Interactions between social capital, natural capital, and resource use in the central lowveld of Mpumalanga Province, South Africa

By

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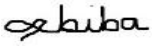
JOHANNESBURG

Academic Supervisor

Professor Wayne Twine

DECLARATION

This thesis is my original research work undertaken towards the Degree of Doctor of Philosophy in Environmental Science, and to the best of my knowledge, contains no material previously published by another person, except where specifically acknowledged within the body of the text. The work has not been submitted for examination elsewhere. For the purposes of consistency, all references cited are formatted to align with the style used for the journal Ecology and Society.

Signed: 

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ABSTRACT

Rural livelihoods have been described through livelihood strategies and capitals that contribute, singly or jointly to derive outcomes for human well-being and environmental change. However, the ways in which these capitals, particularly social capital, translate to better household welfare or improved natural resource management, although a subject of widespread discussion, remain poorly understood. This study addresses the above research gap by exploring the relationships between the availability of natural resources in communal woodlands (natural capital), natural resource use patterns at the household level pre- and post-experience of shocks, and how these relate to the level of social capital, at both the community and household levels, in a rural region of South Africa. Natural resource use and household characterization data were obtained from an existing longitudinal dataset collected for 590 households in nine villages of Bushbuckridge Local Municipality in South Africa, from 2010 to 2014. Natural resource availability was estimated from remote-sensed data using the Enhanced Vegetation Index (EVI) as a proxy. Social capital data were collected from the household survey, nine focus group discussions, and seven key informant interviews in the study villages.

First, empirical models were constructed for the effect of social capital on other household capitals and natural resource use at household level. Second, the study examined the role of natural resources and social capital as safety nets against vulnerability emanating from negative shocks in rural households. Third, in order to improve understanding of social capital as an outcome of natural resource availability, variation of social capital dimensions of reciprocity and membership in societal groups was investigated across a natural resource availability gradient. Lastly, community social capital indices were developed to test the hypothesis that villages with more communal social capital have lower levels of environmental degradation, and thus better natural resource availability. Social capital had differential impacts on the three dimensions of natural resource use. Social capital had a positive association with number of natural resources used, and the intensity of natural resource use per household, but had no relationship with the quantity of natural resources used. As such, social capital does not substitute for natural capital, but rather complements its role in household livelihoods. Household experience of negative shocks was consistently associated with a significant increase in all dimensions of natural resource use.

However, social capital did not significantly reduce natural resource use when households experienced shocks. It is evident that negative shocks are associated with an increase in natural resource use, and that the role of social capital is not sufficient to cushion households when they experience negative shocks. Both reciprocity-receive and reciprocity-give were higher in villages with medium EVI compared to those in high EVI. Group memberships decreased from high to low EVI clusters. The study discovered the importance of disaggregating the components of what is collectively referred to social capital in empirical studies because as described, the performance of different variables of what constitute social capital can vary in response to natural resource availability. Generally, villages with lower aggregate social capital index had low resource availability, whereas trust and satisfaction with local governance did not vary across villages or EVI zones. There was no significant relationship between all dimensions of social capital and natural resource availability, after controlling for natural resource use. There was widespread non-compliance and rule breaking in rural communities due to lack of alternatives, regardless of the level of social capital. Fundamentally, this study fails to substantiate the claim, through empirical evidence, that social capital improves natural resource availability, through improvement of natural resource governance. The findings of this study necessitate critical inquiry into the place of social capital in both natural resource management and household well-being, particularly when they experience shocks. In addition, there is need to investigate further why social capital fails to match its posited role as a safety net when households face negative shocks.

Key words: Sustainable livelihoods, social capital, natural capital, livelihood shocks, Enhanced Vegetation Index, natural resource use.

DEDICATION

To my late father and mother, B. Mbiba Dhlamini and Marian Dhlamini, for all the cotton-ny hard work.

Belizoz'qhenya ngam'

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DISCLAIMER

This thesis is organized such that the data chapters are written in journal article format. As such, repetition of information in some sections is inevitable.

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CHAPTER 1

General introduction

1.1 RATIONALE OF THE STUDY

The former homeland areas of South Africa are complex socio-ecological systems, characterized by high population densities, low land holding and agricultural output, heavy reliance on government and social welfare grants, high usage of natural resources from local woodlands, and diminishing role of traditional institutional control (Adams et al. 1999, Twine et al. 2003a, Shackleton and Shackleton 2004, Shackleton 2004, Kaschula et al. 2005, Lahiff and Cousins 2005, Durieux 2012, Thondhlana and Muchapondwa 2013). In these areas, there are positive and negative feedback loops between rural communities and communal rangelands, as the rural populace employs diverse livelihood strategies from land-based strategies like agriculture, harvesting of natural resources such as fuel fuelwood and wild fruits from communal woodlands (Shackleton et al. 2001, Dovie et al. 2002, Twine et al. 2003a, Dovie et al. 2004, Twine 2013), to migration to seek employment (Hunter et al. 2014). Analysis of rural livelihoods has increasingly been conceptualised using access to livelihood capitals, the complementarities between them, and the strategies that shape them (Bebbington 1999, Ellis 2000a, Carney 2003, Babulo et al. 2008). These livelihood capitals include financial capital (savings, access to credit, etc.), social capital (kinship connections, norms, leadership, etc.), physical capital (durable and productive like cars, houses etc.), human capital (education, health, skills, etc.), and natural capital (soil, water, biodiversity etc.).

Extensive research has established that a healthy ecosystem (natural capital) supports sustainable, resilient, and diversified rural livelihoods (Cavendish 2000, Shackleton et al. 2001, Shackleton and Shackleton 2004, Millennium Ecosystem Assessment 2005, Aggarwal 2006, Tengberg et al. 2012, Twine 2013, Bennett et al. 2015). Numerous studies have been conducted on natural resource use by rural households in various parts of southern Africa, including South Africa (Dovie et al. 2002, Twine et al. 2003a, Shackleton and Shackleton 2004, Mugido and Shackleton 2017,

2018), Zimbabwe (Mcgregor 1995, Campbell et al. 1997a, Cavendish 2000), Malawi (Fisher and Shively 2003, Fisher 2004, Chilongo 2014) and Mozambique (Hegde and Bull 2008). For example, Shackleton and Shackleton (2006) and Paumgarten and Shackleton (2009) looked at relationships between physical/financial capital and use of natural capital by investigating how wealth differentiation influenced household use of natural resources. Other studies have focused on social capital and accumulation of human capital, social capital and household welfare, and other such singular or multidimensional impact on human livelihoods and the environment (Coleman 1988, Grootaert 1999, Maluccio et al. 2000, Pretty 2003a, Bouma et al. 2008, Reynolds et al. 2010). However, these studies have masked the importance of interactions and complementarities between livelihood capitals in meeting livelihood needs, as most studies have investigated only one or two capitals concurrently. At the community level, several studies have focused on natural resource management and communal social capital (Pretty and Ward 2001, Pretty 2003a, Claridge 2004), but there is lack of observations on environmental empirical measurements that are a result from improved management (Murali 2006). One such study, for instance in the context of wildlife resources, looked at how social capital and cooperation among other factors, translates to better biodiversity outcomes (Ntuli and Muchapondwa 2018). Fewer studies have investigated the interlinkages between social capital, household shocks and natural resource (see McSweeney 2005, 2004), how social capital interacts with or influences other livelihood capitals at the household level, how it is operationalized as a livelihood asset, and how it can be both an outcome and a cause of better resource availability (see Barnes-Mauthe *et al.* 2015).

Analysis of social capital dimensions in rural household livelihoods is essential for understanding livelihoods, particularly in the former homelands of South Africa where people value the philosophy of *ubuntu* (Maluccio et al. 2000). Ubuntu is an idea that is embodied in a communal way of life which considers that society must be managed for the sake of all through cooperation, sharing, and charity (Forster 2007). The South African homeland areas present a significantly different context from previous studies on social capital, natural resource use and natural resource availability (see McSweeney 2005 and Berhanu 2011). Investigations into the extent to which household social capital improves household welfare can significantly aid in the understanding of household natural resource use patterns. In addition, new knowledge can be generated on how household social capital influences natural resource use when households experience negative

shocks, while at the same time critiquing the role of social capital as a safety net. Lastly, the feedback between social capital and natural resource availability, whereby social capital can influence resource availability on one hand, and be an outcome of good natural resource management on the other, is a dual linkage that requires further consideration. This study addresses the above research gaps by exploring the relationships between the availability of natural resources in communal woodlands (natural capital), natural resource use patterns at the household level pre- and post-experience of shocks, and how these relate to the level of social capital, at both the community and household levels, in a rural region of South Africa. It presents a unique and novel attempt to gain new insights on the multifarious linkages between social capital, natural capital, and the use of natural resources by rural households, by employing both quantitative and qualitative methodologies.

1.2 LITERATURE REVIEW

1.2.1 Sustainable rural livelihoods

The concept of sustainable livelihoods is central to rural development, poverty reduction and environmental management. Livelihoods consist of capabilities and assets, both material and social resources and activities required for a means of living (DFID 1999). Livelihoods are sustainable when they are resilient in the face of external shocks and stresses, maintain the long-term productivity of natural resources, and do not undermine the livelihoods or livelihood options open to others (DFID 1999). The ability to pursue different livelihood strategies is dependent upon the basic material and social, tangible and intangible assets that people possess (Scoones 1998). A livelihood can be defined as the capabilities, material and social assets and strategies that enable a means of living. A livelihood can be considered sustainable when it can cope with and recover from shocks and stresses, maintain or enhance its capabilities and assets, while not undermining the natural resource base (Chambers and Conway 1991, Scoones 1998, DFID 1999).

1.2.2 The sustainable livelihoods framework

The sustainable livelihoods framework is a way of conceptualizing the complexity of people's livelihoods by presenting the various dimensions of a household livelihood, the strategies and objectives pursued, and the associated opportunities and constraints (Carney et al. 1998, Scoones 1998, DFID 1999, Farrington et al. 1999, Carney 2003, Babulo et al. 2008, Morse et al. 2009) (Figure 1). First, the framework outlines livelihood assets and strategies, which are household options available and implemented for pursuing livelihood goals. Livelihood assets include natural, physical, human, social and financial capitals (Scoones 1998, DFID 1999). *Natural capital* refers to naturally obtained or occurring resources such as land, water, biodiversity, and natural beauty and other environmental resources (Ekins et al. 2003a, Emery and Flora 2006, Bhandari 2013). *Physical capital* comprises infrastructure, for instance a house, and durable assets like a car, cart, implements or household appliances that contribute to livelihoods (Flora *et al*., 2004). *Human capital* is understood to include the skills and abilities of people to develop and enhance their resources and to access outside resources and bodies of knowledge, together with resources such as resource health ability to labour (Coleman 1988, DFID 1999). *Financial capital* refers to the financial resources available to invest in household in the form of formal or informal income, regular remittances or pensions, credit or savings that underwrite the development of businesses or enable households to acquire inputs or to accumulate wealth (Bhandari 2013). *Social capital* refers to relationships of trust, membership of groups, networks, and access to wider institutions. Livelihood strategies are activities pursued by a household to meet its living needs, which might include for instance, intensification of agriculture or migration (Ellis 2000a). The greater the diversity of livelihood strategies, the higher the household's resilience to the shocks, trends, and seasonality conditions within the vulnerability context.

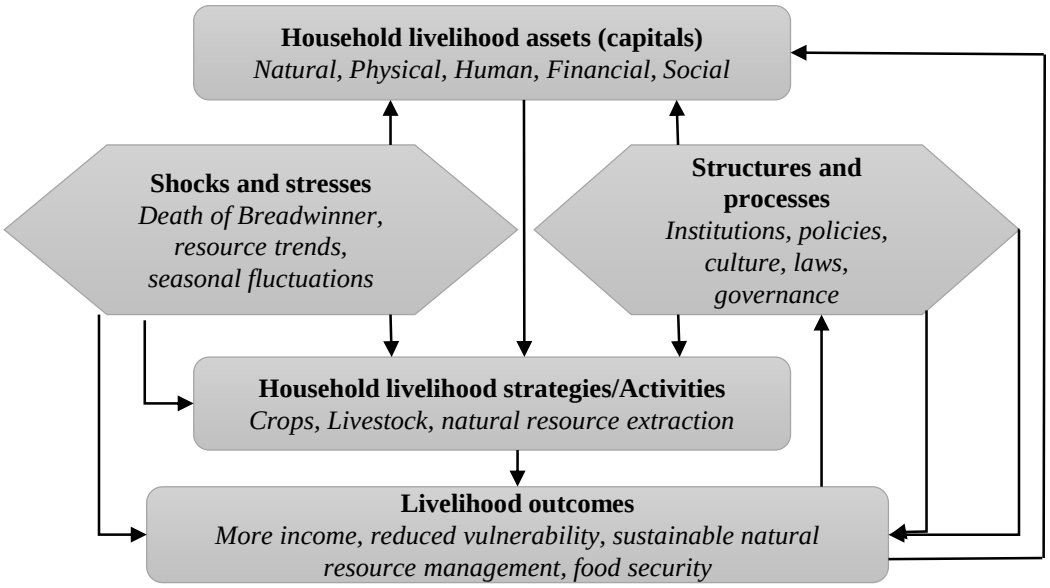

Figure 1. The sustainable livelihoods framework adapted from Carney et al. (1998) and Babulo et al. (2008).

Second, it describes livelihood outcomes (Scoones 1998, Allison and Ellis 2001). Livelihood outcomes refer to the outputs of livelihood strategies. Achievements may include higher income, greater well-being (e.g. self-esteem, physical security, political empowerment), reduced vulnerability, greater food security, and/or improved environmental sustainability. Isolating the influence of one aspect in the framework on rural livelihoods can be difficult since the framework shows multi-causal linkages. However, the influence of certain assets, for instance natural capital, human, and physical capital, on livelihood outcomes has received much attention in both research and practice. On the other hand, assets like social capital have been less acknowledged in empirical studies until recently, which might significantly downplay their contribution to livelihoods outcomes, particularly environmental sustainability and household food security.

Third, it defines a vulnerability context, whereby rural households often experience both stresses and shocks that affect their livelihood assets and options, over which they have very little control (Scoones 1998, Ellis 2000a). Shocks (drought, income, deaths), trends (resources, technology) and seasonality (price fluctuations, employment opportunities, environmental degradation) interplay, exposing households to several challenges that leave them vulnerable to food insecurity (Ellis 2000a, Dercon 2002, Kgathi et al. 2007). Vulnerability describes the external uncontrollable

factors that influence people's assets and livelihood opportunities disabling them from meeting desirable livelihood outcomes. Vulnerability varies among individuals and households, according to their capacity to prevent, mitigate or cope with such events (Kessy and Tarmo 2011).

Lastly, the framework outlines structures and processes that create and enforce legislation, provide the necessary requirements for acquiring and capitalizing upon assets (e.g. private suppliers of building materials), manage natural resources, and provide other services crucial for gaining access to assets, exchanging them, and benefiting from their use. Meanwhile, "processes" determine the interactions between the structures and individuals. Examples of processes include policies, legislation, power relations, norms, market stability, and general rule of law.

1.2.3 Social capital

1.2.3.1 The social capital concept

Social capital has received much attention in many fields of study, but its contribution to rural household livelihood and interactions with other household livelihood capitals remain poorly understood. Social capital is defined as the totality of social organization and networks built on common norms and trust that can improve the efficiency of society by facilitating coordinated actions (Bourdieu 1986, Putnam 1993, Portes 1998, Dasgupta and Serageldin 1999). It has been defined differently by various authors but it converges on central themes. Social capital has been defined as tangible or intangible the resources that accrue an individual or group (for example a household) from social networks (Bourdieu and Wacquant 1992). Other authors have attempted to define social capital as brokerage opportunities in a network to use your financial and human capital (Burt 1992), or the sum of the actual and potential resources embedded within a network of relationships possessed by an individual or social unit (Nahapiet and Ghoshal 1998). The general understanding is that social capital exists in the structure of relationships and it is these which are the actual source of advantage (Portes 1998). As such a person's family, friends, and associates constitute an important asset; one that can be called on in a crisis, enjoyed for its own sake or leveraged for material gain (Woolcock and Narayan 2000).

Social capital can be subdivided into internal or bonding social capital and external or bridging social capital. Bonding social capital refers to internal relations within collectives, for instance within a village (Putnam 1993, Portes 2000a, Putnam 2001). On the other hand, bridging social capital is usually at individual and household level, and their external relations (Compton and Beeton 2012). Other authors have divided social capital into cognitive form, comprising of norms and trust, and structural form, comprising of groups and network connections (Uphoff 2000, Adhikari and Goldey 2010) (See Figure 2). Another interesting disaggregation of social capital refers to tiers of social capital as micro (individual and household), meso (local community) and macro (wider community like a country or region) as illustrated in Figure 3.

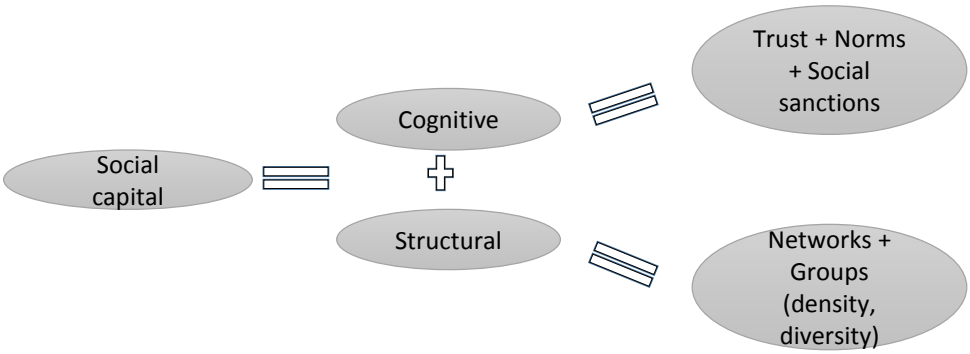

Figure 2. Operationalization of social capital. Adapted from Uphoff (2000) and Adhikari & Goldley (2009)

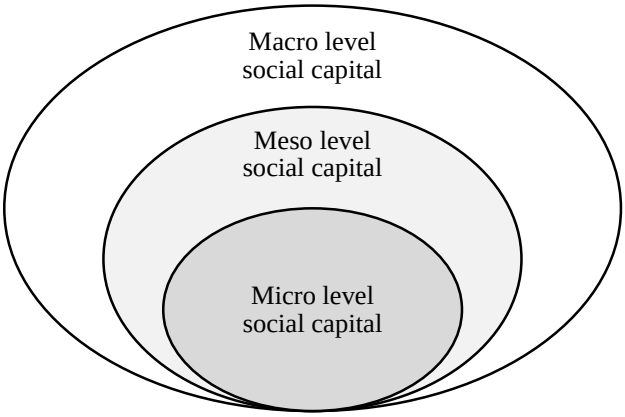

Figure 3. Multilevel conceptualization of social capital (Grootaert, 1999)

Fundamentally then, social capital is a multidimensional concept consisting of non-material values such as belonging to social networks, social connections and social norms which influence individual behaviour, and interaction among people that make it possible to form a community (Petrosillo et al. 2013), and thus comprises both the network and the assets that may be mobilized through that network. Several studies on social capital have focused on how it impacts natural resource management, governance and collective action at the communal level (Pretty and Ward 2001, Pretty 2003a, Pretty and Smith 2004, Murali 2006, Mwakubo et al. 2006, Ballet et al. 2007). On the other hand, literature that relates to how social capital influences natural resource use at household level is limited.

1.2.3.2 Social capital and other livelihood capitals

The idea that there might be complementarities between various forms of capital (natural, social, human, financial, and physical) has been increasingly accepted in the literature. The capitals are interconnected in complex ways, and likely to be complementary, rather than substitutive. Consequently, an over-use of other forms of capital can erode or destroy human and social capital (Onyx 2004). Thus, for instance, general natural capital degradation or individual investment in natural capital access can create conflicts in communities, which can erode social capital. Nevertheless, the pathways of causality amongst these capitals are explained in diverse ways. It is important to pay much more attention to social capital, in that social capital can enhance returns to investment in other forms of capital (Coleman 1988, Putnam 1993). In their study on how social capital influences other livelihood capitals, Abenakyo et al. (2007) found a significant positive linkages between social capital and natural capital conservation, social capital and physical capital and social capital and human capital, and very little association between social capital and financial capital. In another study Krishna (2001), argues that communities that have high levels of social capital produce superior outcomes in joint actions. Emery and Flora (2006) also acknowledge that social capital is an important characteristic of a community that can influence the flow and stock of other capitals.

1.2.3.3 Measuring social capital

Despite the proliferation of studies on social capital, pushed primarily by the World Bank in its developmental projects, and a lot of sociological literature, methodology for quantifying or qualifying social capital remains mired in contestations. Some argue that social capital is so broad that it can be everywhere or nowhere (Woolcock 1998, Durlauf 2002, Durlauf and Fafchamps 2004), making it problematic to measure its existence and/or its influence. Social capital has been understood and measured differently by researchers in different contexts and for different purposes (Adhikari and Goldey 2010). These differences are also explained by the uniqueness of local cultural contexts as social capital can only be understood contextually (Foley and Edwards 1999, Krishna and Uphoff 1999, Reid and Salmen 2000). The existing frameworks and arguments for measuring social capital are at community or group level and with emphasis mainly on measures of social cohesion, trust, reciprocity and other such attributes (Krishna 2004, Ballet et al. 2007, Teilmann 2012) (Figure 4), with less emphasis on household or individual level measures.

The idea of a kind of capital (in this case social), connotes some form of gain from the capital that can be used in tangible ways (Lin 2001). Social capital aspects of cohesion, empowerment, and trust may not be directly observable. What one can observe and measure are some indicators or behavioural consequences of social capital, including both organizational and perceptive elements (Uphoff 2000). Conversely, social capital characteristics of social networks and group memberships at individual or household level can be observed and are a significant determinant of household welfare (Grootaert 1999, Narayan and Pritchett 1999). Thus, studies have used, for instance, community group aspects of group density, group performance and participation as a proxy for social capital (Grootaert 1999, Maluccio et al. 2000, Grootaert and Narayan 2004).

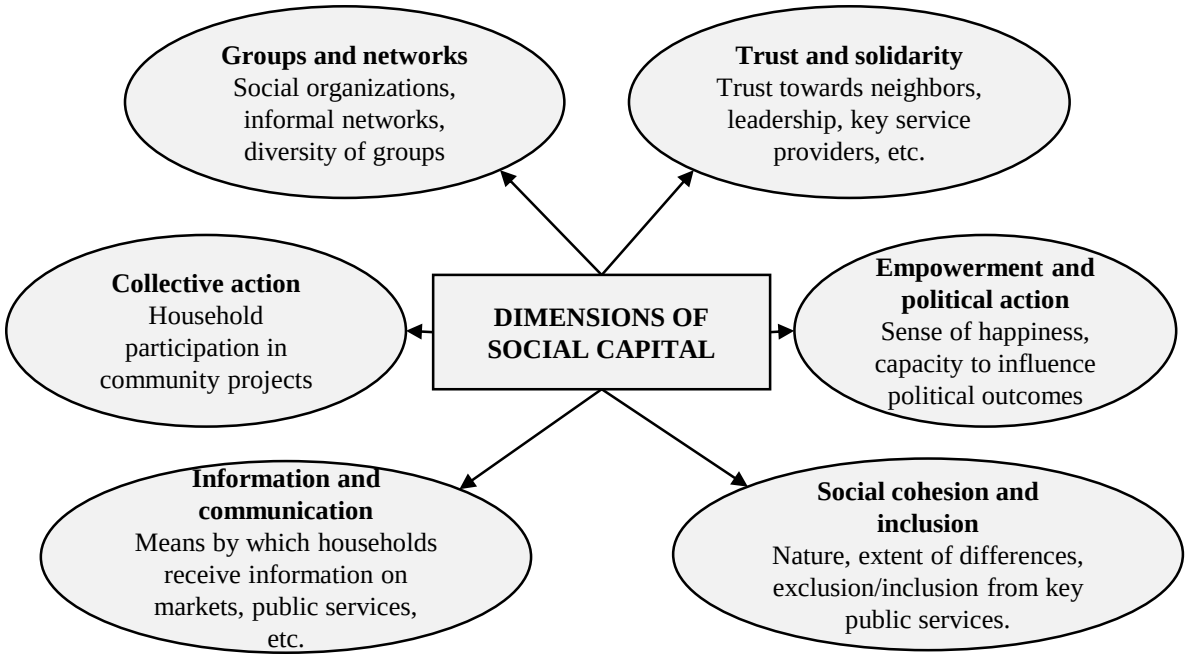

Figure 4.The dimensions of social capital that could be used as measures of social capital at the micro and meso levels (Grootaert and Narayan 2004).

In the several contexts, social capital proxies might include factors such as trust, community perceptions of leadership effectiveness, conflict levels in a community, and the extent and strength of links to key government (Misselhorn, 2009). Misselhorn (2009) also argues that social capital resources are better understood through the way people use their attributes to their advantage in the context of a household or a community. As such, it is more crucial to develop a contextually appropriate index of social in order to examine the contextual value of social capital and to investigate its build-up using adequate knowledge of the specific societal context (Krishna 2004). To illustrate, there are factors that might determine group membership locally, for example, the length of time a household has been in the area, a variable which would be expected to be positively correlated with group membership, if it takes time for people to join groups in a new area (Haddad and Maluccio 2003)

1.2.3.4 Social capital and household welfare

Several studies have attempted to examine the causal relationships between household social capital and household welfare (Grootaert 1999, Narayan and Pritchett 1999). In a study in South Africa, Maluccio et al. (2000) found that social capital, measured using membership in formal and informal groups as proxy, had a positive and significant correlation with per capita expenditure. They argued that this is expected because the concept of social capital has some resonance with the South African concept of *Ubuntu*, which defines the interdependence of members of the society. In most cases, a measure of actual household income is difficult to ascertain due to several factors ranging from reluctance of households to disclose income or income that is difficult to express in monetary terms. However, expenditure measures are much more reliable and are easier to collect than income, particularly in most rural settings (Filmer and Pritchett 2001). Although methodology of measuring socio-economic status of households varies, Principal Component Analysis (PCA) has been validated as a method to collapse socio-economic variables that describe socio-economic status differentiation within a population (Partridge 1998, Kabudula et al. 2017).

1.2.3.5 Household versus communal social capital

As highlighted earlier, dual lines of discourse exist as pertains to social capital and natural resources. At household level, social capital is an asset for livelihoods, whereas at community level, social capital focuses more on governance, management and collective action. For instance, at household level, social capital can impact natural resource use indirectly by diversifying household sources of income or acting as insurance in times of distress (Cassidy and Barnes 2012). The communal level approach dwells more on how communal social capital impacts natural resources management and /or governance (Pretty and Ward 2001, Pretty 2003a). Focus is put on how social capital enhances collective action, institutional coherence and co-management which has beneficial effects on management of natural resources (Murali 2006). However, this view, although widely accepted, has been challenged by some authors who recognize the downside of social capital (Portes and Landolt 2002, Adhikari and Goldey 2010). For instance, the same social capital that can enhance cohesion can create tight-knit groups that can exclude those poorer or less

powerful. As such Field (2003) suggests that social capital should be seen as both an asset in its own right that is unequally distributed and as a mechanism that can promote further inequality. Although there is more that can be done to further understand communal social capital and natural resource management, a broader research gap exists on household social capital and natural resource use at household level.

1.2.5 Natural capital

1.2.5.1 Availability of natural resources in communal woodlands

Communal woodlands are a key source of rural livelihoods. Rural households depend on natural resources for fuelwood, construction materials, edible fruits and herbs, pastures, medicine and other such resources (Campbell et al. 1997, Dovie et al. 2002, Twine et al. 2003a, Fisher 2004, Shackleton and Shackleton 2004, Shackleton et al. 2007). Regrettably, degradation of communal rangelands has resulted in decrease of these vital natural resources (Shackleton et al. 1994, Higgins et al. 1999, Twine 2005, Wessels et al. 2011, 2013). The direct causes of woodland degradation include unsustainable harvesting for fuelwood and poles (Wessels et al. 2013) and land use transformation for settlement (Giannecchini et al. 2007). However, some studies comparing communal woodlands species diversity, richness and cover with adjacent protected areas have found no differences in plant species richness between an intensely used communal land and adjacent commercial land (Prendini et al. 1996, Vermeulen 1996, Joubert and Ryan 1999). Shackleton (2000) found similar results, with increased woody biomass in communal rangelands, and posited that the high species richness in the communal areas could be a result of increased levels of disturbance by humans and livestock which provides niches for establishment of weedy species and increases patchiness in the environment, thus providing opportunities for different species. In comparing a communal area with an adjacent protected area in arid woodlands in Botswana, Dahlberg (2000) found no difference in herbaceous species richness between the two land uses.

While several of these earlier studies reported no significant difference in species richness between communal and protected areas, recent studies have shown a significant decline in woody cover

and density in communal areas (see for instance Wessels *et al.* 2013; Awasthi *et al.* 2003). Higher usage of natural resources around communities can create significant disturbance gradients around communal settlements (Shackleton et al. 1994), resulting in more effort and time needed in collection of daily required natural resources. In a study of local perceptions of environmental change and governance in Bushbuckridge, South Africa , Kirkland et al. (2007) found approximately 90% of respondents perceived that there was resource scarcity, 48% reported having to travel long distances in search of firewood, while 37% had to purchase wood regularly.

1.2.5.2 Social capital and resource availability in communal woodlands

Communal social capital literature emphasizes the benefits of collective action for natural resources management (Mwakubo et al. 2006, Ballet et al. 2007), and thus availability. Proponents of this notion argue that social capital encourages collective action in resource conservation (Pretty and Ward 2001, Pretty 2003a, Pretty and Smith 2004, Sigmund et al. 2010, Gutiérrez et al. 2011) which can significantly alter the dynamics of resource degradation. Ostrom (2015) showed that several examples exist of forests, grazing lands, and fishing areas that have been maintained in a sustainable manner for centuries by the local village, even under conditions of high population density. It is then clear that apart from population pressure, over-use of the common resources is most likely to occur under quite specific circumstances (Onyx, 2004). Consequently, the sustainability of resources in communal woodlands depends on high levels of both household and communal social capital (Pretty and Smith 2004, Bodin and Crona 2008). However, one of the major drawbacks is the lack of relevant observations on environmental variables that validate the findings on the benefits of building of social capital on natural capital. On the other hand, it has been argued that communal rules and norms can also trap people within harmful social arrangements, allowing elites to shape institutions to suit their interests (Portes and Landolt 1996, Field 2003). Contestations often arise over boundaries demarcating a village's woodland resource use area (Nemarundwe 2004, Kirkland et al. 2007). Erosion of traditional values and systems of resource management has led to degradation of natural resources (Murali 2006, Kirkland et al. 2007). In contemporary South Africa, breakdown in the traditional management of communal woodlands has been attributed to a decline in respect for traditional authorities by local constituents (Campbell et al. 2001b, Twine 2005). For instance, the authority of local chiefs, who are once the

traditional custodians of natural resources had been drastically reduced with dire consequences for natural resource access (Kirkland et al. 2007, Makhado et al. 2009). Earlier research had emphasized that population pressure is responsible for resource degradation (see Myers 1993). Research now recognizes that resources like social capital that people can turn to during lean periods are important (Murali 2006), but whether these diversify rural livelihoods enough to lower dependence on natural capital, remains poorly understood.

1.2.6 Natural resource use by rural households

Rural households in sub-Saharan Africa use a wide range of natural resources to sustain their livelihoods, from edible herbs, medicinal plants, firewood, to fencing and construction poles (Cunningham 1993, 1998, Shackleton and Shackleton 2000, Twyman 2001, Dovie et al. 2002, Twine et al. 2003a, Kalaba et al. 2013, Chilongo 2014). Determinants of natural resource use at household level vary greatly from household socio-economic characteristics, resource availability, accessibility, institutional controls, population densities, employment levels, availability of alternatives, to personal and cultural preferences, and social connectedness (Shackleton et al. 2001, Shackleton and Shackleton 2006, Mbereko et al. 2007). Numerous studies have been conducted to quantify natural resource use or trade by rural households in diverse areas in southern Africa, for instance in South Africa (Dovie et al. 2002, Twine et al. 2003a, Shackleton and Shackleton 2004), Zimbabwe (Mcgregor 1995, Campbell et al. 1997b, Cavendish 2000), Malawi (Fisher 2004, Kamanga et al. 2009) and Mozambique (Hegde and Bull 2008). A common and widely used method for measuring resource use is the direct use values of resources, achieved by assigning local prices to the types of resources and multiplying by the quantities reported by household members (Dovie et al. 2002, Twine et al. 2003a). However, challenges with this methodology arise on assigning values to those natural resources that are not traded on the market**.** Hegde and Bull (2008) suggested the use of households' willingness to pay for such non-traded resources, whereas Dovie *et al.* (2002) would use the prices from the closest areas or markets where the resource was traded. Resource amounts were usually measured in weight, volume, bundles, individuals or whatsoever units the household was familiar with and these would standardized through weight or volume calibrations (Shackleton and Shackleton 2000, Dovie et al. 2002, Twine et al. 2003a). Apart from household direct consumption of natural resources, studies have shown that households

living in areas with easy access to forests tend not only to use forest resources but also trade in them to diversify their sources of income in anticipation of income variability (Banks et al. 1996, Pattanayak et al. 2001, Hegde and Bull 2008, Debela et al. 2012). A question worth further exploration is on the determinants of dependence on natural resources at household level, as these are important for both woodland protection and household food security.

1.2.7 Social capital, natural resource use and livelihood shocks

1.2.7.1 Livelihood shocks

Rural households often exist within a vulnerability context in which stresses and shocks affect their livelihood assets and options, over which they have very little control (Scoones 1998, Ellis 2000a) (Scoones, 1998, Ellis, 2000). A shock is an occurrence with a "significant" negative welfare effect which can be environmental (climate change, low fuelwood or low fruit tree availability), social (death or injury of a family member) or economic (loss of a job, cut off of government grants or decrease in remittances) (Heitzmann et al. 2002, Kozel et al. 2008). Shocks can be categorized as idiosyncratic (individual) or spatially covariant (common) whereby idiosyncratic shocks affect an individual household or income earner only (for example, injury, illness, death, divorce, etc.) while spatially covariant affect the whole community for instance drought (McSweeney 2004, Günther and Harttgen 2009, Paumgarten and Shackleton 2011). Idiosyncratic shocks are haphazard, sudden and unpredictable and there is much evidence to support the substantial detrimental effects that the occurrence of idiosyncratic shocks can have on a household (Townsend 1994, Morduch 2004, 2005, Kessy and Tarmo 2011), whereas covariant shocks are predictable stresses which are often continuous and cumulative (e.g. seasonal food shortages) (Chambers and Conway 1991, Kalaba et al. 2013). Households that are more vulnerable to idiosyncratic shocks are those that had low labour income, which was a trend associated with fewer males in the household (Kochar 1995). It has been acknowledged that households often use a variety of strategies such as assistance from friends, neighbours or kinship connections, disposing of household assets and harvesting more natural resources to cope with idiosyncratic shocks (Maxwell et al. 1999, Heemskerk et al. 2004, Paumgarten and Shackleton 2011). Moreover, it has also been shown that the capacity of households to cope with shocks is determined by a number

of factors such as the intensity and frequency of the shock, household characteristics (such as wealth, age and gender) and asset endowment (Pattanayak et al. 2001, Turner et al. 2003). On the other hand, shocks can take a covariant nature, for instance drought, which affect a wide segment of the community such that the provision of insurance is costly and complex and the capacity for informal compensatory measures is undermined (Kessy and Tarmo 2011). Consequently, households in risky environments develop sophisticated strategies to reduce the impact of covariant shocks, sometimes collectively (Dercon 2002). However, because they are widespread, covariant shocks explain little of the variation in individual at household level income or welfare (Deaton 1998). In general, shocks increase the vulnerability of rural households and traps them more in poverty (Wainwright and Newman 2011).

1.2.7.2 Social capital, natural resource use and household response to shocks

As highlighted earlier, there is a growing body of evidence on the role of social capital in household coping with sudden crises (Carter and Maluccio 2003, McSweeney 2003, 2004, Mogues 2011, Cassidy and Barnes 2012). Studies have also demonstrated the myriad of income shocks that households experience in the form of crop loss, livestock loss, and health shocks, and how households choose to respond to these shocks (Rosenzweig and Binswanger 1993, Kochar 1999, Pattanayak et al. 2001, Rose 2001, Fisher 2002, Cameron and Worswick 2003). Rural households with limited or no access to natural resources are have difficulty in obtaining food, accumulating other assets, and recuperating after natural or market shocks or misfortunes (Shah 1997, Cavendish 2000). Although the use of natural resources is well documented, there is bound to be considerable variation in when, how and how much rural households turn to natural resources to recuperate after experiencing shocks. Misselhorn (2009) found that social capital has an impact on vulnerability and that food security proxies for social capital are an important broad indicator of vulnerability. In addition, social capital and connectedness have been shown to have a significant yet complex interface with household resource access and use, and overall recovery from negative shocks and stresses (Debela et al. 2012). A two period model for assessing household welfare prior to (ex-ante) and after (ex-post) a shock was developed by Rose (2001), making it possible to compare household attributes in these periods and assess whether there are causal linkages for instance with social capital. As stated earlier, social capital is a direct or indirect tie of one actor to another actor

or a collection of others, where the central actor can be an individual or an aggregation of individuals (for instance a household). Using this thinking, it would be apt to assume that the more social ties a person or household has, the more social capital advantage they possess. However, as argued by Adler and Kwon (2002), this has to be within confines of reasonable caution to avoid irrational deductions.

The use of forest resources in mitigating risk is often reported as an aggregate trait of the rural poor (see for instance Chambers and Leach 1990). However, research acknowledges the substantial variance within households owing to different household socio-economic characterization (Agrawal and Gibson 1999, Byron and Arnold 1999, Shackleton and Shackleton 2006). A resilient and sustainable rural livelihood can combine migration, access to microfinance, subsistence crop production, natural resource harvesting and having the social networks to gain access to resources (Murali 2006, Twine 2013, Hunter et al. 2014). However, social networks are not simply the extent to which people are connected to others, but equally the nature of those connections, since the influence of social capital is more profound when networks exist among heterogeneous communes (Narayan and Cassidy 2001a). An additional dimension of social capital and natural resource availability in the shock-natural resource use discourse would add depth and insight into the facets rural household livelihoods.

1.3 AIM, OBJECTIVES AND HYPOTHESES

The overarching aim of this study was to examine the interactions between social capital, natural capital and natural resource use and how the natural resource use-social capital relationship plays out in the presence of shocks and stresses at household and community level in a communal area of Mpumalanga province, South Africa. The specific research objectives the study sought to address are as follows:

1. Explore the relationship between household social capital and use of natural resources, after accounting for the influences of other household livelihood capitals.
2. Explore how social capital influences household reliance on natural capital after negative household shocks.
3. Determine how availability of natural capital influences household reliance on social capital.

4. Determine the relationship between communal social capital and natural resource availability in the inter-village matrix.

The study hypothesizes that households which have more social networks and group memberships have more physical assets, higher financial and human capital and are less dependent on natural resources natural resources. It is expected that, overall, households with higher social capital are expected to be less dependent on natural resources after they have experienced negative shocks. In addition, the extent to which households rely on household social capital is greater in villages with lower availability of natural resources. Finally, villages with higher community social capital are expected to have better cohesion in natural resource management and thus lower environmental degradation and better resource availability.

1.4 APPROACH

The general approach was to study household livelihoods and the local environment from which these households derive natural resources for their livelihoods. An existing panel data set obtained from household surveys conducted from 2010 to 2012 in 590 households in nine villages in a rural South African setting was used. The researcher was involved in the collection of data in the last two years of the survey, in 2013 and 2014. The study was carried out as part of the Sustainability in Communal Socio-Ecological Systems (SUCSES) project which falls under the Agincourt Health and Socio-Demographic Surveillance System (AHDSS). SUCSES is a multidimensional study of the interactions on the environment, rural livelihoods and human-well-being. SUCSES employed an in-depth questionnaire to survey 590 households over a 5 year period from 2010-2014. The study approach borrowed empirical methodologies from ecological statistical modelling, ecological economics and quantitative sociology to answer these distinct but interrelated questions. Figure 5 illustrates a conceptual model of the various relationships explored in this study. The interactions of social capital and other livelihoods capitals include natural resource use (which will be central to the analyses, as the response) were examined at household level. An additional layer of analysis was added to include negative shocks on natural resource use, and additionally in the presence of social capital. Community level analyses were conducted to investigate the impact of natural resource availability on levels of communal social capital, and

the influence of social capital on natural resource management and thus natural resource availability (Figure 5). Data were collected through a combination of methods from remote sensing, a comprehensive quantitative household survey, focus group discussions, and in-depth interviews.

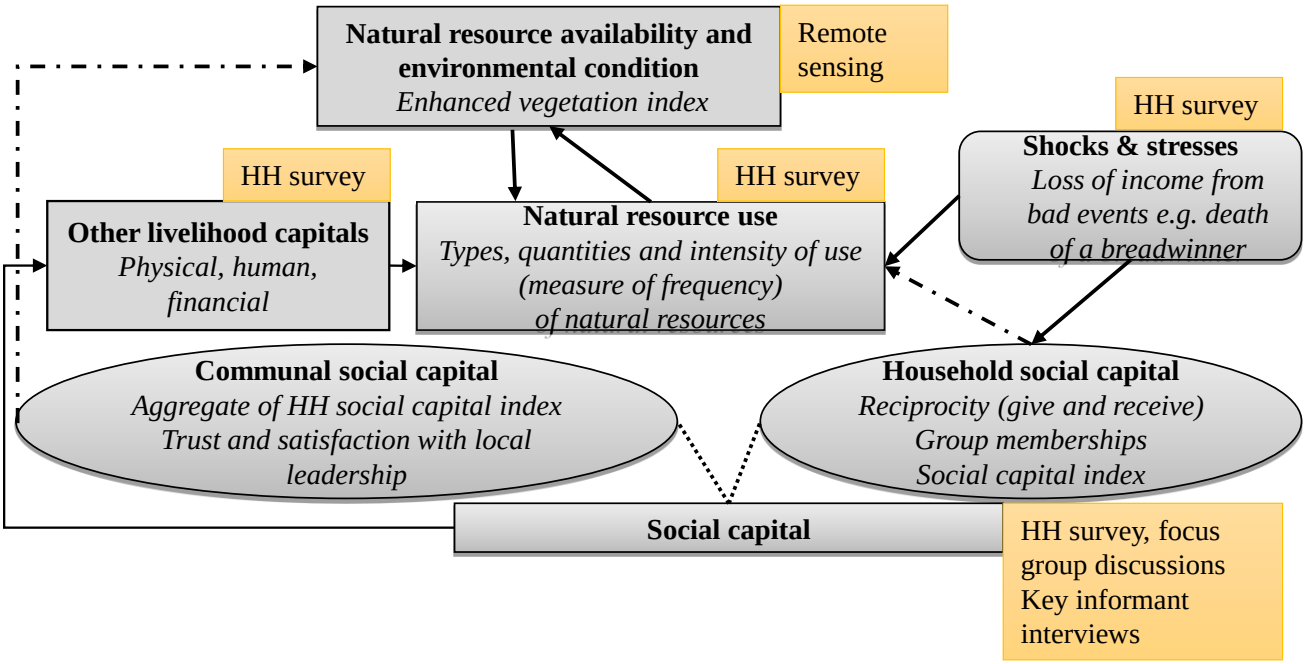

Figure 5. Conceptual model of the relationships explored in the study. The solid arrows indicate direct hypothesized relationships. The broken arrows indicate indirect hypothesized relationships. The broken lines indicate the dimensions of social capital considered. HH stands for household. The yellow boxes indicate the methods used to collect data on each variable

1.5 THESIS STRUCTURE

The way the thesis is structured is shown in Figure 6. Chapter 1 is the general introduction to the thesis laying the theory and framework for the study. It ends with a description of the study area. This is followed by four data chapters written in the format of journal articles, each addressing one of the project objectives. However, references are provided in one consolidated list at the end of the thesis. In the first data chapter (Chapter 2), I investigate the relationship between social capital

and other household livelihood capitals, focusing primarily on natural capital use at the household level. Next, Chapter 3 focuses on how social capital influences household reliance on natural capital after negative household shocks. In this chapter, the roles of both social capital and natural capital as a safety nets when households experience shocks are investigated. This is followed by Chapter 4, where I examine how availability of natural capital influences household reliance on social capital. Social capital dimensions of reciprocity and group memberships are measured across a natural resource availability gradient. Then, Chapter 5 examines the relationship between communal social capital and natural resource availability in the inter-village matrix. Here, the role of social capital in natural resource governance and natural resource availability is investigated. Chapter 6 is a general synthesis of major research findings, including local and large-scale implications of social capital for natural resource use and availability on rural livelihoods.

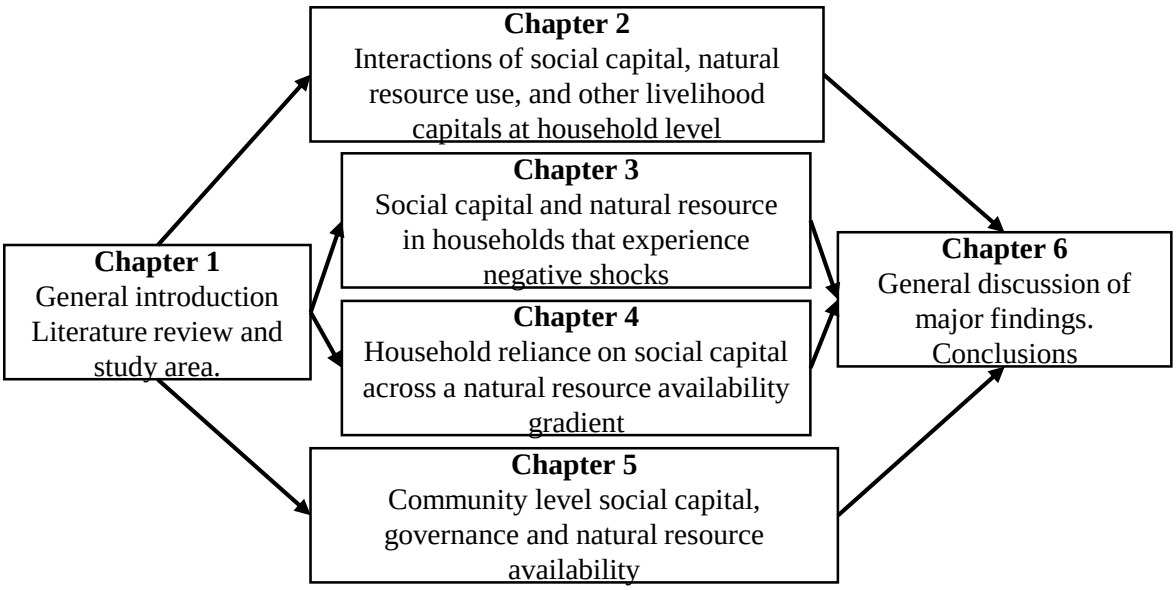

Figure 6. Thesis structure

1.6 STUDY AREA

1.6.1 General description

The study was conducted in the Agincourt Health and Demographic Surveillance System (AHDSS) site in Bushbuckridge Local Municipality in the Ehlanzeni district municipality,

Mpumalanga Province, South Africa, approximately 500 km north-east of the city of Johannesburg (Figure 6). The area was part of the former homeland of Gazankulu under the apartheid government. Approximately a quarter of the population in the area are former Mozambicans immigrants who fled the civil war in Mozambique in the 1980's and self-settled in the study area (Kahn et al. 2012). The settlement pattern is fairly typical of rural communities across South Africa with small household plots that are inadequate to fully support subsistence agriculture. The villages are generally large settlements (> 400 households) in which homestead yards are laid out in a trellis pattern along a network of roads/tracks. The villages have high population densities of 150-300 people/km^2 and unemployment levels are high (Pollard et al. 2003). Each village is surrounded by communal land used for cultivation, grazing for livestock, and harvesting natural resources. The choice of this area was guided by several factors including past research in and around the AHDSS site and continued interest and efforts for research in the former homelands of South Africa.

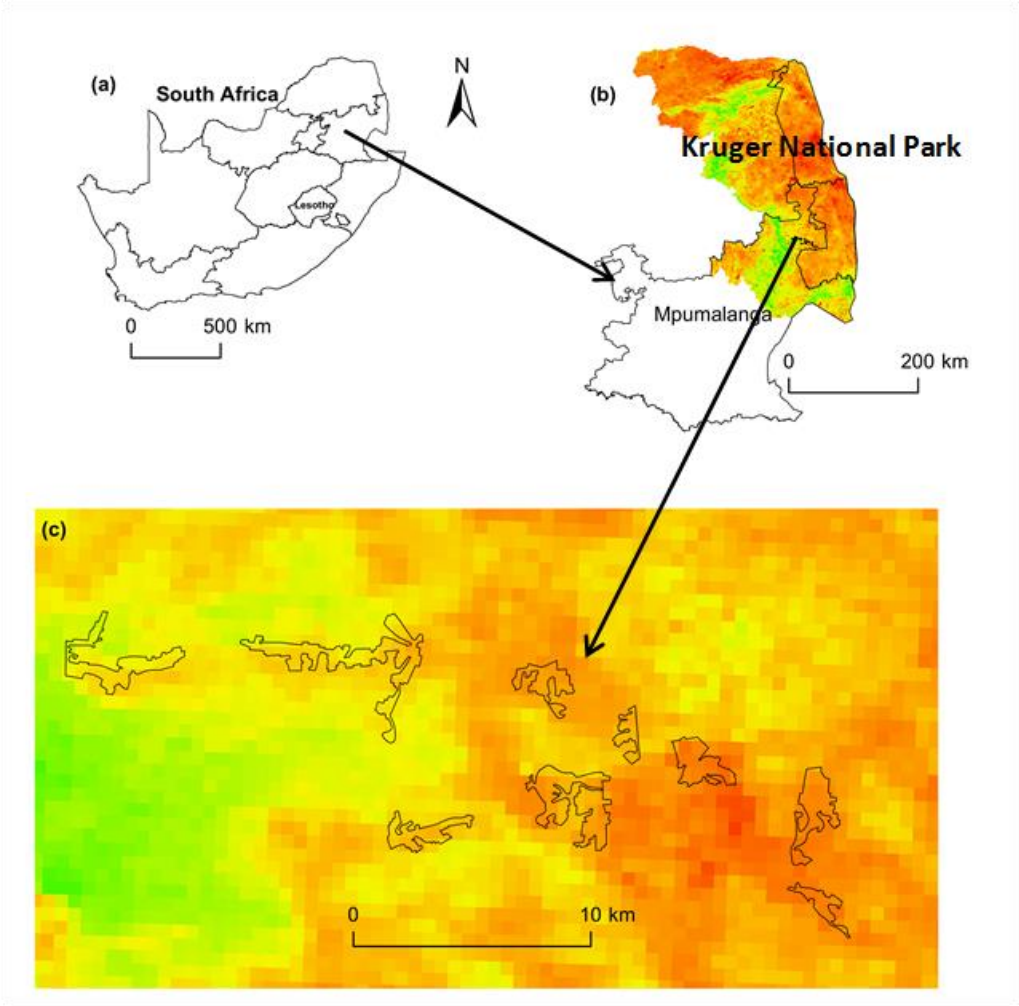

Figure 7. Map showing the location of the study villages in Bushbuckridge South Africa. (a) shows the location of Mpumalanga province in South Africa, (b) shows the location of study villages in the province, while (c) shows the study villages. The colours indicate a gradient of vegetative cover from green (high) to red (low).

1.6.2 Climate, geography and vegetation

Bushbuckridge region is part the savanna biome. The savanna biome covers just over one-third of South Africa, and is home to approximately 9.2 million rural inhabitants. The rural population resident in savannas represents just under one quarter of the total South African human population (Scholes and Walker 1993, Shackleton et al. 2000). Bushbuckridge is semi-arid with mean annual precipitation range of 550-750 mm (Kirkland et al. 2007) and is characterized by an east-west rainfall gradient. The region is characterized by shallowly undulating terrain with an altitude that

is generally less than 600 m above sea level (Banks et al. 1996) The area experiences hot, humid summers and mild winters with a mean annual temperature of approximately 22 °C which increases from southwest to northeast (Madubansi and Shackleton 2007). The geology is dominated by granite, with Timbavati gabbro intrusions (Venter et al. 2003). The soil is generally infertile and characterized to a larger extent by shallow sandy lithosols, except towards the base of the catena where deeper duplex soils are common (Shackleton 2000, Kahn et al. 2012). Vegetation is typically broad leaf savanna woodland characterized by three vegetation types: granite lowveld (dominant), gabbro grassy bushveld and legogote sour bushveld (Mucina and Rutherford 2006). Typical species include *Terminalia sericea*, *Combretum zeyheri* and *C.apiculatum* on the deep sandy uplands, while *Acacia nigrescens*, *Dichrostachys cinerea* and *Grewia bicolour* occur on clay-rich lowland soils. In the two other vegetation types, additional common species include *Sclerocarya birrea*, *Lannea schweinfurthii*, *Ziziphus mucronata*, *Dalbergia melanoxylon*, *Peltophorum africanum* and *Pterocarpus rotundifolius* (Shackleton 2000).

1.6.3 Land use

The main land use types in study area are subsistence farming, livestock grazing and natural resource use. The land in the area falls under communal land tenure, whereby the village land is divided into residential, farming, grazing and resource harvesting areas. Most of the farming is for household subsistence, with very few households selling their produce. However, the inter-village matrix is largely available to the residents of the settlement for the grazing of their livestock and for harvesting of natural resources (Shackleton and Shackleton 2000). Livestock stocking rate is high in these communal rangelands and grazing has resulted in significantly reduced grass biomass, and therefore the occurrence and intensity of fires (Shackleton et al. 1994). The area is skirted by protected areas, which are either state or privately held parcels of land for nature conservation or commercial game hunting.

CHAPTER 2

Empirical models reveal the inadequacy of social capital to decrease dependency on natural resources in rural livelihoods

ABSTRACT

Rural livelihoods have been conceptualized using capital assets and the livelihood strategies that enable rural households to derive outcomes for human well-being. Considerable research has been done to investigate how these capitals conduce, singly or jointly, to the attainment of desirable livelihood outcomes in rural households. However, limited work has been done to examine the interactions between social capital and natural resource use at the household level, particularly whether the welfare-improving advantage of social capital can decrease dependence on natural resources. Using longitudinal survey data from 590 households in nine villages of Bushbuckridge Local Municipality in South Africa, over a five year period, empirical models were constructed to investigate the effect of social capital, quantified as membership in groups, kinship connections and reciprocity, on three dimensions of natural resource use; number of natural resource types used, natural resource use intensity, and quantity of natural resources used. Results indicate that social capital has varying impacts on the three dimensions of natural resource use. Social capital had a positive association with number of natural resources used, and the intensity of natural resources use per household, but had no relationship with the quantity of natural resources consumed. The study concluded that rural households with high social capital have high dependency on natural resources and the welfare-improvement benefits of social capital are not sufficient to offset demand for natural resources. As such, social capital might not substitute for natural capital, but rather complements its role in household livelihoods.

Keywords*:* social capital, livelihood capitals, natural resource use, rural livelihoods, SLF, mixed effects models.

2.1 INTRODUCTION

Rural livelihoods are still widely dependent on biological resources, particularly in sub-Saharan Africa (Vedeld et al. 2007). It was estimated that approximately 1.6 billion people in the world still utilize and/or trade in natural resources for subsistence (Costanza et al. 1997, World Bank 2004). However, household livelihoods, especially in rural communities, are characterized by a complexity of strategies, activities and capitals, that have even more intricate interactions for diverse livelihood outcomes (Ellis 2003). It is imperative to unpack the household dynamics that underlie natural resource dependence, to inform discourse on ecological sustainability and human well-being. The sustainable livelihoods framework has guided research on capitals, strategies and capabilities in rural livelihoods (Bebbington 1999, Ellis 2003, Ellis et al. 2003, Bhandari 2013). A burgeoning human population in low and middle-income countries is exerting pressure on natural resources, which necessitates critical inquiry into patterns harvesting of natural resource use for subsistence or trade by rural households. Previous studies have looked at how wealth differentiation and other household characterization can influence household natural resource use. Although studies have looked into the improvements of household welfare from social capital (Grootaert 1999, Maluccio et al. 2000, Yusuf 2008), it remains unclear whether these improvements in welfare can reduce dependency on natural resource use by households. Against this backdrop, the study sought to test the possibility that higher social capital is associated with less reliance on natural capital after accounting for the influence of other household livelihood capitals.

The approach is premised on the sustainable livelihoods framework (Ellis 2000b). The framework maintains that the capability of a household to pursue different livelihoods strategies is dependent on the possession of, or access to, five key livelihoods assets: social, physical, financial, natural and human capitals. Natural capital refers to goods and services provided by ecosystems, which directly and indirectly support human life (Ekins et al 2003). Natural capital components and processes play social, ecological and economic functions that generate benefits that are of value to human society (Ekins et al 2003). Human capital is understood to include the skills and abilities of people to develop and enhance their resources and to access outside resources and bodies of knowledge (Coleman 1988). Physical capital includes equipment and infrastructure supporting

these activities. Financial capital refers to the financial resources available to invest in household f provisioning for day-to-day and future needs, and enable households to acquire inputs or to accumulate wealth (Bhandari 2013). These capitals facilitate or enable the derivation of productive streams that support livelihoods. The idea that there might be complementarities between reliance and use of various forms of capital, natural, social, human, financial, and physical is increasingly accepted in several studies (Pastor 2001, Abenakyo *et al* 2007). The capitals are interconnected in complex ways, and likely to be complementary, rather than substitutive. Consequently, an over-use of one form of capital can erode or destroy other livelihood capitals (Onyx 2004).

Social capital has been studied widely but its interactions with other livelihood capital for human well-being remain elusive. Social capital has been defined as a multifaceted concept comprising intangible values such as belonging to social networks, social connections and social norms that underpin individual conduct and collaboration among people that enable the creation of a community (Petrosillo et al. 2013). The theoretical underpinning of social capital as a livelihood asset is premised on the notion that it comprises trust, norms, and reciprocity that are inherent in networks and connections, which are convertible to stocks of other capitals directly or indirectly. Some aspects of social capital, such as cohesion, empowerment, trust and reciprocity are not directly observable. However, other indicators or behavioural consequences of social capital, including both structural and cognitive elements can be observed and quantified (Uphoff, 2000). For instance, social capital characteristics of social networks and group memberships at individual or household level can be observed and are a significant determinant of household welfare (Narayan and Pritchett, 1999, Grootaert, 1999). Thus, studies have used household membership in groups as a proxy for social capital normalized by household size (Grootaert, 1999, Maluccio *et al.*, 2000; Grootaert *et al.,* 2004). Measuring group membership provides a set of empirical tools for measuring social capital and can be done using three components: group density, group performance and participation (Putnam, 1993; Grootaert *et al*. (2004).

Several studies have been conducted to investigate interactions of livelihood capitals, for instance physical capital and household welfare, social capital, natural capital use, and accumulation of human capital, and their singular or multidimensional impact on human livelihoods (Coleman 1988, Grootaert 1999, Maluccio et al. 2000, Shackleton and Shackleton 2006). However, fewer

studies have investigated how social capital operates as a livelihood asset, how it translates into usable capital, and how its influence on and together with other livelihood capitals can be quantified. Early attempts, for instance Coleman (1988), acknowledged how social capital aids in the acquisition of human capital. Nevertheless, the pathways of causality amongst the livelihood capitals are explained in many ways. Social capital can enhance returns on investment in other forms of capital. In their study on how social capital influences other livelihood capitals, Abenakyo et al. (2007) found that high levels of social capital, measured as density of group memberships, significantly increased participation in nature conservation activities, and created more opportunities for asset building, and increased likelihood of adoption for natural resource management technologies for households in a communal area of Uganda. In another study, Krishna & Uphoff (2002) established that communities with high levels of social capital produce superior outcomes in collective action. Emery and Flora (2006) also acknowledge that social capital is an important characteristic of a community that can influence the flow and stock of other capitals. Hence, it would be expected that if social capital improves household welfare, it can result in the decrease in the range or the frequency of natural resources use by rural households, as they migrate to alternative foods.

Social capital still remains the most abstract of the sustainable livelihoods assets, and has been conceptualized in diverse ways for different contexts (Putnam 1993, Portes 1998, 2000b). The ways in which social capital interacts with other livelihood capitals, particularly whether it can reduce dependence of rural households on natural capital remain poorly understood. This study seeks to investigate the interactions between social capital, other livelihood capitals and three dimensions of natural capital use. In approach, the study borrows much from current ecological statistical modelling, economics and quantitative sociology empirical methods to answer the following questions: 1. What are the interactions between social capital and other livelihood capitals at household level? 2. How does social capital influence natural resource use after controlling for the effect of other household livelihood capitals? Accordingly, novel models for robust analysis of household livelihood capital metric interactions are introduced to contribute to an understanding on household dynamics that influence natural resource use and ultimately resource availability.

2.2 METHODS

2.2.1 Study area

Refer to Chapter 1, section 1.6 for a description of the study site.

2.2.2 Research design

This study focused on households and the local environment from which the households derive ecosystem services for their livelihoods. Data were collected from 590 households in nine villages in which they occur over a 5-year period from 2010-2014, each year from April to June. The nine villages were selected as clusters of three in three rainfall zones along a west-east axis (rainfall >700 mm/year, 700-600 mm/year, <600 mm/year). The villages were selected to replicate the range of village sizes per rainfall zone. Table 1 below shows the study villages and their rainfall zones.

Table 1. Study villages in the Bushbuckridge area and their distribution across a rainfall gradient

Village names	Rainfall zone
Xanthia Agincourt & Cunningmore B	>700 mm/year
Kildare A, B & C, Ireagh A & Ireagh B	600-700 mm/year
Justicia, Lillydale B & Huntington	<600 mm/year

The sample of 600 households is proportional to village size, representing an 8% sampling intensity. However, during the survey only 590 of the selected households were interviewed, while the difference was households that had either refused to participate or had dissolved by the time of the survey. In each household, a focal individual over the age of 18 was selected to be a respondent, particularly one who was aware of the welfare and activities of the household.

2.2.3 Data collection

Data were collected through a structured questionnaire survey conducted yearly from 2010- 2014. The questionnaire surveys were conducted as part of SUCSES to collect data on household resource use, social capital, and negative shocks. Household variables including ownership of particular consumer durables/assets were recorded. Furthermore, household size, education level and occupation of each household member were recorded as variables to be used as proxies for human capital. Attributes which are indicative of social capital at the household level and within the local context were also recorded. These variables were memberships in groups, kinship connections, and reciprocity. Reciprocity is a key dimension of social capital that encapsulates the presence of relatives or friends connections and the incidence of giving or receipt of assistance from these connections. Moreover, households were asked to report on negative shocks that they had experienced, for instance death of a breadwinner, or loss of crops, that had affected their livelihood. In addition, households were asked to report information on the species and quantities of natural resources collected, frequency of collection and use (weekly/monthly/yearly), and sales along with revenue generated. In addition, households were asked to report on the local prices of the natural resource they use, buy or sell. Natural resources were from the following categories (1) firewood, (2) wild fruits, (3) wild vegetables, (4) edible insects (5) bush meat, (6) medicinal plants and (7) reeds or mats made of reeds. Data were also collected on use of rangeland resources for grazing (indexed by livestock ownership) and use of land for agriculture (using number of fields owned and crops grown in fields outside of yard as proxies).

2.2.4 Data analysis

2.2.4.1 Social capital

Principal Component Analysis (PCA) was used for data reduction to derive operational dimensions of a social capital metric from weights for each contextually chosen variable of social capital (taken from the first principle component) (Table 2) (Figure 1). The rationale for using PCA is that relationships among original variables are large enough so that the first principal components account for most of the variance in the data, as such can be subjected to further analysis without

losing meaning or clarity in the relationships explored (Shackleton et al. 2002). It has been established that PCA can perform as well as other alternative methods, for instance Multiple Correspondence Analysis (MCA) (Kabudula et al. 2017). For the purpose of our analysis we used both memberships and reciprocity to build the social capital index, since there was a significantly positive correlation between social capital metric from variables of group memberships and the social capital metric from variables of reciprocity (N=2679, r=0.208, $p<0.05$). Coefficients for each variable were calculated using the principal components covariance extraction method with the *prcomp* function in the R statistical software (R Core Team 2013).

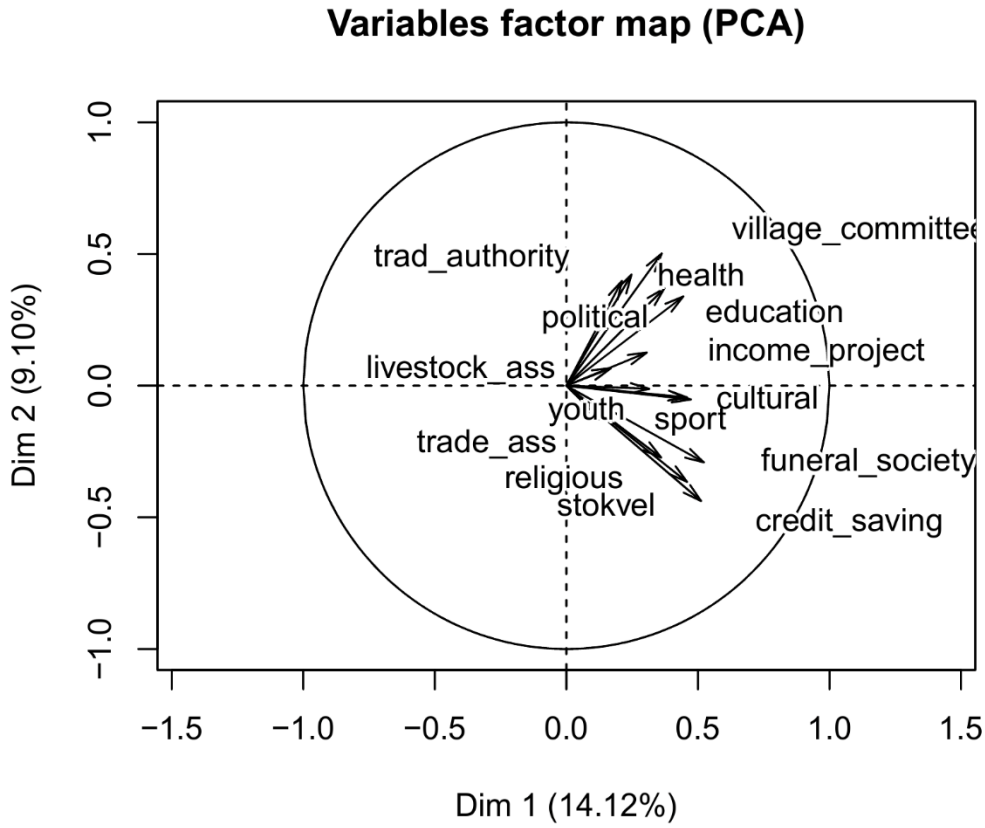

Figure 1 Biplot of principal component for social capital variables.

Table 2. Social capital variables included in analyses and weights obtained from principal component analysis.

Social capital	
Group memberships	
Membership in credit savings group	0.227
Membership in funeral in society	0.221
Membership in grocery savings group (stokvel)	0.207
Membership in sports team	0.166
Membership in cultural group	0.118
Membership in religious group	0.082
Membership in political group	0.075
Membership in income project	0.036
Membership in education group	0.036
Membership in village committee	0.032
Membership in youth group	0.030
Membership in farm livestock association	0.018
Membership in traders association	0.015
Membership in health group	0.015
Membership in traditional authority	0.012
Reciprocity	
Household gave assistance to other household	0.290
Household head has friend in village	0.273
Household got assistance from neighbours	0.232
Household head got assistance from friend in village	0.213
Household got assistance from relative	0.203
Household has relative in village	0.023

2.2.4.2 Physical capital

Akin to the computation of social capital, physical capital was calculated by principal components using carefully selected variables to represent stock of consumer durables owned by households

(Table 3) (Figure 2). The higher the value of an asset in representing physical capital, the higher the magnitude of the loadings. Since the relative value of an asset changes with time, although this might be over longer periods than our 5 year study period, coefficients were calculated by aggregating data across the five years.

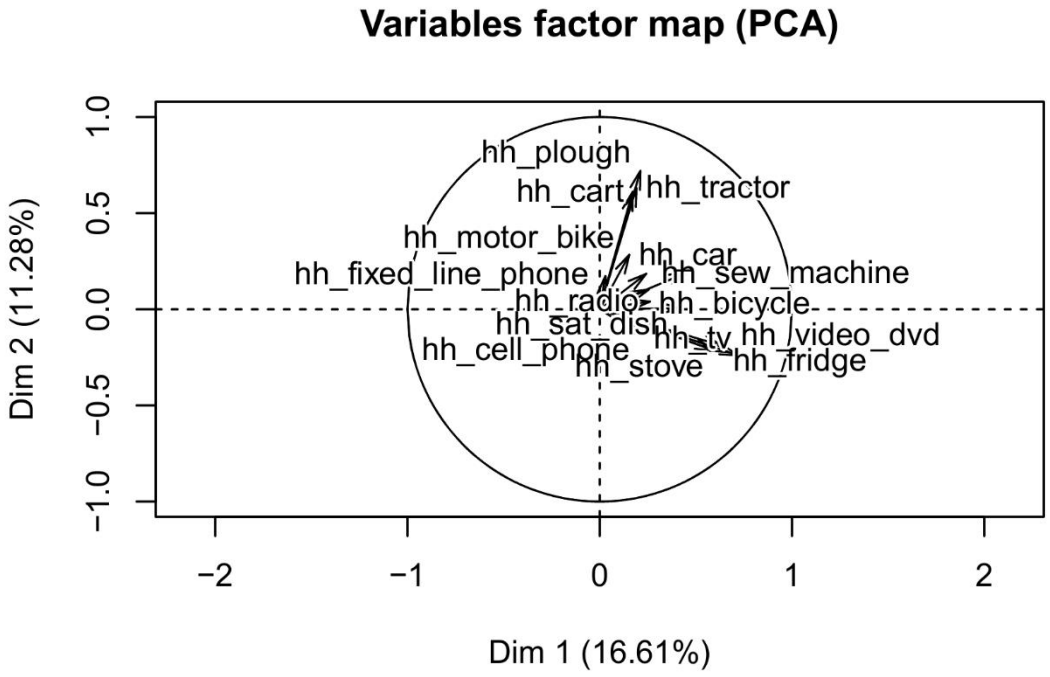

Figure 2 Biplot of principal component for physical capital variables.

Table 3. Physical capital variables included in analyses and weights obtained from principal component analysis.

Physical capital (ownership of assets)	
DVD player	0.316
Radio	0.228
Television	0.231
Car	0.222
Television	0.231
Stove	0.185
Fridge	0.159
Satellite dish	0.151
Bicycle	0.078
Sewing machine	0.050
Plough	0.022
Cellphone	0.016
Cart	0.011
Tractor	0.010
Motor bike	0.006
Fixed line telephone	0.002

2.2.4.3 Human capital

A method of aggregation of household individuals' endowments to use as variables for constructing a human capital index (see Table 4). The selected variables for human capital were first, the proportion of household members with some education (secondary and tertiary). Second, the proportion of household members who were in the economically active age group, the age group between 15 and 64 inclusive against the total members of a household (household size). Also, the proportion of males to females in the household, household size and the gender of the household head (Figure 3). Weights for our variables were obtained by using factorial analysis with the *FAMD* function in the *FactoMineR* package in R (Husson et al. 2016), since some variables were both continuous and categorical. Only weights from the first dimension was used

as it accounted for 28% of the variation (Figure 3). Human capital (index) for a particular household was the sum of the weights of all variables.

Table 4. Human capital variables included in analyses and weights obtained from factorial analysis.

Human capital	
Education of household head: Some education	1.246
No education	0.573
Proportion educated	0.780
Proportion economically active	0.594
Gender of household head: Male	0.386
Female	-0.467
Proportion of males to females	0.340
Household size	-0.301

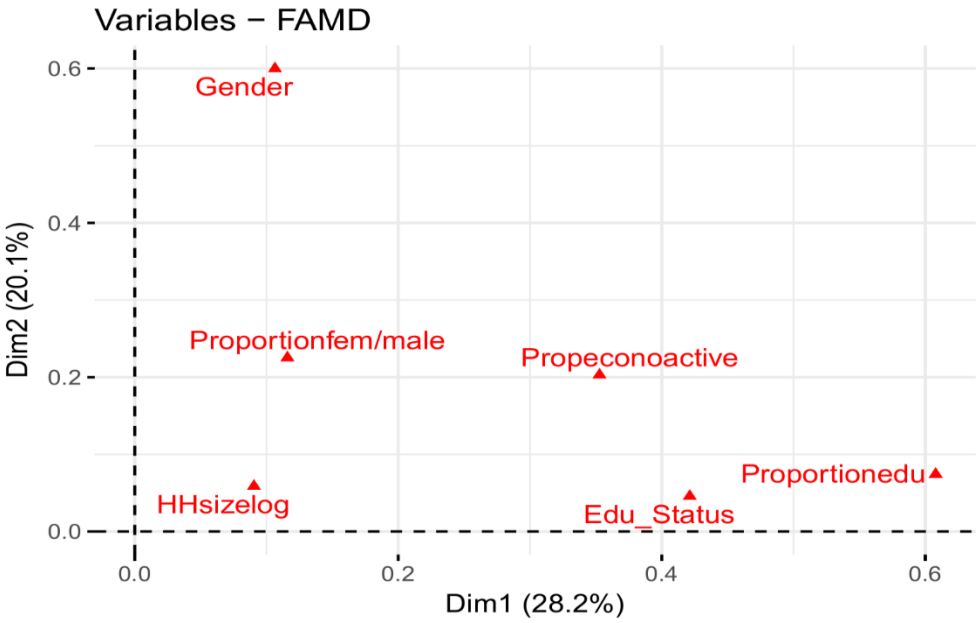

Figure 3 Biplot of principal component for human capital variables.

2.2.4.4 Financial capital

Financial capital metrics for households are known to be highly elusive, partly because most individuals are not willing to share what they earn. Secondly, the interviewee might not know how much a member of the household earns, but just the remittances they receive. For our calculation for financial capital we use monthly income, expenditure and savings per capita (Table 5) (Figure 4). A ratio of expenditure to savings to capture whether the household has more to save after their monthly expenditure. Principal component analysis in R stats package, was used to derive weights for each variable. Only weights from the first principal components, which accounted for 44% of the variation was used (Figure 4).

Table 5. Financial capital variables included in analyses and weights obtained from principal component analysis.

Financial capital	
Monthly per capita savings	0.648
Monthly per capita expenditure	0.493
Monthly per capita income	0.427
Ratio of monthly expenditure to savings	0.394

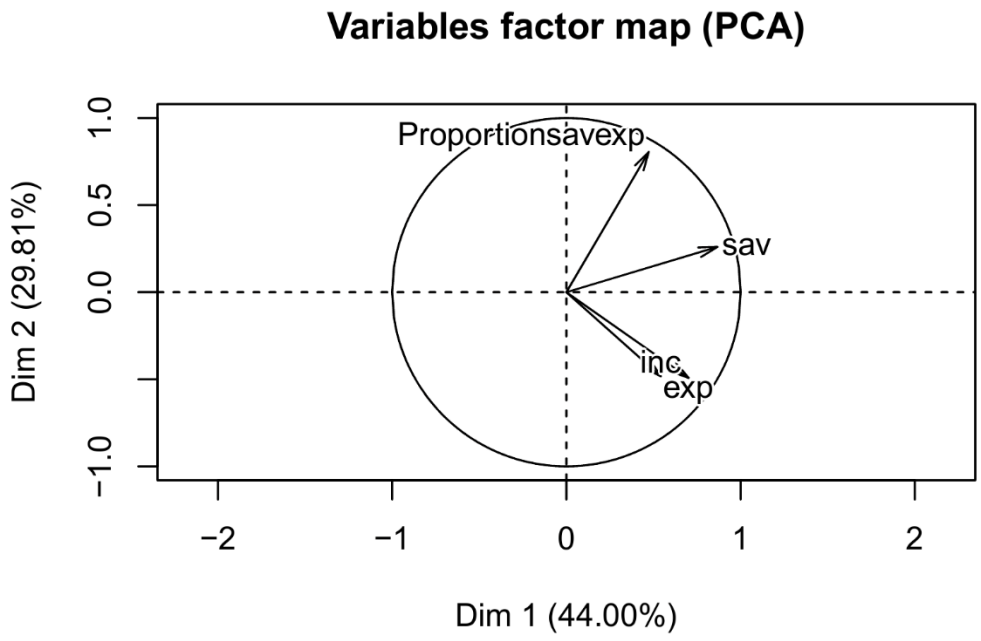

Figure 4 Biplot of principal component for financial capital variables.

2.2.4.5 Natural resource use

Natural resource use was calculated for three dimensions to capture different aspects of dependency on natural resources 1: types of natural resources used, 2: intensity of natural resource use, 3: quantities of natural resource used by a household per year/capita. Resource types were the summation of the binary variable (Yes/No, which was 1/0) representing use of a particular resource by a particular household in the survey year. The total maximum possible resource types was seven, the maximum number of natural resource categories considered in the study. The intensity of natural resource use was a metric computed using the combined frequency of three types of natural resource: fuelwood, wild fruits and wild vegetables which had the most reported cases. This was chosen as an indicator of dependency on natural resource use. Other types of natural resources are not used in computing intensity of natural resource use as they had few records for instance fish from local rivers. The intensity of natural resource use was computed from the recorded variable of frequency of natural resource use as shown below.

$$Resource\ use\ intensity = (\sum_{0}^{3} \text{Frequency of resource use of x})/18$$

Where, x is the frequency of use of a type of resource (fuelwood, wild fruit, etc) per household (values from 0 which indicates 'not used at all', 1 'used once in six weeks', 2 'used 1-4 times per month' and 3 'more than 4 times per month') and, 18 was the highest possible sum of frequencies and this was used to rescale resource use intensity to values between 0 and1.

Quantity of resource use was an aggregate value calculated from quantities of firewood, wild fruits, wild vegetables and edible insects used by a particular household per capita per annum. These categories of resource use were chosen as they had the most responses from our sample of households. Data on quantities of natural resources was often reported in units of cups, wheelbarrows and carts and so on. These were converted through volume and weight calibrations. For instance, the volume of a cup was taken to be that of the commonly used enamel mug, which is 0.40 litres, whereas a *bakkie*-load of wood, which was assumed to be the same as that of a donkey cart, was determined to be 532 kg following Twine et al. (2003) and Shackleton et al. (1999). For resource quantities that were not reported as volume, we converted quantities to volume or volume that could be displaced using mass and volume calibrations to have one metric for quantity of natural resources. For instance, the standardized weight of a *bakkie*-load which was 532 kg would convert to 1584 litres volume space that could be displaced.

2.4.6 Interactions between natural capital use and other livelihood capitals

The relationships among household livelihood capitals were explored using Principal Component Analysis in the package *FactoMineR* in R statistical software (Husson et al. 2016). The *Hmisc* package in R was used to test for the significance of the correlations between the individual capitals (Harrell 2013). For data visualizations, the *ggpairs* function in the R package *GGally* was used (Emerson et al. 2013, Schloerke 2017). Second, generalized linear mixed effect models (GLMMs) were fitted using maximum likelihood (Laplace approximation) to model the interactions of three dimensions of natural resource use and social, human, physical and financial capital variables. For all models, the household (HH) was considered a random effect, whereas year, with five factor levels (years 2010-2014) was placed in the model as a covariate to capture temporal variability from baseline conditions. Data were analysed with the *glmer* function in the *lme4* package (Bates

et al. 2015) in R version 3.2.2 (2015-08-14) with model variations as illustrated in models (1), (2) and (3) below. The predictive power of each fixed effect present in the model were examined using tested using the *Anova* function with the R package *car* (Fox and Weisberg 2011), to check the best predictors of our response in each model.

$$Resource\ types \sim SC\ +\ PC\ +\ HC + FC + Year + (1 \mid HH) \quad (1)$$

$$Resource\ use\ intensity \sim SC\ +\ PC\ +\ HC + FC + Year + (1|HH) \quad (2)$$

$$Total\ per\ capita \sim SC\ +\ PC\ +\ HC + FC + Year + (1 \mid HH) \quad (3)$$

Where, SC, PC, HC and FC are measures of household social, physical, human and financial capitals respectively. Variations of models (1), (2) and (3) were run with no interactions (A) and with 2-way interactions (B) of the covariates as shown below, where natural resource dimension was either of the three dimensions of natural resource use.

$$Natural\ resource\ dimension \sim SC + PC + HC + FC + Year + (1|HH) \quad (A)$$

$$Natural\ resource\ dimension \sim SC *\ PC + SC * HC + SC * FC + Year + (1\ |HH) \quad (B)$$

2.3 RESULTS

2.3.1 Summary statistics

Table 6 shows summary statistics of the variables that were used in all the mixed effects models. The mean household size was six for permanent residents only and 8 inclusive of temporary migrant members. Fuelwood contributed the largest per capita consumption of natural resource per year. The highest mean number of natural resource types in 2010 (3.83) and the lowest in 2013 (2.88). There was no significant variation in the types, intensity and quantities of natural resourced use by households ($p<0.01$) (Figure 1).

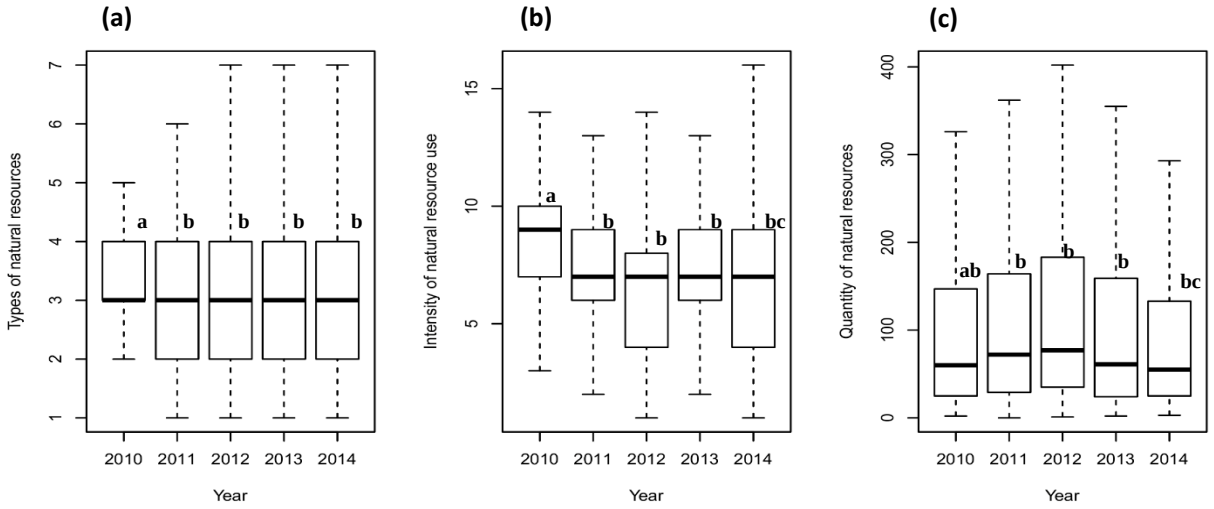

Figure 5. Variation in a) number of natural resources used, b) intensity of natural resource use, and c) quantity of natural resources used for the years 2010-2014. Different superscripts indicate significant differences.

Table 6. Summary statistics for household characterization data means (+/- standard deviations) for households in Bushbuckridge pooled for the period 2010-2014

Variables	**Mean**	**SD**
Social capital index (index of group memberships and reciprocity)	0.887	0.507
Physical capital index (household assets index)	0.942	0.348
Human capital index	0.953	0.476
Types of natural resources used	3.212	1.115
Quantity of natural resources used per capita per annum		
Mean wood volume per capita per year (m^3)	0.720	0.135
Mean wild fruits per capita per annum (litres)	36.584	16.480
Mean wild vegetables per capita per annum (litres)	10.398	1.455
Mean edible insects per capita per annum (litres)	0.716	0.320
Intensity of use	7.400	2.760

2.3.2 Social capital and other household livelihood capitals

Physical, financial and human capitals were all positively correlated with social capital (Figure 2). The strongest correlation was observed between social capital and physical capital, whereas the lowest was for social capital and financial capital. Physical capital was negatively correlated with quantities of natural resources use per capita per household (Figure 3), while there was no significant correlation between physical and human capitals and number of natural resources used (Figure 3).

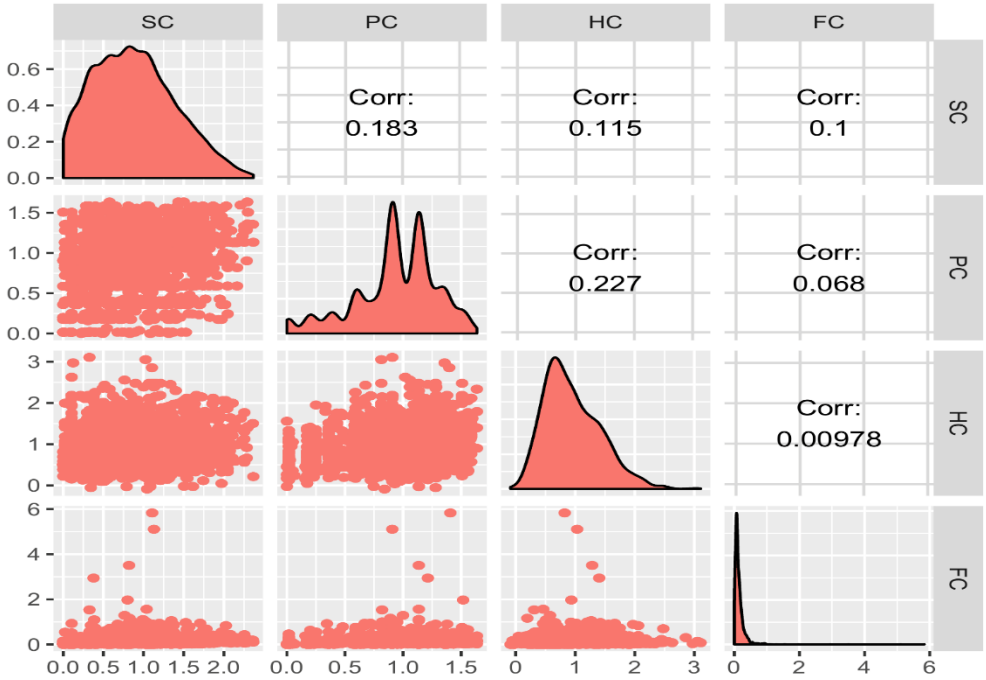

Figure 6. Correlations and distributional densities of household livelihood capitals. SC = social capital, PC = physical capital, HC = human capital and FC = financial capital.

Natural resource use intensity (R=0.905, p<0.001) and the number of natural resources used (R=0.88, p<0.001) had a very strong positive correlation with the first dimension of the principal components (Figure 2). Physical (R=0.69, p<0.001), social (R=0.66, p<0.001) and human (R=0.58, p<0.001) capitals had a significantly positive correlation with the second dimension of the principal components (Figure 3).

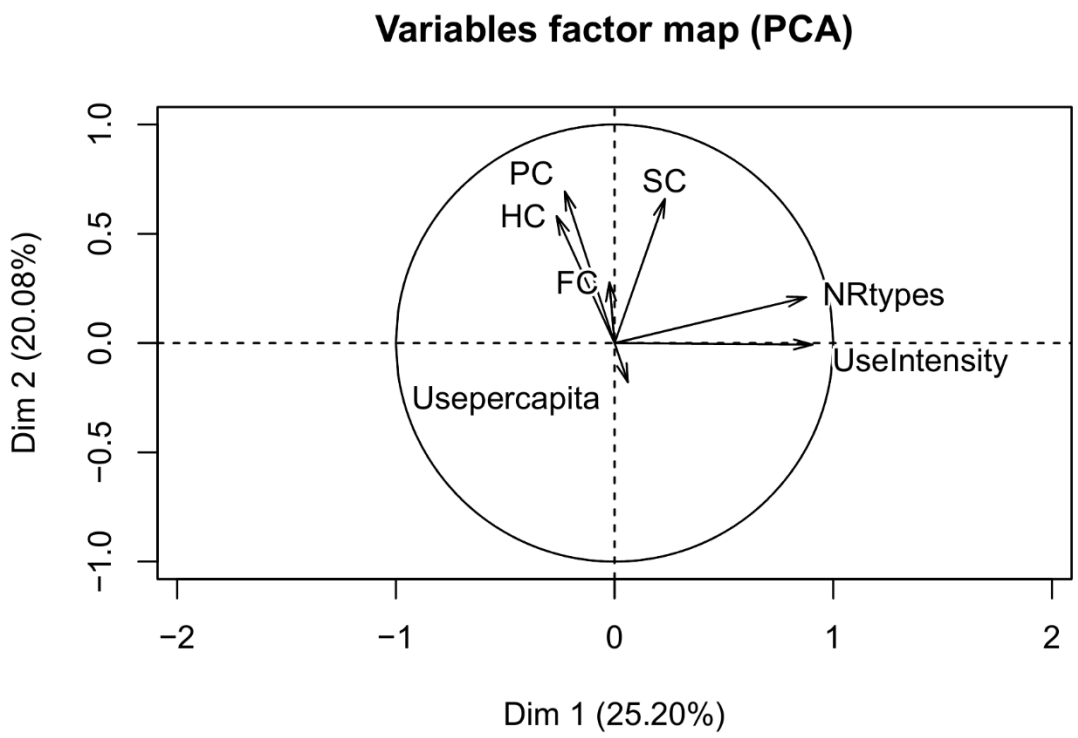

Figure 7. Principal component analysis of household livelihood capitals. NRtypes= number of types of natural resources, use intensity= intensity of natural resource use, used per capita=quantities of natural resources used per capita, PC, HC, SC, and FC=physical, human, social and financial capitals respectively.

2.3.3 Social capital and natural resource use

2.3.3.1 Resource types

In model 1A, which had no interaction terms, the total number of natural resource types used by a particular household was positively associated with social capital ($Z=5.767$, $p<0.001$) (Table 7). The number of natural resources types used increased 1.149 times with a unit increase in social capital. However, physical, financial and human capitals had no significant relationship with the number of types of resources used (Table 7). When the model was run with predictors of two-way interactions between social capital and physical, financial and human capitals, the interactions had no significant relationship with types of natural resources used by a particular household (Table 7, model 1B). Further, financial, physical and human capitals still had no significant relationship with

the number of natural resources. However, social capital had a significant but relatively weaker association with the range of resources used (Z=2.925, p<0.01), in contrast with the strong relationship in model 1A. The model without interactions was better fitted to the data (AIC=7265) than the model including the interactions (AIC=7269)

Table 7. Estimates (standard errors in parentheses) from generalized linear mixed effects models for the interaction between the numbers of natural resources used per capita and social, physical, human and financial capitals. Models were run with no interactions (1A) and 2-way interactions (1B).

Model without interactions		**Model with 2-way interactions**	
Variables	**1A**	**Variables**	**1B**
(Intercept)	1.205***	(Intercept)	1.132***
	(0.045)		(0.077)
Social capital	0.139***	Social capital	0.224**
	(0.024)		(0.076)
Physical capital	-0.019	Physical capital	0.034
	(0.036)		(0.070)
Human capital	-0.035	Human capital	-0.010
	(0.026)		(0.054)
Financial capital	-0.037	Financial capital	-0.033
	(0.051)		(0.153)
Year (2011)	-0.131***	Social capital* Physical capital	-0.062
	(0.036)		(0.069)
Year (2012)	-0.148***	Social capital*Human capital	-0.026
	(0.036)		(0.051)
Year (2013)	-0.149***	Social capital*Financial capital	-0.005
	(0.037)		(0.148)
Year (2014)	-0.138***	Year (2011)	-0.129***
	(0.037)		(0.037)
		Year (2012)	-0.147***
			(0.036)
		Year (2013)	-0.147***
			(0.037)
		Year (2014)	-0.136***
			(0.037)

*** p<0.05, ** p<0.01 and *** p<0.001**

2.3.3.2 Resource use intensity

Natural resource use intensity (a combined measure of number of resources used and their frequency of use) was significantly influenced by social, physical and human capitals when the model was fitted without interactions ($p<0.001$) (Table 8, model 2A). Natural resource use intensity increased 1.106 times with a unit increase in social capital, decreased 0.901 times with a unit increase in physical capital, and decreased with 0.886 times with a unit increase in human capital. However, financial capital had no significant influence on natural resource use intensity. When the model was fitted with two-way interactions of social and physical capitals, social and human capitals, and social and financial capitals, none of the interaction terms had a significant relationship with the intensity of natural resource use (Table 8, model 2B). Social capital now showed no association with natural resource use intensity ($p=0.104$), while human and physical capitals were still associated with significant declines in natural resource use intensity ($p<0.01$ and $p<0.05$ respectively). Financial still had no significant relationship with natural resource use intensity ($p=0.218$). In both models A and B, 2010, which was the baseline, had the highest natural resource use intensity, with declines in all other years (Figure 3). The model without interaction terms was more suited to the data (AIC=10 276) with 5 AIC points less than the model incorporating the interactions (AIC=10 281).

Table 8. Estimates (standard errors in parentheses) of generalized linear mixed effects models for the interaction between the intensity of natural resource use per capita and social, physical, human and financial capitals. Models were run with no interactions (2A) and 2-way interactions (2B).

Model without interactions		**Model with 2-way interactions**	
Variables	**2A**	**Variables**	**2B**
(Intercept)	2.231***	(Intercept)	2.240***
	(0.034)		(0.055)
Social capital	0.101***	Social capital	0.089
	(0.018)		(0.054)
Physical capital	-0.104***	Physical capital	-0.117*
	(0.027)		(0.050)
Human capital	-0.121***	Human capital	-0.105**
	(0.021)		(0.040)
Financial capital	-0.043	Financial capital	-0.136
	(0.036)		(0.110)
Year (2011)	-0.098***	Social capital * Physical capital	0.016
	(0.024)		(0.050)
Year (2012)	-0.212***	Social capital * Human capital	-0.017
	(0.025)		(0.038)
Year (2013)	-0.151***	Social capita * Financial capital	0.095
	(0.025)		(0.105)
Year (2014)	-0.182***	Year (2011)	-0.098***
	(0.025)		(0.024)
		Year (2012)	-0.212***
			(0.025)
		Year (2013)	-0.151***
			(0.025)
		Year (2014)	-0.181**
			(0.025)

***p<0.05, ** p<0.01, and ***p<0.001**

2.3.3.3 Resource quantities

In model 3A, without interactions, the *per capita* quantity of natural resources used by a particular household was negatively associated with social capital (Z=-4.31, p<0.001) and financial capital (Z=-10.86, p<0.001) (Table 9). The *per capita* quantity of natural resources use by a particular household declined by 0.976 times with a unit increase in social capital and declined by 0.888 times with a unit increase in financial capital. In contrast, human capital had a significant positive association with *per capita* consumption of resources (Z=2.15, p<0.05), as a unit increase in human

capital was associated with a 1.025 times increase in per capita quantity of natural resources used per annum. Physical capital, as indexed by ownership of physical assets had no significant relationship with the quantity of natural resources ($p=0.350$). However, in model 3B, which was run incorporating interactions between social and physical capitals, social and human capitals, and social and financial capitals, all four capitals were associated with a significant decrease in natural resources used per capita ($p<0.001$). Further, the interactions effects of social and physical capitals ($Z=11.28$, $p<0.001$) and social and human capitals ($Z=27.80$, $p<0.001$) were associated with a significant increase in our response, while the interaction effect of financial capital and social capital had no significant relationship with natural resources used per capita ($p=0.703$). In both models 3A and 3B, there was significant variability between the baseline year and all other years (Table 9, Figure 3). In model 3A, per capita natural resource declined by 0.869, 0.834 and 0.792 times in 2011, 2013 and 2014 respectively, whereas it was 1.059 times more in 2012 from the level of 2010 (Table 9). Similar to model 3A, in model 3B, per capita natural resource also declined by 0.866, 0.829 and 0.783 times in 2011, 2013 and 2014 correspondingly, while it increased by 1.058 times in 2012. Model 3A was approximately 186 AIC points lower than the model 3B, which means it was much better suited to the data.

Table 9: Estimates (standard errors in parentheses) of general linear mixed effects model (Poisson) for the interaction between quantity natural resource use per capita and social, physical, human and financial capitals. Models were run with no interactions (3A) and 2-way interactions (3B).

Model without interactions		**Model with 2-way interactions**	
Variables	**3A**	**Variables**	**3B**
(Intercept)	4.555***	(Intercept)	4.926***
	(0.039)		(0.040)
Social capital	-0.024***	Social capital	-0.495***
	(0.006)		(0.017)
Physical capital	-0.010	Physical capital	-0.130***
	(0.011)		(0.016)
Human capital	0.025*	Human capital	-0.262***
	(0.011)		(0.016)
Financial capital	-0.119***	Financial capital	-0.119***
	(0.011)		(0.035)
Year (2011)	-0.140***	Social capital * Physical capital	0.166***
	(0.006)		(0.015)
Year (2012)	0.057***	Social capital * Human capital	0.330***
	(0.006)		(0.012)
Year (2013)	-0.182	Social capital * Financial capital	0.013
	(0.007)		(0.035)
Year (2014)	-0.232	Year (2011)	-0.144***
	(0.007)		(0.006)
		Year (2012)	0.056***
			(0.006)
		Year (2013)	-0.187***
			(0.007)

*** p<0.05, ** p<0.01, and *** p<0.001**

As such, wealth as indicated by an accumulation of physical assets had a much stronger influence on per capita natural resource use than other household livelihood capitals, or even interactions of such. The model with interactions was marginally better suited to the data (AIC=24772.9) than the model without the two-way interaction effects (AIC=24775.6).

2.4 DISCUSSION

2.4.1 Interrelationships between social capital and other household livelihood capitals

In this study, social capital was positively correlated with increased physical, human, financial and natural (frequency of use and number of types used) capitals. However, it was negatively correlated with quantities of natural resource use. These findings corroborate results from some previous studies, while they diverge from some. For instance, studies have observed increased human capital associated with high social capital (Coleman 1988), while others have linked general better household welfare with improvements in social capital (Maluccio et al. 2000, Yusuf 2008). Narayan and Pritchett (1999) found a linkage, that they posited was causal, between village level social capital and improved financial capital at the household level. The contribution of livelihood capitals to household livelihoods varies in different parts of the world, as discussed in several studies in the framework of the sustainable livelihoods framework (Bebbington 1999, Ellis 2000b). In southern Africa, studies have reported varying results, from complementary relationships to substitutionary interactions amongst the livelihood capitals (Pastor 2001, Abenakyo et al. 2007).

All other capitals were negatively correlated with natural capital use (quantities). Divergent findings were observed by Shackleton & Shackleton (2006), who demonstrated that improving rural household wealth status had no significant influence on natural resource consumption. In addition, Cavendish (2000) found similar results in a communal area of Zimbabwe, whereby absolute quantities of natural resources did not decline with increasing household wealth. Actually, he discovered that wealthier households (those with higher physical capital), had a higher absolute natural resource consumption (Cavendish 2000). However, unlike in this study, Cavendish (2000) focused only on absolute quantities and not frequency of use. Other studies have shown that although wealthier households might make greater use of natural resources, these resources make a greater contribution to the total household livelihood, relative to other livelihood sources, among poorer households (Cavendish 2000, Babulo et al. 2008, Thondhlana et al. 2012a). In this study, and indeed other studies in the South African context, poorer households derive greater benefits from natural resources than households with relatively more wealth (Shackleton and Shackleton 2006, López-Feldman 2014). Elsewhere, resource extraction was shown to follow a bell-shaped

relationship against wealth (López-Feldman 2014). A rise in income from formal sources has been accompanied by a decline in the share contributed by informal sources of income to total household income, including natural resource income (Dovie et al. 2002).

This study addresses the gap identified by Shackleton and Shackleton (2006) of the need for larger sample sizes in examining the dynamics of natural resource use by rural households. In addition, the analyses is further strengthened by accounting for temporal variation which allows for the elimination or smoothing of time-invariant factors to single out the relationship of social capital and other livelihood capitals. Intimations from most studies about these relationships have been from investigating two or three capitals together, but here the empirical relationship of all the livelihood capitals is examined, including the problematic social capital. Similar to other studies, findings show that social capital was correlated with human and physical capitals (Maluccio et al. 2000). As such, the improvement of a household welfare, as indicated by accumulation of physical assets and human capital endowment, can be attributable in part to their social connectedness. Perhaps, as indicated by the correlations, social capital can result in improvements in both physical and human capital. Social capital had no influence on financial capital. This could be due to a number of reasons. First, the reliability of the metric for financial capital is questionable in most rural household studies as respondents are usually reluctant to divulge their earnings. Second, household income fluctuates more than other household capital, for instance, even when household income is low other capitals such as physical capital can still be high. Lastly, financial capital is invested into other household capitals like physical and human capitals. So, household reporting will usually capture livelihood capitals that would have accrued from financial capital more reliably than financial capitals. Thus, studies advocate for the use of physical capital (asset index) as a more stable wealth index (Filmer and Pritchett 2001, Booysen et al. 2008). These findings are in line with the argument of complementarity (Ekins et al. 2003b, Abenakyo et al. 2007), whereby social capital complements human and physical capitals in rural household livelihoods.

The practical implications of the observed positive association between social capital and use of natural capital can be multifaceted due to complexity of interactions and diverse pathways of causality or association between capitals. Social capital appears to have positive association with natural resource types and natural resource use intensity, whereby natural resource types and

intensity of use increase with increase in social capital. Plausible explanations could be; greater access to or use of social capital can enhance acquisition of natural resources. On the other hand, greater reliance on social capital as a coping strategy can coincide with greater use of resources as another coping strategy in a complementary manner. Then again, the use of natural resources, for instance harvesting wood, can create opportunities for strengthening social capital, perhaps community members are more likely to lend and borrow from neighbours whom they know well from harvesting wood together.

2.4.2 Social capital and natural resource use

In Bushbuckridge, there were divergent impacts of social capital on three dimensions of natural resource use. It can be seen that as social capital increased, the number of natural resources used by a particular household also increased. These findings are inconsistent with most literature that argues that households with higher social capital are more likely to have improved welfare (Maluccio et al. 2000), and thus by inference, reduced reliance on natural resource consumption (Dovie et al. 2002). On the other hand, it can be argued that use of natural resources contributes to welfare, especially of poorer households, for instance by enabling costs savings and contributing to food security. This disparity could emanate from the natural resource use metric used in these studies, which does not separate natural resource use dimensions. A household can use several types of resources but not in large quantities or more frequently. The interactions terms between social capital and all other livelihood capitals had no significant influence on the number of natural resources used by household. A probable explanation for this is that these livelihood capitals are acting singly in influencing the number of resources used per household. It can be deduced that household livelihood capitals are complementary in their influence on natural resource use, and the advantage of an accumulation of one livelihood capital can be discounted by the lack of another.

Social capital was significantly associated with an increase in the intensity of natural resource use. In practical terms, this could imply that social capital could be a characteristic of people who use natural resources frequently. Frequency of use might be a more robust indicator of dependency on natural resources than both types and quantities. Several studies have shown that absolute

environmental income increases with natural resource use, but households in the poorest income quintile or middle income earners have the largest environmental income share (Angelsen and Wunder 2003, Adhikari et al. 2004a, Fisher 2004, Fisher and Shively 2005, Vedeld et al. 2007, McElwee 2008). It is interesting to note that several studies do not conclude with a single standpoint on the relationship between household natural resource use and wealth status (Adhikari et al. 2004a, Shackleton and Shackleton 2006). A likely explanation is that defining natural resource use or natural resource dependency at household level is complex (McSweeney 2002, Newton et al. 2016). However, from this longitudinal analysis, it can be deduced that higher physical capital (our measure of wealth) appears to be strongly associated with significant lower natural resource use.

In addition, analyses indicate that social capital stock is less influential in reducing natural resource use by households. In fact, as highlighted earlier, there appears to be greater natural resource use as the household stock of social capital increases. Again, this is inconsistent with some studies on the subject, which submit that social capital can improve household welfare (Grootaert 1999, Narayan and Pritchett 1999, Maluccio et al. 2000). However, this study does show that increasing resource use is consistent with decline in household welfare, but that social capital, even when correlated with both improved human and physical capitals was not associated with reduced frequency of natural resource use. It is submitted therefore, with insights from the rural context of Bushbuckridge, that the livelihood advantage presented by welfare improvements from social capital might not be adequate to offset demand for natural resources at the household level. It can thus be inferred that it is relatively easier to convert social capital stocks into certain livelihood capitals (physical and human) than others (natural capital). A plausible explanation for the lack of substitutability of natural capital could be the lack of alternatives for key resources such as fuelwood, which households might be using more frequently to lower costs of electricity. Studies have shown that even in rural areas with electricity, there is still high dependence on fuelwood for cooking and heating (Twine et al. 2003a, Matsika et al. 2013). It has been estimated that nearly 95% of rural South African households in rural areas with electricity continue to use fuelwood as a primary household energy source (Madubansi and Shackleton 2006). Importantly, they explicitly state that this is likely due to economic limitation of using electricity for thermal uses (Madubansi and Shackleton 2007). Consequently, although households might accrue benefits from

social capital and other livelihood capitals, they might still make the decision to subsidise household expenditure by using natural resource alternatives. Once more, household livelihood capitals here exhibit a complementary rather than substitutionary relationship.

Finally, social capital was associated with significant declines in the quantities of natural resources used by rural households. A possible explanation for this unexpected observation is the dominance of fuelwood in total resource use by rural households (Madubansi and Shackleton 2007, Pereira et al. 2011, Wessels et al. 2013). It has been reported elsewhere in South Africa that fuelwood contributes the highest to the direct use value of natural resources for rural households (Twine et al. 2003a). As a result, most of the value that constitutes the metric for quantity of natural resources used in this study would be for fuelwood (Table 3). As such, if a household uses alternative sources of energy like electricity, their absolute natural resource use value would significantly decline, yet the number of other natural resources they use remains high, and the frequency of their use remains the same. It is acknowledged that short recall methods of acquiring data that could result inaccuracies in the household reporting of the quantities of natural resources used. However, the data were explored in several dimensions and thus presents a clearer picture of the relationships under study. As discussed earlier, a measure of intensity, derived from how frequently a household uses natural resources, was significantly influenced by social capital. Here, variable interactions of social capital and these three dimensions of natural resource use are observed. It is prudent to explore this relationship in such a manner, since it delivers novel understanding of rural household natural resource use landscape dynamics.

2.5 CONCLUSION

The interactions between social capital and natural resource use were examined after accounting for the influence of other household livelihood capitals in nine villages of Bushbuckridge, South Africa. The sustainable livelihood framework was used to guide analyses of longitudinal household survey data (2010-2014), which allowed for the control of undetected time-independent factors at the household level. Social capital was associated with improvements in other household livelihood capitals. However, social capital was not accompanied by significantly lower dependence on natural resource use at household level. In fact, the number of natural resources per

household per capita and the intensity of natural resource use increased as social capital increased. These findings seem to suggest that higher social capital is an attribute of households that are more dependent on natural resources and use a wider range of resources. However, these are not necessarily the poorer households, as social capital has a positive association with physical capital, the metric of household wealth status. Other capitals, particularly physical and human capitals, were associated with reduced quantities and intensity of natural resource use, and thus appear to be more important in reducing dependence of rural households on natural resources. In view of this, programs that encourage social capital building for improved livelihoods, should not be isolated from wealth-building initiatives in poorer communities. Interventions should focus on building social capital that goes beyond poor communities, to improve access to credit and markets to enable households to build physical and human capital. It emerges that the interactions between social capital and other livelihood capitals are rather complementary rather than substitutionary. However, the extent of substitutability between the capitals cannot be determined, and future study can look into the sustainability of the rural socio-ecological systems as the critical, non-substitutable natural capital declines. In addition, it is apparent that although social capital can contribute to improved household welfare, the net advantage is not sufficient to offset demand for natural resources.

CHAPTER 3

The safety net role of social capital and natural resources for rural households exposed to livelihood shocks

ABSTRACT

Rural livelihoods in developing countries are disproportionately vulnerable to multiple shocks and stresses that can exacerbate vulnerability, which can result in increased dependence on natural resources. However, the role of social capital as a safety that can potentially lower natural resource use when households experience negative shocks has been less studied. Here, the role of natural resources and social capital as buffers against negative shocks to reduce vulnerability in rural households was examined. Using five years of panel data from a rural population in South Africa, multilevel models were constructed to quantify the influence of shocks, social capital and household socio-demographic characterization on three dimensions of natural resource use, namely the number of types of natural resources used, the frequency of natural resource use, and the quantities of natural resources used. Results show that household experience of negative shocks was consistently associated with a significant increase in all dimensions of natural resource use. However, unexpectedly, social capital did not significantly reduce natural resource use when households experienced shocks. This in no way discounts the role social capital plays in cushioning households post experience of shocks, but rather leads to the conclusion that reliance on social and natural capital could be complementary rather than substitutable coping strategies post experience of shocks. Efforts to secure rural livelihoods and achieve sustainability should thus focus on building household physical capital to reduce dependency on natural resources in rural households

Keywords: negative shocks, natural resource use, social capital, vulnerability, mixed effects models.

3.1 INTRODUCTION

Rural livelihoods in developing countries are disproportionately vulnerable to multiple shocks and stresses (Ribot 2009). These shocks, such as crop and livestock loss, coupled with a widespread decline in natural resource availability, can exacerbate human vulnerability, which in turn adversely affects rural livelihoods (Pattanayak et al. 2001, Fisher 2002, O'Brien et al. 2004, Kalaba et al. 2013, Tibesigwa et al. 2015). Natural resources have a vital safety net function, particularly for households isolated from markets (Godoy et al. 1998), poorer households (Takasaki et al. 2004, Fisher and Shively 2007), and those that are at an earlier stage in the demographic cycle (McSweeney 2004). Empirical evidence of the safety net role of natural resources is widespread, with submissions that shocks precipitate greater use of forest resources, especially among asset-poor households (Shackleton and Shackleton 2004, Debela et al. 2012, López-Feldman 2014, Tibesigwa et al. 2015). Further, natural resources are shown to have a gap-filling role, whereby households can turn to them in times of adversity or during seasonal fluctuations in household income (McSweeney 2004, Wunder et al. 2014).

The use of natural resources in mitigating vulnerability has often been reported as an attribute of poorer rural households (see for instance Chambers & Leach 1990; Kant 1997; Shackleton & Shackleton 2004). In Malawi, Fisher (2004) demonstrated that asset-poor households are more dependent on natural resources than their relatively wealthier counterparts. However, several sources have provided conflicting empirical evidence, showing that even when the poor are more reliant on natural resources, greater absolute benefits accrue to the wealthier households (Cavendish 1998, 2000, Escobal and Aldana 2003, Shackleton and Shackleton 2006, Mamo et al. 2007). This amplifies earlier calls to give greater attention to this role of natural resources in sustainable rural livelihoods studies (Cavendish 2000, Pattanayak et al. 2001, Fisher 2002), and especially when there have experienced negative shocks.

Another important safety net, albeit less explored than natural resources in livelihoods literature, is social capital. Social capital is a multidimensional concept referring to the relationships between individuals, households and communities and the resources that accrue from these associations. A few studies exist that have explored the role of social capital in enhancing household welfare and

food security (Maluccio et al. 2000, Carter and Maluccio 2003, Misselhorn 2009), and the role of social capital in dealing with agriculture-related shocks and economic shocks (Carter and Maluccio 2003, Carter and Barrett 2006, Tibesigwa et al. 2015). These studies support the notion that social capital is a stock of capital that a household can draw on in times of adversity. Yet, the influence of social capital on household livelihood is not simply an issue of the extent to which people are connected to others, but equally the nature of those connections, since the influence of social capital is more profound when networks exist among heterogeneous communities (see for instance Narayan and Cassidy 2001).

As highlighted earlier, poorer households are substantially more vulnerable to negative shocks. It has been argued that rural households without access, or with limited access, to natural resources are particularly more vulnerable (Shah, 1997; FAO, 2006). As a result, they may have difficulty in obtaining food, accumulating other assets, and recuperating after natural or market-related shocks or misfortunes (Cavendish, 2000; Ellis & Allison, 2004). Although the use of natural resources is well documented, there is bound to be substantial variability of when, how, and to what extent rural households turn to natural resources to recuperate after experiencing shocks. There is a growing body of evidence on the role of social capital in household coping with sudden shocks (Carter and Maluccio 2003, McSweeney 2004, Misselhorn 2009). However, social capital and connectedness have been shown to have a significant yet complex interface with household resource access and use, and overall recovery from negative shocks and stresses (Debela et al. 2012). Using this thinking, an apt conjecture is that the more social ties a person or household has, the more of social capital advantage they possess, and the less dependent they will be on local natural resources. However, the interactions between social capital and natural resource use in a context of vulnerability to shocks have not been explored.

In order to understand the role of both social capital and natural capital as safety nets when household experience negative shocks, three key questions are addressed using a panel of 590 households in nine South African villages over five years. First, what is the impact on negative shocks on three dimensions of household natural resource use: number of natural resources, intensity of natural resource and quantity of natural resource? Second, how does the influence of shocks on natural resource use vary with household physical assets, household income, gender of

household head and other household characterization variables? Lastly, how does social capital (group memberships and reciprocity) impact the relationship between natural resource use, shocks and household characterization? The findings have important implications for understanding the underlying dynamics of rural livelihoods, particularly impact of vulnerability and the role played by social capital. In order to unpack the complex interactions, the sustainable livelihoods framework and socio-ecological modelling were employed. Thus, the study contributes novel insights that could be beneficial both to design of interventions in natural resources management and use and to methodology in exploring rural livelihoods.

3.2 METHODS

3.2.1 Study area

Refer to Chapter 1, section 1.6 for a description of the study site.

3.2.2 Approach and description of variables

The study was carried out as part of the Sustainability in Communal Socio-Ecological Systems (SUCSES) project which falls under the Agincourt Health and Socio-Demographic Surveillance System (AHDSS). SUCSES is a multidimensional study of the interactions on the environment, rural livelihoods and human-well-being. SUCSES employed an in-depth questionnaire to survey 590 households over a 5 year period from 2010-2014. The response variables were three dimensions of natural resource use; number of natural resources, intensity of natural resource use, and quantity of natural resources. The factors were first negative shocks only, then negative shocks and household characterization, and lastly negative shocks, household characterization and social capital. Negative shocks are adverse events that lead to a loss of household income, or a decrease in consumption, and/or loss of household productive assets (Dercon 2005). Negative shocks were defined first as a binary variable (yes/no) to indicate whether or not a household had experienced at least one negative shock in the last 12 months. Second, defined shocks were defined as a continuous variable (total shocks), as the total number of shocks that the household had experienced in a year. The binary variable reduces bias that comes with the recall method

(Tibesigwa et al. 2015). The continuous shocks variable was maintained to diversify the analyses. Owing to the broad definitions of social capital (Coleman 1988, Putnam 1993, Serageldin and Grootaert 2000) and the need for contextual consideration of the concept, the social capital variable was narrowed to three proxies; group memberships, reciprocity, and social capital index. Group memberships, referred to elsewhere as formal social capital (Pichler and Wallace 2007, Tibesigwa et al. 2015), are the total number of affiliations to institutions, organizations or associations by members of a particular household. Reciprocity is a two-pronged variable that captures the giving (reciprocity-give) or receiving (reciprocity-receive) of assistance by rural households from kinship or neighbourhood connections. Finally, social capital index is an aggregated metric that combines group memberships and reciprocity to compute one variable for social capital at household level. Guided by literature and context, variables were selected to account for household characterization. These include an asset index (physical capital), an income index (financial capital), and household size, age of household head and proportion of female-headed households. For natural resource use, three variables were considered, the number of types of natural resources, the intensity of natural resource use measure (derived from the frequency of use by households of the most widely used resources), and the quantities of natural resources used. Refer to Chapter 2 for a comprehensive description of the data collection procedure and the derivation of the metrics for the three dimensions of natural resource use, social capital and physical asset indices.

3.2.3 Data analysis

In exploring the relationship between natural resource use and household experience of shocks, empirical models were fitted with various combinations of predictor variables. Natural resource use (number of resources, intensity of use, resource quantity) was predicted first by experience of shocks expressed both as a binary and continuous variable (presence or absence of shocks per time *t* and total number of shocks experienced in period *t* respectively). Second, models were fitted for the relationship between natural resource and shocks, accounting for household characteristics (X_{it}), such as household size, gender of the household head and physical assets. Third, the relationship between all dimensions of social capital, two shock variables, household characteristics and three dimensions of social capital (group memberships, reciprocity-give and reciprocity-receive) were explored. Last, models were fitted to predict all dimensions of natural

resource use from shocks, household characterization and an aggregated metric of social capital dimensions, the social capital index. We adapted a general model from current literature (Tibesigwa et al. 2015), and modified it to our context as shown below;

$$Y_{it} = f(Shock_{it} + X_{it} + \varepsilon)$$

where Y_{it} is each of three dimensions of natural resource use (number, intensity and quantity of natural resources used), $Shock_{it}$ is either i) a binary variable indicating presence or absence of shocks at time *t* and ii) a continuous variable indicating the total number of shocks experienced at time *t*, X_{it} describes household characterization (household size, gender of household head, physical assets, social capital and so on), ε is a term that specifies the random error term.

All statistical procedures were conducted using R statistical software version 3.2.3 (www.r-project.org). For each of the response variables a set of generalized linear mixed effects models (GLMMs) fit by maximum likelihood (Laplace Approximation) with Poisson error distributions was constructed to examine the relationship between the response variable and the factors. GLMMs were applied using the *lme4* package in R (Bates et al. 2015). For each global model for one response variable the factors were shock occurrence (binary variable for no shock or at least one shock in a year), total shocks (count of all shocks that occurred in a year) and households characteristics (household size, age and gender of household head, and two dimensions of social capital as reciprocity (which was subdivided into give and receive, for giving and receiving of help from another household respectively) and group memberships (a count of all community formal institutions that members of a particular household reported being part of).

3.3 RESULTS

3.3.1 General description

The most prevalent type of shock in the area was crop loss and/or failure, while that least experienced by households was inheriting debt from deceased member of a household (Figure 1). The highest report for crop failure was in 2012 and the least in the baseline year (2010). A greater

proportion of households experienced shocks in 2012, while the least was in 2013 (Figure 2). Table 1 summarizes the variables used in the models.

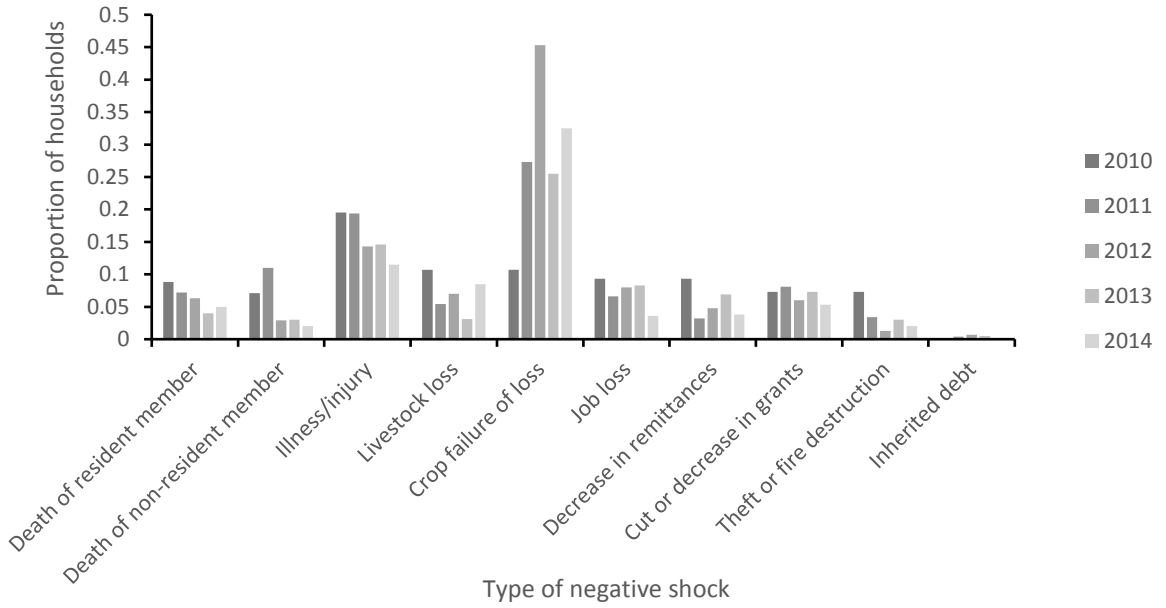

Figure 1. Proportion of households experiencing various types of negative shocks in nine study villages of Bushbuckridge from 2010 to 2014.

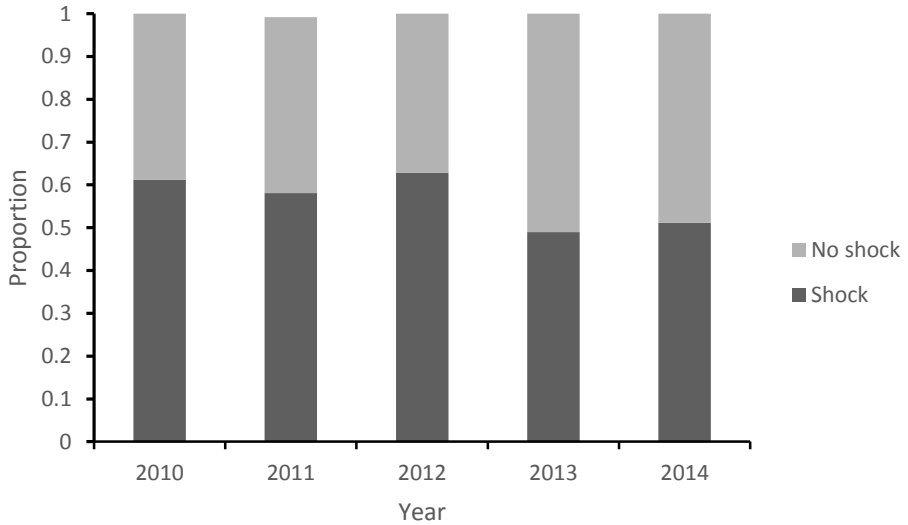

Figure 2. Proportions indicating occurrence or non-occurrence of negative shocks at household level in Bushbuckridge, 2010-2014.

Table 10. Summary statistics (mean, standard deviation and standard error) for predictor variables used in mixed effects models

Variable name	Sample size (N)	Mean	SD	Std. error
Household-level variables				
Negative shocks (total per year)	2863	0.920	1.009	0.019
Occurrence of at least one shock (binary Yes/No)	1610	0.580	0.493	0.010
Social capital				
Aggregate social capital	591	0.887	0.502	0.096
Group memberships	591	0.561	0.389	0.008
Reciprocity-give	591	0.140	0.145	0.003
Reciprocity-receive	591	0.173	0.200	0.004
Natural resource use				
Number of natural resources	591	3.09	1.169	0.023
Total resource volume (litres)	591	798.42	1319.76	25.50
Intensity of use	591	6.900	3.035	0.059
Financial capital index	591	0.153	0.238	0.005
Physical capital index, selected assets	591	0.943	0.345	0.007
Age of household head, years	591	54.2	13.9	0.3
Female-headed household, share	139	0.430	-	-
Household size, adult equivalents	591	8.2	4.2	0.1

3.3.2 Natural resource use, negative shocks and social capital

3.3.2.1 Shocks and natural resource use

First, I present results of the association between natural resource use and negative shock with shocks as the only explanatory variable (both a binary shock variable and a continuous shock variable). Experience of shocks was associated with increased number of natural resource types for both total number of shocks and binary shock variables ($p<0.01$ and $p<0.05$ respectively) (Table 2, Panel A, models 1 and 2). Households that had experienced at least one shock had used 5% more types of natural resources than those that had not experienced any shock (Table 2, model A1). In addition, a unit increase in total shocks was associated with a 3% increase in the number of types of natural resources used per household a unit increase in natural resource use (Table 2, model A2). In Panel B, models 1 and 2 show that both the binary and the total shock variables had

significant positive associations with the intensity of natural resource use ($p<0.001$). The occurrence of at least one shock was associated with an 8% increase in natural resource use intensity (model 3), whereas a unit increase in total shocks per household was associated with a 5% increase in natural resource use intensity (model 4) (Table 1). In Panel C, models 5 and 6, both total and binary shock variables had a significant positive association with the quantity of natural resources used by households in the study villages ($p<0.01$ and $p<0.001$ respectively) (Table 2). Experience of at least one shock was associated with a 43% increase in the quantity of natural resources use by a household (model 5), whereas a unit increase in total shocks was associated with a 26% rise in the quantity of natural resources used (model 6).

Table 2. Estimates (standard errors in parentheses) of the generalized linear mixed effect models (Poisson distribution) for influence of negative shocks (binary and total) on three dimensions of natural resource use: number of natural resource types (Panel A), intensity of natural resource use (Panel B) and quantity of natural resources used (Panel C).

Panel A. Number of natural resources			
Variables	**1**	**Variables**	**2**
Intercept	1.098***	Intercept	1.094***
Shocks (Yes)	0.044*	Total shocks	0.032**
Panel B. Natural resource use intensity			
Variables	**3**	**Variables**	**4**
Intercept	1.860***	Intercept	1.862***
Shocks (Yes)	0.075***	Total shocks	0.045***
Panel C. Quantity of natural resources			
Variables	**5**	**Variables**	**6**
Intercept	5.618***	Intercept	5.615***
Shocks (Yes)	0.355***	Total shocks	0.228***

*** p<0.05, ** p<0.01, and *** p<0.001**

3.3.2.2 Shocks, household characterization and natural resource use

The influence of negative shocks on three dimensions of natural resource use, after accounting for household characterization is shown in Table 3. In models 1 and 2, the binary shocks variable had no significant relation with types of natural resource used, whereas the total shock variable had a

significant positive association with number of types of natural resource used ($p<0.001$). A unit increase in total shocks was associated with a 3% rise in the number of types of natural resources used. In addition, in both models 1 and 2, household size ($p<0.001$) had a significant relationship with the number of types natural resources used (Table 3). The addition of one member to a household was associated with 1.4% rise in the number of types of natural resources consumed by a household. Age and gender of household head, financial and physical capital indices had no significant relationships with the number of types of natural resource used when households experienced negative shocks.

In models 3 and 4, both binary and total shocks variables still had a significant positive association with natural resource use intensity ($p<0.001$) (Table 3). In model 3, the occurrence of at least one shock was associated with 6% increase in natural resource use intensity, whereas in model 4, a unit increase total shocks was associated with a 3.4% times increase in natural resource use intensity. In both models, household size and physical assets had a significant influence on natural resource use intensity ($p<0.001$), although their impacts were divergent. The influence of an additional household member in model was a 2% increase in household natural resource use intensity, while a unit increase in physical assets ownership resulted in *circa* 84% decline in the intensity of natural resource use. In both models, age and gender of the household head and financial capital index had no significant relationship with the intensity of natural resource use.

In models 5 and 6, shocks were associated with substantial increases in the quantity of natural resource used. For instance, in model 5, the occurrence of at least one shock was accompanied by a 31% increase in the quantity of natural resources used, whereas in model 6, a unit increase in total shocks was associated 19% increase in the response variable. In addition, household size, the age of head of the household and physical capital had significant but divergent relationships with the quantity of natural resources used by households when they experienced shocks. First, physical capital was associated with approximately 63% decline in the quantity of natural resources used. Second, an additional household member was associated with an 8% increase in the quantity of natural resources used. Last, households with older household heads used more natural resources than their counterparts, as indicated by the significant positive estimates (Table 3, models 5 and 6).

Table 3. Estimates (standard errors on parentheses) of generalized linear mixed effect models (Poisson distribution) output for influence of negative shocks on three dimensions of natural resource use: number of natural resource types (Panel A), intensity of natural resource use (Panel B) and quantity of natural resources used (Panel C) accounting for household characteristics.

Panel A. Types of natural resources			
Variables	**1**	**Variables**	**2**
Intercept	1.019***	Intercept	1.017***
	(0.059)		(0.059)
Shocks (yes)	0.035	Total shocks	0.025*
	(0.023)		(0.011)
Household size	0.014***	Household size	0.013***
	(0.003)		(0.003)
Gender of household head (female)	-0.043	Gender of household head (female)	-0.043.
	(0.023)		(0.023)
Age of household head	0.001	Age of household head	0.001
	(0.001)		(0.001)
Financial capital index	0.044	Financial capital index	0.044
	(0.043)		(0.043)
Physical capital index	-0.049	Physical capital index	-0.046
	(0.033)		(0.033)
Panel B. Intensity of natural resource use			
Variables	**3**	**Variables**	**4**
Intercept	1.875***	Intercept	1.878***
	(0.057)		(0.056)
Shocks (yes)	0.056***	Total shocks	0.033***
	(0.017)		(0.008)
Household size	0.016***	Household size	0.016***
	(0.002)		(0.002)
Gender of household head (female)	0.007	Gender of household head (female)	-0.007
	(0.017)		(0.017)
Age of household head	0.001	Age of household head	0.001
	(0.001)		(0.001)
Financial capital index	-0.004	Financial index	-0.004
	(0.035)		(0.035)
Physical capital index	-0.177***	Physical capital	-0.174***
	(0.025)		(0.024)
Panel C. Quantities of natural resources used			
Variables	**5**	**Variables**	**6**
Intercept	4.940***	Intercept	4.943***
	(0.155)		(0.154)
Shocks (yes)	0.270***	Total shocks	0.173***

	(0.060)		(0.030)
Household size	0.077***	Household size	0.075***
	(0.007)		(0.008)
Gender of household head (female)	-0.084	Gender of household head (female)	-0.087
	(0.061)		(0.061)
Age of household head	0.011***	Age of household head	0.011***
	(0.002)		(0.002)
Financial capital index	0.008	Financial capital index	0.007
	(0.125)		(0.124)
Physical capital index	-0.484***	Physical capital index	-0.465***
	(0.089)		(0.089)

*** p<0.05 and *** p<0.001.**

3.3.2.3 Shocks, social capital and natural resource use

The interrelations of three dimensions natural resource use and negative shocks, accounting for household characteristics and social capital dimensions of group memberships, reciprocity-receive, reciprocity-give and social capital index were quantified to further explore the role of social capital in natural resource use when households have experienced negative shocks (Table 4, models 1-12). First, the social capital metric used was an aggregation of the three dimensions of group memberships, reciprocity (give) and reciprocity (receive) combined to compute a single household social capital index. In models 1 and 2, the social capital was accompanied a significant rise (18%) in number of natural resource types with both binary and total shock variables ($p<0.001$). Similarly, the social capital index was associated with approximately 11% increase in the intensity of natural resource use in both binary and total shocks models (models 5 and 6). However, the social capital index had no significant relationship with the quantity of natural resources used ($p=0.05$ and $p=0.730$) (models 9 and 10) in the presence of negative shocks.

When social capital was disaggregated into group memberships and reciprocity (receive and give), differential outcomes were observed. Both group memberships and reciprocity-receive had a significant positive relationship with the number of types of natural resources used ($p<0.001$ and $p<0.01$ respectively), whereas reciprocity-give did not have a significant association with the types of natural resources used ($p=0.06$), although it had a positive estimate. A unit increase in group

memberships was associated with about 13% increase in the types of natural resource used, whereas the receiving of help was associated with a 7% increase in natural resource use (Table, 4, models 3 and 4). Similarly, group memberships were associated with approximately 13% increase in the intensity of natural resources used ($p<0.001$), while reciprocity-receive was associated with a 7% increase in the intensity of natural resource use ($p<0.001$) per household (Table 4, models 7 and 8). Again, reciprocity-give had no significant relationship with the intensity of natural resource use ($p=0.671$). Furthermore, group memberships were associates with an increase in the quantity of natural resources used ($p<0.001$), whereas, the receiving of help had no significant relationship with the quantity of natural resources used ($p=0.730$). A unit increase in group memberships was associated with approximately 58% in the quantity of natural resources used ($p<0.001$). Interestingly, reciprocity-give was associated with significant declines in the quantity of natural resources used ($p<0.001$).

The giving of help was associated with approximately 75% decline in the quantity of natural resources used, in both binary and total shock variable models (Table 4, models 11 and 12. As expected, in all model variations, physical capital consistently had a significant negative relationship with natural resource use, resulting in between 58% and 95% declines in natural resources. Nevertheless, financial capital had no significant influence in all models. Household size had a small but significant influence on the types of natural resources used, intensity of natural resource use and the quantity of natural resources used, with between 1% and 8% influence on natural resource use dimensions in all model variations with binary and continuous shocks variables. The age of the household head only influenced the quantity of natural resources used ($p<0.001$), while gender of the household head had no influence on all dimensions of natural resources. The models with interaction effects between social capital and both binary and continuous shock variables were applied but had no significant influence on all the three dimensions of natural resource use and so were left out.

Table 4. Estimates (standard errors in parenthesis) of the generalized linear mixed effect models (Poisson distribution) for influence of negative shocks on three dimensions of natural resource use: number of natural resource types (Panel A), intensity of natural resource use (Panel B) and quantity of natural resources used (Panel C) accounting for household characteristics and social capital.

A. Types of natural resources							
Variables	**1**	**Variables**	**2**	**Variables**	**3**	**Variables**	**4**
Intercept	0.892***	Intercept	0.892***	Intercept	0.919***	Intercept	0.919***
	(0.062)		(0.062)		(0.062)		(0.061)
Shock (yes)	0.019	Total shocks	0.015	Shocks (yes)	0.023	Total shocks	0.017
	(0.023)		(0.011)		(0.023)		(0.011)
HH size	0.013***	HH size	0.012***	HH size	0.013***	HH size	0.012***
	(0.003)		(0.003)		(0.003)		(0.003)
Gender of HH head (female)	-0.043.	Gender of HH head	-0.043.	Gender of HH head	-0.046*	Gender of HH head (female)	-0.047*
	(0.023)		(0.023)		(0.023)		(0.023)
Age of HH head	0.001	Age of HH head	0.001	Age of HH head	0.001	Age of HH head	0.001
	(0.001)		(0.001)		(0.001)		(0.001)
Financial capital index	0.011	Financial capital index	0.012	Financial capital index	0.013	Financial capital index	0.013
	(0.045)		(0.045)		(0.046)		(0.046)
Physical capital index	-0.092**	Physical capital index	-0.089**	Physical capital index	-0.087*	Physical capital index	-0.084*
	(0.034)		(0.034)		(0.034)		(0.034)
Social capital index	0.163***	Social capital index	0.161***	Group memberships	0.118***	Group memberships	0.116***
	(0.022)		(0.022)		(0.030)		(0.030)
Social capital:Shock (Y/N)	0.024	Social capital:total shocks	-0.004	Reciprocity -give	0.046	Reciprocity -give	0.044
	(0.044)		(0.021)		(0.024)		(0.024)
				Reciprocity - receive	0.069**	Reciprocity - receive	0.068**
					(0.024)		(0.024)
B. Intensity of natural resource use							
Variables	**5**	**Variables**	**6**	**Variables**	**7**	**Variables**	**8**
Intercept	1.791***	Intercept	1.797***	Intercept	1.796***	Intercept	1.801***
	(0.059)		(0.058)		(0.059)		(0.058)
Shock (yes)	0.045**	Total shocks	0.026**	Shocks (yes)	0.047**	Total shocks	0.027**
	(0.017)		(0.008)		(0.017)		(0.008)
HH size	0.015***	HH size	0.015***	HH size	0.015***	HH size	0.014***
	(0.002)		(0.002)		(0.002)		(0.002)
Gender of HH head (female)	-0.007	Gender of HH head (female)	-0.007	Gender of HH head (female)	-0.009	Gender of HH head (female)	-0.009
	(0.017)		(0.017)		(0.017)		(0.017)
Age of HH head (female)	0.001	Age of HH head	0.001.	Age of HH head	0.001.	Age of HH head	0.001.
	(0.001)		(0.001)		(0.001)		(0.001)
Financial capital index	-0.029	Financial capital index	-0.029	Financial capital index	-0.035	Financial capital index	-0.034
	(0.035)		(0.035)		(0.034)		(0.036)
Physical capital index	-0.205***	Physical capital index	-0.202***	Physical capital	-0.205***	Physical capital	-0.201***
	(0.024)		(0.024)		(0.025)		(0.025)
Social capital index	0.111***	Social capital index	0.108***	Group memberships	0.119***	Group memberships	0.117***
	(0.017)		(0.017)		(0.022)		(0.022)

Social capital:Shock(Y/N)	0.016 (0.033)	Social capital:total shocks	0.005 (0.016)	Reciprocity -give	-0.007 (0.018)	Reciprocity -give	-0.009 (0.018)
				Reciprocity -receive	0.071*** (0.017)	Reciprocity -receive	0.070*** (0.017)
C. Quantity of natural resources							
Variables	**9**		**10**		**11**		**12**
Intercept	4.856*** (0.162)	Intercept	4.873*** (0.160)	Intercept	4.920*** (0.161)	Intercept	4.845*** (0.163)
Shock (yes)	0.259*** (0.060)	Total shocks	0.167*** (0.030)	Shocks (yes)	0.262*** (0.060)	Total shocks	0.170*** (0.029)
HH size	0.077*** (0.007)	HH size	0.074*** (0.008)	HH size	0.071*** (0.008)	HH size	0.068*** (0.008)
Gender of HH head (female)	-0.084 (0.061)	Gender of HH head (female)	-0.086 (0.061)	Gender of HH head (female)	-0.079 (0.061)	Gender of HH head	0.082 (0.060)
Age of HH head	0.011*** (0.002)	Age of HH head	0.011*** (0.002)	Age of HH head	0.012*** (0.002)	Age of HH head	0.012*** (0.002)
Financial capital index	-0.017 (0.125)	Financial capital index	-0.013 (0.125)	Financial capital index	-0.081 (0.125)	Financial capital index	-0.079 (0.125)
Physical capital index	-0.514*** (0.090)	Physical capital index	-0.490*** (-0.090)	Physical capital index	-0.542*** (0.091)	Physical capital	-0.516*** (-0.091)
Social capital index	0.112. (0.061)	Social capital index	0.093 (0.061)	Group memberships	0.456*** (0.081)	Group memberships	0.441*** (0.081)
Social capital:Shock(Y/N)	-0.120 (0.118)	Social capital:totalshocks	-0.102 (0.058)	Reciprocity -give	-0.276*** (0.063)	Reciprocity -give	-1.005*** (0.220)
				Reciprocity -receive	-0.022 (0.063)	Reciprocity -receive	-0.035 (0.160)

*** p<0.05, ** p<0.01, and *** p<0.001. HH=household**

3.4 DISCUSSION

In general, the results indicate that negative shocks precipitate increased use of natural resources and that social capital can barely cushion households from severe consequences that increase their dependence on natural capital. Indeed, this finding confirms several studies that have identified the role of natural resources as safety nets post experience of shocks (Angelsen and Wunder 2003, Vedeld et al. 2007, Paumgarten and Shackleton 2011, Kalaba et al. 2013). It has been estimated

that forest environmental incomes can contribute up to 22% to total rural household income (Vedeld et al. 2007), and thus contribute a significant portion to the rural household livelihoods portfolio. In this study, three key findings arise that answer pertinent questions on the impact of shocks on natural resource use, and the influence of social capital on that relationship. First, consistent with expectations, negative shocks were associated with significant increases in all dimensions of natural resource use: number of resources, intensity of use, and quantity of resources used. This has been observed elsewhere, where experience of shocks was accompanied by increased forest resource use, particularly among poorer households (Debela et al. 2012). Second, even when household physical assets and general characterization are controlled for, natural resource use is still markedly higher when households experience shocks than in the absence of shocks. Third, when social capital dimensions of group memberships, reciprocity-give and reciprocity-receive were accounted for, there were divergent outcomes. Group memberships and reciprocity-receive were associated with increase in the types and intensity natural resource use, while reciprocity-give was associated with declines in the quantity of natural resources used. There are several plausible explanations for these observations. To begin with, if households experience shocks, they might increase the types of natural resources that they use, that they would otherwise not use if they had other livelihood capitals to smooth household consumption. In addition, households might increase the frequency with which they use natural resources, which signals increased dependency in times when they experience shocks. Further, households might consume larger quantities of natural resources in response to livelihood shocks, perhaps as a cost-saving strategy or to fill food gaps (Byron and Arnold 1999, Pattanayak et al. 2001, Angelsen and Wunder 2003, Wunder et al. 2014).

Wealthier households might be in a better position to give assistance to other households than their poorer counterparts as they are less resource-dependent (Kar and Jacobson 2012, Thondhlana et al. 2012, Thondhlana and Muchapondwa 2013), although some studies have reported findings to the contrary (Cavendish 2000, Wunder 2001). On the other hand, households that received much help (and assuming these are poorer) had higher intensity of natural resource use, whereas higher membership in groups and the giving of help had no significant relationship with natural resource use.

Recent studies have suggested strengthening social capital for ensuring food security in rural communities, particularly when they experience shocks (Tibesigwa et al. 2014, 2015). In these studies, the argument is that social capital, particularly reciprocity, has the effect of cushioning household consumption from shocks. In their analysis, Tibesigwa et al. (2015), hypothesized that agricultural-related negative shocks are likely to have a lower impact in households with social capital. In this chapter, analyses were extended to include a portfolio of diverse shocks that are agriculture-related, and deaths or sickness, for instance, of a household member or a bread-winner, and other economic losses. However, in this instance, social capital had differential relationships with natural resource use dimensions examined. Contrary to expectations from literature, membership in groups and the receiving of help were associated with a significant increase in the demand for natural resources when households experienced negative shocks. Although this is not a direct causal relationship, inference can be made from this that social capital might not adequately cushion households from negative shocks. Instead, these social capital dimensions might be characteristics of poorer households, who i) are already more dependent on natural resource and ii) rely on natural resources more when they experience negative shocks.

Empirical evidence exists elsewhere that demonstrates that households in communities with better social capital are better equipped to deal with economic shocks (Carter and Maluccio 2003). However, it is evident from the results of this study that it is prudent to disaggregate the dimensions of social capital in analyses of household capitals as recommended by Crona et al. (2017), as these can have differential impacts on other livelihood capitals. In addition, due to the variable nature of social capital, from household to another, extrapolation of findings from one context to another should be done with caution (Misselhorn 2009). Nevertheless, broader findings in other studies that have identified both natural resources and social capital as critical safety nets post experience of shocks (Reid and Vogel 2006, Kaschula 2008). In this study, households that gave more help used less natural resources even when they experienced shocks. This, taken together with the observation that physical assets considerably reduce natural resource use even when households experience negative shocks, could be an indication that more efforts for buffering from shocks should be focused on asset-building interventions. In their study, Debela et al. (2012) had similar findings, that durable assets buffer forest use, and are correlated with reduced pressure on natural resources even when households experience unforeseen shocks. In addition, other studies which

have found that although wealthier households use more absolute quantities and types of natural resources, natural resources make a greater contribution to livelihoods of poorer households relative to other sources, such as employment, (Twine et al. 2003a, Shackleton and Shackleton 2006). However, this in no way implies that social capital interventions are not useful, because as indicated in Chapter 2, social capital is correlated with increased physical capital, and as such, social capital could have positive synergies with physical assets in reducing dependence on natural resources when households experience negative shocks.

Likewise, the social capital index was positively correlated with increase in natural resource types, intensity of use and quantity of natural resource used. A possible explanation for this is that households that use more natural resources have various opportunities to build social capital through trips or networks for collection or buying of natural resources, which encourages them to build relationships for borrowing or lending and sharing information about joining societal groups. On the other hand, social capital memberships in groups, particularly the groups in our context, which include *inter alia* grocery and cash groups (locally known as *stokvel*s), religious and cultural associations, could be more appealing to the relatively poorer households who are more dependent on natural resources. Indeed, it is possible that social capital contributes significant benefits to rural households and cushion against the influence of negative shocks, yet households continue to use natural resources as part of a broader portfolio of livelihood strategies. Consequently, although social capital might have considerable effect on reducing natural resource use and the severity of the impacts of shocks on household livelihood, the overall impact is not sufficient to eliminate the negative impacts of shocks and subsequent natural resource use. Thus, social capital could be associating with natural resources in a complementary rather than a substitutionary role.

3.5 CONCLUSION

In light of the above results and discussion, three key conclusions can be drawn to answer the research questions. First, negative shocks can escalate natural resource dependency in rural households. Second, the safety net role of social capital is not sufficient to offset the demand for natural resources. Lastly, the social capital dimensions of group memberships, reciprocity-receive and reciprocity-give behaved in divergent manner in relation to natural resource use when

household experienced shocks. It was evident that the net effect of social capital is inadequate to buffer natural resource use. There are several practice and policy implications of these findings. Foremost, a focus on the sustainable extraction and conservation of natural resource would benefit households more when they experience negative shocks. Indeed, the safety net role of natural resources, and the complimentary role of social capital to rural households that experience negative shocks cannot be overemphasized. Additionally, development of better safety nets in rural areas would decrease the dependence of households on natural resources, primarily interventions that focus on durable asset-building for households as they can reduce pressure on declining natural resources in communal woodlands. Further, and more generally, interventions can focus on diversifying rural livelihoods portfolios to enhance alternative income sources for rural households to reduce both the impact of negative shocks and subsequent natural resource dependency. The findings in this study have implications for the design of local level vulnerability-reduction interventions, and can be applied broadly in informing formulation of interventions elsewhere. However, further research is needed to explore how shock typology, for instance, magnitude of shocks (perhaps as reported by the respondents) influences natural resource use and consequently the role of social capital. Also, studies can explore locally applicable ways of wealth building, for instance extending local structures like cash groups to encompass small business capital lending to develop enterprises.

CHAPTER 4

Social capital across a natural resource availability gradient

ABSTRACT

Social capital improvements associated with better resource availability and resource management have started receiving increasing attention in literature. In this line of argument, social capital can be eroded by poor resource availability and/or breakdown in traditional resource management regimes. However, limited research has been done on whether better resource availability (measured as Enhanced Vegetation Index (EVI)) can foster better social relations, improving social capital. In order to improve understanding of the dynamics of social capital, variation in social capital dimensions of reciprocity and group memberships were investigated across a natural resource availability gradient in a semi-arid communal area in South Africa. It was hypothesized that social capital would be higher in areas with high resource availability because there are fewer conflicts over resource access and use. Associations between reciprocity (both give and receive) and group memberships across villages, EVI clusters, and years were conducted using chi-squared tests of independence and generalized linear mixed effects models. One-way analysis of variance was used to test whether there was significant difference between natural resource use dimensions across EVI clusters. The relationships between social capital and natural resource availability varied according to social capital metric used. Both reciprocity-receive and reciprocity-give were higher in villages with medium EVI compared to those with high EVI. In contrast to the hypothesized relationship, group memberships decreased from high to low EVI clusters. The study underscored the importance of disaggregating the components of what is collectively referred to as social capital in empirical studies because as described, the performance of different variables of what constitute social capital can vary in relation to natural resource availability. However, much can still be done to refine and operationalize these because social capital remains highly contextual.

Keywords: social capital, Enhanced vegetation index, reciprocity, generalized linear mixed effects.

4. 1 INTRODUCTION

Social capital has been presented as fundamental to improving communal natural resource governance or management (Harper 1997, Katz 2000, Pretty and Ward 2001, Pretty 2003a). The proposed mechanisms through which social capital functions differ as widely as the definitions of the concept itself, and the wide spectrum of its effects on rural households and communities. For instance, social capital, particularly reciprocity and group memberships, has been observed to mitigate against the severe impacts of negative shocks on household livelihoods (Carter and Maluccio 2003, Tibesigwa et al. 2015). Moreover, social capital has been shown to significantly improve household welfare (Grootaert 1999, Maluccio et al. 2000, Grootaert et al. 2002, Grootaert and Narayan 2004). For instance, in Burkina Faso, Grootaert *et al.* (2002) discovered that higher levels of social capital, measured as memberships in groups, were associated with higher household per capita expenditure and better access to lines of credit. These observations are corroborated by studies in South Africa, where households in communities with higher social capital were shown to fare better in weathering negative household livelihood shocks (Maluccio et al. 2000, Carter and Maluccio 2003).

Furthermore, social capital has also been observed to be a key constituent of successful natural resource management, improving decision making, promoting sustainable practices and fostering collective action (Katz 2000, Pretty and Ward 2001, Pretty 2003a, Onyx 2004, Pretty and Smith 2004). This dimension is set in social capital theory where social capital is defined by its function (Coleman 1990). However, fewer studies have in the recent past explored social capital as an outcome of improved resource management (Barnes-Mauthe et al. 2015). In this line of argument, social capital can be eroded by poor resource availability and/or breakdown in traditional resource management regimes (Burke 2010). It has been argued that social capital can be created, maintained or broken down by the processes of natural resource management (Ostrom 1997, Leach 2002, Wagner and Fernandez-Gimenez 2008a). Arnold and Fernandez-Gimenez (2007) demonstrated that working together in community rangeland management planning can help in building social capital. For instance, natural capital can facilitate activities that create opportunities for building social capital, for instance fishing or hiking. In rural South Africa, it would be expected that activities such as harvesting of natural resources can foster networks of information

sharing, and thus strengthen social capital. For instance, women and girls may be worried about being attacked or raped in the bush when they gather wood. As such, they gather fuelwood in groups, which provides opportunities for information sharing, bonding and forming relationships which enhances social capital. Yet, harvesting of limited resources can create rivalry over access to resources in common pool or open access systems (Nemarundwe 2004, Fay 2007, Shackleton 2009). Consequently, scarcity of resources or changes in natural resources availability can result in erosion or breakdown of social capital.

However, there is scant literature documenting whether natural resource availability and natural resource management can impact social capital. For instance, a collapse of a fishing community in the Nuxalk Nation in British Columbia resulted in breakdown and decline of social networks (Burke 2010). Burke (2010) demonstrated how marine natural resources play a prominent role in maintaining social capital and social cohesion. In this case, the breakdown in management of resources in this fishing community was associated with declines in the stocks of social capital. In another setting, growth in conventional tourism in coral reefs destroyed traditional systems of natural resource use resulting in the loss of social capital on the Kenyan coastline (Hicks et al. 2009). Furthermore, previous success in collective action has been shown to promote growth of social capital, whereby new members can be encouraged to join or existing members can be maintained or increase their participation in collaborative resource management (Leach and Sabatier 2005).

Consequently, social capital becomes a cause and effect in human interactions that is cross-cutting in its nature and its outcomes, making it a particularly complex phenomenon to unpack. It is a characteristic of horizontal and vertical individual and societal interactions at different spatial and temporal scales. The first exists between groups and individuals at the same power level, while the second exists between heterogeneous groups and individuals of different societal power levels. The position of social capital as one of the key livelihoods capitals necessitates investigation into multi-scale functioning of the concept. Substantial work has been conducted on social capital as a qualitative measure, particularly the influence of its facets of norms, social cohesion and trust on societal function, decision making, natural resource governance is investigated (Katz 2000, Onyx and Bullen 2000, Pretty and Ward 2001, Pretty 2003a, Onyx 2004, Pretty and Smith 2004).

However, limited work has been done in quantifying social capital, across natural resource availability gradients. In order to improve understanding of whether better resource availability fosters better social relations, variation of social capital dimensions were investigated across a natural resource availability gradient in a semi-arid communal area of South Africa. It was hypothesized that social capital would be higher in areas with high resource availability.

4.2 METHODS

4.2.1 Study area

Refer to Chapter 1, section 1.6 for a description of the study site.

4.2.2 Data collection

4.2.2.1 Socio-economic variables

Data were collected annually from 2010 to 2014 in 590 households selected from the nine study villages using a structured questionnaire survey. Household variables including household size and household natural resource use were recorded. For a detailed explanation of how the natural resource use dimensions of intensity of use, quantity of resources used and number of natural resources were arrived at refer to Chapter 3. Attributes that are indicative of social capital in the local context were also recorded. These variables were membership in groups and reciprocity. Membership of groups was used to calculate an index of group memberships per household through Principal Component Analysis (PCA). For how these social capital indices were derived refer to a detailed explanation in Chapter 3. Reciprocity was determined from assistance received or given, which could have been food, money or any other as specified by the respondents. For reciprocity-receive, households that had sought help once or more times were assigned a presence variable (1), while those that had not sought help in that year were assigned an absence variable (0). Similarly, for reciprocity-give, households that had given help were assigned a presence variable (1), while those that had not given any help were assigned an absence variable (0).

Reciprocity is a key dimension of social capital that encapsulates the occurrence of giving or receipt of assistance from these connections kinship, neighbourhood and other such connections.

4.2.2.2 Natural resource availability

The Enhanced Vegetation Index (EVI) from time-series Moderate Resolution Imaging Spectroradiometer (MODIS) was used as a proxy for natural resource availability. EVI represents, in general terms, the degree of vegetation greenness and can thus be used as an indicator of cover. Data were collected for a 5 year period corresponding to the time of the SUCSES household survey. MODIS is a key instrument aboard the Terra (originally known as EOS AM-1) and Aqua (originally known as EOS PM-1) satellites. EVI was derived by adjusting the reflectance in the red spectral band as a function of the reflectance in the blue spectral band (Liu and Huete 1995, Huete et al. 1997), using the following equation:

$$EVI = G \times \frac{\rho_{NIR} - \rho_{red}}{\rho_{NIR} + C_1 \times \rho_{red} - C_2 \times \rho_{blue} + L}$$

where ρ_x are the full or partially atmospheric-correlated surface reflectances

L=1 and is the canopy background adjustment for correcting non-linear differential NIR and red radiant transfer through a canopy

C_1 = 6 and C_2=7.5 are aerosol resistance coefficient terms

G=2.5 and is a gain or scaling factor

The range of values for the EVI is -1 to 1, where healthy vegetation generally falls between values of 0.20 to 0.80.

EVI data were calculated for each of the study villages for the 5 year period at a resolution of 500 m. EVI values for each year were calculated by taking the annual sum of sums of 8-day composites of surface reflectance data. Using ArcGis 10.3 software, a buffer of 1000 m was used to calculate EVI values to record natural resource availability in the inter-village woodland matrix around each village, while at the same time minimizing overlaps with adjacent villages. Following previous studies, to exclude the area within the villages , as this can have artificial watering or exotic fruit

and/shade trees, flowers and remnant semi-protected native vegetation that can distort EVI values (Hunter et al. 2014). In ArcGis, using the greenness pixel values within each buffered village polygon, we generated the sum of sums of all pixel values of greenness for each buffered village polygon for the years from 2010-2014. These values were used as proxies for availability of natural resources for each village natural resource collection zone (the buffer). Villages were clustered into zones of High, Medium and Low natural resource availability, measured as vegetative cover using sum EVI per village per year using cumulative frequencies of EVI data.

4.2.3 Data analysis

The probability of reliance on social capital from neighbourhood and kinship connections across a natural resource availability gradient was modelled. The key social capital variables were group memberships and reciprocity - both the giving and receiving of help from neighbourhood or kinship connections (hereafter referred to as reciprocity-give and reciprocity-receive respectively). Preliminary comparisons of reciprocity (both give and receive) across villages, EVI clusters and years were conducted using chi-squared tests of independence in the library *car* and package *fifer* in R version 3.2.2. One-way analysis of variance was used test whether there was significant variation in natural resource use dimensions across EVI clusters. To determine whether mean reciprocity-receive and reciprocity-give metrics differed significantly between villages and EVI clusters (village zones), binomial error distribution based (logit link functions) generalized linear mixed effects models with maximum likelihood (Laplace Approximation) were fitted using *lme4* package in R version 3.2.2 (2015-08-14) (Bates et al. 2015). Model variations with household size and three dimensions of natural resource use (1) number of natural resources (2) intensity of natural resource use and (3) total resource volume and variations specified each with sum EVI, EVI cluster or village as proxies for availability of resources as explanatory variables were fitted to model determine their influence on reciprocity (both give and receive) as illustrated below.

Reciprocity (either give or receive) ~ Household size + Natural resource use intensity/volume /types + Village/EVI cluster/Sum EVI + (1|Year)

Year was included as a random effect in all models. To determine whether there was variation in group memberships across the EVI gradient, generalized linear mixed effect models (GLMMs) were fitted using maximum likelihood (Laplace approximation) and Poisson distribution. Similarly, model variations with household size and three dimensions of natural resource use (1) number of natural resources, (2) intensity of natural resource use and (3) total resource volume, and also with sum EVI, EVI cluster or village as covariates were specified to determine if group memberships was associated with availability of resources. Pairwise comparison of means across villages were conducted using Tukey's post hoc tests with the *glht* function in the *multcomp* package in R version 3.2.2 (Hothorn *et al*., 2008).

4.3 RESULTS

4.3.1 Natural resource availability

The communal rangelands of Agincourt and Xanthia villages were classified as high EVI clusters, while Cunningmore B, Justicia and Kildare were classified as Medium EVI, and Ireagh A & B, Lillydale B and Huntington were classified as Low EVI clusters (Figure 1). The highest EVI was recorded for the year 2011 whereas the lowest was recorded for 2014 (Figure 2).

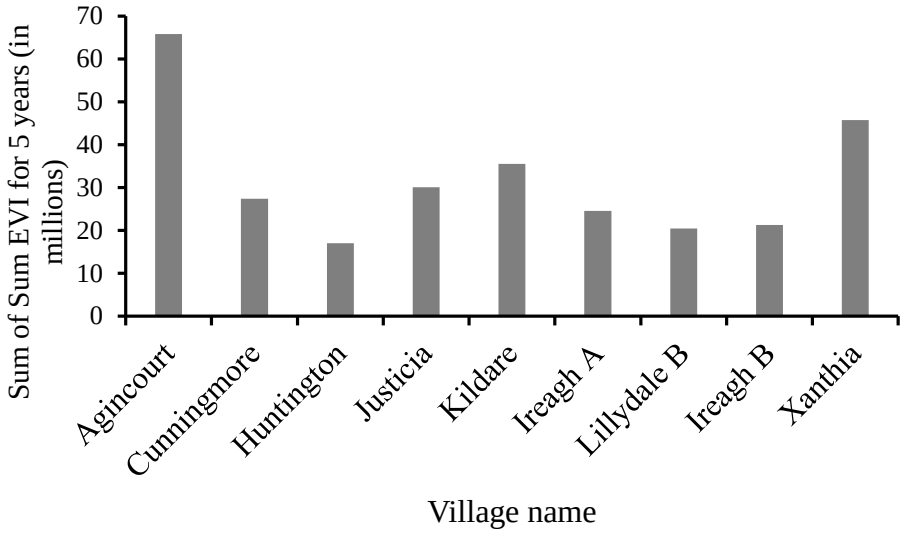

Figure 1. Sum of 8-day composites EVI values for all study villages over 5 years.

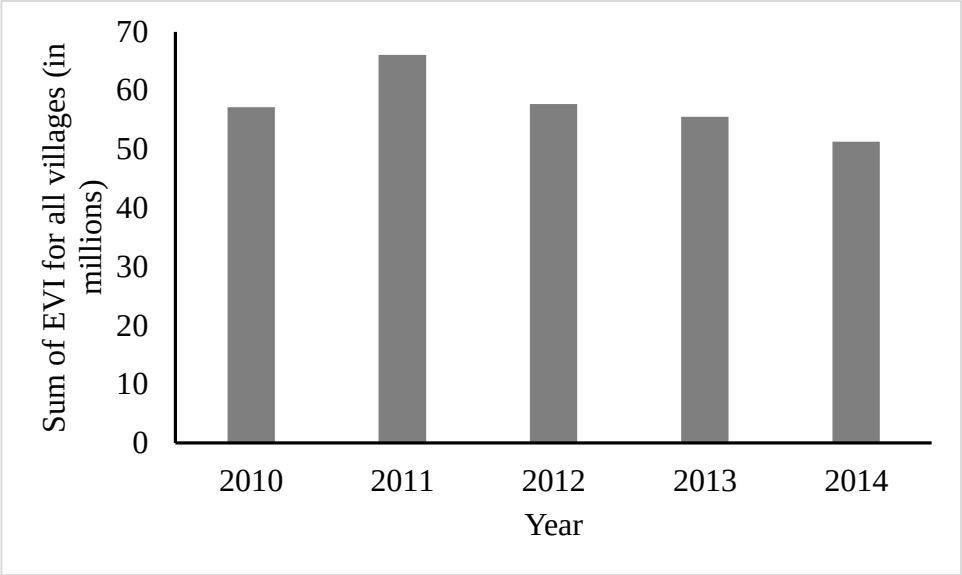

Figure 2. Annual sum of 8-day composites EVI values for all study villages.

4.3.2 Natural resources use across the EVI gradient.

Significantly higher quantity of natural resource use was recorded in households in the high EVI cluster than the medium EVI cluster, ($F=4.245$, $p<0.05$) (Figure 3c). There was no significant difference in the intensity of natural resources ($F=2.184$, $p=0.113$) and the number of natural resource types ($F=0.282$, $p=0.754$) between EVI clusters (Figures 3c and 3a respectively).

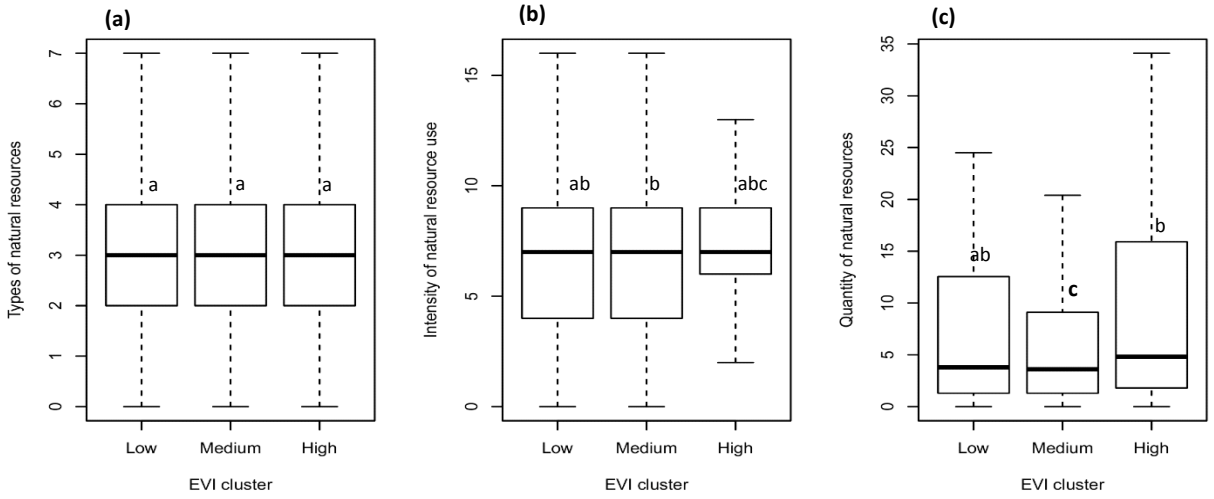

Figure 3. Variation in a) the number of natural resources, b) intensity of natural resource use and c) total resource volume across the EVI clusters of High, Medium and Low. Superscripts that share at least one letter indicate no significant differences.

4.3.3 Reciprocity across time and space

More households reported having given assistance (51%) than those that had received help (49%) (Figure 4). There was a significant association between the proportion of respondent households that had received help and the variable village ($\chi^2 = 32.01$, df = 8, $p<0.001$). Pairwise comparisons revealed that significantly more households had received help than those that had not received help in Cunningmore B, Justicia and Kildare, whereas in both Xanthia and Ireagh A, more households had not received help compared with those that had received help. There was also a significant association between the proportion of respondent households receiving help and EVI clusters ($\chi^2 = 20.51$, df = 2, $p<0.001$). Significant associations were between High and Medium, and Medium and Low EVI clusters ($p<0.01$), whereby more households had received help in the Medium cluster than in both High and Low clusters. More households in the low EVI cluster had higher reciprocity in the truest sense, in that they both gave and received assistance from neighbourhood and kinship connections (Figure 5). There was no significant association between the proportion of households giving help and those not giving help and both villages and EVI clusters. Also, there was no significant association between reciprocity-give and both study village ($\chi^2 = 3.11$, df = 8, p = 0.93) and EVI cluster ($\chi^2 = 5.02$, df = 2, p = 0.08). There was no significant association in both reciprocity-receive and reciprocity-give across the study years ($\chi^2 = 6.40$, df = 4, $p > 0.17$ and $\chi^2 = 8.91$, df = 4, p = 0.06 respectively). However, reciprocity-give had a significant association with year at 90% significance level across years (p = 0.06). Generally, there was a higher proportion of households giving or receiving help in High and Low EVI clusters than in the Medium EVI cluster (Figure 5).

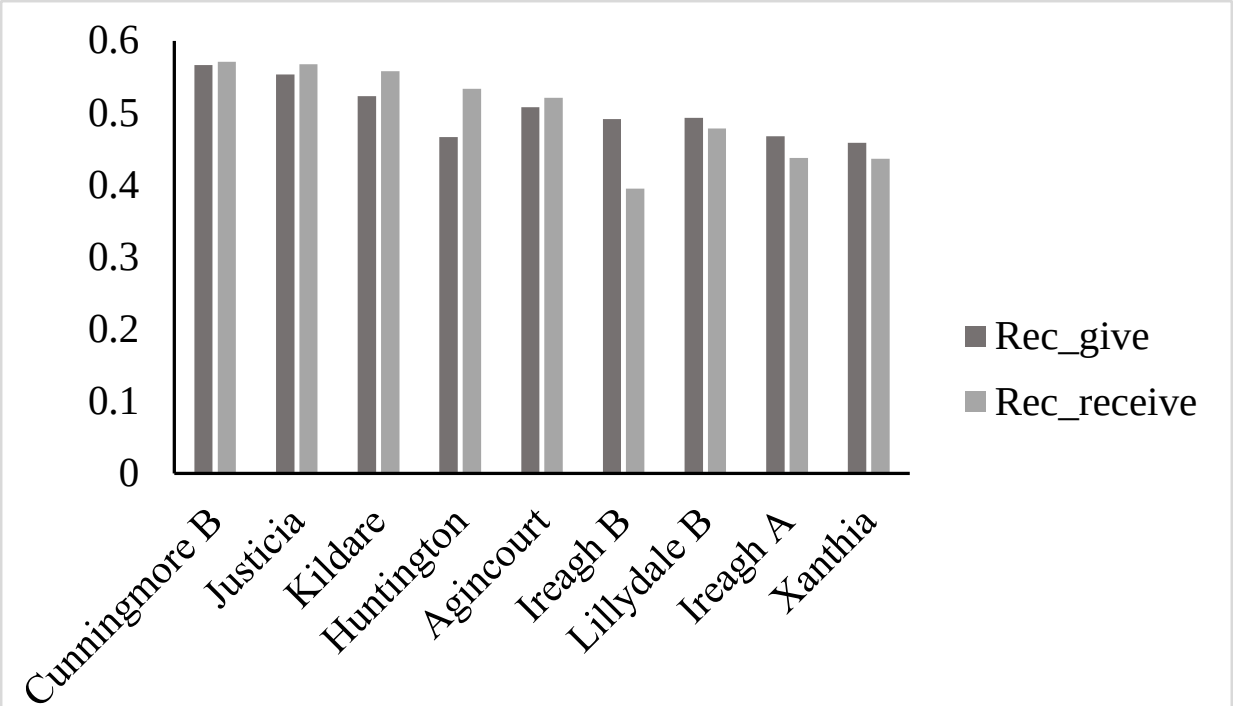

Figure 4. Proportion of households that received and gave assistance to neighbourhood and kinship connections across the nine study villages

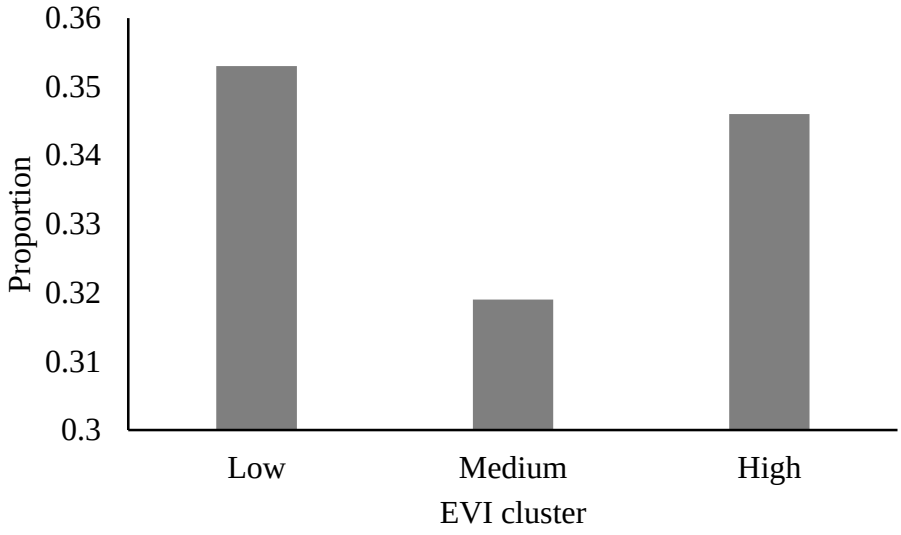

Figure 5. Proportion of households that both gave and received assistance to neighbourhood and kinship connections across EVI clusters of Low, Medium and High EVI.

4.3.4 Group membership variation

The most common group membership was for religious groups, funeral savings, grocery savings, and credit savings groups, whereas the least common were traders association, traditional authority and youth groups (Figure 6). Group memberships did not vary significantly across study villages (p=0.430) and EVI clusters (p=0.17) (Figure 7).

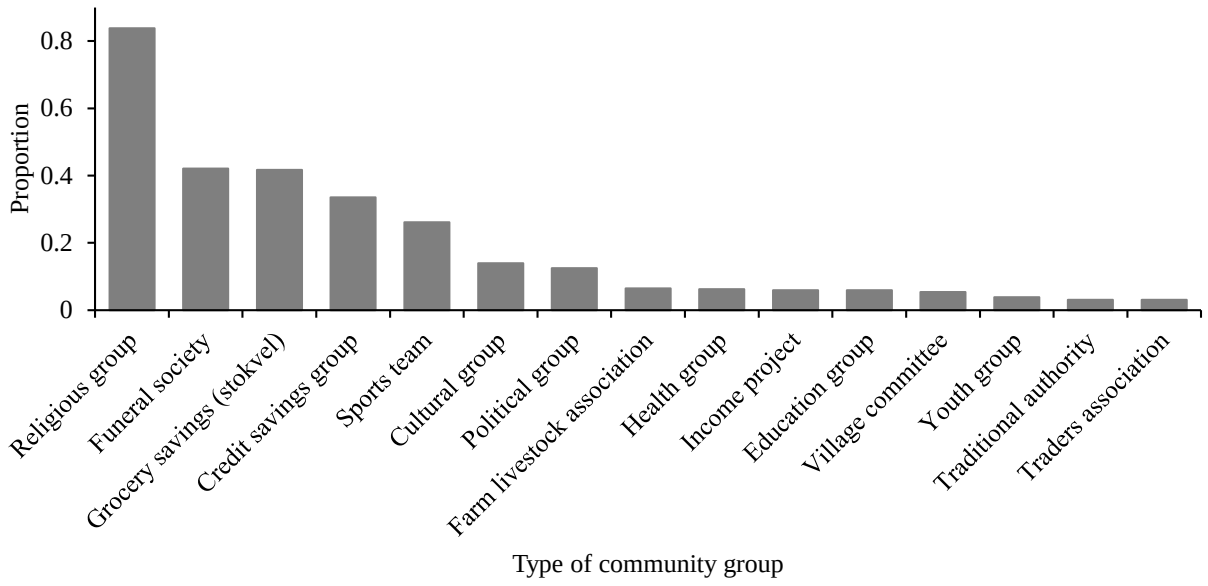

Figure 6. Memberships of respondents in different community groups in the study villages

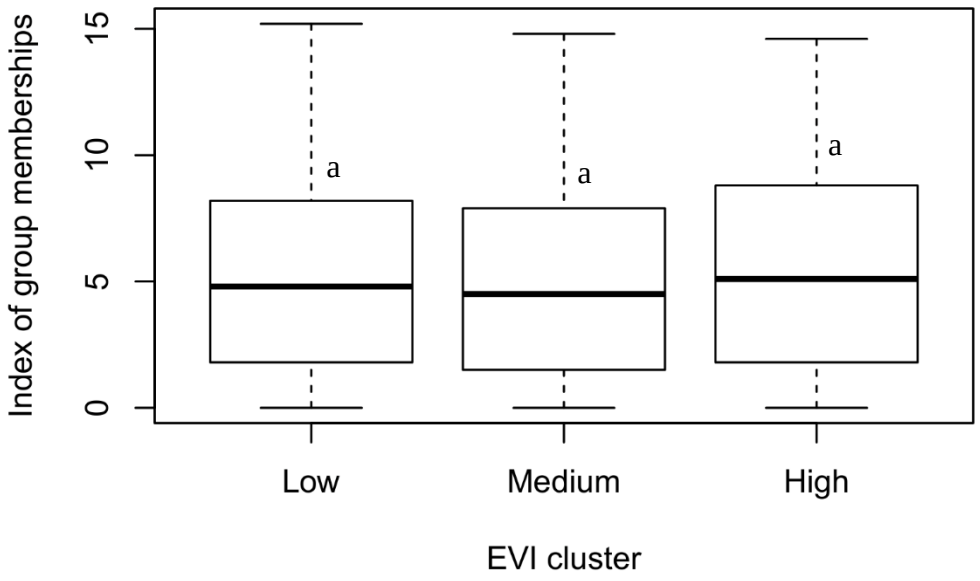

Figure 7. Variation of group memberships across EVI clusters of High, Medium and Low in Bushbuckridge

4.3.5 Reliance on social capital across the EVI gradient

4.3.5.1 Reciprocity

As we move from Agincourt village (intercept), the likelihood of households receiving help from neighbourhood and kinship connections (reciprocity-receive) decreased by 39% for villages Ireagh A and Xanthia, whereas it decreased by 35% for Ireagh B (Table 1, model A). When total resource volume was used as a covariate (Table 1, model B), only Ireagh A had a significant decline in the probability of receiving help (50%), whereas in the model with natural resource types as a covariate (Table 1, model C), the likelihood of presence versus absence of households that had sought help from neighbourhood and kinship connections (reciprocity-receive) decreased by 34% for villages Ireagh A and Xanthia, while it decreased by 30% for Ireagh B (Table 1, model C). There was no significant relationship in reciprocity-receive between Agincourt and all other villages ($p > 0.05$) (Table 1). Ireagh A and B are in low EVI cluster, while Xanthia is in high EVI cluster.

There was a significant association between reciprocity-receive and EVI clusters ($p < 0.05$) (Table 2). The likelihood of a household seeking help from neighbours and kin increased by 50% from the high EVI cluster to the medium EVI cluster as indicated by the positive estimate, while there was no significant decline from high EVI cluster to low EVI cluster (Table 2, model D). The same pattern was maintained in all model variations with total resource volume (62% increase) and number of natural resource types as covariates (46% increase) (Table 2, models E and F). However, when the numeric sum EVI was used, there was no significant relationship between sum EVI and reciprocity in all three model variations level ($p = 0.945$, $p = 0.875$, $p = 0.724$) (Table 2, models A-C). In all models household size had significant and negative relationships with reciprocity ($p < 0.05$) (Tables 1 and 2). There was no significant relationship between reciprocity-give with sum EVI and village (Table 3 & Appendix 1), while there was a significant difference across EVI clusters (Table 3). The likelihood of a household giving help increased by 53% as we move from high EVI cluster to the Medium EVI cluster (Table 3, models D-F).

Table 11. Estimates (standard errors in parentheses) of generalized linear model (binomial) for variation of reciprocity-receive across villages, accounting for household size and natural resource use intensity (Model A), total resource volume (Model B) and number of natural resources (Model C).

Variable	Model A	Model B	Model C
Intercept	-0.083	0.345**	-0.286.
	(0.157)	(0.130)	(0.160)
Household size	-0.031**	-0.021*	-0.036***
	(0.009)	(0.010)	(0.010)
Intensity of natural resource use	0.063***	-0.009*	0.225***
	(0.014)	(0.004)	(0.035)
Cunningmore B	0.170	0.162	0.087
	(0.166)	(0.165)	(0.167)
Huntington	-0.003	0.015	-0.055
	(0.179)	(0.179)	(0.180)
Ireagh A	-0.346*	-0.361*	-0.367*
	(0.164)	(0.163)	(0.164)
Ireagh B	-0.527 *	-0.527	-0.536*
	(0.215)	(0.215)	(0.216)
Justicia	0.175	0.168	0.158
	(0.137)	(0.137)	(0.138)
Kildare	0.162	0.117	0.138
	(0.125)	(0.124)	(0.125)
Lillydale B	-0.185	-0.199	-0.193
	(0.195)	(0.195)	(0.196)
Xanthia	-0.344*	-0.345	-0.360*
	(0.155)	(0.154)	(0.155)

*** p<0.05, ** p<0.01, and *** p<0.001**

Table 2. Estimates (standard errors in parentheses) of generalized linear model (binomial) for variation of reciprocity-receive i n response to sum EVI (Models A-C) and across EVI clusters (Models D-F), accounting for household characterization.

Panel with Sum EVI				**Panel with EVI clusters**			
Variables	**A**	**B**	**C**	**Variables**	**D**	**E**	**F**
Intercept	-0.108	0.302*	-0.374*	Intercept	-0.228	0.215.	-0.434**
	(0.149)	(0.124)	(0.157)		(0.143)	(0.115)	(0.146)
Household size	-0.031**	-0.020*	-0.035***	Household size	-0.031**	-0.020*	-0.035***
	(0.010)	(0.010)	(0.010)		(0.010)	(0.010)	(0.010)
Intensity of natural resource use	0.062***	-0.010*	0.228***	Intensity of natural resource use	0.064***	-0.010*	0.227***
	(0.013)	(0.004)	(0.035)		(0.013)	(0.004)	(0.035)
Sum EVI	0.001	0.002	0.005	EVI cluster-Low	-0.119	-0.123	-0.137
	(0.013)	(0.013)	(0.013)		(0.109)	(0.108)	(0.109)
				EVI cluster-Medium	0.299**	0.271**	0.272**
					(0.094)	(0.094)	(0.094)

*** p<0.05, ** p<0.01, and *** p<0.001**

Table 3. Estimates (standard errors in parentheses) of generalized linear model (binomial) for variation of reciprocity-give in response to sum EVI (Models A-C) and across EVI clusters (Models D-F), accounting for household characterization.

Panel with sum EVI				**Panel with EVI clusters**			
Variables	**A**	**B**	**C**	**Variables**	**D**	**E**	**F**
Intercept	0.029	0.156	-4318e-01**	Intercept	-0.077	0.062	-0.504***
	(0.146)	(0.127)	(1.541e-01)		(0.141)	(0.119)	(0.145)
Household size	-0.008	-0.002	1.559e-02	Household size	-0.008	-0.002	-0.016
	(0.009)	(0.010)	(9.551e-03)		(0.009)	(0.010)	(0.010)
Intensity of natural resource use	0.013	-0.011**	1.952e-01***	Intensity of natural resource use	0.014	-0.010**	0.194***
	(0.013)	(0.004)	(3.445e-02)		(0.013)	(0.004)	(0.035)
Sum EVI	-0.002	-0.002	8.137e-05	EVI cluster-Low	-0.055	-0.055	-0.067
	(0.013)	(0.013)	(1.275e-02)		(0.108)	(0.108)	(0.109)
				EVI cluster-Medium	0.206*	0.191*	0.192*
					(0.093)	(0.094)	(0.094)

*** p<0.05, ** p<0.01, and *** p<0.001**

4.3.5.2 Group memberships

There were significant relationships between group memberships and both village and EVI cluster ($p < 0.05$) (Table 4 & 5), while there was no significant relationship between memberships in groups and sum EVI ($p > 0.05$) (Table 5, models A-C). As we move from the Agincourt (intercept), there is an increase of 3% in group memberships in both Lillydale B and Cunningmore B, whereas there is between 2% and 11% decrease in group memberships in Ireagh A, Ireagh B and Kildare (Table 4). From high EVI clusters to low EVI cluster, group memberships generally decreased by 3% (Table 5, models E-F).

Table 4 Estimates (standard errors in parentheses) of generalized linear mixed effects model (Poisson) for variation of group memberships across villages, accounting for household size and natural resource use intensity (Model A), total resource volume (Model B) and number of natural resources (Model C).

Models	**A**	**B**	**C**
Intercept	3.726***	3.840***	3.631***
	(0.027)	(0.023)	(0.027)
Household size	0.021***	0.022***	0.020***
	(0.001)	(0.001)	(0.001)
Intensity of natural resource use	0.018***	0.001***	0.078***
	(0.001)	(0.0002)	(0.002)
Cunningmore B	0.064***	0.063***	0.033**
	(0.011)	(0.011)	(0.011)
Huntington	0.014	0.010	-0.005
	(0.012)	(0.012)	(0.012)
Ireagh A	-0.111***	-0.115***	-0.116***
	(0.011)	(0.011)	(0.011)
Ireagh B	-0.030*	0.013	-0.029*
	(0.014)	(0.014)	(0.014)
Justicia	-0.003	-0.008	-0.009
	(0.009)	(0.009)	(0.009)
Kildare	-0.012	-0.020*	-0.020*
	(0.008)	(0.008)	(0.008)
Lillydale B	0.040**	0.034**	0.037**
	(0.013)	(0.012)	(0.013)
Xanthia	0.033	-0.005	-0.001
	(0.010)	(0.010)	(0.010)

*** p<0.05, ** p<0.01, and *** p<0.001**

Table 5 Estimates (standard errors in parentheses) of generalized linear mixed effects mode l (Poisson) for variation of group memberships in response to sum EVI (Models A-C) and a cross EVI clusters (Models D-F), accounting for household characterization.

Panel with sum EVI				**Panel with EVI clusters**			
Variables	**A**	**B**	**C**	**Variables**	**D**	**E**	**F**
Intercept	3.729*** (0.026)	3.830*** (0.023)	3.609 (0.027)	Intercept	3.729*** (0.026)	3.842*** (0.023)	3.630*** (0.027)
Household size	0.021*** (0.001)	0.022*** (0.001)	0.019 (0.001)	Household size	0.021*** (0.001)	0.022*** (0.001)	0.019*** (0.001)
Intensity of natural resource use	0.019*** (0.001)	0.002*** (0.0002)	0.079*** (0.002)	Intensity of natural resource use	0.019*** (0.001)	0.002*** (0.0002)	0.079*** (0.002)
Sum EVI	-0.021 (0.007)	0.001 (0.001)	0.002**.** (0.001)	EVI cluster-Low	-0.021** (0.007)	-0.025*** (0.007)	-0.027*** (0.007)
				EVI cluster-Medium	0.003 (0.006)	0.001 (0.006)	-0.006 (0.006)

*** p<0.05, ** p<0.01, and *** p<0.001**

4.4 DISCUSSION

The use of social capital (reciprocity) varied significantly across a natural resource availability gradient. In other words, the dependency of rural households on social capital is associated with changes in natural resource availability. However, the trend was contrary to that hypothesized, in that both reciprocity-receive and reciprocity-give were higher in villages with medium EVI compared to those in high EVI. A plausible explanation is that households in areas with relatively low resource availability are more dependent on interactions with each other and the benefits that accrue from these interactions. There are possibly village level confounding factors such as lack of trust in general, or reliance on other sources of help from relatives far away in towns or cities in the form of remittances that were not captured in our models. It cannot be conclusively deduced from this study that natural resources availability reduces the reliance of rural households on social capital. However, indications that households in relatively resource poorer environments depend more on reciprocity. These findings are in line with previous studies that have demonstrated that the rural poor are dependent on exchanges in labour, goods and services from social networks to

improve household welfare and cushion them from negative shocks (Harper 1997, Grootaert et al. 2002, Carter and Maluccio 2003, Tibesigwa et al. 2015). It can be argued that households in resource poorer environments experienced shortages of natural resources that increases their reliance on other households for assistance. This is contrary to the hypothesis that households in areas with higher resource availability would have more reciprocity as a result of fewer conflicts over resource access. One of the implications of such findings is that it becomes more important to facilitate processes that build community ethos of reciprocity and connectedness as natural resources deplete to act as a safety net for poorer households. However, studies have shown that there is possibilities that resource scarcity has the potential to disintegrate relations and reduce the stocks of social capital (Hicks et al. 2009, Burke 2010), creating negative feedback loops and cycles that can undermine household livelihoods.

As expected, group memberships were higher in the high EVI clusters and decreased to low EVI clusters. It has been suggested that communities where there is better resource availability create opportunities for growth of social capital (Wagner and Fernandez-Gimenez 2008a, Burke 2010, Barnes-Mauthe et al. 2015). In like manner, these findings present evidence to support this notion, showing that high natural resource availability might be favourable for greater group formulation and interactions. It is highly likely that memberships in groups could be an indication of less community conflicts and higher community cohesion in resource-richer communities, whereas reciprocity can indicate dependency on friendship, neighbourhood and kinship connections benefits that accrue to the household.

However, there are differential findings between the social capital dimensions of reciprocity and group memberships, in that reciprocity increased as resource availability decreases and group memberships decreased as resource availability decreased, uncovering complexity of quantitative measure of social capital. A plausible explanation for this observation is that reciprocity could be a livelihood strategy at the household level, illuminating on the functional dimension of social capital (Coleman 1990, Harper 1997, Grootaert 1999, Haddad and Maluccio 2000, Carter and Maluccio 2003, Zhang et al. 2017), whereas group memberships could be an outcome of community level interactions (Pretty and Ward 2001, Leach and Sabatier 2005). Here, these

findings corroborate arguments from elsewhere that described social capital as an ecosystem service (Chan et al. 2012b, Barnes-Mauthe et al. 2015), shown by the positive association between group memberships and higher resource availability. The study addressed, even if in part, a recommendation made by Crona et al. (2017) on the importance of disaggregating the components of what is collectively referred to social capital in empirical studies. This distinction is particularly important because as described, the performance of group memberships and reciprocity across a resource availability gradient diverge.

Nevertheless, there were some limitations in the study. One of the limitations lies with the metrics for reciprocity, in that we only considered help that is tangible, for instance gifts, food or money that a household had received or given. It is possible that there could have been other intangible resources that a household had received or given, for instance information that could assist the household with access to markets, financial or natural resources. Therefore, the results might not capture the whole spectrum of reciprocity, particularly that which pertains to elusive benefits. In addition, household dependence on social capital for access to information networks and other such benefits could be captured in group memberships, which could make counterbalance the weakness in reciprocity metrics. Another potential shortfall is that reciprocity metrics were treated as binary variables (1 for having received of given help, and 0 for not having received or given help) in the analyses. This effect might have masked differences in household reciprocity, mainly those that had received or given more than once in each study year, creating a ceiling effect with most households having at least given or received help. However, this might have insignificant effect on the findings owing to a large sample size and we made comparisons across villages and EVI clusters.

4.5 CONCLUSION

In this chapter, an attempt was made to answer pertinent questions on whether reciprocity and membership in groups, both variables of social capital, had an association with natural resource availability. First, reciprocity (both giving and receiving of help) was higher in villages with lower resource availability, suggesting that low resource availability increased interactions among friends, neighbours and kinsmen for exchange of gifts and assistance. On the other hand, group

memberships were higher in villages with higher resource availability, a finding that seems to suggest that higher resource availability creates an environment of fewer community conflicts that facilitate community cohesion, for instance through higher memberships in community groups. This is a critical discovery, as it highlights the need to disaggregate social capital in rural livelihoods or natural resource management analyses, as these facets can have an effect or be an outcome of one or several dimensions of social capital. Further research is needed to ascertain the interactions of the different facets of social capital and both ecological and social processes and systems, as this study indicated that these can interact with natural capital in different ways. Much progress has been made in improving theoretical frameworks for estimating metrics of the different social capital facets, but much can still be done to refine and operationalize these because social capital remains highly contextual.

4.6 APPENDICES

Appendix 1 Estimates of generalized linear model (binomial) for variation of reciprocity-give across villages, accounting for household size and natural resource use intensity (Model A), total resource volume (Model B) and number of natural resources (Model C) where *** p<0.001 and ** p<0.01.

Variable	Estimate	Std. error	Z value	P value
Model A				
Intercept	0.005	0.155	0.035	0.972
Household size	-0.008	0.009	-0.845	0.398
Intensity of natural resource use	0.014	0.013	1.032	0.302
Cunningmore B	0.227	0.165	1.376	0.169
Huntington	-0.180	0.178	-1.011	0.312
Ireagh A	-0.163	0.162	-1.003	0.316
Ireagh B	-0.071	0.211	-0.339	0.734
Justicia	0.178	0.136	1.308	0.191
Kildare	0.063	0.124	0.505	0.613
Lillydale B	-0.066	0.194	-0.342	0.732
Xanthia	-0.201	0.154	-1.305	0.192
Model B				
Intercept	0.133	0.133	0.996	0.319
Household size	-0.002	0.010	-0.188	0.851
Total resource volume	-0.011	0.004	-2.740	0.006**
Cunningmore B	0.222	0.165	1.348	0.178
Huntington	-0.167	0.178	-0.934	0.350
Ireagh A	-0.170	0.163	-1.048	0.295
Ireagh B	-0.041	0.212	-0.195	0.845
Justicia	0.184	0.137	1.345	0.179
Kildare	0.042	0.124	0.336	0.737
Lillydale B	-0.068	0.194	-0.350	0.726
Xanthia	-0.187	0.154	-1.212	0.226
Model C				
Intercept	-0.426	0.158	-2.695	0.007**
Household size	-0.016	0.010	-1.651	0.099.
Number of natural resources	0.195	0.035	5.608	2.05e-08***
Cunningmore B	0.158	0.166	0.953	0.341

Huntington	-0.231	0.179	-1.289	0.198
Ireagh A	-0.172	0.163	-1.052	0.293
Ireagh B	-0.054	0.212	-0.254	0.799
Justicia	0.172	0.137	1.257	0.209
Kildare	0.062	0.124	0.499	0.618
Lillydale B	-0.060	0.195	-0.309	0.758
Xanthia	-0.201	0.155	-1.303	0.193

Appendix 3 Pairwise comparisons of group membership across villages with factors natural resource use intensity (Model A), total resource volume (Model B) and number of natural r esource types (Model C) where *** p<0.001, ** p<0.01 and * p<0.05.

Villages	**Estimate**	**Std. error**	**Z value**	**P value**
Model A				
Cunningmore B vs Agincourt	0.064	0.016	5.993	< 0.001***
Huntington vs Agincourt	0.014	0.012	1.189	0.956
Ireagh A vs Agincourt	-0.111	0.011	-9.998	< 0.001***
Ireagh B vs Agincourt	0.030	0.014	2.133	0.435
Justicia vs Agincourt	-0.003	0.009	-0.335	1
Kildare vs Agincourt	-0.012	0.008	-1.497	0.849
Lillydale B vs Agincourt	0.040	0.013	3.117	0.045*
Xanthia vs Agincourt	0.003	0.010	0.329	1
Huntington vs Cunningmore B	-0.050	0.013	-3.781	0.004**
Ireagh A vs Cunningmore B	-0.175	0.013	-13.854	< 0.001
Ireagh B vs Cunningmore B	-0.034	0.015	-2.246	0.361
Justicia - Cunningmore B	-0.067	0.011	-6.187	< 0.001***
Kildare vs Cunningmore B	-0.076	0.010	-7.489	< 0.001***
Lillydale B vs Cunningmore B	-0.024	0.014	-1.728	0.717
Xanthia vs Cunningmore B	-0.060	0.012	-5.132	< 0.001***
Ireagh A vs Huntington	-0.125	0.014	-9.22	< 0.001***
Ireagh B vs Huntington	0.016	0.016	0.988	0.986
Justicia vs Huntington	-0.017	0.012	-1.43	0.879

Kildare vs Huntington	-0.026	0.011	-2.317	0.318
Lillydale B vs Huntington	0.026	0.015	1.714	0.725
Xanthia vs Huntington	-0.011	0.013	-0.832	1
Ireagh B vs Ireagh A	0.141	0.016	9.097	< 0.001***
Justicia vs Ireagh A	0.108	0.011	9.589	< 0.001***
Kildare vs Ireagh A	0.099	0.011	9.286	< 0.001***
Lillydale B vs Ireagh A	0.151	0.014	10.47	< 0.001***
Xanthia vs Ireagh A	0.115	0.012	9.375	< 0.001***
Justicia vs Ireagh B	-0.033	0.014	-2.332	0.309
Kildare vs Ireagh B	-0.042	0.014	-3.099	0.048*
Lillydale B vs Ireagh B	0.010	0.017	0.587	1
Xanthia vs Ireagh B	-0.026	0.015	-1.783	0.680
Kildare vs Justicia	-0.009	0.008	-1.099	0.973
Lillydale B vs Justicia	0.043	0.013	3.316	0.024*
Xanthia vs Justicia	0.006	0.010	0.616	1
Lillydale B vs Kildare	0.052	0.012	4.218	< 0.001***
Xanthia vs Kildare	0.015	0.010	1.62	0.783
Xanthia vs Lillydale B	-0.036	0.014	-2.649	0.158
Model B				
Cunningmore B vs Agincourt	0.063	0.011	5.94	< 0.001 ***
Huntington vs Agincourt	0.010	0.012	0.862	0.994
Ireagh A vs Agincourt	-0.116	0.011	-10.405	< 0.001 ***
Ireagh B vs Agincourt	0.013	0.014	0.939	0.99
Justicia vs Agincourt	-0.008	0.009	-0.897	0.993
Kildare vs Agincourt	-0.020	0.008	-2.463	0.238
Lillydale B vs Agincourt	0.034	0.013	2.676	0.148
Xanthia vs Agincourt	-0.005	0.010	-0.539	0.1
Huntington vs Cunningmore B	-0.053	0.013	-4.021	0.002 **
Ireagh A vs Cunningmore B	-0.179	0.013	-14.167	< 0.001 ***
Ireagh B vs Cunningmore B	-0.050	0.015	-3.307	0.024 *

Justicia vs Cunningmore B	-0.071	0.011	-6.604	< 0.001 ***
Kildare vs Cunningmore B	-0.083	0.010	-8.217	< 0.001 ***
Lillydale B vs Cunningmore B	-0.029	0.014	-2.087	0.467
Xanthia vs Cunningmore B	-0.069	0.012	-5.832	< 0.001 ***
Ireagh A vs Huntington	-0.126	0.014	-9.254	< 0.001 ***
Ireagh B vs Huntington	0.003	0.016	0.184	1
Justicia vs Huntington	-0.018	0.012	-1.532	0.832
Kildare vs Huntington	-0.030	0.011	-2.667	0.151
Lillydale B vs Huntington	0.024	0.015	1.593	0.798
Xanthia vs Huntington	-0.016	0.013	-1.223	0.948
Ireagh B vs Ireagh A	0.129	0.016	8.307	< 0.001 ***
Justicia vs Ireagh A	0.108	0.011	9.538	< 0.001 ***
Kildare vs Ireagh A	0.096	0.011	8.971	< 0.001 ***
Lillydale B vs Ireagh A	0.150	0.014	10.394	< 0.001 ***
Xanthia vs Ireagh A	0.110	0.012	9.019	< 0.001 ***
Justicia vs Ireagh B	-0.021	0.014	-1.507	0.844
Kildare vs Ireagh B	-0.033	0.014	-2.446	0.247
Lillydale B vs Ireagh B	0.021	0.017	1.249	0.941
Xanthia vs Ireagh B	-0.019	0.015	-1.254	0.94
Kildare vs Justicia	-0.012	0.008	-1.433	0.878
Lillydale B vs Justicia	0.042	0.013	3.274	0.028 *
Xanthia vs Justicia	0.003	0.010	0.252	1
Lillydale B vs Kildare	0.054	0.012	4.404	< 0.001 ***
Xanthia vs Kildare	0.015	0.010	1.52	0.838
Xanthia vs Lillydale B	-0.039	0.014	-2.884	0.087.
Model C				
Cunningmore B vs Agincourt	0.033	0.011	3.131	0.044 *
Huntington vs Agincourt	-0.005	0.012	-0.442	1
Ireagh A vs Agincourt	-0.116	0.011	-10.417	<0.01 ***
Ireagh B vs Agincourt	0.029	0.014	2.104	0.455

Justicia vs Agincourt	-0.009	0.009	-1.044	0.98
Kildare vs Agincourt	-0.020	0.008	-2.415	0.263
Lillydale B vs Agincourt	0.037	0.013	2.937	0.075.
Xanthia vs Agincourt	-0.001	0.010	-0.147	1
Huntington vs Cunningmore B	-0.039	0.013	-2.935	0.075.
Ireagh A vs Cunningmore B	-0.150	0.013	-11.794	<0.01 ***
Ireagh B vs Cunningmore B	-0.004	0.015	-0.269	1
Justicia vs Cunningmore B	-0.043	0.011	-3.957	<0.010**
Kildare vs Cunningmore B	-0.053	0.010	-5.22	<0.010 ***
Lillydale B vs Cunningmore B	0.004	0.014	0.271	1
Xanthia vs Cunningmore B	-0.035	0.012	-2.958	0.071.
Ireagh A vs Huntington	-0.111	0.014	-8.143	<0.010***
Ireagh B vs Huntington	0.035	0.016	2.164	0.414
Justicia vs Huntington	-0.004	0.012	-0.352	1
Kildare vs Huntington	-0.015	0.011	-1.282	0.932
Lillydale B vs Huntington	0.042	0.015	2.846	0.096.
Xanthia vs Huntington	0.004	0.013	0.29	1
Ireagh B vs Ireagh A	0.145	0.016	9.37	<0.010***
Justicia vs Ireagh A	0.107	0.011	9.436	<0.010***
Kildare vs Ireagh A	0.096	0.010679	9.023	<0.010***
Lillydale B vs Ireagh A	0.153	0.014	10.632	<0.010***
Xanthia vs Ireagh A	0.115	0.012	9.36	<0.010***
Justicia - Ireagh B	-0.038	0.014	-2.756	0.121
Kildare vs Ireagh B	-0.049	0.014	-3.619	<0.010**
Lillydale B vs Ireagh B	0.008	0.017	0.474	1
Xanthia vs Ireagh B	-0.031	0.015	-2.081	0.471
Kildare vs Justicia	-0.010	0.008	-1.23	0.946
Lillydale B vs Justicia	0.047	0.013	3.634	<0.010**
Xanthia vs Justicia	0.008	0.010	0.765	0.998
Lillydale B vs Kildare	0.057	0.012	4.641	<0.010***

Xanthia vs Kildare	0.018	0.010	1.895	0.603
Xanthia vs Lillydale B	-0.039	0.014	-2.835	0.099.

Appendix 4. Pairwise comparisons of group membership across EVI zones with factors nat ural resource use intensity (Model A), total resource volume (Model B) and number of natu ral resource types (Model C) where ***, p<0.001, **, p<0.01 and *, p<0.05.

EVI zone	Estimate	Std. error	Z value	P value
Model A				
Low vs High	-0.007	0.006	-1.096	0.517
Medium vs High	-0.046	0.006	-7.602	<1e-04 ***
Medium vs Low	-0.039	0.007	-5.984	<1e-04 ***
Model B				
Low vs High	-0.007	0.006	-1.105	0.51
Medium vs High	-0.044	0.006	-7.17	<1e-04 ***
Medium vs Low	-0.036	0.007	-5.573	<1e-04 ***
Model C				
Low vs High	-0.009	0.006	-1.431	0.325
Medium vs High	-0.052	0.006	-8.491	<1e-04 ***
Medium vs Low	-0.042	0.007	-6.464	<1e-04 ***

CHAPTER 5

Communal social capital, resource governance, and natural resource availability in the central lowveld of Mpumalanga province, South Africa.

ABSTRACT

Several studies have suggested that it is imperative to strengthen traditional leadership, social sanctions, trust, norms and reciprocity, collectively known as social capital, for robust natural resource management in rural communities. Nevertheless, whether or not social capital can translate to better resource management and improved environmental outcomes, although a subject of widespread discussion, remain poorly understood. To address this gap, community social capital measures from household surveys, key informant interviews and focus group discussions measures were used to test the hypothesis that villages with more communal social capital have better natural resource availability. One-way analysis of variance (ANOVA) was used to test for significant differences in mean social capital index and trust in local leadership across EVI (used as a proxy for resource availability) clusters. Chi-squared tests of independence and generalized linear models were applied to test for associations between social capital metrics of aggregate communal social capital index, trust and group memberships, and natural resource availability. Generally, naturally resource availability was lower in villages with lower aggregate social capital index, whereas trust and satisfaction with local governance did not vary across villages or EVI zones. There was no significant relationship between all dimensions of social capital and natural resource availability, after controlling for natural resource use. In addition, there were perverse outcomes like widespread non-compliance and rule breaking, although there was relatively high social capital. Fundamentally, this study fails to substantiate, through empirical evidence, that social capital improves natural resource availability, through improvement of natural resource governance. Further studies should seek to uncover the sources of inefficiency in natural resource governance in communal areas for the improvement of resource management.

Keywords: communal social capital, natural resource availability, enhanced vegetation index, compliance, focus groups.

5.1 INTRODUCTION

Global forests and savannas face uncertain futures, with anthropogenic threats to biodiversity as ever-growing populations of humans pursue their livelihoods (Twine 2005, Wigley et al. 2010, Wright 2010, Shackleton et al. 2014, Keenan et al. 2015, Lewis et al. 2015). Rural communities the world over are highly dependent on natural resources for food, fuel, fodder, medicine, construction materials and many other intangible ecosystem services (Adhikari et al. 2004b, Babulo et al. 2008, 2009, Arnold et al. 2011, Sunderland 2011). These natural resources can also act as insurance or a safety net for households in times of adversity (McSweeney 2003, 2005, Shackleton and Shackleton 2004, Wunder et al. 2014). In southern Africa, widespread research has documented the dependence of rural households on natural resources (Campbell et al. 1997a, Twine et al. 2003a, Fisher 2004, Shackleton and Shackleton 2004, Shackleton et al. 2007b, Thondhlana et al. 2012b, Hickey et al. 2016). However, unsustainable extraction has also been reported (Wessels et al. 2011, 2013), often resulting in scarcity of resources, particularly around settlements (Kirkland et al. 2007). The causes for decline in availability of natural resources in rural areas are complex; ranging from poverty, population increase, overstocking, agricultural expansion, subsistence harvesting, climate change, to weak resource management and governance (Twine et al. 2003a, Asner et al. 2004, Butt et al. 2005, Giannecchini et al. 2007, Kirkland et al. 2007, Lapola et al. 2010, Palmer and Bennett 2013). Several studies have looked into the dynamics underlying governance of natural resources in rural communities (Ostrom 1997, 2000, Campbell et al. 2001a, Pretty 2003a, Claridge 2004, Pretty and Smith 2004, Ballet et al. 2007, Ostrom 2009, 2015). Findings indicate that it is imperative to strengthen traditional leadership, social sanctions, trust, norms and reciprocity, collectively known as social capital, for robust natural resource management in rural communities (Pretty and Ward 2001, Pretty 2003a, Bodin and Crona 2008, Bouma et al. 2008, Bodin and Crona 2009, Crona et al. 2017). Nevertheless, the mechanisms by which social capital can translate to better resource management and improved environmental outcomes, although a subject of widespread discussion, remain poorly understood (Lehtonen 2004, Ballet et al. 2007).

Social capital is a broad and multidimensional concept that has been explored at varying scales from individual, then household, to community level in diverse communities. Social capital

implies that social network characteristics of trust, cohesion, organization, reciprocity, and social structure can allow individuals and communities to derive benefits to achieve particular aims and interests, albeit at a lower social cost (Coleman 1988, Putnam 1995, 2001, Portes 1998, Pretty 2003b). For instance, it has been suggested that social capital can improve household welfare, cushion households when they experience negative shocks and enhance collaborative natural resource management in communities among other outcomes (Pretty and Ward 2001, Carter and Maluccio 2003, Pretty and Smith 2004). Much research has focused on this functional dimension of social capital, exploring what outcomes social capital can achieve at individual, household and community level. For example, Pretty and Ward (2001) review studies on how social capital can be leveraged for outcomes in collective action when addressing environmental problems. Similarly, Bodin and Crona (2009) review empirical evidence on the critical role of social networks in facilitating natural resource governance. Thus social capital is predominantly defined by its function as a stock of livelihood-enabling capital.

There exists a plurality of discourse that pertains to social capital and natural resource use and management in communal areas. First, at household level, social capital is a livelihood capital that can complement or substitute for other household livelihood capitals to improve household welfare, for instance by diversifying sources of income or acting as insurance in times of distress (Narayan and Pritchett 1999, Maluccio et al. 2000, Carter and Maluccio 2003, Cassidy and Barnes 2012). Second, at a broader community level, social capital has been conceptualized as a catalyst for community organization, cohesion, trust and leadership for natural resource governance, management and collective action resources (Pretty and Ward 2001, Pretty 2003a, Pretty and Smith 2004, Sigmund et al. 2010, Gutiérrez et al. 2011). In this thinking, social capital engenders social learning and common understanding of rules and norms that are generally agreed on or handed down among community members even though they are not documented (Pretty and Smith 2004, Sigmund et al. 2010). These norms give community members the confidence to invest in collective action, trusting that other community members will do the same, while rules ensure that those who break them receive some socially agreed upon punishment that is deterrent. Trust, for example, is viewed as a state in which a party to a relationship adopts a belief that the other party will not act against its interests, and instead, will act in an expected behaviour (Luo 2002, Nkhata et al. 2009). Thus, at community level, focus is placed on how social capital enhances collective

action, institutional coherence and co-management which has beneficial effects on management of natural resources (Murali 2006). However, Murali (2006) pointed out the inadequate evidence to support the notion that social capital can improve natural resource availability. Third, elsewhere, social capital has been described as an outcome, for instance of better management of natural resources (Watson et al. 2005, Barnes-Mauthe et al. 2015). In this line of argument, natural capital can facilitate activities that create opportunities for building social capital for instance fishing or hiking. In rural South Africa, it would be expected that activities like harvesting of natural resources can foster networks of information sharing, and thus social capital. Woolcock (2001) suggested that any definition of social capital should focus on its sources rather than consequences, however, because social capital is widely viewed as a key determinant of natural resource management, it is prudent to look at social capital outcomes.

Although several studies have been conducted on the dynamics of social capital either as an outcome or a catalyst for better environmental management, there still exists ambiguity in the use of the term and contextual variations in the understanding of its outcomes. In-fact, a recent study by Crona et al. (2017) has highlighted the need to disaggregate the facets of what has been broadly defined as social capital in empirical studies as these can have differential effects on outcomes such as natural resource governance. Fewer studies have looked at empirical measures of resource availability as an outcome from improved social capital. Consequently, more research is needed to further understand communal social capital and natural resource management and how this translates to improved resource availability. In this chapter, community social capital indices were developed to test the hypothesis that villages with more communal social capital have lower levels of environmental degradation, and thus better natural resource availability, measured as the Enhanced Vegetation Index. The social capital indices aggregated household social capital (a quantitative measure from household surveys), and trust (a qualitative social capital measure from interviews and focus group discussions). As a result, the study combines methods in the social sciences, ecology and geographic information systems in a quest to answer complex questions on natural resources in communal socio-ecological systems.

5.2 METHODS

5.2.1 Study area

Refer to Chapter 1, section 1.6 for a description of the study site

5.2.2 Research design

This study focused on households and the local environment from which the households derive ecosystem services for their livelihoods. Questionnaire surveys were conducted as part of SUCSES to collect data on household trust and satisfaction with leadership conflict resolution. The data were collected from 590 households in nine villages in which they occur over a 5-year period from 2010-2014, each year from April- June. The nine villages were selected as clusters of three in three rainfall zones along a west-east axis (rainfall >700 mm/year, 700-600 mm/year, <600 mm/year). The villages were selected to replicate the range of village sizes per rainfall zone. The villages were further clustered in into natural resource availability gradient of high, medium and low clusters using Enhanced Vegetation Index (EVI). In addition, a subset of five villages was selected from which key informant interviews with village heads, known locally as *Indunas* and focus group discussions with selected village residents were conducted. These villages were chosen to represent the rainfall gradient in the study are of High, Medium and Low rainfall. The study employed both quantitative and qualitative approaches to field research as its core methodology. This was premised on the need to understand both patterns and collaborative behavioural processes in natural resource management that result in better resource availability (Nkhata et al 2008).

5.2.3 Data collection

5.2.3.1 Communal social capital

Data on communal social capital was collected using semi-structured questionnaires, key informant interviews and focus group discussions. Firstly, semi-structured questionnaires were

used to interview 590 households in 9 study villages annually over a 5 year period from 2010-2014. The questions asked were on household use of services of community leadership and satisfaction with outcomes from three authorities in the rural context; the municipality, the local chieftaincy and village heads and the Community Development Forum. In addition, households were asked to report on their membership in various social groupings in the community, and reciprocity among networks of friends, and family in the village or in neighbouring villages. Secondly, key informant interviews were conducted with village headmen (known locally and referred hereafter as *Indunas*) from a subset five of the study villages. The subset of villages was representative of a rainfall gradient of high medium and low rainfall. Normally, each village has one *Induna*. However, one of our study villages, Kildare A, had two Indunas and both of them were interviewed separately. The *Indunas* were asked questions on their perceptions on people's respect for local rules governing natural resource use, people's trust in their leadership and local rules enforcement. Finally, focus group discussions were conducted in the same select subset of villages, with randomly recruited respondents in the villages. In recruiting focus group discussion participants, members of the CDF and *Indunas* were excluded. The focus groups were moderated by a trained local field worker who speaks both English and Shangaan (the local language) fluently. A recorder was used to capture the whole focus group discussion for transcription. The focus group proceedings were transcribed by the same field worker to produce a script that was used for identification of common themes and narratives.

5.2.3.2 Natural resource availability

The Enhanced Vegetation Index (EVI) from time-series Moderate Resolution Imaging Spectroradiometer (MODIS) was used as a proxy for environmental condition and natural resource availability. MODIS is a key instrument aboard the Terra (originally known as EOS AM-1) and Aqua (originally known as EOS PM-1) satellites. EVI values for each year were calculated by taking the annual sum of sums of eight-day composites. EVI data was calculated at a resolution of 500 m in a 1 km buffer around each village over a 10-year period. The 1 km buffer zones represent the areas of resource harvesting, while minimizing overlaps of buffers of separate villages. A detailed account of how the EVI data was derived is provided in Chapter 4. Data were collected for a 10 year period including the time of the SUCSES household survey, with four years before

and a year after the survey. Five years that were not part of the five-year timeline of the SUCSES survey (four years before and a year after) were included because the process of building communal social and natural capital and the outcomes thereof are influenced over large temporal scales. EVI values were used as proxies for availability of natural resources for each village natural resource collection zone. Villages were put in the three categories of High, Medium and Low using cumulative frequencies of sum EVI data over a period of 5 years by dividing the full range into 3 equal sizes. A record of the villages in each category is described in Chapter 4.

5.2.4 Data analysis

5.2.4.1 Quantitative data

One-way analysis of variance (ANOVA) was used to test for significant differences in mean aggregate social capital index per village and trust in local leadership across an EVI gradient of High, Medium and Low EVI values. The social capital variable of trust was derived from the proportion of the respondents who had consulted the *Induna* or traditional authority headman in the village, the Community Development Forum (CDF) and the Local Municipality on any matter against those who were satisfied with the outcome of the consultation. All social capital variables were pooled to village level, to get a mean value for each dimension of social capital per village. For a detailed description of how the other social capital index variable was calculated, refer to Chapter 2. To determine if there were associations between villages, EVI clusters and years and the proportions of the respondents who had brought matters to the traditional authority, the community development forum and the municipality and were satisfied or dissatisfied with the outcomes, chi-squared tests of independence were done in the library *car* and package *fifer* in R. To test for the association between social capital metrics of aggregate communal social capital index, trust and group memberships and natural resource availability generalized linear models were applied, controlling for intensity of natural resource use and mean natural resource use volume. The response variable was sum EVI, with one of the three dimensions of communal social capital (aggregate social capital index, trust or mean group memberships) and either of mean household natural resource use intensity or mean household total resource volume used as covariates. All statistical analyses were conducted in R Statistical software version 3.2.3.

5.2.4.2 Qualitative data

Data from focus groups and key informant interviews was summarized using themes that represent the topics covered in the discussions following suggested frameworks of analysis (Krueger 1994, Krueger and Casey 2000, Rabiee 2004), adapted to suit the current study. To achieve this, first, the transcripts were read three times at a familiarization stage (Krueger 1994). Second the responses were rearranged so that answers for each interview protocol question were put together. Third, codes were created for interesting themes of the data in a systematic manner (following the key questions that had been asked) through the entire data set. These themes represented each question or several interrelated questions. Third, for each focus group discussion and interview, data relevant to each code was collated and organized per village. Next, a synthesis of the recurrent main ideas or major opinions on each theme were drawn up for all villages and charted. Finally, some quotations were chosen to illustrate some of the key themes.

5.3 RESULTS

5.3.1 Natural resource availability

Using cumulative mean of sum EVI frequencies for clustering villages into EVI zones, there were two villages in the high EVI zone, three in the Medium EVI zone and 4 in the Low EVI zone (Table 1). Agincourt and Xanthia consistently had the highest EVI values across the 10 year period while Huntington had the lowest. Justicia had higher EVI values than unexpected, and was classified in the Medium EVI zone, even though it is at the lower end of the rainfall gradient in the study site (Figure 1 & 2). All study villages experienced a decline in sum EVI over a 10 year period (Figure 1), each losing between 46% and 54% of initial EVI. The steepest absolute decline was experienced in Agincourt followed by Xanthia, whereas the lowest decline was experienced in Huntington. However when the loss was expressed as a proportion of the 2006 EVI values, the highest proportional loss was recorded in Lillydale B (54%), while the least was recorded for Agincourt (46%).

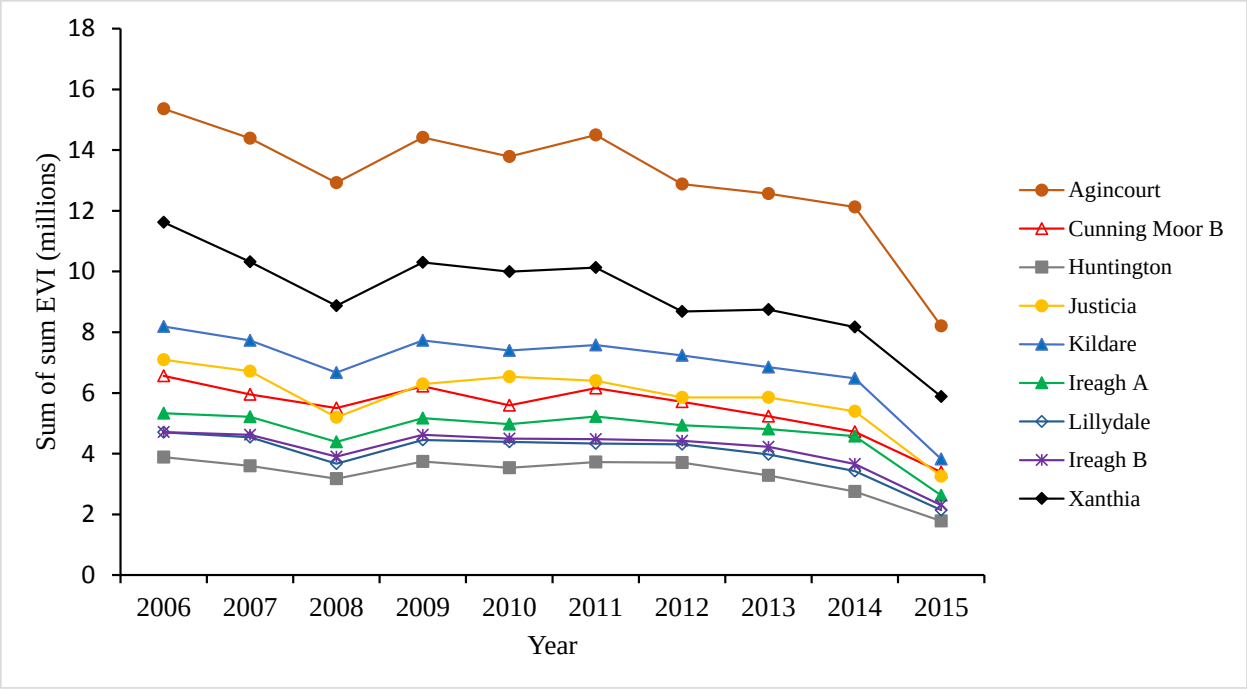

Figure 1. Variation in sum EVI values per village averaged over a 10-year period from 2006-2015 in nine study villages.

Table 12 Classification of villages into EVI zones using mean of Sum EVI over a 5- year period.

Zone	Village	Mean of Sum EVI
High	Agincourt	13,171,458
	Xanthia	9,144,784
Intermediate	Kildare	7,107,377
	Justicia	6,006,921
	Cunningmore B	5,479,909
Low	Ireagh A	4,905,264
	Ireagh B	4,255,951
	Lillydale B	4,082,330
	Huntington	3,397,072

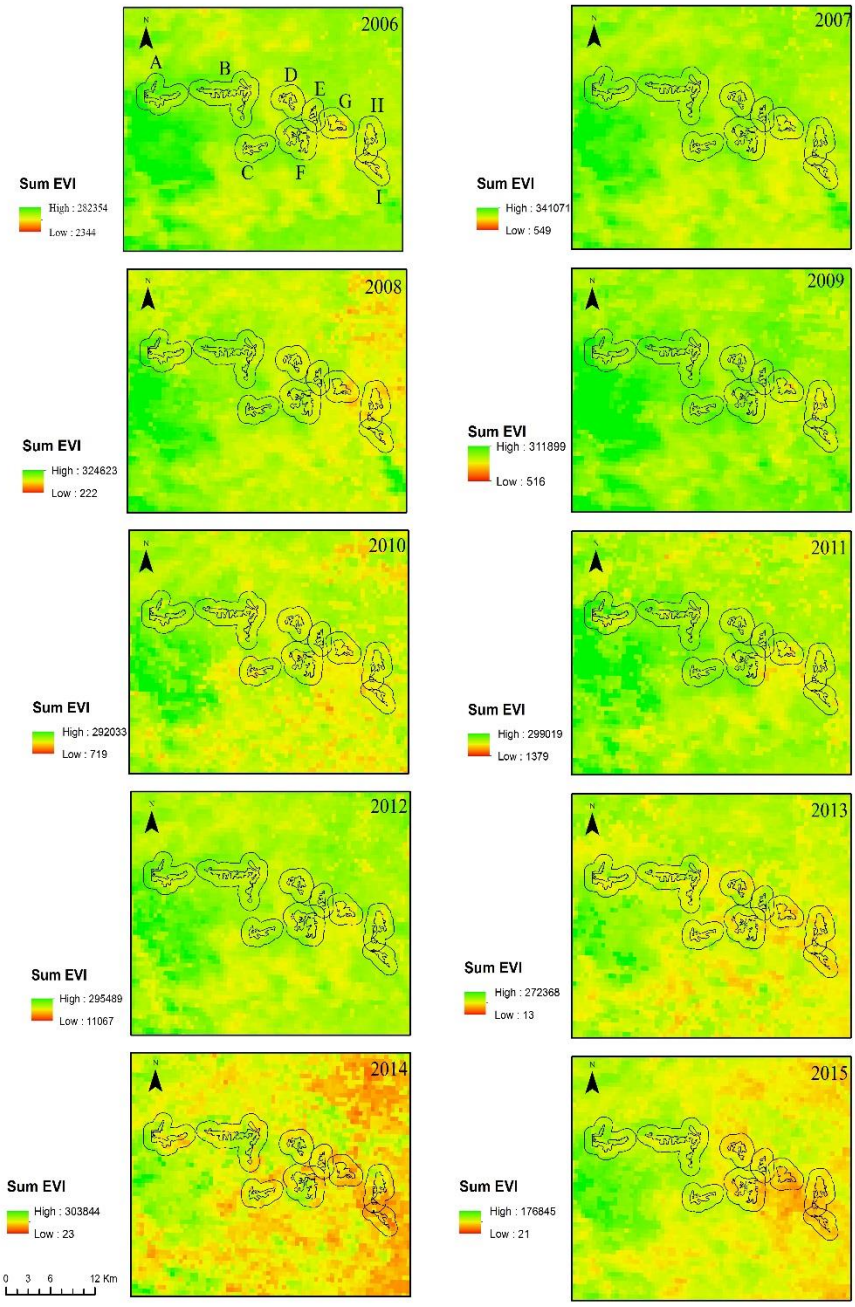

Figure 2. Land cover in the SUCSES study village buffer zones from 2010-2015. The green hues indicate areas of high EVI values, the yellow hues indicate medium EVI values while the orange and red hues indicate low EVI values. Villages are labelled as follows A) Xanthia, B) Agincourt, C) Cunningmore B, D) Ireagh A, E) Ireagh B, F) Kildare, G) Lillydale B, H) Justicia and I) Huntington. The order of villages is the same for all study years.

5.3.2 Communal social capital

5.3.2.1 Social capital index

There was a significant variation in aggregate social capital index across villages ($p < 0.05$) (Figure 3), EVI zones ($p < 0.05$) and years ($p < 0.05$). For village, significant differences only occurred between Cunningmore B and Ireagh B (Figure 3). For EVI zones, significant differences were recorded between Low and Intermediate and Intermediate and High EVI zones and not between Low and High EVI zones. Significant differences were also recorded between 2011 and the years 2012, 2013 and 2014, whereby the highest aggregate social capital index was recorded in 2014, while the lowest was recorded in 2011. Cunningmore B had the highest aggregate social capital index while Ireagh B had the lowest. The

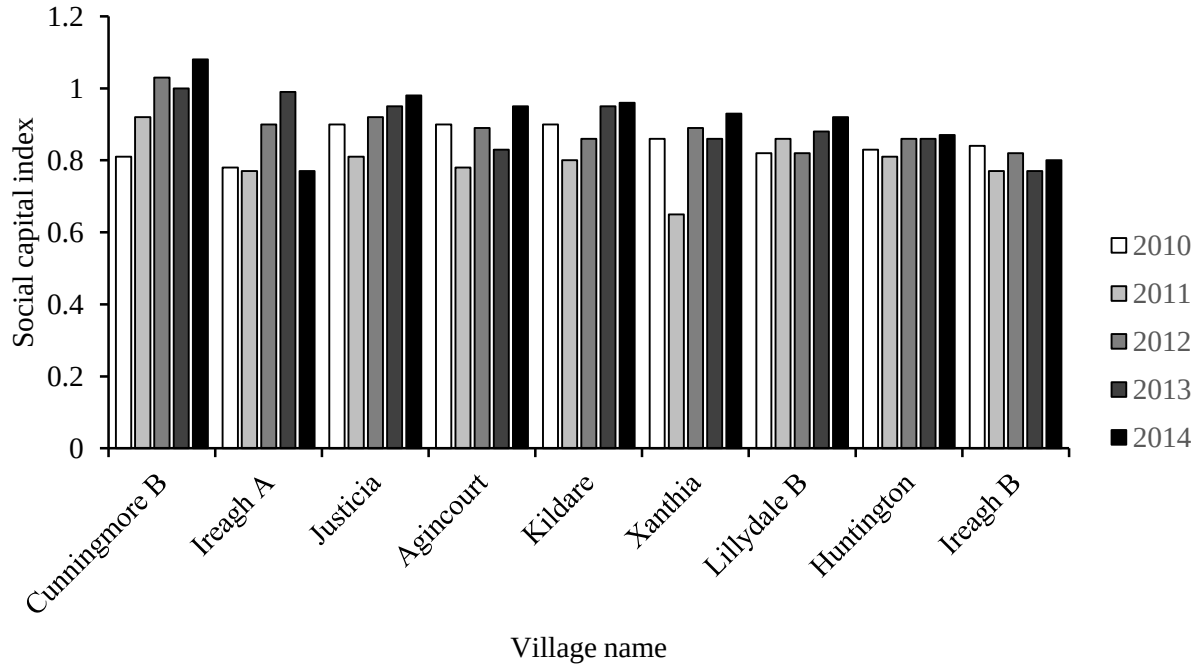

Figure 3. Distribution of mean household social capital index aggregated to the village level for the period 2010-2014 in villages of Bushbuckridge, South Africa

5.3.2.2 Social capital dimension of trust in local leadership

There was no significant association between village and the proportions of people satisfied and unsatisfied with execution of duties by traditional leadership, (χ^2 = 0.496, df = 8, p = 0.999, CDF (χ^2 = 0.398, df = 8, p = 0.999) and the municipality (χ^2 = 0.115, df = 8, p = 1) (Figure 4). In addition, there was no significant association between EVI cluster and the proportions of people satisfied and unsatisfied with execution of duties by traditional leadership, the CDF and the municipality. Generally there was a 73% satisfaction with local traditional authority (the *Induna* and chieftaincy), 65% satisfaction with the village Community Development Forum (CDF) and 90% satisfaction with the local municipality.

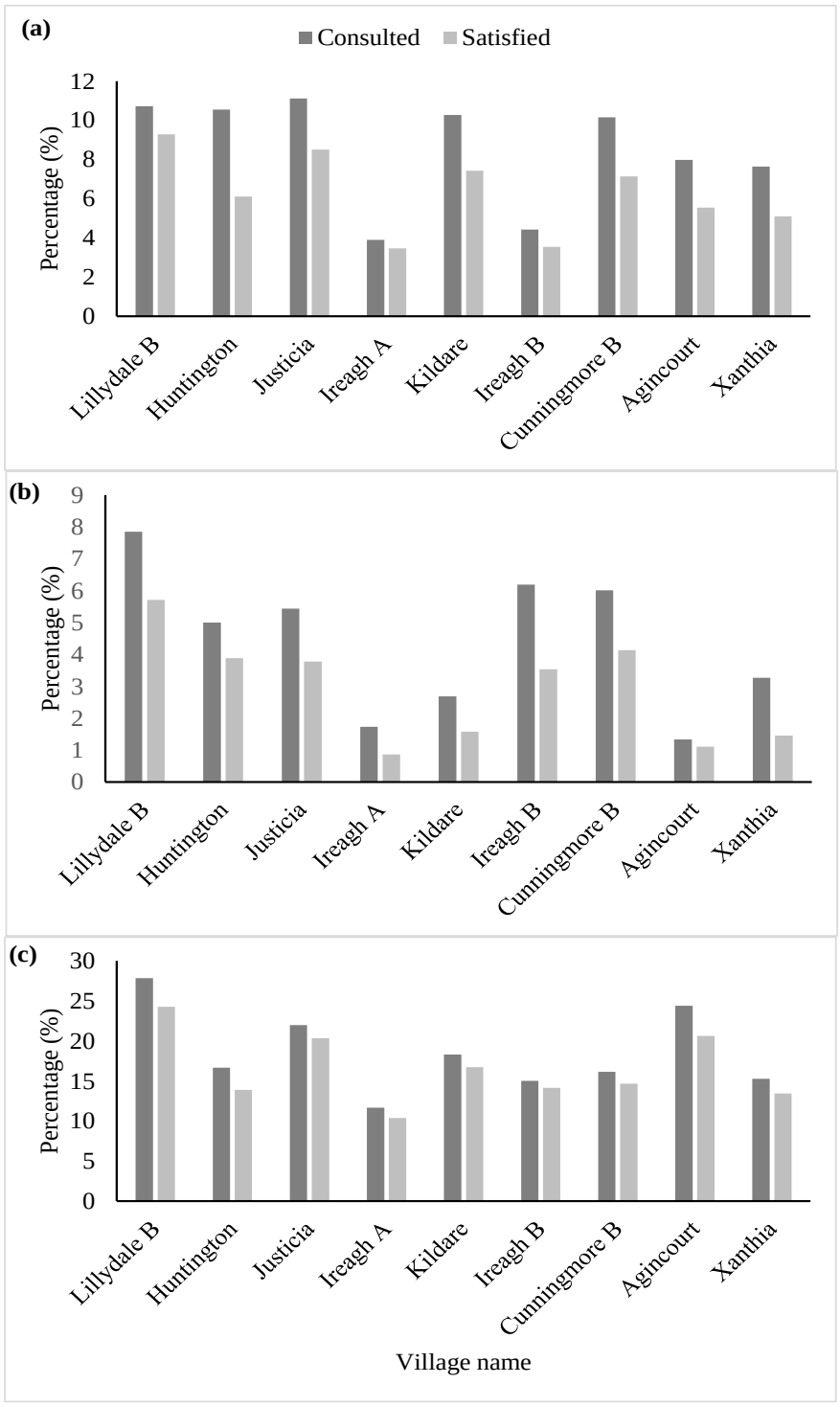

Figure 4. The proportion of respondents who brought matters before a) the Traditional Authority, b) the CDF, and c) the Municipality versus the proportion satisfied with the outcomes.

There was no significant variation on the index of trust across villages (p = 0.953) and across EVI zones (p = 0.738) (Figure 5). Trust did not vary significantly across years (p = 0.258) (Figure 6). Huntington village, which is in the low EVI cluster, recorded the lowest levels of trust, while Xanthia, which is in the high EVI cluster, had the highest index of trust (Figure 5, Table 1). The highest levels of trust were recorded for the year 2012 whereas the lowest were recorded for 2010 across all study villages (Figure 6).

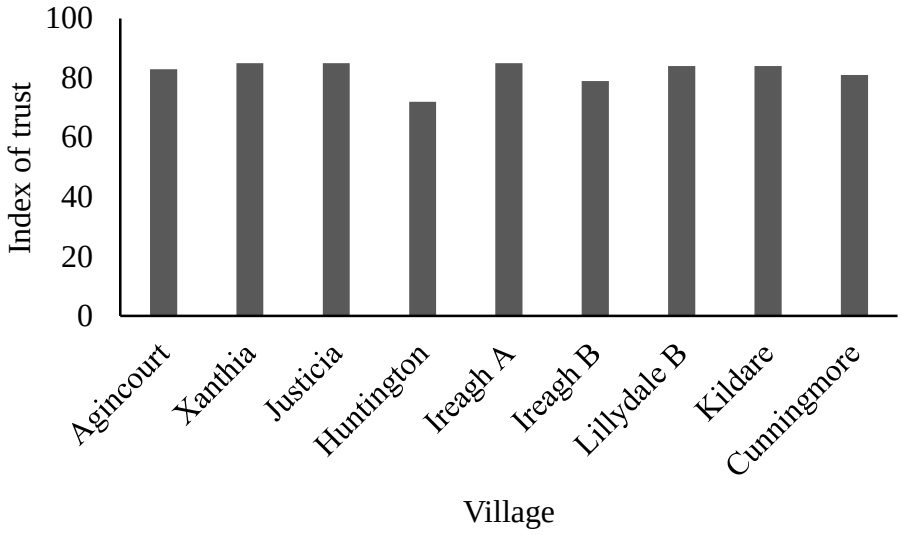

Figure 5. Spatial variation in index of level of trust in local leadership.

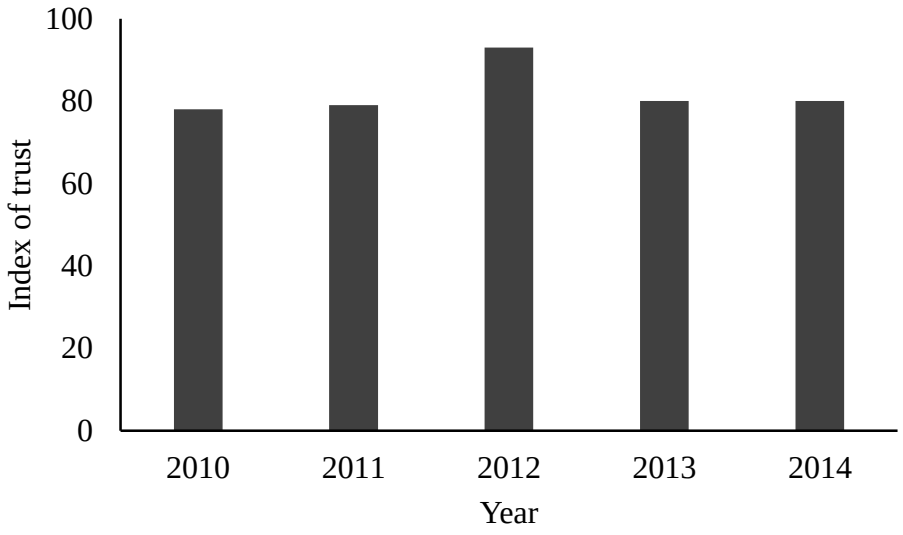

Figure 6. Temporal variation in index of level of trust in local leadership.

5.3.3 Communal social capital and natural resource availability

There was no significant influence of aggregate communal social capital, trust and group memberships on village natural resource availability (Table 3).

Table 13 Estimates (standard errors in parentheses) from generalized linear models for the association between social capital metrics of aggregate communal social capital index, trust and group memberships and natural resource availability controlling for intensity of natural resource use (A-C) and mean natural resource use volume (D-F).

1. Intensity of use					
Variables	**A**	**Variables**	**B**		**C**
Intercept	0.591 (7.208)	Intercept	-1.448 (5.253)	Intercept	1.026 (6.448)
Social capital index	0.652 (5.767)	Trust	2.457 (2.982)	Group memberships	0.004 (0.081)
Average intensity of use	0.759 (0.611)	Average intensity of use	0.846 (0.605)	Average intensity of use	0.747 (0.600)
2. Average resource volume					
Variables	**D**	**Variables**	**E**		**F**
Intercept	7.019 (5.331)	Intercept	5.036# (2.669)	Intercept	6.536 (4.991)
Social capital index	-0.825 (5.777)	Trust	1.608 (3.005)	Group memberships	-0.004 (0.083)
Average resource volume	9.295e-05 (1.514e-03)	Average resource volume	2.938e-05 (1.508e-03)	Average resource volume	0.0001 (0.002)

 # p<0.1

5.3.4 Communal social capital and governance of natural resources

From the focus group discussions, participants from the villages Agincourt, Kildare and Justicia reported that they trusted the local leadership as both the custodians and rule-enforcers in natural resource management. However, some mistrusted leadership in Ireagh A and Xanthia due to corruption. In all study villages participants reported that they do not comply with local rules governing natural resource access, even though they were aware of the rules governing natural resources. As one respondent explained:

"Like trees in the woodlands, the trees that bear fruits is what …., they are not supposed to be cut, like the marula tree and the jackal berry, yellow monkey trees there is a lot that is in the bush that our children, when they grow up have to know… we are not allowed to cut trees but we go to the bush and we cut it..." (Participant from Ireagh A)

It was also reported that law enforcement had weakened over the past decade and that this was mainly due to corruption. As a result, there was scarcity of natural resources. This is illustrated by the following quote:

"I don't have a car and I don't have a wheelbarrow, I carry fire wood with my head they arrest me. Some will get a car full of the wet fire wood they will leave it, it means that they get something from the cars and put it in their pockets (bribe). From me they see that they will not get anything that is why they arrest me…" (Participant from Xanthia).

Table 4 below summarizes the rules governing natural resource use and access and leadership in the villages as reported by the focus group participants. The highlights are that village residents are aware of rules governing natural resources but because of decline in natural resource availability and lack of alternatives, for instance of fuelwood, they continue to break harvesting laws and taboos. In addition, there appears to be selective application of rules to offenders emanating from corruption and cronyism. A more detailed account of responses from the focus groups is presented in Appendix 1.

Table 14. Summary of focus group discussion on natural resource management, rule enforcement and trust in leadership in select villages in Bushbuckridge

Governance theme	Synthesized responses
Informal and formal rules governing NRM	• No cutting fruit trees, without permit, fruit tree, live trees • No burning of woodlands • No hunting of wild animals
Rule observance	• Some do, some do not observe rules (some get away with paying bribes). • People cut fruit trees, even fruit trees, without permits due to lack of alternatives, population rise.
Satisfaction with access to natural resources	• No, there is scarcity, especially nearer to villages. • No cars to fetch firewood further from villages
Changes in natural resource governance in past 10 years	• Corruption abounds, especially from commercial harvesters of resources • Increased commercialization of resources e.g. marula beer • The traditional authority has less power to preside over cases of abuse of resources • Law enforcement was weaker now
Consequences of rule-breaking and fairness of consequences.	• Arrest and payment of fines • Appear before tribal court • Confiscation of illegally harvested resources • Consequences not fair, as there are no alternatives
Who is responsible for NR protection?	• Users in community • Rangers • Chief • Tribal authority • Local leadership
Trust in local leadership as custodians	• To some extent yes, notably the Chieftaincy • To some extent no, there is nepotism and corruption among some • Some confiscate wood from community members and use it in their homes
Satisfaction with how issues pertaining to NRM are handled in community e.g. courts	• To some extent yes, but we do not heed their calls not to cut trees • To some extent no, in the past there were rangers • Some leaders break the rules themselves e.g. you find wet fuelwood in their yards. • Favoritism for those who harvest with cars (the richer) than those who harvest headloads. • 'Outsiders' with cars come harvest in our village
Suggested improvements in NRM	• Employ more rangers to patrol woodlands • Involve community members • Local leadership must be trustworthy • Transparency on who has permit to cut wood so villagers can help policing • Increased awareness • Guard against harvesters from other villages
Changes in NR availability in past 10 years	• Woodlands destroyed resulting in decline in fuelwood and fruit trees • No more locusts, animals and fishes • Shortage of water • Pollution of river

From the *Induna* interviews, it emerged that the community leaders in Xanthia, Agincourt and Justicia believed that community members trusted their leadership in natural resource governance. However in Kildare, one of the Indunas believed community members do trust their leadership, while the other had reservations preferring to state that some do while others see their leadership as inducing suffering as they regulate access to the natural resources they need.

5.4 DISCUSSION

5.4.1 Natural resource governance, resource availability and communal social capital

Contextual communal social capital indices were developed to test the hypothesis that villages with more communal social capital have better natural resource management, low environmental degradation and thus better natural resource availability, measured as the Enhanced Vegetation Index. Findings indicate there is variance in the relationship between communal social capital dimensions of aggregate communal social capital index, satisfaction and trust in leadership and natural resource availability. Generally, villages with lower aggregate social capital index also had low resource availability, whereas trust and satisfaction with local governance did not vary across villages or EVI zones. However, after controlling for natural resource use we find that there is no significant relationship between all dimensions of social capital and natural resource availability. Here, there are two distinguishable types of social capital - the structural and the cognitive. The former can be observable as networks, ties, memberships in groups and reciprocity and is captured here as the social capital index, while the latter resides in people's minds as norms, values and attitudes (Krishna and Uphoff 1999) and is hard to change, which is captured here as trust in local leadership. Unfortunately, the cognitive dimension can be more important in behavioural change that could positively influence natural resource management and subsequently natural resource availability. The structural dimension of social capital varies with natural resource availability, while the cognitive dimension has no association with natural resource availability.

These results differ from other studies that have attributed better resource management and subsequently resource availability to trust and the resultant collective action, which improve

natural resource governance (Pretty and Ward 2001, Pretty and Smith 2004, Sigmund et al. 2010). For instance, Ishihara and Pascual (2009) proposed two mechanisms by which social capital can translate into collective action, which are (i) creation of common knowledge and (ii) diffusion of common knowledge. However, shared knowledge might be insufficient to translate into better resource availability as observed in this study. Villagers demonstrated a good and commonly agreed upon knowledge of what is permitted or good to do in natural resource access and harvesting from communal woodlands. Still, there was widespread reports of non-compliance. Individual motivations, cultural dissimilarities, and differential wealth endowments can influence people's investment into collective action. For instance, a community member might deviate from the collective goal of communal woodland conservation, to engage in unsustainable extraction of fuelwood for trade so that they meet individual or household needs of food security or human capital development. The results fundamentally challenge the notion that social capital results in better resource management, although this could be an outcome of other factors not captured. Perhaps, stronger social capital would promote more sustainable management of natural resources in contexts where resource supply relative to demand was not as constraining than in the current study context.

The creation of social capital can be costly and that the outcomes of social capital are not uniform across dissimilar socio-cultural landscapes (Ballet et al. 2007). As discovered in this study, the presence of social capital might not halt natural resources depletion – or more precisely, might be unrelated to the availability of natural resources when (i) the community does not have alternatives to high value natural resources like fuelwood and/or (ii) there is high levels of corruption, rule-breaking and general non-compliance. Following the arguments by Ballet et al. (2007), it is such underlying factors or contextual specificities that can help us understand harmful or inefficient social interactions.

Alternatively, social capital can actually be exhibiting its 'dark side', by which community members can engage in rule-breaking with impunity and elite capture of resources, fostering or reinforcing imbalances in power, and sustaining inequalities (Portes and Landolt 2002, Field 2003, Adhikari and Goldey 2010). For instance, social capital can be created or accumulate within informal cliques of power that do not promote collective good, are exclusionary or discriminatory

towards people of different tribal groups, or those poorer. Individuals or groups may use their social capital to exclude others or to form alliances that benefit elite factions rather than the common good (Singleton 2002, Walker and Hurley 2004). This can result for instance in selective application of rules, partiality in granting of permits for resource harvesting, resulting in cycles of resource overharvesting and consequently a decline in natural resource availability. The respondents in all villages decried the prevalence of corruption or cronyism in natural resource access which results in those breaking natural resource harvesting rules paying bribes in certain instances. As such the downside of social capital becomes embedded in powerful social groups, who are not accountable to traditional authorities or can buy natural resource access (Narayan and Cassidy 2001b).

Moreover, there have often been concerns that there are outsiders, especially vehicle owners who harvest natural resources in the area, causing massive declines of natural resources in communal woodlands (Twine et al. 2003b, Kirkland et al. 2007). These outsiders can be the reason for sharp declines in natural resource availability in high resource availability villages like Xanthia and Agincourt in recent years (Figure 1), notwithstanding of the levels of social capital or trust/mistrust of local leadership. On the other hand, this can just be the 'scapegoat' outlook towards outsiders referred to by Ballet et al. (2007). In this case, instead of community members taking responsibility for natural resource use and depletion, they might have a shared view that if it were not for outsiders the situation would not be so dire.

In addition, the breakdown of other traditional institutional controls of natural resource access in rural communities (Campbell et al. 2001a, Kirkland et al. 2007) can undermine community cohesion and limit the expected impact of social capital on natural resource governance processes. The lack of a strong association of natural resource availability and social capital could be an indication that resource availability is a function of many other factors, such as rainfall, agricultural expansion and socio-economic characterization of the community, while granting social capital in the community can contribute to resource availability indirectly. Another plausible explanation for the deviation is that social capital is contextual; and as such in this context, it might have little influence on natural resource governance, or its influence is overridden by other factors like population growth and the ensuing demand for natural resources. In their study (Adhikari and

Goldey 2010) found that social capital varies from one village community to another, and so it follows that so do its outcomes, including natural resource availability. However, this study fails to substantiate that social capital improves natural resource availability, through improvement of natural resource governance (Pretty 2003a).

5.4.2 Limitations of data metrics

It is imperative at this stage to highlight the limitations of EVI used as a proxy for resource availability and general environmental condition in the study and of social capital metrics. First, studies have shown that EVI data can be aerosol-and cloud-contaminated, resulting in errors in values of greenness (Bevan et al. 2008, Samanta et al. 2011, de Leeuw et al. 2012). For instance in the highly disputed study by Saleska et al. (2007), whereby different findings were found on replication of the study and the errors were attributed to atmospheric corruption of EVI data (Samanta et al. 2010, 2011). However, data in this study were generated through the MODIS bi-directional cloud-free and atmospherically adjusted surface reflectances (CSIR-Meraka Institute 2011), to reduce noise on derived EVI data (Huete et al. 1997). Second, the EVI metric might not capture the whole range of resources used or available in communal areas. For instance, greenness captures photosynthetically active plants, and yet fuelwood can be dead wood or moribund material. Lastly, aggregated social capital variables pooled to community level for instance social capital index might mask variability within individual components of social capital like group memberships. In chapter 4, findings indicated that it is necessary to disaggregate the components that underpin social capital in analyses for in-depth understanding of the cause and effect. However, our resource availability measure was per village, and this could a prudent level to assess resource availability and social capital interactions owing to the communal ownership of woodlands. Access to natural resources in communal woodlands is basically open to members of the community and there is limited household level plots.

5.5 CONCLUSION

This chapter sought to answer the question: does communal social capital result in better natural resource availability? There was no empirical evidence of a relationship between social capital at the village level, and local resource availability. Nevertheless, the study does not find sufficient

qualitative data to disqualify that there are some mechanisms through which social capital can function to improve governance of natural resources. In addition, even with relatively high social capital in villages there are perverse outcomes like widespread non-compliance and rule breaking in rural communities due to lack of alternatives. However, several issues remain unclear. Further research is required to explore the dynamics of social capital and how it influences the process of decision making by households pertaining to natural resource access and harvesting. In addition in-depth qualitative empirical work can be conducted to explore the influence of power relations on social capital and the access to resources that these provide. Such work can unearth the sources of inefficiency in natural resource governance in communal areas for the improvement of resource management.

5.6 APPENDICES

Appendix 1 Summary of focus group discussions on natural resource management, rule enforcement and trust in leadership in separated by village in Bushbuckridge

	Village				
Governance theme	**Agincourt**	**Kildare**	**Xanthia**	**Justicia**	**Ireagh A**
Informal and formal rules governing NRM	No cutting fruit trees No cutting trees for firewood without permit.	No cutting fruit trees No cutting live wood for fuel Burning the bush Killing wild animals	No cutting trees, without permit No grass burning Harvest only dry wood Plant trees Look after woodlands	No cutting live trees No cutting fruit trees	No cutting of trees No cutting fruit trees e.g. jackal berry, yellow monkey trees No burning bush- for cattle and for wildlife, like insects No killing of wild animals
Rule observance	Some do, some do not (some get away with paying bribes)	No they do not- people cut fruit trees Dry wood is finished- so people now cut live trees They need firewood for cooking	No- cut live trees People need firewood, electricity shortage No money for electricity	No-people still cut live and fruit trees	We cut trees Even fruit trees, without permit from Jongilanga Shared communal woodlands and population rise makes it hard eg Ireagh A, B and Kildare Not enough resources and power cuts Poverty causes people to cut

					Permits given for far away places when people have no cars to go there and fetch firewood
Satisfaction with access to natural resources	No quite, because some of us would like to trade in natural resources but we are not given permits.	No, there is scarcity, especially nearer to villages.	No, there is a decline of fruit firewood species	No- there is not enough resources	No, woodlands are smaller. They fenced off our animals in Kruger, but community does not benefit They arrest you if you try to fetch anything Access needs a car because we now have to go further for firewood
Changes in natural resource governance in past 10 years	Corruption abounds more, especially from commercial harvesters of resources Increased commercialization of resources e.g. marula beer	There were rangers, now they are not there anymore The traditional authority had more power to preside over cases of abuse of resources	No change However, bribery increasing	Worse	Law enforcement was stronger then, they would even search houses for firewood

Consequences of rule-breaking and fairness of consequences.	Arrest, fines	Arrest Appear before tribal court Some say it is fair (2 people)- because people destroy nature, some say it is not	Arrest, fines Confiscation of illegally harvested resources Not fair, especially confiscation because we still need to cook.	Arrest, taken to tribal authority, (e.g. R500) Not fair, money will not bring back the trees fines	Arrest, and consequence fair
Who is responsible for NR protection	Self, users, rangers	Chief Tribal authority Community	Community- us Need to teach on another as the community to protect natural resources It is us who destroy, so we have the responsibility to protect	No one?	Community residents Local leadership
Trust in local leadership as custodians	Yes	We do, they want good for us Another says no, there is nepotism and corruption among them	No- they are corrupt Some cut more trees than community members They harvest with bakkies, and so wood is finished for us Population increase makes it harder to protect natural resources	Yes- 1 response	Yes- chieftaincy And no, some rangers if they confiscate wood from people they take it home to their places Poor enforcement- participant had been arrested with firewood but says they solved nothing because she still went back

			They steal		Not enough rangers
Satisfaction with how issues pertaining to NRM are handled in community eg courts	Yes, but we do not heed their calls not to cut trees	They are no longer looking after our natural resources In the past there were rangers Some break the rules themselves eg you find wet wood in their yards	Favoritism for those who harvest with cars (the richer) than those who harvest headloads – seems they are easy to arrest The richer pay bribes People from other villages with cars come harvest in our village	No, fewer arrests because of bribery	No, too much pollution of rivers where we used to fetch water (eg with pampers)
What could be improved	Hire more rangers Community member should be involved Local leadership must be trustworthy Transparency on who has permit to cut wood so villagers can help policing	Employ rangers to patrol woodlands Increased awareness	Guard against car harvesters from other villages		Employ rangers
Changes in NR availability in past 10 years	Lots of bush/trees destroyed Population increase putting	No more wild animals Decline in fuelwood	No more wild animals Nomore dry wood for firewood	Decline in fish Shortage of water Decline in trees	Pollution of river Children do not know natural resources anymore,

	pressure on the environment Nomore locusts- we grew up fetching but now they are nomore Lots of ticks now Many birds coz people don't hunt them anymore	Scarcity of fruit trees	Decline in fruit trees		the fruit trees are finished
What has changed the most, least, remained the same		Animals have changed the most- the rabbits, duikers Firewood is still, if you go the bush you will come back with some Water is still scarce	Animals changed the most, nomore rabbits, duiker etc killed a lot Changed the least- monkey orange trees Nothing has remained the same	Animals(zebras, impala etc) changed the most	Animals have changed the most Guinea fowls, birds and snakes have changed the least Nothing has remained the same
Has use of natural resources increased/decreased in the past 10 years		Decreased- young people do not go looking for fruits in the bush- (or is it because of scarcity)	Use has increased as the natural resources have decreased	increased	
Any other matter	The chief has to do more for awareness on the state of the environment	There is water scarcity- the government should intervene	nothing	Talk of social problems of sickness and deaths	

Children should be taught in schools not to burn	

CHAPTER 6

Study discussion and synthesis

6.1 INTRODUCTION

Studies on the role of social capital in rural household livelihoods are essential for understanding livelihoods. Although research had been conducted in South Africa on social capital and various aspects of rural livelihoods (Maluccio et al. 2000, Carter and Maluccio 2003, Poortinga 2006, Pronyk et al. 2008), further analyses in this study provided key insights on the multilevel and multifaceted interactions of social capital and natural resources. In this study, I presented in-depth analyses of the multifaceted concept of social capital and its impact on natural resource use by rural households and natural resource availability in communal woodlands in the central lowveld of South Africa. The aim of the study was to examine the interactions between social capital, natural resource availability and natural resource use and how the natural resource use-social capital relationship is influenced by the presence of shocks at the household level.

6.2 Summary and discussion of major findings

6.2.1 Social capital and other livelihood capitals

First, I explored the interactions between social capital and other livelihood capitals at household level, as well as how social capital influences natural resource use after controlling for the effect of other household livelihood capitals (Chapter 2). In the study, and indeed other studies in the South African context, it was discovered that poorer households derive greater benefits from natural resources than households with relatively more wealth (Shackleton and Shackleton 2006, López-Feldman 2014). For instance, higher income has been observed to be accompanied by a decline in the share contributed by informal sources of income to total household income, including natural resource income (Dovie et al. 2002). In addition, social capital was correlated with human and physical capitals (Maluccio et al. 2000). Also, the improvement of a household

welfare, as indicated by accumulation of physical assets and human capital endowment, resulted in a decline in natural resource use. These findings are in line with the argument of complementarity (Ekins et al. 2003b, Abenakyo et al. 2007), whereby social capital complements human and physical capitals in achieving better livelihoods for rural households. Social capital appears to have positive association with natural resource types and natural resource use intensity, whereby natural resource types and intensity of use increase with increase in social capital (Figure 1).

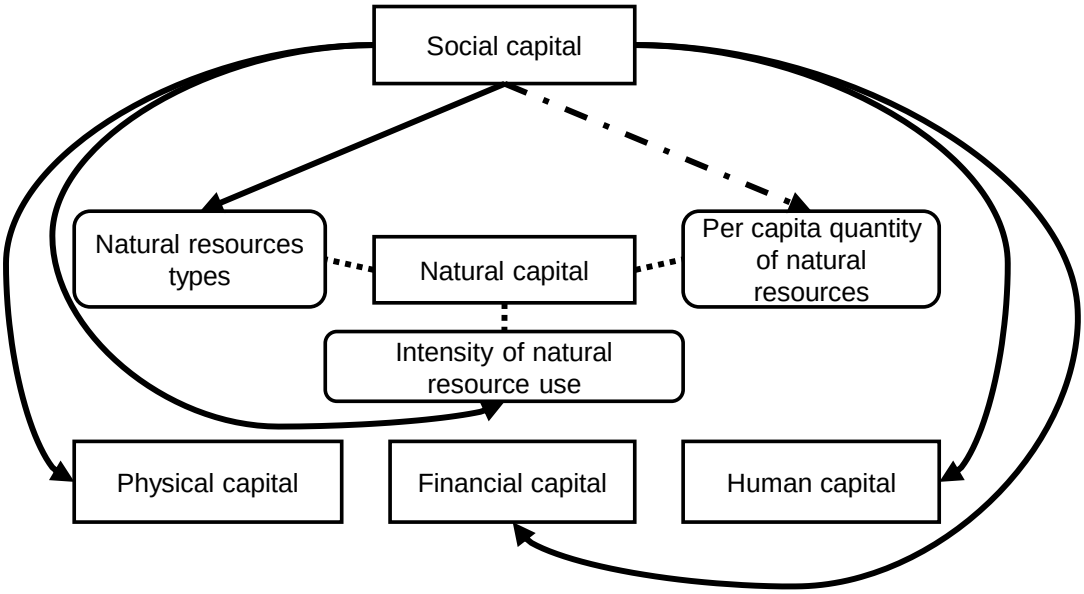

Figure 1. The interactions between social capital and physical, financial and human capital and the three dimensions of the use of natural capital. The solid arrows indicate positive associations, while the broken arrow indicates a negative association. The broken lines indicate the three dimensions of natural capital as explored in Chapter 1.

A possible explanation could be that greater access to or use of social capital can enhance acquisition of natural resources. It can be seen that as social capital increased, the number of natural resources used by a particular household also increased. The findings in this regard are inconsistent with most literature that argues that households with higher social capital are more likely to have improved welfare (Maluccio et al. 2000), and thus by inference, reduced reliance on natural resource consumption (Dovie et al. 2002). A critical evaluation of this conjecture is important. On the other hand, in communities where there is widespread use of fuelwood for energy and other

natural resources, reduced dependency on natural resource use might be a poor indicator of welfare improvement. Alternatively, where critical resources like fuelwood for energy are concerned, social capital might not substitute for these, as rural households might not afford alternative energy sources such as electricity. Evidence exists to suggest that fuelwood use in South African communal areas can be inelastic under certain circumstances, for instance, where there is resource scarcity (Matsika et al. 2013).

Moreover, social capital was significantly associated with an increase in the intensity of natural resource use, which could imply that higher social capital is associated with higher dependency on natural resources. Several studies have shown that the natural resource income share was highest in households in the poorest income quintile (Angelsen and Wunder 2003, Adhikari et al. 2004a, Fisher 2004, Fisher and Shively 2005, Vedeld et al. 2007). On the contrary, social capital was associated significant declines in the quantities of natural resources used by rural households. A key discovery here is that, the welfare-improving impact of social capital is thus not high enough to offset the need for natural resources. Other studies have corroborated this finding, particularly those focusing on community health, cautioning against a focus on social capital in rural livelihoods discourse, which they argue can idealize rural community life and draw attention from critical concerns of poverty and wealth-building (Muntaner et al. 2001, Navarro 2004, Ziersch et al. 2005). In addition, others have deliberated that social capital is less useful in supporting rural households or buttressing vulnerability in the absence of other livelihood capitals (Gilbert and Walker 2002). Others have suggested that the social capital concept runs the risk of being used so extensively and diversely such that it loses its capacity to contribute to academic and policy dialogue (Fine 2001).

6.2.2 Social capital, negative shocks and natural resource use

Second, I introduced shocks in exploring the relationship between natural resource use and social capital (Chapter 3). In this chapter, I addressed three key questions. First, what is the impact of negative shocks on the three dimensions of household natural resource use: number of natural resources, intensity of natural resource and quantity of natural resource? Second, how does the influence of shocks on natural resource use vary with household physical assets, household

income, gender of household head and other household characterization variables? Lastly, how does social capital impact the relationship between natural resource use and negative shocks after accounting for household characterization? Negative shocks precipitated increased use of natural resources in all three dimensions of use we explored: the types, intensity and quantities of natural resources (Figure 2).

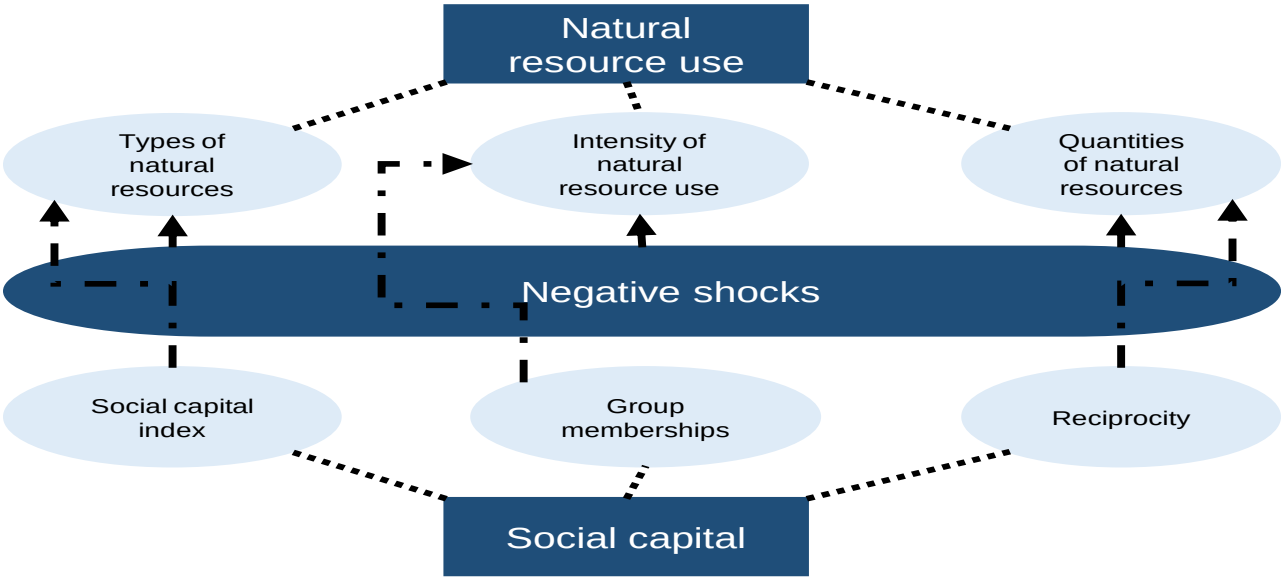

Figure 2. Conceptual model for the influence of negative shocks on three dimensions of natural resource use with shocks only (solid arrows), and with negative shocks and social capital (broken arrows). The dimensions of social capital and natural resource use investigated are indicated by the broken lines.

When social capital was included in the analyses, the effect of shocks on the three dimensions of natural resource use was not significantly lowered. In fact, some have posited that informal safety nets such as social capital, are deficient when shocks are extreme and cumulative (Heemskerk et al. 2004). However, the analyses did not separate shocks according to severity, which could have resulted in the low impact of social capital when households experience negative shocks. The increased natural resource use strengthens the observations from elsewhere that have identified natural resources as a vital safety net for households post experience negative shocks (Angelsen and Wunder 2003, Vedeld et al. 2007, Paumgarten and Shackleton 2011, Kalaba et al. 2013). Here, three key findings answer pertinent questions on the impact of shocks on natural resource use, and

the impact of social capital on that relationship. First, consistent with expectations, negative shocks are associated with significant increases in all dimensions of natural resource use. Second, even when household physical assets and general characterization are controlled for, natural resource use is still markedly higher when households experience shocks than in the absence of shocks. Third, when social capital dimensions of group memberships, reciprocity-give and reciprocity-receive were accounted for, there are differential outcomes. Group memberships were associated with an increase in natural resource use, while reciprocity-give was associated with a decline in the types, intensity and quantities of natural resources used. It is possible that when households experience shocks, they might use different types of natural resources that they would otherwise not use if they had not experienced negative shocks. In addition, households might increase the frequency with which they use natural resources, which signals higher dependency on natural resources in times when they experience negative shocks. Further, households might consume larger quantities of natural resources in response to livelihood shocks, perhaps as a cost-saving strategy or to cushion themselves from the effects of these shocks on household consumption. However, households which give more help (supposing these have more wealth endowment, or at least have more resources share) are associated with lower natural resource use in general, even when they experience shocks. Consistently, physical capital was associated with considerable declines in natural resource use, even when households experienced negative shocks. This highlights the importance of physical assets in sustaining households, an observation that has been made in previous studies that households can dispose of assets to cope with shocks (Dercon 2002, Wainwright and Newman 2011, Heltberg et al. 2013, Börner et al. 2015). Moreover, the results suggest that physical capital and natural capital are to a greater extent, substitutable for each other. In this setting, what emerges is that both physical and natural capitals emerge as key components of household livelihoods when they experience of shocks, contrary to other studies elsewhere (see Carter and Maluccio 2003).

6.2.3 Social capital across a resource availability gradient

Next, I explored the relationship between social capital and natural resource availability at village level (Chapter 4). I tested the hypothesis that communities in resource richer areas are less dependent on others to cushion their livelihoods. To achieve this I examined how social capital

dimensions of reciprocity and membership in societal groups vary across a natural resource availability gradient. The use of the social capital dimension of reciprocity (receive and give assistance) varied significantly across a natural resource availability gradient (Figure 3, arrow A). It emerged that social capital dimensions of reciprocity were higher in low resource availability villages, whereas group memberships were higher in villages with higher resource availability. Expressly, the dependency of rural households on social capital and community groupings are associated with changes in natural resource availability, though with divergent performance. One possibility is that, reciprocity is high in low resource areas as households rely on each other for subsistence, and as such the role of social capital as a safety net in these areas is magnified (Grootaert 1999, Haddad and Maluccio 2000, Heemskerk et al. 2004, Zhang et al. 2017). On the other hand, group memberships could be higher in high resource areas, as there are likely less resource conflicts that can hinder community cohesion. Research has shown that in areas where there is higher resource availability, or better resource management, social capital stocks tend to be high, making them an ecosystem service (Chan et al. 2012b, 2012a, Barnes-Mauthe et al. 2015). In general, the relationship between natural resource availability and social capital emanating from communal interactions has been widely acknowledged (Claridge 2004, Pretty and Smith 2004, Leach and Sabatier 2005, Wagner and Fernandez-Gimenez 2008b, Compton and Beeton 2012). It has been argued that natural resource availability can create opportunities for the growth of social capital, whereas resource scarcity breakdown in natural resource management systems, can result in diminished social capital stocks (Burke 2010, Barnes-Mauthe et al. 2015). Thus, the results of this study corroborate these arguments, while at the same time making a critical contribution to livelihoods research by highlighting the importance of breaking down social capital dimensions in analyses (Crona et al. 2017).

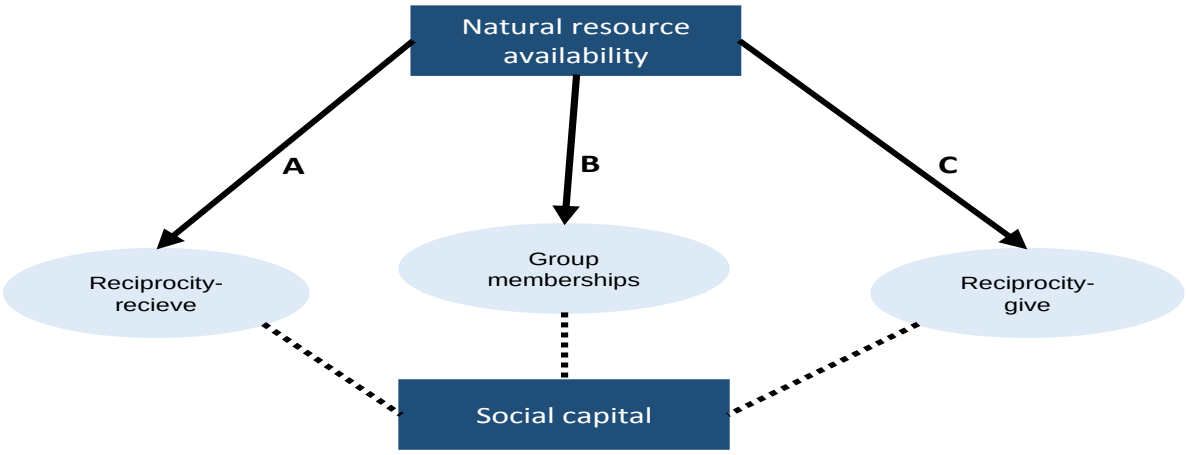

Figure 3. The relationships between three dimensions of social capital and natural resource availability. The solid arrows indicates significant relationships. The broken lines indicate the dimensions of social examined.

6.2.4 Does social capital improve resource governance and availability?

Lastly, I tested the hypothesis that higher community-level social capital resulted in better natural resource management, and hence availability in communal woodlands (Chapter 5). Studies have highlighted the importance of social capital in natural resource management, arguing that it can translate to better resource availability (Pastor 2001, Pretty and Ward 2001, Pretty 2003a). Generally, I found that villages with lower levels of trust in leadership have low resource availability, whereas those with higher levels of trust in local governing authorities have higher resource availability. However, this relationship was not empirically significant, and so it cannot be concluded with confidence that improved social capital results in better resource availability. These findings differ from other studies that have attributed better resource management and subsequently resource availability to dimensions of social capital like trust and the resultant collective action, which improve natural resource governance (Pretty and Smith 2004, Sigmund et al. 2010). The lack of empirical measurements of natural resource availability in previous studies may well have led to these generalized claims. It is prudent therefore to conduct more studies that link social capital stocks and natural capital stocks, particularly with empirical measures of resource availability.

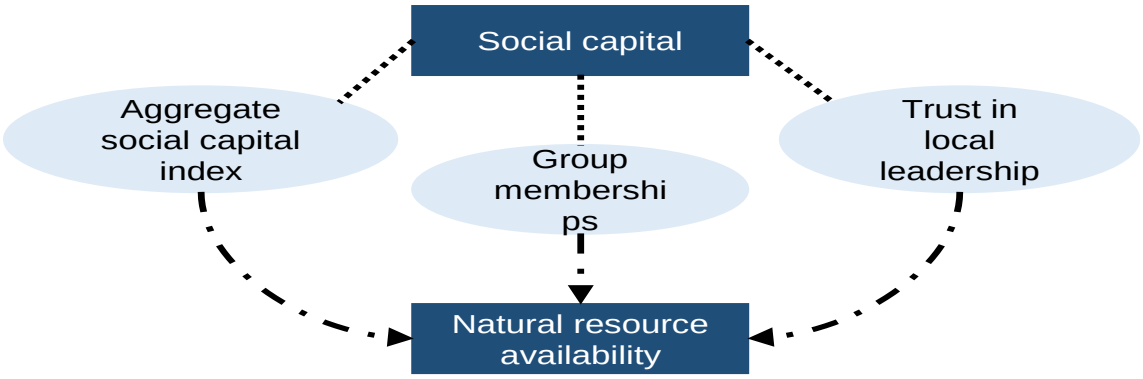

Figure 4. The interactions between communal social capitala and natural resource availability. The broken arrows indicate no relationship, whereas the broken lines indicate the dimensions of social capital investigated.

6.3 Local and scaled-up implications of study findings

The findings of this study support several dominant and emergent notions on social capital, while they refute some claims. First, and in line with other studies, at the local scale, social capital has complex interactions with other livelihood capitals and negative shocks (Figure 5). Figure 5 tries to capture some of these complex relationships as explored or inferred from this study. The role of social capital is not sufficient to offset demand for natural resources. In contrast to existent literature on social capital and coping with economic shocks, it emerges that the safety net role of social capital is less pronounced in this context of rural South Africa (Figure 5). Although the reasons for this can vary from the nature of social capital measured, or high dependency on inelastic-demand resources like fuelwood (Matsika et al. 2013), to the highly modernizing rural environment which might modify the outcomes social capital stocks, what is evident is that empirical evidence exposes the shortfalls of social capital as a stock of livelihood assets. On the other hand, social capital has positive associations with physical and human capitals, indicating that as social capital stocks improve, there may be accompanying improvements in for instance in education (Nawrotzki et al. 2012), or in physical wealth. The implication here is that it is important to conduct critical inquiry into the placement of social capital at the same level as physical and other capitals in assessing household vulnerability in rural South Africa, say to negative shocks.

However, at national and regional scales, and indeed in other contexts, generalizations cannot be made without risking gross misinterpretations of the role of social capital.

In addition, it is important that empirical investigation of social capital and other household capitals should seek to disaggregate components of what is often collectively reported as social capital (Crona et al. 2017). This study reinforces this suggestion as the outcomes of the components of social capital behaved differently in relation to other capitals and negative shocks. Primarily, this is because these components of social capital can exhibit complex and divergent outcomes on other livelihood capitals (Figure 5). Moreover, these dimensions are derived from various aspects of households, and these vary from one context to the next. In addition, different elements of social capital inform us about varying dimensions of rural households, for instance, group memberships can be an index of reliance on community, whereas reciprocity can be an indication of reliance on more close knit kinship, neighbourhood or friendship relations.

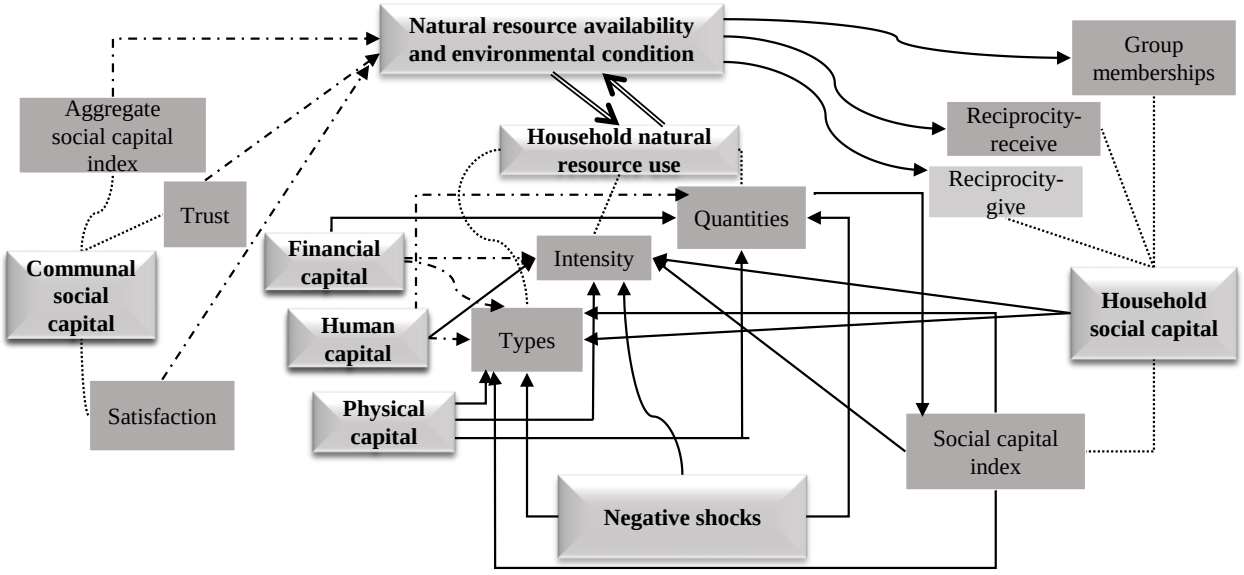

Figure 5. A conceptual model for the observed interactions between social capital, natural reosurces, livelihood shocks and natural resource availability. The solid arrows show at least one type of relationship, the broken arrows indicate no significant interaction, whereas the broken lines indicate the dimensions of each variable investigated. The thick hollow arrows indicate an inferred relationship.

Lastly, the role of social capital in improving resource availability is questioned, as the study fails to find empirical evidence of improved resource availability owing to improved social capital. The implication is that there are other critical factors that might be contributing to both better resource management and availability. Enquiry needs to extend to explore the thresholds at which social capital fails to contribute significantly to better resource availability through better resource management. In the bigger picture and at wider scales, and cohesion might contribute to overall social cooperation between actors in natural resource management (Katz 2000, Pretty 2003a, Pretty and Smith 2004, Plummer and Fitzgibbon 2006), plausibly with desirable outcomes, whereas at the local and finer scale other factors might be more prominently at play, like rainfall and local population size and linked resource consumption levels.

6.4 Research and policy recommendations

At the household level, further inquiry should be made on whether social capital should be placed at the same position as other household livelihood capitals, as it is evident that other capitals, for instance physical and human capitals, are more influential in lessoning the dependence of rural households on natural resources. In addition, research should focus on how policy can encourage investment in processes that can protect communal natural resources, given the high levels of resource dependence and resource use, even among households with higher physical capital. At the community level, further research can focus on exploring the underlying causes and dynamics of non-compliance and rule breaking, which undermines natural resource conservation in these environments. In addition, research should focus on shock typology when exploring the response of household consumption of natural resources when they experience shocks, for instance shock magnitude. The impact of shocks on households has been argued to depend of such factors as shock magnitude and frequency (Heemskerk et al. 2004). There has been growth in research dedicated to the interlinkages between household socio-economic characterization and the environment. Much research has exposed the complexities at this interface owing to many relationships between biophysical and socio-economic systems and components. This has necessitated multi-level and multi-dimensional analyses on these socio-ecological analyses with different but complementary methodologies. Findings indicate that it is imperative to aggregate

and disaggregate the socio-ecological system components in both quantitative and qualitative research. It is also important to focus on the abstract components like social capital, which have been proven to be instrumental in rural livelihoods.

Development efforts should acknowledge the role that this elusive capital plays in sustaining rural livelihoods, cushioning households from the deleterious impacts of negative shocks on household livelihoods. However, care should be taken in assuming that social capital yields the same livelihood advantages as other capitals such as physical and human capital, as it might not in all contexts. Moreover, livelihood interventions should be wary of applying findings on social capital from one setting in another, as the ties among social capital and other livelihood capitals is highly variable. In addition, efforts to conserve natural resources in communal woodlands should recognize the dual role of natural resource availability in sustaining household livelihoods and conserving already existing social capital. Natural resource scarcity can threaten social groupings, reciprocity and trust in local leadership. Although it is not empirically evident that social capital can improve natural resource availability in communal woodlands, it is important to nurture principles and processes presumed to conserve and grow the stock of communal social capital to increase cooperation and cohesion in collective action.

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