> *"One law to control agribusiness was a soil passport, but the project of the law was not very professional so no one took it seriously." (Interviewee 17)*

A successful soil passport system could eventually provide necessary documentation for implementing a payment system to farmers for carbon sequestration instead of focussing solely on enforcement. However, in order for any laws to have any true impact in Ukraine they need to have greater validity in the view of citizens. Policymakers continue to use a top-down approach to laws even though they have no ability to enforce such measures. Unfortunately, a lack of trust between citizens and the state also impedes citizen engagement.

Foreign investment as a bridge: comparing Ukraine and receiving foreign feedback

Foreign investment does not have to be limited to business investment or even traditional rural development. During interviews, several types of foreign assistance and feedback were observed to help in the past and perceived as necessary for the future. For example, the leader of a small-holder cooperative learned the cooperative model from international presenters at a conference. However, it should also be noted that some interviewees raised concerns about foreign involvement, in the form of large agri-holding companies. Some of the researchers and policy makers interviewed were concerned about large producers exhausting the soil for short-term gains. Meanwhile, some interviewees from farming associations and development agencies mentioned newer more effective technologies being used by large farming operations. Nonetheless this section discusses a different type of foreign assistance not necessarily related to financial investment, but focussed on capacity building and knowledge transfer, driven by participants rather than top-down and including states from the FSU. Interviewees from all backgrounds felt that in the absence of effective national support, the best way forward for Ukraine is better integration with the international community. For instance, one mid-sized producer noted:

"The biggest problem is Ukrainian politicians. Ukraine had a chance to be part of EU. If they had become part of EU they could use the legal base of EU, but now we have leaders who do nothing. It could have been solved by becoming part of EU."(Interviewee 10)

Interviewees often compared Ukraine to the rest of the world. The 'Comparing Ukraine' category emerged during coding of transcripts and cut across various topics from inefficient use of water and electricity to lack of crop insurance to a lack of support for farmers from the government and citizenry. Comparing to other countries shows recognition of problems: the first step in the process of change.

The continual work on crop insurance in Ukraine highlights the importance of knowledge transfer. The International Finance Corporation established and financed a pool of insurance companies to develop training programmes for staff, educate farmers and ensure transparency in loss adjustment (IFC, 2010).

Learning from other transition countries provides another tactic. Agriculture groups have made some headway in convincing governments to start stockpiling wheat instead of enforcing restrictions on exports by highlighting what has been done in other countries. A respondent from a farming association explains:

"Kazakhstan keeps enough stock for thirty-six months, so they do not tell the farmers what to do with their harvest...the current recommendation is to have stock for two months in Ukraine, but two months is not enough." (Interviewee 10)

As in the wheat-stockpiling example, environmental NGOs also mentioned benefiting from learning about mitigation projects in other countries. For instance, they described a project in the Czech Republic in which money from selling AAUs to Japan was invested in a separate account. Citizens could then apply for that money to make efficiency improvements on their own homes. The mechanism was very transparent and provided additional benefits. While NGOs are lobbying against AAUs in favour of stronger emission reductions, they are also working with the current system.

Moreover, knowledge from international groups helps environmental NGOs counter incorrect national views and ideas. For example:

"According to international studies Ukraine's emissions will not grow. Ukrainian policy-makers are using faulty data and projections." (Interviewee 2)

Foreign investors provide feedback to motivate change. For example, one respondent from an agri-holding company explained how the creation of an environment department was a requirement of foreign investors. International feedback could be the most effective bridge to overcoming climate

change barriers; however, lax emission reductions needed under Kyoto and the resulting AAUs are currently an impediment to addressing climate change. As noted by a development worker:

> *"Because of AAUs the politicians do not care and nobody else cares about mitigating climate change, only NGOs care, and a few businesses care because it is not an international obligation." (Interviewee 12)*

Environmental groups are trying to lobby government to change and support more efficiency improvements. NGO leaders interviewed believe that eventually Ukraine will not be able to sell AAUs because it does not truly reduce greenhouse gas emissions. NGO leaders have tried to convince the government that Ukraine would benefit from an increase in foreign investment and attract more investments by setting higher targets.

Discussion and Conclusions

This paper has highlighted the extent to which the political and economic problems of post-Soviet transition in Ukraine can hinder climate change action. Interviewing stakeholders involved in all aspects of climate change and applying grounded theory permitted the integration of adaptation, mitigation and capacity. One potential weakness is that interviews reveal only the perceptions of stakeholders. However, the perceptions of interviewees were corroborated by other sources and it is of particular interest that diverse stakeholders mention the same barriers and bridge. Given the level of agreement, addressing corruption, targeting assistance to the most vulnerable instead of direct interference with markets and building capacity in addition to support payments will likely receive considerable support throughout much of Ukraine[12].

This research demonstrated how national problems are perceived to affect the ability of producers and businesses to build financial capital and ultimately capacity. The barriers identified are a function of Ukraine's national response capacity. Focusing on response capacity can reveal how path dependent institutional, cultural or political courses create barriers to addressing climate change and maintain unsustainable systems (Burch, 2009; Burch and Robinson, 2007; Shove, 2010). The determining factors of mitigative and adaptive capacity indicate that the best climate policies for some nations might not specifically involve climate (Yohe, 2001). Indeed the barriers identified during interviews are not immediately apparent or directly linked to climate, thus this case study empirically demonstrated the insights gained by focussing on response capacity. Building capacity does not always directly translate to climate action, but in Ukraine policy measures that eliminate corruption should improve climate change response (Nijnik and Oskam, 2004).

[12] In order to be successful objectives would need to be clearly communicated and done in a transparent manner. In addition, residents of eastern Ukraine might not be as open to foreign involvement as what has been expressed by this sample of interviewees.

Barriers interact and reinforce each other. For instance, an element of corruption flows through each of the categories, which weakens the rule of law and plays a part in market interventions. Countries of the FSU share many similarities; however, caution should be used when trying to extrapolate across the FSU. The process of transition differed between countries and structures in these countries differ as well (Kubicek, 2009; Sabonis-Helf, 2003). Nonetheless, corruption is high throughout much of the FSU and inefficient systems remain in use (Evans, 2003; Fankhauser and Lavric, 2003). These similarities indicate that other post-Soviet countries will likely share the barriers identified here. However, Ukraine has been one of the most willing countries of the (non-EU) FSU to import EU standards and norms (Buzogány, 2013). Therefore, individuals in other countries may not be as receptive to foreign involvement.

The current barriers can also be viewed as maladaptive strategies. Maladaptation happens when short-term strategies increase vulnerability in the long-term (Jones et al. 2010). Corruption is a way of coping in an uncertain environment. While corrupt behaviour provided some benefit in the short-term, in the long-term it increases vulnerability. Export restrictions can be viewed as a national adaptation measure; however, this strategy increases the vulnerability of producers, leads to greater uncertainty in the future and amplifies global food insecurity. This also reveals a trade-off. Food prices are low for consumers, so it appears to be a reasonable strategy. However, it hampers the capacity of producers. Maintaining a buffer stock and programmes that target assistance to the most vulnerable would be more appropriate rather than direct interference in markets (Anania, 2013; Grueninger and von Cramon, 2008; IEA, 2012).

Countries of the FSU have an opportunity to mitigate climate change through improvement of inefficient systems (sources) or by enhancing marginal lands (sinks), but more investment is needed (Nijnik, 2004). The JI scheme demonstrates that foreign investment can be a win-win for both parties, but JI would benefit from increased transparency. Prior research has shown that aspirations for EU membership lead to stronger environmental regulations (Andonova, 2004), but an open foreign business climate has been shown to weaken environmental policy in the FSU (Andonova et al., 2007) . The conditions that allow foreign investment to benefit instead of hinder environmental policy need to be explored further. In this case a diverse group of stakeholders viewed foreign involvement; such as feedback and knowledge transfer as beneficial. The international community could do more such as working with environmental NGOs to emphasise the potential financial benefits from increasing emission reductions for Ukraine. In particular, FSU states have an opportunity to share knowledge gained from their successful projects.

Chapter 5. The role of social capital in building climate-resilience

Preface

This study examines a cooperative as a livelihood strategy in Ukraine. Access to the five types of capital within the assets pentagon of the SLF determines response capacity. These assets are used to fulfil livelihood strategies and ultimately determine outcomes. This work provides insights to the role of social capital in capacity building, and provides direct links between capitals and livelihood outcomes including planned adaptation and mitigation. Therefore, this chapter meets the first objective of revealing synergies.

This chapter follows the style guidelines of the journal Climate and Development. It is currently under review with the full title: 'How can a cooperative function to address climate change? Lessons in improving social capital from a sustainable livelihood perspective'.

Abstract

Increasing support to small-holder farmers plays an important part in meeting the adaptation-mitigation challenge of agriculture: realising global food security under increasing climate variability, while also reducing greenhouse gas emissions. Cooperatives offer a well-established livelihood strategy and method to support and reach small-holders. This case study examined a Ukrainian cooperative using the Sustainable Livelihoods Framework (SLF) to understand: how cooperatives can function to address climate change, and the process by which capacity is used to adapt and/or mitigate climate change. Climate change does not prompt cooperative formation, so the SLF provided a means of understanding the process in the context of sustainable development. Cooperative members and stakeholders outside of the cooperative participated in semi-structure interviews. Social capital and trust emerged as a theme with interviewees from all backgrounds. Initially closed networks and distrust prevented members from joining the cooperative. As the cooperative built new networks, the benefit of joining became apparent to members. Information gained through networks improved access to other capitals, improved livelihood outcomes and addressed climate change. Social capital fulfils key roles in the process of capacity building and implementation of sustainable measures; thus improving social capital could arguably be the chief benefit of cooperatives.

Key words: adaptation; mitigation; social capital; capacity; post-Soviet; agricultural cooperative

Introduction

Agriculture must meet a dual challenge: production needs to improve despite increasing climate variability from climate change (adaptation), and environmental impacts such as greenhouse gas emissions and land degradation must be reduced (mitigation). Training and supporting smallholders has increasingly been viewed as a way to achieve climate change adaptation, mitigation and

sustainable agriculture (Bage, 2008; IFAD, 2013; Wolfenson, 2013), while cooperatives have been promoted as one of the most effective ways of supporting smallholders (FAO, 2012). Cooperatives strengthen smallholders through collective action, thereby addressing many of the challenges they face including: poor market access, low purchasing power for inputs and reduced access to financial services (Crowley, 2013; UN News Centre, 2012). Cooperatives can provide many improvements to livelihoods and in this context can be viewed as a 'livelihood strategy' defined as the way people make a living (Chambers and Conway, 1991).

Climate change does not motivate smallholders to form cooperatives. Indeed, climate is not the immediate reason for many decisions in agriculture, but many daily decisions affect climate change mitigation and have long term consequences for vulnerability and adaptation. For instance, continual cropping might occur for short-term economic gains, but can degrade soils making them less resistant to drought, while also affecting climate change mitigation by reducing the carbon stored in the soil (Lal, 2010). Similarly, some financially motivated production changes, such as improvements to fuel efficiency, also benefit climate change. Therefore, context and other motivating factors need to be considered along with climate when researching mitigation and adaptation strategies.

The sustainable livelihood framework (SLF) is particularly advantageous when other social and environmental issues are deemed more pressing than climate change. The SLF allows for an understanding of decision-making in the context of sustainable development, it enables incorporation of climate change into other development goals and it emphasises the improvement of response capacity. The capacity to adapt or mitigate have the same determinants as sustainable development. All three responses depend on the political, social, and cultural context; governance; and access to financial, social, physical, human and natural capital (Brooks and Adger, 2005; Brooks et al., 2005; Swart and Raes, 2007; Yohe, 2001). However, the indicators of capacity only reveal potential, while application of this potential depends on decision-making and other processes (Vincent, 2007). S. C. Moser and Ekstrom (2010) proposed that performance at stages could be the key to understanding adaptation and mitigation and that elements of capacity may substitute for each other. Research is needed to understand how to address barriers and how capacity is used to achieve adaptation and mitigation (Klein et al., 2005).

This case study helps to fill that gap by analysing a cooperative in Ukraine. The SLF informed interview questions and coding of responses. Climate change was made explicit by modifying the SLF to include planned adaptation and mitigation in the livelihood outcomes (see: figure 1, chapter 1). In this case, the aim was to gain a qualitative understanding of how cooperatives address climate change even when it is not a motivation for their creation. The process was broken into four stages: 1) commencing, 2) surmounting, 3) growing and 4) realising. The first stage identifies motivations and barriers to forming a cooperative. The second details how barriers were addressed. The third examines the conditions necessary for the development of the cooperative, while the final stage addresses livelihood outcomes with particular attention to planned adaptation. The entire

process needs to be understood since barriers to cooperative creation effectively also hinder addressing climate change. Furthermore, this study moves beyond barriers by revealing how barriers were addressed in a successful case.

Social Capital

This research found that at every stage the most apparent changes related to social capital improvements. Social capital has two components: cognitive aspects including trust, norms and beliefs and structural aspects such as networks and groups (Uphoff, 2000). Moreover, the types of social capital can be divided further into the connections between people within the same group; connections to people outside of a group or community; and connecting to people with greater power termed: bonding, bridging and linking social capital respectively (World Bank, 2000). Social capital has been deemed crucial in sustaining successful development interventions, disseminating information, building human capital, reducing vulnerability and addressing climate change (Adger, 2003; Brooks and Adger, 2005; Coleman, 2000; Klein et al., 2005). In terms of cognitive social capital, Jones et al. (2014) observed that a greater trust in institutions translated into a greater willingness to accept these institutions suggested climate change solutions.

Nonetheless, social capital can produce negative outcomes. For instance, social networks maintain corrupt systems. While bonding social capital allows groups to work toward common goals, in the case of heat waves, bonding social capital was found to not reduce and potentially worsen the vulnerability of the elderly in the UK when inaccurate information spread through networks (Wolf et al., 2010). In these cases, bridging or linking social capital can help if the new or more accurate information is gained through the new connections.

The importance of social capital has been covered extensively in sustainability literature, how to foster and improve social capital and how it can function to address climate change is not well understood. While this study contributes specifically to sustainability issues in post-Soviet states, it also has wider application to understanding how social capital, one element of capacity, develops and functions. As explained in the next section, the formation of a cooperative in Ukraine provides a particularly valuable case for understanding how social capital affects climate change adaptation and mitigation.

Reasons for cooperative focus in Ukraine's south

Two billion smallholders produce seventy per cent of the world's food (Bage, 2008; Fairtrade Foundation, 2013). Paradoxically, smallholders often live in poverty, encounter food insecurity and political, economic and social factors make them particularly vulnerable to climate change (Morton, 2007). While the importance of smallholders in global food production, their marginalization and the potential of cooperatives to provide much needed support has received increasing recognition, this deliberation has mostly focused on developing nations in Africa and Asia. Yet eastern European countries depend predominantly on smallholder production. Ukrainian smallholders produce over 60 percent of the agricultural output of the country (Thuroczy, 2009).

In addition, the country has a poverty rate of 20 percent with the majority of those in poverty living in rural areas (Round et al., 2010).

Ukraine has traditionally and continues to be an agriculturally important country. While Ukraine could have significantly higher yields and better agricultural production, it ranks among the top 15 wheat producing countries and is an important producer of grains and technical crops (Karacsonyi, 2010; World Bank, 2005). Moreover, climate change mitigation in Ukrainian agriculture has received little research attention despite vast amounts of arable land (Smith, 2007). Finally, compared to other regions in Ukraine, the south is drought-prone and likely to have the greatest climatic impacts due to droughts (Falloon and Betts, 2010).

Cooperatives can be open organisations for smallholder collaboration, so it appears to be a simple solution to the challenges of sustainable development; however, post-Soviet history complicates their implementation in Ukraine. Collectivization was violently forced on Ukrainians; the purpose of the collective farm was to benefit the state and the memory of this period still serves as a barrier for cooperative formation (Turner et al., 2013). Smallholders prefer to work individually due to this historical memory, while cooperatives require trust and collaboration. Nonetheless cooperatives have been successfully established in Ukraine (personal communication: Larissa Artmenko). This research analyses the adoption and evolution of a livelihood strategy to understand how cooperatives can function to address climate change in Ukraine.

Methods

This exploratory case study required a successful cooperative in order to understand the conditions necessary for an effective livelihood strategy. A rural development worker in Kyiv provided the contact information for a key informant in Khersons'ka, who in turn facilitated access to the milk service cooperative.

Interviews were carried out at three different scales: national (national experts n=18), regional (regional experts n=13, farmers in region n=5) and cooperative (cooperative staff n=2, cooperative members n=8). A purposive sampling strategy was used to gain a variety of perspectives from various stakeholders and farmers. Interviewees varied in expertise and knowledge; therefore, open-ended questions were administered in a semi-structured format. Typically, interviews were conducted in Ukrainian with simultaneous translation; however, some of the national interviews were conducted in English. All interviews were recorded after verbal permission was granted by interviewees. Interview length varied depending on type. Stakeholder interviews took between 30 minutes to 1 hour, farm level interviews typically lasted longer, while some of the smallholder interviews were conducted during milk truck pickups and were much shorter.

Initial questions related to access to capital, adaptation, mitigation and vulnerability context as shown in Appendix A, but interviews were semi-structured and included follow-up and probing questions. The interviews of national experts, regional stakeholders and farmers helped to understand barriers and challenges in Ukraine and Khersons'ka respectfully. Cooperative members

and leaders were questioned about joining and forming the cooperative. Interviewees who were not full members, but still sold milk through the cooperative were asked about the motivations for joining the cooperative and about any unexpected benefits received after joining. Interviews were conducted in the spring and summer of 2012. In addition, speeches made during an event celebrating the cooperative were treated the same as interviews and coded during analysis. In order to understand the progress of the cooperative, follow-up interviews along with tours of the office, pasture and milk collecting facility happened in the summer of 2013. Each interviewee type contributed to understanding different stages and required different types of questions as shown in table 8.

Table 8. Stages of cooperative development, interviewees and question type.

Stage	Interviewees	Focus of Question	Research Questions
Commencing	All interviewees	Vulnerability context, Barriers and Motivations	What were the motivations for starting and joining the cooperative? What prevented it from happening sooner?
Surmounting	Cooperative members/staff	Observation at celebration, context/ challenges, follow-up	How were barriers addressed?
Growing	Cooperative staff	Observation at celebration, changes in access to capital	How did the cooperative strengthen and sustain itself?
Realising	Cooperative members/staff	Access to capital, benefits of membership, follow-up	How does it address climate change? How is capital access linked to livelihood outcomes?

The SLF informed both questions and coding of data. Once interviews were transcribed coding was completed using Max QDA software. Codes included the vulnerability context, access to capitals, changes in processes, and livelihood outcomes. Memos were written shortly after each interview using a contact summary template (see Miles and Huberman,1994). In these memos, themes that emerged from each interview were noted. Social capital and trust was a theme from interviews at each scale and thus became the focus.

Results

The first section of the results draws from interviews at all scales and interviewees from all backgrounds to examine the commencing stage and demonstrate how the vulnerability context including climate, market access and historical memory motivated and hindered the adoption of livelihood strategies. The second section addresses the surmounting stage by arguing that bonding social capital initially prevented members from joining the cooperative, but by building reputation over time the cooperative eventually overcame this barrier. The third section explores how the cooperative grew by creating bridging and linking social capital and the relationship between social and human capital. The final section relates improvements in capital access to livelihood outcomes. Particular attention focussed on planned adaptation for droughts.

Commencing Stage: Vulnerability Context Motivates and Hinders Livelihood Strategies

All interviewees in Khersons'ka mentioned that droughts naturally happen every fourth or fifth year and thus it had always been difficult to farm in the region. Many farmers said that since they had always experienced droughts, they had learned how to adapt. Moreover, all farmers found accessing markets and getting a fair price for products difficult and more problematic than climate. Interviewees were split about whether they saw any significant changes in climate with some stating that shifts in seasonal patterns had become onerous, while others said it was part of a natural cycle.

Diversification is the most common livelihood strategy in the region particularly for smallholders. Smallholders in the region have jobs outside of agriculture, own a small plot of land in which they grow crops and have one or two cows or other livestock. Livestock are viewed as insurance in years with failed crops; however, farmers remarked that obtaining enough feed for cattle can be difficult during droughts.

According to interviews, cooperatives have been promoted as a livelihood strategy in Ukraine because combining outputs helps to access better markets and negotiate better prices, sharing inputs and equipment helps to improve production, and members can provide a social safety net to each other. This case study's cooperative deals solely with milk production. Smallholders produce more than 80 percent of the milk in Ukraine and are thus too important to supply for buyers to ignore (Danone, 2013). Therefore, buyers are motivated to work with cooperatives, so they can educate producers to improve milk quality and ensure a healthy supply of milk to customers. Before joining the cooperative, members sold milk at small local markets where sales and price are not guaranteed. They could spend all day at market and not sell their milk. Compared to the cooperative, they can get a higher price at local markets on good days, but good days do not happen consistently. Thus, members benefited and were motivated to join the cooperative because of the time saved by having milk picked up by the truck, and a more stable price with guaranteed sales.

Problems with accessing markets clearly demonstrate that climate is not the only determinant of vulnerability. In addition, historical context increases vulnerability and serves as a barrier to adopting some livelihood strategies. The most common problem mentioned by interviewees from all backgrounds was the 'Soviet mentality'. This response was followed by a number of issues related to cognitive human and social capital such as strong individualism, dependency, trust and fear. The absence of civil society in the Soviet system created a dependency on others, but orchestrated by the government, affecting both human and social capital (Powell, 1992; Rose, 2008). People have a desire for independence, but a want to be cared for by the government. This dichotomy was expressed in the following quote from a rural development expert:

> *"On one hand people are tired of being bunched up, they want to think for themselves and be independent, and care only about their own families. On the other hand they have this tradition of forced cooperation and mutual dependency that lasted for generations and it is very difficult to shake it off." (Rural Development Expert 1)*

Trust and fear was mentioned consistently by various stakeholders as a barrier to cooperative formation and training farmers. Again this was related to Soviet history as explained by the head of an agricultural support group:

> *"Another problem is lack of trust and social capital. People are not able to organise and work together. Soviet period and especially perestroika period people have a lack of trust for working together." (Agricultural NGO Leader1)*

As a result of this history, farmers do not want to work together causing a barrier to cooperative formation. Moreover, the norm of reciprocity does not apply in this case because many believe that people have ulterior motives when they give to others. This belief and other issues related to 'Soviet mentality' are detailed in table 9.

Table 9. Summary of some of the issues perceived to be related to a Soviet mentality.

Theme	Quote	Interviewee
Individualism	*"It is hard to get Ukrainians to work together. The mentality is that it is my business and I will take care of myself."*	Regional Administrator 1
Dependency	*"It is difficult to teach them to be responsible for the equipment because they have been used to not caring about it during Soviet times."*	Rural Development Expert 2
Fear	*"If you go now to the villages and to the small farmers, they are afraid of everything."*	Kyiv Agricultural Expert 1
Fear	*"People are afraid of anything new."*	Cooperative Leader
Fear/Trust	*"They do not know what will happen in a year or two because it could be taken away from highest level."*	Rural Development Expert 2
Trust	*"People think if someone gives something: Will they take back more?"*	Cooperative Member 1
Trust	*"It is difficult to be a leader: people believe a person who gives took more than they gave."*	Regional Administrator 1
Trust	*"People do not belong to groups because they don't trust the associations."*	Farmer 1

In summary, the vulnerability context includes more than just climatic factors. In the Kherson region, a drought prone climate leads to a strategy of diversification. Market and price challenges mean that cooperatives are a beneficial strategy, but the historical context influences cognitive social capital and amplifies vulnerability and functions as a barrier to cooperative formation. The next section explains how the cooperative addressed this barrier.

Surmounting Stage: Building Reputation and Overcoming Bonding Social Capital

Larger farmers in the region tended to belong to a few groups, but in general smallholders do not join associations because of trust issues. The cooperative was the only group in which smallholders belonged. The leader of the cooperative explained how she dealt with fear and trust:

"People were afraid of joining the cooperative, so we started to get milk from other villages. Because people communicate, they saw that it is fine, so people started to join."

Social networks were present but these networks were used to perpetuate fear, so gossip initially prevented people from joining the cooperative. In this case, the bonding social capital in the village prevented progress. This sentiment was confirmed during interviews with some of the cooperative members. A few interviewees mentioned an earlier opportunity to buy pasture land and share the land through the cooperative, but villagers said that the cooperative leader would only take the land from them. The interviewees said it was a mistake not to trust and with hindsight they regretted the decision. However once the cooperative became successful and a good reputation was built, gossip became positive and smallholders were then motivated to join. Surprisingly small actions led to trust being built fairly quickly. Many members at the celebration mentioned that they enjoyed working with people in the cooperative because they had pleasant conversation and they brought sweets on Women's Day and other holidays. It was these small actions that convinced them over time that the cooperative was trustworthy.

The leader of the cooperative believed fear would continue to function as a barrier in the early stages of the next phase of the cooperative. This next phase involves developing the family farm model. In this model, they plan to have smaller cooperatives working within the cooperative, but first they plan to issue brochures explaining how it will work and to have two or three people try it. The leader explained that people are afraid to be the first to try the family farm model because they will have to demonstrate their work to others including journalists. According to her,

"Village people are modest and do not like to show off farms, so they are a bit afraid to do it."

In addition to building reputation for those they wanted inside as members, they also had to build an outside reputation. A staff member at extension services said the following:

"She (cooperative leader) got more support from Heifer and Danone because she works so hard and does not take money for herself. She gets more and more support over time."

The cooperative leader mentioned the same matter the following year. She said that people recognised the cooperative and they got more support because nothing was stolen by the organisation, also adding that for nothing to be stolen is unfortunately rare in Ukraine.

Growing Stage: Improving Social and Human Capital by Building Bridges and Acquiring Information

The first connection between human and social capital was the leadership capability of the head of the cooperative. She built her reputation along with the cooperative and this was paramount to building social capital. Her abilities were credited with bringing the people together by many inside and outside the cooperative. As noted by one smallholder,

"She has iron nerves because it is difficult to deal with people, but she is always friendly." (Cooperative Member 2)

The second connection between social and human capital comes from the leader gathering information through new social networks and then disseminating that information to members. As the cooperative's reputation became known, groups approached the cooperative, and in this manner, bridging and linking social capital were created. In terms of linking social capital, Heifer International offered assistance and Danone signed a business agreement with the cooperative shortly after the cooperative was formed. Members did not necessarily have to trust new groups, since the cooperative presented the information to members and was beginning to build trust. In interviews, cooperative members stated they were too busy to get information on their own, but through the cooperative they have increased access to information.

Likewise, in 2012 interviews, the head of the cooperative said she got all of her information from her contact at extension services. A year later she said she was being contacted by groups and getting ideas from a larger network. An instance of bridging social capital and learning from groups in similar circumstances arose when cooperative staff went to a cooperative in Dnipropetrovsk oblast to learn about building modern milking barns.

The cooperative was also able to create linking social capital by getting support and assistance from regional administrators which is very rare for smallholders in Ukraine. Indeed, interviewees at the national level remarked about the lack of support from national government and the inadequacy of regional administrations. It is very difficult to open a new business in Ukraine, as explained by the cooperative head:

"You have to do everything according to the law. All of the laws are written in such a way that they have to be broken by the officials who wrote them to do something."

When the cooperative needed lighting for their building where they accept milk, regional administrators helped to obtain connection to power lines.

Finally, the head of the cooperative's ability to plan, to engage with new ideas and to seek solutions through social networks is fundamental to moving from just coping to being sustainable. The idea of starting the cooperative came from the leader's engagement with other groups as explained here:

"A huge market opened in L'viv and we were invited. Representatives from Europe gave a presentation about how cooperatives work in Europe and how it is possible to work in Ukraine. From there came the idea, the region has lots of cows and problems with market so we thought to do it with milk. We have a problem with price but the number of cattle are good."

Some members responded that they had no other option, but to join the cooperative. They had no ideas of how to improve their livelihoods. When asked about long term plans one cooperative member responded:

> *"Not worried about planning, not working at planning, this year we have enough food for the cattle." (Cooperative Member 3)*

Similarly, when the cooperative leader was asked in 2012 about getting adequate feed for cattle during droughts she replied that she prayed. A year later she was taking a much more proactive approach. In the following quote, she explains how she uses her social networks and linking social capital to address any new issues that arise.

> *"There is a proverb that for the person who knows, the door is open. When we have some problems then we talk to regional government and try to refer to any doors we have for a way out. We try not to put problems aside; we try to solve them."*

The most apparent problem for the cooperative involves the interaction of two issues related to the vulnerability context. Drought conditions affect the price paid for milk and therefore the cooperative needs to address this issue to keep members content. The next section explains how price concerns led to planned adaptation and how access to social capital improves access to other capitals.

Realising Stage: Improving Access to Capitals and Improving Livelihood Outcomes

While producers are motivated to join the cooperative to get a better price for milk, the price paid to cooperative members varies according to milk quality specifically milk fat content. The cooperative supplies producers with information about price and milk fat content. Cooperative members said that they valued this information and they had noticed a decrease in fat content in the summer when the cattle use the pasture for feed. This information gives them quicker feedback and more incentive to improve pasture quality, so the cooperative is now working on planned adaptation instead of waiting to address the feed issue when they no longer have enough. The cooperative has a few strategies: i) they are looking to use electric fences to keep the cattle only on certain sections of the land at any one time; ii) they hope to have storage barns built to keep feed and iii) they are looking at sources of feed from outside of the region. Better pasture management has the potential to increase carbon in soils thereby also mitigating climate change (Conant and Paustian, 2002). However, the third strategy causes a trade-off between adaptation and mitigation because of additional emissions from transporting feed. The first two strategies were learned from visiting other cooperatives and thus provide another example of bridging social capital.

This example demonstrates that building linking and bridging social capital improved information and ultimately the human capital of members. While better income is the motivation for improving pastureland, this strategy also addresses climate change. Electric fences have an additional benefit of freeing up time, since members currently tend the cattle in pasture all day.

In addition, membership in the cooperative and better social networks improves access to other types of capital and in turn improves livelihood outcomes. Table 10 provides a summary of the benefits from joining the cooperative as described by interviewees and how these outcomes related to types of capital.

Table 10. Summary of access to other forms of capital and improved livelihood outcomes.

***** Cooperative members were given yoghurt as part of their payment. The yoghurt available in rural stores is often spoiled.

Capital	Description	Livelihood Outcome
Financial	Access to low interest loans	More Income
Financial	Guaranteed sales	More Income
Physical	Milk truck – time saved going to market	Increased Well-being
Human-Natural	Information – Manure storage and pasture management	Mitigation
Human-Natural	Information – Long-term planning for feed strategies	Adaptation (Planned)
Natural	Drought tolerant cattle suitable for region Best genetic material for breeding	Adaptation (Planned)
Natural	Feed provided to members during shortage	Adaptation (Reactive)
Not applicable	Yoghurt received from Danone (in lieu of payment)	*Food Security

Discussion and Conclusions

While social capital has been deemed an important element of capacity, the role social capital plays and the concept of it as a form of capital has been highly debated (Bebbington et al., 2004). In this case study social capital was both a barrier to cooperative creation and necessary for the success of the cooperative. While focusing on a single cooperative limits the generalisability of the results, existing literature in the area of social capital supports each of the key findings including: distinguishing the types and quality of social capital, the importance of leadership in building and using social capital, and the presence of feedbacks creating virtuous cycles. In addition, this case demonstrates how social capital functions to increase access to other forms of capital and how a cooperative as a strategy can help overcome trust issues, build social networks and ultimately results in planned adaptation instead of just coping and reacting.

Cooperatives have been promoted in Ukraine to achieve immediate practical outcomes such as pooling of resources and improving market access. However, improvements to social capital could be the more critical transformation, since social capital plays a key role in improving livelihood outcomes including planned adaptation. Social capital improves with use and cooperatives provide a means to exercise social capital. Fukuyama (1995) argued that the destruction of civil society by the Soviet system perhaps had the worst and longest lasting consequences. Any activity that improves social capital in post-Soviet states has greater consequences and should be considered an achievement in itself. Gijselinckx and Bussels (2014) argued that while memory of the communist model of cooperatives hinders cooperative formation in transition economies, it does not mean there is no potential for cooperation. Rather multilevel analysis is needed to understand the

interactions between motivations, resources and context and how that influences farmers to join cooperatives (Gijselinckx and Bussels, 2014).

Moreover, it is not simply a shortage of social capital in post-Soviet states, but rather the quality and type of social capital. Rose (2008) argued that Soviet rule led to the creation of informal networks in order to undermine government controls and resulted in "more social capital than society". Social capital does not always lead to a desired outcome and one of the clearest examples of this is in post-Soviet states. For instance, in this case, bonding social capital initially prevented those within the same village from joining the cooperative because social networks were used to perpetuate distrust leading to a collective decision not to join. In addition, pasture land would have been beneficial to obtaining feed in years of drought, but distrust prevented members from supporting the collective purchase of land. This cooperative was able to overcome the barrier by building reputation quickly and using the network to spread a more positive message. Bonding social capital initially formed a barrier; moreover, during the growing phase the cooperative persisted because of the creation of bridging and linking social capital. The idea for the cooperative came from outside the village network and thus occurred due to bridging social capital.

Wolz et al. (2010) found that bonding social capital did not improve income and possibly hinders development among smallholders in Ukraine; moreover, they found that income improved with the creation of bridging social capital that is the creation of networks with people from different backgrounds. While Wolz et al. (2010) determined a quantitative relationship between type of social capital and income, this work explains how bonding social capital functions to cause negative outcomes and the benefit of bridging social capital. Cook et al. (2004) argued that closed networks limit access to information and new opportunities. Since climate change presents new situations, bridging and linking capital help to gather new information needed to adapt. Moreover, in a comparison of socio-economic factors, cooperative membership had the greatest influence on Nigerian farmers adapting technological innovations to deal with climate change (Kolade and Harpham, 2014). Thus, Kolade and Harpham (2014) suggest intervention programs in agriculture should focus on promoting farmer cooperatives for better diffusion of innovation along with better linking social capital to connect to markets and services.

Along with building new networks this case study found effective leadership to be crucial to success. The cooperative's leader's ability to build reputation attracted assistance and led to the creation of bridging and linking social capital. The cooperative already had a considerable amount of human capital with her leadership. As the cooperative acquired new information through networks, the information than developed the human capital of cooperative members. In this way human capital also improved with the creation of more networks. This supports Purdue's (2001) argument that leadership is important for building a level of trust needed to effectively use and establish communal and collaborative social capital.

This work demonstrated how the different types of social capital feedback to increase social capital over time. As more outside groups become involved in the network, the benefits of being in the

cooperative became more obvious, more members joined and positive outcomes created greater trust. Likewise, López-Gunn (2012) described the development of a virtuous cycle with continual feedbacks between a gradual increase in citizen participation, an increase in trust, strengthening capacity and developing organised culture. In contrast to the assumption that social capital is difficult to build, Durlauf (2002) argued that models indicate that a small change can be amplified through feedbacks to create a large change in the level of trustworthiness and development of social capital. This case demonstrated that even small actions increased trust and social capital was built relatively quickly. The change does not end at the cooperative, since social capital built in one cooperative can become a model for other cooperatives within the network. In this manner, cooperatives and other types of small development projects enable substantial improvements in social capital (Newman, 2007).

Social capital improves access to other forms of capital and ultimately improves livelihood outcomes including climate change adaptation. Specifically, the new information that the cooperative gained through networks has led to awareness for the need to address the quality of pasture and feed which ultimately led to strategies for planned adaptation. Planned adaptation is needed to move from just coping to long-term sustainability. Planning involves building preparedness and reduces impact more effectively than just reacting at time of a crisis. However, individuals tend to be reactive whereas planned adaptation requires cooperative action (Brooks and Adger, 2005). Bridging and linking capital are needed for ideas, but ultimately bonding capital puts these ideas in action and the right combination of these different types of social capital addresses climate change, while also improving rural livelihoods. Cooperatives can provide a strategy in which the right combination of social capital can be created and maintained to address climate change.

Chapter 6. Crop rotation in Ukraine: A triple-win?

Preface

This chapter focuses on the triple-win technique of crop rotation. Crop rotation is perceived to have benefits independent of climate change and yet it is not consistently implemented in Ukraine. Moreover, crop rotation has become a contentious issue. Q methodology was used to examine the dissensus surrounding crop rotation. Distinct discourses were revealed, but stakeholders appear to agree that the current political economy hinders farmers. A triple-win strategy applies to the objective of seizing synergies; however, in the current political economy farmers must trade-off coping in the short-term with long-term sustainability.

This chapter follows the style guidelines of the journal Climatic Change and is currently under review with the full title: 'Win-win or no-regret policies, why isn't everyone doing it? A participant-driven research method to reveal barriers to crop rotation in Ukraine'. I declare that the work submitted is my own. Alessio Pruneddu is a co-author as he contributed software for data collection and collaborated during data analysis.

Abstract

The agri-food sector must adapt to changes in climate variability, while also helping to mitigate climate change. Win-win and no-regret measures exist that mitigate and adapt to climate change, while also improving soil health, thereby increasing yields. These measures should be the easiest to implement, but in practice barriers prevent full realisation. This study aims to move beyond previous research efforts that identify and categorize barriers by i) revealing hidden barriers, ii) understanding the interactions between barriers and iii) exploring ways to address barriers. A case study focusing on crop rotation as a win-win strategy in Ukraine demonstrates how a participant-driven iterative research approach can achieve these objectives. During semi-structured interviews with farmers and stakeholders, crop rotation emerged as an area of considerable dissensus with stakeholders commonly citing the greedy behaviour of producers as the problem. Further discussion indicated that the political economy of Ukraine caused financial constraints for producers and Q methodology allowed for additional clarity on the opposing views of crop rotation. Three factors emerged: producer insecurity, national insecurity and business climate insecurity. These three perspectives reveal contrasting priorities with producer insecurity and business climate insecurity concerned with the conditions under which producers must operate, while national insecurity has a focus on improving agricultural production to benefit the nation. Consensus statements across all factors could provide first steps to addressing barriers and an opportunity to open discussions amongst stakeholders. Finally, barriers arising from political processes demonstrate that climate policy needs to be integrated with other sector specific policy decisions.

Keywords: agriculture; climate change; adaptation; mitigation; stakeholder engagement; sustainability

Introduction

In 2015, global atmospheric carbon dioxide levels surpassed 400 ppm underscoring the urgency for mitigating and adapting to climate change. Win-win measures or no-regret policies should be some of the easiest and quickest measures to implement due to the additional benefits provided, yet this does not consistently happen (Moran et al., 2013). The agri-food sector provides an ideal case study to explore why, since globally the sector must increase production, reduce emissions and adapt to climate change (Wolfenson, 2013). Moreover, options that can meet all three of these challenges exist in this sector. Measures that adapt, mitigate and improve food production include: diversification of crop rotation, prevention of nutrient leaching from soils, conservation of soil moisture, restoration of organic soils and improved management of crop and grazing lands (Glantz et al., 2009; Smith and Olesen, 2010). The failure to consistently implement these options indicates the presence of barriers. Barriers can be defined as obstacles that can be overcome through use of resources, policies, effort, management and a change in perceptions and attitudes (Metz et al., 2007; Moser and Ekstrom, 2010).

Considerable research has identified barriers to mitigation, adaptation and pro-environmental behaviour. Smith et al. (2007) found that barriers to climate change mitigation in agriculture related to uncertainty, cost and technical feasibility. Adaptation barriers have been categorised as technological, financial, social, cultural, cognitive and behavioural (Adger et al., 2007). A lack of communication (Raymond and Robinson, 2013), political commitment (Semenza et al., 2008) and trust in government (Macnaghten and Jacobs, 1997), as well as an incomplete understanding of the problem or a misperception of risk (Gifford 2011; Lata and Nunn 2012) provide for further categorization of barriers.

While barriers have been identified and categorised, this study fills some notable gaps in the literature. In a review of adaptation barrier research, Biesbroek et al. (2013) found that studies did not explain how and why barriers arose or how to overcome them. Furthermore, the interdependencies between barriers and the processes that allow barriers to persist have not been explored (Eisenack et al., 2014; Jones and Boyd, 2011). Through a case study of sunflower and crop rotation in Ukraine, this study's aim is to understand how political, economic and social context, climate and differing perceptions interact to function as barriers.

Ukraine provides a compelling country for this type of study due to the many opportunities and challenges related to adaptation, mitigation and improved agricultural production. As the second largest country in Europe with 69% arable land, some of the most fertile soils in the world and a central location to access many world markets, Ukraine's agri-food sector has many geographical advantages (Fileccia et al., 2014). However, climate projections indicate increasing droughts and greater extremes in precipitation events for Ukraine (Dronin and Kirilenko, 2012; Fischer et al.,

2014). Meanwhile agricultural production in Ukraine has not been climatically robust. Ukraine's agricultural output decreases substantially during droughts and climate fluctuations have caused crop losses of up to 75% in recent years (Adamenko and Prokopenko, 2011; Karacsonyi, 2010). Moreover, Ukrainian agriculture faces challenges independent of climate change; such as, worsening soil erosion and declining soil fertility (Fileccia et al., 2014).

This research approach differs from previous barrier research. Biesbroek et al. (2013, 2014) describe a lack of clarity for the term barrier in the literature, specifically a lack of consistency as to what is being prevented. In this case, the end point, crop rotation as an example of a win-win measure has been made explicit. However, unlike most other research, interviewees were not explicitly questioned about barriers to crop rotation. Instead this research uses an iterative, participant- driven research method incorporating semi-structured interviews, ethnographic data collection and Q method.

Case study description and Methodology

Crop rotation and the cultivation of sunflower emerged as an area of considerable disagreement during the initial interview process. These themes were further explored through the use of Q methodology. Crop rotation provides many benefits including: soil fertility improvements, erosion decline, pest reduction, reduction of agricultural chemicals and climate change adaptation (Bio Intelligence Service, 2010). Due to improved yields and an increase in carbon content of soils, crop rotation technically qualifies as a win-win strategy (Bullock, 1992; Lal, 2004). In Ukraine crop rotation is an accepted practice, so path dependence and lock-in barriers as highlighted by Maréchal (2007) are not a potential barrier.

Yet, many farmers reportedly do not follow the official recommended crop-rotation calling for sunflower to be planted at most once every seven years in the same field (Lindeman, 2004). The area sown with sunflower began increasing in the late 1990s due to increased profitability from reliable export markets (EBRD and FAO, 2008; Lindeman, 2004). Ukraine became the top global exporter of sunflower in 2012 (McFerron, 2014; Ministry of Foreign Affairs of Ukraine, 2012). In addition to profitability, the deep rooting system of sunflower provides another advantage by allowing it to grow well under dry conditions. However, sunflower removes higher amounts of water and nutrients relative to other crops and continuous cropping increases soil fungal diseases (National Sunflower Association, 2003; Robinson, 1966).

Soil quality and erosion can have a variety of measurements and definitions depending on the stakeholder's perspective: from a loss of productivity to a decrease in key indicators of soil health (Robbins, 2011). In this methodology, diverse stakeholders with a variety of perspectives set the agenda by providing definitions of the problem, potential explanations and revealing the complexity of solutions. This research employed an iterative, participant-driven method to reveal the less apparent barriers and interaction of barriers to crop rotation by first allowing participants to indicate that crop rotation was a topic of concern. This approach follows the precepts of Fourth

Generation Evaluation as described by Guba and Lincoln (1989). Stakeholders identify areas of concern during semi-structured interviews, claims from stakeholders are introduced to other stakeholders via the Q sort, clarification is sought from Q sort participants and finally if consensus cannot be achieved the process provides clarity on future steps to be taken. Q method fits well with fourth generation evaluation, since it gives a voice to the many different perspectives of an issue (Rogers, 1995; Van Exel and de Graaf, 2005). In addition, conflicting understandings can be a barrier independent of any other issues (Parry et al., 2007) and Q method can clarify differing interpretations.

Interview Process

Interviewees consisted of national agricultural, development and environmental experts in Kyiv (n=18), regional experts[13], large agriholdings and smallholder farmers. Regional experts and farmers came from three different regions of Ukraine: the Forest-Steppe region of western Ukraine (L'viv and Ternopil oblasts), the mixed forests of the Polissia region in northern Ukraine (Chernihiv oblast) and the Steppe region of southern Ukraine (Kherson oblast). This provided coverage of the three major agro-ecological zones of Ukraine. Most of the regional focus and farmer discussion happened in the Kherson oblast (regional experts n=13, farmers in region n=15). While the Steppe zone already has a semi-arid climate, projections indicate an increase in the intensity and frequency of droughts for the zone, making it the most climatically vulnerable region in Ukraine (Adamenko and Prokopenko, 2011; Dronin and Kirilenko, 2012). In this region, field observations, key informant discussions, regional expert opinion and farmer's views could be compared. Statements from interviews in Ukraine's west (n=4) and north (n=4) were included in the concourse for the Q sort. The concourse is a collection of statements covering the range of perspectives on a topic.

Snowball sampling was used in Kherson, where a key informant assisted in reaching experts and farmers managing farms of various sizes and ownership structures. Interviews were conducted in the spring and summer of 2012. Typically interviews were conducted in Ukrainian with simultaneous translation; however, some of the national interviews were conducted in English. Interviews were recorded after verbal permission was granted by interviewees. Interviews typically took from 30 minutes to 1 hour, but lasted up to 4 hours when farm or facility tours were included in discussions.

Interviewees varied in expertise, so open-ended questions administered in a semi-structured format ensured that research remained flexible and participant driven. National and regional experts were questioned about adaptation, mitigation, and the most pressing social and environmental issues for the country and region respectively. Farmers were asked about farming in Ukraine, adapting to climate variability, efficiency measures and soil improvements as shown in Online Resource 1.

[13] Regional experts included leaders of agricultural support groups and representatives of government agricultural agencies operating at the oblast and raion levels (provinces and districts).

The constant comparison process of grounded theory revealed crop rotation as an area of considerable dissensus (McGhee et al., 2007). As part of this constant comparison process, memos were written to note themes using a contact summary template shortly after each interview (see Miles and Huberman, 1994). Each line of the transcript was given gerunds or in-vivo codes using Max QDA software (see Charmaz, 2006). Preliminary results from coding of interviews were used to explore potential perspectives and possible explanations prior to developing the Q sort concourse.

Q Methodology

In Q methodology, sample size does not equate to the number of participants doing the sort, but rather the number of statements used. The concourse was built exclusively from the interview transcripts. Typically statements consisted of direct quotes from interviews. However, statements in the "responsibility" category were changed to a more positive and less blaming tone. For instance, statements such as "smallholders do not follow crop rotation" were changed to a more positive tone with "smallholders follow crop rotation". Statements covered the full range of views expressed by respondents pertaining to crop rotation, sunflower (oilseed crops), soil health and land tenancy.

The Q sort was administered to participants online using Q-sortware (Pruneddu and Zentner, 2011) from mid-2014 through to 2015. As typical of similar studies, a small group of purposely chosen respondents provided for a diversity of perspectives (Cairns and Stirling, 2014). Eight out of ten of the Q sort participants were a subset of the original interviewees. Since farmers and large agri-holdings participants from earlier interviews were difficult to reach, two new participants were recruited to complete the Q-sort. One of the newly recruited participants was a farmer and the other participant was an economist working closely with large agri-holdings; thus covering the range of stakeholders desired for the study.

Participants sorted statements into a quasi normal distribution by placing a fixed number of statements (indicated in parentheses) into boxes labeled strongly agree (3), agree (4), partially agree (4), undecided/neutral (5), partially disagree (4), disagree (4), strongly disagree (3) as shown in Online Resource 2. Since the individual must carefully consider each decision in relation to the other sentences, a forced distribution helps to reduce issues often associated with completion of self-reports; such as providing answers perceived to please the researcher and choosing extreme and middle values among the range of options (Block, 1978; Fluckinger, 2014).

Data analysis was performed using the 'qmethod' library (Zabala, 2014) within R v32.2. Factor analysis measures the relationships among many statements across respondents (Brown, 1980). As a result, the analysis reveals the range of viewpoints shared by specific groups of participants rather than individual narratives (Watts and Stenner, 2005). A preliminary evaluation of the statement correlation matrix suggested the presence of three factors. Therefore factor analysis was performed forcing the extraction of three factors and Varimax rotation maximised the variance explained while keeping the factors independent.

In order to aid in factor interpretation, a follow-up email was sent to respondents inquiring about their reasoning behind statements placed in the strongly agree and strongly disagree columns. In addition, the respondent who had the highest loading (correlation) for each factor was sent a description of the factors to elicit feedback or corroborate the final interpretation.

Results

Abandonment of crop rotation and subsequent soil depletion was the natural resource problem mentioned most by stakeholders during interviews. However, a lack of consensus emerged as to who was responsible for the problem, if a problem even existed, why crop rotation was not being followed and finally what needed to be done to solve the problem. Technical crops such as sunflower and rape were viewed as a problem due to increased cultivation. Sunflower was also provided as an example of already observed climate change due to the crop being cultivated farther north than it had in the past.

The statements used in the concourse for the Q sort indicate the major subject areas emerging from interviews, key informant discussions and field observation. Results from interviews and statements used in the Q sort concourse have been organised according to the categories: problem definition, responsibility, explanation and possible solutions.

Interview Findings

Problem Definition: Is the problem crop rotation, expansion of sunflower or deteriorating soil?
According to interviewees the problem could be defined as a deterioration of soil health, an increase in technical crops and/or the abandonment of crop rotation. The scope of disagreement amongst stakeholders about the problem is evident in the following two quotes.

> *"Protection of the environment is vague and distant for businesses in Ukraine. The biggest concern is growing too much sunflower." (Peter[14], National Agriculture Expert)*

> *"I don't think crop rotation is an issue because we have good soil and we don't work to spoil it." (Sergey, Kherson Farmer)*

While most interviewees valued and approved of crop rotation, some respondents saw the current recommendations as too strict and believed that other alternatives to maintaining high quality soil existed. Sunflower and technical crops were viewed to cause two distinct problems: the continuous cultivation was viewed to deteriorate the soil and food security was threatened by the desertion of other crops. The quality of Ukrainian soil was described as a treasure and important to national security. Some respondents expressed an opinion that soils were better cared for during Soviet times; others would disagree with that statement vehemently.

[14] Names have been changed to insure anonymity of respondents.

The Q sort statements for this category include:

- Expansion of technical crops (oilseed) threaten food security.
- The increase in technical crops causes soil problems in Ukraine.
- Crop rotation is not a necessity; alternatives exist to maintain high quality soil.
- Soils were cared for better during Soviet times.
- The quality of Ukrainian soils is deteriorating.
- Ukrainian soils are a matter of national security.

Responsibility: Who is not following crop rotation?

> *"It is a lie that farmers don't follow rotation and don't care. Farmers are the real owners of the land and they know what is better. It is stupid for someone in Kyiv to dictate what is done." (Roman, Kherson Farmer)*

> *"They (large agri-holdings) take land for rent and grow sunflower until land is not good and then stop renting land. They don't stick to technologies because they can leave land whenever they want." (Peter, National Agricultural Expert)*

Typically, farmers held the view that producers followed crop rotation. Only one interviewee from an international agri-holding declared that bribes could be paid to officials in lieu of adhering to the recommended crop rotation. Stakeholders often claimed that large agriholdings were blamed for growing mostly technical crops for profits and destroying the land. Although a few respondents claimed large companies use the best and most current technologies and practices, so they were not the problem. Meanwhile, small-holders often specialise in fewer crops. According to an agriculture support worker in Khersons'ka, some villages define what they grow and only grow one crop. In their experience, smallholders were not following crop rotation.

The Q sort statements for this category include:

- Large agri-holdings use the best technologies available.
- Large agri-holdings follow crop rotation.
- Small-holder producers follow crop rotation.

Explanations: What factors contribute to the recommended crop rotation being abandoned?
Due to the profitability of sunflower and technical crops, stakeholders but not farmers often attribute the failure of farmers to follow crop rotation to greed. However, after speaking to farmers, field observation and further discussion with stakeholders other issues emerged.

According to scientists at a soil testing facility in Kherson farmers abandon crop rotation to plant the most profitable crops (sunflower and rape) and/or soil problems arise due to farmers experiencing financial constraints. Furthermore, farmers only contacted the facility when they observed a problem with the soil and did not work at preventative measures due to a lack of finances. The lack of financial assistance available to farmers is apparent in the following quote.

"Farmers do not have enough resources to support the soils and do the right practices, so land is not used efficiently." (Igor, Kherson Farmer)

Due to the land sale moratorium farmers do not truly own the land, so land cannot be used as collateral to secure low interest loans adding to financial strain. The land sale moratorium was also believed to cause short-term planning and unsustainable practices. One interviewee stated that an agri-holding did not follow crop rotation because of the potential for agricultural land to be taken by those in political power. The agri-holding's managers were not confident that they could take a long-term view of business and the land and decided to make the most profit in the short-term. This explanation has more to do with insecurity of land tenancy rights, contrasting with the seemingly more prevailing belief that large agri-holdings managers think that the land can be abandoned once the soil has been exhausted and profits gained.

The 2011/2012 season in Kherson demonstrated how climate change and financial constraints can interact to form a barrier to crop rotation. A law had just been passed limiting the amount of area of grown sunflower to 10%. From personal observation, the area under sunflower cultivation in the region appeared close to 80 per cent. When queried about the dominance of sunflower in the region, a village head explained that the law was new and that this year sunflower was planted because of crop failures. Many farmers experienced multiple crop failures due to climate variability. One farmer stated that winter wheat was destroyed by frost, spring wheat was destroyed by heat, and the grapes and gardens did not do well due to seasonal variability. An agricultural support worker in the region identified planting sunflowers late as an adaptation strategy, but they also acknowledged that it might not work. While planting a deep-rooted plant, such as sunflower, provides a short-term strategy, it could prove to be maladaptive in the long-term because of the large volume of water extracted from the soil. Interviewees explained that farmers could opt to grow a different crop, but after losing several crops they preferred to minimise risk by cultivating the most profitable crop. While the government issued support payments to farmers in the region to compensate for the losses, interviewees in the region said that farmers did not receive payments. Interviewees often mentioned problems with corruption in the country and support payments being stolen instead of making it to the farmers. In the following quote, a farmer explains crops in the region, the difficulty experienced in the 2011/2012 season and the attempts made to follow recommendations for growing crops.

"The main crops we grow are sunflower and rape. The problem with rape is that we do not get enough rain early in the season. We grow sorghum and oat for rotation but it does not make a lot of money. We try to stick to all the rules and technologies and fertilizers. This year we planted some seeds according to the rules, but the rest we planted a bit later and it got enough rain, so it helps not to sow all of them at the same time…It turned out pretty good, but we might not get a good harvest. We look at the period for sowing and if we see that the soil is not moist enough then we sow some of the seeds later in the season." (Orest, Kherson Farmer)

According to many respondents, government policies have created a difficult business environment for agricultural production. In response to seasons with poor harvests of wheat and barley the Ukrainian government has often set export quotas. However, the government's interference in markets leads to uncertainty making it difficult for farmers to plan accordingly (Brummer et al., 2009). One farmer stated that he did not wish to grow wheat due to the instability in pricing. When export quotas lead to a decrease in the price paid for wheat, it becomes even less profitable compared to sunflower and rape.

Finally, smallholders often have a tradition of growing only one or a few crops, so tradition acts as a barrier preventing them from following crop rotation.

The Q sort statements for this category include:

- When producers do not follow crop rotation it is because of greed.
- Government gets in the way of business.
- Small-holders receive no support from the state.
- When smallholders fail to follow crop rotation it is because they have a tradition of growing only a few crops (or a single crop).
- Producers abandon crop rotation during difficult years.
- If producers owned the land they would take better care of it.
- Insecure land tenancy agreements lead to short term planning and ultimately shortened crop rotations.
- Producers believe that those in power can take land away from them at any moment.
- Export quotas discourage producers from growing some crops.
- Sunflower can be grown in more regions of Ukraine because of changing climate.
- Producers who do not follow crop rotation can pay unofficial payments to avoid fines.
- Rules and laws for crop rotation are too strict.

Solution: What changes should be made to ensure producers follow crop rotation?

Occasionally respondents in Kyiv voiced frustration about lack of accountability compared to Soviet times. One respondent said that in the old days someone who did not follow crop rotation would be sent to Siberia. Some respondents want laws to be enforced feeling that the government needs to ensure that the country produces enough food. However, others argue that rules cannot be enforced due to corruption. Most agree that the land sale moratorium needs to end, but how and when to end the moratorium continues to be debated. Lifting the land sale moratorium will help producers with acquiring more affordable loans and potentially increase land tenancy security, but many interviewees worry that the current business and political climate is not yet right and those with political connections could potentially benefit the most[15].

Foreign investment is also a debated topic. Some respondents expressed concern about foreign interests gaining control of land and deteriorating the soil. At the same time, many argue that

[15] The Yanukovych government was in power at the time of interviews, thus responses often reflect the views of a government that has since been overthrown. However, subsequent conversations with interviewees indicate that much progress still needs to be made by government to gain people's trust. Moreover, the Q sort was completed after the new government was in place.

foreign investment brings needed expertise and knowledge to Ukraine that would encourage sustainable practices.

The Q sort statements for this category include:

- Foreign investment should be encouraged.
- Lifting the land sale-moratorium will help producers.
- Producers will have greater security when they truly own the land.
- Foreign investment needs to be monitored.
- People with political ties will benefit the most from lifting the land sale moratorium.
- The government needs to implement policy to ensure that enough food is produced in the country.

Q – Sort Analysis

The factor analysis explained 53% of the total variance, the first and the second factor each explained 19% of the variance and the third factor explained 15%. Reliability of each factor was acceptable (>0.8), with 0.94 for Factor 1, 0.92 for Factor 2, and 0.89 for Factor 3. The three factors were highly independent. Factor 1 and 2 had no correlation at all (r=-0.01), Factor 2 and 3 (r=0.18) and a very weak correlation between Factor 1 and 3 (r=0.21).

Table 11 shows the z-scores for each of the statements along each factor. The 'qmethod' package also evaluated the absolute difference between z-scores in each factor for every statement. A significant difference between z-scores ($p<0.05$) indicated disagreement between factors. If the difference between z-scores was not significant, the three factors were determined to hold a similar opinion and the statement was labeled as "Consensus". Of all the 27 statements, only 8 were consensus statements indicating that the three factors gave voice to different views on crop rotation. Refer to Appendix 5 for a visual representation.

The three factors have been described as Producer insecurity, National insecurity and Business climate insecurity. Respondents in the producer insecurity factor tends to 'side with farmers'. For instance, the statement that farmers abandon crop rotation due to greed falls into disagree for this factor, while this statement falls in the neutral category for the other two factors. Those belonging to the national insecurity factor tend to be most concerned with what is best for the nation and less with individual producers. The business climate insecurity factor reveals the view that the political economy of Ukraine causes problems by creating a difficult business climate.

Table 11. Statements from the final Q-set and respective Z-scores for each factor. Consensus statements are indicated in bold. Z scores in bold with grey shading indicate the statements important for each factor. Negative z-scores can be interpreted as disagreeing or of less importance.

Statements	*Factor 1*	*Factor 2*	*Factor 3*
	Producer	*National*	*Business*
1. Small-holder producers follow crop rotation.	-0.76	-0.94	-1.25
2. Large agri-holdings follow crop rotation.	**0.58**	**-1.18**	**-1.88**
3. Producers who do not follow crop rotation can pay unofficial payments to avoid fines.	-1.45	**1.21**	-0.77
4. Rules and laws for crop rotation are too strict.	-1.14	-1.45	-0.39
5. The quality of Ukrainian soils are deteriorating.	1.02	1.28	1.50
6. Producers believe that those in power can take land away at any moment.	**1.48**	0.03	-1.11
7. Insecure land tenancy agreements lead to short term planning and ultimately shortened crop rotations.	0.16	**0.90**	0.04
8. When smallholders fail to follow crop rotation it is because they have a tradition of growing only a few crops.	-0.14	0.33	0.14
9. If producers owned the land they would take better care of it.	0.55	0.34	**1.88**
10. Soils were better cared for during Soviet times.	**1.16**	-1.52	-0.53
11. Sunflower can be grown in more regions of Ukraine because of changing climate.	-0.30	-0.42	0.24
12. The increase of technical crops causes soil problems in Ukraine.	-0.38	-0.48	0.14
13. Expansion of technical crops threatens food security.	-1.34	-0.63	-0.14
14. The government needs to implement policy to ensure that enough food is produced in the country.	0.16	**1.84**	-0.63
15. Crop rotation is not a necessity; alternatives exist to maintain high quality soil.	0.01	-1.88	**0.87**
16. Export quotas discourage producers from growing some crops.	-0.67	-0.67	-0.48
17. Small-holders receive no support from the state.	**1.57**	0.43	-0.04
18. Government gets in the way of business.	**1.63**	0.48	**1.40**
19. Producers abandon crop rotation during difficult years.	0.45	1.02	1.16
20. When producers do not follow crop rotation it is because of greed.	**-1.39**	**0.60**	0.14
21. Large agri-holdings use the best technologies available.	0.10	-0.55	**0.77**
22. Lifting the land sale-moratorium will help producers.	-1.18	-0.05	**-1.64**
23. Foreign investments should be encouraged.	0.91	0.24	0.48
24. People with political ties will benefit the most from lifting the land sale moratorium.	**1.21**	-0.39	**-1.64**
25. Foreign investment needs to be monitored.	**-1.32**	0.24	0.48
26. Producers will have greater security when they truly own the land.	0.29	-0.78	**1.25**
27. Ukrainian soils are a matter of national security.	-1.21	**2.00**	0

Factor 1: Producer Insecurity

Respondents who loaded on to this factor included: two farmers, a farm extension service worker and a person working in agricultural business support. In general participants loading on to this factor felt that conditions needed to be improved for producers through institutional changes and better support systems. Respondents in this factor held the view that large agri-holdings follow crop rotation and smallholders do not receive support from state. Two statements pertaining to security of land tenancy and corruption appeared in the agree side of the distribution for this factor: i) producers believe that the land can be taken away from them by those with power and ii) people with political ties will benefit the most from lifting the land sale moratorium. While they have the view that the current state is not secure they also see difficulties with establishing a land market in the political climate at the time of data collection.

This factor demonstrates the view that soils were better cared for during Soviet times. This could be due to greater support from the state during Soviet times or accountability. However, those in this factor also viewed government to get in the way of business indicating that current policy was not helpful. They also supported foreign investment[16].

Factor 2: National Insecurity

Respondents who loaded on to this factor include: two researchers at national research centres and a national organic certifier. The perspective in factor 2 disagrees considerably with the view revealed by factor 1 as evident in table 11. Those loading onto this factor have a concern for the conditions of the nation as evident in agreement with statements: soils are a matter of national security and government needs to implement policy to ensure enough food is grown in the country. They agree that insecure land tenancy agreements lead to short-term planning and shortened crop rotation; however, this does not necessarily relate to producer insecurity. Rather when producers rent land they do not need to think in the long-term, so they do what is best in the short-term.

Factor 3: Business Climate Insecurity

Respondents who loaded on to this factor included: an agricultural economist and the leader of a national non-profit agricultural organisation. Factor 3 indicates a perspective that the business climate in Ukraine needs to be improved. Those in this factor hold the view that land ownership needs to be addressed as evident in their agreement with the following statements: i) producers would have greater security if they owned the land and ii) producers would take better care of the land if they truly owned it. In addition, respondents loading onto this factor disagree that those with political connections will benefit the most from removing the land sale moratorium. Like those in Factor 2, respondents loading to this factor disagree that large agri-holdings follow crop rotation,

[16] Many of the interviewees working in agricultural support stated that all assistance to farmers had come from international groups and none had come from the Ukrainian government.

however, in contrast, they hold the view that crop rotation is not always necessary, as other technologies exist. In addition, those loading to this factor believe that large agri-holdings use the best technologies available. Respondents belonging to factor 1 and factor 3 both agree with the statement that government gets in the way of business. However, this factor has the most favourable view of large agri-holdings and does not place lack of smallholder support in agree. For these reasons, this factor has been labelled business climate insecurity and provides a voice that differs from producer insecurity.

Comparing Factors: Partial Agreement and Consensus

Factor 1 and factor 2 disagree considerably. However, respondents loading onto both these factors disagree with the statement that the rules for crop rotation are too strict. Factor 3 is neutral on this point, but agrees with the statement that alternatives exist.

Those in factor 2 agree that producers can pay unofficial payments to avoid fines for abandoning crop rotation whereas those in factors 1 and factor 3 disagree. Potentially those in factor 2 believe that producers have an easier way around the system than those in factor 1 and factor 3.

According to the consensus statements across all factors, agreement appears possible for statements in each of the categories. The quality of Ukrainian soils is deteriorating (problem definition), small-holders do not follow crop rotation (responsibility), producers abandon crop rotation during difficult years (explanation) and foreign investment should be encouraged (solution).

Discussion and Conclusions

This study demonstrated the complexity of climate change barriers by using an iterative, participant- driven approach. Open conversations in initial interviews highlighted the various disagreements relating to the 'win-win' strategy of crop rotation. The diverse perceptions about crop rotation and agriculture coming from the interviews were included in the Q sort to facilitate clarification of different perspectives and allowed for connections to be made between issues.

While greed was a reason provided in interviews as an explanation for producers not following crop rotation, it was often followed up by the financial constraints farmers face. In addition, when presented with other potential explanations in the Q sort, greed did not rank as an explanation for abandonment of crop rotation. The producer's greed statement was placed in the disagree column by respondents loading to one of the factors, while it was a neutral statement for the other two factors. Moreover, the statement 'farmers abandon crop rotation during difficult years' appeared as a consensus statement across all factors; consistent with observations and interviews during the 2011/2012 farming season in the Kherson oblast. The difficult years and corresponding financial difficulties will only worsen with climate change and thus continue to be a barrier for crop rotation if not addressed. These results relate to factors and not individual stakeholders, so it cannot be said that everyone has exactly the same view. However, only one stakeholder placed greed in the agreement side of the sort.

Statements pertaining to land ownership also appeared in the agree side for each of the factors indicating that this could be an area of some agreement and could potentially be a barrier that can be addressed. Disagreement appears to exist in the detail or mechanism for which land ownership matters the most. Factor 1 reveals the view that producers feel that land can be taken away from them at any moment, but also demonstrates concern over who benefits from lifting the land sale moratorium. Factor 2 captures the view that short-term agreements lead to short sighted planning and shortened crop rotations. Factor 3 reflects that when farmers own the land they have higher security and they would also take better care of the land. Moreover, the inability to own land constrains farmers financially due to the lack of collateral available for low interest loans; thus interacting with problems that arise during 'difficult years'.

Biesbroek et al. (2014) argued that investigating the mechanisms behind barriers can point to more detailed and appropriate solutions. For instance, when inadequate financial resources are identified as a barrier (see, Adger et al., 2007; Smith et al., 2007), the proposed solution might be limited to increasing or improving the use of resources. In this case study, financial constraints are the most apparent barrier preventing producers from following crop rotation, but several issues interact and augment the financial constraints of producers in Ukraine. As demonstrated, removal of the land sale moratorium could secure land tenancy rights, lead to longer term planning and allow producers to access low interest loans. A well-developed plan to remove the land sale moratorium provides a more precise policy to address financial issues than just increasing financing available to producers and/or enforcement of crop rotation.

Given the background of each respondent, the factor that respondents load onto does not come as a surprise. Producers and those working to support local producers had greater concern for producer security, while those working at the national scale had concern for the nation's food production and resources. Risbey et al. (1999) maintain that adaptation is a multi-scale process requiring recognition of complexity and scale during investigations. Indeed, the differing perceptions of stakeholders revealed during factor analysis reflect the scale at which each stakeholder operates. Moreover, while the disagreements at first seem unsurmountable consensus actually does exist beneath the surface.

Guba and Lincoln (1989) maintain that fourth generation evaluation never stops it only pauses. In this case study, this method has an additional strength in that it can be used to shift blame away from greed and could open up discussions amongst stakeholders. Areas of consensus can be a place to start further discussion amongst stakeholders as well. Furthermore, all factors agree that Ukrainian soils are deteriorating demonstrating some agreement about the problem and showing the potential for motivation to act. This is particularly important for the next steps needed to implement solutions. Foreign assistance also appears to be favoured by participants. Therefore, this method not only reveals barriers, but could potentially help to address barriers as well.

This work focused on crop rotation because, as a well-accepted strategy, it should easily be implemented in Ukraine. In reality, it is a source of considerable disagreement. While technically a

win-win measure, within the context of the political economy of Ukraine, crop rotation does not appear to be a winning measure for farmers. The agreement that farmers abandon crop rotation during difficult years indicates that the loss of short-term profits are too large a financial burden for many farmers. Increasing the diversification of crop rotation and conservation tillage face the same challenging context and additional barriers as the techniques require equipment and specialist knowledge (Fileccia et al., 2014). If more complex strategies are to be implemented successfully, the hidden barriers must first be understood and addressed for the simpler measures.

This research demonstrated how the political economy can hinder farmers and thus serve as a barrier to climate change measures. Farmers in Ukraine need to adjust to changes in an uncertain business climate in conjunction with climatic changes. The politics behind these processes needs to be understood and climate policy needs to be integrated with other policies to ensure that the most vulnerable in a country do not pay the biggest price.

Chapter 7 Discussion and Conclusions

Results Summary

The IPCC 2014 report identified the need for more evidence to support the concept of climate-resilient development pathways, specifically determining a need for more context-specific case studies (Denton et al., 2014). Through a case-study of Ukraine's agri-food sector, this research answers this call. The aim of this work is to understand how to foster a climate resilient development pathway by revealing synergies, trade-offs and processes linking response capacity to climate action. Chapter 4 met the first objective by revealing the potential to seize synergies by identifying shared barriers and bridges between adaptation, mitigation and sustainable development (AMS). Chapter 5 detailed the process of change in social capital in a cooperative to uncover the link between assets related to capacity and climate action. Chapter 6 examined crop rotation as a triple-win technique, but found crop rotation to be a trade-off for farmers between short-term survival and long-term sustainability in the current political economic context. Moreover, all three data chapters revealed an interacting system of barriers that created a persistent, but not resilient, development pathway.

Past studies have described barriers to addressing climate change, but not delved deeper to understand the processes or how to overcome barriers (Biesbroek et al., 2013; Biesbroek et al., 2014; Eisenack et al., 2014). Chai and Yeo (2012) reasoned that barriers interact; the interactions go unnoticed and thus serve to sustain the function of barriers. This process can be best described as a hurdle. The word hurdle comes from the old English world 'hyrdrle' defined as a "frame of intertwined twigs used as a temporary barrier"(Harper, 2016). As such, a hurdle has complexity but also impermanence since it can be dismantled or surmounted. Moreover, a hurdle describes an interacting system of barriers that can be changed instead of the more common static and stand-alone view of barriers. In addition, a seemingly small change to the system can potentially create and lead to significant changes over time.

As discussed in chapter 3, Ukraine's agricultural sector has a long history of uncertainty and change, most recently with the Yanukovych government, leading to a lack of trust from citizens towards institutions. Change created uncertainty instead of positive transformation. Coping in the short-term proved to be maladaptive in the long-term due to an absence of mechanisms encouraging novelty. These hurdles can be surmounted, but a more transformative change of the development pathway would do a great deal more to foster climate-resilience.

In chapter 4, barriers reinforced each other with an element of corruption in each of the themes, weakening law enforcement and playing a part in market interventions. Political pandering also served to maintain corruption since low food and energy prices helped to 'take care' of the population as during Soviet times, however, oligarchs reap the greatest benefits from the system. Both export restrictions and corruption provide an example of reactive coping strategies becoming maladaptive. Export restrictions as an adaptation strategy for reduced yields serves as a trade-off

with low food prices for consumers in Ukraine happening at the expense of global market stability, and reducing the financial capital and capacity of farmers in Ukraine. Corruption as a form of negative social capital used to survive and cope with shocks in the short-term became self-sustaining and hampered resilience in the long-term. Foreign involvement, particularly learning about strategies from other countries was viewed as a bridge that could help overcome current barriers.

Chapter 5 focussed on a cooperative as a livelihood strategy. The most immediate benefit of the cooperative was the change from negative social capital in the form of gossip networks acting as a barrier to slowly building positive social capital. A vicious cycle of distrust and individualistic drive due to a historical tradition of forced cooperation became a virtuous cycle of growing trust leading to increased networks, improvement of the cooperative and feeding back to trust. Moreover, the case of this cooperative revealed the role of social capital in improving access to other capitals and ultimately achieving the outcomes of planned adaptation and sustainable development. The continued education from one cooperative to the next provides a tool that could work in a manner similar to foreign involvement and education outlined in chapter 4. In chapter 4, improved social capital through networks to international communities lead to development of human capital by learning about new ideas, while in chapter 5 it was shown that learning comes predominantly from cooperatives within Ukraine although often with the assistance of international groups.

Chapter 6 focused on a particular triple win strategy: crop rotation. Strikingly different opinions of crop rotation were revealed during interviews; therefore, Q method was used to better understand the different perspectives. During initial interviews the dominant narrative was that farmer greed led to abandonment of crop rotation. However follow-up questions revealed that some of the themes that impacted farmer capacity in chapter 4 could be playing a role in crop rotation not being followed. Further examination by means of Q method revealed considerable agreement that farmers abandoned rotation during difficult years and that land tenancy issues related to the land sale moratorium in particular caused problems for farmers. Perspectives on why the land sale moratorium poses a problem varied. Inability to secure low interest loans due to not being able to use land for collateral was one of the clearest issues. Again corruption serves as a barrier since one of the reasons the moratorium has not been removed is for fear of corrupt interests gaining access to most of the land. This study began with the assumption that crop rotation is a triple win technique, but found crop rotation to be a trade-off for farmers in the short-term due to the current political and economic context. Risbey et al. (1999) reason that adaptation requires the maintenance of production, profitability and sustainability objectives in the face of changing markets, policies and climate; therefore, a farmer will not plan adaptation for the future if they are unable to adjust to current political economic context. In this study agreement that farmers abandon crop rotation during difficult years indicated that short-term needs interfered with long-term sustainable actions. Moreover, while sowing the most valuable crop sunflower, is a coping

strategy in the short-term, it threatens to be maladaptive in the long-term due to the higher moisture demands of sunflower and the predicted increase of drought in Ukraine.

While, these barriers, opportunities and trade-offs are specific to the context of Ukraine's development pathway the uncovered processes provide an indication of issues that might occur in other contexts. In order to support the generalizability of key findings, a comparison is made between this work and recent case studies integrating AMS. First, an overview of recent case studies and a comparison of approaches used in research help to better understand how this case compares to and differs from recent case studies. Next, the themes arising from these case studies and how they contribute to ongoing debates within climate literature will be discussed. Then, a comparison between Ukraine's case and climate change research in countries of the former Soviet Union will highlight wider policy implications and areas for future research. The final section examines the main conclusions of this study as both an instrumental and intrinsic case by discussing the strengths of integrated AMS research and the principal findings specific to the context of Ukraine.

Comparison of Case Studies

Considering the thesis as a whole, the unit of study for this case was the climate development pathway of Ukraine's agri-food sector. However, each chapter has a different subject for analysis thus combining national issues, a strategy (cooperative) and a technique (crop rotation). Similarly, each of the case studies integrating AMS focused on broad large scale issues, a strategy or project, or a technique as indicated in table 12. However, a thorough search of the literature did not find any case studies that combined all three units or types of analysis as was done in this study. The two studies with a broad focus had limited engagement with stakeholders during data collection and analysis. Jackson et al. (2011) interviewed agency representatives and surveyed farmers to understand farmers level of engagement with climate change. In a study of forest commons adaptation was not explicitly part of the focus, but was implied within the context of livelihood strategies and thus was included in this discussion of AMS integrated case studies (Chhatre and Agrawal, 2009). The studies using a strategy or project focus tended to have the highest level of stakeholder engagement and explored social and political factors. However, these studies did not typically integrate AMS as a single process. For instance, Chandra et al. (2016) looked at mitigation outcomes arising from an adaptation project. Finally, of the four studies focused on a particular technique all researched irrigation and three used a quantitative analysis of emissions, water use and economic cost. Only one of the studies focused on irrigation engaged with farmers through discourse and narrative analysis.

In addition to these studies, a growing literature has researched the practicalities of adhering to the three tenets of conservation agriculture: crop rotation, reduced tillage and crop residue retention (for example: Baudron et al., 2015; Beuchelt et al., 2015; Giller et al., 2009; Homann-Kee Tui et al., 2015; Jaleta et al., 2013; Naudin et al., 2015; Valbuena et al., 2015). Although not explicitly

stated as integrated AMS studies, these studies also provide insight about potential trade-offs and are included in the discussion that follows. Similarly, agroforestry can provide mitigation, adaptation and sustainable development options (Mbow et al., 2014); therefore, recent studies pertaining to agro-forestry have also been included.

Table 12. Summary of case studies integrating AMS.

Rows without shading have a broad unit of analysis, light grey indicate project or strategy focus and darker grey indicate a focus on technique.

Geographical Area	Research Focus	Methods	Citation
Africa, Asia, Latin America	Forests	Livelihood index and basal area of trees per hectare	Chhatre and Agrawal (2009)
California	Agriculture	Literature review, models, interviews and survey	Jackson et al. (2011)
Alaska and Nepal	Indigenous Communities	Transformational change framework	Thornton and Comberti (2013)
Kenya	Smallholder Farmers	Models, field survey and expert opinion	Bryan et al. (2013)
Lao PDR	REDD Project	Ecosystem analyses, group discussions and interviews	Ingalls and Dwyer (2016)
Timor-Leste	Smallholder Farmers	Interviews, field observations and document analysis	Chandra et al. (2016)
Vietnam	REDD+ and Agriculture	Role-playing game with farmers and an Agent Based Model	Salvini et al. (2016)
Zanzibar, Tanzania	Coastal Livelihoods	Household surveys and community-level focus groups	Suckall et al. (2014)
Australia	Irrigation	Hydrological, emission and economic modelling	Mushtaq et al. (2013)
Australia	Irrigation	Hydrological, emission modelling, and cost-benefit estimation	Maraseni et al. (2012)
Australia	Irrigation	Discourse and narrative analysis	Beilin et al. (2012)
Philippines	Irrigation (reuse)	Water use, productivity, energy and economic efficiency	Hafeez et al. (2014)

A comparison of these studies demonstrates not only the importance of integrating AMS, but also how these studies contribute to and expand existing debates pertaining to power, capacity and equity within the climate change literature.

Integrating AMS: Acknowledging Short-term Local vs. Long-term Global Needs

The climate change literature referring to integrated studies and policies predominantly highlights the potential benefits of taking such an approach (Denton et al., 2014; Klein et al., 2007). Nonetheless, some have expressed concerns pertaining to a lack of coordination between the variety of government agencies tasked with adaptation and mitigation, the potential for higher costs due to additional complexity of integration, a loss of focus on more immediate social issues and a reduction in funds directed towards adaptation (Kok et al., 2008; Locatelli et al., 2016). Moreover, Tol (2005) argued that adaptation and mitigation should be studied separately due to the differences pertaining to spatial and time scales. Mitigation happens at the international to national scale with short-term action having the potential of long-term effects, while adaptation happens at the local scale and short-term action relates to short to medium term effects. However, Tol (2005) made an exception for facilitative adaptation: described as actions that improve robustness to climate variability and socio-economic changes. Facilitative adaptation corresponds to building adaptive capacity in that it provides the needed structure to ensure appropriate responses in the local context. In this case-study of Ukraine's agri-food sector the focus was predominantly on facilitating appropriate adaptation responses.

Nonetheless, in reviewing the case study literature, the argument that differing spatial and time scales precludes integrating case studies appears to be incorrect; moreover, working across scales appears to be one of the main strengths of integrated research. Trade-offs typically occur across local, immediate and global long-term scales; and therefore trade-offs can remain hidden when studies are not integrated. The potential outcomes depend greatly on context. For instance, in a study of 80 forest commons across Asia, Latin America and Africa, Chhatre and Agrawal (2009) found a lack of association between the global long-term benefit of carbon storage and the local short-term benefits related to livelihood outcomes indicating that both win-win and trade-off situations are equally likely. In a review of development interventions, Suckall et al. (2015) found projects to be evaluated according to either adaptation or mitigation benefits even when triple-win benefits were evident. While triple-wins are likely to go unreported, they also identified a need for interdisciplinary approaches to balance immediate, local needs with long-term global issues (Suckall et al., 2015). Concerns pertaining to short-term needs become evident in the debates pertaining to conservation agriculture. Giller et al. (2009) argue that intense promotion of conservation agriculture by international research and development organization stifles debate particularly since existing evidence does not always indicate which of the three principles of conservation agriculture, crop rotation, minimal tillage and residue management, provides the desired effects in varying contexts. Moreover, adopting conservation agriculture practices can lead

to decreased yields in the short-term and weed management can lead to a gender shift in the balance of labour when herbicides are not used (Giller et al., 2009). The provision of cereal crop residue for soil management instead of livestock feed presents one of the most well-known trade-offs in conservation agriculture (Jaleta et al., 2013; Tittonell et al., 2015). While conservation agriculture improves long-term yields and increases soil carbon (FAO, 2009; Rusinamhodzi et al., 2011), these issues demonstrate a need for research to describe trade-offs in contrasting socio-ecological contexts and to design context specific strategies (Jaleta et al., 2013; Tittonell et al., 2015). As previously mentioned, crop rotation is one of three tenets of conservation agriculture. In the case of Ukraine, crop rotation was abandoned to meet short term needs by growing the most profitable crop after multiple climate-related crop failures. These integrated case studies demonstrate the trade-off between local short-term needs and long-term global needs within the context of the current development pathway. They indicate the need to address underlying issues rather than simply implementing measures that are perceived to deliver a 'triple-win'.

Constrained Capacity and Power Struggles

The purported strength of studies integrating AMS is their ability to identify synergies and trade-offs in practice rather than merely identifying possibilities. Certainly the cross-scalar approach is necessary to reveal whether a trade-off happens; however, political processes and power often influence how and why trade-offs occur. Recent climate change literature has reflected a growing unease with how the problem and potential solutions, particularly adaptation, have been framed. For instance, Tanner and Allouche (2011) argued that power and resources need more attention rather than focusing solely on apolitical, techno-managerial solutions. Yet, Bassett and Fogelman (2013) found a dominance (70%) of 'adjustment adaptation' research approaches in the literature. The adjustment or incremental adaptation approach views climate shocks as the main source of vulnerability. In contrast to 'transformative adaptation', 'incremental adaptation' fails to address the political economy and politics of maladaptation by ignoring the social processes that create vulnerability (Bassett and Fogelman, 2013; O'Brien, 2011; Pelling, 2010). Consequently, in terms of trade-offs, attention must be paid to the individuals, policies, and sectors that are winning and losing, as a win-win discourse can disguise power relations and justice issues (Adger et al., 2001; Isaksen and Stokke, 2014; Naess et al., 2015).

This study did not begin with a political focus, but rather a participant-driven approach, engaging multiple stakeholders, directed the work towards a focus on power. Considering Foucault's concept of power as a productive force and returning to the modified SLF, a livelihood strategy or actions taken to achieve a livelihood can be viewed as a consequence of power or rather capacity in action. Households and individuals have access to assets (capacity); however, others can use power to influence access to assets and constrain the options and livelihood strategies available. Ultimately power dynamics influence livelihood strategies and create livelihood outcomes that are either sustainable or unsustainable. As Burch and Robinson (2007) highlight, capacity is a function of the current development pathway with processes that both enable and restrict the options available to

adapt to climate change. Arguably the failure to capture power is not a reflection of the SLF, but rather how the framework has been used in past research. By applying the framework in a qualitative manner and focusing on processes influencing access to assets, this case study brought power to the forefront of analysis.

Response capacity can be used to adapt, mitigate and/or for further development, but this study demonstrated that the use of limited capacity can also lead to maladaptive responses. For instance, in chapter 6 respondents agreed that farmer's abandoned crop rotation during difficult years. During interviews, respondents reported that farmers planted sunflower as an adaptive response after multiple crop failures. Arguably, farmers are using limited capacity and power to meet short-term needs by growing the most profitable crop. Instead of addressing the underlying causes of crop rotation abandonment, the dominant discourse calls for an exercise of power by enforcing regulations to maintain crop rotation. Similarly, Ingalls and Dwyer (2016) project found that in Lao PDR Reduced Emissions from Deforestation and forest Degradation (REDD) had a tendency to react to local drivers of deforestation rather than addressing structural factors rooted in the broader political economy. Thus local livelihoods were restricted limiting the options available for adaptation, while deforestation due to road expansion and allowances made to attract foreign investments remain overlooked (Ingalls and Dwyer, 2016).

The uncertainty created by government interfering with agricultural markets and inconsistent policies also contributed to the vulnerability of farmers in Ukraine. Similarly in Australia, a failure to integrate numerous disparate policies affecting agriculture, amplified farmers' vulnerability to climate change causing farmers to act with the limited options available (Beilin et al., 2012). As in Ukraine, the farmers in Australia viewed their actions as necessary for survival (Beilin et al., 2012). In Ukraine, the inability to own land and secure low interest loans was perceived to be one of the policies affecting land management. Salvini et al. (2016) found that land ownership in Vietnam influenced sustainable practices with farmers who did not have land use right certificates being less willing to invest in agricultural management compared to those with certificates. However, as in the case with lifting Ukraine's land-sale moratorium, concerns were expressed about corruption hindering the issuing of certificates in Vietnam.

These cases demonstrate how the political economic context influences access to assets, leading to restricted capacity that then limits options available. Farmers respond by using their available power to meet short-term needs with potentially negative consequences in the long-term. For instance, the continuous cropping of sunflower in Ukraine would be maladaptive in the long-term due to the high water demand of sunflower crops. In a similar manner, incremental adaptation threatened future capacity when climate-caused food shortages in Nepal led to over-harvesting impacting future crop yields (Thornton and Comberti, 2013). These cases demonstrate how incremental adaptation is often not suitable in the long-term. Moreover, the actions in Ukraine and Nepal can be deemed acts of resistance. When taken cumulatively and sustained over a longer time period these seemingly small acts of resistance can lead to significant outcomes (McHoul and

Grace, 1993). Moreover, these instances demonstrate that incremental adaptation can have negative outcomes in the long-term thereby contradicting Tol (2005) contention that adaptive action have short to medium-term effects. K. Brown (2011) maintained that current adaptation interventions often undermine resilience and lead to maladaptation in the long-term. One potential reason for this failure is that adaptation requires skills and capital that poorer households lack, thus local capacity must also be strengthened in order for interventions to succeed (Eriksen and O'Brien, 2007).

Confronting Power by Strengthening Capacity

In reviewing the case studies using an integrated approach the value of building capacity, in particular, the social and human capital elements, emerged as the most repeated theme. For instance, Szlafsztein (2014) concluded that the greatest role of fifteen projects in Brazil related to the strengthening of existing adaptation capacity, which then facilitated the integration of adaptation measures. Suckall et al. (2014) found long-term adaptation, mitigation and development responses to be inhibited by resource, regulatory, learning and governance barriers in Zanzibar, Tanzania. Chandra et al. (2016) understood the key to facilitating climate resilient agriculture in Timor-Leste (Southeast Asia) was to improve capacity through improved financing, collective projects and building networks across different governance levels. Comparable to the milk cooperative in Kherson, Ukraine (chapter 5) a case study from Uganda found improvements in bonding and bridging social capital and strong leadership allowed stakeholders to improve trust and overcome inequality and corruption (Cooper and Wheeler, 2015).

Similarly, Rahn et al. (2014) argued that non-monetary benefits such as technical assistance and capacity building could be effective in promoting synergies at low costs for coffee farmers in northern Nicaragua and extension visits were found to have a significant and positive impact on the profitability of agroforestry farms in Southwestern Cameroon (Molua, 2005). Collectively these findings indicate that investment in targeted and specific education through extension services and/or cooperative formation can provide the necessary human capital to ensure a true triple-win. A true triple-win provides mitigation, but not at the expense of the most vulnerable members of the population.

Magnifying Equity

Balancing long-term global with short-term local needs brings the issue of equity into focus. Much of the equity debate in climate change has been on the responsibility of developed countries to mitigate. The developing countries are viewed to be more vulnerable to impacts, while not being historically responsible for emissions causing climate change. Fundamentally, countries are not vulnerable, people are vulnerable and essentially people are responsible for mitigating climate change (Tompkins and Adger, 2005). Moreover, vulnerability varies between groups and sectors within countries regardless of level of development (Adger, 2006). This research demonstrated that integrated AMS case studies can expand the equity debate. This is of particular value since little research has examined the politics and institutional aspects of win-win strategies (Mayrhofer and Gupta, 2016). For instance, no matter how small, the benefits arising from a ‘mitigation win’ are

distributed to the entire world population. However, a small 'mitigation win' due to increased carbon sequestration happening in a single field can cause a significant loss in short-term profits and thus increase the vulnerability of an individual farmer. In addition, the policy actions in Ukraine that maintained low food prices during drought years placed a burden on farmers during an already difficult time. More targeted policies that specifically help the poorest to afford food and other necessities instead of assuring low food prices for even the richest of the population would provide a more equitable approach.

While building capacity emerges as one of the most suitable approaches for balancing power dynamics and ensuring an equitable response, addressing these inequities can also involve modifications to suit specific contexts. For instance, when harvest residues needed to feed livestock in mixed crop-livestock farms prevents their use as soil cover, conservation agriculture practices could be adjusted to meet this need (Corbeels et al., 2014). Although not explored in this study of Ukraine's agri-food sector, other case studies have looked at paying farmers for mitigation actions due to a low adoption rate of seemingly highly beneficial land management practices (Bryan et al., 2013; Rahn et al., 2014). Salvini et al. (2016) explored synergies and trade-offs between the mitigation project REDD+ (Reduced Emissions from Deforestation and forest Degradation), with the adaptation project 'Climate Smart Agriculture'. Their research in central Vietnam used a role-playing game with local farmers to generate scenarios as inputs for a model (Salvini et al., 2016). They established that payments were at times set too low and with a payment for ecosystem services all farmers would implement measures (Salvini et al., 2016). These findings relate to a hypothetical scenario, so other issues could arise during implementation. Moreover, in order to successfully implement payments in Ukraine, capacity would first need to be developed to ensure adequate monitoring and transparency.

Policy Implications and Future Research

In addition, to integrated AMS research, Ukraine's case can be compared to climate change research conducted in countries of the former Soviet Union. In particular, these comparisons help to inform future research needs and draw attention to policy implications. As in Ukraine, Fraser and Stringer (2009) and Stringer and Harris (2014) found that uncertainty during times of political and economic transition in Romania increased vulnerability and unsustainable land-use. Câmpeanu and Fazey (2014) found adaptation to be a process dependent on legacies where dominant pathways can reinforce inequalities in rural Transylvania. Moreover, adaptive capacity varies considerably in countries of the former Soviet Union with large farms demonstrating relatively high adaptive capacity compared to small subsistence farms (Sima et al., 2015).

Due to the time constraints of this research, potentially important areas raised by interview participants were not fully explored. These issues still relate to a post-Soviet legacy as they pertain to deteriorating infrastructure and low physical capital. For instance, in Ukraine's south irrigation was consistently mentioned as an issue important for climate change adaptation. Similarly, Sima et

al., (2015) found the rehabilitation or construction of new irrigation systems to be the most commonly raised climate change adaptation measure. As well, markets and storage infrastructure are not in place to deal with many crops being grown in Ukraine's south. One farmer interviewed had photos of tomatoes spoiling due to an absence of processing facilities for his harvest. Meanwhile, farmers in the region have been advised to switch to crops that are now grown in Italy in order to adapt to future climate change. Farmers also mentioned a preference for less efficient Soviet machinery due to the ease of repair and ability to obtain replacement parts. This indicates a need for better services and rural development before farmers can invest in more efficient machinery. A concerted effort needs to be made to involve stakeholders in discussions to target physical capital improvements as these changes will need to made to facilitate adaptation and mitigation.

Countries belonging to the former Soviet Union have historically not engaged stakeholders in decision-making and continue to find it challenging to implement more participatory types of governance, yet improving community participation would provide multiple benefits (Stringer and Paavola, 2013, Stringer et al., 2009). Moreover, Ukraine has been undergoing dramatic change and reforms in the years since this research project commenced. Guba and Lincoln (1989) argue that participant driven evaluation should never end but only pause. This argument is especially true for Ukraine where significant policy reforms are currently happening. These changes will likely have unanticipated consequences. Thus, stakeholder-driven research will be necessary to ensure that capacity is built in an equitable manner.

Conclusions

In the context of Ukraine, the issues that hinder climate-resilience relate to a post-Soviet political economy, but they are not limited to post-Soviet countries. This work demonstrated that synergies can be achieved by addressing issues not directly related to climate, thus building response capacity. Capacity represents potential, and capacity is necessary but not sufficient for climate action (Burch, 2010). Additional research is needed to understand exactly what aspects of capacity need to be targeted and the most efficient means of improving capacity in varying contexts. The case study in Ukraine shared features with case studies from both developed and developing countries. For Ukraine and the cases of developing countries, building capacity was determined to be the most effective means of addressing climate change. However, as has been demonstrated in many developed nations capacity does not always equate to action. Interestingly, the cases from developed countries had limited engagement with stakeholders making a comparison of findings more difficult. Australian farmers had to deal with numerous disparate policies that ultimately resulted in them adopting short-term coping strategies for survival (Beilin et al., 2012). Comparing the Australian case with the case in Ukraine demonstrates the variability of capacity for populations living within a country, but, as importantly, they demonstrate the need for integrated, consistent polices.

However other AMS case studies largely focus on understanding what is not working and did not integrate multiple units of analysis. This case demonstrated that foreign involvement helped to address barriers; negative social capital can be harnessed and changed to a virtuous cycle of increasing social capital with improved livelihood outcomes; and understanding the different perspectives related to the triple-win technique of crop-rotation can reveal underlying problems of the political economy.

In Ukraine, addressing corruption would help to achieve better mitigation projects. Instead of bribe payments determining the speed of approval for mitigation, a project's quality would determine approval. Moreover, tackling corruption would create a system where ecosystem payments to farmers would be a possible option providing them with the capacity to follow best practices. Farmers' security and capacity is also affected by an inability to own land. Lifting the land-sale moratorium could strengthen capacity to help farmers achieve a triple win. Finally, the cooperative demonstrated how overcoming lack of trust to build networks for learning and collaboration helped to address climate change. Cooperative formation is not a popular or easily implemented measure in Ukraine; therefore, on a small scale, the success of this cooperative can be considered to be a transformative act towards both adaptation and mitigation. Considering the collective body of evidence from each chapter of this study, improving capacity could create more transformational change necessary to prevent incremental measures from becoming maladaptive.

Appendices

Appendix 1. Researcher's journal

My personal background and experience influenced data collection and analysis. Specifically, I have a rural background, my family's livelihood was farming and I have Ukrainian ancestry. For the most part, a foreign researcher in Ukraine has an advantage. Ukrainians are very welcoming to foreigners and eager to form partnerships. I met Americans and Canadians in Ukraine who shared similar experiences. Ukrainian generosity and energy can be overwhelming for many to the point that it is even documented in travel guides. For instance, I was touring a soil science facility and some people working there had never met a foreigner. One woman said that she felt like the queen was visiting. In addition, my Ukrainian ancestry was obvious which might have made people even more welcoming. I had one farmer tell me that my name was more Ukrainian than Salo (cured pork fat – the ultimate Ukrainian delicacy).

I was surprised about the level of openness from most interviewees. I had some awareness of the problem of corruption in Ukraine, but had no intention of inquiring about corruption, as I perceived it to be a sensitive area. One memorable example of openness involved a farmer in Ukraine's northern region. I spent hours at his home and he gave me a tour through a wooded area and showed me an area of land that he was farming 'illegally'. He said that he wanted to pay taxes for that land, but could not afford the taxes and did not feel that they were spent responsibly. This was a level of trust that I did not anticipate.

At the same time, I also recall at least one interview where the interviewees did not want to say anything that would give a bad impression of Ukraine. Fortunately, my interpreter relayed this information to me and I also understood Ukrainian well enough to know when people were holding back. Being interviewed by a foreign researcher carried prestige (as relayed to me by a key informant) providing me with the opportunity to speak to a wide variety of farmers. In summary being a foreign research was more an advantage than a hindrance.

I had decided early on to not ask quantitative questions and this might have helped with the openness of farmers. I was not interested in amount of land farmed or money in savings accounts. From my family background, I know that farmers do not like to share this information because it can be rather personal and it can also be tedious. Moreover, I have heard many of complaints from farmers about surveys. They simply do not have the time, but if you find just the right moment you can have a discussion over coffee. I was more interested in how and why type questions, so this research approach worked for both my research questions and for the participants.

I also brought inexpensive gifts from York to give to interviewees for their time. Small gifts carry significance in Ukraine, so this small gesture helped in building networks. The relationships built were particularly valuable and important as I returned to the same interviewees with the Q sort and additional questions.

I have a tendency to support the 'underdog', so I had to be mindful about not choosing sides. I decided early in the research process to explore the potential for all types of farming rather than making judgments about my preferences. I have seen both the small farmer and the potential for large-scale technology romanticized in the literature. I thought looking at both types of production and fostering the best in each could help to avoid this issue.

Because of my background I have always considered what a low price for food means for producers. My Dad would often say, "What does that have to do with the price of wheat?" Interestingly as I was interviewing dairy producers in Ukraine and they were discussing how little they were paid for milk, the media was covering the story of UK dairy farmers and their dealings with the major grocery chains. Farmers consistently mentioned the effect of low prices, so I would think any other researcher would notice it as well. However, one Climate Policy reviewer mentioned that low food prices were not seen as a problem before, so this was a new insight. Therefore I do need to acknowledge that my experience possibly brought this finding to light.

Finally, Foucault argued that a researcher should add clarity to complex problems so stakeholders can then use the information to make the best decision. This approach fits my personal philosophy of trying to understand others instead of judging and to help others to come to the realization of what is best for them instead of giving advice. In presenting conclusions, I try not to promote my values, but rather outline the options available and give voice to the concerns of various stakeholders.

Appendix 2. Research plan and research adjustments

Production in Ukraine is dominated by two very different farm structures: large agri-holdings of hundreds of thousands of acres and smallholder production of only a few acres. Current debates surround the topic of what type of agriculture provides the ideal balance of sustained production (high yields) and environmental sustainability. Is it large intensive agricultural practices? Or is it smallholder production with an increase in public and private support? Should producers follow the tenets of conservation agriculture or organic practices? Rather than entering this debate, I wanted to understand how opportunities could be seized with each type of production.

The SLF has traditionally been used at the household level, but it can also be applied to large businesses. My original research plan was to apply the SLF to a large agri-business, a smallholder cooperative and an organic business by asking each a comparable set of questions. I decided I would find a 'successful' case study for a large business, smallholder cooperative and an organic farming business. I reasoned that if synergies truly exist than successful cases should be implementing measures to seize benefits independent of climate change (ie: improved yields or money saved through more efficient use of inputs). In addition, I would interview national and regional stakeholders with a complementary set of questions.

I also wanted to cover each agro-ecological zone in Ukraine to get an idea of regional issues. Establishing case studies happened relatively early in the research process. I was able to speak to the CEO of one of the first organic production companies in Ukraine. They were located in the north east of Ukraine the forested Polissya region. I also made contact with one of the longest running and largest agriholdings in Ukraine with land in several oblasts in Ukraine's west including the Western forest zone and forest steppe zones. Finally Heifer International in Ukraine assisted in contacting milk service cooperatives in Ukraine's southern steppe region. Thus, I had case studies for very different types of agricultural enterprises and covering all of the agro-ecological zones in Ukraine as shown in figure A_1.

I met with the organic producer and he was very enthusiastic about helping with my research. He was particularly proud that they were able to achieve what they had without paying bribes. The next visit to Ukraine he informed me that he had lost controlling shares of his business. I tried to discuss past practices to keep communications open with people within the company. However, the case study I planned had been lost. I was able to interview staff within the large agriholding, but interviews were limited to their rather small environment department. I interviewed other large agriholdings and from these interviews I was able to capture the perspective of big business in Ukraine, but I did not have enough to base a case study on a single enterprise. The dairy cooperative in Kherson did prove to be a strong case study.

Figure A_1. Study locations in Ukraine.

I had a key member of the community assist with locating interviewees in southern Ukraine (Kherson). I had expressed a particular interest in speaking to successful smallholder cooperatives and regional stakeholders. However, my key informant felt that I should also speak to a wide variety of farmers. This proved to be very helpful in getting additional perspectives needed for the large scale national issues (chapter 4) and the variety of perspectives related to crop rotation (chapter 6). I was also able to supplement interviews with field observations.

Corruption was mentioned very often and became an apparent theme in the memo writing after each interview. However all of the national issues only became clear during the process of open coding and sorting of codes into categories.

I was invited to the cooperative celebration on the penultimate day of my first trip to southern Ukraine. This celebration was a great opportunity. The speeches were particularly valuable since the participants were not influenced by my presence or limited to answering my questions. I was also able to speak to cooperative members after the celebration. However, I needed another day to complete more interviews and I could not change my travel plans. Returning the following year to conduct interviews delayed completion of that case study, but being able to follow-up with changes a year later provided additional findings. The social capital theme first became apparent on the train ride back to Kyiv from Kherson. As I was reviewing notes and reading papers, I noticed that an interviewee in Kyiv had said that Ukraine has a shortage of social capital. All of the presenters at the cooperative celebration spoke a great deal about working together and trust. They also mentioned that it was difficult to get Ukrainians to work together.

I had a coding category develop with statements related to crop rotation. However, the idea for the article first came from a 'discussion' with my translator. We had returned from interviewing farmers in Kherson to interview more stakeholders in Kyiv. As we left the offices of one interviewee, my translator expressed frustration exclaiming, "Do these people never speak to each other?" I said to her that I thought I could write an entire article about crop rotation and she agreed. While I could see possible linkages, I did not have enough data. I had used a paper sort with interviewees during the first set of interviews. Despite the challenge of sorting values and making tough decisions, the vast majority of respondents enjoyed taking part. I realized that the topic of crop rotation was ideal for a study using Q method. It was contentious and I had collected a wide variety of views on the topic.

The original research plan had many modifications, but interviews in each of the three eco-regions and in Kyiv did contribute to the research findings. Table A_1 details how interviews were used as a source of data in this research

Table A_1. Summary of interviews for thesis. N indicates number of interviews. (Q) indicates interviewees also took part in the crop rotation Q sort. Interviews in the last two regions were used as a source for Q statements.

Location	N (Q)	Interviewee's Affiliation	Data
Kyiv (Capital)	5 (1)	Agricultural business (2 agri-holdings)	Chapters 4,5,6
	6 (1)	Agricultural non-governmental organisation	
	2	Environmental non-governmental organisation	
	1	Non-profit rural development group	
	3 (1)	International development agency	
	2	Other international agricultural agency	
	3 (2)	Researchers	
	1 (1)	Policy-maker	
Khersons'ka (Steppe)	5	Private farmers (mid-sized farms)	Chapters 4,5,6
	10 (1)	Small-holder farmers (5 in 2012, 10 in 2013 follow-up)	
	3	Farming association leaders (also farmers)	
	2 (1)	Agricultural support groups	
	1	Head of a state farm	
	2	Researchers	
	5	Regional or village administrators	
Ternopil/Lviv (Forest - Steppe)	2	Private farmers (mid-sized farms)	Q statement source Chapter 6
	1	Small-holder farmers	
	1	Regional or village administrators	
Chernihiv (Polissya)	2	Farmers	Q statement source Chapter 6
	2	Researchers	

Appendix 3. Yanukovych's policies and climate-resilience

The manuscript for chapter 4 originally had a theme titled 'Political indirection and inaction: Surviving an uncertain environment'. As this theme pertained largely to the policies of the now dissolved Yanukovych government, the section was removed from the manuscript prior to submission to *Climate Policy*. The section has been appended as it pertains to the history of change in agricultural policy and influenced climate change mitigation outcomes.

As a result of instability and uncertainty, producers find it difficult to plan for the future. A respondent working in rural development noted:

> *"They don't know what will happen in a year or two because it could be taken away from highest level." (Interviewee 12)*

The lack of clear direction in agricultural policy is evident by the continual debate of topics that were discussed in the 1990s; such as, allowing foreign investments and promoting public or private agricultural development (Williams, 2011). Even with pursuing private sector development, Ukraine has two very different paths in agriculture development. While both paths could be pursued, they are seen as competing with large agri-holdings dominating and winning the competition against smallholders. For example:

> *"In Ukraine nobody knows what the best way is for us. We have this big scale agriculture. People keep 100,000 ha and they manage and grow crops in big coordinates. Or small-scale and we support villages and the development of villages and rural territories. Or if we should do something in between, we should have both. Maybe we should have both, but our government now supports big businesses more. One year ago the biggest was 300,000ha and now the biggest is more than 500,000 ha." (Interviewee 8)*

Some respondents expressed the view that the government had not decided who to support and any support provided could not be counted on in the future. However, more common was the expression that smallholders and 'the village' received vocal support, especially during election season, but it was not backed by financing. Interviewees placed a high level of importance on the village and spoke of it as a concept not just a place. Particularly at the cooperative celebration, villagers/smallholders spoke of how important their work was to Ukraine as an independent country. Interviewees living in Kyiv also spoke about their connection to the village. A researcher from Kyiv commented:

> *"Politicians say the village needs to be resurrected but they should not have destroyed it in the first place." (Interviewee 15)*

Leaders in agriculture support and farming associations commonly stated that small farmers have the biggest problems and need more support. Interviewees often mentioned that support or rural

development programmes exist but only on paper, extension services for instance does not have the resources to implement training programs.

At the same time, fulfilling the expectations of villagers could be taking a step backwards instead of moving forward. One foreign investor said villagers expected rebuilding of kolkhoz (collective farms), whereas large agri-holdings typically only want the land not the buildings or cattle. Historically, collective and state farms provided for all services in rural areas including infrastructure, social and cultural activities, and this role remains virtually unfulfilled in most rural areas (East Agri, 2005). At times, villagers express a wish to return to this type of security and level of support.

Moreover, the change that elections bring seems to cause confusion instead of clarity. For instance, environmental non-profit respondents working in mitigation had difficulties negotiating with government after political reforms were in place. Prior to reforms they knew who to speak to within government. In general, political will is low in Ukraine, but Ukraine's government has even less political will for addressing climate change. According to some, Ukraine must address more pressing problems as noted:

> *"They (policy-makers) say we paid for AAUs with our social problems." (Interviewee 21)*

> *"Climate change is not a problem in Ukraine. They (other countries) have cockroaches we have elephants." (Interviewee 2)*

Interviewees expressed dissatisfaction that climate change mitigation has a focus on making money often without reinvestment in further improvements. AAUs provide an easy means to make money so any further actions are deemed unnecessary especially in the face of more pressing issues in the short term.

To the frustration of respondents from the environmental community, policy makers do not have the long-term vision needed to build a sustainable economy. Meanwhile agriculture support and rural development workers say that policy makers have no long term plan for capacity building. The uncertainty and short-term vision causes people to live in survival mode thereby holding back progress for the people and the country.

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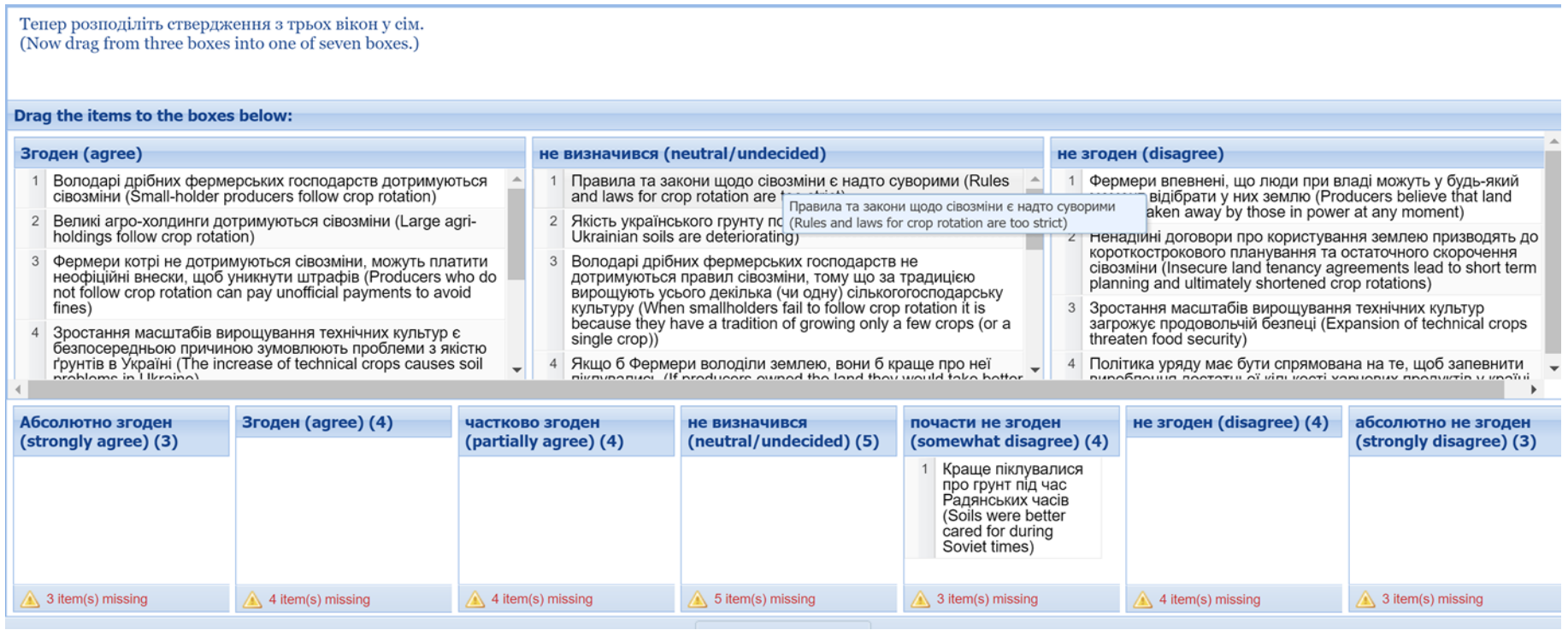
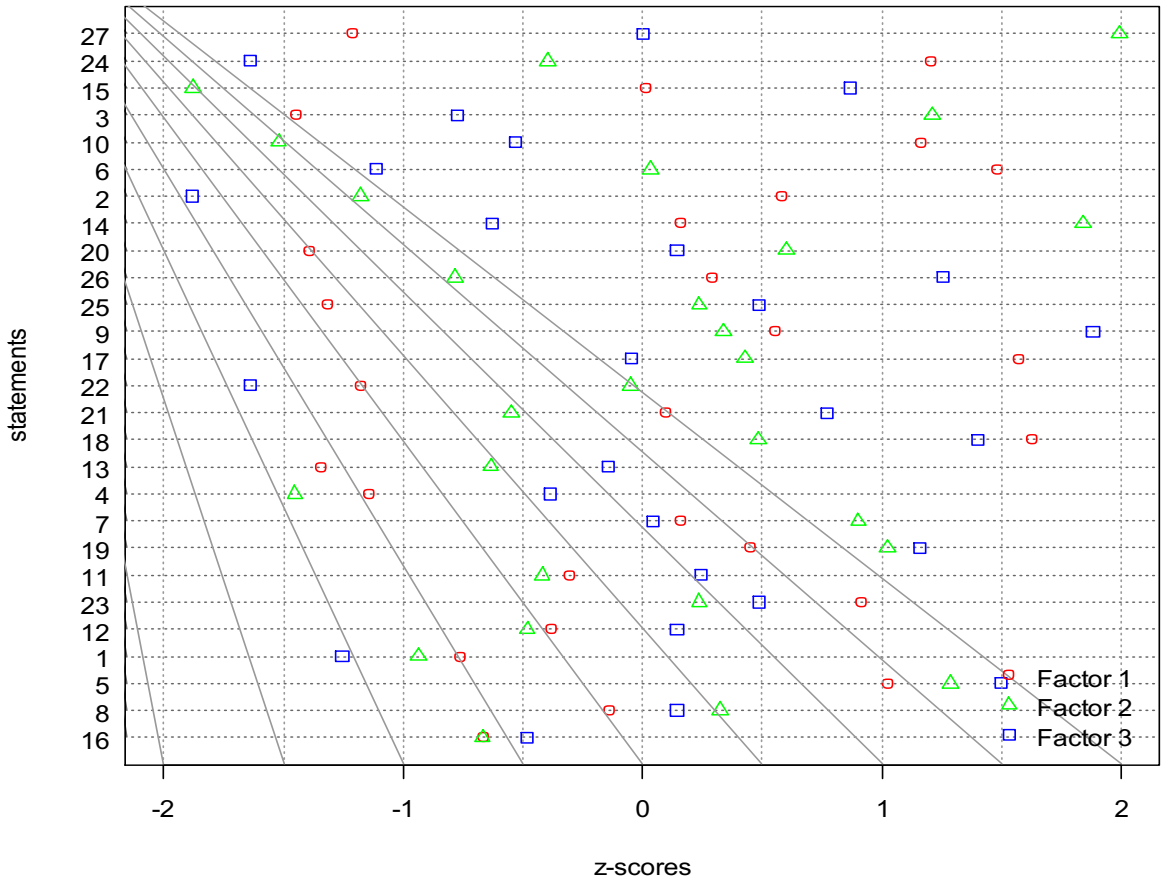
Appendix 4. Screenshot of Q sort procedure



Appendix 5. Statement and Z-score for each factor.



Statements are ranked according to the absolute difference calculated. The greater the difference, the higher the statement appears in the graph and the greater distance between symbols. To illustrate, statement n27 (Ukrainian soils are a matter of national security), was the most distinguishing statement, while statement n16 (Export quotas discourage producers from growing some crops), had similar scores across the three factors.

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