Exploring climate change adaptation in the Mongolian steppes using an Ecosystem Services approach

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Dedication

This thesis is dedicated to my late great grandmother (my mother's grandmother) ***Tsezmaa Bazar***, who was an open-minded, ordinary herder woman. Thank you, GG, for everything you taught me and guided me through.

[Cover photo: Ulz River Valley, Norovlin soum, Khentii aimag, Mongolia [photo: Navchaa Tugjamba]]

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Statement of candidate

I certify that the work in this thesis entitled *Exploring climate change adaptation in the Mongolian steppes using an Ecosystem Services approach* has not previously been submitted for a degree and nor has it been submitted as part of a requirement for a degree to any other university or institution other than Macquarie University.

I also certify that the thesis is an original piece of research and it has been written by me, except as otherwise indicated. Any help and assistance that I have received in my research work and the preparation of the thesis have been appropriately acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis. All study protocols have been approved by the Macquarie University Human Research Ethics Committee, with reference number 5201800162.

Navchaa Tugjamba
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Date: 02 June 2020

Abstract

In dryland regions of the world, the risks from climate change of severe impacts on pastureland ecosystems, and local livelihoods dependent on them, are high. Improving climate change adaptation to support local livelihoods and sustain natural ecosystems in these regions is needed. The Mongolian steppes are a substantial dryland region that is experiencing faster climate change than most other regions of the world. This thesis explores climate adaptation challenges and opportunities in the pasturelands of the northeast Mongolian steppes, where nomadic herding is the predominant use of the landscape. In the process, it investigates ways in which ecosystem services approaches can contribute to local environmental decision-making in rural areas in developing economies.

A mixed methods approach, consisting of in-depth interviews with nomadic herders and with key informants from the local municipalities and natural resources management organisations, focus group discussions, a survey of nomadic herder households, and a policy workshop in the national capital, were used to investigate climate change impacts on local livelihoods and pastureland ecosystem services. The study explores herders' experience of climate change impacts on key ecosystem services: changing water availability, changing quantity and quality of pasture, and livelihoods changing as a result.

The study shows that traditional knowledge has and is continuing to play a key role in adapting to environmental variability - traditional herd management practices, collective institutions, and mobility strategies all contribute substantially. However, nomadic communities are facing unprecedented climate risks that threaten their livelihoods. Possibilities for future adaptation are explored. The study found that the traditional understanding of the relationship between nomads and the pasturelands, which is governed by "*baigaliin khishig*"- commitment to benefiting from nature without altering its structure - resonates with western ecosystem services thinking. This study highlights that an ecosystem services approach can contribute to local environmental management in ways that support climate change adaptation, if it leverages traditional ecosystem services thinking. The research adds significantly to the ecosystem services literature by contributing a local, rural, developing world case study from the drylands.

Key words: *climate change, nomadic livelihoods, ecosystem services, adaptation, pastureland ecosystem, Mongolia*

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Contribution to papers

This PhD is presented in a thesis by papers form. The core findings of the chapters are the stand-alone papers, but these are linked with other chapters and contribute to the overall aim of the thesis. This section provides a brief overview of co-authors with their specific contributions. The stand-alone chapters are articles, under review (chapter 4, 5, 6 and 7) in the journals. The papers are co-authored with a team of supervisors (see Table 1).

Table 1. List of contributors

Principal supervisor	Dr.Greg Walkerden Senior lecturer, Department of Geography and Planning Macquarie University, Sydney, Australia
Associate supervisor	Dr.Fiona Miller Associate Professor, Department of Geography and Planning Macquarie University, Sydney, Australia

Table 2 summarises the contributions made by each respective contributor.

Table 2: Specifying contributions of each contributor

	Paper 1	Paper 2	Paper 3	Paper 4
Conception	Tugjamba 85% Walkerden 10% Miller 5%	Tugjamba 85% Walkerden 10% Miller 5%	Tugjamba 85% Walkerden 10% Miller 5%	Tugjamba 85% Walkerden 15%
Data collection	Tugjamba 100%	Tugjamba 100%	Tugjamba 100%	Tugjamba 100%
Analysis	Tugjamba 100%	Tugjamba 100%	Tugjamba 100%	Tugjamba 100%
Writing	Tugjamba 85% Walkerden 10% Miller 5%	Tugjamba 88% Walkerden 10% Miller 2%	Tugjamba 85% Walkerden 10% Miller 5%	Tugjamba 85% Walkerden 15%

Abbreviations and Acronyms

ADB	Asian Development Bank
CES	Cultural ecosystem services
CICES	Common International Classification of Ecosystem Services
EEA	European Environment Agency
EMG	Environment Management Group of the United Nations
FAO	Food and Agriculture Organization of the United Nations
FGD	Focus Group Discussion
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
MARCC	Mongolian Second Assessment Report on Climate Change
MEA	Millennium Ecosystem Assessment
MEGD	Ministry of Environment and Green Development, Mongolia
MNET	Ministry of Nature Environment and Tourism, Mongolia
NAPCC	National Action Program on Climate Change
NGO	Non-Governmental Organization
NSC	National Statistical Commission of Mongolia
TEEB	The Economics of Ecosystems and Biodiversity
TEK	Traditional ecological knowledge
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WGP	Water Global Practice
WWF	World Wildlife Fund for Nature

Preface

A nomadic journey from the Badiin Gol riverside area, central Mongolia to Macquarie Park, Australia

My PhD research at Macquarie University led me to look back to my nomadic roots in my riverside area, where I explored how climate change impacts on local livelihoods and pastureland ecosystem services in the open steppes of Mongolia. As a successor to the nomads, I grew up in two parallel worlds. I was born and grew up in a small steppe *soum*[1] (village) in central Mongolia. Since my parents were school teachers, we used to spend 3 seasons a year (autumn, winter and spring) in the village house. In summer, then, we had moved to a summer place with my great grandparents to stay in the *ger*[2] as nomads. Thus, I had grown up having friends from two different places; i) friends from the same street in the *soum* centre and ii) friends from *Badiin gol* riverside area.

When I was six years old, one day, I was impatiently waiting for my father to come from work. When I saw him on the other end of the street, I ran to him and said I was puzzled. He smiled calmly and asked what was bothering me. I replied to him '*it seems everybody has own riverside area, for example, you are from Muursiin Gol*[3]*, mom is from Badiin gol. Thing is there is no river close to our soum centre (village), so, us kids from the soum centre, don't have our river. Where do we belong to?'* Instead of answering directly, he asked me what I did today. I was still wondering but answered that I was playing with my friends. Then he asked again who my friends were? It made me more anxious, but I replied 'you know them dad, my friends from neighbourhoods'. He did not take that answer and was continuing with his question, saying why you are playing with them instead of the other children. My answer was because we live on the same street. Finally, he said: "You see, you have your street, my daughter, the kids at the *soum* centre have their streets'. This talk was enough to stop me from worrying about belonging to any riverside area. Later, however, I realized that deep down, because of the influence of my great-grandparents (my mother's grandparents had taken care of us) in our childhood, I began to identify as a nomadic girl from the *Badiin Gol* area. Understanding about belonging to a certain *Gol Us* (River) is broader than just coming from near a river, it is traditional socio-ecological unit of nomads. In general, traditional nomadic culture in Mongolia is similar everywhere, but each riverside area (*gol us, nutag us*- Нутаг ус in Mongolian) has its special customs, their traditions differ from each other.

1 Soum- primary administrative district of Mongolia. Similar to sub-district. Soum centre is a village.
2 Ger- yurt, Mongolian traditional house
3 Gol- a river in Mongolian

It is not only my unique story; despite the fact that they live in cities or towns, most Mongolians also consider themselves to belong to a certain riverside area. This sense of belonging to a particular riverside area defines our origins, identifies the cultural customs that we have to follow, and is a source of inspiration and spirituality.

Following in my parents' steps, I graduated from the Mongolian State University of Education (MSUE) as a teacher of geography. After I graduated from university, I started my career as an associate researcher at the Institute of Geography, Mongolian Academy of Sciences. Then I decided to pursue my career as a university lecturer, following my childhood dream. Teaching environmental science subjects at the University of the Humanities gives me a lot of opportunities for personal and academic development. Besides working at the university, I had worked as an environmental management expert for several years in Mongolia. Being a researcher and consultant in environmental management allows me to get to know different parts of Mongolia. However, as a traveller, I enjoyed it more easily at the very beginning of these years and over time it has brought me different feelings and thoughts. This is due to the fact, more and more statistical reports and scientific presentations indicating that "Mongolia is one of the most vulnerable countries to climate change", or "the average annual temperature increase is higher than the global average"; the drying rivers, disappearing wetlands have given me a greater sense of needing to explore and understand our environmental issues, fundamentally. For instance, when I was a child there were 3 small streams that all run into *Badiin Gol* in our riverside area. At present, 2 streams have disappeared, and only one is left but the flow is reducing year by year. The flow of *Badiin gol* has already decreased. With the reduced size of river flow and disappearing streams and lakes, traditional culture and custom have altered. It is greatly affecting our sense of belonging, inspiration and spirituality of being nomads. The time of elders telling stories for kids, singing the traditional long songs, kids enjoying watching the crane dance [the birds' mating dance] is now almost something of the past. The unique socio-ecological system of nomads that has existed for centuries is changed due to climate change.

I completed an MSc in Geography on Mongolian desertification issues at the MNUE. Then, I studied at UNESCO-IHE, The Netherlands, and received MSc in Environmental science. There, I conducted modelling of the water demand of agricultural sectors in the river basin under climate change. Thus, before coming to study at Macquarie University, I had focused on physical geography issues of environmental and climate changes. The first six months at Macquarie University guided me to focus on the relationship between humans and nature, more specifically, the relationship between nomads and open steppe pastureland. I had hoped that I could find some

answers to address the climate and other drivers' impacts on the riverside areas - everyone’s, not only mine - in Mongolia.

Thus, based on my knowledge and experience on land degradation mapping and water resources modelling, I aimed to examine the applicability of the ecosystem services approach to improve the adaptation strategies at a local scale for nomadic livelihoods. I was aware that changing the discipline from Physical geography to Human geography is a challenge. However, I believed that my geographical education, working experiences in the field and my nomadic background would help me minimize these constraints. So, I have conducted this research study as a geographer with a nomadic soul.

Chapter 1. Introduction

> *If we understand the landscape, as the Mongols do, as everything around us, then the landscape includes the sky and its phenomena, such as blueness, clouds, rain, lightning, stars. And rays of light. The sky is the power above all powers. Not only does it give the light, warmth, and rain which makes the earth fertile and allow humans and animals to live, but it also expresses this by means of its will (zaya) which sets out destinies of all living beings (Humphrey, 1995, p. 142).*

Under the guidance of the eternal blue sky and with the support of Mother Earth, the Mongolian Plateau has been the cradle of nomads for centuries. The traditional Mongolian way of life is connected with pastoral livestock husbandry, where people have to be flexible and mobile, herding their livestock along the vast steppes in search of better pasture and water (Yembuu, 2016). However, Mongolia is a country where climate change effects are particularly pronounced: having endured 2.14°C of warming between 1940 and 2008, the country is considered to be one of the countries most vulnerable to climate change because of its geographic and climatic circumstances, and with its dominant livelihoods' crucial dependency on nature and climate. The relationship between nomadic herders and the pastureland ecosystems, where local communities' livelihoods depend directly on the drylands natural environment, is an example. A case study of nomadic herders provides an opportunity i) to explore climate change adaptation options for local communities from the dryland regions, and in the process, ii) to investigate how an ecosystem services approach can be helpfully used.

1.1. Background

This thesis aims to explore climate change adaptation in the Mongolian Steppes using an ecosystem services approach. The impacts of climate change on livelihoods and ecosystems are becoming intensified, so that there is high demand for testing possible approaches and exploring ways to improve adaptation to climate change, not only in Mongolia but also throughout neighbouring affected regions. Since the *Millennium Ecosystem Assessment Report* (MEA, 2005) was released, the interest and effort to utilize the ecosystem services framework in environmental decision-making and natural resources management have increased substantially. Numerous studies have applied the approach, and its methods have been carried out during the last two decades. However, there are some critical issues that have arisen regarding the strengths, weaknesses, and limitations of the approach.

Ecosystem services – “the benefits people obtain from ecosystems to sustain or advance wellbeing” (MEA, 2003) – can change according to both socio-economic and environmental factors. The global issue of climate change especially affects “the benefits from ecosystems” (MEA, 2005). The existing literature reveals that climate change impacts negatively on ecosystem services. However, most studies rely on aggregated data covering broader areas with a lack information on local contexts. An understanding of the complexities of climate change impacts on local livelihoods and ecosystem services is important in environmental decision-making to improve climate-change adaptation.

Review studies on the application of ecosystem services approaches also show that most applications focus on island, coastal, and forest areas, with very few dryland case studies (Gret-Regamey, Adrienne Siren, Elina Brunner, & Sibyl Hanna Weibel, 2017; Runting et al., 2017). Potentially, the ecosystem services approach is a supportive concept to guide decision-making in natural resources management, but there is no clear evidence of the usefulness of the approach at a local scale, in data-scarce conditions, where it needs to be used in conjunction with traditional knowledge (Pandeya et al., 2016). Some work on ecosystem services analysis has shown that the applicability of the approach can be advanced by drawing on traditional knowledge (Bhatta, van Oort, Stork, & Baral, 2015; Gómez-Baggethun, Corbera, & Reyes-García, 2013; Leonard, Parsons, Olawsky, & Kofod, 2013). However, a shift to reliance on ecosystem services thinking can also undermine traditional ways of sustaining ecosystems, such as giving respect for place a central role in decision-making. Developing countries in arid regions are particularly vulnerable to climate change due to lack of water availability, inadequate precipitation and poor conditions for vegetation growth, and traditional lifestyle and its high dependence on the natural resources as a life-supporting system.

This thesis considers ‘ecosystem services’ as a contributor to decision-making alongside the presence of traditional ecological knowledge (TEK). The thesis investigates the opportunities and risks associated with integrating ecosystem services approaches into environmental decision-making in support of climate change adaptation at a local level in the dryland regions, where local livelihoods are directly dependent on natural ecosystems. A mixed-methods approach, employing both qualitative and quantitative research methods, was used to explore climate change adaptation in the Mongolian Steppes, using an ecosystem services approach. Mongolia was selected as a pertinent representative of a developing country’s dryland, recognising that research in such a setting has so far been limited. A case study exploring the adaptation of nomadic herder’s livelihoods to climate change permits an assessment of the

potential benefits and risks of such an approach in local environmental planning for countries where nomadic livelihoods are dominant in dryland regions. This thesis employs such an approach to conceptualize how the ecosystem services approach can be applied at the local level in Northeast Mongolia. The thesis thus provides a critical understanding of the potential implications of how such an approach as a strategy for environmental decision-making is used, articulated and likely to trigger risks and opportunities for adaptation to climate change in Mongolia. This study then contributes to an improved understanding of the risks and opportunities of using ecosystem services approaches in a local environmental decision-making context, specifically that of adaptation in Northeast Mongolia.

1.2. Dryland region: climate change adaptation challenges in the Mongolian steppes

> *Dryland systems are lands where plant production is limited by water availability; the dominant human uses are large mammal herbivory, including livestock grazing, and cultivation (MEA, 2005, p. 29).*

Dryland[4] regions cover about 41% of the world's land area (MEA, 2005), and supporting approximately two billion people, 90% of whom live in developing countries (EMG, 2011). Climate change and other human-induced factors, such as unsustainable land and water use, are leading to further resource degradation in dryland regions. Climate change impacts on the temperate grasslands of dryland regions are increasing very rapidly (IPCC, 2014a; MEA, 2005). According to the Millennium Ecosystem Assessment, 15 of the 24 ecosystem services assessed in the drylands are in decline. This has significant consequences considering that dryland pasturelands support around 50% of the world's livestock. "Pressures on dryland ecosystems already exceed sustainable levels for some ecosystem services, such as soil formation and water supply, and are growing" (MEA, 2005). Desertification and land degradation affect the livelihoods of millions of people in drylands (EMG, 2011; MEA, 2005). For instance, Mongolia is one of the countries most vulnerable to climate change, with more than 90% of its territory considered dryland, and with dominant livelihoods highly dependent on nature and climate. There is a lack of detailed assessment of ecosystem services in Mongolia. However, climate change assessment reports indicate that more than 70% of Mongolian pastureland ecosystems are degraded (MARCC, 2009, 2014).

[4]I used the UN definition of 'drylands', which refers to drylands as land areas with an aridity index of less than 0.65.
Aridity index (AI) is the ratio of annual precipitation (P) and potential evapotranspiration rates (N. Middleton & Thomas, 1997).

Global mean-surface temperature change "will likely be in the range of 1.5°C to 2.0°C" over the next decades (IPCC, 2018). Temperature increase in drylands is predicted and will lead to increased potential evapotranspiration rates (White & Nackoney, 2003). Within the framework of IPCC AR5, a national climate change assessment was conducted in Mongolia. As the second climate change assessment report of Mongolia stated (MARCC, 2014), "the annual mean temperature in Mongolia increased by 2.14°C during the last 70 years with certain fluctuations", which is higher than the world average (0.85°C over the period 1880 to 2012 (IPCC, 2014a)). According to the United Nations Intergovernmental Panel on Climate Change report (IPCC, 2014a), the warming trend will continue in Asia for the next few decades, even if rapid action on climate change is taken. There is considerable confidence that the expected temperature increase in Mongolia will be higher than the world average in the coming decades, with a projected increase from 2.1°C (2016-2035) to 6.7°C (2085-2100) in the winter, and between 2.2°C (2016-2035) and 6.0°C (2085-2100) in the summer, according to the different scenarios.

Approximately half of the northern continental hemisphere is arid, and a large part of the Asian continent is considered dryland. With the increasing warming trend, water scarcity is expected to be a big challenge, not only in Mongolia but also in other Asian countries (IPCC, 2014b). Such regions that are already experiencing water stress will experience even greater water scarcity (WGP, 2016). Thus, Mongolia is highly representative of developing country dryland, presenting a unique case within the Asian continent, as it comprises large arid, semi-arid and hyper-arid climatic zones (Prăvălie, 2016), and is one of 14 countries that have more than one-million square kilometres of dryland (White & Nackoney, 2003). More than 20% of the total population still live as nomadic herders, grazing their own livestock, and benefitting directly from the pastureland ecosystems. For the past 3,000 years, a nomadic livelihood has been the main lifestyle on the Asian high plateau. Nomads experienced three different social regimes in the last century (traditional kinship, communist collectivization, and market economy), with about 90% of Mongolians in 1921 considered to be herders. The latest national statistical report stated that 66,480,160 head of livestock are grazed on Mongolian pastures, and that about 22% of Mongolians are considered nomadic herders (NSC, 2018). The increasing rate of natural hazards, such as drought and *dzud*[5], as consequence of increasing temperature and declining precipitation, is becoming the key issue in the Mongolian Steppes. Pastureland degradation

[5]A zud or dzud (Mongolian: зуд) is a Mongolian term for a severe winter in which large numbers of livestock die, primarily because of starvation, being unable to graze, or in other cases dying directly from the cold. "White dzud" is a consequence of heavy snowfall. "Black dzud" results from a lack of snow on the pastureland.

throughout the country is accelerating due to both climate change and the intensive growth in livestock.

A better understanding of the impact of climate change on local livelihoods and ecosystem services in the drylands region is important for the development of climate change policy options. Improvement of climate change policies is essential to ensure human well-being in the homeland of large populations whose livelihoods depend directly on the physical environment (N. J. Middleton & Sternberg, 2013). The relationship between nomadic herders and pastureland ecosystems is an example of a complex socio-ecological system that can provide useful insights into the adaptation strategies of dryland communities. Traditionally, nomadic livelihoods are adaptive to environmental changes through their approaches to movement linked with pastureland management. A case study exploring the adaptation of nomadic herders' livelihood to climate change will inform the potential benefits and risks of using ecosystem services approaches in local environmental planning for nomadic communities in developing countries. A case study of herders provides an opportunity to investigate how the use of ecosystem services thinking can work alongside leveraging traditional knowledge. This is a crucial issue to explore when testing the usefulness of ecosystem services approaches at a local level, where adaptation decisions need to fit local communities and local conditions, and need to make sense in the context of a wide variety of changes occurring at once (not simply climate change). There are dramatic increases in pressure on pastoral ecosystems occurring from both (i) climate, and (ii) growth in herd animal numbers in Mongolia. So, it is a location in which adaptation planning is greatly needed.

In particular, the Ulz River Basin in Northeast Mongolia is an interesting place to explore the impact of climate change on local livelihoods and the open-steppe pastureland ecosystems. The Ulz River Basin, which represents the Northeast Mongolian ecosystem of forest-steppe and steppe, covers an area of approximately 38,000 km^2 (Yembuu, 2020b) . This river basin area provides an opportunity to look at adaptation in a wider range of circumstances than would be possible by simply studying herding in many other locations in Mongolia.

1.3. Using an ecosystem services approach in environmental management

The *Millennium Ecosystem Assessment* report defines ecosystem services as the "benefits people obtain from ecosystems" to sustain or advance well-being (MEA, 2005, p. 3). This definition is used in this study to explore climate change adaptation in the Mongolian Steppes

with a focus on nomadic herders' livelihoods. As defined in *The Oxford Handbook of World History*:

> *Nomadic pastoralists live in societies in which the husbandry of grazing animals is viewed as an ideal way of making a living and the regular movement of all or part of the society is considered a normal and natural part of life (Barfield, 2011).*

Nomadic[6] Mongolians have lived by moving in search of a better campsite for their well-being, and for the best pasture and water for herding. Herders' livelihoods are highly dependent on nature, especially access to water and grassland. Nomadic people's knowledge and practices have accumulated and developed through nomadic practice over centuries, becoming embodied in custom and culture. Nomadic people's existing knowledge is the main platform for their adaptation to environmental changes. It is interesting to explore how traditional ecological knowledge (TEK) has been used in current adaption strategies and how influential the ecosystem services approach is in environmental decision-making at a local level. As defined by Berkes, Colding, and Folke (2000, p. 1252), TEK is:

> *a cumulative body of knowledge, practice, and belief and handed down through generations by cultural transmission, about the relationship of living beings with one another and with their environment.*

As a relatively holistic approach, the ecosystem services framework addresses the importance of different knowledge, particularly so-called traditional or Indigenous knowledge (Díaz et al., 2015). One highly influential conceptual framework regarding ecosystem services, which was launched by IPBES (The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 2012), and which extends the Millennium Ecosystem Assessment Framework, includes recognition of multiple knowledge, such as Western science, Indigenous, local and practitioners' knowledge, and their interlinkages (Díaz et al., 2015). The framework supports increasing the role of local knowledge in ecosystem services assessment. Another highly influential framework is the Common International Classification of Ecosystem Services (CICES), developed by the European Environment Agency (EEA). It has been used quite

[6] Nomadic: of, relating to, or characteristic of nomads: nomadic herders. https://www.merriam-webster.com/dictionary/nomadic
nomad: a member or group of people who move from one place to another rather than living in one place all of the time. https://dictionary.cambridge.org/dictionary/english/nomad

frequently to assess ecosystem services at different scales in recent years. An important strength of the updated CICES V5.1 is that TEK is included in the scientific knowledge section as "characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge", indicating cultural ecosystem services (Haines-Young & Potschin, 2018). Both MEA (2003) and the IPBES (Díaz et al., 2015) provide comprehensive and valuable frameworks for understanding the dependence of human well-being on ecosystem services.

The Millennium Ecosystem Assessment Framework is widely used to study ecosystem services (J. A. Fisher et al., 2013). This conceptual framework for linkages between ecosystem services and human well-being is conceptually rich and detailed. The framework has been successfully used in a wide variety of cases, facilitating comparison between cases, and thence sharing lessons between localities. The framework can be used to analyse the relationship between nomadic herders and the open pastureland ecosystem services. For instance, the transition from a centrally planned Communist society to a democratic open-market system in the 1990s was the major driver of socio-political change in Mongolia. It was followed by privatization, which freed Mongolians to own property, resulting in changes in factors directly affecting ecosystems, such as local land-use changes (where the massive growth of the livestock population is causing more pressure on pasturelands). Climate change and increasing pressure on the open-steppe pasturelands are altering the ecosystem services of pasturelands, and this is affecting the well-being and livelihoods of nomads.

This thesis addresses these linkages at the local scale and discusses adaptation actions, either in response to negative changes or to enhance positive change (MEA, 2005), adopting the Millennium Ecosystem Assessment Conceptual Framework (Figure 1.1) to provide a conceptual framework that:

- illuminates how climate change impacts ecosystem services and local livelihoods (explored in Chapter 4);
- supports identification of the main cultural ecosystem services that underpin nomadic herders' well-being in Mongolian pastureland (Chapter 5); and

- illuminates climate change adaptation challenges from an ecosystem services perspective, helping identify adaptation strategies of nomadic herders in Northeast Mongolia (Chapter 6).

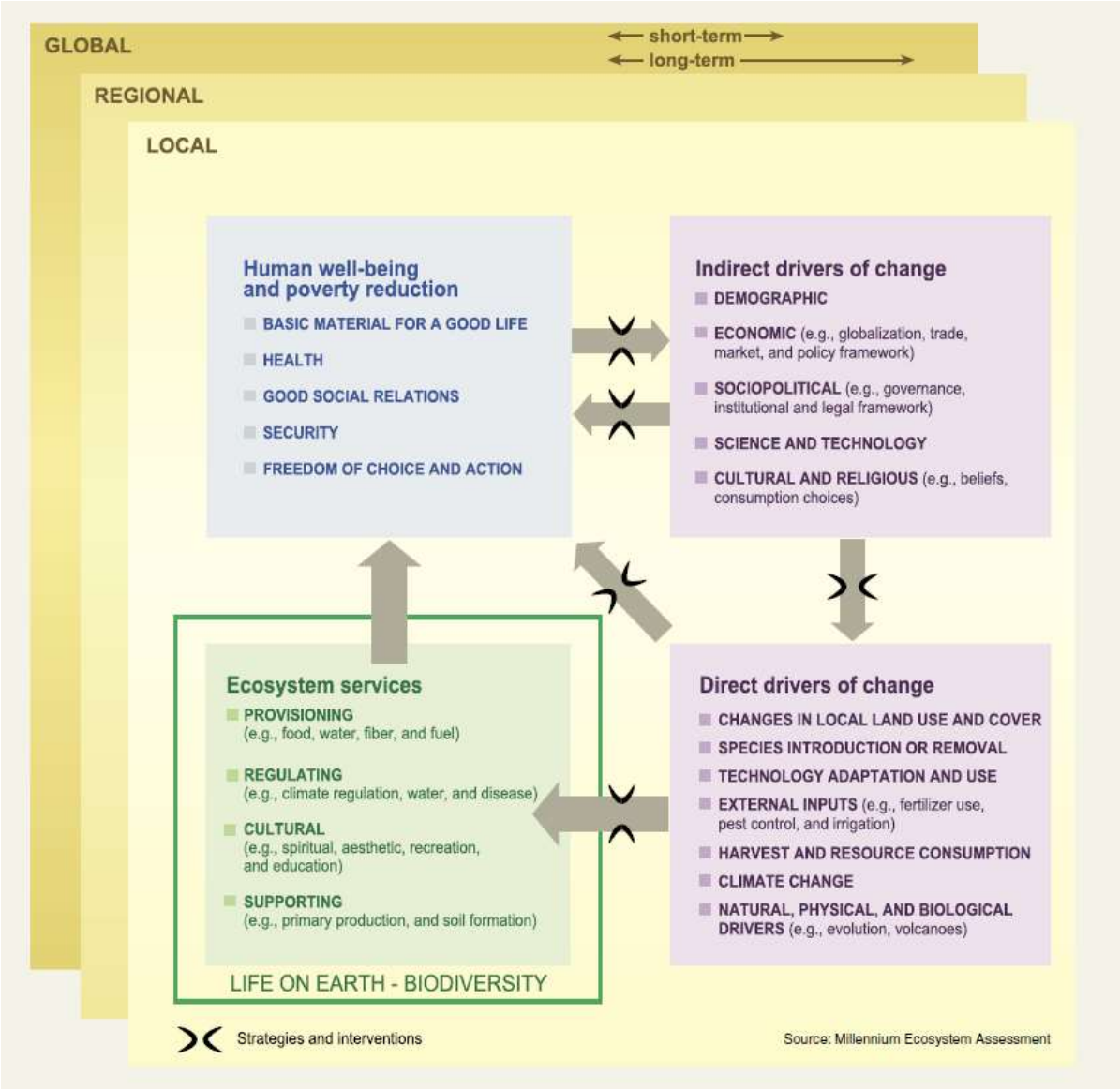

Figure 1.1. Millennium Ecosystem Assessment Conceptual Framework of interaction between ecosystem services, human well-being and drivers of change (Source: adapted from (MEA, 2005))

To explore climate change adaptation strategies, the IPCC (2014a) definition of "*the process of adjustment to actual or expected climate and its effects*" is adopted in this study of climate change adaptation at a local level. Ecosystem services, such as grazing, water resources and the spiritual, symbolic, and inspirational values of the open pasturelands are essential for nomadic herders' well-being. Addressing nomadic livelihoods, I focused particularly on the provisioning and cultural ecosystem services as I investigated the applicability of ecosystem services approaches for pastoral land management under climate change at a local scale. The CICES

V5.1 (Haines-Young & Potschin, 2018) ecosystem services list was used to explore cultural ecosystem services in this study, because it supports the broad analysis needed at a local scale, and provides more detailed guidance to explore the relationships between human well-being and ecosystem services. The match of the spatial and temporal institutions to manage ecosystem services and the scales of the services themselves is important (Costanza et al., 2017), and a traditional nomadic institution, such as "*khot ail - saakhalt ail - neg goliinkhon*",[7] is a clear example of this alignment at the local level. The discussion with nomadic herders about the direct drivers of change and its impacts on local livelihoods, human well-being and ecosystem services was illustrated by these traditional nomadic institutions in the case-study area. In this thesis, ecosystem services thinking, alongside traditional ecological knowledge, was called upon to investigate the current adaptation actions taken by nomadic herders and to identify future adaptation options to support nomadic livelihoods.

1.4. Research gaps

My review of existing literature on the impact of climate change on livelihoods and ecosystem services in dryland regions in developing countries, where local livelihoods are directly dependent on nature, found that this has not yet been adequately studied (Chaudhary, McGregor, Houston, & Chettri, 2015; Costanza et al., 2017; Gret-Regamey et al., 2017; Pandeya et al., 2016; Runting et al., 2017). Review studies show that most studies on the applicability of the ecosystem services approaches to environmental management have been conducted at the global, regional and national levels, and mostly in developed countries, in particular in urban land-use planning (Chaudhary & McGregor, 2018; Gret-Regamey et al., 2017; Runting et al., 2017). As such, there is a paucity of relevant studies to inform the study of where ecosystem services approaches are applicable in rural environmental management in dryland contexts.

Scale

The main critique of the application of the ecosystem services approach is related to the scale. Most climate change and ecosystem services work has been applied at a large scale – in particular, relatively little work has been done that explores its appropriateness in decision-making at a local scale. Because the approach is mainly used at a larger scale, there are some

[7]A hierarchy of informal social networks and institutions, including the khot ail (a network of households sharing resources within a particular region), saakhalt ail (neighbours) and neg goliinhon (people from one river area), have been presented as the basis of the traditional Mongolian nomadic pastoral system in this thesis.

'core' issues, such as practical implications, and the participation of key stakeholders, for example, that are not well discussed and addressed. The approach has been mostly employed in developed nations; there is much less experience applying this approach in developing nations. Practical application of the approach at a local level, from the developing world, still demands attention (Costanza et al., 2017). Moreover, recent research studies highlight the importance of conducting local and regional ecosystem service assessments, rather than relying on averages or aggregates from other contexts (Chaudhary & McGregor, 2018). To manage ecosystem services, it is essential to incorporate the impact of key local drivers of change along with global drivers such as climate change (Runting et al., 2017). Therefore, a case study conducted in developing countries that investigates the impact of climate change on livelihoods and ecosystem services at a local scale is significant.

Why a dryland region?

Research on ecosystem services in drylands is increasing, but research on dryland pastureland ecosystems in developing countries is still limited. IPCC, FAO, IUCN and other key organizations have warned that drylands are the most vulnerable to climate change due to their environmental and climatic conditions, and to people's direct dependence on nature and ecosystem services for their livelihoods. Nomadic livelihood in the Mongolian Steppes is one of the examples where human well-being and livelihoods of dryland local communities are directly dependent on the pastureland ecosystem services. To date there has been limited research on ecosystem services in Mongolia.

Cultural ecosystem services

Because of the difficulties in characterizing intangible values, and because economic and ecological values are dominant in the ecosystem services discourse, cultural services studies are very limited (Chaudhary et al., 2015; Gret-Regamey et al., 2017). When ecosystem services approaches attempt to take into account communities' experience of place (e.g., their spirituality) within the framework, it does so by assessing 'Cultural Services', and this is difficult to do because such connections are intangible, and is obviously limited because it is only a partial representation of the complex experience of place. The locally generated knowledge of cultural ecosystem services is an important input to climate change adaptation by local communities, especially in the absence of other forms of knowledge of environmental conditions and adaptations.

Traditional ecological knowledge

Relatively little work has been done to explore how ecosystem services thinking can work helpfully alongside traditional knowledge, and there are risks of it obscuring, silencing and disempowering local knowledge-holders. Decision-makers, particularly local authorities, need accurate information about ecosystem services to make decisions that support climate change adaptation at the local scale (Pandeya et al., 2016). In studying local livelihoods that are directly dependent on nature, such as nomadic livelihoods, traditional or local knowledge plays an important role in contributing to an improved understanding of local complexity by all decision-makers. Exploring the impacts of climate change on livelihoods and ecosystem services through engaging with TEK contributes to a better understanding of the relationship between humans and nature. Local communities that depend directly on nature for their livelihoods have a long and successful history of responding to environmental variability and managing scarce resources (especially water). Their knowledge and practices provide an important source for guidance on adaptation strategies. For instance, nomadic livelihoods in the Mongolian Steppes, one of the longest-existing cultures that has prevailed for millennia, provide an interesting example of adaptability to changing conditions.

1.5. Research aim and questions

The research study aims ***to investigate climate change adaptation in the Mongolian Steppes using an ecosystem services approach, in the process exploring the applicability of ecosystem services thinking to local land-use planning.*** The following research questions emerge from the literature review and seek to address climate change impacts on nomadic livelihoods and pastureland ecosystem services, taking account of TEK contributions towards understanding cultural ecosystem services and climate change adaptation, and the usage of ecosystem services approaches in environmental management at the local level.

Research question 1: *Through a focus on the changing provision of ecosystem services, how are local livelihoods changing and how is climate change influential in this process?*

To respond to the question, a case study was conducted at the local level in Northeast Mongolia, drawing on interviews with local herders and key informants, and on focus-group discussions (FGDs). Chapter 4 presents how the ecosystem services of pasturelands are affected by climate and other socio-economic changes in the Mongolian Steppes. Nomadic herders' knowledge and observations of environmental change contribute to the investigation of temporal and spatial

changes in precipitation, increases in temperature, and seasonal changes, and how these changes affect their livelihoods, herding practices, and pastureland management.

Research question 2: *What are the main cultural ecosystem service benefits experienced by nomadic herders that support their well-being, and what role can an exploration of TEK play in developing an understanding of the cultural ecosystem services provided by landscapes at a local level?*

An in-depth assessment of local nomadic herders' perceptions and knowledge of cultural ecosystem services reveals what is missed in large-scale studies and frameworks, such as the Millennium Ecosystem Assessment (MEA, 2005); IPBES (Díaz et al., 2015) and CICES (Haines-Young & Potschin, 2018). Nomadic herders deeply value the spiritual importance of the cultural ecosystem services of the steppes. TEK underpins an understanding of cultural ecosystem services that support well-being in the Mongolian pastureland ecosystems. Historical and cultural heritages, sacred and religious landscape values, symbolic and aesthetic values, and the inspirational values of the landscape are the key cultural ecosystem services that support nomads' well-being in the Mongolian Steppes. These are elaborated upon further in Chapter 5.

Research question 3: *How are local herder communities adapting to climate change, and what adaptation strategies have potential to better inform formal adaptation planning?*

To address this question, Chapter 6 is guided by the following sub-questions:

- *What already-existing climate change adaptation is apparent? What is the role of traditional ecological knowledge in this adaptation?*
- *What future adaptation options should be considered in light of current and future climate change, and how can ecosystem services thinking inform adaptation planning to improve benefits for herders?*

This study explores existing climate change adaptation and the role of traditional ecological knowledge in adaptation. Possible future adaptation options to support nomadic livelihoods and protect the pastureland ecosystems are explored in the light of current and impending climate change. The usefulness of ecosystem services thinking in supporting climate change adaptation at the local level is discussed, based on semi-structured interviews with local herders, key informants, and a survey of nomadic households in Northeast Mongolia. According to nomadic herders, their nomadic livelihoods are adaptable, yet climate and traditional livelihoods are changing and the benefits from pastureland ecosystem services are declining. TEK plays an

important role, however, in climate change adaptation and pastureland management. A better understanding of TEK is required in order to evaluate longer-term adaptation strategies that sustain local livelihoods and nature conservation.

Research question 4: *What are the potential benefits and risks of using ecosystem services approaches in local environmental management plans (e.g., a pastureland management plan) with nomadic communities in developing countries?*

This question is guided by the following research sub-questions:

- *How and to what extent has the ecosystem services concept been integrated into local planning in Mongolia?*
- *What are the risks and opportunities of using ecosystem services approaches in local planning?*
- *How can ecosystem services approaches be used to maximize the advantages and minimize the disadvantages in supporting adaptation?*

Chapter 7 explores the extent to which ecosystem services approaches have been integrated into local planning in Mongolia, and identifies a range of risks and opportunities in using ecosystem services approaches in local planning. The ecosystem services approach has been introduced in some national policy documents. The content analysis of the local land-use-related planning documents revealed that a kind of ecosystem services thinking is present in these local plans without the authors using the actual term 'ecosystem services'. This chapter also discusses possible ways of using ecosystem services approaches to support climate change adaptation.

1.6. Overview of Research Methods

To address these research questions and incorporate both qualitative and quantitative research, a mixed-methods approach was used to investigate climate change impacts on nomads' livelihood and ecosystem services and to explore nomadic herders' knowledge and practices on adaptation at a local level. The primary data collection study consisted of two field trips. Primary data were collected through interviews with key informants (n=20) and nomadic herders (n=30), focus-group discussions (six FGDs), and household surveys (n=115) in a case-study area, and a policy workshop in Ulaanbaatar. To support the fieldwork results, the secondary-data sources, such as national and regional policies and programs on climate change adaptation and sustainable development, and local planning documents, particularly on land and pastureland management, were analysed.

The case study was conducted in Mongolia because (i) it enables an examination of dryland ecosystems, and (ii) it is a relatively unstudied area. The research study consisted of six main phases.

1. Literature and policy reviews on ecosystem services integration into local environmental management and adaptation.
2. Detailed design of fieldwork approach, including preparation for interviews and an Ethics application.
3. First fieldwork visit (June-July 2018). To identify current climate change impacts on local livelihoods and pastureland ecosystems and to explore cultural ecosystem services provided by pastureland, I conducted interviews with nomadic herders and key informants, organized focus-group discussions, and administered a household survey.
4. Analysis of findings, and explication of adaptation issues and options for later discussion. The data analysis strategy was inductive and the interview transcripts were coded using NVivo 12 qualitative data analysis software. Quantitative data were analysed using Microsoft Excel, and descriptive statistics were used to present the data. I synthesized primary and secondary data to elicit the main drivers of climate change and its impacts on nomadic livelihood and ecosystem services (Chapter 4), cultural ecosystem services from the pastureland which support nomadic herders' well-being (Chapter 5).
5. The second fieldwork visit (June-July 2019) was to explore adaptation options, testing and exploring the usefulness of ecosystem services approaches, by conducting semi-structured interviews with nomadic herders and key informants and by organising focus-group discussions. The trip was also used to verify conclusions drawn from the previous fieldwork, examining the applicability of ecosystem services thinking in supporting climate change adaptation. A policy workshop was organized to assess the risks and opportunities of integrating ecosystem services approaches in local environmental management.
6. Analysis of findings from the second visit, and development of the remainder of the argument. I synthesized primary and secondary data to elicit the way in which nomadic herders adapt to climate change, and the possibilities and future opportunities of adaptation strategies in Northeast Mongolia (Chapter 6), and examined the applicability of ecosystem services approaches in local environmental management (Chapter 7).

1.7. Thesis Argument

The research interest in the potential usefulness of ecosystem services approaches in environmental decision-making is increasing, especially regarding climate change adaptation. The ecosystem services approach has been used most commonly at the national and regional levels in developed countries. The approach presents the benefits derived from ecosystems; however, its applicability in the case of developing countries, where local livelihood is directly dependant on natural resources, is not sufficient. Particularly, in dryland regions of the world where local communities are the most vulnerable to climate change, using this approach to support climate change adaption and sustain livelihoods should be essential where applicable.

Examining the applicability of the approach in supporting local environmental governance and adaptation strategies, by studying the traditional customs, practices, and language of traditional management and conservation, could provide potential guidance for research. One of the advantages of ecosystem services approaches is its relatively holistic way of framing the relationship between humans and nature. Therefore, exploring the usefulness of local knowledge and practices of ecosystem services' in supporting climate change adaptation through active engagement of the key users of the ecosystem services, such as nomadic herders, provides more opportunities to better understand the combination of traditional ecological knowledge and Western scientific knowledge.

In the Western scientific tradition, an ecosystem services approach assessment requires a high level of data input, which may be challenging to use in the case of data limitations. However, local communities who have long-term existing history, culture and knowledge can provide important data, while traditional ecological knowledge can play a potential role in supporting the use of the approach when required at a local level. Global- and regional-level reports of climate change impacts are usually developed using large-scale aggregated data, but when it comes to explaining the local-level impacts, the uncertainties are high. Locally generated knowledge, for instance, nomadic herders' perception and observation of weather and environmental changes, are helpful in more accurately exploring the local-scale impacts of the global drivers, such as climate change. Thus, there is potential for investigating the climate change impacts on local livelihood and ecosystem services through TEK.

1.8. Thesis Contribution

International and national reports on climate change very often mention that Mongolia is one of the countries most vulnerable to climate change due to its geographical location and

dominant livelihoods (ADB, 2014; MARCC, 2014), but the country is relatively understudied and is considered to be one of the countries for which data are insufficient. The case study in Northeast Mongolia provides a more detailed understanding of how climate is changing and the impact of climate change on local livelihoods and ecosystems.

The study contributes to an understanding of the traditional knowledge of ecosystem services that nomadic herders have derived from their local use and management of pasturelands. The study investigates ways in which traditional Mongolian culture demonstrates sensitivity to the benefits from nature in sustaining their nomadic livelihoods and protecting the pastureland ecosystems. The findings of this study contribute to the improvement in knowledge of possible future adaptation pathways through an enhanced understanding of the applicability of ecosystem services approaches at the local level in the dryland region. The thesis explores the role of traditional ecological knowledge in climate change adaptation in Mongolian nomadic herding communities. Traditionally, nomadic livelihoods are adaptive to environmental changes through the traditional movement patterns and practices that make efficient use of the landscape's scarce resources. The study identifies ways to strengthen the traditional adaptive capacities of nomadic livelihoods in order to improve adaptation to climate change. The thesis demonstrates the importance of local traditional institutions (*khot ail-saakhalt ail,* or '*neg goliinhon'*) to enhance adaptation to climate change in the context of globalization, e.g., a transition to democratic governance (freedom to own private property), the growth of cashmere markets (leading to a change in herd structures), and a booming mining sector (land-use change and other issues).

The research study identifies risks (that of neglecting traditional ecological knowledge and the needs of local stakeholders, for example), and opportunities (leveraging traditional knowledge of ecosystem services to empower local communities, for instance) in using ecosystem services approaches in environmental decision-making in local, complex conditions in the context of climate change. The inventory of issues, and lessons derived from them, will help decision-makers and ecosystem services practitioners to assess, select and apply suitable indicators and methods for use within a local case decision-making process. The practical implications of the methodology used to examine the usefulness of ecosystem services approaches in rural land-use planning at the local level in order to understand local complexities and improve environmental decision-making are not only useful in drylands, but anywhere else where livelihoods are directly dependent on nature.,

In Mongolia, detailed information on changes in local ecosystem services is not usually provided in the generalized or aggregated national reports that Mongolian decision-makers use as sources of information for developing adaptation policies. This thesis's exploration of the impacts of climate change at the local level, arrived at by researching the knowledge and practices of herders when engaging with, monitoring and assessing pastureland ecosystems to sustain their livelihoods and manage the pasturelands, makes a useful practical contribution to land-use planning in Northeast Mongolia. Locally generated, disaggregated data with local herders' engagement shows that the main indicator of climate change is shortage of water resources, which is typical of the dryland regions. As a community that is directly dependent on nature and climate, nomadic herders' livelihoods and the open-steppe pastureland ecosystems are more sensitive to any slight changes in the distribution and patterns of precipitation. Changes in precipitation distribution and patterns affect the plant growth, while pastureland ecosystem changes lead to changes in herding practices.

1.9. Limitations

This thesis addresses adaptation to climate change in drylands at a local level, particularly the northern temperate pastureland ecosystems in the context of a developing country. The study investigates climate change impacts on nomadic livelihoods and the forest-steppe and steppe-pastureland ecosystems. Most lessons from my case study are applicable to Mongolia and the dryland-steppe ecosystems; however, I did not explore the climate change impacts on mountain and desert ecosystems. Discussion with herders from the mountainous (yak-herding) area and desert regions (where the camel is a common livestock) in the drylands might be different. The study focuses on how an ecosystem services lens can be helpful in local environmental decision-making.

This study addresses the provisioning services, particularly grassland and water resources, and investigates the cultural ecosystem services provided by the pasturelands, rather than focusing on all types of ecosystem services. There are tensions between herding and mining communities that could be further explored from both the mining company and national economy perspectives, but that is outside the scope of my work, partly for pragmatic reasons, but also because much of what needs to be addressed regarding adapting herding as the climate changes can be considered independently of mining policy.

1.10. Thesis Structure

The core of this thesis was developed as a set of publications, so Chapters 4 to 7, which lay out the thesis's main findings, are presented as a series of chapters formatted for publication in peer-reviewed journals. These papers are framed by brief linking pieces that underline how the papers contribute to the overall argument of the thesis. Figure 1.2 outlines the structure of the thesis.

Chapter 1 presents the rationale for the research and briefly outlines the main purpose of the research towards bridging the knowledge gaps in climate change adaptation and in research on ecosystem services through local case studies. The chapter outlines the research questions that led to the main conclusions, key terms used, research limitations, and the contributions and overall structure of the thesis.

Chapter 2 presents the literature review on the application of ecosystem services approaches at a local scale and the possibilities and risks of using the approach to support climate change adaptation.

In **Chapter 3**, I describe the context and methods employed in the research to address the research objectives. After a brief overview of methods, I introduce the case-study area.

In **Chapter 4,** I address objective 1 by reporting case-study results. The study investigates the applicability of ecosystem services approaches in exploring climate change impacts on local livelihoods and ecosystem services in the case of Mongolia. The paper is prepared for submission to the Journal of *Geographical Research*.

Chapter 5, addressing objective 2, investigates the importance of cultural ecosystem services for nomadic livelihoods in Mongolian pasturelands, and how TEK can support cultural ecosystem services analysis at a local level. The article is under review by the *Landscape Research*.

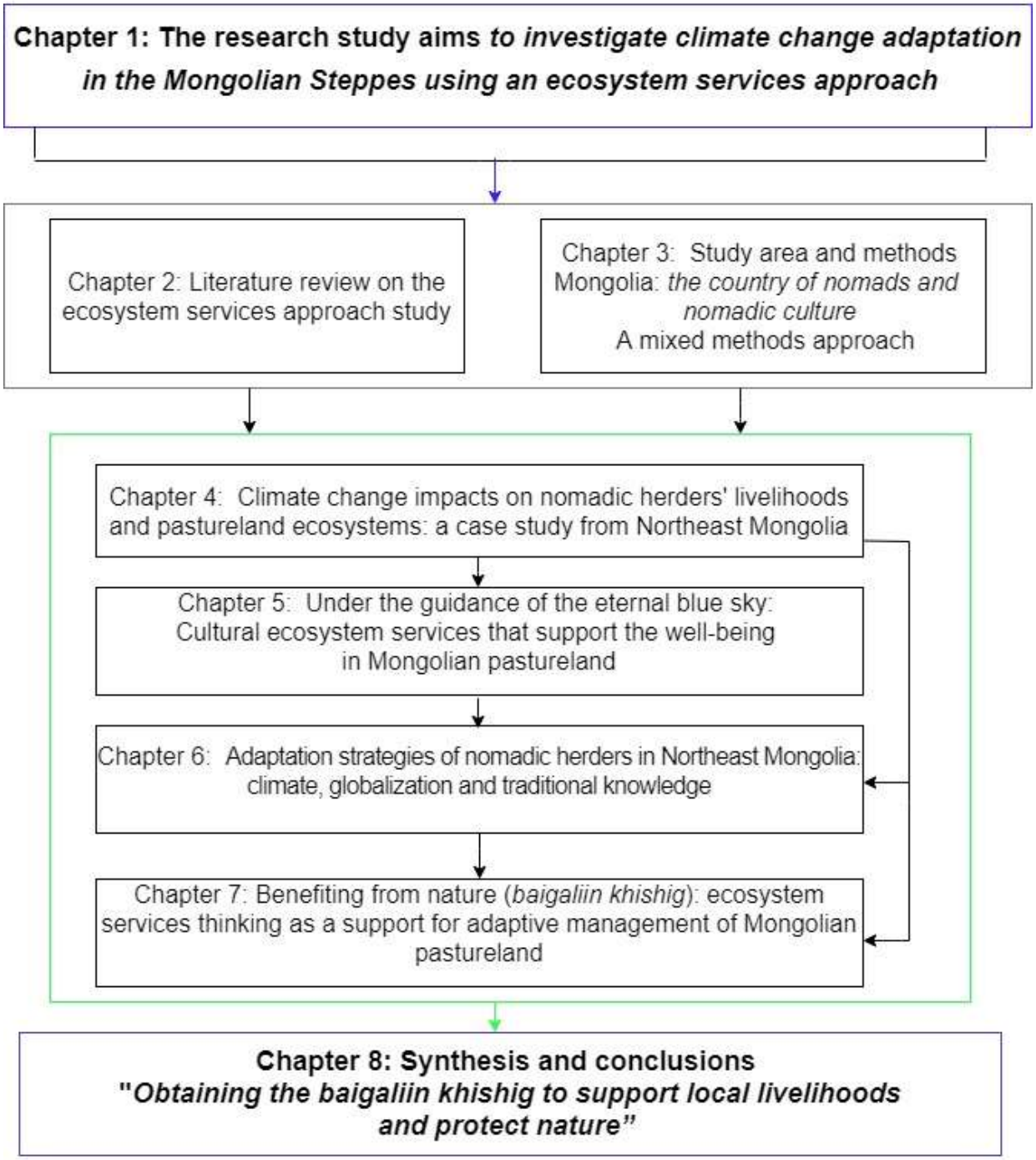

Figure 1.2. Structure of the thesis

Chapter 6 considers objective 3, exploring how herder communities adapt to climate change and the potential role ecosystem services approaches could play in informing the development of effective adaptation strategies. The paper is under review in the *Journal of Local Environment: The International Journal of Justice and Sustainability*.

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Chapter 7, dealing with objective 4, discusses the risks and opportunities of integrating ecosystem services approaches into local decision-making, based on a content analysis of land-use planning documents at the regional and local level of Mongolia. The paper is under review by the journal of *Ecosystem Services*.

In Chapter 8, the findings from the four papers (Chapters 4, 5, 6 and 7) are drawn together in a concluding final chapter. Each of the four findings chapters is discussed from a perspective of critical thinking about the implications of ecosystem services approaches on environmental decision-making at the local scale in Mongolia. The overall purpose of the thesis and its contributions to addressing the research problem is discussed further in this chapter. I discuss the implications of this research in terms of theory and application, and I conclude this chapter by emphasizing the importance of mixed methods for analysing ecosystem services, as well as the value of TEK, offering suggestions and recommendations for future research.

Chapter 2. Literature review

This chapter presents a brief review of existing literature on the applicability of ecosystem services approach to local decision-making, looking particularly at the opportunities and risks of ecosystem services approaches. The chapter also covers the role of traditional ecological knowledge in integrating ecosystem services approaches into environmental decision-making, the importance of landscape cultural values in local land-use planning, and the use of ecosystem services approaches to support adaptation to climate change, and its' relevance with my research study. A detailed discussion of each topic is presented in the following sections.

2.1. Historical overview of the ecosystem services approach and environmental decision making

Ecosystem services provision is affected by climate change and other drivers (from global to local), along with decisions relating to their management. These decisions, by influencing local drivers, address the ecosystem services either directly or indirectly. Consequently, "identifying and incorporating these key drivers of change in ecosystem services is essential for designing context-appropriate management strategies" (Runting et al., 2017) at a local scale. Because environmental decision-making is the process of evaluating the ways in which humans make choices that impact the natural environment. In general terms, environmental decisions are those choices or judgments that have significant impacts on the environment.

The history of the ecosystem services approach dates back to the 1970s (Gómez-Baggethun, De Groot, Lomas, & Montes, 2010). The term "ecosystem services" was introduced in the scientific literature with the book *"Extinction: The Causes and Consequences of the Disappearance of Species"* (Ehrlich & Ehrlich, 1981). Through clear explanations on how "Natural ecosystems support human life through an array of absolutely essential, free public services" (Ehrlich & Ehrlich, 1981, p. 77) the idea became popular, but it remains primarily an ecological concept.

Then, two main publications, a book "*Nature's services: societal dependence on natural ecosystems"* (G. Daily, 1997) and a research paper on valuing ecosystem services and natural capital (Costanza et al., 1997) were published and both contributed to mainstream ecosystem services approach in both academic research and policy-making processes (Chaudhary et al., 2015; Gómez-Baggethun et al., 2010). With the release of the Millennium Ecosystem Assessment (MEA, 2005) synthesis report, an understanding of the ecosystem services

approach at a global scale came to the fore. As the MEA (2005, p. 3) outlines, ecosystem services are "*the benefits people obtain from ecosystems to sustain or advance wellbeing".* They are categorized into four types: regulating, supporting, provisioning and cultural services. Furthermore, the MEA (2005, p. 6) report states that "15 out of 24 of the ecosystem services examined during the assessment are being degraded or used unsustainably". Recommending "a wide range of deliberative tools, information-gathering tools, and planning tools (which are typically used to evaluate potential policy options) can assist decision-making concerning ecosystems and their services" (MEA, 2005), the report made a strong contribution to incorporating the ecosystem services approach into environmental decision-making and policy at the global, regional and national level. A clear limitation of the report, though, is that it did not explain how the approach would work at a local scale.

The ecosystem services concept originated in the USA; its use has since gradually expanded into Europe (Chaudhary et al., 2015). Inspired by the Millennium Ecosystem Assessment report, a global initiative, the Economics of Ecosystems and Biodiversity (TEEB), was initiated by Germany and the European Commission (Costanza et al., 2017). This initiative prepared an interim report which aimed to develop a stronger understanding of the economic values of ecosystem services (Sukhdev, 2008). In 2012, the IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) was established as an independent intergovernmental body, with currently over 134 member-states. The main work of the IPBES is to assess the state of Earth's ecosystems, biodiversity and its services for human development, and identify policy-relevant tools and methodologies, and facilitate their use (IPBES, 2020). The platform makes a strong contribution to promoting the expansion of research studies to incorporate the ecosystem services approach into environmental policy and decision-making at national scales (Díaz et al., 2015). In 2013, the European Environment Agency (EEA) introduced the Common International Classification of Ecosystem Services (CICES V4.3) based on environmental accounting. The hierarchical classification of the CICES builds on the original classification proposed in the Millennium Ecosystem Assessment report (of supporting, provisioning, regulating, and cultural services). The updated version of CICES V5.1 was introduced in 2016 (Haines-Young & Potschin, 2018). At present, the frameworks of both CICES and TEEB are commonly used in ecosystem services research. Since all ecosystem service frameworks are based on the Millennium Ecosystem Assessment (MEA, 2005), the general concepts, terms and definitions are very similar (Table 2.1).

Table 2.1. Definitions, emphases and knowledge systems used in the ecosystem services frameworks

Framework	Definition	Knowledge system	Scale	Anthropocentric value	Classification
Millennium Ecosystem Assessment	*"the benefits people obtain from ecosystems*"(MEA, 2005)	Western- *ecosystem services*	Global-national	Human well-being	24 ES divided into 4 categories: provisioning, regulating, supporting and cultural
The Economics of Ecosystems and Biodiversity project	*"The direct and indirect contributions of ecosystems to human well-being"* (TEEB, 2010).	Western- *Economic value of ecosystem services*	Global-local (Wittmer, Berghöfer, Förster, Almack, & Pushpam, 2010)	Human well-being	22 ES divided into 4 categories; *provisioning, regulating, habitat and cultural & amenity services*
IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services)	*"The benefits that people obtain from ecosystems- Nature's benefits to people"* (Díaz et al., 2015)	Western: *ecosystem services and goods* Other knowledge systems: *Nature's gift*	supranational (subregional, regional or continental) to global geographical scales (Díaz et al., 2015)	Good quality of life Living in Harmony with Nature	No specific category
Common International Classification of Ecosystem Services (CICES, 2013; 2016)	*"The contributions that ecosystems make to human well-being"* (Haines-Young & Potschin, 2018)	Western, however, TEK is included in the last version	Regional-local	Human well-being	*3 categories of ES: 'provisioning', 'regulation and maintenance', and 'cultural'*

ES- ecosystem services

The Millennium Ecosystem Assessment introduces an influential classification of ecosystem services, but the focus on human well-being is aggregated. TEEB's framework is very similar to MEA (2005), mainly focused on expanding the economic valuation of benefits from ecosystem services (J. A. Fisher et al., 2013). The categorization introduced by the Millennium Ecosystem Assessment (MEA, 2005), then adopted and updated in the Economics of Ecosystems and Biodiversity (TEEB, 2010) divided ecosystem services into 4 categories:

i) **Provisioning services**: products obtained from ecosystems including food and fibre, freshwater, fuelwood, genetic resources, biochemical etc.

ii) **Regulating services:** benefits obtained from the regulation of ecosystem processes, including air quality maintenance, climate and water regulation, erosion control, water purification, carbon sequestration, waste treatment, pollination, and regulation of human disease etc.

iii) **Cultural services**: the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences.

iv) **Supporting services:** basic ecosystem processes, such as soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat.

In the MEA (2005) and TEEB (2010) frameworks, cultural ecosystem services was the least developed category (Costanza et al., 2017). The Common International Classification of Ecosystem Services (CICES, 2013; 2016) is a hierarchical and science-based classification and designed to account and access ecosystem services. (Haines-Young & Potschin, 2018).

In this way, the ecosystem services approach, initially developed by ecologists and economists working in the USA addressing environmental degradation and biodiversity loss and accounting natural capital and ecosystems' benefits (Chaudhary et al., 2015; Gómez-Baggethun et al., 2010), has been mainstreaming rapidly in multidisciplinary research. With its expanding application and interest in the approach in different research fields, the ecosystem services approach has been defined by several disciplines and collaborating more effectively has been explicitly encouraged (Costanza et al., 2017). To mainstream the approach at national and local levels, "more spatial and place-based approaches in ecosystem services assessments to provide more precise definitions of the service-providing units" are needed (Potschin & Haines-Young, 2011).

2.2. The integration of the ecosystem services approach into environmental decision making as an analytical tool

2.2.1. Ecosystem services approach: opportunities and risks

Interest in applying the ecosystem services approach, as "*benefits people obtain from ecosystems*" (MEA, 2005), in environmental decision and policy making to support human well-being is growing. An ecosystem services is a relatively holistic approach to address complex environmental management challenges. It integrates aspects of different sectors by examining the nature of benefits to human well-being (Gret-Regamey et al., 2017). Ecosystem services thinking is being used more at a global level, and it is also being used more often for environmental policy and decision-making at regional and national scales. Its potentials and risks (Table 2.2) need careful consideration, however.

Table 2.2. Ecosystem services framework: Opportunities and risks of integrating the approach into environmental decision-making

Opportunities/advantages	Risks/disadvantages
✓ The ecosystem services concept has been applied at the global and regional scale (Chaudhary & McGregor, 2018) ✓ Recognition of the concept and its benefit to adaptation and sustainable development (Scholes, 2016); ✓ Holistic approach. An interactive science-policy process (involving scientists, local experts, stakeholders and decision-makers to produce the result) (Bull et al., 2016; Gould, Morse, & Adams, 2019) ✓ The framework focusses to support more equity in natural resources allocation and more equitable distribution of natural resources amongst stakeholders (McDermott, Mahanty, & Schreckenberg, 2013) ✓ Operationalization of sustainability: Ecosystem services assessment could provide the framework to make sustainability more assessable and applicable (Costanza et al., 2014) ✓ Specific knowledge to support adaptation (i.e. herders' knowledge)- Joint knowledge production (Díaz et al., 2015)	- Reductionist- western and anthropocentric approach (Kronenberg, 2014; McCauley, 2006) - Scale issue: The ecosystem services approach is used mostly at global/national scales, in the developed countries (Chaudhary et al., 2015) - Most of the approach application is in case of urban land use planning (Hansen et al., 2015); application in case of rural land use is still outstanding - Inefficient institutional and collaboration and coordination/ Uncertainty how to use helpfully at the local level (Gret-Regamey et al., 2017; Pandeya et al., 2016); - Tends to support top-down control. The utilization level of the range of stakeholders is not clear in the policy-making processes (Galler, Albert, & von Haaren, 2016); - Lack of institutional capacity and awareness across public (Costanza et al., 2017); - Political interferences and lack of political interests are key threats to a potential ecosystem services integration in environmental decision-making (J. A. Fisher et al., 2013) - Assessing the cultural ecosystem services is not clear (Chan, Satterfield, & Goldstein, 2012), and integrating the value of the service in environmental decision-making is limited (Gret-Regamey et al., 2017).

Recognition of the approach and its benefit to land use planning and climate change adaptation are considered one of the advantages (Schetke, Lee, Graf, & Lautenbach, 2018; Scholes, 2016), however, the contribution of the ecosystem services thinking to inform management for sustainable use is still less addressed (Rusch, Rusch, Goijman, Varela, & Claps, 2017). Existing literature on the ecosystem services approach integration into environmental decision-making reveals that most of applications are from developed countries, particularly from North America and Europe (Chaudhary et al., 2015; Runting et al., 2017). As a result, one of the main gaps of the application of the ecosystem services approach is limited research at a local scale in

developing countries. The application of the approach for integrated valuation of ecosystem services at local levels and in data-scarce regions is still not clear (Pandeya et al., 2016).

Moreover, most studies are focused on island, marine, mountain and forests ecosystems, while dryland ecosystem assessment is very rare (Costanza et al., 2017; Gret-Regamey et al., 2017). Dryland ecosystems in inland regions of continents are affected by climate change impacts more intensively (EMG, 2011). In East Asia, for example, Mongolia is a landlocked country and over 90 % of its territory is considered dryland. The impact of climate and other changes on dryland ecosystems in East Asia is increasing and ecosystem services have been significantly altered, however, there is very limited study of ecosystem services used by nomadic herders in Mongolia (Zhen et al., 2010) and usage of the ecosystem services approach in decision-making (Gret-Regamey et al., 2017). Scarce natural resources, land degradation and frequent droughts severely challenge food production in these areas. Thus, assessment of the ecosystem services of dryland regions to support people's livelihood and strengthen climate change adaptation is required.

Lack of knowledge of ecosystem services and how they support human well-being is one of the limiting factors of the approach application. Even though it has been discussed for over 30 years, there are still some confusion between ecosystem functions and services (Chaudhary et al., 2015). Ecosystem services and ecosystem functions are not synonymous. Ecosystem services are 'the functions and processes of ecosystems that benefit humans' (Costanza et al., 2017). Some critics consider the ecosystem services approach as anthropocentric (Kronenberg, 2014; McCauley, 2006) or instrumental (McCauley, 2006), however, the approach reflects systematic thinking that addresses the interdependence and interrelations between humans and nature (Costanza et al., 2017) informing how the decision-making action will affect human uses of and benefits from ecosystem (von Haaren & Albert, 2011). Bull et al. (2016) also stress that the ecosystem services approach can be seen as a way to communicate the complexities of human-nature interactions. McCauley (2006) argues that the ecosystem services approach should also imply nature's benefits as a conservation strategy. Ecologists use the approach to strengthen nature conservation successfully, policymakers use the concept to strengthen environmental governance in predominantly neoliberal regimes, and economists assess how much benefit people obtain from the provision of ecosystem services. The ecosystem services narrative and detailed assessment information could provide the framework to make sustainability more assessable and applicable.

To improve the knowledge of the ecosystem services approach and its integration into environmental decision-making processes, a more comprehensive approach is needed (Chaudhary & McGregor, 2018; Pandeya et al., 2016). Decision-makers need detailed information about ecosystem services to make decisions that improve livelihoods and sustainable development at a local scale. However, making natural resource management decisions based on untested assumptions and sparse information to improve ecosystem services and human well-being is common at the local scale where there is insufficient data (Carpenter et al., 2009; Pandeya et al., 2016). Addressing the inefficient institutional capacity, limited collaboration and coordination at a local scale also needs to be taken into consideration. Improving public understanding of the ecosystem services approach to support livelihood sustainability and to strengthen the capacity building is important.

"The decision context for utilizing ecosystem services research is also crucial for mobilizing the ecosystem services concept" (B. Fisher, Turner, & Morling, 2009). As a holistic approach (Gould et al., 2019), ecosystem services approach can be appropriate for using specific knowledge to support adaptation (i.e. herders' knowledge). However, as Kull, de Sartre, and Castro-Larrañaga (2015) state, "ecosystem services approach is only one out of many possible ways of framing environment-society relationship". Appropriateness of the approach depends on the arena where it is used and what is used for. Bull et al. (2016) found that the ecosystem services framework lie in its interdisciplinary potential and in its ability to support improved decision-making. However, using ecosystem services approach in regional and local planning is still challenging and requires further work on data generation and cooperation among actors (Galler et al., 2016). The top-down tendency of environmental decision-making is common in most of the countries, and leads to reduced effectiveness of the ecosystem services integrating into local decision-making, as the spatial and temporal scale of the institutions to manage ecosystem services does not match with the scale of services (Costanza et al., 2017). The active participation of key users of ecosystem services in decision-making is therefore important to improve decision-making in support of climate change adaptation. Making effective decisions with limited information and substantial uncertainties require innovative methods (Runting et al., 2017), however, local knowledge and practices might potentially fill this gap.

2.2.2. Nomadic pastoralism and traditional ecological knowledge

Nomadic pastoralism is a form of livelihood in which pastoralists depend on moving in search pastures to feed and water their livestock. Pastoralism is practiced on 25 percent of the world's land area from the African drylands, the Arabian Peninsula to the Asian and Latin American

highlands (Nori & Davies, 2007), and supports approximately 200 million livestock households (IUCN, 2012). In 1985, there were around 200 million nomads and they had occupied around 40 percent of land in the arid and semiarid regions. As a result of the government's efforts to settle nomads and implement land reforms, in many countries the number of nomadic populations is decreasing year by year, and today nomadic herding is limited to only Asia and Africa (Koocheki & Gliessman, 2005). At the beginning of this century there were about 30-40 million nomadic pastoralists in the world, most of whom lived in Central and East Asia, the Sahel region of North and West Africa, and other parts of Africa such as Nigeria and Somalia, but the size of the nomadic population is quite speculative (Blench, 2001). In the 1980s and 1990s, particularly in African countries, there was significant statistical invisibility of mobile pastoralists (Randall, 2015). Interestingly, this issue of minorities being ignored has not arisen in Mongolia, where until recently nomads were in the majority, and the nomadic lifestyle is known and respected by all (Randall, 1993; Yembuu, 2016).

Nomadic livelihoods have been recognized as a sustainable way to exploit marginal pasturelands (IUCN, 2012). However, nomadic communities and livelihoods have faced many challenges, most of which are related to social and economic factors. For example, the pasture area of the Raika camel nomads in Rajasthan, India has decreased dramatically since the mid-twentieth century (Köhler-Rollefson, 1992), and the Kenyan government has implemented a program of land reform on the pastures of the Maasai tribes, as a result of which half of the pastureland is now in the hands of non-Maasai (Galaty, 2013). Open grasslands were converted to irrigated agriculture in Inner Mongolia, China (Brogaard & Xueyong, 2002). As a result, more and more nomadic people are becoming semi-nomadic or sedentary ranch owners. Due to the expansion of the industrial and mining sector, as well as climate change, the number of nomads is decreasing in Iran, where one of the largest nomadic communities used to live (Annamoradnejad & Lotfi, 2010). In addition, many nomadic communities are threatened by regional and civil conflicts and wars in the Middle East and Southeast Asia, for example, nomads have been living in danger in Afghanistan for several decades (Schütte, 2012). In this way, the future of pastoral nomadism in some regions of the world is not promising.

Mobility is a key strategy for pastoral adaptation and risk management for nomads around the world to adapt for changing environments, including natural disasters and resource depletion (Agrawal, 1993; Fernandez-Gimenez & Le Febre, 2006; Little, Smith, Cellarius, Coppock, & Barrett, 2001; Naess, 2013). Apart from moving in search of grasslands, the main similarity amongst nomadic communities around the world is that they have extensive knowledge of the

phenological stages of plant development, reproduction strategies and overall carrying capacity of pasturelands, as these are the most important aspects of the optimal use of natural vegetation (Koocheki & Gliessman, 2005). However, in recent decades, nomadic populations have faced challenges such as the desiccation of the environment due to droughts, degradation of pasture lands, and shrinking water resources, as well as various socio-economic factors (Niamir-Fuller, 1998). The results of most climate change models predict that increases in temperature and decreases in precipitation will affect dryland pasturelands (Field, Barros, Mastrandrea, et al., 2014). As stated in the 'Global Review of the Economics of Pastoralism' (Hatfield & Davies, 2006, p. 3) "pastoralists are the best custodians of drylands environments, but their stewardship is undermined by inappropriate policies and strong competition over their natural resources". Better understanding of pastureland complex systems, and recognizing the potential of pastureland livestock for sustainable production of valuable goods on marginal lands, is a way to improve adaptation, but a holistic understanding of pastureland resource management is still lacking. The adaptive capacity of pastoralists should be seen as the main indicator of pastureland sustainability (Nori & Davies, 2007).

Due to its importance in nature conservancy, interest in exploring and engaging with traditional ecological knowledge (TEK) has increased since the 1980s. Through the reports of the International Conservation Union (IUCN), the term "Traditional ecological knowledge" was introduced (Johannes, 1989) to the field of natural resources management. Based on Berkes (1999) definition of traditional knowledge (TEK) as "a knowledge-practice-belief complex", Berkes et al. (2000, p. 1252) developed a working definition of TEK as "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment".

The study of local knowledge to understand climate change has been expanding since the 2000s, but there is a lack of geographical balance within local research, and case studies of cold arid environment is limited (Reyes-García et al., 2016). Some case studies show that TEK is useful for monitoring the impact of climate change and to inform about adaptation to it (Leonard et al., 2013). For example, a Japanese local community, dependent on coastal ecosystem services, has developed its specific resource management practices and the concept '*satoumi"* seascape (Chakraborty & Gasparatos, 2019). TEK plays an important role in adaptation to climate change enabling flexibility and innovation in hunting for the *Inuit* community in the Canadian Arctic (Pearce, Ford, Willox, & Smit, 2015). In the Australian

context, ‘caring for country’ is the main principle of traditional natural resources management for Indigenous groups. The *Miriwoong* people, an Australian aboriginal community, use their seasonal calendar, based on observations and adaptation to changing environmental conditions over long periods, for harvesting, hunting, and fishing (Leonard et al., 2013).

TEK was presented in the Millennium Ecosystem Assessment report (MEA, 2005) addressing the current unsustainable consumption of ecosystem services. Indigenous and local communities and their TEK, indicating a good quality life as *'Living-well in balance and harmony with Mother Earth'*, were then identified as a key component of the conceptual framework of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (Díaz et al., 2015). The latest version of the Common International Classification of Ecosystem Services also included the TEK in cultural ecosystem services category as “*characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge*” (Haines-Young & Potschin, 2018). Following these frameworks, the recognition and acknowledgement of TEK in environmental decision-making has increased, however, it is still challenging to integrate the different knowledge system with western-science-oriented environmental decision-making. A key difference between a western-science-oriented ecosystem services approach and traditional knowledge of ecosystem services is knowledge generation and creation. Traditional knowledge of ecosystem services is embedded in local social processes (Berkes et al., 2000), and the western science-oriented ecosystem services approach focuses on quantitative, empirical description of ecosystem functions.

Combining the knowledge of local people, whose livelihoods are directly dependent on nature, with data from climatology analysis has the potential to reduce uncertainties and improve adaptation to climate change (Marin, 2010). The relationship and interconnection between Mongolian nomadic herders and open steppe pastureland is an example of a complex socio-ecological system (Ostrom, 2009). Because of their direct dependence on nature, nomadic herders have valuable knowledge of the socio-ecological system to inform adapting to changes. Therefore, their knowledge should be integrated into local, regional and national adaptation planning processes. A study from Mongolia could provide a valuable example of how nomadic communities have adapted to climate change. In particular, understanding nomadic knowledge of ecosystem services and ways of integrating ecosystem services thinking into local decision making could be useful for neighbouring Central Asian countries such as Kazakhstan and Kyrgyzstan, which have been through similar socio-economic transitions. However, there is

less research on what is traditional ecological knowledge for herders and what is its role in pastureland management (Fernandez-Gimenez, 2000). Understanding local or traditional knowledge and ways to respond climate change (Leonard et al., 2013) as well as using management practices based on local knowledge (Berkes & Folke, 1998) will help to make effective decisions and develop successful adaptation strategies. Mongolian nomads monitoring ecosystem changes and making decisions to rotate and relocate herds is an example of local knowledge-based management practices (details in chapter 6).

Traditional ecological knowledge and practices are generally consistent with adaptive management as an integrated method for resources and ecosystem management (Allen & Gunderson, 2011; Holling, 1978). Carpenter et al. (2009) suggest that real-world observations and analysis are useful to understand complex socio-ecological systems and TEK can play this role. TEK systems have the potential to contribute to building resilience in the changes and sustaining biodiversity and ecosystem services (Gómez-Baggethun et al., 2013) and producing locally relevant data (Reyes-García et al., 2016), as they continue to be amended and modified by new experiences and observations (Fernandez-Gimenez, 2000). Most case studies have shown that local knowledge is consistent with the western scientific measure of climate change (Klenk, Fiume, Meehan, & Gibbes, 2017). Integrating traditional knowledge of ecosystem services into climate change adaptation policy and planning is possible if the knowledge holders are actively participating in decision-making (Kupika, Gandiwa, Nhamo, & Kativu, 2019).

Local knowledge's contribution to adaptation depends on its interactions with other knowledge (Naess, 2013); however, there is still limited progress in combining traditional or local knowledge and modern scientific knowledge (R. D. Lam, Gasparatos, Chakraborty, Rivera, & Stanley, 2019). Further interesting research on the place of TEK in environmental decision-making explores the landscape values of traditional or indigenous communities (details in chapter 5). As stated by Humphrey (1995), for Mongolian nomads, understanding of landscape extends beyond the geographical component of a natural feature: it embraces a sense of belonging, a sense of existence, past, present and future. As an example of data-scarce countries of the dryland region, herders' knowledge of pastureland management is likely to be a valuable support for the limited scientific information for a local land management plan (Berkes et al., 2000) in Mongolia. Nomadic herders' traditional knowledge of pastureland management and herding practices have potential to provide benefits for adaptive management solutions because they have specific knowledge based on observations of extreme and variable events of weather rather than on average changes that are analysed by the dominant trend (Marin, 2010). A better

understanding of local knowledge will provide insight into different management alternatives for decision-making at the local level.

2.2.3. Cultural ecosystem services and their importance in environmental decision-making

Cultural ecosystem services (CES) are defined as the non-material benefits people obtain from ecosystems including cultural diversity, spiritual and religious values, knowledge systems (traditional and formal), educational values, inspiration, aesthetic values, social relations, sense of place, cultural heritage values, recreation and ecotourism (MEA, 2005). However, there is still theoretical challenges to understand ecosystems as cultural construction or objects of cultural concern (Fish, Church, & Winter, 2016). Furthermore, information of non-material value of ecosystems is underrepresented in decision-making documents (Hernández-Morcillo, Plieninger, & Bieling, 2013). Milcu, Hanspach, Abson, and Fischer (2013) claim that CES was generally seen as part of a broader analysis rather than as a priority for research projects. However, there is a growing awareness of the importance of cultural services for human well-being provided by landscapes (Lamarque, Quetier, & Lavorel, 2011). One importance of CES is cultural factors such as values, beliefs, and norms that a group shares influence consumer behaviour, and they can be particularly important drivers of environmental change (MEA, 2005).

Although "ecosystem services assessment has been well established for terrestrial ecosystems and a selection of services they provide, the assessment of cultural services is limited" (Grêt-Regamey, Sirén, Brunner, & Weibel, 2016; Runting et al., 2017), and cultural ecosystem services are most frequently studied in European case studies (Czúcz et al., 2018). Recent review studies also reveal that CES are represented quite well in the urban land use planning literature (Hansen et al., 2015; S. T. Lam & Conway, 2018), however, in contrast, its application in the local land use planning documents is very limited in rural areas of developing countries. CES are strongly associated with people's well-being, where livelihoods directly depend on land use. Also, recreation and ecotourism are the most presented and valued CES categories, while inspirational and educational values are less investigated (Hernández-Morcillo et al., 2013).

As Hirons, Comberti, and Dunford (2016) highlight, there are many aspects of how people value the environment that cannot be compared or substituted for each other. According to Fish et al. (2016, p. 209), CES is relational and it derives from 'the perspective of people's

interactions with, and understanding of places, localities, and landscapes'. There are a number of definitions and concepts developed in the study of landscape. The Oxford Dictionary of Geography defines it as "all the visible features of an area, the appearance of the area or a collection of objects that create this appearance- the expression of interaction between man and his environment" (Mayhew, 2015). In general, the surface of the earth that can be simultaneously observed in one place is called a landscape. A landscape that has been modified by humans is called a cultural landscape. Carl O. Sauer's definition of cultural landscape is extensively used in social and anthropological research. As Sauer (2008) puts it, "the cultural landscape is formed on the basis of the natural landscape by a cultural group. Culture is the agent, the natural area the environment, and the cultural landscape the result" According to the MEA (2005) "the term cultural landscape is often used when referring to landscapes containing significant human populations". As defined by the UNESCO World Heritage Committee, a cultural landscape is "the cultural properties that represent the combined works of nature and of man" (UNESCO, 2012).

Local environments and landscape can be valued differently by different people in different environments because of their importance to human well-being. However, identification of CES can be used in landscape planning (Plieninger et al., 2015) as CES are influential motivators of local land management decisions (Hirons et al., 2016). Thus, to understand the changes in land use at a local scale, exploring CES with local stakeholders' participation as key drivers can be helpful (Szücs, Anders, & Bürger-Arndt, 2015). Milcu et al. (2013) also have suggested that incorporating non-material benefits of landscape into natural resource management can improve the social recognition and legitimacy of management decisions. For that new methods are required to integrate cultural ecosystem services into decision support tools (Gret-Regamey et al., 2017). Cultural ecosystem services analysis can provide important information to characterise a socio-ecological system (Carpenter et al., 2009); and, to assess cultural services (ethical and spiritual values and traditional livelihood culture), it is important to explore traditional ecological knowledge and practices. However, it requires transdisciplinary collaboration and innovative thinking to include culture in environmental decision-making (Gould et al., 2019). Thus, investigating cultural ecosystem services from the dryland ecosystems contributing to human well-being is important to understanding land use and livelihood changes at a local level (details in Chapter 5).

2.2.4. Use of the ecosystem services approach to support climate change adaptation

Climate change negatively impacts on ecosystem services and livelihoods (Lavorel et al., 2015; Runting et al., 2017; Scholes, 2016). As understanding of climate change adaptation has improved, there is growing recognition of local knowledge and its importance. Recent research studies highlight the importance of conducting assessments of local and regional ecosystem services to support climate change adaptation, rather than relying on averaged or aggregated data from other contexts (Bhatta et al., 2015; Makondo & Thomas, 2018; Naess, 2013; Runting et al., 2017). Climate change adaptation is "actions taken to help communities and ecosystems cope with changing climate condition" (UNFCCC, 1992). Adaptation' refers to both the process of adaptation and adaptation outcomes. As described by Smit, Burton, Klein, and Wandel (2000, p. 228), "adaptation defines a system of interests (who or what adapts), climate-related incentives (adaptation to what), and the processes and forms involved in the process [of adaptation] (how adaptation occurs)".

"Adaptation has been framed as a continuum of resilience, transition and transformation" (Pelling, 2010) at different scales and sectors. Resilience is a concept that has advanced in relation to the dynamic development of complex adaptive systems with interactions across temporal and spatial scales (Carl Folke, 2006). Resilience, for social-ecological systems, is related to (i) the magnitude of shock that a system can absorb and remain within, or return to, a given state; (ii) "the degree to which the system is capable of self-organization" (C. Folke et al., 2002), iii) the capacity of a system to maintain its equilibrium (Close, Zammit, Boshier, Gainer, & Mednis, 2009).

Transitional adaptation is an intermediate adaptation towards potential fundamental changes (Field, Barros, Dokken, et al., 2014). Transformative adaptation requires fundamental changes in a certain socio-ecological system to reduce the root causes of vulnerability when serious or drastic impacts of climate change are expected (Fedele, Donatti, Harvey, Hannah, & Hole, 2020). Therefore, adaptation policies and strategies should consider the livelihood needs of key affected communities and individuals carefully.

The main challenge is how to design the framework of adaptation as resilience and transition to reduce negative impacts on ecosystem services (Lavorel et al., 2015) and to support local livelihoods. The participatory approach might be helpful to identify a local context, because, "participatory data and knowledge co-generation may not only support a better management of

ecosystem services but also their adaptive use for improving local livelihoods" (Buytaert, Dewulf, De Bièvre, Clark, & Hannah, 2016). To improve local stakeholders' participation in environmental decision-making to support their livelihood sustainability, a deep research study is needed to investigate at a local scale with their involvement.

As Pelling (2010) states, the antecedents and current work on adaptation provides a rich basis for analysis, but they do not yet capture the full significance of adapting to climate change as a dynamic in socio-ecological coevolution. Adaptation to climate variability and change is important both for impact assessment and policy development (Smit et al., 2000). By assuming adaptation decisions can be managed in a traditional risk framework, adaptation efforts have tended to be problem-oriented and reductionist in approach. Additionally, in many cases and particularly in the contexts of a developing country, research and planning efforts to support adaptation have adopted approaches based on the assumption that an identifiable rational decision-maker exists with decision-making authority. This requires social processes, institutions, organizations, skills and capabilities necessary to guide, facilitate, and manage the "when", "where" and "how" of adaptation for building the resilience of desirable system functions and for transforming values, decision-making processes and governance arrangements (Wise et al., 2014).

Climate change is changing the ecosystem services that ecosystems can supply. Ecosystem-based approaches to climate change should recognize the multiple links between ecosystem services and climate change: management can enhance contribution of ecosystem services to adaptation and mitigation and, as climate change will affect the ecosystem and their services, adaptation measures are needed to reduce negative impacts and maintain ecosystem functions (Locatelli, 2016). The concept of Ecosystem-based Adaptation (EbA) developed by the IUCN, has been used in different countries in various ways. "EbA is the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change" (Colls, Ash, & Ikkala, 2009). EbA is embedded in a broader concept of nature-based solutions and shares common elements with a wide range of other approaches to building sustainability of socio-ecological systems (Cohen-Shacham, Walters, Janzen, & Maginnis, 2016). According to the IUCN definition, EbA is focused on the use ecosystem services as part of overall adaptation strategy (CBD, 2009) and emphasises that adaptation solutions can always be found in nature (Wamsler et al., 2016). Evidently, adaptation to climate change is a complicated and complex problem, and system sensitivity is essential for decision-making, requiring long-term and integrated solutions. So, the main challenge is how

to design the framework of adaptation as resilience, transition and transformation to reduce negative impacts and maintain ecosystem functions. Social responses to climate change will vary from short-term incremental management aimed at maintaining existing ecosystem characteristics, through to transformational change that promote resilience of novel ecosystems. As a relatively systemic approach, ecosystem services thinking might be useful for improving climate change adaptation strategies in a complex socio-ecological system.

The ecosystem services approach is recognized as an opportunity to guide sustainable development (Gret-Regamey et al., 2017) and support climate change adaptation strategies through its holistic and interdisciplinary approach connecting broad cross-sectoral actors. Applying an ecosystem services approach to environmental decision-making can be beneficial as it establishes a direct link between human well-being and ecosystems (Van Wensem et al., 2017) if it is considered with due sensitivity to local institutions and cultural contexts (Brendan Fisher et al., 2008). In this case, more disaggregated locally produced data on ecosystem services are important to inform environmental decision-making (Runting et al., 2017).

As Runting et al (2017) argue, a major gap still exists in developing and applying decision-making methods for ecosystem services under climate change that are robust against uncertainty. In this case, adaptive decision-making might be a strategic choice process (Holling, 1978) that includes development of alternative solutions (Harding, Hendriks, & Faruqi, 2009; Walters, 1986). The adaptive management approach (Holling, 1978; Walters, 1986) was introduced as the methodological innovation and resource management technique in the 1970s (Lee, 2001). Holling (1978) suggested that scientists and managers should come together to share existing knowledge, identify uncertainties, consider multiple possible management options, evaluate these options using ecological models, monitor (i.e. by treating policy implementation and management actions as experiments), and adapt management on the basis of newly gained information. As an analytic framework to investigate the relationships between humans and nature, an ecosystem services approach can be one of the useful options to solve a complex problem. Building local knowledge and understanding of the needs of local people in response to climate change through a participatory approach is important to develop potential solutions and appropriate adaptation strategies (details in chapter 6).

2.3. Ecosystem services thinking in local land use and environmental management planning

The ecosystem services approach is defined by several disciplines, and its research progress is encouraging different sectors to collaborate more effectively. While we have discovered more about human impacts on nature "the notion of ecosystem services emerged with and recognition that human's negative actions are degrading earth's ecosystems" (Chaudhary et al., 2015). However, the ecosystem services approach is used mostly on upper political scales (national and international) and communication usually on high political decision tiers. To operationalize this approach at the national and local levels, "a more spatial and location-based approach is required to ensure a more accurate measurement of service" (Potschin & Haines-Young, 2011).

As mentioned previously, existing publications on the ecosystem services research show that ecosystem services is a western knowledge-oriented approach (Chaudhary et al., 2015; Dempsey & Robertson, 2012) which is commonly used in the case of urban planning of the developed world (Hansen et al., 2015; Kaczorowska, Kain, Kronenberg, & Haase, 2016; S. T. Lam & Conway, 2018; Nordin, Hanson, & Alkan Olsson, 2017; von Haaren & Albert, 2011). These cases, however, enables us to examine the possibilities of using the approach to support adaptive decision-making at a local level, for rural land use planning. Integrating the ecosystem services approach into local landscape planning is still a challenging task (Costanza et al., 2017; De Groot, Alkemade, Braat, Hein, & Willemen, 2010). Yet, there is potential for the ecosystem services approach to be applied in the context of local planning in rural areas where livelihoods are highly dependent on nature. Hence the approach focuses on the relationship between humans and ecosystems and its benefits for human well-being (MEA, 2005).

The characterization of environmental components function is always location-dependent and includes the development potential and pressure, so "this procure has the potential for a wider ecosystem services approach because it provides a place-based implementation, for which pressure factors, as well as potentials, have to be addressed" (von Haaren & Albert, 2011). Depending on the level of participation of the stakeholders, the top-down tendency of the ecosystem services approach integration into decision-making promotes the benefits' inequities among the stakeholders. Assessing cultural ecosystem services with the active engagement of local stakeholders would be helpful to bridge this gap. In response to a major criticism of the approach to ecosystem services as an anthropocentric and instrumental approach, integrating CES in land use planning, drawing on traditional ecological knowledge, most particularly

local/indigenous landscape values, can be the potential to strengthen the applicability of the approach.

As a relatively holistic approach, it requires collaborative actions to integrate the ecosystem services approach into environmental decision-making. In this case, actors need a common language and clear understanding of the approach (Verburg, Selnes, & Verweij, 2016). Because diverse ecosystems and various local communities respond in different ways to the changes, therefore, it is needed to explore more on how to interpret and integrate the ecosystem services approach into environmental decision-making and operational activities on different levels and contexts. GIS-based and monetary valuation methods are the most common methods used to assess ecosystem services to support decision-making (Gret-Regamey et al., 2017), however, usage of multiple or combination of methods such as participatory mapping, focus group discussion and other interview techniques (key informant interviews, for example) are increasing in ecosystem services research (Gould et al., 2019).

Participatory assessment methods provides an opportunity to understand a more complex system in an aggregate form, thus creating more favourable conditions for political decision-making (Gómez-Baggethun & Kelemen, 2008). A common approach to public participation in environmental matters is to establish a committee composed of experts or representatives of pressure groups or a combination of both (Harding et al., 2009). Some ecosystem services that are essential to a people's own identity are not fully captured by utilitarian methods, but can be elucidated using participatory methods (MEA, 2005). Participatory data and knowledge co-generation may not only support a better management of ecosystem services but also their adaptive use for improving local livelihoods (Buytaert et al., 2016). Thus, a participatory approach is promising to improve the applicability of the ecosystem services thinking to inform climate change adaptation at a local level. However, utilization level of the range of stakeholders is not clear in policy-making processes, even the participation frame is not well defined in certain contexts of decision-making. Since different stakeholders (or even individuals) perceive different benefits from the same ecosystem processes (B. Fisher et al., 2009) it is complicated how to keep balance on environmental decision-making in certain cases. Recognition and integration of different knowledge from various actors contributes to a more comprehensive understanding of social-ecological system dynamics and processes (Villamor, Palomo, Santiago, Oteros-Rozas, & Hill, 2014).

Environmental management is “a purposeful activity with the goal of maintaining and improving the state of an environmental resource affected by human activities” (Pahl-Wostl, 2007). Environmental decision-making is a term used to identify the ways humans make choices that impact the natural environment (Harding et al., 2009). Local decision processes with specific ecological and socio-economic contexts require more dynamic, spatially-explicit information and more community involvement (Costanza et al., 2017; Hedden-Dunkhorst, Braat, & Wittmer, 2015). Thus, the integration of ecosystem services approaches into decision-making processes at a local scale is complex process and requires: i) a better understanding of key drivers of the changes, such as climate and socio-economic, local stakeholders’ knowledge and practices dealing with changes; ii) ways of incorporating local/traditional knowledge and practices into theoretical decision-making (adaptation approaches); iii) developing a broader vision for adaptation and approaches that move from confrontation to participatory efforts providing a wide range of benefits; and iv) a mixed-methods approach to address an interdisciplinary and holistic approach as ecosystem services in complex socio-ecological systems, such as Mongolian nomadic livelihoods. To improve participation of local stakeholders in environmental decision-making for supporting their livelihood sustainability, further research is needed to investigate at a local scale with their involvement (details in chapter 7).

Conclusion

The understanding of ecosystem services as benefits people obtain from ecosystems was initiated in the earlier 1970s as an ecological concept. Since the release of the “*Millennium Ecosystem Assessment”* report (MEA, 2003), research on the ecosystem services approach in environmental decision-making and natural resources management has increased profoundly. While increasing the effort of conducting research studies and applying the ecosystem services approach, there is some critical issues are arisen, addressing the approach applicability. Ecosystem services in drylands are less explored, furthermore application of the approach at a local level, from the developing world, is still challenging. Leveraging traditional ecological knowledge might be more helpful to assess and understand the applicability of the ecosystem services thinking in local environmental management. Thus, a study on the applicability of the ecosystem services thinking in local environmental management to support climate change adaptation is needed to address how to reduce risks and to leverage opportunities in applying this approach.

Chapter 3. Study area and methods

This chapter describes the case-study areas where the research was conducted, and the methods used in collection and analysis of data. This chapter consists of two sections: The first section introduces the background of the case study, including a brief historical analysis of nomadic livelihoods and environmental issues in Mongolia; and the second section describes the methods employed to address the aims and objectives of the research study.

3.1. Mongolia: country of nomads and nomadic culture

3.1.1. Background

Mongolia is a landlocked country in Eastern Asia, located between Russia and China. The total land area is 1.56 million square kilometres and the total population is 3.24 million, according to the 2018 population census (NSC, 2018). The population density is 1.9 people per square kilometre. Thus, the country is considered the 19th largest, in terms of the area, and the most sparsely populated country in the world.

With its varying climate, landscape, soil, flora, and fauna, Mongolia is divided into six different natural zones, including high mountains, taiga (swampy coniferous forest), forest-steppe, steppe, semi-desert, and desert (Dash, 2015). Average annual temperatures are around 8.5^{o}C in the Southern Gobi and -7.8^{o}C in the northern high mountainous areas. The extreme minimum temperature in January ranges from -31.1^{o}C in the Southern Gobi to -55.3^{o}C in the far north, and the extreme maximum temperature in July ranges from +28.5^{o}C in the northern mountainous areas to +44.0^{o}C in the south (Dorjgotov, 2009). The annual average precipitation is 200-220 mm, ranging from 38.4 mm in the Gobi Desert region to 389 mm in the northern forest area. Some 90% of Mongolia is arid or semi-arid. About 90% of precipitation evaporates, and only 9.9% forms surface runoff, partially recharging into groundwater aquifers. The majority of precipitation falls in June, July and August (about 90% of precipitation falls during warm seasons); the dry months are from November to March, and only 10% of precipitation falls in winter, due to anticyclone dominance over Siberia (Yembuu, 2020a).

The first official population census was documented by Russian scientist Maiskii in 1918. M. Maiskii (1921) presented the total population of Mongolia in 1917 as 542,504, with 90% categorised as nomadic herders. The modern history of Mongolian nomadic pastoralism begins in 1921, when a constitutional monarchy was established as a result of the Republic Revolution

with the support of Russian communists. In November 1924, with the ratification of its first constitution, the Mongolian People's Republic was declared. Following the Declaration of the National Constitution in 1925, the Mongolian Republic moved to a centralized planned economic system, with a population of 684,000 (Murzaev, 1948). In the next seven decades, Mongolians experienced a process of economic and social transformation, involving the consolidation of ties with the former Soviet Union, the expansion of industrial and mining activities, and the establishment of collective pasture management unions (Neupert, 1999).

Modern Mongolian culture and lifestyle is based on nomadic livelihoods. Animal husbandry has always been the main productive activity of Mongolia's population, directly and indirectly. With the revolution of 1921, political, economic and environmental reforms started in Mongolia. The primary reform of land use was implemented in 1931 and had significant consequences for nomadic livelihoods, reducing the distances available for traditional nomadic movement (Murzaev, 1948), with the government announcing new administrative units and boundaries. Until 1931, Mongolia was divided into 5 *aimags* (regions), which consisted of 86 *khoshuu* (*soum*-subdistricts). The new administrative arrangements divided the country into 13 *aimags* and 300-304 *soums*. Today, there are 21 *aimags* and 360 *soums*, and the main nomadic movement strategy between seasonal pastures has been preserved. However, the overall movement radius has been restricted as a result of this reduction in territorial units, limiting nomadic access to a wide range of ecological zones and diverse forage resources (Fernández-Giménez, 1999). Being nomadic implies moving in search of the best pastures and campsites.

Table 3.1. Dynamics in the population, and nomadic herders of Mongolia

	Year	Total population	Percentage being nomadic herders
1	1918	647,504 (542,504 Mongolians)	90
2	1925	684,000	86.6
3	1956	845,500	74
4	1990	2,190,000	40.5
5	2000	2,397,000	34.5
6	2015	3,000,000	25
7	2018	3,238,479	22

Data source: Mongolian National Statistics Commission, www.1212.mn

Our ancestors have lived for more than 3,000 years as nomads, herding five types of livestock, or *tavan khoshuu mal* – horses, sheep, goats, cattle, and camels (Bazargur.D, 1998). Nomads have lived in ger (traditional dwellings), which over the centuries have been adapted to the

realities of nomadic life in the open steppes. In winter they are warm, in summer they are cool, and they are easy to carry and dismantle. The daily life of nomads is focused on caring for their livestock, grazing, milking, shearing or combing animals and living as free as the vast open steppes (Yembuu, 2016). One hundred years ago, 90% of Mongolians were nomadic herders. At present, 22% of Mongolians' livelihood is directly related to herding and thus dependent on environmental conditions and natural resources (Table 3.1). As Randall (1993) notes, Mongolian nomads were the majority of the population until recently, which is why the nomadic livelihood is known, valued, and respected by all in the country. Nomadic pastoralism is economically important in Mongolia; it is the main source of livelihood for one third of the country's households and is the main supplier of food for urban population (Marin, 2010). Most of all, nomadic lifestyle and culture are the main elements of Mongolian identity.

Mongolian nomadic pastoralism has passed through three main stages between 1921 and the present day, as a result of socio-economic changes. In the 1930s, the government organized a campaign of forced collectivization, which resulted in a sharp decline in the livestock population. The second attempt at reorganization was quite successful, with a national campaign organized for the pastoral economy to create *negdel* or "pastoral cooperatives". As a result, almost 90% of the private livestock were collectivised into the *negdels* and the government announced 1959 to be the Year of the *Negdel* Victory. As a consequence of the creation of the collectives, private ownership of livestock was restricted and private property of land was abolished, and all products were supplied to the State. "Pastoral cooperatives" existed until 1990; and although traditional nomadic herders became paid herders, they retained traditional herding knowledge and skills during *the negdel* period.

In 1990, the transition to a free-market economy began, with a subsequent liberalization of the livestock economy. In 1991-1992, state-owned livestock was privatized and given to *negdel* members. This privatization process was subjective, and the outcome was different in each region. Not only herders, but all the people who worked in the *negdel*, such as administrative and other services (e.g. veterinary, irrigation sectors) were included in this process. Depending on the amount of the total livestock of the *negdel*, the number of livestock per person differed. For instance, my home *soum* was one of the largest *negdel* in terms of its population, the total number of livestock, and the size of the territory. Each member of the herder families of the *negdel* received 25 head of livestock (including sheep, goats, cattle, and horses) and 16 head were given to each member of the other families. So, the overall procedure was the same; however, obtaining benefit was different in each *soum*.

According to Undargaa and McCarthy (2016), analysts usually misinterpret Mongolian pastures as examples of an "open access" system without property rights. Although nomadic herders own their livestock privately, they have continued to use and share 'free common pool resources', notably pasture land and water. As stated in the National Constitutional Law (2019) pastureland is '*the public property of the State'*. Pastureland access is still managed and governed through informal institutions based on traditional customary rights in Mongolia (Upton, 2012). In Mongolia, where pasturelands are managed by their traditional group ownership institutions, and there are large-scale movements between seasonal pastures (Ostrom, Burger, Field, Norgaard, & Policansky, 1999), the reliance on traditional institutions means that users of shared resources tend to make reliable commitments to sustainable use without reference on external authorities (Ostrom, Walker, & Gardner, 1992).

Until recently, steppe pasturelands remained ecologically stable, except in small areas around cities (Neupert, 1999); however, the carrying capacity of pastures is decreasing due to the increase in livestock numbers. Privatization has resulted in the total number of livestock more than doubling over 20 years, leading to intensification of land degradation and desertification processes. In 1999, desertification occurred on 47% of the total land area; by 2013 it was reported that "over 75% of pastureland is degraded*"* (Tsogtbaatar & Khudulmur, 2014).

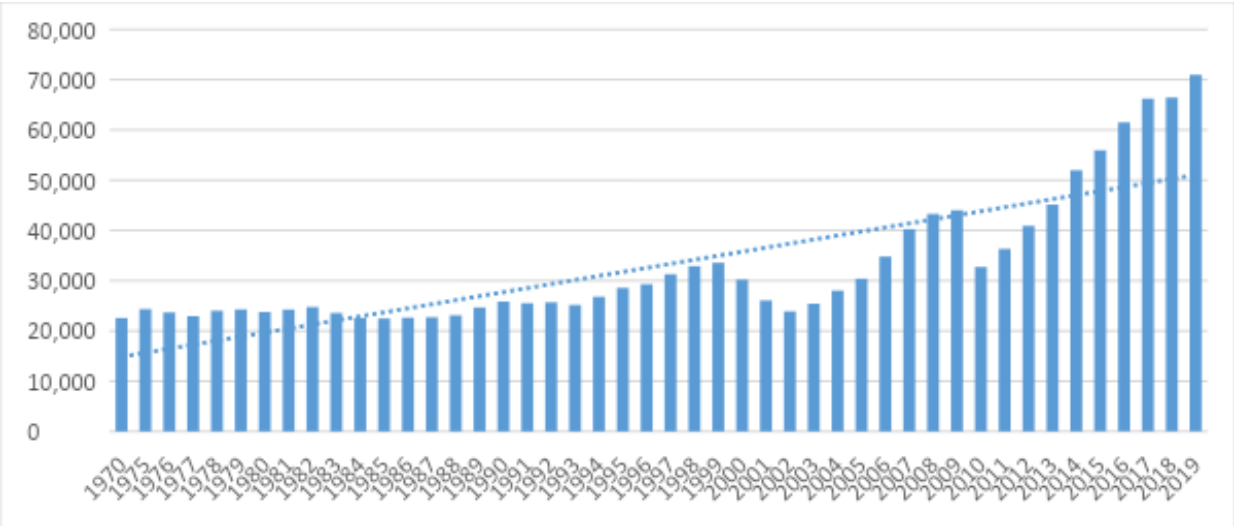

Figure 3.1. Dynamics in livestock population of Mongolia, 1970-2019 (by thousand)
(Source: Mongolian National Statistics Commission, www.1212.mn)

Meanwhile, natural disasters have had significant influence on the livelihood dynamics in the country. The summer of 1999 was extremely dry, and a severe drought affected more than 60%

of Mongolia in 2000. This was followed by a *dzud* (severe winter) in 2000, and the 2001 summer was extremely hot (Damdin Dagvadorj, Natsagadorj, Dorjpurev, & Namkhainyam, 2009). During these three years, modern Mongolians experienced these extreme weather and environmental changes and how negatively they could impact on their livelihoods (Rao et al., 2015). As stated in official documents, in 2000, Mongolians faced the worst winter in 30 years. High livestock mortality was recorded between 2000 and 2002 (Figure 3.1), and herders who had lost their livelihoods moved to the city. As is evident in the national statistics, this severe event resulted in the biggest migration from the countryside to the city in Mongolian history (Batjargal, Oyun, Togtokh, & Sangidansranjav, 2002). Since 2005, the livestock population has grown more intensively, having doubled in just 15 years. In recent years, pressure on pastureland ecosystems has increased dramatically due to both (i) climate change, and (ii) growing numbers of livestock. These relatively recent changes have had major implications for the sustainable use of pastureland in Mongolia's open steppe. Pastoral economies rely on extensive livestock production (Fernández-Giménez, 1999) and herders' income depends on several sources, such as the selling of live animals, meat and dairy products. Since 1995, the raw cashmere market has intensified, and today cashmere is the main source of income for herders (NSC, 2018). The increase in raw cashmere prices has been followed by a change in livestock composition, with the most dramatic change occurring in the number of goats in the country.

3.1.2. Traditional nomadic institution and nomadic knowledge

Seasonal movements are the central pattern of nomadic culture and livelihoods (Jagchid, 2019). Due to the direct dependence on nature and climate, nomadic herders have developed a deep and complex knowledge of spatial and temporal variability in the environment, particularly in terms of good pasture and water availability, which reflects the strategy and practice of animal husbandry developed over many centuries. Traditional pastureland management is based on a strong nomadic conservation ethic that recognizes the principle of sustainable pastureland use (Neupert, 1999). For centuries, Mongolian nomadic herders have developed an in-depth knowledge of ‘ecologically preferable lands/zones’ as a model for using pastureland which shapes herders' livelihood strategies (D Bazargur, 1998). Herders have learnt and accumulated valuable knowledge on the nature of climate and environment, seasonal variations and livestock behaviour, and have developed a mobile and flexible herding strategy to manage the landscape in order to benefit from the environment, as well as from animal husbandry (Fernandez-Gimenez, 2000; Fernández-Giménez, 1999; Marin, 2010). Thus, investigating the role that pastoralist nomadic ecological knowledge plays in natural resource management, is crucial to

understanding the long-term existence of traditional resource management institutions and ways of adapting to a changing environment.

Figure 3.2. Traditional socio-ecological unit of the case study area

The pattern of nomadic movements is based on traditional ecological knowledge, customs and rules for using shared resources such as pastures and water (Reading, Bedunah, & Amgalanbaatar, 2010). Herders' decision-making on herding and movement is based on their detailed knowledge of the landscape, plants and weather conditions at a particular time. Utilizing this knowledge, they predicted the condition of the coming seasons and made decisions about where they will move or how to preserve the pasture (Jagchid, 2019). Traditional socio-ecological units, *khot ail* (herder families), *saakhalt ail* (neighbouring groups)

and the *neg gol usniikhan* (people from one riverside area) have managed the pastureland and traditional movement collectively (Figure 3.2), playing an important role in nomadic livelihood and resource management (D Bazargur, 1998; Fernández-Giménez, 1999). The *khot ail* is the most important social group for nomads (Tserendash.S, 2017) and has existed as a socio-economic unit for at least 2000 years (Damdinsuren, 1957). A hierarchy of informal social networks and traditional institutions including the *khot ail* (a network of households sharing resources within a particular region) and *neg goliinhon* (people from one river area- Нутаг ус in Mongolian) have formed the basis of the traditional Mongolian nomadic pastoral system (Bazargür, Shiirevadja, & Chinbat, 1993). These traditional nomadic institutions based their livestock management and spatial sharing of key resources on consideration of common seasonal camping areas, grassland and water sources. This system of social organization, which still survives in modern Mongolia, has served as a regulatory function for land use management and as a mechanism amongst the herders to provide safeguards against natural hazards (Bazargür et al., 1993). Traditional nomadic movement and herding practices serve as an effective way to control the use of pastures and prevent off-season grazing and other environmentally and socially inappropriate uses of resources (Fernández-Giménez, 1999) within the boundary of *neg gol us* (Figure 3.2).

Traditional nomadic culture in Mongolia is similar everywhere, but each riverside area (*gol us, nutag us*-) has its special customs; their traditions differ from each other. Herders from one riverside area (neg goliinkhon) own the same types of herds and have similar pastoral practices. Like other natural resources- and climate-dependent people, Mongolian nomadic herders hold a detailed understanding of weather and climate at a local level, which carries great potential for use in adaptation to climate change (Marin, 2010). Whilst the notion of nomadic herders living in harmony with nature and striving for its preservation and protection remains the prevailing view of most Mongolians (Reading et al., 2010), the continued existence and resilience of nomadic livelihoods under the accelerating changes is questioned (Humphrey, Sneath, & Sneath, 1999). As climate change challenges Mongolia's nomadic livelihoods and traditions, it also compromises the traditional ecological knowledge needed for adaptation and resilience to climate and socio-economic changes.

3.2. The case-study area of Northeast Mongolia

3.2.1. Location

The case-study area was in the Northeast Mongolian steppe and wetland region. The study area is a Mongolian part of the Daurian Steppe Global Ecoregion[8] and the Landscapes of Dauria World Heritage Site, and includes a major Ramsar-listed wetland (WWF, 2011). The Mongolian Daurian (or *Daguur*, *Монгол Дагуур* in Mongolian) Steppe and Wetlands encompass the Khentii mountain range and large rivers, such as the Onon, Ulz, and Balj, flow in the ecoregion (Yembuu, 2020b). The Mongolian Daurian Steppe is one of the largest remaining examples of a relatively undisturbed steppe ecosystem in the world and the location of Mongolia's first Ramsar site. The mean altitude is 1100-1200 m a.s.l (above sea level) in the steppe. The lowest point of the country, the Khukh Nuur depression (561 m a.s.l) is in the region.

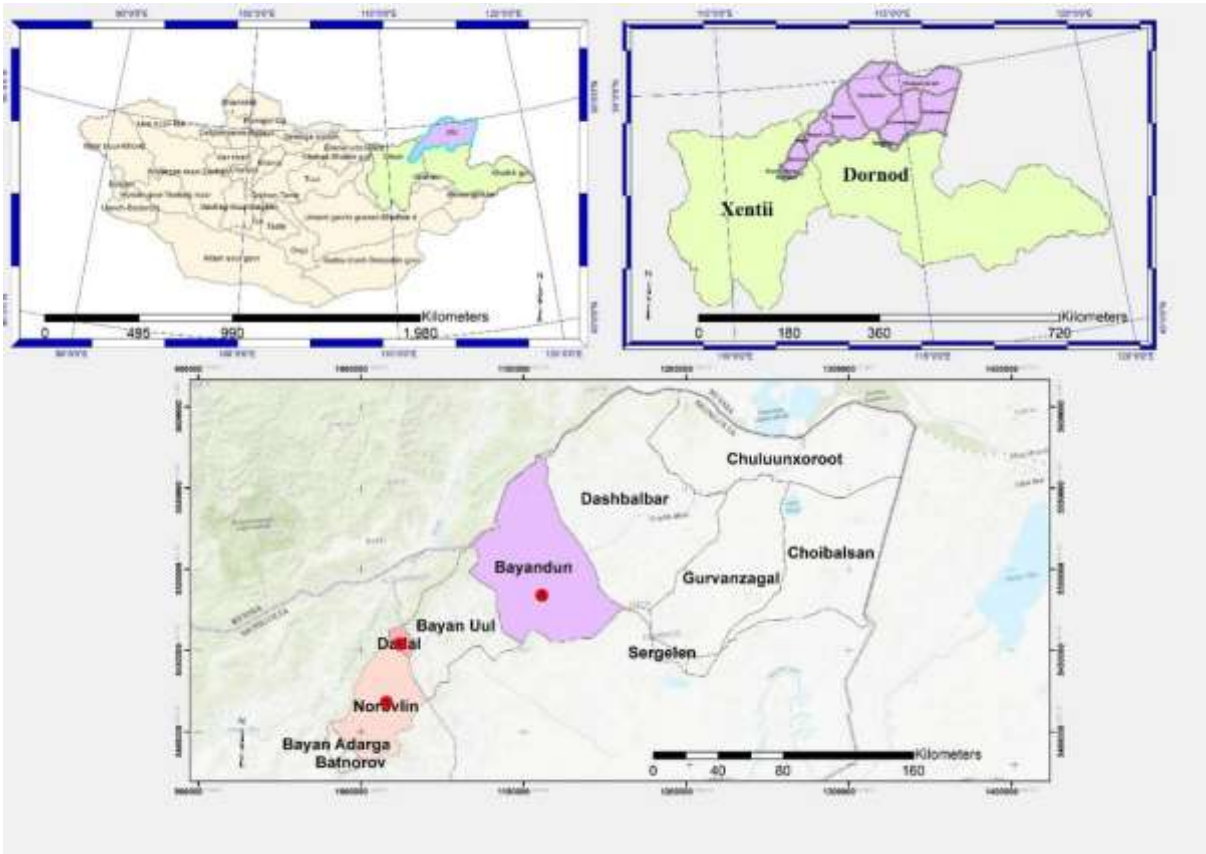

Figure 3.3. A case-study area: Northeast Mongolia

[8] The Daurian forest-steppe is a mosaic of grass and forest that straddles the border between Russia and east-central Mongolia. The ecoregion includes a small part of China that supports sheep grass and needle thatch grassland in the Inner Mongolia Autonomous Region. (sources: https://amurinfocenter.org/en/ecoregion/dauria-steppe/

The main location of the case study was the Ulz River Basin (Figure 3.3), which represents the Northeast Mongolian ecosystems of forest-steppe and steppe and covers an area of approximately 38,000 km^2 (MEGD, 2013). This study area has an important environmental gradient/transition zone from the Siberian taiga to the steppe ecosystem of Eastern Mongolia as an ecotone of forest-steppe and steppe ecosystems (Tsegmid, 1969).

The protected areas network in the region consists of the Mongol Daguur Special Protected Area, Onon-Balj National Park, and Ugtam Uul Nature Reserves across the ecoregion. The steppe is a habitat for diverse rare species of fauna, such as the white-naped crane, great bustard, and other endangered migratory birds, and it provides a migratory path for the Mongolian gazelle (Ouyngerel.B, 2009) .

3.2.2. Climate

The climate in the Ulz River Basin is typical of the mountain forest-steppe and the wide valley of the Dornod Steppe. In winter, it is wet and cold, and in summer, it is cooler over the upper part of the river and dryer and warmer in the steppe area. It also has characteristics of a transition zone from the Khan Khentii Mountain, which varies from a wet and cooler climate to drier and warmer climate (Jambaajamts, 1989).

In Northeast Mongolia, the average annual temperature ranges from -0.5^{o}C to +1.5^{o}C, but the mean monthly temperature varies from -20°C to -22°C in the coldest month (January) to +18°C to +20°C in the warmest month (July) (MEGD, 2013). In summer, the maximum temperature can be as high as +38°C to +39°C. The average annual precipitation ranges from 230 mm to 350 mm. An estimated 90% of the total annual precipitation falls in the warm season (in April-October) in the northeast Mongolia. As for the monthly distribution, the smallest amount of precipitation, 1-2 mm, falls in January and the maximum of 64-80 mm falls in July. Maximum wind speeds reach 12-20m/s in almost all months, but in spring they reach 14-24m/s. Snowstorms are observed annually for 10-20 days and dust storms for 15-20 days, most of which occur in spring. The annual average temperature has increased by an average of 1.3^{o}C over the period 1976 to 2011, and the warming rate was similar throughout the study area (Gomboluudev.P, 2017a). The climate is changing in the case-study area due to an increase in annual mean temperature and changes in the precipitation distribution pattern, with herders having to face climate-related issues more than ever.

3.2.3 Vegetation

The forested area in the Ulz River Basin is predominantly composed of larch, pine, birch, and poplar forest. Since 1996, it has been immensely impacted by human and natural factors, such as large fires, the infestation of forest insect pests, and a high level of illegal logging. According to an Administration of Land Affairs, Geodesy and Cartography report (2017), 78.5% of the total territories of the Ulz River Basin is agricultural land, 3.12% is designated forest area, 7.92% is the state special-purpose land, and 10.4% is identified as a water reservoir, city, village, urban area, and power grid area. 93.4% of the total agricultural land is pastureland, 4.7% is cropland, and 1.9% is arable land (NSC, 2018).

3.2.4. Water and mineral resources

The Ulz River rises from the Ikh and Baga Burd springs in the Norovlin *soum* territory of Khentii Province. Its drainage basin is 37,391 square kilometres and it flows through Khentii and Dornod Provinces to the northeast, crossing the state border, then flows into Baruun Tari Lake in Russia. Some 89.8% of the total territory of the Ulz River Basin lies in Dornod Province, 7.4% in Khentii Province, and only 2.8% lies within the territory of the Russian Federation. The total length of the Ulz River is 510 km (the length from its source to the Mongolian border is 495 km). The river basin has a total of 176.6 square kilometres of land covered by water resources, consisting of rivers, lakes, ponds, salt marsh, and springs. Ulz River Basin has 99 rivers, such as the Ulz, Turgen, Duch, Bayan, Ar Jargalant, Mekheerch, over 360 wells, spring-well, mineral waters, and over 250 lakes and salt marshlands (MEGD, 2014).

The basin has a variety of minerals used in the extracted for industry. The moderately elevated mountains are rich in gold, silver, iron, and zinc; the middle part of the basin is rich in tin, kinds of spar, lead, uranium, chalcedony and agate, and the delta part of the basin is rich in polymetallic ore and non-metallic resources, such as coal, bitumen, and precious gems (Dorjgotov, 2009). Similar to other parts of the country, the mining sector has grown in the last 20 years in the basin. Due to the intensive development of the mining sector, the consequent demand for water is increasing and this is contributing to the degradation of pasturelands (MEGD, 2014).

3.2.5. Population and livelihoods

The three case-study areas chosen to investigate the applicability of the ecosystem-services approach to support climate-change adaptation were three *soums* (village-subdistricts) in two

provinces along the river basin. A *soum (“сум”* in Mongolian), is the second-level administrative subdivision in Mongolia. The three that are the focus of this research each have approximately 2,500-3,000 inhabitants who depend directly or indirectly on animal husbandry for their livelihoods. Dadal and Norovlin are located in the upstream area, while Bayandun is in the midstream area. At present, 42.9% of all households in these three *soums* are nomadic families (Table 3.2). Compared to the other two *soums,* Dadal has fewer livestock due to the predominance of forests and limited open pasture. However, because of its historical significance and natural beauty, Dadal is one of the most attractive tourist destinations in Mongolia.

Table 3.2. Population dynamics of case-study soums, in 2018

Province/Soum	Total population	Number of herders	Total households	Number of herder households
Dornod/Bayandun	3,112	778	882	440
Khentii/Dadal	3,089	506	942	310
Khentii/Norovlin	2,547	625	787	370

Data source: Mongolian National Statistics Commission, www.1212.mn

The natural and climatic conditions of the river basin are most suitable for grazing cattle, raising horses and sheep herding. The composition of livestock herds has been established by adaptation to prevailing conditions over hundreds of years and differs from *soum* to *soum,* depending on natural conditions. For instance, a herd structure of “sheep-goat-cattle-horse” is common for Bayandun, whereas a structure of “sheep-goat-horse-cattle” is better suited to the Norovlin *soum* (D Bazargur, 1998), where the sequence in the structure indicates which animals are most to least abundant in the herds. Like other *soums* in Mongolia, these three were former *negdel,* or “pastoral cooperatives”, until 1990. After privatization, the livestock numbers have increased tremendously in the case-study area, reflecting the wider trend throughout the country. For example, in 1990 the total number of livestock was 741,900 and the latest statistics show that it now reaches 167,410 head in Norovlin *soum* (NSC, 2018). In summary, the case-study area has special significance in Mongolian history, and fairly typical steppe pastureland ecosystems for semi-arid Mongolia. It’s changing environment and nomadic livelihoods provide opportunities to investigate the climate change impacts on nomadic livelihoods and pastureland ecosystem services.

3.3. Mixed methods case-study approach

The research study used an ecosystem services approach to examine its applicability to supporting climate change adaptation at a local level. This study draws on two periods of fieldwork in Northeast Mongolia, which were conducted in June-July 2018, and June-July 2019. The nature of the research study is interdisciplinary, integrating elements of the social and biophysical sciences and drawing on both qualitative and quantitative research methods. A mixed-methods approach, using both qualitative and quantitative methods (Teddlie & Tashakkori, 2009), was used to investigate climate change impacts on ecosystem services and livelihoods, to explore nomadic herders' knowledge and practices regarding climate change adaptation at a local scale. I used qualitative methods to elicit the experiences, perceptions, values and traditional knowledge and practices of the nomadic herders – interviews with key informants and nomadic herders, focus-group discussions at *soum* centres, and a national policy workshop in Ulaanbaatar. A household survey in the case-study area was used to assess the importance of key ecosystem services from the pasturelands and adaptation actions. The full details of the methods are provided in the main finding chapters. Analysis of findings and development of further papers and thesis material using the data analysis outputs are set out in Table 3.3.

The focus of this research was fieldwork to explore climate change impacts on people's livelihoods and ecosystem services, and to explore the advantages and disadvantages of using an ecosystem services approach to support planning at a local scale. During the first visit, I explored herders' experience of climate change, how they perceive its impacts, how they depend on so-called 'cultural services', and how they participate in local environmental and natural resource management decision-making.

To test the applicability of the ecosystem services approach to support adaptation strategies, a second fieldwork period was organized. On the second visit, I discussed with many stakeholders what adaptation strategies appeared promising to them, and while having those conversations, I explored how applicable an ecosystem services approach is – looking for opportunities and risks to use it in environmental decision-making.

Table 3.3. Methods, theory and data employed in the papers and chapters

Chapter (Paper) No.	Methods	Data
Chapter 4: Climate change impacts on nomadic herders' livelihoods and pastureland ecosystems	**Literature review:** Existing knowledge, theory and applications on climate change impacts on herders' livelihood and ecosystem services. TEK-related papers: Nomadic herders' livelihood, their tradition and culture **Fieldwork:** - Interviews with herders - Key informant interviews - Field observation - Focus-group discussions to document local knowledge and perceptions of change - Household survey on ecosystem services benefits, climate change impacts	**Secondary data:** Socio-economic: Population, agriculture, income-source related data Natural environment: Climate: t^{o}C (max, min), precipitation, water resources, pasture land **Primary data:** - Major climate change impacts on ecosystem services at a local scale - The impacts on nomadic herders' livelihoods - Local herders' perception, knowledge and practice on climate change impacts - Traditional natural resources management practices
Chapter 5: Cultural ecosystem services that support well-being in Mongolian pastureland	**Literature review:** Cultural ES theory and applications, CES support to human well-being **Fieldwork:** - Key informant interview - Field observation - Focus-group discussion - Household survey on ecosystem services benefits, integrating TEK into CES assessment method	**Primary data:** - Local herders' specific cultural events, tradition and custom - Experiential use of plants, animals and landscapes at a local scale - The physical use of landscapes - Traditional nature conservancy - Local herders' knowledge and perception of cultural heritage and value of nature - Symbolic, sacred and religious functions of local nature and environment
Chapter 6: Adaptation strategies of nomadic herders in Northeast Mongolia: climate, globalization and traditional knowledge	- Interview with key stakeholders and group discussions to document the main current adaptation strategies of local people - Field observation - Household survey on climate change adaptation and participation in environmental decision-making at the local level - A national policy workshop	**Primary data:** - Nomadic herders' knowledge, perception and practice on climate change adaption - Herders' participation level in local decision-making processes related to the adaptation - Local stories on adaptation - Differences of adaption experience among the local communities Review of secondary data sources
Chapter 7: Using ecosystem services thinking in adaptive management of Mongolian pastureland	Content analysis of local planning documents 2nd field trip to investigate and discuss the applicability of the ecosystem services approach into adaptation strategy and policy at a local level: - Focus-group discussion - Workshop with main stakeholders	**Primary data:** - Suggestions and pathways of introducing and integrating the ecosystem services approach into environmental decision-making in nomadic communities - The ecosystem services approach presence in regional and local environmental plans

TEK-Traditional ecological knowledge; CES- cultural ecosystem services

3.3.1. Ethical considerations

The Macquarie University Human Research Ethics Committee approved the research methodology on 10 April 2018, in accordance with Australia's National Statement on Ethical Conduct in Human Research (2007). All the methods and questionnaires conducted in the field comply with the terms and conditions of the Human Research Ethics code. The approval letter is provided in Appendix 1.

A consent letter and information, in Mongolian, about the case-study research was shared with all stakeholders and participants. Before conducting the interviews and a household survey, the information and consent process was explained and each participant was given the opportunity to read the Information and Consent Form and the questionnaire and decide whether to complete the survey. Surveys, interviews and focus groups were only undertaken with participants who expressed their informed consent.

3.3.2. In-depth interviews: exploring nomadic livelihoods and environmental changes, and traditional knowledge and practice

Information gathered from narratives provided by stakeholders often proves to be the most valuable way of understanding complex phenomena (Teddlie & Tashakkori, 2011). Therefore, to explore the climate change impacts, nomadic herders' knowledge and practices of adapting to changes, their perceptions of the cultural values of the pastureland, and the potential future changes, I conducted in-depth interviews with key informants (KIs) and nomadic herders in three *soums* in two *aimags*. The nomadic herders are the pastureland ecosystem services users in the case-study area.

Interviews with the key informants. The snowball sampling method and personal networks are the most commonly used and appropriate ways to reach key informants (Lavrakas, 2008). Thus, I used my previous experience and personal and professional networks to contact key informants in local *soum* governors' offices, Onon-Balj National Park and the Ulz River Basin Authority; they in turn identified further potential interviewees (MacDougall & Fudge, 2001). I conducted ten semi-structured key informant interviews with the local municipality officers, River Basin Organization (RBO) and National Park administrative workers, and local business people. The interviewees were asked to document i) local livelihoods and natural-resource usage, ii) climate change and adaptation practices at a local level, and iii) local herders' participation in natural-resources management and decision-making.

To connect to local herders, I enlisted the help of key informants (MacDougall & Fudge, 2001; Robinson, 2014). With the help of these informants, I visited herder families and asked how their nomadic livelihoods have been affected by climate change and how they adapt to the natural and socio-economic changes, through general, semi-structured interviews with open-ended interview questions (Bernard, 2011).

I started the fieldwork preparation while working on ethical considerations in Sydney, and when I arrived in Ulaanbaatar, I made some final clarifications and arrangements for a field trip in the case-study area.

The journey began in *Norovlin soum*, the *Khentii aimag*, which is located in the northeast, 533 kilometres by car from Ulaanbaatar, the capital of Mongolia. On the way, I gained an idea of how the summer was starting by observing the vegetation cover. I observed in my diary:

> *11th June 2018: We are travelling to Northeast Mongolia. As a rural person, I am always so excited to travel to the open steppe, countryside. Looking out the car window and admiring and exploring the passing view is one of the most exciting things about travelling. But, this time, I am feeling a bit sad because of the colour of the land. It is supposed to be summer here, however, we have seen that the golden yellow land passing alongside the roadside is prominent. So, I am feeling that we are travelling in the middle of the autumn, maybe someday of October. It seems like it hasn't rained for ages. We used to sing that "Rain, rain go away, come back another day". At that moment, I really wish to sing that "Rain, rain come back. Don't go away".*

An old Mongolian saying goes that, "If you drink the water of the area, you follow the custom". Complying with the traditional greeting of the country, during my trip I greeted people by asking, "How is the summer going? (*Saikhan zusaj baina uu*)". Depending on the season, Mongolians ask, "Are you having a good winter? (*Uvuljuu tablag uu*)", or "How is summer? (*Saikhan zusaj baina uu*)"; one is enquiring how their livestock are. For Mongolians, questions about the season are much like "How are you?" for other nationalities. Thus, my greeting enquiring about their summer was followed by a discussion relating to substantive climate change and livelihood issues. As mentioned in my diary, it was too dry along the road and in the *soum* area as well. The local people were worried about how late summer was and began to share their perceptions and experiences of changes regarding temperature, rain and snow distribution, seasonal patterns, and their impact on their livelihoods.

Interviews were conducted face-to-face and were for 1.5 to 2 hours (Appendix 3). The interviews indicated that the key ecosystem services related to local use and management of pasture and water, so the study focused particularly on provisioning services from the pastureland ecosystem and water resources. In the discussions of the findings, herders (H) are identified as H1, H2, H3... in the order in which they are first quoted. The key informants (KI) are similarly identified as KI1, KI2... to protect their anonymity.

To explore how nomadic livelihoods have been affected by climate change and how they adapt to the natural and socio-economic changes, I also interviewed 15 herders during the second field trip. General, semi-structured and open-ended interview questions were asked. Semi-structured interviews (including both some quite structured and some with open-ended questions) were also conducted with several key stakeholders in environmental planning and decision-making at a local level to explore the themes of interest.

3.3.3. Focus-group discussions

A total of six focus-group discussions (FGDs) of 5-10 participants were used to explore perceptions on particular themes of interest (Teddlie & Tashakkori, 2009). FGDs provide an opportunity to gain significant insights into the experiences, observations, and opinions of nomadic herders, local decision-makers, business people and natural resources managers (Massey, 2011). FGDs are commonly used to capture traditional or indigenous knowledge-based information on diverse issues and to examine the contribution of indigenous knowledge to agriculture and climate change adaptation (Nyumba, Wilson, Derrick, & Mukherjee, 2018).

I conducted FGDs to identify local people's perceptions, knowledge and practices on (Appendix 4):

- Benefits from the pastureland ecosystem services and the most important ecosystem services for herders;
- Cultural ecosystem services at a local level and shared understanding of the nonmaterial benefits of nature for their well-being;
- Suggestions and recommendations on climate change adaptation and applicability of ecosystem services approaches at a local level; and
- Traditional knowledge of herders on environmental changes and adaptation.

FGDs were organized with 6-8 stakeholders consisting of local and regional natural resource managers, park managers and The River Basin Authority specialists, and ministry-level specialists. To identify potential participants from amongst the herders, we also used snowball

sampling based on suggestions from key informants. Each focus group took about three hours. The first was held with eight residents of Bayandun *soum*, including River Basin Authority officers; the second was with six nomadic herders from the Mogoit riverside area of Norovlin *soum*; and the third was with six residents of Dadal *soum*, including national park rangers. Draft FGD questions were modified in the case-study area to incorporate learnings from the interviews.

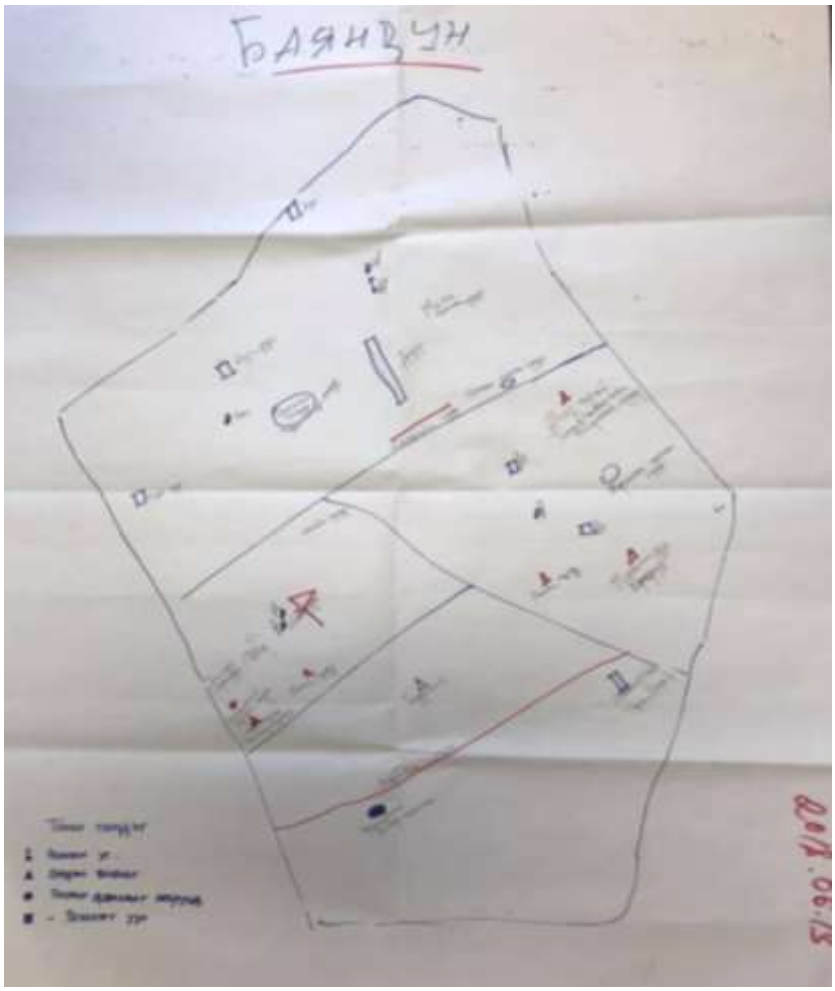

Figure 3.4. Map from FGD. Bayandun soum, Dornod Aimag.

The first task of the discussion was to draw a local map with information on cultural and historical sites and other specific natural components. Each group produced an informative map, which was used for the subsequent discussions (Figure 3.4).

Participants then identified the benefits they drew from the pastureland and nature and made a list of historic and cultural sites in their local area, sharing information about the historically important sites. They described the interlinked changes in grassland and livelihood and reasons for changes in the local area (Figure 3.5).

Figure 3.5. A nomadic community workshop (photographs used with prior consent).

Continuing the discussion, participants produced a seasonal calendar of the *soum* area. Seasons, weather conditions, and the main herding and cultural events were described in the hand-drawn table shown in Figure 3.6.

Figure 3.6. Seasonal calendar of the soum area (photo used with prior consent).

The final task of the FGD was to describe the changing trends in the environment and benefits from nature, and how these are impacting traditional nomadic livelihoods (Figure 3.7).

Figure 3.7. Capturing a photo of a horseman who is herding is a rare opportunity at present. Horses have been replaced by motorcycles in the open steppe

Information and data from FGDs were used to investigate local knowledge of climate change impacts, adaptation, and the applicability of ecosystem services thinking in local decision-making and are discussed in the main findings chapters (Chapters 4, 5, 6 and 7).

3.3.4. Household survey

Following the interviews and focus-group discussions, in-person household surveys were conducted to identify the importance of key ecosystem services and the factors affecting their use and change over time. I have used a flexible approach to administer the household survey. To make the research more context-sensitive and participatory, I conducted a pilot survey with five households from each *soum* in June, and then updated the survey and administered it again in July 2018. A convenience sampling method was used to take a pilot survey (Marshall, 1996): some of the interviewed herders were invited to participate in the pilot survey. The herder families invited to undertake the household survey in the case-study areas were randomly chosen to administer the main survey. Due to the scattered location of nomadic herders and seasonal movement, it was difficult to use a systematic sampling method. Local key informants and some of the interviewed herders led me to possible destinations for meeting/visiting as many herder families as possible within the *soum* boundary. Thus I have used a random spatial sampling method (Berry & Marble, 1968; Kondo, Bream, Barg, & Branas, 2014) to conduct

the household survey to collect 115 samples. The survey was conducted in Mongolian. The household survey started with general questions to capture the respondents' age, gender, education and herding experiences. The questionnaire is provided in Appendix 6. The youngest herder surveyed was 19 years old, and the oldest was 70. The average number of years spent herding was 19.25, which means that the participants in the survey were comparatively experienced herders.

Aiming to explore nomadic herders' knowledge and practices regarding climate change adaptation, the questions covered their experience of climate change, ways of adapting, and their level of participation in local decision-making, and future possibilities to improve adaptation strategies. Based on focus-group discussions, the current adaptation actions for climate change were clarified and listed in a household survey. The survey also included questions on the nonmaterial benefits provided by forests, wetlands, grassland and river basin, and how the herders experience and value the landscapes in which they live. The survey was semi-structured and contained both fixed and open-ended questions. Importance of adaptation actions was elicited through a 4-level scale, which rated the importance as: "very important", "important", "somewhat important", and "not important". The survey results are presented in Chapters 5 and 6. (The household survey was used as a reference to supplement the herders' interviews and focus group discussions, so the survey results are not explained in detail there.)

3.3.5. National policy workshop

In the last stage of data collection, I organized a workshop in Ulaanbaatar, inviting academics, decision-makers and policymakers, and nature conservation NGO representatives (n=12) who have expertise in environmental and natural-resources management. The aim was to investigate how traditional knowledge and practices can contribute to supporting effective adaptation, and the applicability of the ecosystem services approach to support local climate change adaptation strategies. The workshop, which involved scientists and the traditional ecological knowledge holders, was designed to allow better understanding of emerging issues and offer further insights (Huntington, 2000). In the workshop, participants provided their understandings of the issues and their views on the applicability of the ecosystem services approach in the context of sustaining Mongolian nomadic livelihoods and supporting local decision-making. The main findings of the workshop are presented in Chapter 7.

3.3.6. Document analysis: academic papers, reports, and policy documents

In the initial stage of the study, a review of the literature on the applicability of the ecosystem services approach in environmental management and climate change adaptation at the national and regional level was conducted. Further investigation of the strengths and weaknesses and uncertainties about the utility of an ecosystem services approach was undertaken to develop detailed plans for the fieldwork visits.

A content analysis of key local and regional land use-related plans was conducted to examine how local people's concerns were, and were not, addressed in local and regional land use-related plans. The local plans analysed were collected from the local municipality offices during the field trips. National and provincial policy documents were collected from the official websites of the Parliament of Mongolia and the Ministry of Nature, Environment and Tourism. Six planning documents regulating pastureland issues in the case-study area, specifically the local land management plans, the river basin integrated management plan, the national park management plan, etc., were selected for close analysis. The main findings of the content analysis are presented in Chapter 7.

3.3.7. Data analysis and conceptualizing the findings

Interviews and focus groups were conducted in Mongolian and all interviews were digitally recorded with the permission of the participants. The recordings were transcribed manually and then translated into English. The data analysis strategy was inductive, in order to identify emerging patterns and themes in the data (Bernard, 2011; Ezzy, 2002). The interview transcripts were coded using NVivo 12 qualitative data analysis software. Quantitative data were analysed using Microsoft Excel, and descriptive statistics were used to present the data.

Based on the initial encoding results from NVivo, I compiled a list of key topics to be presented and explained as fieldwork results. I then formulated a conceptual framework for each research objective. Figure 3.8 shows how pastureland degradation issues are associated with the increase in livestock and environmental changes.

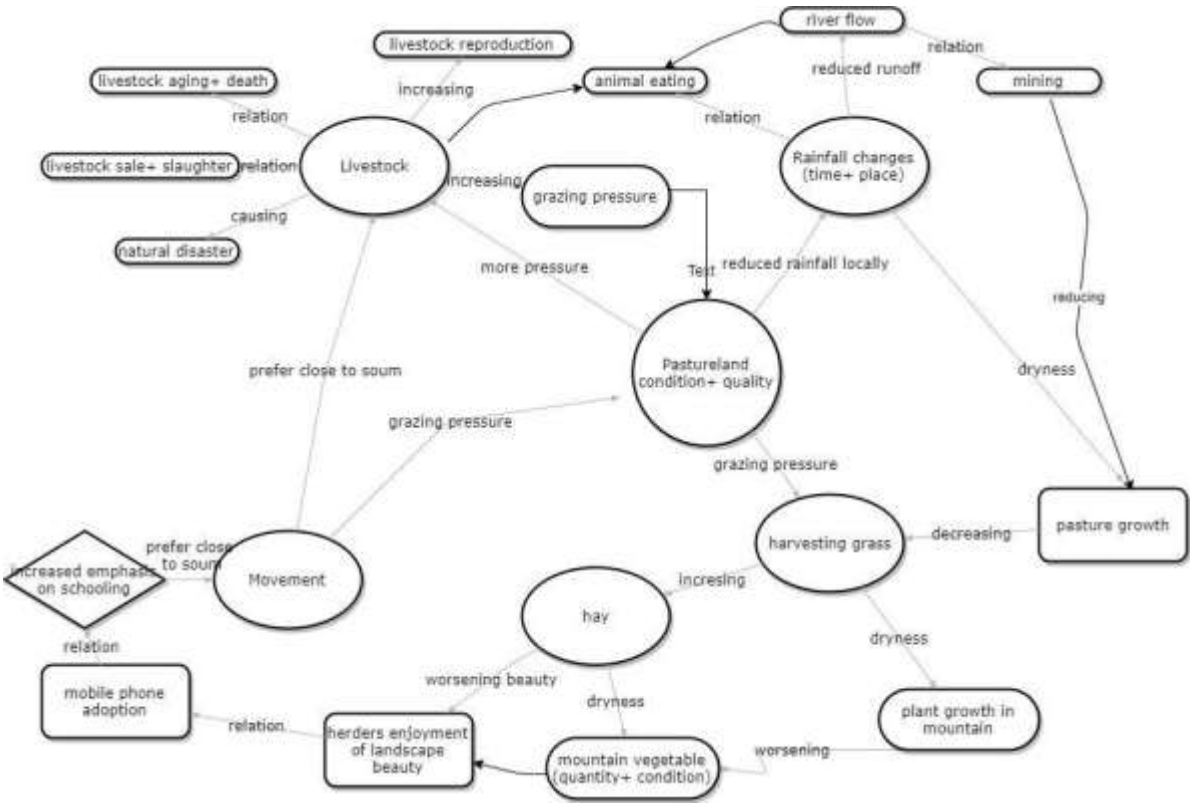

Figure 3.8. Whiteboard discussion to conceptualise the research framework; based on the coding results and key topics

Socio-economic data, such as demographic and livestock data, were obtained from the annual reports of the Mongolian National Statistical Commission and local municipalities. Additionally, meteorological observational data comprising monthly maximum and minimum temperatures and precipitation data from meteorological posts in the *soum* was collected, and a time series analysis was carried out to support the interview results. Synthesised results of primary and secondary data analysis are discussed in Chapters 4, 5, 6 and 7.

3.4. Positionality and reflexivity

I graduated from the Mongolian National University of Education (MNUE) as a teacher of geography (majoring in physical geography). I started my career as an associate researcher at the Institute of Geography, Mongolian Academy of Sciences. There I had a chance to go to Northeast Mongolia for the first time in 1999, working as a research assistant on a joint Mongolian-Russian expedition to conduct a background study entitled "*Establishment of Onon Balj National Park*", which was supported by WWF Mongolia. This trip was full of discoveries for me, visiting new places, meeting new people, experiencing a new culture and learning from the experienced scientists in the field. The trip allowed me to see the breathtaking beauty of the

mountains, rivers, caves, streams, and ponds, and the significant historical heritages. Because of the attractiveness of the nature and the warm hospitality of the nomadic people, the area has had a special place in my heart and my mind ever since.

I then changed my job to become a lecturer at the University of the Humanities in Ulaanbaatar. While working at the university, I worked as an environmental management expert for several years in Mongolia. In 2012, an ecosystem-based adaptation project began in Northeast Mongolia, in particular in the Ulz River Basin, with the support of the UNDP and the Adaptation Fund. The project brought me back to the area and allowed me to explore it from a different perspective. In 2012-2016, I had worked as an expert on natural-resource management with the project and travelled around the river basin area frequently. It was initially very exciting to return to the area, but I began to feel frustrated as I was at the same time dealing with local issues. It was shocking to find out that the natural beauty had altered, the areas of forest were decreasing, rivers were in decline and lakes were becoming smaller. This experience working on the project gave me the initial idea of investigating the ecosystem services approach and integrating it into natural resources management, and my interest in doing something that might help local people to adapt to these accelerating changes and to protect nature was developed more profoundly.

Figure 3.9. The mineral spa Gurvan Nuur (Three Lakes)

It has been well known among the Mongolians for centuries for its historical and therapeutic importance. The Mongolians have used the mineral water and mud of this lake for healing purposes for many generations. It is becoming drier every year.

I was pictured here (in July 2019) sitting on a platform that had been in the middle of the lake 20 years ago. I have a photo taken at this place in June1999, when the water level was up to my knees.

As a nomadic woman, researcher, educator and mother (and also a daughter), I would like to help our communities adapt to changing environments in order to obtain *baigaliin khishig* ('benefits from nature') to support nomadic livelihoods and protect open steppe pastures.

3.5. Limitations of the methods

The thesis findings are derived from a particular case study and are therefore limited in their applicability to other places. The findings are also affected by my positionality within the research. My background in physical geography, and several years of experience teaching natural science-related subjects at the University in Mongolia, has led me to focus on environmental concerns, so to start conceptualizing the research framework in a way that also engaged with social concerns to explore the complex socio-ecological system was challenging.

To investigate this case study, the main limitations were seasonality and accessibility issues in the field area. The climate in Mongolia is challenging, and I could travel only in the three summer months. In summer, herders have more free time for relaxing, entertaining and resting, while the rest of the year they are busy with herding and other nomadic activities. Thus, it was not ethical to ask them to take part in interviews and spend time on my research in the more demanding seasons. As an interdisciplinary research project that focused on nomadic herders' perceptions and understanding of climate change, there is a close interest in details of the weather elements that affect grazing lands and water resources, which may be ignored or overlooked by others.

As a researcher, I set out to analyse the existing situation using the disciplines of natural and social sciences, however, my positionality as part of a nomadic culture influenced my access to, and interpretation of, nomadic experience. My ancestors, up until my great-grandfather on my mother's side and grandfather on my father's side, were nomadic herders – and this goes back countless generations. Moreover, I had previously worked in the case-study area with the support of international donors and the Ministry of Nature, Environment and Tourism, and this professional experience also shaped my sensitivities. Also, although I explained clearly my current position as an independent researcher and the purpose of the project to research participants, sometimes people still saw me as a representative of the decision-makers or someone with the power to solve their problems. This may be reflected in the stories, perceptions, and opinions that people shared with me during interviews; however, I have addressed this issue by cross-referencing these findings with other research literature.

3.6. Conclusion

Mongolia is a landlocked temperate country and the homeland of nomads and nomadic culture. Nomadic pastoralism has been the main source of livelihood and the primary economic activity in Mongolia from ancient times up to the present. Due to climate change and socio-economic changes, nomadic livelihood and benefits from nature have changed in the pasturelands. This case study to investigate the applicability of the ecosystem services approach to decision-making at the local level in a dryland region was conducted in Northeast Mongolia in 2018-2019. A mixed-methods approach that involved collecting qualitative and quantitative data to explore nomadic livelihoods and the relationship between nomads and the open steppe pastureland through nomadic customs was used. I followed the traditional nomadic custom in interviewing herders and local stakeholders. The following chapters provide detailed insights into the climate change impacts on nomadic livelihoods and pastureland ecosystem services, and the potentials and risks of using the ecosystem services approach to support climate change adaptation at the local level.

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Chapter 4 (Paper 1): Climate change impacts on nomadic herders' livelihoods and pastureland ecosystems: A case study from Northeast Mongolia

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In order to investigate the applicability of an ecosystem services approach in supporting local adaptation to climate change, it is necessary first to understand how climate change affects local livelihoods and ecosystem services. This chapter addresses a key question of the thesis, exploring the climate change impacts on local livelihoods and ecosystem services in the drylands, using the case of Northeast Mongolia. A traditional ecological knowledge was used to explore the complex process and links between climate change, ecosystem services and livelihood at a local scale.

The findings of the chapter are based on interviews with nomadic herders and key informants from local municipalities, and focus-group discussions in Northeast Mongolia. Both local livelihoods and pasture ecosystems are severely affected by climate change. Nomadic herders' experience of climate change at a local level helps to explore the key indicators of climate change, such as temperature increase, changes in precipitation distribution and patterns, and seasonal shifts that are occurring in the open-steppes of Northeast Mongolia. The chapter demonstrates the trend of benefits derived from the Northeast Mongolian pasturelands ecosystem services over the past 30 years. Provisioning services, particularly pastureland and water resources, are discussed to illustrate how climate change is impacting on the pastureland benefits. The climate change indicators that are reported by herders are not only consistent with and supported by meteorological and other scientific data, but also reveal the temporal and spatial details of changes not normally reported by hydrological and biodiversity investigations. This chapter contributes to a better understanding of how climate change is affecting local livelihoods and ecosystem services in Mongolia and highlights the importance to natural resource management of ecosystem services thinking engaging in conjunction with TEK.

Abstract

The study investigates the applicability of the ecosystem services approach to understanding climate change impacts on local livelihoods and the pastureland ecosystems of Mongolia. Nomadic Mongolians move in specific areas in search of the best pastures and campsites for their herds and are highly dependent on natural resources for their livelihoods. Pastureland ecosystems are increasingly being affected by climate and other anthropogenic changes, such as socio-economic and cultural changes, challenging nomadic livelihoods in the drylands. The research presented in this paper is based on extensive semi-structured interviews with local herders, key informants, and focus group discussions in Northeast Mongolia. Nomadic herders' perception and practices, supported by meteorological data, reveal that climate change has affected the provisioning of key ecosystem services, especially the availability of water and the quality and availability of pastureland. This has changed the seasonal movement patterns of nomadic herders and their livelihoods. Such changes present challenges for current and future management of pastureland and adaptation to climate change at local and regional scales. The research study suggests that valuing, maintaining and conserving traditional ecological knowledge is essential to sustaining nomadic livelihoods and adapting to changing ecosystem services.

Key words: *ecosystem services, climate change impacts, pastureland ecosystems, nomadic herders, traditional ecological knowledge, adaptation*

4.1. Introduction

While much research has been conducted on the integration of the ecosystem services approach with environmental decision making, land management, and forest resources management, most assessments focus on island, marine, mountain and forest ecosystems (Carpenter et al., 2009; Chaudhary et al., 2015; Grêt-Regamey, Sirén, Brunner, & Weibel, 2017; Pandeya et al., 2016; Runting et al., 2017), with very few focusing on dryland ecosystem assessment. The main emphasis in this approach is on the human benefits of ecosystem services. Gaining "*benefit of ecosystem services*" (MEA, 2005, p. 3), such as pastureland provision or water supply, can change due to socio-economic and environmental factors.

Climate change, as a global environmental driver, affects the benefits, their continued availability and sustenance, and distribution from ecosystems (Díaz et al., 2015). Climate change impacts on most ecosystem services negatively, and this will continue as climate change worsens (Nelson et al., 2013; Runting et al., 2017; Scholes, 2016). Because of the high level of uncertainty and the fact that it is a long-term process, it is difficult to assess the impact of climate change on ecosystem services. It is likely that there will be a decline in current and

projected supply of ecosystem services as a result of climate change, and a worsening of the relationship between the projected supply capacity and projected future demand (Scholes, 2016). Therefore, climate change will likely put at risk many of benefits humans derive from ecosystem services such as land and water (Pedrono et al., 2016). Thus, Marin (2010) states that using local observations recorded by nature-dependent people would be helpful to reduce the uncertainty of climate change predictions and improve ecosystem services assessment at a local level by obtaining detailed and specific knowledge of the area. Costanza et al. (2011) suggest that we need to improve our understanding of ecosystem services and how they will be affected by climate change, and that stakeholders should be active collaborators to assure relevance in local contexts. There is a need to protect ecosystems and resources within the changing climate, and study of the impacts on ecosystem services resulting from interactions between climate change and other factors is essential for understanding the complexities of these impacts (Runting et al., 2017).

As stated in the "Millennium Ecosystem Assessment" (MEA, 2005), the current trend of climate change impacts is increasing very rapidly in the temperate grassland of the drylands. The United Nations Intergovernmental Panel on Climate Change (IPCC) report of 2014 advises that global mean surface temperature change "will likely be in the range of 0.3°C to 0.7°C" (IPCC, 2014b) for the next 20 years. The predicted rise in temperature is expected to increase potential evapotranspiration rates in drylands (White & Nackoney, 2003) and the regions already experiencing water stress will experience even greater water scarcity (Practice, 2016). On a continental scale, the warming trend will continue in Asia. The impact of climate change on ecosystem services is likely to be disproportionate for developing countries (Runting et al., 2017), and it is most likely to be uneven for local livelihoods. However, there are areas of the interior and at high latitudes where the monitoring coverage of key variables is insufficient in continental Asia for the assessment of climate change impacts (Barros et al., 2014). People who depend heavily on nature for their livelihoods have well-developed knowledge and practices on weather and climate variability, and climate change. Their knowledge and life experience support understanding of these complex systems in data scare conditions. Again, case studies of local climate change indicators are very rare in temperate drylands (Reyes-García et al., 2016) and further research is needed to examine the relationship between the impacts of climate change on ecosystems and ecosystem services, and how changes affect local people and their livelihoods (e.g., the livelihoods of nomadic herders) in drylands.

To understand the sensitivity of drylands and explore their vulnerabilities to climate change in a developing country context, Mongolia was chosen as the focus of this case study. Mongolia is one of 14 countries that have more than one million square kilometers of drylands (White & Nackoney, 2003). Its continental climate is temperate and very arid (Goodall, Perry, & Howes, 1979) with clear seasonal precipitation patterns and high seasonal and daily temperature variations. The annual mean temperature in Mongolia has increased by 2.14°C over the last 70 years (MARCC, 2009) and the country is highly vulnerable to climate change impacts due to its geographical location, arid zone ecosystems and the nature of human livelihoods (MARCC, 2014). As stated in the "*Mongolia - Second Assessment Report on Climate Change 2014"* (MARCC, 2014) climate change has negative impacts on local livelihoods and ecosystems. Mongolian nomadic herders' knowledge and practices of natural resources usage and communication has continued for at least 3000 years (D Bazargur, 1998). Thus, an understanding of the perceptions and practices of nomadic herders in the context of climate change would be useful for maintaining livelihoods and preserving ecosystem services, as weather observation and interpretation and climate prediction are part of the traditional ecological knowledge (TEK) (Marin, 2010).

In the face of current and projected climate changes, various concepts and approaches have emerged to support adaptation decision making. The ecosystem services approach is potentially a constructive concept in guiding adaptation that focuses on local communities where livelihoods are directly dependent on nature, however, there is little experience of applying such an approach in local, data-scarce conditions. There is also a challenge as to how local knowledge is integrated with other forms of knowledge to gain an understanding of adaptation. The fundamental challenge is to understand the dynamics of ecosystem services and human well-being as they interact from local to global scales in the context of multiple changing drivers (Carpenter et al., 2009), such as changing pattern of land use, water consumption, economic priorities etc. To investigate the complex process and links between climate change, ecosystem services and livelihoods at a local scale, using TEK approach is potentially helpful.

Even though, the term has been used since the 1980s to address natural conservation issues, as Berkes (1999) states, the practice of traditional ecological knowledge is as old as ancient hunter-gatherer culture. In the last two decades, some indigenous studies have shown that an ecosystem services approach can undermine traditional knowledge, and in particular, traditional ways of sustaining ecosystems (e.g. giving respect for the place a central role in decision making) (Gómez-Baggethun et al., 2013). Leonard et al. (2013) highlight the need for planners and

decision makers to understand indigenous knowledge and value systems to negotiate appropriate and equitable strategies for responding to changes in the environment. Bhatta et al. (2015) suggest that using local people's adaptation strategies to increase benefit of ecosystem services is appropriate as local farmers have long been practicing valuable and reliable strategies to deal with climate change impacts. Nevertheless, ecosystem services assessment in dryland ecosystem is very rare due to the lack of data (Lu, Wang, Ning, Yu, & Fu, 2018) and case studies in Asia are very limited. Like other locally based studies in the different regions, nomadic herders' livelihoods are very highly dependent on the provision of ecosystem services.

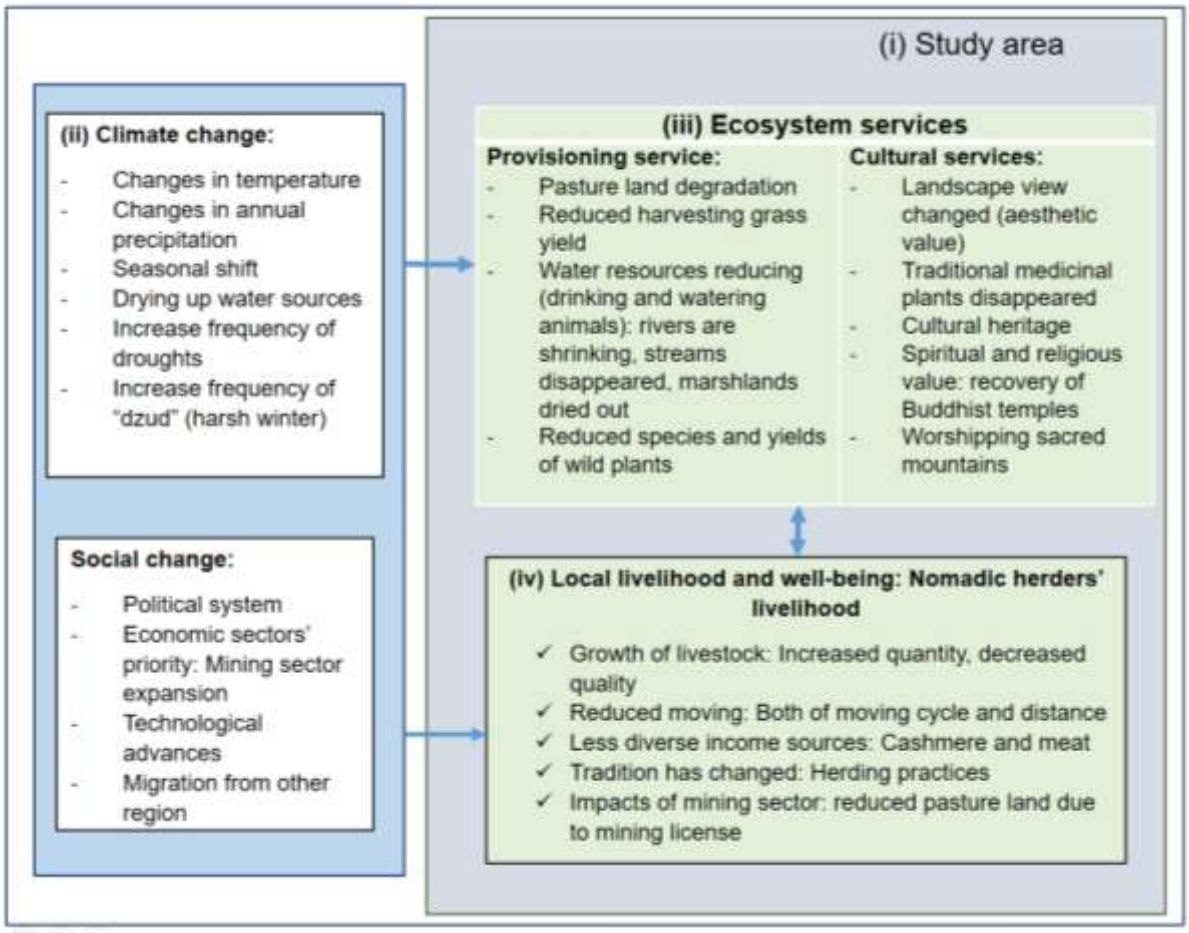

Figure 4.1. A simplified conceptual framework illustrates how climate change impacts on ecosystem services and local livelihood. This framework is used to structure the paper, shown in the order of the roman numerals

However, there is insufficient study of the impacts of the changing environment on the traditional culture and the livelihoods of nomadic herders, specifically on the traditional knowledge of ecosystem services. The challenge is in exploring the ecosystem services benefits associated with climate change at a local level, particularly in the case of nomadic livelihoods, which have a high dependence on natural and climate conditions. Nomadic herders' beliefs and

the spiritual components of traditional knowledge are important to understand the ecosystem services in the case of nomadic livelihoods. Thus, this paper aims to investigate how local livelihoods are changing and how climate change is influential in this process through a focus on the changing provision of ecosystem services.

Figure 4.1 presents the interrelations of nomadic herders' livelihoods and pastureland ecosystems as linked by ecosystem services, which are defined as "*the benefits people obtain from ecosystems to sustain or advance wellbeing"* (MEA, 2005). This framework was used to investigate climate change impacts at a local scale. Mongolian herders provide a case where: (i) local livelihoods are highly dependent on environmental conditions and natural resources, and, as with other natural resource-dependent communities, have their own experience and knowledge of nature and its services derived from their local use and management of pasture and water. There are dramatic increases in pressure on pastoral ecosystems occurring from both climate changes, livestock growth and wider-scale development changes (such as the expansion of mining) in Mongolia. In this article, we explore how local herders perceive and understand the interactive nature of local livelihoods and ecosystem services under changing conditions in Northeastern Mongolia. The results are structured to reflect (ii) climate change impacts on (iii) the benefits of ecosystem services and (iv) the livelihoods of nomadic herders in Northeast Mongolia.

4.2. Study area

The research study was conducted in Northeast Mongolia. The main location of the case study was the Ulz River Basin (Figure 4.2) which represents the ecosystems of forest-steppe and steppe of Northeast Mongolia, and covers approximately 38,000 km^2 area (MEGD, 2013).

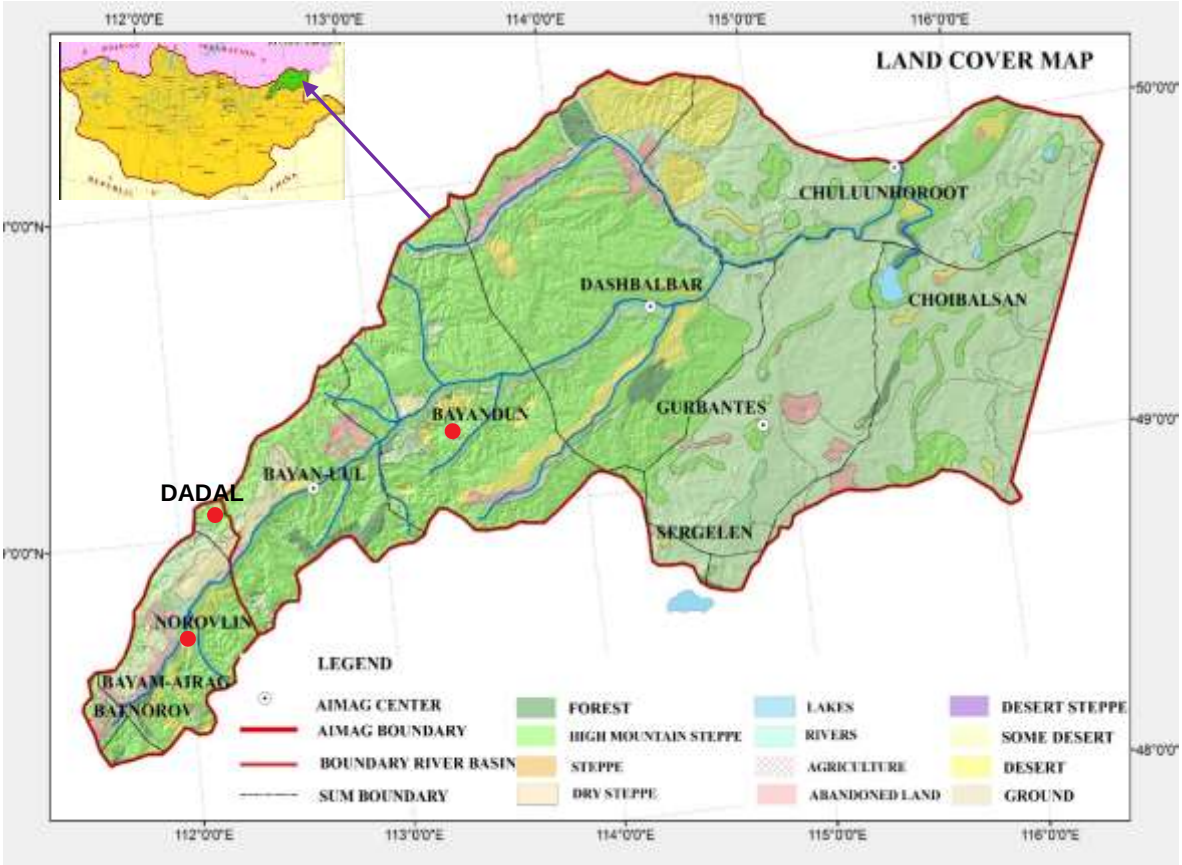

Figure 4.2. Case study area: Ulz River Basin
(Source: Ulz River Basin Integrated Management Plan 2014-2021)

Aiming to explore climate change impacts on ecosystem services in the context of nomadic livelihoods, the three case study areas chosen were three *soums* (village districts) in two provinces along the river basin. A "*soum*" ("сум" in Mongolian), or district, is the second level administrative subdivision in Mongolia. The three that are the focus of this research each have approximately 2000-5000 inhabitants, primarily nomadic herders. Animal husbandry has always been the main productive activity for most of Mongolia's population; at present, 42.3 percent of all households in these three *soums* are nomadic families (Table 4.1).

Table 4.1. Population dynamics of case study soums, in 2019

Province/Soum	Total population	Number of herders	Total households	Number of herder households
Dornod/Bayandun	3094	715	868	400
Khentii/Dadal	3057	534	933	330
Khentii/Norovlin	2596	623	747	350

Data source: Mongolian National Statistics Commission www.1212.mn

The natural and climatic conditions of river basin are most suitable for grazing cattle, raising horses and sheep herding. The composition of livestock herds has been established by adaptation to prevailing conditions for hundreds of years and differs from soum to soum depending on natural conditions. For instance, a herd structure of "sheep-goat-cattle-horse" is common for Bayandun, whereas a structure of "sheep-goat-horse-cattle" is better suited to Norovlin soum (D Bazargur, 1998), where the sequence in the structure indicates which animals are most to least abundant in the herds. Like other soums of Mongolia, these three were former *negdel* or "pastoral cooperatives" until 1990. During the *negdel* period, private ownership of livestock was restricted, the private property of land abolished, and all products owned by the State. Although traditional nomadic herders became paid herders, they kept traditional herding knowledge and skills during the *negdel* period. In 1990, a transition toward a free-market economy began, with the subsequent liberalization of the livestock economy. In 1991-1992, state-owned livestock was privatized to *negdel* members. Although nomadic herders privately hold livestock, they still use and share free common pool resources (notably pastureland and water). After privatization, the livestock numbers have increased tremendously in the case study area and generally in the country.

4.3. Methods

The nomadic herders' knowledge and perception of climate change and ecosystem services were sampled in fieldwork conducted in three soums of Ulz River Basin area, between June and July 2018. To gather information on (i) herders' perception of climate change, (ii) their knowledge of climate change, and (iii) changes to practices that they have made, semi-structured and open-ended interviews (Bernard, 2011) with local herders (n=15) were conducted. Herder (H) interviews are quoted in the order of the interview in the results section. Interview questions focused on five broad themes: household, livestock, herders' movements, pasture and natural resource issues, and traditional culture. All interviews were face-to-face and were conducted over 1.5 to two hours.The interviews indicated that ecosystem services were derived from local use and management of pasture and water, and so the study focused particularly on provisioning services from the pastureland ecosystems and water resources (appendix 3).

We also interviewed staff of local municipal authorities, the river basin authority, administration of the national park and business owners (n=10) to gather background information. Key informants (KI) were coded by the order of interviews. The interviewees were asked to document i) local livelihood and natural resources usage, ii) climate change and

adaptation practices at a local level, and iii) local herders' participation in natural resources management and decision making.

Three focus group discussions were conducted to identify local people's perceptions of ecosystem services and the benefits provided by nature to assess trends in local ecosystem services' and benefits' provisioning over time (appendix 4). We also aimed to understand the link between nature and environmental services and grassland cover from the perspectives of local citizens. Each focus group took about three hours. The first was held with eight residents of Bayandun *soum*, including river basin authority officers; the second was with six nomadic herders from the Mogoit Riverside area of Norovlin *soum*; and the third was with six residents of Dadal *soum*, including national park rangers.

Interviews and focus groups were conducted in Mongolian and all interviews were digitally recorded with the permission of the participants. The recordings were transcribed and then translated into English. Data analysis strategy was inductive, with the goal of identifying emerging patterns and themes in the data (Bernard, 2011; Ezzy, 2002). The interview transcripts were coded using NVivo 12 qualitative data analysis software.

Initially, it was planned to start the interviews by questioning the herders about household issues, however in practice, the interviews began with discussions about climate and weather conditions in their *soum* area. This reflects the Mongolian traditional greeting custom which tends to focus on the climate and weather. When meeting someone, nomadic Mongolians ask "how is the winter place?" (*uvuljuu tablag uu*), or "how is summer? (*saikhan zusaj baina uu*) depending on the season. For Mongolians, questions about the season are much like "how are you?" for other nationalities. Our interviews were conducted in June and July, so inquiries such as "how is the summer starting?" or "how was the spring?" were followed by discussion relating to substantive climate change and livelihood issues. These general discussions about climate and environmental change guided us to explore how the changes are impacting on livestock growth and livelihoods. Herders' observations were at three resolutions: "*khot ail*" (herder families), "*saakhalt ail"* (neighbours-including themselves) and "*neg gol usniikhan*" (one riverside area). The *khot ail* is still the most important social basis of nomadic animal husbandry (Tserendash.S, 2017) and has existed as a socio-economic unit even prior to 1206 when the Mongolian Empire was established (Damdinsuren, 1957). A hierarchy of informal social networks and institutions including the *khot ail* (a network of households sharing resources within a particular region) and *neg goliinhon* (people from one river area) have formed the basis

of the traditional Mongolian nomadic pastoral system (Bazargür et al., 1993). These networks based their livestock management and spatial sharing of key resources through consideration of common seasonal camping areas, grassland and water sources. This system of social organization has served as a regulatory function for land use management and as a mechanism amongst the herders to provide safeguards against natural hazards (Bazargür et al., 1993) which still survives in modern Mongolia. Although modern nomadic livelihood and custom have changed considerably because of political and economic changes and shifts, these original societal units still exist and influence the country's socio-economic development.

In addition, meteorological observational data comprising monthly maximum and minimum temperatures and precipitation data from the Bayandun and Norovlin meteorological posts were used to make a comparison with local herders' perception and knowledge. Socio-economic data, such as demography and animal husbandry were generated from the Mongolian National Statistical Commission annual reports[9] and data from local municipalities were used to clarify the primary data and explore the evidence.

4.4. Results

4.4.1. Herders perceptions of climate and weather: Worseníng and changing?

Herders' high dependence on weather and natural conditions leads nomadic herders to observe and record the characteristics of climate and other environmental variables. All respondents agreed that weather and environmental conditions had changed significantly in the area of case studies over at least the past two decades. Our discussions started by wondering why this summer was coming so late and continued to how dry the last winter was. The interviewees highlighted that until last March there was no snow at all in the region. This means that 'black dzud[10]' had occurred in the winter, as Mongolians call it. According to the informants, the weather becomes more "unstable and unpredictable" with "less and late rainfall", "less hot summer days", and having long "cold and windy spring days".

The topography of the Ulz river basin, like elsewhere in Eastern Mongolia, is characterized by mountain forest steppe and wide valleys in the Dornod steppe. Winter is wet and cold, while

[9] www.1212.mn
[10] A zud or dzud (Mongolian: зуд) is a Mongolian term for a severe winter in which large numbers of livestock die, primarily due to starvation, being unable to graze, or in other cases directly from the cold. "White dzud" happens due to heavy snowfall. "Black dzud "results from a lack of snow in the pastureland.

summer is cooler over the upper part of the river and drier and warmer in the steppe area. It also has characteristics of a transition zone from Khan Khentii Mountain, which varies from a wet and cooler climate to a drier and warmer climate (Jambaajamts, 1989). The average annual temperature ranges from -0.2°C to +1.5°C, but in the coldest month varies from -20°C to -22°C in the basin. During winter and spring, it is chilly and harsh, and the minimum temperature overnight is 38° to -40°C in January. In summer, the average air temperature is 18° to 20°C, and the maximum temperature is +38 to +39°C (Dorjgotov, 2009). Annual precipitation ranges from 230 mm to 350 mm, which is higher than in other parts of the eastern mountain steppe (MEGD, 2013).

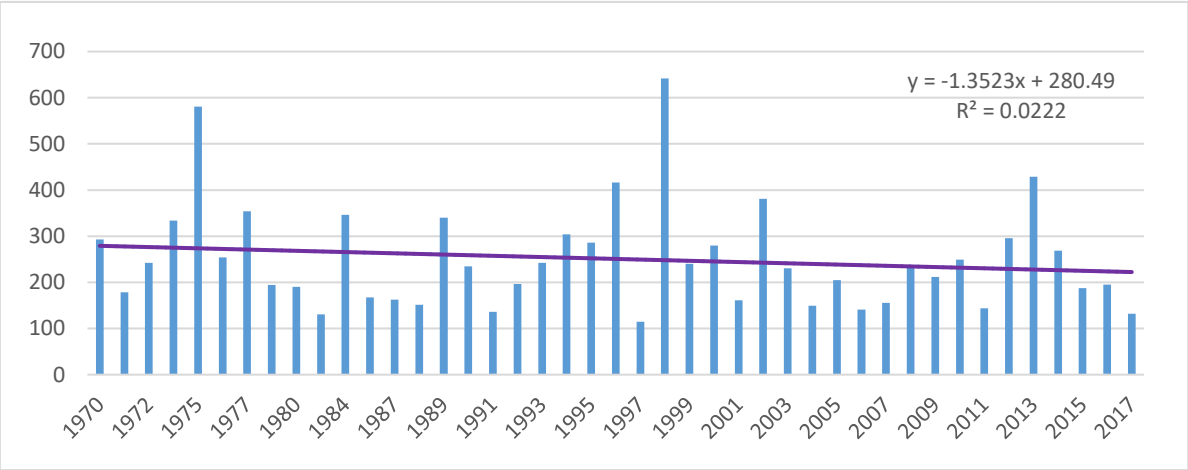

Figure 4.3. Annual mean precipitation, mm, 1970 - 2017. Bayandun soum, Dornod aimag
Trend line is computed by linear regression.
(Data source: Institute of Meteorology and Hydrology, Mongolia)

According to informants, the amount of precipitation is decreasing, and the timing of precipitation is changing in the case study area. As presented at the "Mongolian National Atlas" (Dorjgotov, 2009), the lowest monthly average precipitation (1-2 mm) is in January, and the highest (64-80 mm) is in July in Northeast Mongolia. Meteorological data indicates that the annual mean precipitation decreased significantly in the period 1970-2017 (Figure 4.3). All informants talked about the seasonal changes, as summarized by a senior herder man in this description:

> *How nice [and] rainy was the summer. We haven't had continual warm rainy days in recent years. At present it is so dry and windy. Autumn was pleasantly warm. Now it is getting windier just like spring. Winter is shortening and not so cold. The spring is becoming longer and windier (H1, Bayandun).*

Thus, the herders suggest that the seasons have changed, and a seasonal shift has occurred. We must note that the herders' conversation about the seasons refers to the traditional Mongolian calendar (based on a lunar calendar), which identifies auspicious or symbolic dates for nomadic activities (e.g. celebrating special occasions, moving, shearing, harvesting, worshipping). Rainfall between mid-May to mid-June is essential to support plant growth in Mongolia. Late rainfall with a short plant growth period is an indicator of a short summer, according to herders. The variations herders have experienced in the *timing* of precipitation has been more important for their livelihoods than the variations they have experienced in the total rainfall. Further, according to herders, the number of warm rainy days in July and August is decreasing. Overall, winter is getting warmer, but familiar summer weather is happening over a shorter period. Autumn and spring seasons are becoming dominant. At the beginning of autumn, it is cooler, and autumn becomes colder and windy by the end of the season. In spring, it is windy and stormy and becomes dry by the end of the season so that cold and stormy spring days with scarce pasture are extended.

Herders and key informants claimed that the main reason for precipitation and seasonal changes is a gradual temperature increase and/or climate change in the area of the case study, although, some informants also believe that human intervention contributes greatly to the instability of the weather. The nomadic herders believe themselves to be constantly ''under the sky power'' with the support of "mother earth*",* and "the realization that nature in general and weather, in particular, control their lives is ubiquitous and explicitly formulated" (Marin, 2010). For Mongolians, who talk about "blue sky" as father and "the earth" as mother, "the land is controlled by governing spirits (masters of the land) who have the power to bestow good weather or if angered, drought and pestilence" (Humphrey, 1995). So, nomads believe that humans need to be respectful to nature, otherwise it will 'pay back'. For instance, herders consider that cloud seeding and mining have negative impacts on weather patterns. Since 2006, experiments on cloud seeding have been actively conducted in the country. According to the herders, cloud seeding has made the weather more unpredictable and unstable, and this has an impact on traditional weather forecasting methods and practices:

> *Because of cloud seeding, traditional weather prediction methods no longer work. We can predict weather if clouds appear naturally. Furthermore, cloud seeding has produced unstable and unpredictable weather conditions like heavy snow fall last winter and no snow at all this winter (H1, Norovlin).*

Following the discussion on climate change, the informants identified key issues that have affected their livelihoods and ecosystem services, including water scarcity and degradation of pasture lands.

4.4.2. Declining ecosystem services benefits

Interviews and focus group discussions gave an opportunity to outline trends in natural resources over the past three decades (Table 4.2).

Table 4.2. The trend of benefits from the ecosystems services according to the herders' perception

Before 1990s	2000s	The current situation
Water: The river was so deep. Average depth was up to the waist. We couldn't go to the other side by motorcycle. Many small rivers and streams were run into Ulz river. There were many types of fish.	Small rivers and streams started drying out Getting fewer fishes	The river is not so deep now. Average depth is up to knees or less. So, we can go to other side by motorcycles. Hard to fish. Most species of fish disappeared.
Forest: It was easy to collect plenty of birch sap (The people who live in the forest area used to harvest once a year at the beginning of spring for healing purpose). There was forest fire, but little evidence registered. Less forest diseases and insects.	A lot of evidence of forest fires. Forest disease spreading.	It is so hard to collect the birch sap. Birch is drying. Larches are getting dryer and smaller. Tree groves are disappearing Diseases of trees and insects spreading and intensively increased
Harvesting: Distance: Enough grasses had grown around the winter place to harvest Quantity: Used to prepare 80 haycocks from one hectare	It was getting harder to harvest near the winter place, so we had traveled 10 km far from the winter place. 60 haycocks from one-hectare area	Need to travel further to find harvesting place, approx. 30-40 km. 40 haycocks from one hectare
Color of landscape: Because of enough grasses, mountains were green Because of grass cover, land surface was not very hot	Because of intensive and frequent forest and steppe fire, mountains were grey dark	Land is getting drier. Less grass, so mountains are reddish now.

It seems that there were few concerns regarding environmental change in the case study area until the late 1990s. This is not only the herders' memories; the literature also suggests that

"environmental degradation does not seem to be a problem" (Neupert, 1999) and "pasture land degradation is not yet widespread" (Humphrey et al., 1999) in Mongolia at this time. Elders remember that the weather was pleasant and humid between 1984 and 1996. Long and prolonged rainy days lasted for three to four days, even a whole week. According to them:

> *Since 1998, rain has reduced. We haven't had such pleasant warm continual/widespread rain in the last decade. The natural environment has changed dramatically over the past 20 years" (H3, Bayandun).*

More than 90% of annual precipitation in the entire country falls between April and September during the warm season. Figure 4.3 supports the accurateness of herders' perceptions. The mean annual precipitation in Bayandun *soum* during the study period (1970-2017) was 243.0 mm. The maximum amount of recorded precipitation was 642.1 mm (in 1998, the wettest year) and 67.2 mm (in 1986, the driest year), respectively. 1984 was the year of highest rainfall between 1970-1990, and the highest amount of precipitation in the last three decades was recorded in 1998. Mongolians then faced extreme droughts in the subsequent two summers (MARCC, 2009).

Table 4.3. Linear regression result (warm season and annual precipitation) (1970-2017)

	Change in rainfall (mm/year)	% of total precipitation
April	0.171	2.7
May	0.446	8
June	0.804	19.2
July	-2.512	31.1
August	-2.088	20.4
September	-0.019	10.3
Annual	-1.352	100

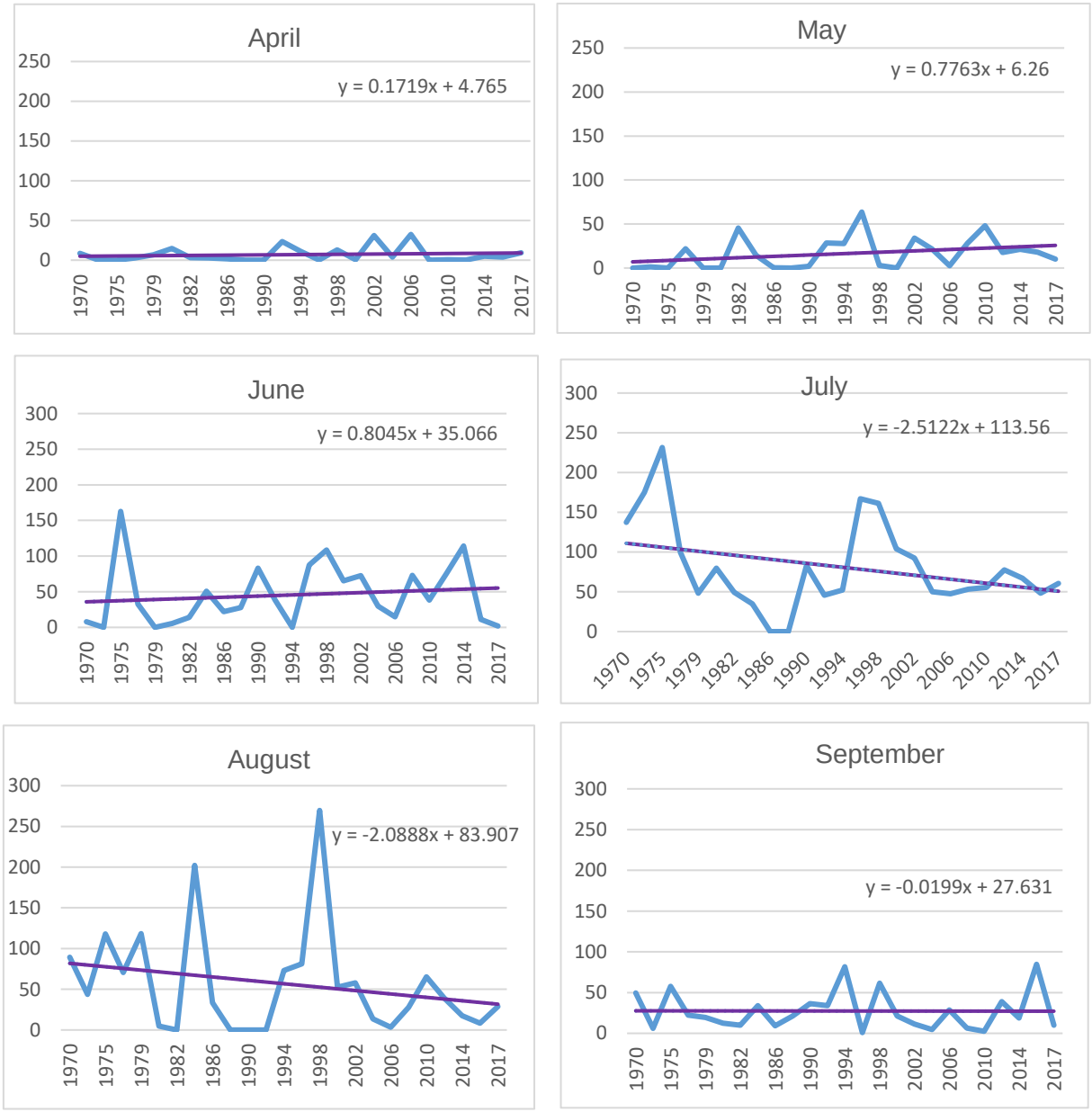

Figure 4.4. Warm season precipitation, mm. Bayandun soum, Dornod aimag (1970-2017)
Trend line is computed by linear regression
(Data source: Institute of Meteorology and Hydrology, Mongolia)

July is the main month of rainfall in the case study area (31.1 percent of the total annual precipitation) and for the entire country (Jambaajamts, 1989). Figure 4.4 shows a decreasing trend in precipitation in July and August. The rate of change in precipitation is determined using a linear regression model (Table 4.3) which in this case is approximately -1.352 mm/year, -2.512 mm/year, -2.088 mm/year, -0.019 mm/year for annual, July, August and September, respectively. Although the precipitation trend in other months indicates that the amount of precipitation has not changed much or has increased slightly, this is less than the decrease in precipitation in July and August (which accounts for more than 50 percent of the total annual

precipitation). Therefore, variations in precipitation quantity, intensity and distribution can have a significant impact on the natural environment and local livelihoods. The changes are uneven across the seasons and that livelihoods are sensitive to extreme changes at particular times of the year. Due to the short summer period, any slight changes in precipitation quantity and distribution may require changes to herding practices and other livelihood needs. Because of their nomadic livelihoods, herders spend most of the daytime outside, and their herding practices lead them to observe nature and weather closely. This may enable them to remember the exact time of extreme events well, such as heavy rains, strong winds or drought.

All key informants identified that the main problem of their local area is water shortages. Surface waters have dried up as a result of climate change and other anthropogenic factors. Ulz is the only big river in Norovlin and Bayandun *soum*, and most of the Ulz River Basin is open steppe. In recent years, the basin has become drier (Tugjamba, Sereeter, & Gonchigjav, 2014). Residents believe that climate change and the mining sector are having a negative impact on water resources. According to them, the streams have disappeared, and the river flow has decreased, while the mining sector has been booming. Climate change modelling shows that the discharge of the Ulz River will decrease by 5.4% by 2030, assuming an increase in the average temperature of 2.1^{o}C (Davaa G., 2014). As presented in the recent report of the Ministry of Environment and Green Development (MEGD, 2013), the average annual temperature in the Ulz River basin has increased by an average of 1.3^{o}C over the period 1976-2011. In summer especially, temperatures have increased greatly, by 2.8^{o}C. In contrast, winter temperatures have decreased slightly by -0.4^{o}C. An increase in the amplitude of the annual temperature variation implies the likelihood of extreme climatic events associated with surface air temperature (D Dagvadorj, Batjargal, & Natsagdorj, 2014). As air temperatures rise, potential evaporation is definitely increasing. Climate change is already impacting the water regime in the basin.

Since the early 1990s, evidence of forest and steppe fires in Mongolia as a result of illegal hunting and other activities has increased (Zahler et al., 2004); 95 percent of forest fires were caused by human activities (Nasanbat & Lkhamjav, 2016). And human-caused forest and steppe fires were becoming the main disaster in Mongolia by the 2000s. Northeast Mongolia was the main region of intense and frequent forest and grassland fires (Farukh, Hayasaka, & Mishigdorj, 2009). As a result, forest cover reduced, and the color of the landscape has changed over the past 20 years. Together with logging, the disappearance of forest cover, which protected soil moisture, has impacted on soil water-holding capacity and contributes to environmental dryness. This is supported by a key informant's opinion that *"the forest cover of the mountain*

valley in which I grew up has completely disappeared", adding "*And, frequent forest fires lead to water scarcity*" (KI2).

Focus group discussions and trend analysis indicate a change in both harvest timing and yield. The herders claim that the distribution and abundance of plants on pastures has changed due to aridity and intensive herding and the plant growing season has changed due to less or late rainfall. Then, harvesting times and practices changed. In addition, herders noted a decrease in the yield of vegetation and plant species. Some useful plants for cattle breeding and medicinal plants have already disappeared, and less useful plants have grown. A herder man explained that

> *A number of plant species that had grown in the mountain and riverside area have disappeared. The grass "Ulun", which used to grow up to horse saddle stirrup*[11]*, hasn't appeared in recent years*" *(H1, Dadal).*

Human activities also have a great impact on plant growth. A senior herder man explained

> *We cannot say that pastures have degraded only because of climate change. Changes in human attitudes have also played a major role in degradation. We used to harvest grass after the plants' seeds dispersed. Now, people have harvested before the grasses have blown the seeds. Yet people are saying that plants are disappearing because of climate change. (H3, Norovlin).*

In addition, the herders' harvesting practices indicate a decrease in harvesting yields. In the case study area, it was previously common practice to harvest near the winter place. At present the herders need to travel far to find the proper area with enough grass to harvest, and the yield per hectare has significantly decreased. In the 1990s, the herders used to harvest approximately 80 haycocks per hectare, but in recent years, they have harvested a maximum of 40 haycocks per hectare.

Taken together, the above evidence and the following results show that there is a link between climate change and the benefits of ecosystem services. Over the past two decades, the benefits of forest-steppe and steppe ecosystems have declined dramatically. If the decline continues, local herders, who depend heavily on natural resources for their livelihoods, will face challenges in maintaining their livelihoods.

[11] "Grass grows up to horse saddle stirrup- Mongolian expression of how that grassland is plant-rich

4.4.3. Rising water scarcity and pastureland degradation

Surface water is the main source for drinking and watering herders' livestock in the case study area. Using wells for watering animals during the warm season is not a common practice there. Thus, most of the herder families live along the Ulz River, preferably close to the *soum* center in the summer. The key informants describe that following low summer rainfall and water shortages, pastureland degradation has intensified along the river because of overgrazing.

Mogoit riverside area, Norovlin soum, Khentii aimag, Mongolia.

Focus group participants from *Mogoit* riverside area produced the local map. Google map illustrates the landscape of the *Mogoit* river valley.

Eight herder families settle here during the summer. "*Our livelihood depends on water. So, along this small stream, around 10,000 head of livestock graze. The migrants' livestock has contributed to the pastureland degradation more than the livestock of herders from the local soum.*" (*H4, Norovlin*).

"*To choose the settling place: water source and sufficient grass for grazing are vital needs. And open*

Figure 4.5. Herder families from one riverside area (neg goliinkhon)

Figure 4.5 was was produced by a focus group of local herders in Norovlin *soum.* They described the Mogoit riverside area, which is one of the main tributaries of the Ulz. The water flow of Mogoit has been reduced year by year and now it does not flow into the Ulz River. Figure 4.5 presents two important points. The google map satellite view illustrates the narrow landscape of the Mogoit river valley, where six to eight herder families with some 10,000 livestock live along the river in the summer. The hand drawn map beneath conveys an idea of the main herding areas in the soum. The continuous and non-continuous curved blue lines represent the rivers and streams in Norovlin *soum*. The largest part of the soum territory has no surface water.

The situation is the same in Bayandun *soum*. Overgrazing has intensified because of the reduction in water resources. A herder woman stated that

> *four to five families, with more than 2,000 heads of livestock, depend on that small stream. Streamflow runs only 100 m. Because of herding and living around the stream intensively, pasture land has degraded. Obviously, we would like to move further away, but there is no more water in the more distant area (H4, Bayandun).*

As herders described that *"If there is no water, it does not matter how beautiful is a grassland, it is not a pastureland*".

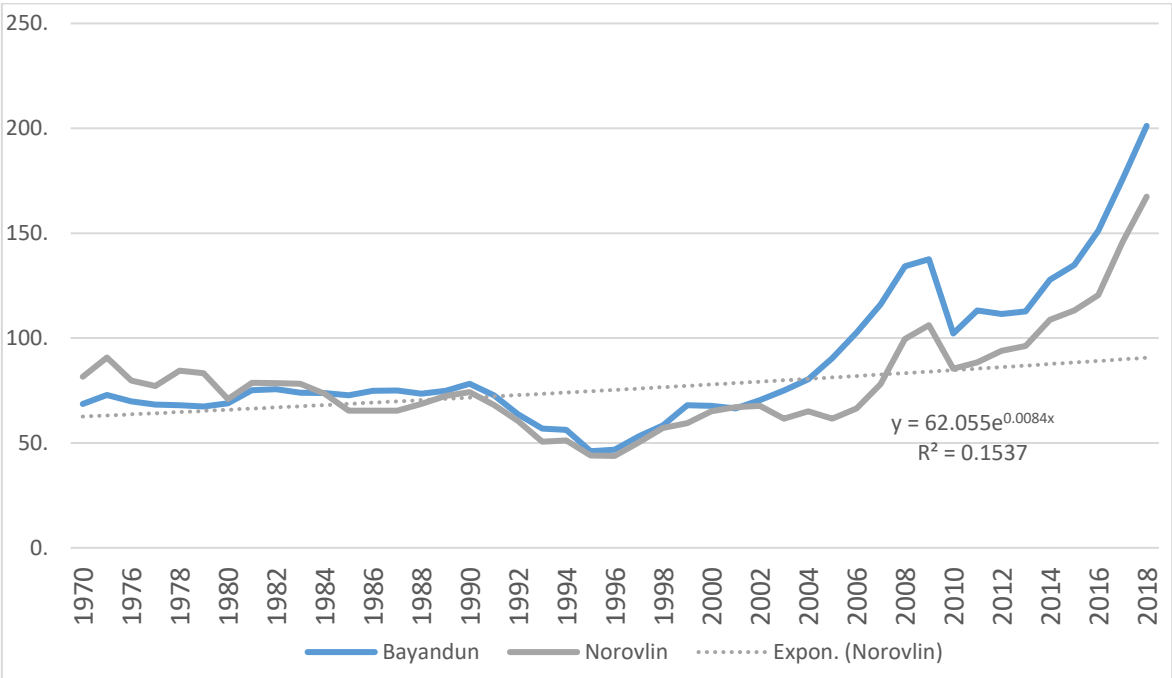

Figure 4.6. Livestock growth dynamics in Norovlin and Bayandun soum, between 1970-2018 (per thousand) (Source: National Statistical Commission reports, Mongolia)

Pastureland degradation has intensified along the Ulz River over the last 20 years. The informants perceived that two main factors influence pastureland degradation. The first is natural; because rain falls intensively in a short time, much of the rainwater runs off before infiltrating into the soil and produces temporary intensive runoff which erodes the soil surface, and produces a hard clay layer, further reducing infiltration. The second is related to human activity; staying longer in the same place with large livestock herds has led to degraded pastureland along riverside areas (Figure 4.6). Meanwhile, natural disasters have played a major role in growth dynamics in the country. The summer of 1999 was extremely dry and severe drought occurred in more than 60 percent of Mongolian territory, followed by the "*dzud*" in 2000. The following summer was extremely hot, and Ulz River Basin was one part of the affected area. Figure 4.6 shows the growth of livestock numbers in the case study area in the period 1970-2018. As has been well documented, in 2000 Mongolians experienced the worst winter of the last 30 years. Livestock loss and socio-economic damage was very large. Herders who had lost their life support sources moved to the city. National statistics show that this severe event was followed by the largest migration from the countryside to the city in Mongolian history. Also, in 2009-2010, the total number of livestock in the basin territory decreased by 23 percent because of the severe weather conditions (MEGD, 2013). However, the population of livestock recovered, and the livestock population is now about double that of 1990 in the case study area, and generally in Mongolia.

Traditionally, nomadic herders moved at least four times per year. As herders informed, currently, herders move two to three times per year. Reduced mobility is becoming a major factor in pastureland degradation in the case study area. In Northeast Mongolia, the herders' movement radius formerly ranged from between 25 to 50 km from a particular camp, and this distance was measured by the distance a horse could travel in a day (D Bazargur, 1998). Interviews and FGDs results show that it is currently limited to 10 km (to gain access to water and mobile phone coverage etc.) in the case study area. Significantly, the herders' preference to stay longer along the river or lakes influences soil degradation. Less movement reduces the possibility of restoring soil fertility. Herders explained the reason for the reduced movement as being that

> *Most of the herders prefer to stay close to the Ulz River because of water needs. Also, some of them have needs to live close to the soum center. If it is far from the center, there is no mobile network" (KI5).*

The traditional practice of herding has changed substantially in a short period of time. The largest change is the reduction in the range of the herders' movement and the number of movement cycles. Being nomadic means moving in search of the best pastures and campsites (Yembuu, 2016). The nomadic herders' traditional movement was "an important role in ensuring the sustainability of the future" (Humphrey et al., 1999). With the transition from a communist to a market based economic system in 1991-1992, Mongolian nomadic herders "became, once again, entirely responsible for their own herd management decisions, as well as all production risks and inputs" (Fernandez-Gimenez, 2000). Since then, "*nobody has cared about the pasture land capacity, and everybody has acted like they are in competition to grow livestock*" (H2, *Dadal),* as one herder man put it. At present, reduced mobility is emerging as a major factor in soil degradation in the study area.

4.5. Discussion

The main goal of the study was to examine the impacts of climate change on local livelihoods and ecosystems and the importance of the ecosystem services approach in assessing the impacts on local livelihoods. The uncertainty of climate change impacts at a local scale is a high (Marin, 2010) and using the nomadic herders' knowledge and perception of climate change is helpful (Mijiddorj, Alexander, Samelius, Mishra, & Boldgiv, 2020) to assess climate change and its impacts on ecosystem services and local livelihoods. Understanding and maintaining the provision of ecosystem services and the capacity of the local environment to support livelihoods is "key to the sustainability of dryland pastoralism" (EMG, 2011). However, it must be acknowledged that the nomadic herders' perceptions and understanding of climate changes reflects a principal interest in the elements of the weather that influence pastureland and water resources which might be ignored or missed by others.

As other researchers have found (Akwetaireho & Getzner, 2010; Bhatta et al., 2015; Boafo et al., 2016; Cummings & Read, 2016; Leonard et al., 2013; Mijiddorj et al., 2020), our research results show that local case studies are crucial to understanding climate change impacts on ecosystem services and local livelihoods. The stories and responses of the herders, supported by meteorological data, suggest that nomads have recently experienced climate as more variable than in previous years, which is reflected in the increasing difference between maximum and minimum temperatures, and unexpected or unpredicted differences in warm and cold season precipitation. The frequency and intensity of the extremes, such as heavy rainfall, windstorms, dzud and drought have increased.

As herders observed, these changes intensified from 1998. The trend analysis of aridity indices[12] has shown that a significant increase in aridity has been observed in the steppe and dry steppe ecosystem over the period from 1961-2015, and the aridity level is likely to increase in Mongolia during the twenty-first century (Nyamtseren, Feng, & Deo, 2018). According to this assessment, the inflection point in Ulz Basin aridity (*Dashbalbar* station) occurred around 1998. This perhaps explains the suggestion by participants in the study that the weather was pleasant and humid in the period 1984-1996 and becoming dry from 1998.

The research findings demonstrate that climate change has had severe impacts on ecosystem services, particularly provisioning of grassland and water supply in the dryland area. Increasing temperature and temporal change of precipitation lead to an increase in potential evapotranspiration rates in the arid lands. These changes lead to changes of traditional livelihoods. Reduction of water resources in the case study area is the main issue impacting the herders' livelihood. Reduced provisioning of water resources leads to changes in the herders' seasonal migration patterns and their livelihoods. Because of water shortages and other socio-economic drivers, pastureland degradation has intensified along the rivers and streams, in most cases near the *soum* center. Moreover, anthropogenic factors have resulted in deforestation (forest fire), soil erosion (intensive herding) and deterioration of plant species (early harvesting). In turn, these have led to a change in the water regime in the case study area. Those changes may also influence whether nomadic herders' traditional institutions, such as the *khot ail* and *neg goliinhon* (people from one river area), continue over the long term.

Pastureland provides Mongolian herders with a number of ecosystem services. Pasture ecosystems supply forage needed for livestock production in the Mongolian steppe. In Northeast Mongolia, sandy soil with a light mechanical structure is dominant (Dorjgotov, 2009). Dry and windy climate conditions place approximately 90 percent of the country's pastureland under high risk of exposure to soil erosion, and human activities are accelerating the rate of degradation (Tsogtbaatar & Khudulmur, 2014). Moreover, unsustainable growth of livestock numbers is believed to be the main cause of pastureland degradation. Herders are also staying in the same place for longer. Intensive grazing obviously has a negative impact on ecosystem structure and function, but grazing impacts also depend on the type of livestock

[12] Aridity index (AI) is based on the ratio of annual precipitation (P) and potential evapotranspiration rates (UNEP, 2003)

(Maestre et al., 2016). The growth in livestock has led to a change in the herd structure of the livestock population in the study area and in the country.

Another serious issue is that climate change, according to Scholes (2016), has a negative impact on animal productivity and quality. Scholes' research was undertaken in southern Africa and we do not yet have enough data to assess this proposition for Mongolia, however pastureland degradation and water shortage may contribute to the reduction of the quality of animal husbandry in the case study area. Most informants advised that the animal live weight has reduced in recent years. A young herder man supported this claim:

> *There is a big difference between the live weight of the animals, compared with when I was a kid and at present. For instance, the live weight of sheep was 30-40 kg before, and is 20-25 kg at present; the weight of live cattle was 500-600kg, now 300-400kg (H5, Dadal).*

Pastureland-based dairy production is sensitive to environmental changes, especially heating (Thornton, 2010), however herders indicated that the reduced production was "*because of plant species changes; the milk yield of the cow is reduced a lot. Previously it was 5 litres per cow, now it is 2-3 litres per day*" (H3, *Bayandun).*

Another significant change that has influenced herder livelihoods relates to the emergence of significant new economic activity, most particularly mining that has placed increased demands on land and water in the northeast. Since 2005, mining has boomed throughout the country. Within a short period, in just 10 years, mining has become the main source of national income. A key informant held the view that "The government has issued too many exploration and exploitation licenses, and it is not controlled well. Herders do not like mining" (KI8). This is also linked to enforcement issues. Another key informant stated:

> *"The long-named law*[13] *is not being implemented. The Mineral Resources Authority has given exploration licenses to mining companies along the Ulz River. One mining company has blocked the flow of the Duch and is washing gold ore." (KI9, 10).*

The Duch is one of the main tributaries of the Ulz River. Most of the licensed mining sites in the case study area were previously pastureland. There is a total of 119 mineral licenses in the

[13] The Law of Mongolia on the Prohibition against Exploration and Mining in Headwater Areas, Protected Zones for Water Reserves and Forest Lands ("Prohibition Law"), which was approved by the Great *Khural* (Parliament) on 16 July 2009.

basin, of which 89 are for exploration and 30 are mining licenses. The area covered by mining and exploration licenses is 4,967 km^2, which is equivalent to 2% of the entire territory of Ulz river basin (MEGD, 2014). It is most likely that the area covered by mining licenses will increase in the near future, according to the key informants' information. The herders suggest that these influences on nature should be stopped: "*It is better to reduce mining and cloud seeding*". From their perspective, intensive mining has a huge negative impact on the natural environment and weather. More detailed research on mining impacts on water resources and on pastureland is needed. There is also a lack of research on the effect of cloud seeding on weather patterns and the consequences of cloud seeding on the environment and society is needed.

Finally, some research studies suggest that nomadic pastoralism will not be the major future form of land use, as a result of pastureland degradation and loss of ecosystem services, as well as socio-economic changes. However, recent research studies challenge this expectation (Fernandez-Gimenez & Allen-Diaz, 1999; Vetter, 2005). Seid, Kuhn, and Fikre (2016), arguing that rather than forsaking nomadic pastoralism, the regeneration of traditional knowledge and practices is essential to sustain pastoralists' livelihoods and ecosystem services. Humphrey et al. (1999) left open-ended the question, "The End of Nomadism?", however nomadic pastoralism remains the main livelihood in Mongolian society. Although the natural environment has changed due to climate and social changes, nomadic herders still herd sheep on horseback and pack up their yurts[14] to pursue better pastureland with sufficient water. Twenty years since Humphrey and others posed this question, nomadism is still vibrant.

Herders have used their traditional system of extensive pastoralism to sustain their livelihoods (Reading et al., 2010). Mongolia's vast grassland, where nomadic livelihoods have existed for more than 3000 years, has been facing pressure from the huge growth of livestock in the last two decades. Rapidly changing environmental and socioeconomic conditions might have driven the herders to disregard or lose their traditional knowledge and practice of regulating and conserving ecosystem services to sustain their livelihoods, as Boafo et al. (2016) suggest. Although all the interviewed herders said that they do not want to change or lose the traditional way of nomadic livelihoods. This "business as usual" approach may lead to the breakdown of common pool resources sharing (Dietz, Ostrom, & Stern, 2003). If common pool resources sharing and traditional management are to be maintained, several actions are needed. More detailed research on herders' traditional knowledge of ecosystem services is required to

[14] Yurt- *ger* (гэр-in Mongolia) - traditional house of Mongolian nomads. Yurt or *ger* means home or household.

understand nomadic livelihood's capacity for climate change adaptation at a local scale. Most notably, traditional ecological knowledge continues to play an important role in shaping nomadic herders' understanding of changes in pastureland ecosystem services in Northeast Mongolia. However, at present, the ecosystem services approach is still a scientific tool largely employed by experts to explore issues at national and regional scales, and has not yet been usefully employed as a decision-making tool at the local level.

4.6. Conclusions

The research results demonstrate that the benefits of ecosystem services are decreasing due to climate and social and economic changes in the case study area. Due to reduced nomadic movement and early harvesting, the amount of grass available to harvest for winter has significantly reduced. Herders now need to travel far to harvest enough hay, and the productivity of the average hectare has reduced. The tradition of sharing common pool resources means the 'first come, first served' principle also applies to grass harvesting. The findings suggest that these changes will be followed by the risk of reducing quality of livestock and dairy products, as has occurred so far.

The case study provides an opportunity to investigate how the use of ecosystem services thinking alongside engaging with traditional ecological knowledge can work. The study suggests that the ecosystem services approach can be helpful, if it properly engages with local knowledge, because traditional ecological knowledge provides a clear picture of how, for example, nomadic pastoralists assess the benefits gained from the ecosystems which they depend on. The critical issue is the interpretation and 'translation' at a local level; this requires a cultural understanding of the communities and their efforts to explore their circumstances. Investigating traditional knowledge of ecosystem services is important to building effective and appropriate adaptation pathways. Local communities and their knowledge should play a fundamental role in local decision making as they have essential knowledge of the surrounding environment, ecosystem services, and their usage.

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Chapter 5 (Paper 2): Under the guidance of the eternal blue sky: Cultural ecosystem services that support well-being in Mongolian pastureland

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In order to investigate the applicability of an ecosystem services approach in supporting local adaptation to climate change, it is necessary to understand the relationship between human well-being and ecosystems through a locally focused study of cultural ecosystem services. Based on the analysis in Chapter 4 (Paper 1), which highlights the need to analyse how climate change affects the non-material values of pastureland ecosystems, this chapter focuses on investigating the relationship between landscape and the well-being of Mongolian nomads, using a cultural-ecosystem-services lens. Drawing on a case study from Northeast Mongolia, the chapter shows that traditional ecological knowledge is an important factor in assessing those pastureland cultural ecosystem services associated with local well-being in Mongolia. Initially, the CICES list was used to compose a list of cultural ecosystem services on pasturelands. Herders identified non-material benefits from the pasturelands, such as historical and cultural heritage, the sacred and symbolic values of nature, etc. The household survey illustrates the importance of the non-material values of the pasturelands to the well-being of nomads. Based on the results of interviews and the household survey, the chapter discusses the insights of the aesthetic values, enjoyment of plants and animals, cultural heritage values, the symbolic values of animals, horse culture, sacred and religious values, educational value, and scientific and other knowledge that supports nomadic well-being in Mongolian pasturelands.

The key contributions of this chapter are practical and methodological. The practical implication of the paper is that a cultural ecosystem services assessment that is identified by local stakeholders, for instance, nomadic herders in the case of Mongolia, is valuable in informing climate change adaptation planning at a local level. The study demonstrates that a mixed-method approach with local-community engagement is useful in assessing the non-material benefits of the landscape at a local level. The chapter emphasises the value of using a more holistic approach in assessing the non-material values of the landscape at the local level, where local livelihoods depend directly on nature and environmental dynamics, rather than using large-scale frameworks and classifications such as CICES.

Abstract

This paper investigates what 'cultural ecosystem services' are important for nomadic herders' well-being in Mongolian pasturelands, and how nomads' knowledge facilitates understanding of these cultural ecosystem services. Nomads' appreciation of cultural ecosystem services is an aspect of their local knowledge and practices. Interviews, focus group discussions, and a household survey were conducted in the case study area of northeastern Mongolia to understand what the main cultural ecosystem services that are relied upon at a local level are, and how people perceive their benefits. The key cultural ecosystem services supporting their well-being are historical and cultural heritage, sacred and religious landscape values, inspirational values of landscape and the symbolic and aesthetic meaning of the landscape. The paper contributes to debates regarding cultural ecosystem services assessment by addressing the importance of memories and perceptions of local communities and emphasises its importance for local decision making.

Keywords: *cultural ecosystem services, pastureland, local knowledge, nomads, well-being, Northeast Mongolia*

5.1. Introduction

An influential interdisciplinary discourse has developed around the ecosystem services approach, and the ecosystem services approach has become a platform for research and policy. The ecosystem services approach is a way of understanding the relationship between human well-being and ecosystems (Brendan Fisher et al., 2008), developed to define and assess the benefits people receive from ecosystems (Hirons et al., 2016) which the approach differentiates into provisioning services, regulating services, cultural services and supporting services (MEA, 2005; TEEB, 2010). However, rather less work has been done on cultural ecosystem services specifically particularly as a lens on landscape values (Chan, Guerry, et al., 2012; Grêt-Regamey et al., 2017; Runting et al., 2017), even though cultural ecosystem services make a crucial contribution to human well-being (Wangai, Burkhard, Kruse, & Müller, 2017). This relative neglect of the cultural values of ecosystems is partly due to the difficulties in characterizing intangible values (Tengberg et al., 2012). As defined in the "*Millennium Ecosystem Assessment*" (MEA, 2003, p. 58) report, cultural ecosystem services are "*the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences"*. Although the context and theory of integrating cultural values into the ecosystem services framework is well established on a large scale (Fish et al., 2016; Hernández-Morcillo et al., 2013; Jaligot, Hasler, & Chenal, 2018), their use at the local scale is still problematic because the methods used to assess cultural

ecosystem services are not well defined (Gould et al., 2015; Szücs et al., 2015; Zwierzchowska et al., 2018). Applying the ecosystem services framework to engage with the cultural value of landscapes requires holistic methods (Fraser et al., 2016; Gould et al., 2015), cross-cultural sensitivity combined with an historical perspective (Tengberg et al., 2012), and a deep interdisciplinary approach (Fish et al., 2016).

As previous systematic reviews have revealed (Carpenter et al., 2009; Chaudhary et al., 2015; Grêt-Regamey et al., 2016; Pandeya et al., 2016; Runting et al., 2017) there is much less experience applying an ecosystem services approach in so-called developing nations, where local livelihoods are highly dependent on natural conditions and resources. Where traditional cultures are present, as is the case with nomadic herding in Mongolia, it is essential for cultural ecosystem services assessment to consider nomadic herders' knowledge since their traditional cultures have long histories of strong, intimate interdependence with nature.

Traditional ecological knowledge (TEK) was presented briefly in the Millennium Ecosystem Assessment report (MEA, 2005, p. 23). The conceptual framework then launched in 2012 by IPBES (The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) includes recognition of multiple knowledges, such as Western science, Indigenous, local and practitioners' knowledge, and their interlinkages (Díaz et al., 2015) supporting the increased role of local knowledge in ecosystem services assessment (Chaudhary et al., 2015). Another highly influential framework is the Common International Classification of Ecosystem Services (CICES), developed by the European Environment Agency (EEA). It has been used quite frequently to assess ecosystem services at different scales in recent years. An important strength of the updated CICES V5.1, is that traditional ecological knowledge is included in the scientific knowledge section (Haines-Young & Potschin, 2018).

Engaging with local knowledge is essential, in any case, when an ecosystem services assessment is intended to support improvements in management, e.g. adaptation, because culture is a driver of change in ecosystems (MEA, 2005). Each community has its own unique culture that plays a central role in its daily life, shaping community members' livelihoods and supporting well-being, and as a result, culture is a driving factor in the management of local resources (Chan, Guerry, et al., 2012; Chaudhary, McGregor, Houston, & Chettri, 2019).

Cultural ecosystem services shape human well-being through their contributions to the aesthetic, recreational, educational, cultural, and spiritual aspects of human experience. However, in most cultural ecosystem services studies, only the aesthetic and spiritual values of landscapes are discussed (Cooper, Brady, Steen, & Bryce, 2016). Compared to other types of

ecosystem services, cultural ecosystem services require a greater understanding and interpretation of personal perceptions, relations and experiences. Therefore they need to be examined, at least in part, through participatory methods and analysis of case studies, drawing on views expressed by stakeholders (Gould et al., 2015; Haines-Young, 2011; Hirons et al., 2016). Cultural ecosystem services assessments at a local level that are intended to support local management, must be much broader, as all of these values need to be borne in mind when seeking to inform management. The Common International Classification of Ecosystem Services (CICES) framework (Haines-Young & Potschin, 2018) analyzes relationships between ecosystem services and human well-being and how these might be mutually supportive. We adopted the CICES V5.1 (Haines-Young & Potschin, 2018) categories to identify cultural ecosystem services in this study because it supports the broad analysis needed at a local scale.

Mongolia is vulnerable to climate change because rural livelihoods are highly dependent on nature. However, there is a lack of detailed assessment of ecosystem services in Mongolia (Zhen et al., 2010). Nomadic herders, who have lived in the pastureland ecosystem of the open steppes for many generations (Bazargur.D, 1998; Jagchid & Hyer, 1979), are a clear example of the link between ecosystem services and human well-being (MEA, 2005). Traditional ecological knowledge of herders plays a central role in pastureland management in Mongolia (Fernandez-Gimenez, 2000). Because there is very limited study of ecosystem services thinking informed by nomads' knowledge (Upton, 2020), it is interesting to explore what the study of local nomadic herders' perception and knowledge of cultural ecosystem services allows us to see that is missed in large-scale studies and frameworks, such IPBES (Díaz et al., 2015) and Common International Classification of Ecosystem Services (CICES) (Haines-Young & Potschin, 2018). What might we learn about how to use an ecosystem services approach to support climate change adaptation at a local scale from a locally focused study of cultural ecosystem services? This study explores these issues through two key questions:

- What are the main cultural ecosystem service benefits experienced by nomadic herders that support their well-being?
- What role can an exploration of local indigenous knowledge play in developing an understanding of the cultural ecosystem services provided by landscapes at a local level?

Mongolian nomadic herders provide us with a case study which is (i) local, (ii) in a 'developing' nation that (iii) involves careful consideration of local knowledge, and (iv) needs a wide-ranging assessment of cultural ecosystem services. Assessing cultural ecosystem services as

experienced by nomadic herders in Mongolian pastureland (Figure 5.1) therefore provides multiple opportunities for advancing cultural ecosystem services research.

Figure 5.1. Cultural ecosystem services from the pastureland in Northeast Mongolia acknowledged by nomadic herders during focus groups discussions and interviews (Photos were taken by Navchaa, between June-July 2018)

This study uses the Millennium Ecosystem Assessment definition of "Human well-being [as including] basic material needs for a good life, the experience of freedom, health, personal security, and good social relations" (MEA, 2003, p. 73) to provide a conceptual framework to guide identification of the main cultural ecosystem services that underpin nomadic herders' well-being in Mongolian pastureland.

5.2. Study area

The case study was conducted in the Northeast Mongolian steppe and wetland region (Figure 5.2). The study area is a Mongolian part of the Dauria Steppe Global Ecoregion[15] and Landscapes of Dauria World Heritage[16] and includes a major Ramsar-listed wetland. Mongol Dauria (or *Daguur*, *Монгол Дагуур* in Mongolian) steppe and wetlands encompass the Khentii

[15] https://amurinfocenter.org/en/ecoregion/dauria-steppe/

[16] https://whc.unesco.org/en/list/1448/

mountain range and include the Onon, Balj and Ulz rivers (Tsegmid, 1969). Mongol Dauria steppe is one of the largest remaining examples of a relatively undisturbed steppe ecosystem in the world. The average altitude of the mountains is 1400-1800 m a.s.l, and the mean altitude is 1100-1200 m a.s.l in the steppe.

The mean annual temperature (^{0}C) is +0.6^{0}C and the average temperature in July is +22^{0}C. Annual mean precipitation is 250 mm. The temperature has increased by on average 1.3^0 C over the period 1976 to 2011 and the warming rate was similar throughout the study area (Gomboluudev.P, 2017b). The steppe is a habitat for diverse rare species of fauna, such as the white-naped crane, great bustard, and other endangered migratory birds and it is a migratory path for the Mongolian gazelle (Ouyngerel.B, 2009). Under the Law on Protected Areas of Mongolia, in addition to conservation and research activities, only two main activities, ecotourism and traditional animal husbandry are permitted[17] in the territory of the Dauria steppe, due to its "international and national environmental significance".

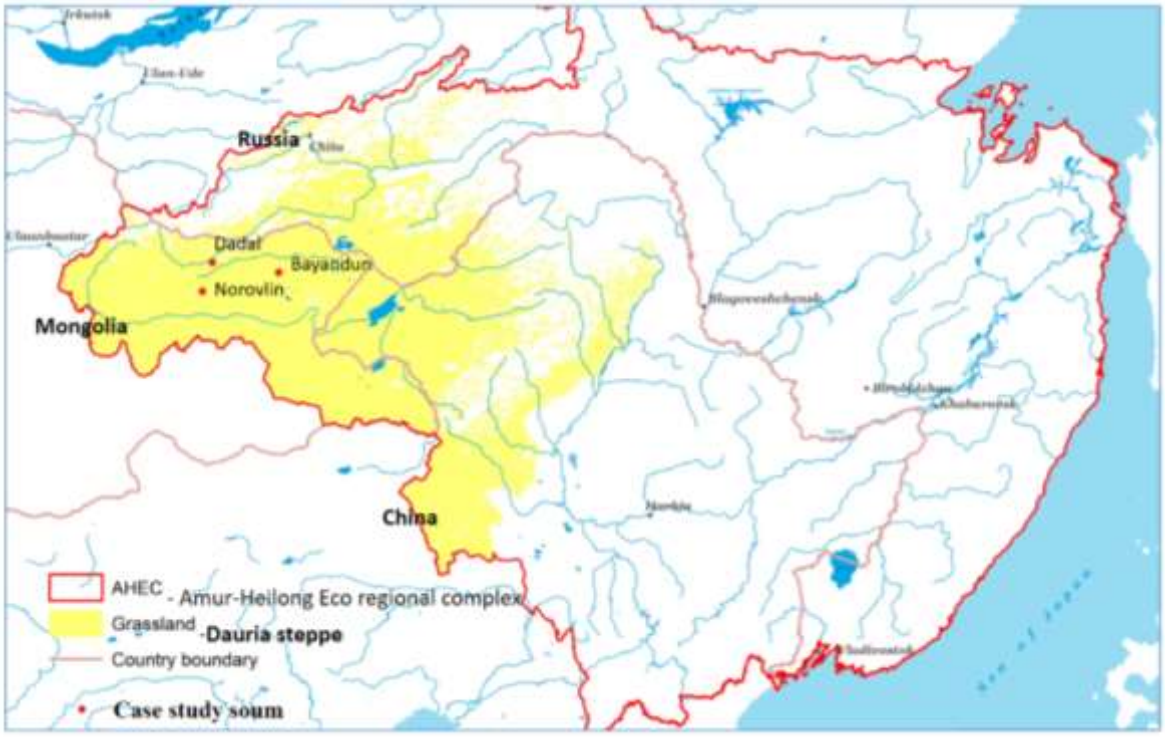

Figure 5.2. Case study area: Daura Steppe, Northeast Mongolia
(Source: adapted from https://amurinfocenter.org/en/ecoregion/dauria-steppe/)

The three case-study areas chosen to explore the nomadic herders' perception of cultural ecosystem services were three *soums* (village-sub district) in two provinces along the river basin. A *soum ("сум"* in Mongolian), is the second-level administrative subdivision in

[17] Law on the Protected Areas of Mongolia. Article 13. p.5

Mongolia. The three that are the focus of this research each have approximately 2,500-3,000 inhabitants who depend directly or indirectly on animal husbandry for their livelihoods. Nomadic livelihoods, tradition and culture are quite similar throughout the case study area.

5.3. Methods and materials

The study employed a mixed-methods approach using both quantitative and qualitative methods. Fieldwork was conducted between June and July 2018, in Northeast Mongolia. The following studies were carried out during the fieldwork:

(1) Herder family household survey (n=115). To be more context sensitive and to be participatory, we did (i) conduct a few interviews first, and (ii) then did a pilot survey with 10 households, iii) refined the survey again and iv) administered the survey. A random sample of herder households in each of the three *soums* was surveyed. The survey included questions on the nonmaterial benefits provided by forests, wetlands, grassland and river basin, and how they experience and value the landscapes in which they live (appendix 6).

(2) Interviews with herders (n=15). We conducted semi-structured and open-ended interviews (Bernard, 2011) with herders to gather information on each of (i) the herders' perception of cultural ecosystem services of the pastureland, (ii) their knowledge of environmental benefits, (iii) changes to practices that they have made (appendix 3). Key informants from local *soum* governor offices, Onon-Balj National Park and Ulz river basin authorities identified potential interviewees for us (MacDougall & Fudge, 2001).

(3) Focus group discussion (3 groups, 20 participants, a mix of herders, local business people, local experts and administrators; the majority were herders). To investigate cultural ecosystem services at a local level and shared understanding of the nonmaterial benefits of nature for their well-being (appendix 4), we conducted three focus group discussions (FGDs). To identify potential participants of the herders, we used snowball sampling beginning with suggestions from key informants (Lavrakas, 2008).

FGDs participants produced a local map with the information on cultural and historical sites and other specific natural components. The participants also made a list of historical and cultural sites at their local area and shared information about the sites. Each FGD continued around 3 hours. Interviews and FGDs were conducted in Mongolian and all interviews were digitally recorded with the permission of the participants. Recorded results were transcribed and then translated into English. Inductive data analysis was used to identify themes in the data (Bernard, 2011; Ezzy, 2002).

The household survey started with general questions to capture the respondents' age, gender, education, and herding experiences. The youngest herder, who was surveyed was 19 years old, and the oldest was 70. Relatively experienced herders participated in the survey (Table 5.1). Quantitative data were analyzed using Microsoft Excel and descriptive statistics were used to explain the data.

Table 5.1. Demographic Statistics from the survey

The average age of the respondents (years)	40.9
Mean number of years of herding	20
Gender ratio of respondent (%male: %female)	66:34
Average education level	High school

5.4. Results

Herders identified the non-material values of nature, such as its beauty, its symbolic and religious values, and places with cultural and historical values, etc. as important cultural ecosystem services. All herders who participated in the survey identified the beauty of the natural landscape as important to them (52% of respondents said "*very important*" and 48% picked "*important*").

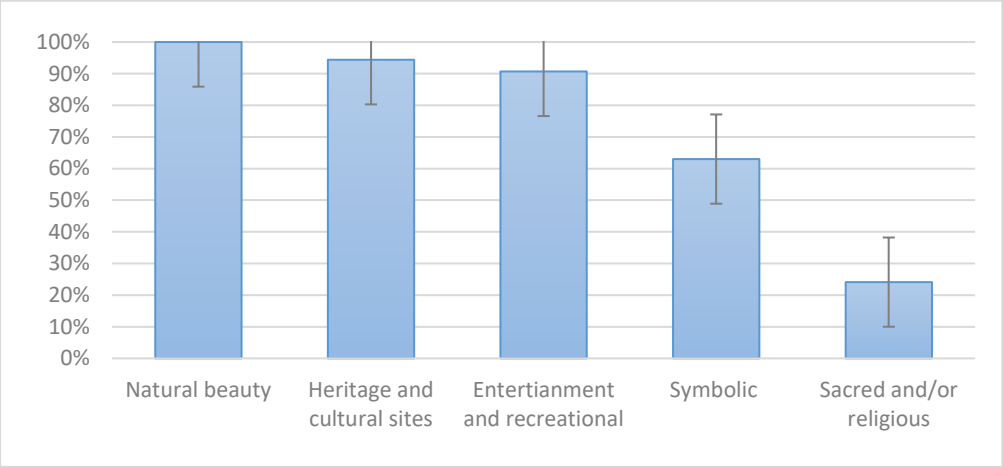

Figure 5.3. Identified non-material benefits of pastureland

More than 90% of herders also indicated that heritage and cultural sites were significant benefits on pastureland. Interestingly, only 22% identified sacred and religious values of nature as important to them, but more than half of the respondents (62%) agreed that they enjoyed symbolic benefits from nature (Figure 5.3). Respecting and protecting the sacred mountains was an integral part of both Shamanic and Buddhist practice in Mongolia (Jugder.Ch, 1984). However, during the Communist period, religion was banned. Both traditional religions - Buddhism and Shamanism – have re-emerged after the transition to democracy, but currently,

only a minority of Mongolians identify with them strongly. Nonetheless, the traditions about the importance of places like the tops of mountains and sources of streams have carried through, so for many herders, there are symbolically important places that, for them, are not also explicitly religious or sacred.

Interviews with herders provide an understanding of the experiences that these statistics point to. Long-standing traditions and the central role of the interrelationship of natural, spiritual, cultural and political aspects of Mongolia have made the protection of the natural landscape and sacred sites synonymous with Mongolian cultural identity, nomadic livelihood, well-being and the nation-state, as described by one herder:

> *I would say that our most inspiring traditional culture or heritage, which expresses the relationships between humans and nature, is our traditional long song*[18]*. It defines Mongolians, it represents the steppe, it represents mountains, it shows rivers and lakes. The long song is like a horseman singing as he rides upwind, from sunrise to sunset. The song is nature's voice, transmitted through man. (A local folk singer and herder.)*

Traditional long songs tell of how the sun cares for the world, about the speed of horses, and the freedom of nomadic life, for example.

5.4.1 Aesthetic value

All herders identified the beauty of the landscape as important, however, what they value specifically depends on where they live. Some emphasized that *"Living close to the mountain and water is the most important"* (Herders from the forest-steppe), whereas others emphasized that "*the beauty of the landscape is hidden in its openness, the vast open steppe expands your vision"* (Herders from the steppe). The colour of the landscape is observed closely by nomadic herders, for whom it is an indicator of environmental change. Dryness and forest fires make the landscape browner and blacker, changes that nomads experience as both disturbing ecologically and as a loss of beauty.

5.4.2 Enjoyment of plants and animals

Mongolia's nomads see their livestock as a central part of nature. As one herder said, "*without livestock, nature is empty*" (A herder, Norovlin), and a popular song runs "The beauty of the countryside is in its many livestock, the richness of the forest is in its animals for hunting"[19].

[18] The Mongolian traditional long song was approved by UNESCO as a cultural heritage in 2008.

[19] "My country" (poem is written by D.Sengee and melody by L.Murdorj)

While herding, herders observe nature, gather fruit and other plants, and hunt wild animals. What they observe helps them to plan and organize their seasonal movement and other aspects of their nomadic livelihoods. Hunting is often for entertainment, and both hunting and collecting plants have strong traditional customs that involve enjoyment of the plants and animals. Being entertained by and enjoying nature are bound up with benefiting from it in diverse other ways. Elders' evening stories, traditional long songs and games are strongly inspired by natural beauty and differ from one region to another.

5.4.3 Cultural heritage values

Nomads also identified heritage and cultural sites as important in their lives. Northeast Mongolia has a rich heritage and many cultural sites due to the region's significant role in Mongolian history:

> "*Our soum is the birthplace of Chinggis khaan*[20]*. So there are many important historical and cultural sites and places from Mongolian history"* (*A herder, Dadal*).

And,

> *"There are a number of historical heritage sites in our soum, dating from the 13th century to the recent [Communist] revolution of 1921. Many of them are so famous that they are mentioned in the "Mongolian Secret book".*[21] *(A retired teacher and herder, Norovlin*).

Because the steppes have been their home for so long, nomads see historical heritage as part of nature too – the culture-nature binary, present in western ontologies, is alien to their experience of place. When focus group participants listed therapeutic (springs) resorts and medical institutions, for example, they explained that they all have a rich history. Nomads have used several hot and mineral springs and lakes in the area for treatment and recreation since at least the 13th century (Damdinsuren, 1957). Medicinally useful spas, lakes and other natural objects (rocks, tree etc.) are significant historical and cultural heritage.

5.4.4 Symbolic value of animals

Mongolian history and culture are unimaginable without and inseparable from horses. For most of Mongolia's history, the horse has been a symbol of the speed and power of Mongolians.

[20] Genghis Khan - in western literature, we used here in Mongolian spelling (Чингис хаан- Chinggis Khaan)

[21] The Secret History of the Mongolia is the oldest written text in the Mongolian language, written in the XIII century. The only and most significant native Mongolian account of Chinggis Khaan.

Horses are used in herding and transportation, and in entertainment. During the warm season, horse racing festivals are organized around the country. The biggest is the *three 'manly' games* (horse racing, wrestling and archery) festival, the "*Naadam" (*Наадам *in Mongolian)* National festival. *Naadam* is organized at three levels: *soum*, *aimag* and nation. Thousands of horses gather for racing in *Naadam*. Naming, in advance, the colour of the winning horse is the main entertainment in horse racing. Usually, experienced elder horse trainers observe the morning weather on a race day. This is called the "game of cloud racing"; they observe the colour of the cloud just at the moment of sunrise on the race day and from that predict the winning horse's colour. The trainers say that

> *"Horse is a sky creature. Last year I backed a horse, in a bet [for prestige, not money] against my neighbour and lost. I didn't realize that there was a little shiny moon shape inside the dark cloud [at sunrise]. So, I chose a dark grey horse. My neighbour named a "Tolin Khul" (толин хул in Mongolian) - a dark grey horse with a shiny bright moon shape on the forehead and his horse came in the first." (Senior horse trainer and herder, Dadal).*

Sky and horses are intertwined in local experience of place. Horse culture is a very important strand of local indigenous knowledge about how to survive in the steppes.

In addition to horses, there are other animals of significance in nomadic culture, notably as totems. Nomads have believed in totemism since the prehistoric period (Damdinsuren, 1957). Both the wolf and the deer are the most common totems among nomads. Deer was the main totem during the Bronze Age in Mongolia (Nassen-Bayer, 1992). Even though the wolf is less represented in historical art, Mongolians still believe that the wolf is a sacred creature and it is a good sign or good omen to meet the wolf when you are traveling. Although today wolves can be killed to protect livestock, killing a wolf has long been considered taboo.

> "*The wolf is a symbol of the spirit. We believe that wolves have hiimori (хиймор*ь *in Mongolian-spirit); they are revered for their strength, intelligence, and speed. At the same time, we say that wolves are enemies of herders because they attack our livestock." (A herder, Bayandun).*

Nomads have special attachments to particular animals that are deeply embedded in culture and can be traced back tens of thousands of years (Jagchid & Hyer, 1979). For instance, the swan is also important for Mongolians. The swan was a totem of the *Buryats*[22] (Nassen-Bayer, 1992).

[22] Buryat (Буриад in Mongolian) is a Mongolian ethnic group. The vast majority of Dadal and Bayandun population is Buryat.

In North and Northeast Mongolia, there are many monuments of deer stone (ancient megaliths, carved with symbols) depicting a warrior's belt with a stylized flying deer or other animals (Fitzhugh, 2009). Deer stones are the symbol of ancient Mongolian culture and art for modern nomads.

5.4.5 Sacred and religious values

One of the most important intangible cultural heritages created, developed and practised by ancient Mongolians is the tradition of worshipping sacred mountains and water. The origin of the tradition is shamanism, and this has been enriched by Buddhist ideology and ritual (Jugder.Ch, 1984). As noted above, only 22% of herders' surveyed identified sacred and religious values of the landscape as important for them personally, however, religious traditions infuse nomadic culture in unselfconscious ways. Mongolians believe themselves to be being constantly ''under the sky power (tengeryn khuch- тэнгэрийн хүч in Mongolian)'' with the support of "the land master" (gazariin ezen- газрын эзэн in Mongolian); "*the realisation that nature in general and weather, in particular, control their lives is ubiquitous and explicitly formulated*" (Marin, 2010), and *"the land is controlled by governing spirits ('masters of the land') who have the power to bestow good weather or, if angered, drought and pestilence"* (Humphrey, 1995). According to the nomads' belief, each natural feature, such as a mountain, stream, river, or lake, has its own deity or spirit (Chimedsengee, 2009) and are designated male or female. They are respected and feared and for the herders these deities or spirits evoke different experiences as they shape their relations with place. Traditionally male deities are associated with the sky as a father (*Tenger- тэнгэр in Mongolian*), and female deities are associated with the Earth as a mother (*Etugen*) (Jugder.Ch, 1984).

The tradition of mountain worship, for example, has very specific customs and rituals, which include the chanting of sutras and the transfer of knowledge, legends, blessings, poems, epics, songs, art and performing arts. Shamanism and Buddhism combine to honour sacred mountains through the building of *ovoo* (овоо in Mongolian- stone cairns). When passing a hill with an *ovoo* on it, nomads traditionally stop and walk around the cairn three times. This ritual has its roots in shamanism but is now simply part of everyday culture – practised by most Mongolians, regardless of whether they formally practice Shamanism or Buddhism. For the herders, the main benefit of worship is that it leads to abundant rain: "*every year we worshipped sacred mountains; it rains in most cases"* (*Herders, Norovlin*). Also, *"we worshipped three mountains this year and after that, the rain fell pretty well"* (*Herders, Bayandun*). These traditions, of sacred connections to aspects of the landscape, make a great contribution to the preservation

and protection of the environment and wildlife in contemporary Mongolia by encouraging people to care for, conserve and protect aspects of nature.

5.4.6 Educational value and scientific and other knowledge

As mentioned above, the study area forms the habitat of many endangered migratory birds and is a migratory path for the Mongolian gazelle. Conserving and being entertained by nature are integral to traditional nomadic livelihoods, as explained by one herder from Bayandun:

> *"Our soum is the homeland of many migratory birds. Mongolians have special traditions and customs to protect them. We know when spring and autumn come and end because these birds come and leave [they migrate]. Watching cranes dance is one of the entertainments for countryside kids. The elders used to tell us: don't put your shadow on the crane's egg." (A herder, Bayandun*).

Observing the migratory routine of cranes is believed to indicate what the upcoming summer or winter will be like and helps people prepare and manage their livelihood.

Animal habits and hunting techniques are common knowledge among the nomads (Jagchid & Hyer, 1979) and herders have developed practically important traditional ecological knowledge, as a senior herder described:

> "*The natural environment is our lifelong teacher. I started hunting when I was 12 years old, though I haven't hunted in the last 15 years. We used to hunt thoughtfully [not hunting when animals are raising young, just taking what you need, etc.] and selectively [preferring older animals, and males, and not shooting the leader of a group of animals]. I learned this from experienced elders."* (*A senior herder and hunter, Dadal*).

Traditional knowledge is passed to the younger generation from elders. This knowledge has adapted, in the service of conservation as the herders (from Dadal) said:

> *"There was a lot of deer in the northern, forested mountain. After the privatization of livestock [with the introduction of democracy in 1991], illegal hunters hunted almost everything. Now, we rarely see deer, wild pigs, and brown bears. So, we request our local people to not tell others if they see those animals. We need to protect them from illegal hunters*".

Elders' knowledge and experience of the interaction between humans and nature throughout their life leads them to protect nature, adapting hunting practices to sustain populations, and they encourage young people to also protect nature.

Nomads have lived on this beautiful vast grassland for thousands of years. The pastureland keeps alive many generations' of history, culture, and tradition. Nomads have ridden horses, sustained themselves, maintained the pastureland and protected nature. Whilst nomadic livelihoods have changed as a result of socio-economic, political and environmental changes, nomads have kept their deep-rooted traditions of interaction and interdependence with the landscape. As one herder said,

> *"You know, most of the territory of our soum is National Park. Many endangered and rare birds, and other animals, inhabit this mountain and marshland. So, everyone who lives in this area has to contribute to protecting nature. Being a nomad means living with less impact on nature." (A herder, Dadal).*

Understanding the importance of their natural environment for their livelihoods and well-being leads many herders to strive to protect nature. They see the landscape as their homeland for generations past and future:

> "*at least 9 generations of my family have lived in this beautiful and blessed steppe. I hope that my grandchildren and their children will live here. Our traditional livelihood has changed a lot. I can't say that my grandchildren will be herders too. But I do believe that our nomadic livelihood will be long-lasting"* (*A senior herder, Bayandun*).

As herders mention very often, nomadic lifestyles have adapted to many changes. They are confident in the continued existence of their nomadic livelihoods into the future, with the support of mother earth and under the guidance of father sky.

5.5. Discussion

Local knowledge is relational, shaped by the particular context it is formed in, and adaptive to the changing environment. As previous studies highlight (Bieling & Plieninger, 2013; López-Rodríguez, Escribano-Bombín, Hernández-Jiménez, & Bell, 2019; Stålhammar & Pedersen, 2017), the benefits of ecosystem services are often dependent on relations with a particular place; nomadic herders perceive natural beauty differently depending on where they are from. Unsurprisingly, mountain people prefer living near the mountains, and others find beauty in the steppes.

Herders describe how "Nature is a life-long teacher", and they have learned to understand nature while living with and connecting with nature. Although the educational and entertainment value of nature is clearly differentiated in the CICES framework, local nomads do not see them separately. While living in nature they find ways of being entertained by nature

and, at the same time, they learn from nature, and maintain connections to valued animals, places and pastureland. Symbolic, sacred and/or religious values are also expressed by herders in relation to nature. The views of the local hunters, who are keen to protect wildlife, show how experiencing nature as aesthetically and spiritually valuable also involves a sense of moral responsibility towards nature (Cooper et al., 2016). Thus, this study demonstrates that the cultural ecosystem services of landscapes, such as spiritual and inspirational values, the sense of belonging, entertainment, and cultural and historical heritage are as important for nomadic herders' well-being as grasslands and water resources.

Northeast Mongolian nomads also experience and value the living, historical heritage present in pastureland as an inseparable part of nature. Heritage objects, such as ancient graves, monuments, and deer stones, are profound places within nomads' sense of belonging in the landscape. Therefore, the study suggests that using an explicit list or discrete categories, such as CICES, to assess cultural ecosystem services is not sufficient. To fully appreciate people's connections to ecosystems services, frameworks like CICES need to be supplemented by a more holistic approach to understanding how place is contributing to human well-being.

Quantitative data, such as the household survey used here, provide a general understanding of how people perceive the cultural benefits of nature at the local level (Fish et al., 2016). However, without qualitative data, such as in-depth interviews and focus group discussions, the assessment of cultural ecosystem services at the local level is inadequate (Gould et al., 2015). A mixed-methods approach, as applied here, with active interaction with the local population is an effective way of investigating cultural ecosystem services and their contribution to human well-being at a local level. This is important for supporting local decision making because the nonmaterial values of pastureland guide local decision-making practices by nomadic communities. A key policy priority should, therefore, be to plan for the long-term care of cultural ecosystem services as part of efforts to sustain nomadic livelihoods in these landscapes. While provisioning and supporting services are vital for nomadic herders, cultural ecosystem services are vital for their livelihoods since the cultural ecosystem services are important drivers of well-being (MEA, 2005). Integrating the cultural ecosystem service approach into natural resource management decision-making is still challenging; how it should be employed is not yet settled (Gould et al., 2019). "Cultural services can enhance adaptive capacity by providing alternative livelihood opportunities" (MEA, 2005) since each adaptation strategy includes values, rules, and knowledge about the socio-ecological system (Adger, Arnell, & Tompkins, 2005).

One specific challenge is that one of the main benefits of the pastureland is its inspirational value; the landscape's capacity to inspire is a cultural benefit of ecosystems (Coscieme, 2015). The traditional long song of Mongolians is an example of this. However, although MEA (2005) states that ecosystems are a source of inspiration for art, folklore and national symbols, the inspirational benefits of ecosystem services are not easily placed in the CICES framework and similar classificatory systems (Hernández-Morcillo et al., 2013). This too underlines the importance of supplementing investigation of specific cultural ecosystem services with the holistic assessment.

The findings of this study demonstrate that local knowledge and practices make a central contribution to understanding the cultural ecosystem services provided by landscapes at a local level. The importance of non-material values for practice - for nomadic lives - shows that incorporating non-material benefits of landscape into natural resource management can greatly improve the practicality and legitimacy of management approaches (Milcu et al., 2013). Pastureland management plans or adaptation strategies of "soums" should clearly reflect the spiritually or culturally significant characteristics of the pastureland, as nomads' knowledge is central to local environmental decision-making. Assessments of cultural ecosystem services, as deeply informed by locals, can make important contributions to management (Gould et al., 2015; Satz et al., 2013). Nomads' appreciation of natural beauty and observation of its changes affects the well-being of herders, and this resonates with the relational value of ecosystem services, as in "Living in harmony with nature" (Díaz et al., 2015). These explorations need to be informed a local adaptation strategies.

5.6. Conclusions

This study investigated the main cultural ecosystem services provided by pastureland in Mongolia and their importance for nomadic livelihoods and well-being. A mixed-methods approach was used to collect data, and fieldwork was conducted in Northeast Mongolia. Nomadic livelihoods have shaped and been shaped by the steppes from prehistoric times (Bazargur.D, 1998). Pastureland provides essential cultural ecosystem services that sustain nomads' existence such as a sense of place, identity, symbolic, cultural and historical heritages, inspiration for creativity (e.g. traditional long songs, myths, legends e.g) and shared knowledge of human-nature interactions. Nomads keep moving to different places in search of pasture and water, at the same time they gain inspiration and seek entertainment from songs under the sky power with the support of mother earth.

This study illustrates how traditional knowledge makes an important contribution to assessing ecosystem services – specifically cultural ecosystem services – are linked to well-being at a local scale. The participation of local people in the assessment of ecosystem services is thus essential, underlining the importance of local indigenous knowledge for developing ecosystem services approaches to environmental management.

The study suggests that cultural ecosystem services assessment at the local level requires a holistic approach to fully understand local experience. In particular, using explicit lists or categories of kinds of cultural ecosystem services to assess cultural ecosystem services is not sufficient, and a more holistic and relational way of understanding the nonmaterial value of nature and their contribution to human well-being is needed. The cultural services assessment approach needs to be further developed to support adaptation planning. An important practical implication is that strengthening local stakeholders' capacity, nomadic herders in this case, to participate in and shape local decision making is necessary in order to ensure the ecosystem services approach informs local adaptation planning soundly.

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Chapter 6 (Paper 3): Adaptation strategies of nomadic herders in Northeast Mongolia: Climate, globalization and traditional knowledge

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This chapter draws on the findings of Chapters 4 (Paper 1) and 5 (Paper 2), which explored how climate and other drivers are changing, and identified the impacts of these changes on local livelihoods and the pastureland ecosystem services, upon which nomads directly depend. The chapter emphasizes current adaptation actions that build on traditional ecological knowledge and herding practices in Northeast Mongolia. Investigating climate change adaptation in the Mongolian Steppes using an ecosystem services approach, and in the process exploring the applicability of ecosystem services thinking to local land-use planning, the chapter outlines a simplified conceptual framework illustrating the climate change adaptation challenges from an ecosystem services perspective.

Based on the results from interviews with nomadic herders and key informants, focus-group discussions, and a household survey in Northeast Mongolia, the chapter discusses the combined impacts of climate and socio-economic changes on local livelihoods and environment, the current adaptation to changes in ecosystem services at a local level, and investigates the role of traditional ecological knowledge in this adaptation. Nomadic livelihoods have changed due to climate and socio-economic factors; however, traditional ecological knowledge still plays a key role in adaptation in rural Mongolia. Nomadic herders take various measures to cope with changes in order to sustain their livelihood and protect nature. The chapter contributes by emphasising how ecosystem services thinking can, with the active participation of local stakeholders, support the development of effective local adaptation strategies. The chapter highlights that the traditional customs and spirituality of nomadic herders are key to collective efforts to responsibly use, protect and conserve the pasturelands, but that this requires more support in order to face transformative adaptation in the future.

Abstract

Herders in Mongolia have adapted to changing environmental conditions over thousands of years through innovations in pasture and herd management practices, knowledge, collective institutions and mobility strategies, yet they now face unprecedented climate risks threatening their livelihoods, economies and ways of life. This paper presents the results of a study into how herder communities adapt to climate change and the potential role an ecosystem services approach could play in informing the development of effective adaptation strategies. The findings are based on semi-structured interviews with herders, key informants, focus group discussions and a survey of nomadic households in Northeast Mongolia. The benefits of pasture ecosystem services have changed considerably due to climatic and socio-economic changes in the Mongolian steppe resulting in degradation of the pastureland and water resources. The ways that traditional ecological knowledge and practices can support adaptation to climate change are explored. In particular, the seasonal movement of nomads represents a valuable form of knowledge and practice of adaptation in response to the changes in temperate dryland ecosystems. To continue to maintain mobility as part of adaptation strategies other adaptation actions are required, such as the implementation of an appropriate livestock insurance systems that addresses climate and weather risks, and restoration of dryland ecosystem services, notably through reforestation and improvement of water supplies. Further changes in the pastureland ecosystems may lead to further adaptations in nomadic livelihoods, leveraging nomadic herders' knowledge of local ecosystem services.

Keywords: *climate change adaptation, nomadic livelihoods, pastureland ecosystem services, nomadic herders' knowledge*

6.1. Introduction

Engaging with traditional ecological knowledge to understand the magnitude of the capacity and resilience of systems at a local scale can improve adaptation. "Traditional ecological knowledge may be holistic in outlook and adaptive by nature" (Berkes et al., 2000). Enhancing the exchange of insights from traditional ecological and western scientific knowledge provides an opportunity for effective adaptation strategies at a local level (Makondo & Thomas, 2018). Because of their high direct dependence on nature and resources, most Indigenous communities' livelihoods are highly affected by climate change (IPCC, 2014a; Ramos-Castillo, Castellanos, & Galloway McLean, 2017). Even though Indigenous knowledge and practices for coping with natural hazards and adapting to changing environments have long been transmitted from one generation to the next (Berkes, 1999), such knowledge and practices are often ignored or marginalized in formal adaption strategies (Leonard et al., 2013; Makondo & Thomas, 2018; Naess, 2013). Whilst there is growing attention given to Indigenous and traditional ecological

knowledge in adaptation (Leonard et al., 2013; Pearce et al., 2015) there are few studies looking at its role in temperate arid climate regions (Reyes-García et al., 2016). There has also been limited consideration given to Indigenous knowledge and practices in formal adaptation. Though previous studies have shown that local knowledge should be a key component of adaptation decision-making (Leonard et al., 2013), for example, on the Mongolian steppes traditional understanding of movement patterns make central contributions to adaptation. However, how such knowledge can be integrated into adaptation, and what role ecosystem services thinking might play, has not yet been clearly investigated (McNamara & Buggy, 2017).

Some studies have highlighted the importance of determining which environmental characteristics are related to cultural heritage values in a given cultural context, and how changes in these characteristics may affect these values (Naess, 2013; Reyes-García et al., 2016). Furthermore, the period of meteorological observations in many temperate arid regions is relatively short, interpretation of the recent climate is challenging in arid zones (Lioubimtseva, 2004). There has also been very limited study of ecosystem services (ES) affected by climate change in Mongolia specifically (Upton, 2020; Zhen et al., 2010), and arid regions generally (Runting et al., 2017). Responding to these gaps, adaptation strategies in a region of Mongolia with a long history of Indigenous land stewardship and nomadic livelihoods, and which climate change is already affecting significantly, were examined with a view to develop a better understanding of local adaptation options. Understanding nomadic herders' knowledge (Fernandez-Gimenez, 2000) and ways of responding to climate change , including the development of management practices based on local knowledge (Berkes & Folke, 1998; Leonard et al., 2013), will help to develop effective adaptation strategies (Bhatta et al., 2015; Szücs et al., 2015). As a relatively holistic approach (Gould et al., 2019), an ecosystem services approach may be appropriate to improve adaptation to complex socio-ecological systems like nomadic herding in open steppe pasturelands. Recognising that Mongolian nomadic herders have a long history of successful adaptation, this paper begins from the expectation that they are likely to have more reliable knowledge and practices to adapt their livelihood systems to a changeable environment than the less locally astute knowledge of external experts (Naess, 2013).

Mongolia is one of the most vulnerable countries to the impacts of climate change due to its geographic and climate conditions, vulnerable ecosystems and the nature of livelihoods (Damdin Dagvadorj et al., 2009). The average annual temperature is 8.5^0C in the southern part and -7.8^0C in the northern mountainous area, with the annual total precipitation approximately

200-220 mm, although there are some regional differences (Dorjgotov, 2009). According to the Mongolian Climate Change Assessment report (MARCC, 2014), the annual mean temperature has increased by 2.14°C over the last 70 years, which is significantly higher than the world average. It follows that changes in water resource regimes, pasture and soil degradation are more intense, with overall environmental degradation accelerating drastically in Mongolia with 77.8 percent of the total territory affected by degradation (MARCC, 2014).

Nomadic livelihoods have existed for more than 3000 years (D Bazargur, 1998) in the Mongolian plateau under a temperate, very arid continental climate (Goodall et al., 1979). Mongolian nomadic pastoralism has passed through three main stages (feudalism, collectivization of herds, and privatization of herds) between 1921 and the present day, as a result of socio-economic changes (Yembuu, 2016). However, herders have remained as nomads. Nomadic pastoralism has been the main source of livelihood and economic activity for Mongolians since ancient times, and the steppe ecosystem has been considered ecologically stable (Neupert, 1999). Moreover, Mongolia is home to one of the longest-standing nomadic cultures and livelihoods in the world, and in Mongolia nomadic culture is highly valued and respected (Randall, 1993). Because Mongolian nomadic herders have accumulated valuable knowledge of the nature of climate and environmental conditions, vegetation, water sources, livestock behaviour and so on, they have developed a mobile and flexible herding strategy to interact with and manage the landscape in order to benefit from the environment, particularly in terms of animal husbandry (Fernandez-Gimenez, 2000; Fernández-Giménez, 1999). As with other people whose livelihoods are directly and intimately dependent on nature, Mongolian nomadic herders have a detailed understanding of weather and climate at a local level - knowledge which has great potential to be used for adaptation to climate change (Marin, 2010). Traditional seasonal movements are the central pattern of nomadic culture and livelihoods (Jagchid, 2019). Carefully planned, repeated, seasonally sensitive patterns of mobility of people and animals through the landscape is what distinguishes nomadic cultures and their forms of open pastureland management. The patterns of nomadic movement are based on traditional ecological knowledge, customs and norms for governing pastureland usage (Reading et al., 2010) and ensuring the health and wellbeing of their herds. Nomadic herders have detailed knowledge and experience of how to cope and adapt to changes in the vast Mongolian steppe. However, as a result of globalization and social change in Mongolia, traditional lifestyles and nomadic culture have changed in various ways, e.g. motorcycles are now increasingly used for herding, and most herders now use mobile phones and watch TV at home (Yembuu, 2016). Keeping this history and recent changes in mind, this paper investigates *how local herder*

communities are adapting to climate change and how their adaptation strategies can inform formal adaptation planning in a way that supports local herders' livelihoods.

To address these questions, the research study was guided by the following questions:

- What climate change adaptation is already evident, and what is the role of nomadic herders' knowledge in this adaptation?

- What future adaptation options should be considered in light of current and future climate change, and, how can ecosystem services thinking contribute, alongside local knowledge, to adaptation planning?

The IPCC (2014a) definition of adaptation as "the process of adjustment to actual or expected climate change and its effects" is adopted in this study at a local level. We also draw upon the *Millennium Ecosystem Assessment Report's* definition of ecosystem services as 'the benefits people obtain from ecosystems to sustain or advance well-being' (MA, 2005). The ecosystem services approach reflects systematic thinking that addresses the interdependence and interrelations between humans and nature in ways designed to inform decision-making about human uses of ecosystems (Costanza et al., 2017; von Haaren & Albert, 2011). Carefully considering the relationship between local livelihoods and ecosystem services is central to improving climate change adaptation when local livelihoods are highly, directly dependent on nature. The differentiation into regulating, supporting, provisioning and cultural services is used to guide exploration of adaptation options at the local level. The paper examines (i) the local experience of climate change and co-occurring socio-economic changes, and the combined drivers and impacts on nomadic livelihoods and ecosystem services (Section 3.1), (ii) the way nomadic herders are adapting to climate change, and the role of local knowledge in this (Sections 3.2), (iii) possibilities and future opportunities for adaptation strategies (Section 3.3), and the anticipated future changes based on climate change scenarios in northeast Mongolia. The discussion section focuses on future adaptation options and ways ecosystem services thinking can inform adaptation planning.

6.2. Methods

6.2.1. Study area

The study was conducted in the Ulz River Basin, in northeast Mongolia (Figure 6.1), a representative example of the open steppe pastureland landscape (Simonov, Goroshko, & Tatiana, 2017). The river basin is located in the Mongolian part of Daura Steppe Global Ecoregion (WWF, 2011). The ecoregion covers the eastern part of the Khentii mountain ranges and the Mongol Daguur steppe in Mongolia. The Ulz river basin belongs to the arid-steppe (BSk) and snow-winter dry (Dwc) category of the Koppen-Geiger climate classification system (Kottek, Grieser, Beck, Rudolf, & Rubel, 2006). The topography of the region is relatively homogenous and flat; therefore, the gradient of climate variables is small, and zonal distribution is dominant within the region (Tsegmid, 1969; Yembuu, 2020b). As WWF (the World Wildlife Fund) highlights, the Dauria steppe ecoregion is an example of "the last areas in the Palaearctic that still support stable herds of larger vertebrates", and it is a transition zone from the forest-steppe to steppe ecosystem in the Northern hemisphere (Tsegmid, 1969). This highly significant ecosystem is under threat from mining, cropland expansion, infrastructure development, overgrazing and climate change (MNET, 2013).

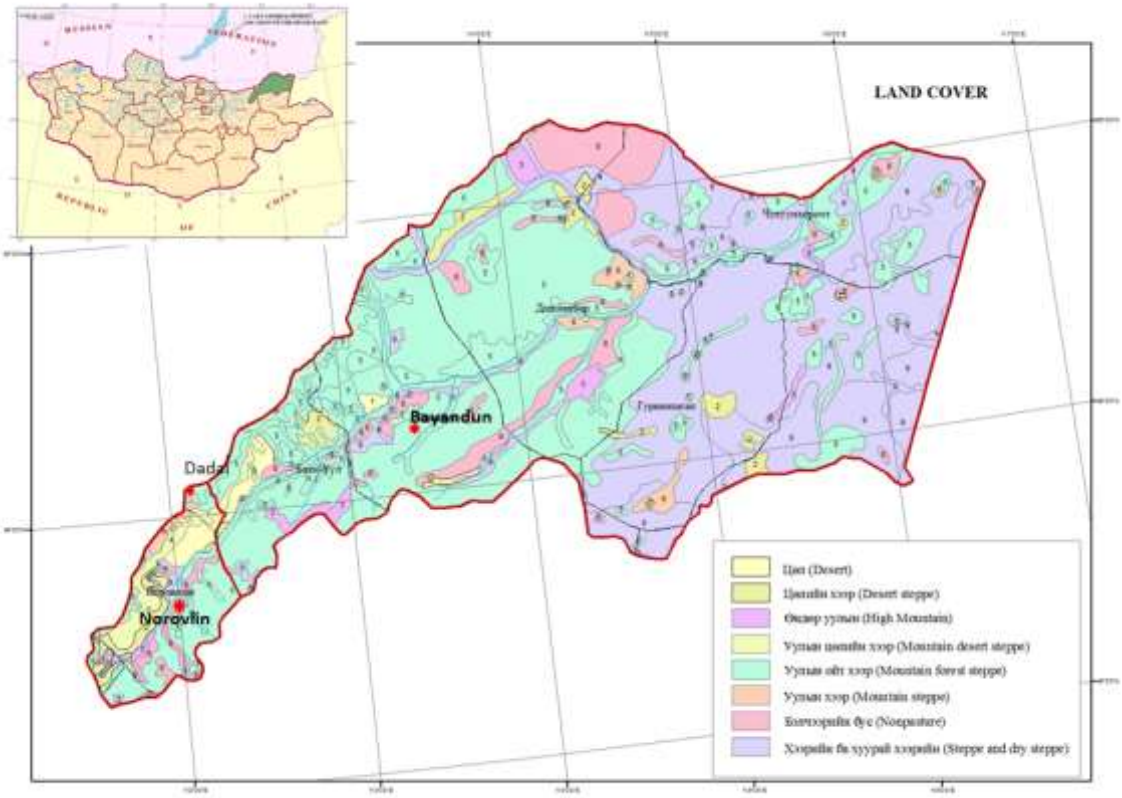

Figure 6.1. Land cover map of Ulz river basin in Mongolia

In this paper, we focus on nomadic herders, whose livelihoods are highly dependent on the northeast Mongolian steppe ecosystem. To explore climate change adaptation knowledge and practices of local herders, three *soums* (сум in Mongolian - a district - the second level administrative subdivision in Mongolia) of two provinces, Norovlin (Khentii), Dadal (Khentii) and Bayandun (Dornod), were chosen as case study areas (Figure 6.1). The focus of the research is at river basin level, and the three *soums* were chosen to provide a cross-section of nomadic livelihoods within the river basin (predominantly herding, but with a significant component of ecotourism). The basin itself was chosen because it is a good location in which to explore how ordinary nomadic livelihoods are being affected by climate change - not close to markets or a large city, and less affected by mining than many areas.

Each of the *soums* has approximately 2000-5000 inhabitants, primarily nomadic herders. At present, 22.3 per cent of the total workforce is nomadic herders in Mongolia as a whole and 42.3 per cent of all households in these three *soums* are nomadic families (NSC, 2018). The three *soums* were former *negdel* or "pastoral cooperatives" until 1990. Like other parts of Mongolia, livestock growth has intensified in the case study area after the *decollectivization* and privatization of the 1990s, following the end of the communist regime, and at the same time herd structure has changed significantly, in response to market changes (notably the number of goats, which supply cashmere, has increased). Even though livestock is now owned privately, as it was prior to collectivization in 1959, herders have used, shared and carefully managed common pool resources (notably pastureland and water) for generations.

6.2.2. Data collection and analysis

Addressing the research aims and incorporating both qualitative and quantitative research methods, a mixed-methods approach was used to investigate nomadic herders' knowledge and adaptation practices at a local scale. The study draws on fieldwork conducted in June-July 2018 and July 2019. Primary data were collected (Table 6.1) through 1) interviews with key informants and 2) nomadic herders, 3) focus group discussions, 4) a household survey in the case study area, and 5) a workshop in Ulaanbaatar, the capital of Mongolia.

Table 6.1. The structure of the primary data collection

Tools	Participant numbers	Focus/aim
Key informants interviews (KI)	10	To explore the local context and understand better past/current resource use patterns and economic activities.
Semi-structured and open-ended interviews with nomadic herders (H)	15 in 2018 10 in 2019	To explore how nomadic livelihoods have been affected by climate change and how nomadic herders are adapting to the ecological and socio-economic changes
Focus group discussions with community members (FGD)	20	To identify the key ecosystem services derived from the case study *soums* and elicit local perceptions of these ecosystem services, the impacts of climate change, and current and possible adaptations.
Household survey	115	To explore nomadic herders' knowledge and practices to climate change adaptation
Policy workshop with national experts and academics	12	To investigate how can local knowledge and practice contribute to support effective adaptation strategies and to access ecosystem services approach applicability to support climate change adaptation

To reach a pool of key informants, we used snowball sampling, leveraging personal networks (Lavrakas, 2008). We conducted semi-structured interviews first with key informants (KI), including local municipality officers, the River Basin Organization, National Park administrators, and local business people. The herders we approached were suggested by key informants (MacDougall & Fudge, 2001; Robinson, 2014). Interviews (appendix 3) were conducted face-to-face and were for 1.5 to 2 hours.

After conducting all interviews, we organized FGDs (appendix 4). The first FGD was held with eight residents of Bayandun *soum*, including River Basin Authority officers; the second was with six nomadic herders from the Mogoit riverside area of Norovlin *soum*; and the third was with six residents of Dadal *soum*, including national park rangers. Draft FGD questions were modified in the case-study area to incorporate learnings from the interviews. Possible

approaches to climate change adaptation and local use of an ecosystem services thinking were discussed.

Following the interviews and FGDs, in-person household surveys were also carried out to elicit the importance of key ecosystem services, the factors that influence their use, and changes over time. Herder families in the case study area who were invited to undertake the household survey were randomly chosen. To explore nomadic herders' knowledge and practices regarding climate change adaptation, the questions covered their experience of climate change, changes in practices, approaches to adaptation, their level of participation in local decision-making issues, and ways future adaptation strategies might be improved. The focus group discussions provided the starting point for the list of current adaptation actions for climate change that were included in the household survey. To tune the survey to local conditions, we (i) did a small number of interviews first, and (ii) then conducted a pilot survey with 10 households, and then (iii) further refined the survey, and (iv) administered the survey generally. The survey was semi-structured and contained both multiple-choice and open-ended questions.

The workshop in Ulaanbaatar included academics, government decision-makers and policymakers, and natural conservation NGOs representatives with expertise in environmental and natural resources management (appendix 5). The focus of the workshop was on how nomadic herders' knowledge and practice can contribute to effective adaptation and how ecosystem services analyses can contribute to local climate change adaptation strategies.

Interviews, focus groups, household surveys and the workshop were conducted in Mongolian, and all interviews were digitally recorded with the permission of the participants. The recordings were transcribed and then translated into English. An inductive data analysis strategy was used to identify trends and themes (Bernard, 2011; Ezzy, 2002). 115 surveys (10 per cent of the total number of households represent a significant statistical proportion) were carried out with randomly selected herder families (Singh, 2007). The majority of respondents were experienced herders (the average age of the respondents was 41) with an average of 18 years of herding experience. The survey data was analyzed using Microsoft Excel and descriptive statistics were used to guide interpretation of the data. The importance for adaptation actions, from herders' perspectives, was elicited through a 4-level scale, which rated their importance as: "very important," "important," "somewhat important," and "not important". Secondary data sources, including national and regional policies and programs on climate change adaptation,

sustainable development, and local planning documents particularly on land and pasture management, were also examined.

6.3. Results

The main findings cover three themes: major drivers (both climate and socio-economic changes) on local livelihoods and pastureland ecosystem services, nomadic herders' knowledge and adaptation practices to changes, and future suggestions to improve adaptation strategies at a local level.

6.3.1 Combined drivers and impacts of climate and socio-economic changes on local livelihoods and environment

Survey questions on climate change focused on people's observations of temperature and precipitation changes, frequency of droughts and "*dzud*". A *zud* or *dzud* is a Mongolian term for a severe winter in which large numbers of livestock die, primarily due to starvation from being unable to graze, or in other cases directly from the cold. "White *dzud*" happens due to heavy snowfalls; livestock starve because they are unable to reach grass through the thick snow cover. "*Black dzud"* results from a lack of snow in the pastureland which leads to livestock suffering from a lack of water (N. Middleton, Rueff, Sternberg, Batbuyan, & Thomas, 2015).

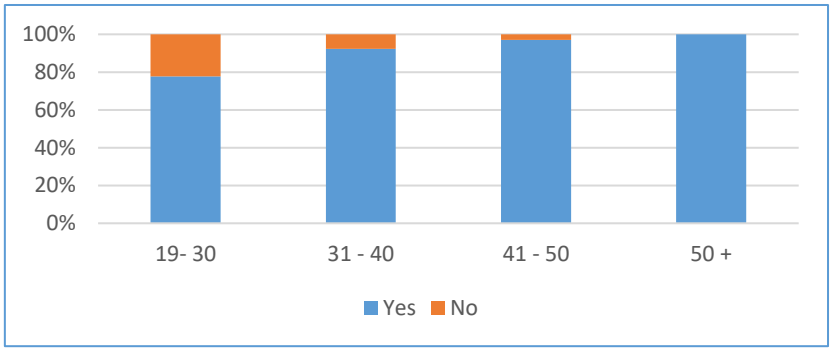

Figure 6.2. Herders' observation of long-term shifts in temperature in the local area, by age group

Herders' observations of the long-term shifts in temperature on the pastureland varied with their age. Twenty per cent of the young herders (19-30 years old) said that they had not noticed any difference while senior herders (over fifty years) all reported that they had noticed changes (Figure 6.2). Herders' perception of the temperature changes aligns with the meteorological data. As stated in the national assessment report, the annual average temperature has increased by an average of 1.3ºC over the period 1976 to 2011, and the warming rate was similar throughout the study area (Gomboluudev.P, 2017a). Regarding their observation of changes in

precipitation, people reported that it is decreasing and that a seasonal shift is happening (the summer rainfall period is getting shorter, and the autumn and spring seasons are becoming dominant) in the case study area. Meteorological data indicates that the annual mean precipitation decreased significantly in the period 1970-2018 (Figure 6.3).

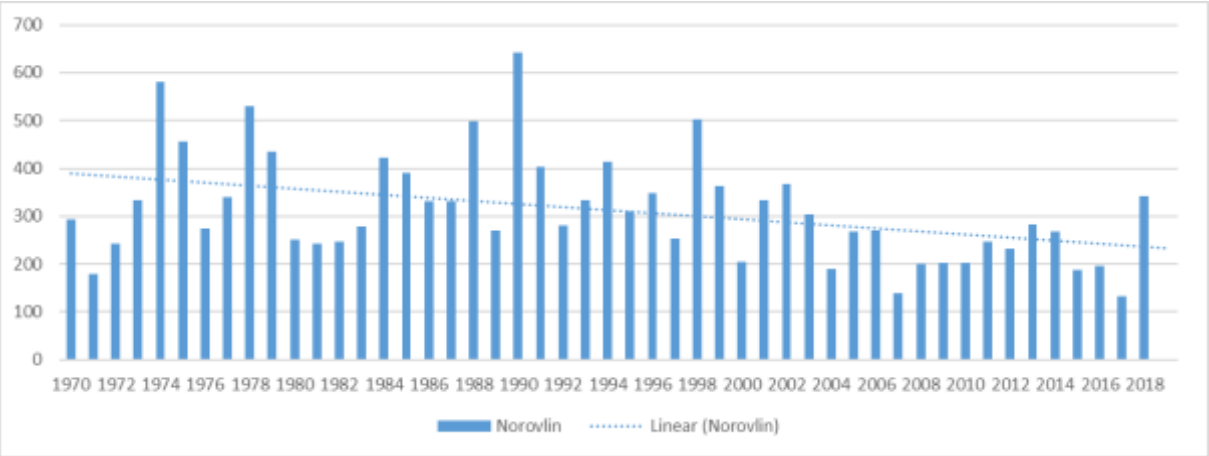

Figure 6.3. Annual mean precipitation, mm, 1970 - 2018. Norovlin soum, Khentii aimag. Trend line is computed by linear regression.
(Data source: Institute of Meteorology and Hydrology, Mongolia)

Focus group discussions, interviews and surveys identified the main ecosystem services that nomadic herders benefit from and indicated how climate change impacts are and will impact on these benefits associated with regulation, provisioning and cultural ecosystem services that directly affect the livelihoods and well-being of nomads (Table 6.2).

Table 6.2. Climate change impacts on pastureland ecosystem services and local livelihoods as identified by nomadic herders

Ecosystem services	Direction of change	Direct Impacts	Impacts on Livelihoods
Regulating services			
- Climate regulation - Water purification - Soil quality regulation - Natural hazard regulation	- Temperature is increasing - Precipitation amount and distribution is changing	- Increased occurrence of natural hazards - Intensified erosion - Soil quality deterioration	- Getting harder to predict the coming season's weather in order to plan herd movements and numbers - Increased frequency of droughts and "dzud" leads to loss of livestock
Provisioning services			
- Grassland for grazing - Freshwater	- Declining - Declining	- Pastureland degradation - Reduced water resources	- Change of herding practices

- Harvesting grass for herding - Fibres and timber - Plants and animals	- Reducing - Reducing - Reducing	- Fewer haycocks per hectare - Some useful plants disappearing	- Staying longer near the riverside area - Reduced movement - Travelling far to harvest grass - Pastureland is getting less productive
Cultural services			
- Aesthetic value - Historical and heritage value - Spiritual value - Educational value - The symbolic value of nature	- Degrading - Degrading - Stable - Reintroduced - Stable	- Landscape colour is changing because of dryness - Historical heritage items are degrading	- Inspirational value is changing - Traditional custom might be changed

The benefits of pasture ecosystem services have changed considerably as a result of both climatic and socio-economic changes in the Mongolian steppe. Increasing temperature, changing patterns of precipitation, and increasing frequency of droughts and black *dzud* have led to a reduction in water resources. According to herders' observation and experiences, "black dzud" occurs following a dry summer and it has occurred every two to three years in the last two decades. Mongolian National Climate change assessment report (MARCC, 2014) states that drought and "dzud" intensity has increased since 1940, and has become particularly more intense since 2000. It causes livestock mortality in the cases study area and in Mongolia generally (Fernandez-Gimenez, Batkhishig, & Batbuyan, 2012; Rao et al., 2015). Also, a dramatic increase in herd size is contributing to more pressure on the pastureland ecosystem. The natural and climatic conditions are most suitable for grazing cattle, raising horses and sheepherding in Bayandun and Norovlin *soums* (D Bazargur, 1998). Livestock numbers have been increasing by an average of approximately 10.5 thousand/year and 6.4 thousand/year in Bayandun and Norovlin *soums*, respectively. Overall, the size of all livestock types is growing, however, due to the increasing demand for goat cashmere, the proportion of goats in herds has been increasing markedly in the case study area (Figure 6.4).

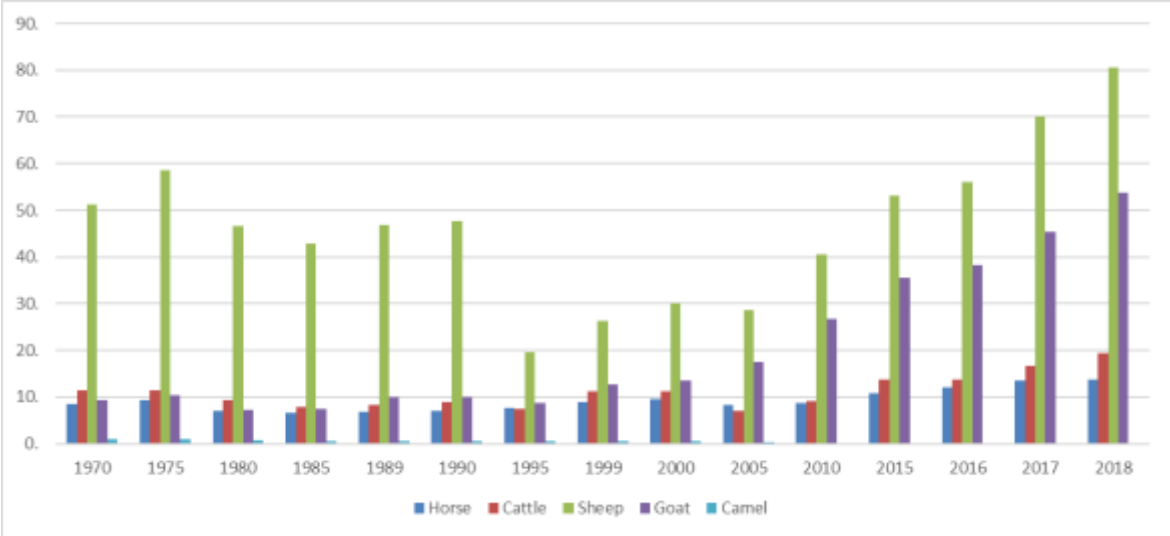

Figure 6.4. The growth of livestock in Norovlin soum, 1970-2018 (by thousand)
(Source: National Statistical report of Mongolia-2018. www.1212.mn)

Furthermore, uncontrolled migration from other regions and soums, by herders seeking more reliable water sources, is also putting pressure on pastureland ecosystems in the case study area. Herders claim that,

> "*Until recently, our livestock numbers weren't huge. Of course, there were some rich people who had more than a thousand animals, but not many; it's very different now. The second most serious cause of pastureland degradation is herders coming in from outside the region. Last winter, more than 10,000 livestock owned by three families from a different region were grazing in the southern part of the soum. More than 5000 horses were grazing in the same area for 3 months! Nothing is left for the following season*." (H1, *Bayandun soum*).

Mining is also a key issue. Each year, the area of land for which licenses for exploration and extraction of minerals are issued increases, and this leads to a reduction in the area of pastureland. In the Ulz river basin, the area committed to mining and exploration licenses is currently about 5000 km^2. The exploration licenses are valid up to 2035 - 2045 (MEGD, 2014). Mining in the Ulz river basin may continue for at least another 30 to 40 years, and perhaps much longer. The extent of mining is a significant constraint on herding, as herding is excluded from exploration and operational areas, and also because mining leases are quite often located beside rivers.

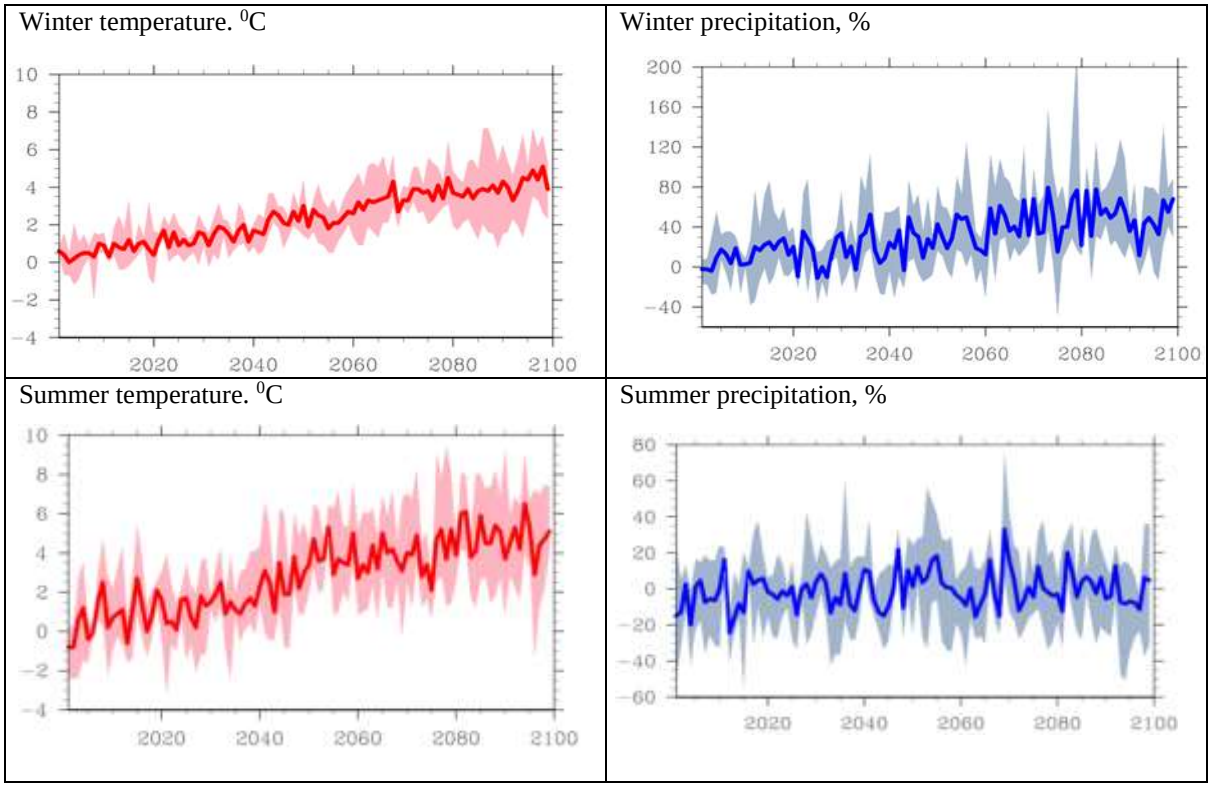

Figure 6.5. 4GCMs output and its ensembles mean of inter-annual variability of time series from 2011-2100, which is determined under A1B GHG scenarios over Ulz river basin (MNET, 2017)

When developing long-term adaptation plans, projections of future climates play a central role. To explore future climate possibilities in the case study area, the seasonal climate change projections for the Ulz river basin were used (Figure 6.5), as presented in the Mongolian Second Assessment Report on Climate Change (MARCC 2014) and the Regional Economic and Ecosystem Services Assessment report (MNET, 2017). Winter temperature is projected to increase by 1.6-2.9^{o}C by mid-century, and by 3.0-3.8^{o}C at the end of the century, and summer temperature is expected to increase by 2.7-3.4^{o}C by the mid-century, and by 3.6-6.1^{o}C by the end of the century.

Broadly, the winter climate is expected to become warmer and snowier (increasing temperature and precipitation) and summer hotter with broadly similar rainfall but increased evapotranspiration compared to the present climate (Gomboluudev.P, 2017a).

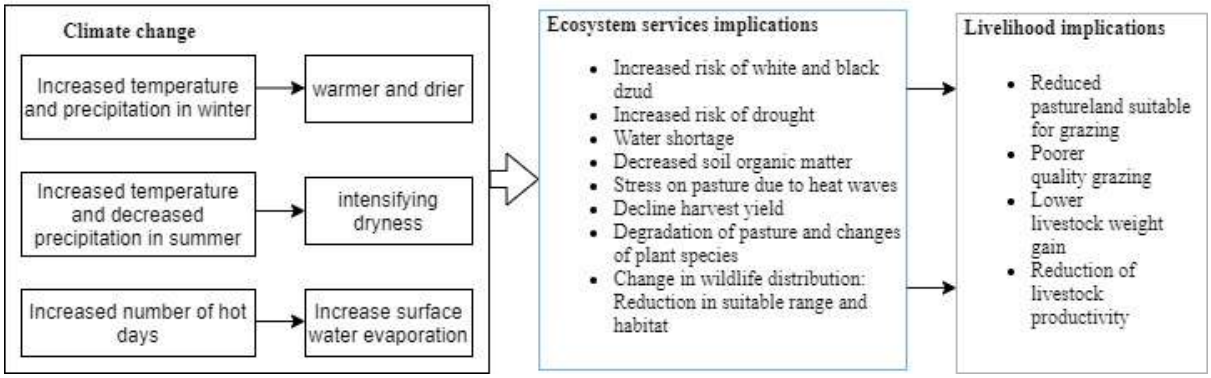

Figure 6.6. Climate change impacts on local livelihoods and ecosystem services

Based on the projection of climate change in the Ulz river basin, a conceptual model was built to explore the changes in the pastureland socio-ecological system (Figure 6.6). It is predicted that in the case study area (Gilbert, Buuveibaatar, Fine, Jambal, & Strindberg, 2016; MNET, 2017; Simonov et al., 2017):

- there will be an increasing number of hot days, evapotranspiration will increase, and river flows decrease;
- the increased variability will involve an increase in the frequency of black and white *dzud* and drought;
- organic matter content of the soil will decrease;
- the land area suitable for grazing will contract; and
- overall there will be a reduction in livestock productivity.

6.3.2. Current adaptation to changes in ecosystem services

Because of the climate and the socio-economic changes described above people are willing and interested to talk about adaptation. The following comment from a herder is typical:

> *"Traditionally, nomadic livelihoods are very adaptive to changes. Their flexibility is why nomadic livelihoods and culture have existed for many generations without substantial changes. Nomadic movement is the key to being adaptive to environmental changes. The main problem now is that we are moving less and over shorter distances"* (*H1, Norovlin*).

As mentioned in the methods section, current adaptation actions were identified in the focus group discussions and then included in the household survey to establish how widespread their use was. The survey respondents identified all the listed actions as important, with none of them identifying any of the actions as "somewhat important" or "not important". Figure 6.7 shows the results broken down by age categories, revealing some important differences in perceptions by age.

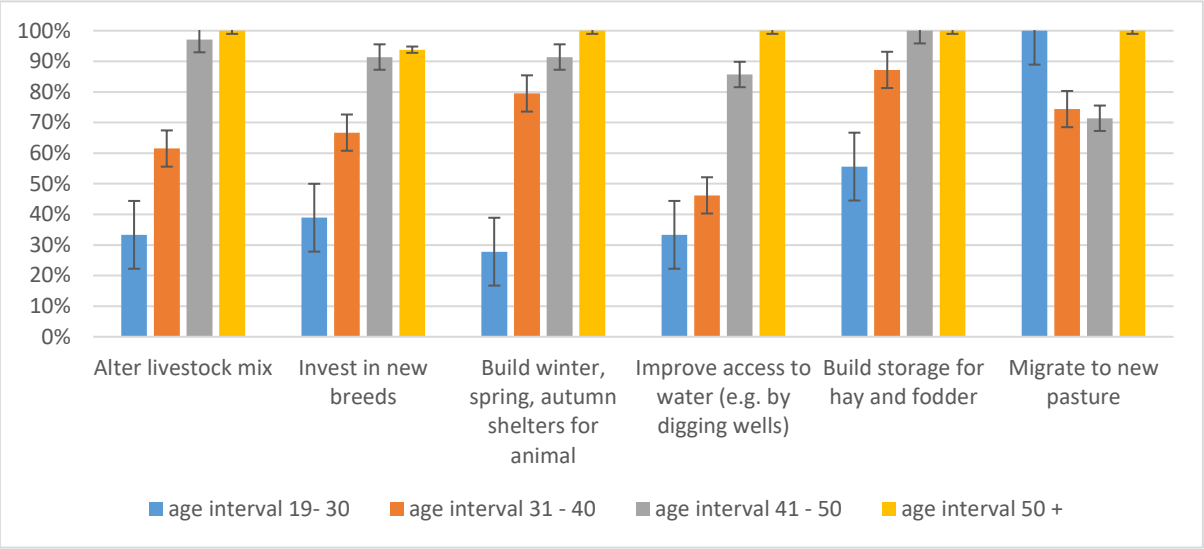

Figure 6.7. Adaptation actions being taken by herders in the case study area

The household survey indicates that herders have taken different actions to adapt to environmental change in ways that correlate with their age and experience. Senior herders (above 50 years of age) have tried all adaptation actions, whereas younger herders concentrated on a couple of actions. Interestingly, young and more senior herders all answered that migrating to new places is an important adaptation option. Herders underlined this in interviews, with one herder noting that "*We try to move very often to preserve pastureland and improve our livestock fattening as well" (H3, Bayandun soum).* Traditional seasonal movements are a defining characteristic of nomadic livelihoods in Mongolia, however, seasonal movements are becoming more limited and the distance travelled is decreasing. Herders claim that because of a decline in availability of water, they cannot move far or change camping places often. However, key informants and some senior herders suggested that for young herders living close to a mobile network and staying close to schools for school-age children were the main reasons for reduced movement distance and frequency.

Most respondents identify building storage facilities for hay and fodder as "very important", and approximately seventy per cent identify investing in water sources as also "very important". Streams and rivers are open access for all, and wells (collective) are intended for both domestic and livestock use in the pastureland. During the interviews, many herders said that improving access to water sources is important for everyone, however, they are cautious about having an extensive program of digging wells because, as one herder put it,

> *"Although we need more water and wells for people and animals, we must be careful where we can dig wells and where we cannot dig. In recent years, quite a lot of wells have been dug near rivers and streams, and river flows have reduced. We think that digging wells near streams leads to a decrease in the flow of water in the river."* (H2, *Norovlin*).

As a herder suggested, *"establishing wells in the isolated areas, where we don't have any open water sources" (*H4, *Norovlin soum)* is what is needed to address water shortages, instead of digging wells near the *soum* centre or riverside areas. It was also noted that increased demand for water from mining is also putting pressure on water resources in *Norovlin* and *Bayandun* soums (MNET, 2014).

There is an initiative to plant crops for winter feed to support livestock. One key informant advised that "*I have started to plant alfalfa (tsargas) in a 5-hectare area to feed 400 sheep and goats and 40 cattle during the wintertime" (KI2, Norovlin).* Other respondents agreed that planting vegetables to feed animals is also useful for improving the carrying capacity of degraded pastures. But this option is likely to lead to changes in natural ecosystems and loss of native grasses, so it is not an option supported by nature conservation NGOs.

Climate change is also affecting traditional weather forecast practices. Herders observe the moon's position, stars' appearances, and other natural phenomena to anticipate weather conditions and patterns. People integrate knowledge from traditional forecast methods with information from the national meteorological forecasting service. The national meteorological forecasting system and technology has been much improved in the last 20 years and using the coming years' weather prediction of local senior herders and the meteorological forecast information, some herders may sell livestock to prepare for harsh winters and save money to buy again next year.

Issues of livestock overstocking need to be addressed in conjunction with climate change adaptation and broader socio-economic changes. Herders have started talking about how to reduce the size of their herds and improve the quality of livestock. As one herder remarked,

> "*We have run into a competition to increase the number of livestock. People are now starting to understand that having so many livestock is causing pastureland degradation. Also, we are having a labour resources problem. (H5, Bayandun soum).*

Herders reported that the productivity of livestock has also been decreasing, with sheep becoming smaller, and the milk yield from cows decreasing year by year. Modifying the composition of herds and investing in new breeds are adaptations that herders are presently adopting to address these concerns, but these are still in the initial stages and not widely used. The labour challenge that has more recently emerged is the result of the dramatic increase in livestock numbers whilst the number of people engaged in herding is declining. Most herders' children now prefer to live in the *soum* centre (village), regional centre (town) or city, and very few of them have become herders by following the traditional apprenticeship model, as a senior herder explained,

> *I have been herding since my twelfth year. I have 4 kids - one of them lives in Germany, he is a pilot, and the other three live in Ulaanbaatar. None of them will come to live here. I don't know who will take care of our livestock in the future. (H2, senior herder, Dadal).*

This view was also echoed by a younger herder,

> *I have three kids; they live in the soum centre with my mother. The eldest is 12 years old and he doesn't ride a horse. So, it is only me who herds livestock. (H5, younger herder, Norovlin).*

A clear response to these challenges has not emerged yet. Mongolia has developed a national strategy on climate change, and implemented adaptation policies (NAPCC, 2011); however, their impact on local practice in the study area is unclear. As one key informant comments "*It is not clear how the national program supports local adaptation. We do not have a budget for its implementation*" (KI5). Locally sensitive and supportive adaptation strategies are essential.

6.3.3. Potential future adaptation strategies

Focus group discussions and a workshop revealed that herders are concerned with the immediate and short-term challenges, as well as with developing long-term coping strategies. The various adaptation options identified by herders are summarized in Table 6.3.

Table 6.3. Adaptation options identified by herders

Options	*Details*
Improve pasture management and maintain ecosystem services	
Improve pasture by supporting the traditional system of seasonal movement of herds	• Assess the carrying capacity of pastureland and use pastureland respectfully, and also regulate this to improve compliance. • Use isolated areas routinely, and stay for shorter periods at each campsite, to improve vegetation cover in pastureland
Reforestation, and planting in degraded areas of pasture	• Plant grasses and other plants that are valuable for herd animals in areas of degraded pasture
Expand and rehabilitate water supplies	• Dig wells in isolated areas and far from rivers and streams • Establish an artificial pond and lakes • Protect rivers from mining (illegal consumption), both extraction and pollution • Reintroduce traditional water use customs, such as protecting headwaters, camping at some distance from rivers, etc.
Leverage traditional knowledge of ecosystem services	• Herders draw on extensive traditional and personal knowledge to maintain and manage the pastureland resources • Traditional local institutions have their own rules, norms and values that guide management of local pastureland
Improve animal productivity	
Change herd composition through the selection of different animals and breeds	• Herd livestock in the appropriate ecological zones. Herders know which part of the soum area is suitable for grazing and for certain types of livestock. • Reducing overgrazing will improve the quality of pasture which will improve livestock quality
Improve animal health	• Improve mobile veterinary services • Use traditional methods to treat and heal animals
Increase support for herding businesses	
Establish an insurance system to protect against loss of animals	• Link the system to climate change adaptation
Establish prevention funds	• Help herding communities to establish risk/disaster prevention fund
Develop/transfer new technologies that support herding	• Rainwater harvesting, planting vegetables to feed animals, etc.

Options	*Details*
Expand the range of renewable energy-based services available to herders	• Improve the accessibility of television and other information-sharing facilities. • Provide more accurate meteorological information, and other information useful to herders
Improve access to markets	• Improve the infrastructure to access markets for livestock and their products
Promote and support the establishment of different kinds of enterprises	• Increase local herders' involvement in the tourism business
Support local culture and organizations	
Promote traditional collective communities	• Support traditional local institutions: "*Khot ail*", *"neg goliinkhon*" • Use these collective communities to manage pastureland ecosystem services sustainably
Train young herders	• Promote traditional herding knowledge and practice
The extension of mobile phone coverage to more areas	• Encourage people to travel further from soums, alleviating pressure on those pastures near soums. It might also help herders' children to study online.

As Table 6.3 shows, diverse types of adaptation actions could be taken by and with herders to help herder communities cope with change. Some interviewees also supported the idea of shifting to a different form of pastoral livelihood, a "*hybrid system of animal husbandry, like semi-intensified farming" as a way of adapting to the combined climatic and socio-economic changes* (KI2, *Bayandun soum*). Given the semi-arid climate and the uncertainties about future surface and groundwater water availability, it is unclear whether semi-intensified farming would actually be adaptive in the long-term. It would certainly entail a massive change in social relations to land.

Overlaid on the climate and cultural challenges are governance challenges. Mongolia's current political and legal system requires local authorities to follow and implement action plans that have been approved and designed at the regional and national levels. One key informant commented:

> *Plans with options for local land and natural resources management are needed to improve climate change adaptation at a local and regional level* (KI4).

Another commented similarly,

> *We need to give more rights to local municipalities to do locally-based planning of natural resource management. At present, local municipalities have limited rights. In environmental decision-making processes, a top-down approach is used in Mongolia* (KI1).

In response to the need for more locally-sensitive responses, in Norovlin *soum* a local authority has established "herder families groups" to increase herders' involvement in decision making (KI1). According to the initial plan, herder family groups will take full responsibility for pastureland management in the family group's herding area. Each herder family group will make an agreement with the *soum* authority about how the land will be managed.

There is a strong need for integrated planning and long-term capacity development of stakeholders at the local level, to cope with current and emerging environmental issues, and support the adaptation of nomadic livelihoods to climate and other changes at a local level. In the focus groups held with national experts, policymakers and practitioners, they highlighted the need for collaboration and synergy among the various institutions working in these areas. Key informants suggest giving more rights to the local authorities and developing plans with options that support more locally appropriate responses. Moreover, to support herders' participation, and local decision-making generally, relevant, accurate data is essential. Local managers suggest that there are significant difficulties with basic information that need to be overcome:

> *"We need to improve data and information sources. The research data available for environmental impact assessment and the actual situation are quite different. We need more accurate data for everything. We count livestock by phone, and it is same for water accounting as well. We need to improve the processes for water accounting and for the livestock census."* (KI3).

Though herders have identified diverse actions they are taking, or propose to take, to adapt to the changes, most of these actions are oriented to the relatively short-term; major long-term adaptation strategies remain unclear.

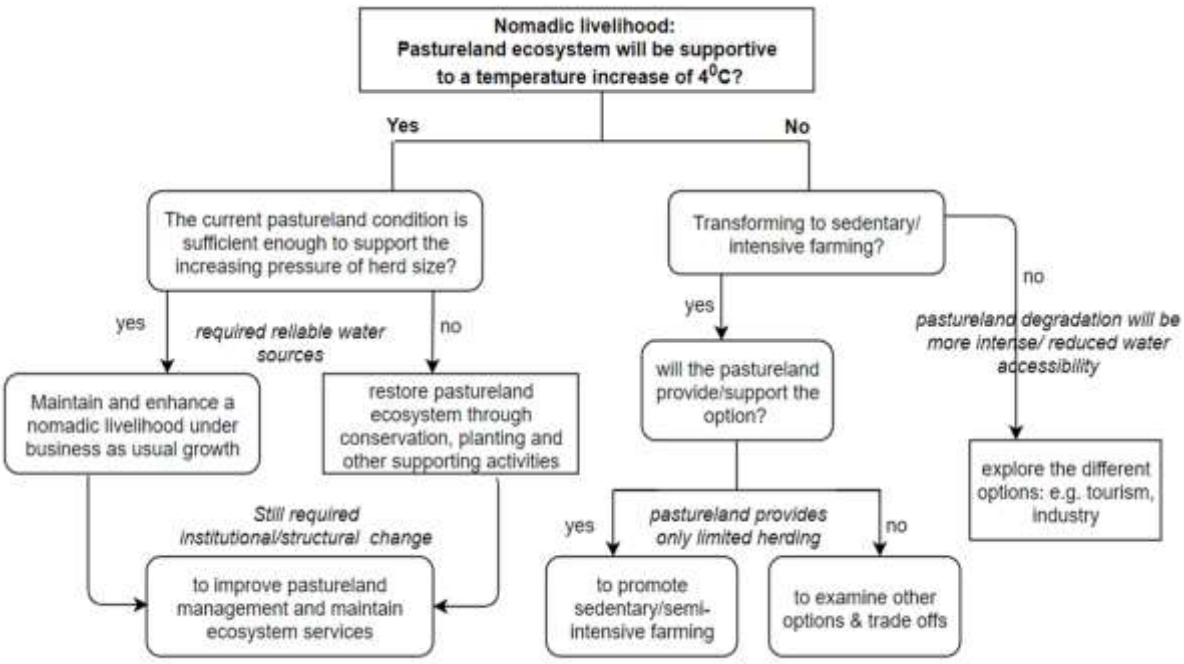

Figure 6.8. Decision tree for pastureland management under climate change, using the example of Northeast Mongolian pastureland: A Nomadic livelihood existence

Over the long-term, climate change projections for the Ulz River basin reveal the probability of irreversible, transformational changes in ecosystems, that have the potential to have major detrimental impacts on the nomadic culture and livelihoods that depend upon them (Colloff et al., 2016; Wise et al., 2014). Planning for transformative adaptation (Fedele, Donatti, Harvey, Hannah, & Hole, 2019) is needed in the case study area. Figure 6.8 outlines a possible logic for this kind of transformation. It should be noted, as well, that climate change scenarios for Mongolia are based on a relatively short climate data set (30 years), and uncertainties are very high (MARCC, 2014) - and the open steppe pastureland of the Mongolian high plateau is the cradle of surprises. However, the question of the sustainability of nomadic livelihoods in a world where the average annual temperature has increased by 4^0C remains unanswered.

6.4. Discussion

Nomadic herders have a long history of adaptation to environmental change (D Bazargur, 1998), but over the past 30 years they have faced more climate change impacts than ever before, and at the same time, there have been significant changes in Mongolian society and economy. Ongoing adaptation at the local level is essential. Nomadic herders' knowledge and practices obviously have a central role in this, as is the case for indigenous communities generally (Bhatta et al., 2015; Kupika et al., 2019; Naess, 2013; Pearce et al., 2015). Adaptation to varying conditions is central to nomadic livelihoods; seasonal movement and management of livestock in the open pastureland are at the core of this. Herders provide key insights into impacts and

opportunities at the *soum* level; they have extensive knowledge of the ecosystem services the region provides.

Figure 6.9 indicates the main ways in which the ecosystem services that nomadic herders are dependent on are put at risk by climate change.

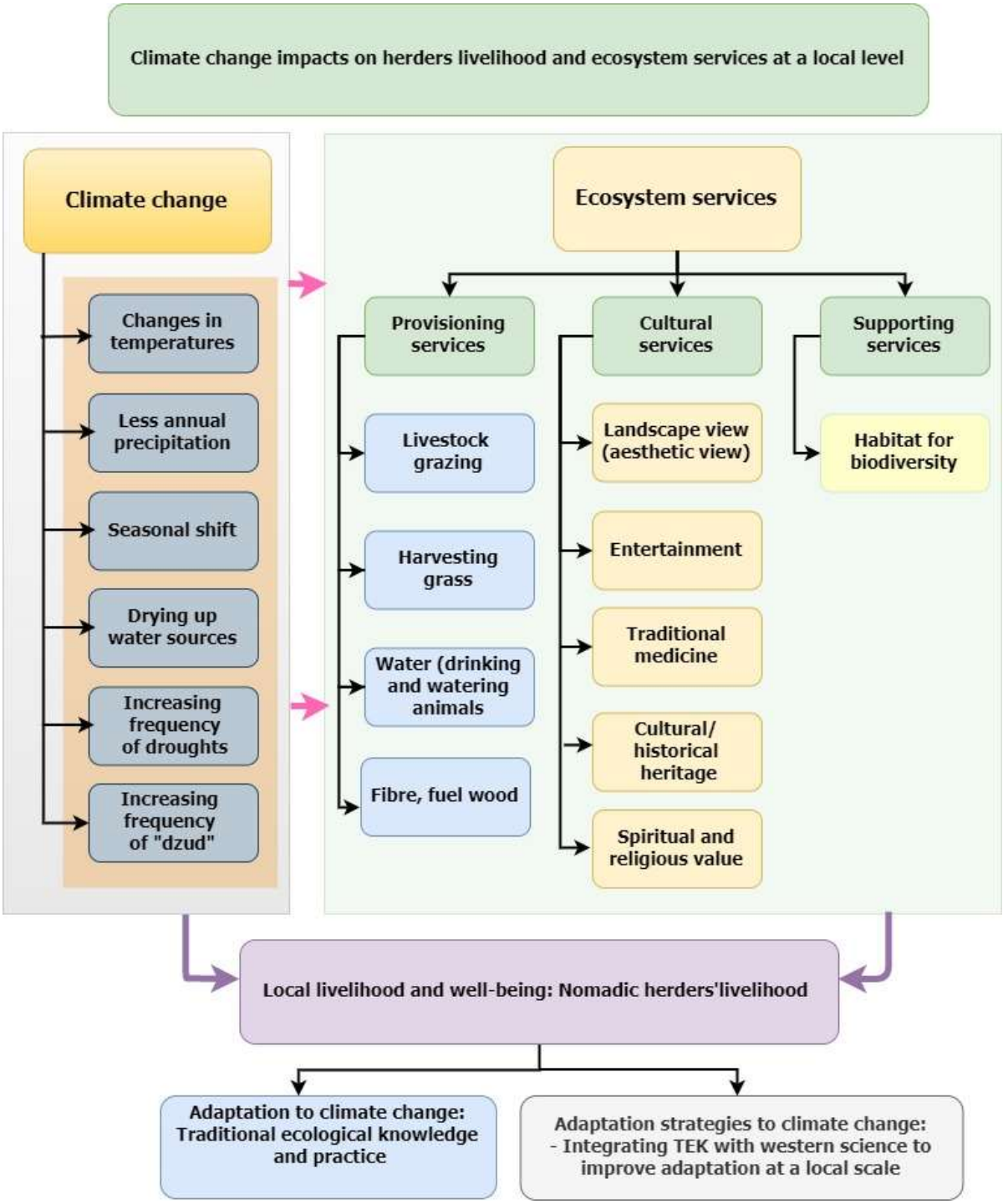

Figure 6.9. A simplified conceptual framework illustrating the climate change adaptation challenges from an ecosystem services perspective

Household surveys show that experienced herders are taking more adaptation actions than young herders to cope with changes. This suggests that the effectiveness of adaptation depends on herders' knowledge of pasture ecosystems and pasture management skills. Elders focus on how to herd livestock in the resource-scarce pastureland and manage livelihoods while moving in search for better pasture and water sources for livestock. Elder herders and local key informants acknowledge the need for institutional support to assist in strengthening the transmission of traditional ecological knowledge among younger herders. Reemphasis on local knowledge and its' supporting social mechanisms is important for shaping adaptation options for local communities (Berkes et al., 2000) as well as for nomadic herders in Mongolia.

Like other pastoralists around the world, Mongolian herders hold detailed knowledge of pastureland plants (Seid et al., 2016) and their perceptions of spatial and temporal variability in the surrounding environment are reflected in the decision making about herding strategies (Fernandez-Gimenez, 2000) as well as how to adapt to the impacts from climate and socio-economic changes (Fedele et al., 2019). Climate and other socio-economic factors are leading them to adapt to changes by altering traditional ways of herding and maintaining pastureland ecosystems. Traditional seasonal movements have reduced significantly, as the importance of formal education for children has increased and as herders have adopted new technologies. As Fernández-Giménez (1999) has pointed out, this is resulting in an increase in pressure on pastures in Mongolia and is facilitated by the absence of strong institutions to manage seasonal movements and coordinate the herders' actions. Nonetheless, the seasonal movement of nomads embodies a valuable understanding of local variability and is a skillful adaptation to the dynamics of this temperate dryland ecosystem. Findings suggest that through improved support, more traditional, nomadic movement patterns may well be an appropriate adaptation strategy for the next few decades. In particular, herders suggest making more use of isolated areas by improving access to water, supplemental winter feed crops, etc. Other supports for increased movement could include enhancing mobile veterinary services, social services that follow nomadic communities, and a livestock insurance system to help manage increasing climate and weather risks.

Reduced availability of water is expected to be the main way climate change impacts nomadic livelihoods. Thus, key informants, including natural resources management specialists, recommended calculating pasture carrying capacity more accurately by integrating assessment of water sources and their accessibility, rather than simply focusing on the total size of unoccupied areas. More detailed and accurate carrying capacity assessment will provide more

opportunities to plan local land management and organize nomadic movement at an adaptive scale (Dietz et al., 2003). A clearer strategy to support people into alternative livelihoods is also required.

Alongside the expected changes in pastures, changes in wetland and forest habitats are also expected. The wetlands of Northeast Mongolia are the homeland of numerous migratory birds. The white-naped crane, which is listed as endangered, is an example. Knowledge of its migration is part of traditional ecological knowledge of local herders and stories of its migration are highly valued (see previous chapter). However, the suitable habitat of the white-naped crane is predicted to decrease by almost 50 per cent by the end of this century. Forests are also predicted to decline (MNET, 2017). It is very unclear how nomadic livelihoods and pastureland ecosystems will respond to the predicted temperature increase of about 4^0C by the end of the century. The anticipated changes in environmental conditions encourage us to look beyond current adaptation options and strategies to prepare for and mitigate the possible impacts and risks of climate change.

How support for adaptation should be funded needs to be considered. Mongolian nomads use common pool resources (notably pastureland and water sources), using herders' knowledge and practices, in a market-oriented society. At present, Mongolians do not pay any taxes for the use of vital natural resources, such as pasture and fresh water for livestock and there is no insurance system for natural disasters. Indeed, the government gives a range of subsidies or incentives[23] to the herders, such as payment for production of cashmere, wool, fur, etc. This unconventional system of national policy has led to dramatic increases in the number of livestock, and provides more opportunities to wealthy herders or urban-based owners of a large amount of livestock to benefit from pastoral ecosystem services, as compared to ordinary, local nomadic herders. Fairer regulation in the interests of herders (not business owners) is required. Our research suggests that introducing a livestock insurance system, perhaps funded by a new tax on herders, should be considered as part of long-term adaptation strategies to sustain nomadic livelihoods.

Governance arrangements will probably need to evolve. Previous research (Zhen et al., 2010), and our findings, both reveal that nomadic herders prefer that pastureland ecosystems and resources are managed at a local or *soum* level. After the privatization of the agricultural sector in the early 1990s, Bazargür et al. (1993) suggested supporting the traditional local institutions,

[23] The 394th order on "Incentives for herders and people who own livestock", which was approved by the Government of Mongolia on 30th November 2013.

such as *khot-ail* and *neg goliinhon*, to support sustainable livelihoods and the environment. Our conclusions, 25 years later, are similar. Traditional, local social institutions necessarily have key roles in managing change (Berkes et al., 2000; McNamara & Buggy, 2017). The National Action Program on Climate Change (NAPCC), in 2011-2021 of Mongolia aims to ensure environmental sustainability, development of socio-economic sectors adapted to climate change, and reduction of vulnerabilities and risks, however, the current institutional arrangements have clearly not been designed to implement such a program. The need for broad institutional change is very apparent.

Although the research findings show that the traditional nomadic culture has changed to some extent, most Mongolians believe that the nomadic lifestyle, which about 22 per cent of the total population follow, has retained its basic character (NSC, 2018). Herders are ready to take action to adapt incrementally (Fedele et al., 2019), however, they do not want to change the foundations of nomadic livelihoods which are strongly based on using common pool resources and mobility strategies. Their approach has wide support. Mongolians, in general, hold the view that preserving and supporting the existence of nomadic livelihoods should be one of the main priorities of the country. Yet this is in tension with the prioritization of mining over herding in various locations. Finding ways to support adaptation that meets the needs of nomads in ways that fit in with nomadic cultural norms is challenging, as adaptation must make sense amidst the integrated effects of globalization, modernization, and climate change. Gómez-Baggethun et al. (2013) and Whyte (2013) argue that the integration of scientific and local knowledge is a promising approach to developing scientifically sound, locally appropriate adaptation strategies. Deeper integration of ecosystem services thinking and traditional knowledge is a specific strategy that needs further work (Munang, Thiaw, Alverson, Liu, & Han, 2013).

Our findings suggest that the traditional customs and spirituality of nomadic herders may guide pastureland management in ways that encourage collective efforts to responsibly use, protect and conserve pastureland ecosystems, and as such these should be supported by *soum*, region and national institutions.

6.5. Conclusions

Nomadic herders derive many, diverse benefits from the open pastureland ecosystems; these underpin the long-term existence of nomadic livelihoods. Nomadic herders in Northeast Mongolia are concerned about shifts in climate, including changes in temperature and rainfall. Herders' knowledge of ecosystem services provides insights into the changing climate and

environment and ways to adapt to changes; in a scientific data-scarce setting such as Mongolia's open pastureland, these contributions are especially helpful.

Herders are also very aware of socio-economic factors that are driving changes in their local environments, including the continuing expansion of the mining sector, increasing herd sizes, uncontrolled migration from other regions and *soums*, and the adoption of new technologies by herder families. Acting together, climate change and these Mongolian socio-economic changes are having a marked impact on nomadic lifestyles and herding practices. Our research indicates, though, that nomadic herders' knowledge and practices continue to play a crucial role in guiding adaptation. Traditional seasonal mobility strategies are the main way nomads have been adaptive; herders move to find better pasture and water sources to maintain or improve the wellbeing of their herds. This nomadic movement is continuing to play an essential role in the maintenance, restoration and conservation of pastureland ecosystem services.

Nomadic herders have been practicing a range of adaptation strategies to deal with the impacts of climate change. However, the rates of change are high. Government policy needs to support current adaptation whilst preparing for longer-term adaptation that may be considerably more radical. To be implementable, short to medium term and long-term adaptation strategies need to be built with the active engagement of local herders.

This study demonstrates that using traditional knowledge of ecosystem services to understand resilience and the adaptive capacity at a local scale can make a strong contribution to coping with and adapting to climate change. Leveraging local knowledge is essential to developing appropriate, locally-based policies and adaptation plans.

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Chapter 7 (Paper 4): Using ecosystem services thinking in adaptive management of Mongolian pastureland

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Traditional ecological knowledge still plays a key role in adaptation challenges on the open-steppes of Mongolia; however, the current and future socio-economic and climate dynamics require the use of different lenses in local environmental decision-making. Thus, this chapter investigates the applicability of ecosystem services thinking alongside the local knowledge of livelihoods and environmental conditions, analysing its risks and opportunities in local planning processes. Building on the findings of Chapters 4 (Paper 1), 5 (Paper 2) and 6 (Paper 3), this chapter (Paper 4) responds to the research question of how and to what extent the concept of ecosystem services has been integrated into local planning in Mongolia, and how an ecosystem services approach can be used to maximize benefits and minimize disadvantages in support of adaptation. An ecosystem services approach has introduced policy at a national level that is supported by international organizations and donors in Mongolia. As in many other countries, the top-down approach dominates decision-making in Mongolia, so the approach is likely to be used in regional and local environmental management plans shortly. However, there are some issues concerning the use of the approach in regional and local environmental plans.

Based on the analysis of local land-use-related planning documents, fieldwork interviews, and a workshop, this chapter explores demonstrable sensitivity to and understanding of ecosystem services in the local plans of Northeast Mongolia. Although the exact term 'ecosystem services' is not used directly in regional and local land-use-related plans in Mongolia, this paper argues that the lack of a precise term in policy-oriented documentation does not mean that in some sense this kind of thinking is not being employed. This chapter highlights that an ecosystem services thinking has existed in nomadic society as "*baigaliin khishig"* – benefiting from nature without altering its structure. So, the chapter emphasises the differences in framing between the Western scientific approach of ecosystem services and the traditional knowledge of ecosystems services, and highlights the risks and opportunities of using an ecosystem services approach in environmental management at the national and local levels. The paper also discusses the benefits and risks of a top-down trajectory in environmental decision-making, as well as

integrating an ecosystem services approach into environmental management at different scales. The chapter suggests the leveraging of traditional ecological knowledge of ecosystem services in order to develop a holistic and actionable plan at the local level by empowering local communities in local development plans. The chapter demonstrates that an ecosystem services approach is useful for integration into local planning, as long as careful consideration is taken of differences in place, culture, and tradition.

Abstract

Interest in using an ecosystem services approach in environmental decision making and natural resources management has increased markedly, however, use of this approach at a local level, particularly in the developing world, is challenging. Mongolian pastoral society provides an opportunity to investigate what is possible. Focus groups, interviews with key informants, decision-makers, experts and nomadic herders, and a policy workshop, were used to explore its applicability. These were complemented by a policy document analysis that assessed the level of sensitivity to ecosystem services in current land use planning practice. The study demonstrates that a sensitivity to provisioning ecosystem services is integral to traditional nomadic pastureland management. Consideration of regulating and supporting services is less developed. Exploring options for nomadic herders adapting to climate change brought out some of the challenges and opportunities of bringing traditional culture into dialogue with ecosystem services thinking. Ecosystem services thinking arrives at the local level down a governance hierarchy, and this creates risks of marginalization of local interests and understandings. Finding ways to leverage local knowledge and to use ecosystem services thinking to empower local communities are essential.

Keywords: *ecosystem services, land use planning, adaptive management, nomadic livelihood, pastureland ecosystem, Mongolia*

7.1. Introduction

Ecosystem services thinking is being drawn on more widely in environmental policy making. The establishment of IPBES (The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 2012), followed by the release of the *Millennium Ecosystem Assessment's* reports (MEA, 2005), have played a key role in this. Its use in global and regional policy-making is now quite prominent (Díaz et al., 2015). It is also commonly used in urban planning in the developed world (Hansen et al., 2015; Kaczorowska et al., 2016; S. T. Lam & Conway, 2018; Nordin et al., 2017; von Haaren & Albert, 2011). The range of its local and operational uses is still quite limited, however, and there are questions about its usefulness outside broad policy making (Costanza et al., 2017).

There are a number of reasons why exploring its potential to support local environmental decision making is attractive. To decision-making processes that tend to emphasize economic values, at the expense of the environmental values on which economic activity depends, an ecosystem services lens brings an important rebalancing: inviting careful consideration of this interdependence (Schleyer, Görg, Hauck, & Winkler, 2015). To intellectually siloed decision-making processes it brings a commitment to interdisciplinarity. Because it focuses attention on

interfaces between livelihoods and ecosystems, it brings cross-sectoral issues into focus (Saarikoski et al., 2018). And lastly, because socio-ecological dynamics are central to ecosystem services thinking, it invites cooperation across administrative boundaries.

Any systems thinking approach could make similar contributions. What makes ecosystem services thinking particularly worthy of attention is, firstly, that its relative simplicity makes it relatively accessible to decision makers and policy professionals (it focuses on ecosystem / livelihood interfaces rather than socio-ecological dynamics at large), and secondly, its prominence in international policy gives it useful legitimacy.

The challenges that climate change and socio-economic change are creating for nomadic livelihoods in Mongolian pastureland (Densambuu, Sainnemekh, Bestelmeyer, & Budbaatar, 2018; MARCC, 2014) provide a way to probe the usefulness of ecosystem services thinking in local planning that has the potential to add substantially to the body of research into ecosystem services approaches. Ecosystem services are defined as "*the benefits people obtain from ecosystems to sustain or advance wellbeing"* (MEA, 2005, p. 3). Mongolian pasturelands are rural landscapes, local communities are deeply and intimately dependent on their local environment, traditional ecological knowledge makes a core contribution to these livelihoods, and Mongolia is relatively early on a modern development trajectory. There has been much less experience with using ecosystems services approaches in developing nations (Grêt-Regamey et al., 2017; Pandeya et al., 2016; Runting et al., 2017), though interest has been rising (Ferraro, Lawlor, Mullan, & Pattanayak, 2011), however, the majority of this work has been in just two countries, China and Brazil (Chaudhary & McGregor, 2018), which are both substantially further along a modern development trajectory than Mongolia. And aside from urban planning in developed nations, there has also been little exploration of the utility of ecosystem services thinking at a local scale (Pandeya et al., 2016; Runting et al., 2017).

The impact of climate and other changes on pastureland ecosystems in the Mongolian plateau is increasing and ecosystem services have been significantly altered (Zhen et al., 2010), however, there is very limited study of ecosystem services thinking used by nomadic herders in Mongolia (Upton, 2020). Probing the usefulness of ecosystem services thinking to support Mongolian nomadic livelihoods in a changing climate therefore has the potential to contribute substantially to our understanding of where - and particularly how - ecosystem services thinking can be employed to benefit local communities, and thus support national and global efforts to develop sustainably.

To investigate the risks and opportunities, this paper examines Mongolian experience to date with ecosystem services thinking, and ways in which ecosystem thinking can be drawn into local planning for pasturelands to support ongoing adaptation.

7.2. National legislation and policy of Mongolia

The local agencies work within frameworks established by Mongolia's national government. The preservation, restoration, and sustainable use of Mongolia's pasturelands are priorities in many national policy strategies. The first Mongolian law governing land use - the "*Ikh Zasag*" or "Great Law" - was created in the XIII century by *Chinggis Khaan* (Damdinsuren, 1957). Amongst other things, this law governed migration between administrative units. In the section on "traditional land ownership and authority", this law stated that "pastureland is the property of the state". This principle has not been changed over the centuries. This law became the main tool for regulating and protecting Mongolian nomadic customs and traditions.

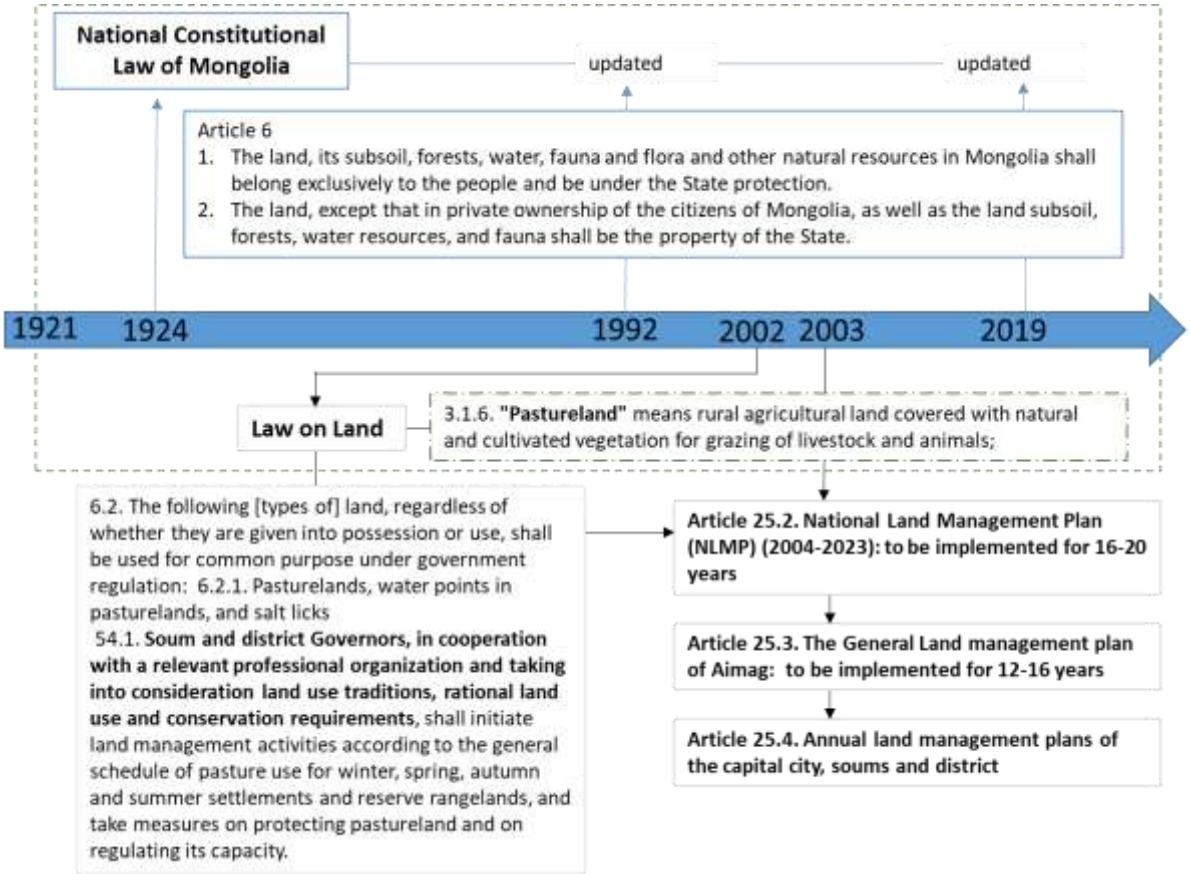

Figure 7.1. Land management planning in Mongolia

Since the XIII century, many laws and programs have been developed and implemented within the framework that the Great Law established to preserve and support nomadic use of pastureland as a common property resource. Spatial planning in Mongolia is currently regulated by the "Law on Land" (issued and approved the Parliament of Mongolia in 2002, Figure 7.1).

This law establishes three levels of land use planning: national (the government of Mongolia), regional (*aimag-province*) and local (*soum* – district municipalities). The National Land Use Plan functions as a guidance document for long-term land use planning in the country (Figure 7.1). Regional land-use plans are based on the National Plan; these are for periods of 12-16 years. Every year, a local land management plan is developed, at *soum* level, for pasturelands in Mongolia; this is much more detailed. In November 2019, the parliament of Mongolia approved the second set of amendments to National Constitutional Law and it is effective from 25 May, 2020. According to the new amendments, natural resources are defined as 'state property that is available for public use', to make it clear that in their case being 'state property' does not mean that beneficial uses (e.g. communities using particular areas of pastures as a commons) are excluded by the state's ownership. Thus, it is expected that changes in Mongolia's natural resources policy will occur soon after the new amendment is in effect.

In Mongolia, the term "ecosystem services" was introduced in 2012 by the project *'Ecosystem-Based Adaptation Approach to Maintaining Water Security in Critical Water Catchments in Mongolia*' (2012 - 2018), co-funded by the Government of Mongolia, The Adaptation Fund and UNDP. The project produced several guidelines and policy papers using the term, but the approach is still considered relatively new in Mongolia, and is not often used in environmental management and decision-making processes. In the national level documents, the term 'ecosystem services' was explicitly used in Mongolia's Green Development Policy (2014), defining it as "*ways humankind benefits [in the Mongolian version of the Policy the word is 'profits'] from ecosystems, in the form of provisioning, such as food, raw materials, and natural resources, regulating, such as the control of climate and impacts of rapid environmental changes, supporting human life, and cultural services, such as spiritual benefits"* (GDP, 2014, p. 4). Associated policy development was supported by the Swiss Agency for Development and Cooperation. In 2014, the Asian Development Bank released a report on *"Making grasslands sustainable in Mongolia: International experiences with payments for environmental services in grazing lands and other rangelands"* (ADB, 2014) presenting some key issues relating to the design of payment for environmental services schemes in the context of Mongolian grasslands. Then, the National Biodiversity Program was approved by the Government of Mongolia in 2015 with the support of UNEP and WWF. The Program's ecosystem services approach was identified in "*Goal 13: Taking into account the value and importance of pasture, water resources and forest ecosystem services, develop and implement a framework for sustainable use and conservation of natural resources in which social and economic benefits of these resources are appropriately protected*" (MEGDT, 2015, p. 34).

As Figure 7.1 shows, pastureland management issues is regulated by the general "Law on Land" in Mongolia. Article 54 is specifically states pastureland, its rational use and protection. According to the article 54.1, as "*Soum and district Governors, in cooperation with a relevant professional organizations and taking into consideration land use traditions, rational land use and conservation requirements"* (Khural, 2002), the above mentioned national policy, program, and guidelines are needed to take account in the local (*soum* level) land-use plan.

This legitimizing of the ecosystem services thinking at the national level as a lens to guide regional and local planning is a major practical reason for exploring how ecosystem services thinking can be drawn on helpfully in local land use planning.

7.3. Methods

The case study area is in the Dauria Steppe Global Ecoregion, northeast Mongolia. The ecoregion covers the eastern part of Khentii mountain ranges and Mongol Daguur steppe in Mongolia. The large rivers such as the Onon, Ulz, and Balj flow in the ecoregion. Within this ecoregion, there is a network of protected areas that includes the Mongol Daguur Special protected area, Onon-Balj National park, and the Ugtam Uul Nature reserve. As the Worldwide Fund for Nature (WWF)- Mongolia highlights, the Dauria steppe ecoregion is an example of "the last areas in the Palaearctic that still supports stable herds of larger vertebrates'[24], and it is a transit zone from the forest-steppe to steppe ecosystem in the Northern hemisphere (Tsegmid, 1969).

The fieldwork was conducted in June-July 2019, in three *soums* (districts – a second level subdivision) - Norovlin and Dadal in Khentii province, and Bayandun in Dornod province. Each *soum* has approximately 2000-5000 inhabitants, primarily nomadic herders. We conducted interviews with local key informants (n=10) and nomadic herders (n=25) in the case study area, and organized a workshop in the capital of Mongolia, Ulaanbaatar, inviting the policymakers and experts who work in environmental management (n=12). Interpretive approaches are used in qualitative research to understand and contextualize human experience and its specific meanings (Putnam & Banghart, 2017). We used an interpretive approach to analyse the interview and workshop transcripts (Elliott & Timulak, 2005), to identify the key issues, risks and benefits, and options for managing the risks and making use of the opportunities. The interviews and workshop were complimented by a document analysis, looking for explicit and

[24] http://mongolia.panda.org/en/

implicit mentions of ecosystem services in the key land use, water resource and economic development plans covering the case study region.

To explore how appreciation of ecosystem services was already embedded in local understanding and local planning, we analysed the transcripts of conversations with herders and local key informants, to identify the ecosystem services that they mentioned, and then analysed six key regional and local planning documents, to see how local people's concerns were, and were not, addressed in local and regional land use related plans.

To analyse the key local and regional land use related plans, we identified whether the ecosystem services that local people identified were mentioned explicitly, implicitly or not at all, using a method based on Hansen et al. (2015) definitions that have been used by various other researchers, for example Nordin et al. (2017); Chaudhary and McGregor (2018):

> "Explicit reference indicates a conscious uptake of the ecosystem services concept while implicit references are understood to be based on similar conceptual understandings or underpinnings of [in our case, rural] ecosystems and their benefits without conscious linkages to the ecosystem services concept" (Hansen et al., 2015, p. 229).

To adapt this method to explore Mongolian sensitivities to dependence on ecosystem services, we asked, resonantly, whether there was explicit or implicit mention of 'benefiting from nature' in each element of the plans. For example,

> "to increase the number of water points to enable the use of reserved pasture, and take actions to restore degraded pastureland" (Ulz River basin Integrated Management Plan 2014-2021, MNET (2014, p. 25)) is an *explicit* mention of the contributions of freshwater and grassland to livelihoods, i.e. these are natural resources that are directly used by nomadic herders; also, specifically these are provisioning services.

And,

> "to protect the keystone species in grassland ecosystems" is *implicitly* referring to pastureland as a provisioning service, given that one of the reasons for this being an objective is because these ecosystems are homelands for nomadic herders *(*Onon-Balj National Park Management Plan, MNET (2013, p. 7)).

7.4. Results and discussion

7.4.1. Environmental management issues

Nomadic pastureland management is an example of a dominant use regime (Ruhl, 2016): the vast majority of the pastureland in the case study area is used for nomadic herding. This pastoral system has existed for more than 3000 years (Bazargur.D, 1998). Pastureland makes up roughly three-fourths of Mongolia's land area, providing grazing land for around 67 million head of livestock, supporting the livelihoods of about 22 percent of the country's total population. Five kinds of livestock dominate: sheep, goats, cattle, horses, and camels. Livestock production is the second largest sector of the national GDP (NSC, 2018). Mongolia's open steppe pastureland is also an important habitat for wild species, including many endangered species.

Nomadic herding is low-input agricultural regime. Seasonal movement enables adaptive use of pastureland, water, wetlands, and forest resources, in an arid and semi-arid environment. However, herd sizes have increased greatly over the last three decades (NSC, 2018) and climate change has been relatively rapid in Mongolia and the annual mean temperature has increased by 2.14°C during the last 70 years (D Dagvadorj et al., 2014). Estimates suggest about 75% of pastureland is overgrazed and overstocked with domestic livestock (Jamsran Tsogtbaatar, 2013); combined with climate change, causes significant land degradation (D Dagvadorj et al., 2014). Permafrost used to be usual feature of Mongolian landscape covering more than 63 % of the country area, where half of the area was the continuous permafrost, currently it covers only 29 % of a total territory in Mongolia (Sharkhuu, 2003).

The effects in our case study region in northeast Mongolia have been large. The average annual temperature has increased by 1.3^{o}C over the period 1976 to 2011. The climate in is getting drier, and the frequency of extreme climatic events, notably droughts, is increasing. The projected increase in average temperature is 4.0-4.2^{0}C by the end of this century (2081-2100) (MNET, 2017). As is the case in many other parts of Mongolia, overgrazing, and other activities, notably mining and infrastructure development, are also threatening nature conservation in the study area (MNET, 2013).

Traditional ecological knowledge can clearly speak to these adaptation challenges, however the current challenges include both socio-economic and climate dynamics that are outside traditional experience; this is a fundamental reason for drawing on fresh lenses in local planning processes, alongside the (evolving) local knowledge of livelihoods and environmental

conditions. The key environmental decision making organisations in the case study area are the local *soum* municipalities, the Ulz River Basin Organization (URBO), and the Onon-Balj National Park administration. The challenges and opportunities for them of using ecosystem services thinking in their decision making are the focus of the paper.

7.4.2. Framing differences

As we move from the national to the local scale, one of the first things that stands out is differences in the framing. 'Ecosystem services' is a concept that emerged from efforts to include the contributions of natural systems to economic life (in particular) (G. C. Daily, 1997), whereas placing economics at the centre of land management is quite alien to nomadic herding culture, which emphasises livelihoods and place. As others have identified, 'ecosystem services' is a distinctly western lens for looking at nature
(Chaudhary et al., 2015; Dempsey & Robertson, 2012).

There is a lack of a shared, clear understanding of the ecosystem services approach in Mongolia. As one key informant (KI) remarked:

> *"The word "ecosystem services" is used in national policy, specifically the Green Development program. But there are no clear explanations or guidelines for how to use the approach in local planning. We need an appropriate and understandable guideline for use when developing local planning documents."* (KI1).

Translation issues are a key challenge, as the translations have to address the cultural differences, not simply the finding linguistic analogues (Chaudhary & McGregor, 2018). Another expert commented:

> *"'Ecosystem service' is a new term in Mongolia. We should be careful when we translate the term into Mongolian for use in environmental planning. Maybe translating literally is not appropriate, but the concept has to be used in the nature conservation and protection field, because Mongolia has joined and is implementing many international conventions and programs.*" (Expert 1 in workshop).

An area of particular difficulty is the translation of the word 'services'. Two - to an English speaker apparently similar terms - "payment for ecosystem services" used by, for example, the UNDP, the UN's Adaptation Fund, and IUCN, and "payments for environmental services", used by the Asian Development Bank (ADB, 2014) - are confusing for local Mongolian practitioners because the common concept 'services' is counter-intuitive for them, and the term 'environment', in Mongolian (*khureelen bui orchin- хүрээлэн буй орчин*, in Mongolian), is

much broader than ‘ecosystem’ (ecosystem –*экосистем*, in Mongolian). Without a background in ecosystem services thinking, ‘environmental services’ and ‘ecosystem services’ sound like two different things to local Mongolian professionals. A common Mongolian language and understanding is needed (Hansen et al. (2015); (Verburg et al., 2016)). Culturally appropriate definitions and guidelines are needed to mainstream the approach.

Experts in the national workshop commented:

> “*At present, how the ecosystem services approach is understood and used is largely dependent on the individual understandings of decision-makers and national experts*.” (Expert 2)

and,

> “*There is a lack of regional and local institutional capacity and capable local practitioners*.” (Expert 3)

Workshop participants agreed that national experts need to play a stronger role in bridging the gap between international experts and local practitioners in the science-policy dialogue. Likewise, at a local level, practitioners called for capacity building. As Costanza et al. (2017) have also identified, if the ecosystem services approach is to be influential in local planning, capacity building for local practitioners is essential. The next section explores where a cultural fit, that can make an important contribution to capacity building, was found.

7.4.3. Common concerns

As others have said (e.g. Nordin et al. (2017)), the lack of a precise term ‘ecosystem services’ in policy-oriented documentation does not mean that in some sense this kind of thinking is not being employed. As one leading expert said, of their work with building ecosystem services thinking into national planning,

> “*We had thought that we were introducing a new approach into natural resources management in Mongolia. During the implementation of the project, our thoughts have changed. The term sounds new; however, we have realised that it is not a particularly new notion in Mongolia. It is just another way of identifying the relationship between humans and nature. Mongolians speak of “benefiting from nature" - baigaliin khishig.”* (Expert 4).

Resonantly, when we began our field work, herders used the term “*baigaliin khishig*, in Mongolian” - “benefits from nature” - as their way of talking about what we understood as ‘ecosystem services’. This served well as language to use to explore how climate change is

impacting the local environment and nomadic livelihoods, and the benefits nomads get from pastureland. As one herder put it,

> *"Our livelihoods are highly dependent on benefits from nature (baigaliin khishig). Therefore, our traditional customs have developed a focus on the proper use of natural resources, with our own understanding of how to manage and protect nature.*" (H1[25], *Bayandun*).

Table 7.1 presents the results of these analyses. The column on the left lists the ecosystem services that we identified through an analysis of transcripts of conversations with local people. What stands out from that is that while diverse regulating, provisioning and cultural ecosystem services were mentioned, only one supporting service was mentioned. What we anticipate that this reflects is the fact that local people's dependence on supporting services is less direct than on other kinds of ecosystem services, so they are more likely to be ignored in conversations about how herding communities 'benefit from nature'. One lesson we draw this is that this points to the benefit of bringing ecosystem services thinking into dialogue with local understanding, when developing local and regional plans, in contexts where socio-economic and climate dynamics are taking the local people outside the range of historical experience. This is the kind of contribution that systems thinking lenses can be expected to make, and it is a potentially very consequential contribution in the context of a rapidly changing climate.

The six documents analysed in Table 7.1 are the six local and regional plans that relate directly to land use or environmental management. (Not analysed are plans for specific pieces of infrastructure, and other sectors, e.g. education.) The individual ecosystem services that herders' identified (column 1 in Table 7.1) were grouped into four categories based on the Millennium Ecosystem Assessment (MEA, 2005) and CICES (Haines-Young & Potschin, 2018) - regulating, provisioning, supporting and cultural services - to enable comparison at a 'kind of service' level.

[25] H - refers to herder

Table 7.1. Individual ecosystem services presence in the planning documents

	Local			Regional		
Ecosystem services	Soum land management plan (Norovlin) - 2018	Ulz River basin integrated management Plan (2014-2021)	Onon-Balj National park management plan (2015-2018)	Land management Plan of Khentii aimag (2008-2020)	Development Program of the Khentii aimag (2010 – 2021)	Khentii aimag-sustainable development vision- 2030
Regulating services						
Climate regulation	i	i	i	i	i	i
Water purification and water treatment	e	e	e	e	e	e
Soil quality regulation	e	i	i	e	i	i
Erosion regulation	e	i	i	e	i	i
Natural hazard regulation	e	i	i	e	i	i
Provisioning services						
Grassland for grazing	e	e	e	e	e	e
Freshwater	e	e	e	e	e	e
Harvesting grass for herding	e	nm	i	e	e	e
Cropland	e	i	i	e	e	i
Fibres and timber	e	i	e	e	i	i
Plants	e	nm	e	e	i	i
Animals	e	nm	e	i	i	i
Supporting services						
Habitat for biodiversity	e	i	e	e	e	i
Cultural services						
Aesthetic value	nm	nm	i	nm	nm	nm
Historical and heritage value	e	nm	i	i	i	i
The symbolic value of nature	i	nm	i	i	nm	nm
Educational value	nm	nm	e	nm	nm	nm
Religious value	i	nm	i	nm	nm	nm

Legend: e-explicit; i-implicit; nm-not mentioned

None of the plans analysed explicitly include the phrase ‘ecosystem services’. However the emphases on ‘benefits from nature’ were plain. Some examples of their overall objectives are:

- “to ensure local ecosystems support livelihoods” (Norovlin, 2018);
- "to reduce pollution of nature, create an appropriate land-use system, protect water, guide wise use of water, and provide the population with water that meets health requirements“ (Development Program. Khentii (2010)); and

- "to protect pasture by providing additional water storages and guiding appropriate use of water*" (MNET, 2014).*

The ecosystem services with the most direct and profound impacts on nomadic livelihoods are all mentioned explicitly in all six planning documents - freshwater availability, water treatment and grassland for grazing. Climate regulation is in the background of all plans but mentioned explicitly in none - reflecting the fact that nomadic herding is not seen as a significant opportunity for mitigation; for herding, adaptation is what is in focus. Cultural services are largely taken for granted - either not mentioned at all, or mentioned implicitly. All the plans indirectly engage with cultural ecosystem services in some way, however. Ecotourism's intersections with cultural services are what brings them into focus in these plans, for example one broad objective of the Onon-Balj National Park is:

> "*A territory of responsible tourism with undisturbed wildlife and bird habitats, forests, freshwater resources, and wetlands, rich historical and cultural heritage, where local communities have a quality of life in harmony with nature*" (MNET, 2013, p. 6).

We suspect that cultural services get few explicit mentions because they are more intangible, and perhaps because of an underlying clash of knowledge cultures: herders' sense of belonging to place is hard to articulate in plans developed with a natural science ethos and disciplines. However, nomadic herding involves a high, intimate dependence on natural systems. The plans reflect this. Looking at the plans through the lens of 'benefits from nature' (*baigaliin khishig*) demonstrates the sensitivity to ecosystem services that is fundamental to nomadic society.

7.4.4. A top down trajectory

Although local and regional plans for land use and environmental management clearly reflect many aspects of herders concerns with 'benefits from nature', as noted above, they do not include any explicit references to 'ecosystem services'. This reflects the fact that, as also discussed above, ecosystem services thinking, in the formal sense, has entered Mongolian planning discourse from the top down - from international agencies. A strong national to local trajectory in planning is usual in Mongolia, as members of the group of national experts at the Ulaanbaatar workshop commented,

> *"A top-down approach to environmental decision making with less involvement of local stakeholders is the way local planning is approached in Mongolia."*

This is very common, globally, as von Haaren and Albert (2011) comment: "[local] planning strategies are usually adopted from the regional/provincial land management plan".

This top down trajectory brings both risks and opportunities. As ecosystem services thinking is commonly entering national planning discourse from international conversations, and often being delivered to local planning processes from national planning, ways to mitigate the risks and leverage the opportunities are important for ecosystem services thinking to make a helpful contribution, at the local level, in practice.

From discussions with herders, and with planners and experts at both local and national levels in Mongolia, it's evident that the key risks that need to be managed are:

- poor design for local plans arising from flawed consideration of local issues and concerns;
- weak implementation flowing from weak ownership of plans by local stakeholders (notably the herders, whose decisions are the primary anthropogenic influence on pastureland condition);
- risks of inequities arising from those with hierarchical power shaping plans to preferentially serve their interests; and
- plans that fail to address the range of issues that influence livelihoods in an integrated way, because top down agendas and models determine what can and cannot be addressed.

The next two sections take up key ways in which these risks can be mitigated and opportunities leveraged, looking at ways to give traditional and local knowledge central roles in local planning, and more generally to empower local communities in plan-making and implementation processes.

7.4.5. Leveraging local understanding

Mongolian culture brings together both scientific traditions of thought and traditional ecological knowledge - sometimes in the one person. Privileging Western knowledge over traditional ecological knowledge, as sometimes happen in Mongolian natural resource planning, brings many risks.

The term 'traditional ecological knowledge' tends to obscure the dynamism of local knowledge: herders' current local knowledge is in fact an evolving body of knowledge, grounded in tradition, but adapting as circumstances and thence practices change. Local knowledge, in this sense, is a core resource for local land use and environmental management planning.

Nomadic herders have their own understanding of their surrounding environment with which they identify changes, assess their implications for their livelihoods, particularly for herding, and from which they work out how to adapt. Nomadic herders' ecological knowledge and perceptions are reflected in their pastureland resources usage and herding practices (Fernandez-Gimenez, 2000). Giving this knowledge a central place in planning strengthens plans in multiple ways. An example of how this is so is that when natural scientists are playing a central role in development of local plans, their disciplinary training can readily lead them to focus the plans on how the dynamics of socio-ecological systems shape outcomes for natural ecosystems, e.g. focusing on saving wetland for birds migration, or protecting river flows, without also keeping livelihoods in mind. When natural scientists embrace an ecosystem services perspective, one implication is that it directs more of their attention towards 'cultural ecosystem services': ways in which pasturelands function as 'home' for nomadic herders are brought more into the foreground. This is certainly helpful, so far as it goes. However, looking from a herder's perspective, 'cultural ecosystem services' is a poor way of talking about the beauty of nature, and its rich symbolic and spiritual significances. When this unreflective insensitivity is embodied in planning processes, plans are developed that fail to support livelihoods, in a broad sense, and cannot be implemented because local people do not align with them. Sound planning in the Mongolian steppes must acknowledge the mutuality of the two knowledges, and demonstrably respect both.

Land use planners and environmental managers need local knowledge for all phases of their planning processes.

Understanding place. Local knowledge makes an important contribution simply because the available socio-economic and biophysical data for pastureland communities is relatively limited, as one key informant noted:

> "*Accuracy of information and reliability of data are the most important for planning. Our environmental and socio-economic data are always insufficient to follow national-level guidelines*." (KI2).

Pandeya et al. (2016) likewise highlight that it is often hard to find, or gather, ecosystem services data at a local scale in rural areas in developing countries. Local knowledge's importance is not, of course, just that it contributes in places where Western style planning knowledge is limited. There are, as outlined above, ways in which a radical mutuality of

herders' and professionals' knowledges is essential to developing a holistic, actionable understanding of place.

Establishing scope. In landscapes where natural resource dependent livelihoods play a central role, and a plan intends to improve or change livelihoods in some way, e.g. altering herding practices, provision of additional services, etc., exploration of the change needs to have a broad enough framing to address the issues that might arise for herding communities. Engagement with herders' understandings of their circumstances therefore has a key role to play.

Setting objectives for local plans. Broadly speaking '*baigaliin khishig'* - benefiting from nature without altering and damaging its structure - needs to underpin the objectives of land use plans in Mongolian pasturelands. This is a foundation for alignment with nomadic herding communities. A key issue is that ecosystem services thinking is explicitly anthropocentric; allowing traditional understanding of relationships to place to shape plans' objectives is a way to build into plans a commitment to protecting nature (Haines-Young & Potschin, 2010; Schröter et al., 2014). For herders, '*baigaliin khishig'* involves mutuality: both gaining benefits from nature, and protecting nature.

Designing effective adaptation strategies. As Berkes et al. (2000) remark, traditional knowledge can be rediscovered as adaptive management. In Mongolian pastureland, as one key informant remarked,

> "*Nomadic traditional movement is the main factor that has needed to be taken into account when developing local land management plans. Nomadic herders know how to obtain benefits from nature without altering the landscape's structure. Using [nomadic herders'] knowledge and practices, we [the local authority] could resolve pastureland issues locally, if we were given the power to do so.*" (KI4).

Traditional movement patterns are an adaptation to constraints and opportunities in space and time of availability of water and grass. This tradition of flexibility in relation to variability in resources is a support for future adaptation. It can, for instance, guide strategies to increase availability of water in grasslands that are currently not able to be used for herding. There are many challenges to address that do not currently have obvious solutions. Traditionally a set of areas of grassland plus water (e.g. 'riverside areas') 'belonged' to a group of neighbouring herding families, who usually moved between them seasonally at approximately the same time. Traditional herding culture respected these relationships to place. Currently, with absentee

ownership of herds playing a significant role, and climate change driven internal migration, these relationships to land that protected pastureland as it was being used have been breaking down. Also, herders with historical connections to a *soum* area (established when communist rule began in the 1930s) are moving less frequently within it, partly in response to changed availability of water (notably from climate change), but also partly from cultural shifts associated with development (e.g. availability of schooling and other services at *soum* centres). Potentially new legal and taxation arrangements that draw on traditional understandings of both benefiting and protecting pastureland can provide an adaptive path for Mongolian herders.

Building alignment to support implementation. Plans for action at a landscape scale are difficult to implement if the stakeholders who implement them do not support the plans. Herders have a central role to play in adaptive management of pastureland, so the plans need to make sense to them, from their own perspectives, for the plans to be likely to be implemented as intended. As a national expert commented,

> *"Traditional ecological knowledge plays a key role at a local level when introducing the ecosystem services approach to local decision-makers, planners, and herders."*

That applies generally to all approaches to local planning; the intelligibility and practical logic of plans are enhanced if they are well grounded in local knowledge.

Close engagement with local knowledge particularly reduces the risk of design flaws stemming from inadequate understanding of local circumstances.

7.4.6. Empowering communities

Concerns about disempowerment of local people often arose. One expert commented - against the background of a law to govern use of pastureland having been in draft form for 10 years - that,

> *"To improve pastureland management, we need to give local authorities greater decision making power. At present, pastureland management is regulated by national land law [which says very little about pastureland]. When it comes to making local decisions, the current land law is too general, and its implications are not clear. So, a law to guide use of pastureland is needed." (Expert 5).*

Local government officials supported this view. For instance, one commented, while addressing the related question of how empowered herders are to participate in local planning,

"Our herders have participated actively in soum and "bag" (subdistrict) meetings where we discuss pastureland management issues, since these are their main priority for their livelihoods. However, local authorities' rights are quite limited in planning [compared to those of regional and national governments]. We work within the frame of national and regional land management planning." (KI1).

Herders, equally, reported feeling disempowered in local planning processes, however. One advised, for instance,

"I haven't participated in bag meetings, because I am herding livestock and usually I cannot attend." (H3, Norovlin)

A second commented,

"We only meet and see each other once a year during our bag meetings. Unfortunately, many herders cannot be present very often because of herding, especially young herders" (H6, Bayandun).

Although the current Land Law (Khural, 2002) states that most decisions regarding the development and implementation of a local pastureland plan at very local levels (*soum* and *bag (subdistrict)*), local administrations have encountered difficulties in implementing these decisions (Fernandez-Gimenez & Batbuyan, 2004; Undargaa & McCarthy, 2016). National policy guidelines in Mongolia call for the active participation of key stakeholders in local planning, and herders are at the centre of pastureland management. Policy and practice are not closely aligned. Providing incentives for local participation in planning processes is not new to Mongolia. Over the past two decades, some efforts have been made to introduce community-based management and create "herder family groups" to empower local herders. Most of these efforts have depended on support from international donors (Fernández-Giménez, 1999; Ulambayar & Fernández-Giménez, 2019; Undargaa & McCarthy, 2016). However, as key informants claim

"*The durability of these arrangements has been relatively poor, due to the lack of practical alignment between the internationally funded projects and Mongolian public authorities. In most cases, the local groups have become inactive when the projects have ended" (KI 8)*.

For ecosystem services thinking to make a positive contribution to local planning - and for local planning in general to be effective - ways of addressing these disempowerments are needed.

Suggestions that emerged from consultations with herders and local key informants included:

- using participatory planning approaches in which local understandings of '*baigaliin khishig*' play central roles; and
- giving long-standing traditional nomadic institutions [e.g. *khot ail* (2-3 herder families, camping in the same place) - a basic socio-economic unit of nomadic herders, *neg usniikhan* - a larger neighborhood group of families living along one riverside area] a vital role in local planning.

To help with mainstreaming ecosystem services thinking specifically, changes to legislation governing local planning to align it with national commitments to ecosystem services approaches were recommended:

> *"We need a legal obligation to integrate the ecosystem services approach into local planning within a law for pastureland that is based on traditional customs and traditional knowledge.*" (KI3).

To assist with this, research to develop a more thorough understanding of local ecosystem services, and articulating findings in ways that align with herders' traditional ways of understanding landscapes and livelihoods, were also recommended.

Ecosystem services thinking was seen by some as an opportunity to improve equity. Water and grass in Mongolian pasturelands are common property. Focusing attention explicitly on these as ecosystem services was seen as having the potential to bring inequities into focus. The current land use controls count everyone who owns livestock in Mongolia as a herder. Mongolian law states that pastureland (grass and water) are state property and makes it available for use by herders as a commons. This works to the advantage of wealthy herders, and absentee owners, with large herds of livestock as a herder described

> *Last winter, 2 families of 10,000 horses were grazing in the southern part of the soum. We overheard that the owners are wealthy businessmen who live in Ulaanbaatar. Imagine that 10,000 horses spent 3 months in the spring pastures of the local herders. Obviously, they don't pay anything for using free pastures. There's nothing left for spring grazing (H9, Norovlin).*

An ecosystem services approach is seen as having the potential to highlight these inequities (Costanza et al., 2017), and perhaps, for example, to lead to arrangements where owners of large herds make some kind of payments for ecosystem services. There have been suggestions

from the international organizations that payments for pastureland ecosystem services should be introduced. This would need a change in the law, but the most important policy design issue would be finding ways to demonstrably reduce, rather than increase, inequities. A payment regime that levied charges only on large herders and used the funds raised to add watering points (wells, dams) to grassland areas that lack reliable water is one possibility.

Empowering herding communities in development of local plans is a way of improving use of local knowledge, reducing the risk of designing in inequities, and strengthening commitment to implementation. It has, in other words, potential to address key risks associated with top down approaches to local planning. For advocates of ecosystem services thinking, specifically, this is particularly important, because - at least in rural areas in developing countries - ecosystem services thinking arrives in local planning processes in a top down way. To prevent harm and benefit local people, the planning processes need to empower them.

7.4.7. Usefulness elsewhere

The most prominent uses of ecosystem services thinking are at national scales and higher, and when it has been applied locally, this has predominantly been in urban settings in the developed world. Exploring its usefulness in local planning for management of pastureland by nomadic herders in Northeast Mongolia - a rural, developing world setting - helps test the breadth of its application.

The analysis above identifies challenges and opportunities that are likely to be relevant in a wide variety of cases. In rural settings, being directly dependent on ecosystem dynamics is usual. So local people will have sensitivities to ecological dynamics that echo concerns that inform ecosystem services thinking - as "*baigaliin khishig"* - *"*benefits from nature" illustrates. When a Western, anthropocentric orientation like ecosystem services thinking is introduced to a rural, developing world context, framing differences are certain to be encountered, however. To leverage ecosystem services thinking effectively, a culturally accessible understanding of ecosystem services is needed as a starting point. More fundamentally, planning processes that draw out the strengths of both local and Western scientific knowledges are needed. Capacity building to support this is needed. Ecosystem services thinking's emphasis on regulating and supporting services is a helpful compliment to local knowledge, as it brings more systematic attention to dependencies that are less obvious because less direct than dependence on provisioning services. These contributions are particularly important for rural communities experiencing climate change and integrated into the global economy (e.g. as Mongolian herders

are, as providers of wool for cashmere), as climate change and globalization are taking these communities outside the range of historical experience, and thence of traditional knowledge's understanding of how communities can adapt and survive. Conversely, framing place-based identity and spirituality as dependent on 'cultural ecosystem services' does not grasp the seriousness and profundity of these experiences of place and belonging for local people.

The Mongolian experience of ecosystem services thinking arriving in local planning processes via top down agenda setting processes is likely to be widely replicated, as its roots are developing countries' engagement with international funding bodies. This pathway has obvious risks from a local perspective. *Local knowledge* is essential for developing holistic and actionable plans. Local communities have an intimate understanding of impacts on their livelihoods, and, as their actions are central to any adaptation that can occur, local insights into what is actionable must play a central role in designing adaptation strategies. Embedding ecosystem services thinking in an approach to planning that is explicitly committed to empowering local communities is a way to mitigate the risks that this top down pathway carries. The risks are substantial: flawed consideration of local circumstances, designing in inequities, and weak local commitment to implementation. Local knowledge and local ownership are needed in all phases of planning processes.

7.5. Conclusion

An ecosystem services lens was introduced into Mongolian national plans in response to the support of international organizations active in conservation and development in Mongolia. We investigated how it can support local land use planning. Although the language used locally is different, many of the fundamental concerns resonate. An analysis of six plans shaping land use and environmental management in the case study area showed that the traditional Mongolian emphasis on "obtaining the *baigaliin khishig* [benefits from nature] in ways that support local livelihood and protect nature" resonated strongly with Western ecosystem services thinking. In these plans, provisioning services are mentioned most frequently, and regulating and supporting services received less emphasis. This underlines the potential of ecosystem services thinking to add value to local planning, in circumstances where socio-ecological dynamics are moving outside the range of historical experience.

Exploring how ecosystem services thinking can be used in planning the use of pastureland, with nomadic herders, local municipality officers, and national level decision-makers and experts, revealed a range of issues that users of ecosystem services thinking in rural settings in

developing countries are likely to need to engage with. In many developing countries, top down directives are likely to be the trajectory along which ecosystem services thinking arrives at local decision making processes, because they are introduced via engagements with international funding bodies brokered at a national level. That trajectory carries obvious risks for the soundness of local planning. To mitigate these, both international funding bodies, and national planners, can embrace an emphasis on leveraging local knowledge and designing planning processes to empower local people.

Chapter 8. Synthesis and conclusions

'I learnt more about the Mongols, in their own language, than from other peoples in other languages' (Lattimore, 1941)

8.1. Introduction

The American scholar Owen Lattimore's works have made a significant contribution to shaping realistic insights into Mongolian nomadic livelihoods and society in the first half of the 20th century. Reading his books feels as if we're looking at ourselves in a mirror or learning more from the elders. He described the relationship between nomads and nature as *"…hence 'virtue' could be deeply felt (without necessarily having to be sharply defined in words) as adequate service rendered by man to nature in acknowledgment for the bounty and fruitfulness of nature and the environment on which man depended"* (Lattimore, 1941, p. 180). Inspired by his and other scholars' works (D Bazargur, 1998; Fernandez-Gimenez, 2000; Humphrey et al., 1999; Jagchid, 2019) in Mongolian study, particularly in nomadic pastoralism, I aimed to explore the relationship between nomads and the open steppe pasturelands in the context of climate change using an ecosystem services approach, as a geographer with a nomadic background.

This thesis investigates the applicability of ecosystem services approaches to support climate change adaptation at a local level through a case study in Northeast Mongolia. Nomadic herders, local key informants and environmental management experts at national and regional level were involved in this research study. Drawing on the findings of two field work trips in the case study area, the thesis examined the impacts of climate change on local livelihoods and ecosystem services, and how nomadic herders have adapted to these changes (Chapter 4 and Chapter 6). The thesis addresses the cultural values pastureland holds for herders (Chapter 5) as documented through Indigenous knowledge (Chapter 6), as well as the presence of ecosystem services thinking in local planning documents (Chapter 7). The results of the study reveal that climate change negatively affects nomadic livelihoods and pastureland ecosystem services (Chapter 4). Nomadic herders' knowledge and experience of climate change impacts, as documented in this study, are aligned with scientific research, revealing that traditional ecological knowledge is a valuable source of information to understand the complex socio-ecological system at the local level. Nomadic herders acknowledge the importance of cultural ecosystem services to the landscape for their well-being (Chapter 5). As expressed by herders, nomadic livelihoods are adaptive to change with nomadic movement being key to adaptation (Chapter 6). However, because of climate change and wider socio-economic changes, nomadic mobility patterns are changing and are becoming more spatially and temporally restrictive.

Nomadic herders have adopted various adaptation actions to cope with a changing environment such as altering the livestock mix, and investing in new breeds. Traditional knowledge of ecosystem services plays a key role in adapting to the changing environment and sustaining pastureland ecosystem services. Thus, this study investigates the presence of ecosystem services thinking in local decision-making, particularly in pastureland management (Chapter 7). To examine the applicability of ecosystem services approaches to support climate change adaption, a structured context analysis was conducted to explore the approach as presented in planning documents relevant to the case study area. The context analysis shows that the ecosystem services approach is acknowledged in these documents, and accords to some extent with the idea of benefiting from nature without altering its' structure, as reflected in the concept of *baigaliin khishig – benefiting from nature,* which shapes the nomadic livelihoods principle in Mongolia.

The following sections synthesise key findings and discuss the impacts of climate change on local livelihoods and ecosystem services in Northeast Mongolia, as well as the applicability of ecosystem services approaches in local decision-making. The chapter concludes with a summary of findings, discusses the significance of the findings and limitations of the current study, and offers directions for future research.

8.2. Synthesis

8.2.1. Climate change impacts on local livelihoods and ecosystem services

In management of ecosystem services, it is essential to incorporate the impact of key local drivers of change along with global drivers such as climate change (Runting et al., 2017). A case study conducted in the dryland region of a developing country to investigate the impact of climate change on livelihoods and ecosystem services at a local scale is significant in contributing to the development of a better understanding of local adaptation options. As one of the largest dryland countries where local livelihoods depend directly on nature (particularly pasturelands) and climate, Mongolia is an interesting place to study the impact of climate change on local livelihoods and ecosystem services. As dryland pasturelands support around 50% of the world's livestock (MEA, 2005), exploring how nomadic herders perceive and understand the interactive nature of local livelihoods and ecosystem services under changing conditions is helpful to understand climate change impacts at a local level. Locally-generated data on the relationship between nomadic herders and the pastureland ecosystems with which they have had a long history provide insights into the main drivers of change, how climate change affects local livelihoods and ecosystem services, existing adaptation measures and

potential future adaptation options. Northeast Mongolia was selected as a case study area to investigate how local livelihoods are changing in response to climate change and other processes through a focus on the changing provision of and access to ecosystem services at a local level (Figure 3.2). To document the impacts of climate change on local livelihoods, particularly nomadic livelihoods, and pastureland ecosystem services, a mixed methods case study research approach was adopted, seeking to draw on the knowledge of key informants, herders, and officials and experts.

Due to their direct dependence on nature and long history of Indigenous land stewardship, nomadic herders hold valuable knowledge of ecological processes, weather and climate at a local level, which has informed their adaptation to climate change. Figure 4.6 illustrates how climate change impacts on nomadic livelihoods and pastureland ecosystem services. According to herders' perceptions, the climate in the case study area is changing, as described by one herder (quoted in chapter 4)

> *How nice [and] rainy was the summer. We haven't had continual warm rainy days in recent years. At present it is so dry and windy. Autumn was pleasantly warm. Now it is getting windier just like spring. Winter is shortening and not so cold. The spring is becoming longer and windier (H1, Bayandun).*

Temporal and spatial changes in precipitation are the main indicators of climate change for nomadic herders, with the growth and composition of pastureland plants greatly affected by changes in precipitation patterns, as detailed in Chapter 4.

The main negative impact of climate change on livelihoods in Northeast Mongolia, and in the country as a whole, is a shortage of water. Geographically, most parts of the country have a limited surface water. Most of Mongolia is drylands. Due to the increase in the annual mean temperature in Mongolia, the evaporation rate has increased, and at the same time, precipitation is not only decreasing but the pattern of distribution is also changing. Any slight changes in precipitation have significant consequences in dryland ecosystems, causing plant growth changes, especially in places like Mongolia, with a short plant growth season. The shortage of available water is affecting herders' traditional movement routines and cycles, leading to pastureland degradation near rivers and wells.

The study found that herders' memories and observations of the timing of weather extremes and the changing trends align with scientific meteorological records and provide more place-

specific data. The accelerating changes in climate combined with socio-economic drivers are leading nomadic herders to change their livelihoods, and significantly altering their traditional ways of herding.

Pastureland provides herders with various ecosystem services. Mongolia's open-steppe pastureland is also an important habitat for wild species, including many endangered and migratory bird species (Oyungerel, Tseveenmyadag, & Tuguldur, 2014). Provisioning services such as grasslands and water resources are the most important for the herders; it is these services that are most negatively affected by climate change in semi-arid, open pastureland landscapes. Yet, it is not only climate change that herders must contend with, but also the increased pressure on ecosystem services due to socio-economic drivers such as mining and increased immigration from other regions. These changes are also undermining herders' traditional institutions, such as the *khot ail* (herder families) and *neg goliinhon* (people from a riverside area) and associated customs. Moreover, climate change is having negative impacts on local knowledge and traditional practices associated with predicting seasonal weather patterns that inform particular herding practices.

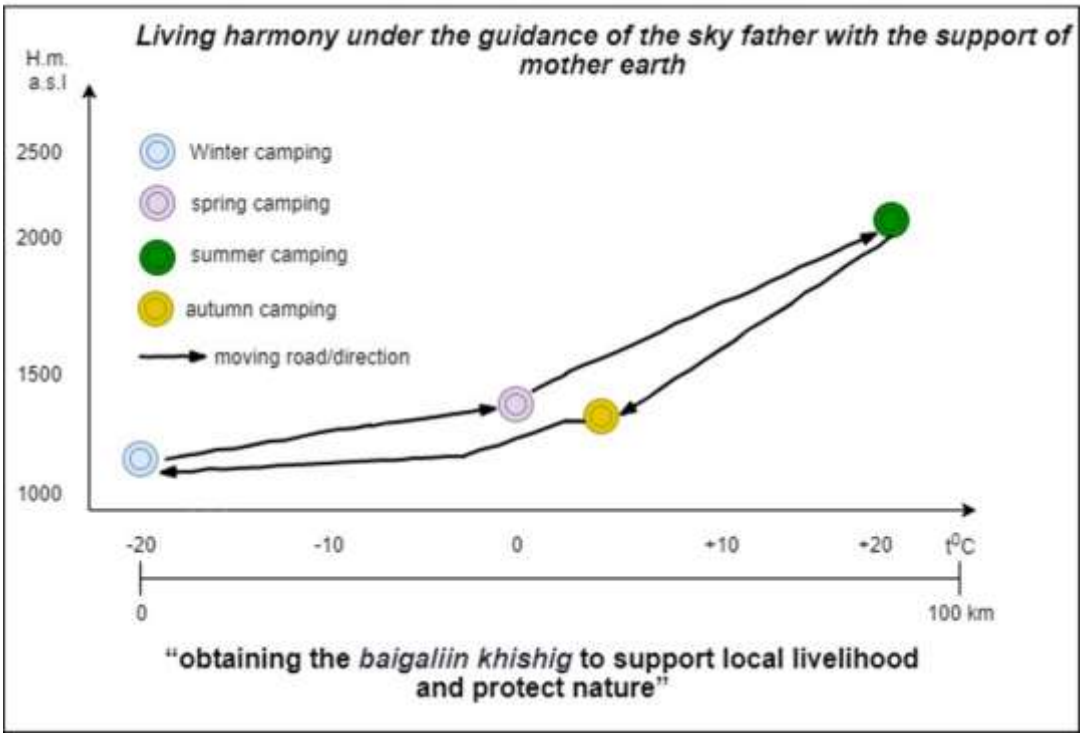

Figure 8.1. Geography of nomadic movement (the idea of this scheme adapted from "Geography of pastoral animal husbandry" (Damba Bazargur, 2005))

Because there are four distinct seasons, nomads move in search of abundant pastures for their livestock, and their movement (shown in Figure 8.1) is determined by landscape elements such

as the elevation of the geographical location (H. a.s.l[26]), weather conditions (especially the average temperature of the season) and availability of water resources. The average temperature in the case study area in January is around -20^{0}C and in July it is +20^{0}C. In response, in winter the herders move to lower altitudes and in summer they move to higher altitudes.

Over the last hundred years, nomadic herders have experienced three different socio-economic systems: feudalism; a centrally planned communist system; and a market-oriented democratic society. However, the traditional nomadic principle of seasonal movements through the pasturelands has not changed much. Yet the persistence of this nomadic principle is now being severely tested. This research reveals that the livelihoods of herders have changed over the last twenty years due to climate and other socio-economic drivers. The main indicators of these changes are the reduction of movement cycles and distances, and a rapid increase in the livestock size as well as changes in herd structure.

In line with a number of other case studies (Akwetaireho & Getzner, 2010; Bhatta et al., 2015; Boafo et al., 2016; Cummings & Read, 2016; Leonard et al., 2013), this research finds that local case studies are essential to understanding climate change impacts on ecosystem services and local livelihoods. Local case studies reveal the nuanced way different people are affected in different ways, the equity impacts, the combination of impacts, and the differentiated impacts on young and older herders. Thus, local studies provide more detailed and valuable information for decision-makers in developing locally oriented and effective environmental policy and adaptation strategies. In line with the adopted Millennium Ecosystem Assessment conceptual framework of interaction between ecosystem services, human well-being and drivers of change (Figure 1.1), this study demonstrates that local knowledge is quite important for assessing provisioning (e.g., grasslands, water) and cultural ecosystem services (e.g., spiritual, aesthetic and educational) at the local level, where livelihoods are directly dependent on nature.

8.2.2. Cultural ecosystem services and their contribution to nomads' well-being at a local scale

The cultural ecosystem services that support the well-being of nomadic herders derive from their livelihoods, traditional customs, and their relations with and enjoyment of place (Chapter 5). Once Lattimore (1941, p. 215) noticed, "the lie of the land is one of the best things to talk about with all kinds of Mongols". As Lattimore reported, I experienced investigating the non-

[26] a.s.l – above sea level

material values of the pastureland ecosystems through nomadic herders' appreciation of it. Nomadic movement is not only a search for pasture and water but also an embodiment of the cultural links between nomadic people and pasturelands. As Lattimore (1941, p. 216) described it, "They have to do with things that are real and utilitarian, like the relation of exposure to drainage and pasture and the relation of lines of movement to areas of pastures". This pragmatic or realistic tendency even reflects their preference for the non-material values of the landscape (details in chapter 5). According to herders, the cultural values of the landscape are a sense of place, identity, symbolic, cultural and historical heritage, the inspiration for creativity, and learning from nature, as they state "nature is a lifelong teacher". The relationship between nomads and pastureland landscape creates an outstanding cultural landscape comprised of rich traditions, diverse ecological practices and traditional knowledge systems. The provisioning ecosystem services, principally pastureland and water resources, are vital for nomads as their livelihoods are highly dependent on nature, and the non-material values of nature are also important. By virtue of its long existence and history, herders perceive this historical heritage as part of nature, and livestock as the central part of nature. These historical resonances may be one of the reasons why herders identified the symbolic value of nature as more important than its religious value.

The significance of these cultural values is better understood in the context of nomads' long history of relations with the landscape. For centuries, environmental stewardship has played an important role in the survival and existence of Mongolian nomads, and these traditions and practices have continued in modern society as a whole, and contributed to nature conservation, which in turn helps to sustain Mongolia's traditional livelihoods and environment.

The study reveals that the benefits of place are often dependent on relations with a particular place; nomadic herders perceive natural beauty differently depending on where they are from. While observing nature and natural phenomena, nomads have also observed changes in the colour of the landscape as an indicator of environmental changes. Each season has a certain colour of beauty (green summer, yellow golden autumn, white winter, for example) and the typical colours of the landscape are changing because of dryness and forest steppe fires. For nomads, this is a loss of natural beauty. These changes also affect herders' livelihoods and herding practices, such as changes in the times and patterns of movement. These explorations demonstrate that investigating cultural ecosystem services and their contribution to human well-being at a local scale is important for supporting local decision-making, particularly land-use planning and adaptation strategies as cultural ecosystem services are important drivers for well-

being (MEA, 2005). These cultural services inform the values, rules and knowledge of the socio-ecological system (Adger et al., 2005), and thus are crucial to sustainability. Overall, the period of plant growth is strongly associated with seasonality and weather; together with access to water resources, they form the main drivers for decision-making on where to camp and when to move. However, the study also showed the importance of cultural values in the way people interact with pastureland, influencing where and when people camp during the year. In open-steppe pastures, herders have learned from and been inspired by nature and, as described by one herder, it supports their well-being (chapter 5):

> *I would say that our most inspiring traditional culture or heritage, which expresses the relationships between humans and nature, is our traditional long song. It defines Mongolians, it represents the steppe, it represents mountains, it shows rivers and lakes. The long song is like a horseman singing as he rides upwind, from sunrise to sunset. The song is nature's voice, transmitted through man (A local folk singer and herder).*

So, in response to the main goal of the thesis, this study demonstrates that traditional ecological knowledge and practices make a central contribution to understanding the cultural ecosystem services provided by landscapes at a local level.

8.2.3. Traditional knowledge of ecosystem services

Based on the previous studies of traditional ecological knowledge of the pasturelands and nomadic livelihoods (Damba Bazargur, 2005; Fernandez-Gimenez, 2000; Fernández-Giménez, 1999; Humphrey et al., 1999; Jagchid, 2019), this study addresses traditional knowledge of ecosystem services of nomadic herders from the open steppe pastureland in Northeast Mongolia. The study engaged traditional nomadic culture and customs to investigate climate change adaption in the case of the relationship between nomadic livelihoods and the pasturelands.

This study shows that using the nomadic herders' knowledge and perception of climate change is helpful to explore climate change impacts on ecosystem services and local livelihoods. A case study engaging with local herders' understanding and perception of climate change indicators provides more detailed insights into how climate is changing and how global factors such as the impact of climate change are affecting livelihoods and ecosystem services at a local level. The study demonstrates that traditional ecological knowledge plays an important role in shaping nomadic herders' understanding of changes in pastureland ecosystem services (details in chapter 4). Herder elders have carried traditional knowledge of pasturelands and managed

their livelihoods, moving in search of better pastures and water sources for livestock, and transferring the knowledge to young people. This study of cultural ecosystem services that support nomadic well-being in Mongolian pasturelands (chapter 5) explores which cultural ecosystem services are important for nomadic herders' well-being, and how traditional ecological knowledge facilitates understanding of these cultural ecosystem services. This study highlights that nomads' appreciation of cultural ecosystem services is an important aspect of their local knowledge and practices. Herders' expression of the aesthetic value of pastureland shows that when assessing the cultural ecosystem services engaging with local knowledge, the aesthetic value of landscapes is related to and shaped by nomads' daily lifestyle.

As one of the countries most vulnerable to climate change, the Government of Mongolia has taken actions to cope with and reduce the risks associated with climate change, but traditional knowledge and methods of coping with and adapting to natural hazards are often overlooked and are less included in formal adaptation strategies (NAPCC, 2011). The traditional nomadic institution, as the fundamental socio-economic system of nomadic livelihood and culture such as "*khot ail",* (2-3 families), "*saakhalt ail"* (neighbours), and "*neg goliinkhon"* (people from a riverside area), which have existed throughout the entire history of Mongolians (Bazargür et al., 1993; Tserendash.S, 2017). These networks have shaped livestock management and spatial sharing of key resources through consideration of common seasonal camping areas, grassland and water sources. The study suggests that traditional ecological knowledge and associated social mechanisms are important to the design of alternative adaptation options to support nomadic livelihoods in Mongolia.

Improvement of nomadic livelihood resilience and adaptation support of traditional local institutions, such as *khot-ail* and *neg goliinhon*, is very important for both sustainable livelihoods and nature protection, because traditional local institutions have their own rules, norms and values that guide management of local pastureland. Thus, the recognition of local traditional culture and institutions in understanding adaptation to climate change is crucial, as the traditional customs and spirituality of pastoral nomads encourage cooperative efforts to use resources responsibly, including protection and conservation of pastureland ecosystems (Chapter 5). Herders state that nomadic livelihoods are adaptive to environmental changes due to traditional herding practices and movement strategies. Whilst herders have practiced various actions to cope with climate change, most of these actions are oriented to the short term, such as moving to new places and altering herd structure, however long-term strategies are now required. And then, nomadic herders want to continue being nomadic, so the integration of

scientific and traditional knowledge of ecosystem services thinking is likely to be useful for planning long term adaptation that meets nomadic needs in a way that is consistent with nomadic cultural norms.

8.2.4. Ecosystem services thinking in environmental decision making at a local level

The ecosystem services approach was introduced in Mongolia in the 2010s with the support of international donors, particularly in water resources management and nature conservation fields. The study demonstrates that the absence of the precise term 'ecosystem services' in policy-oriented documentation does not mean that the approach/thinking is not being used, in some sense, in local environmental management plans. Even though it is a relatively new term in the natural resources management field, ecosystem services thinking echoes traditional thinking regarding '*baigaliin khishig* – benefiting from nature' to support local livelihoods whilst protecting nature in Mongolia (Chapter 7). This analysis demonstrates that the ecosystem services approach can be a useful lens for local land management planning.

A key observation of this thesis is that a sensitivity to ecosystem services is embodied in a key principle guiding nomadic livelihoods – an orientation to living in harmony under the guidance of the sky father with the support of mother land by obtaining the *baigaliin khishig* to support nomadic livelihoods and protect nature. This traditional ecosystem services thinking, obtaining *baigaliin khishig,* has guided nomadic movement in terms of regulating and conserving pastureland ecosystem services to support livelihoods for centuries. This analysis implies that to increase the usefulness of the ecosystem services approach in local environmental management, it is better to combine western scientific knowledge with local knowledge by empowering local communities.

On the open-steppe pasturelands, this transfer of knowledge has occurred over centuries, resulting in resilient and adaptive herding practices that interact with and manage the landscape (Fernandez-Gimenez, 2000; Fernández-Giménez, 1999). *Baigaliin khishig* captures this idea of humans benefiting from nature without altering and damaging its structure. The thesis suggests that nomads have reliable knowledge and practices in adapting their livelihoods to changing environments that complement the knowledge of external experts (Naess, 2013). The ecosystem services approach is relatively holistic, and thus it resonates with the holistic conceptualization of and adaptive approach to nature reflected in traditional knowledge systems. Thus, the use of traditional knowledge of ecosystem services, in combination with western science, is an appropriate option for development of policies and plans to support

climate change adaptation where livelihoods are directly dependent on natural conditions, but local conditions are moving outside historical experience.

8.2.5. Key insights for environmental decision making in the context of climate change

Climate and socio-economic drivers are leading to the need to take serious action to adapt to a rapidly changing environment in the open-steppe pasturelands of Mongolia. The major policy implication of this analysis is that current adaptations need to be supported whilst longer term adaptation strategies are planned with the active engagement of local herders. A core challenge is that nomadic herders do not want to change the nomadic nature of their livelihoods. The following insights into adaptation strategies seek to address this dilemma.

i) Nomadic herders' contributions and roles in improving climate change adaptation.
A key adaptation strategy that has merit would be to work on improving the quality of livestock instead of increasing the numbers. The study shows that herders are starting to understand the importance of this strategy, as one herder said (chapter 6):

> *We have run into a competition to increase the number of livestock. People are now starting to understand that having so many livestock is causing pastureland degradation (H5, Bayandun soum).*

Livestock is the main source of income for herders, so every herder obviously wants to have more livestock. In the last twenty years, the raw cashmere market has developed rapidly in the country, thus the rate of growth of the goat population has almost tripled, resulting in huge changes in the herd structure. The traditional structure of sheep and goat herds was more than 80% sheep and less than 20%. Currently, goats in Northeast Mongolia, for example, account for more than 40% of the herd. As mentioned in chapter 6, the natural and climatic conditions are most suitable for grazing cattle, raising horses and sheep herding in *Bayandun* and *Norovlin soums* (Bazargur.D, 1998). A rapid increase in herd size and changes in its structure lead to degradation of pastureland. Therefore, herders have to consider both improving the quality of their livestock and increasing its population in harmony with the natural and climatic conditions.

Reduced movement of herders is also related to family needs for education, and market and mobile communication network access. In order to send their children to school, young herder families prefer to be close to the *soum* centre, resulting in more concentrated herding near the

centre, which also leads to the degradation of associated pasturelands. However, this reduced movement leads to a reduction in the quality of livestock and pastureland degradation. Thus, strategies that address access to education etc. for herding family children are required: for example, with better mobile network coverage, students could pursue distance education.

Herders' contributions are key to strengthen traditional ecological knowledge of the relationship between nomads and the pasturelands. Elders need to teach the youth traditional herding practices and knowledge, and young herders need to learn to use and develop the traditional knowledge and practices that rely on a changing environment. Diminishing or neglecting traditional knowledge of nomadic herding and ways of communicating with nature may lead to the next generations of herders losing their Mongolian identity as herders, and the traditional understandings that continue to have the potential to make a strong contribution to ongoing adaptation. More importantly, herders must be actively involved in local decision-making processes regarding questions of pastureland and water resources management and nature conservation. As the main users of pastureland resources, herders' opinions and needs need to be central considerations in local planning. The study shows that herders' participation in local decision-making is not sufficient at present (chapter 6). The absence of the key users of pastureland ecosystem services is a major reason underlying ineffective local environmental management and disregard for local knowledge and practices. Another important adaptation strategy is to look for other income sources and possibilities to support livelihoods, for instance through engagement in tourism activities. Nomadic livelihoods and traditional customs are the main attractions of tourism in Mongolia. Thus, there are plenty of opportunities for nomadic herders to engage in tourism businesses in tourism development regions, for instance in *Dadal soum.*

ii). The *soum* authority.

To enhance socio-ecological sustainability and to support local livelihoods, policies should support herders' engagement in local decision-making, particularly in development of pastureland and water resource management and adaptation strategies. *Soum* municipalities have to work to improve mobile veterinary services to provide access to all herders (details in chapter 6). To prevent pastureland degradation, the pastureland's carrying capacity must be assessed, based on the area where there is reasonable access to water, not the entire area. Most importantly *soum* authorities need to support and consider the benefits of traditional nomadic institutions in addressing pastureland management (details in Chapters 4 and 6). Providing herders with more accurate information on climate change projections and planned

development actions and promoting herders' participation in local decision-making should be the main task of the local authority.

iii) At the regional and national level, the current socio-ecological situation requires land-use related legislation changes.

In particular, specific laws on management of the pastureland are important to ensure that the land is managed in ways that support traditional nomadic livelihoods and pastureland restoration. The existing legal framework for animal husbandry and nomadic livelihoods currently contributes to inequalities among the herders. Mongolia needs to confront questions such as "who is *really* a nomadic herder?" Based on these reflections, there is a need to reconsider the policy of animal husbandry and local livelihood support so as to prioritize support for households directly involved in herding, rather than large-scale commercial enterprises (details in Chapter 6). Governance arrangements also need to evolve to enhance local authorities' rights on pastureland decision-making processes, and support local planning in ways that manage the risks that top-down decision-making processes create for local environmental management.

To sustain and support nomads' livelihoods, the country needs to explicitly prioritize institutional support and policy reforms for animal husbandry, as discussed in Chapter 6. More flexible and equitable governance mechanisms are needed to protect nomadic livelihoods. Countries such as Mongolia, where traditional livelihoods are dominant, should also look back on their past national policy to support local livelihoods. As mentioned in Chapter 6, the current non-traditional national policy framework has led to intensive livestock growth and provides more opportunities for wealthy herders or large urban livestock owners to benefit from pastureland ecosystem services than for ordinary local nomadic herders in Mongolia.

At present, herders do not pay any tax for using pastureland resources. Instead, they receive financial support (Chapter 6) from the government for cashmere and raw wool production in relation to the amount of livestock they own. This unconventional system supports great injustice. As a country vulnerable to climate change, there is a need to introduce insurance schemes to cover climate change risks. Mongolia does not have this type of insurance system. Introducing an insurance system will take time and require financial and institutional capacity. However, in a rapidly changing environment, to support local development and sustainable livelihoods, it is necessary to take risks into account by implementing insurance schemes. The

taxation system needs to evolve. Herders are willing to pay tax for the use of pastureland if the payment is reinvested in improving pastureland management (chapter 4 and 6).

8.3. Summary of findings

Research objective 1: *Investigate* h*ow local livelihoods are changing and how climate change is influential in this process through a focus on the changing provision of ecosystem services.* This research objective was addressed in Chapter 4.

The study examined the impact of climate change on local livelihoods and ecosystems, and the applicability of the ecosystem services approach in assessing the impact on local livelihoods. In total, 15 herders and 10 key informants were interviewed and three focus group discussions were held. The study found that investigating nomadic herders' knowledge and perceptions of climate change helps to understand climate change and its impact on ecosystem services and local livelihoods. The pasturelands provide various ecosystem services to herders, and herders' memories and observation of environmental change are consistent with scientific observations. As the study demonstrates, the changes herders have experienced are uneven across the seasons. The shortening of the summer period, in particular, has had marked impacts on herding practices and other livelihood needs. Herders' memories of extreme events such as heavy rains, strong winds, drought, and *dzud* provide clear insights into how their livelihoods are being affected by climate change. Herders' perceptions provide opportunities to understand the trend of benefits from pastureland ecosystem services at a local level. In this way, the environmental knowledge and experience of nomadic herders has helped to provide more nuanced, disaggregated information on climate change indicators at the local level. The study indicates that the ecosystem services approach is useful for assessing pastureland ecosystem services if it effectively engages with local knowledge and practices.

Research objective 2: *Explore the main cultural ecosystem service benefits experienced by nomadic herders that support their well-being and what role can exploration of TEK play in developing an understanding of the cultural ecosystem services provided by landscapes at a local level.* This objective was addressed in Chapter 5.

To use an ecosystem services approach to support climate change adaptation at a local scale, methods need to engage with the role of traditional knowledge in understanding cultural ecosystem services. Historical and cultural heritages, sacred and religious landscape values, inspirational values of landscape and the symbolic and aesthetic meaning of the landscape are key cultural ecosystem services that support nomads' well-being in Northeast Mongolia. The

cultural ecosystem services that support the well-being of nomadic herders derive from their livelihoods, traditional customs, and their enjoyment of place.

A mixed-methods approach was applied to study the main cultural ecosystem services provided by the pasturelands in Mongolia, seeking to appreciate their importance for nomadic livelihoods and well-being. Traditional knowledge plays an important role in assessing ecosystem services, especially the relationship between cultural ecosystem services and local well-being. The study shows that nomadic herders perceive historical heritage present on pastures as an integral part of nature and that it has deep significance in nomadic people's sense of belonging to the landscape. The study suggests that assessing cultural ecosystem services through explicit classification categories is not sufficient and that a more holistic and comprehensive approach to examine their contribution to human well-being is required. As herders describe it, "nature is a life-long teacher"; they have learned from natural change, maintained their livelihoods and transferred nomadic knowledge from generation to generation. The pastureland is not only a place of herding: it gives a sense of belonging, inspires art, songs, folk stories and shapes culture and customs. At heart, pastureland defines them. The study demonstrates that, as an important driver of local livelihoods and well-being, the cultural ecosystem services provided by pasturelands should be integrated into local environmental management and adaptation.

Research objective 3: *Investigate how local herder communities are adapting to climate change and what adaptation strategies have the potential to better inform formal adaptation planning.* This objective was addressed in chapter 6.

Nomadic livelihoods that have existed for millennia are threatened by climate change. Winter is becoming harsher, summer is becoming drier. At the same time, the livestock population has increased tremendously in response to market opportunities, such as increasing demand for raw cashmere (the main income source of herders) and wool, causing a dramatic increase in the rate of pastureland degradation. The changes in the open steppe pasturelands are forcing nomadic herders to adapt and find ways to increase the efficiency with of adaptation approaches to sustain livelihoods. Whilst the nomadic herders' knowledge and practices of pastureland management have played an important role in their adaptation to a changing environment in Mongolia, they are now seriously challenged by the pace and magnitude of change associated with climate and other socio-economic drivers. The effectiveness of adaptation depends on the herders' knowledge of pasture ecosystems and resource management skills. Herders have taken

various adaptation actions, such as altering livestock mix, investing in new breeds, improving access to water, building storage for hay and fodder, and increasing the cycle of movement.

In Chapter 6, future adaptation options were considered in the light of current and future climate change and responses as to how ecosystem services thinking could inform adaptation planning were proposed. For instance, assessing the carrying capacity of pastureland, using it respectfully and regulating usage to encourage compliance is one option to improve pasture management and maintain ecosystem services. Herders draw on extensive traditional and personal knowledge to maintain and manage pastureland resources, so leveraging traditional knowledge of ecosystem services is important to cope with and adapt to changes. Like with other natural resource-dependent communities, herders have valuable knowledge of local variability and are skilful in adaptation to the dynamics of this temperate dryland ecosystem. The study shows that, if well supported, nomadic movement patterns may well become a suitable adaptation strategy for the next few decades, using isolated areas by improving access to water, additional winter fodder crops, etc. This would require the expansion of mobile veterinary services, social services that follow nomadic communities and livestock insurance systems to help cope with increasing climatic and weather risks. Maintaining (and preferably expanding) pastureland and access to water is essential. This will require a more integrated method to assess pastureland carrying capacity in relation to water resources and their availability. The results of an integrated assessment will provide more options for a land management plan, which will also require an effective strategy to support people in ensuring alternative livelihoods.

Research objective 4: *Investigate what are the potential benefits and risks of using an ecosystem services approach in local environmental management plans (e.g., pastureland management plan) in nomadic communities in developing countries*. This objective was addressed in Chapter 7.

The study investigated the potential opportunities and risks of using an ecosystem services approach in local environmental management planning by exploring how and to what extent ecosystem services thinking has been employed in local planning in Mongolia. The study reveals that the ecosystem services approach is introduced in environmental management by a top-down trajectory in Mongolia. Using the western scientific approach in environmental management, where local livelihoods are directly dependent on nature, brings some risks and opportunities. If it is applied mechanically, without the opportunity for reinterpretation and

adjustment to local conditions through participation and engagement with TEK, then it is likely not to be very appropriate.

The paper examined the presence of the ecosystem services approach in the six regional and local land planning documents. The study revealed that ecosystem services sensitivity is being applied in development of the local plans, but these lack a clear understanding among the decision-makers, as the perspectives and knowledge of direct ecosystem services users and beneficiaries were not strongly engaged in the planning. The content analysis found that ecosystem services thinking has been applied to some extent, in the sense that a commitment to 'obtaining the *baigaliin khishig* to support local livelihood and protect nature' has informed the land use related plans. Traditional ecological knowledge plays a key role at a local level to guide the approach of local decision-makers, planners, and users of ecosystem services. The paper discusses the risks and opportunities that arise from the top-down approach of environmental decision-making in using an ecosystem services approach in local rural environmental management.

The exclusion of TEK and local herders from the application of this approach in adaptation is a major risk. However, there are some possibilities to mitigate the risks and leverage the opportunities. Leveraging local understanding is one way of mitigating the risks. Local knowledge should be used for all phases of planning processes, such as understanding place, establishing scope, setting objectives for local plans, designing effective adaptation strategies, and building alignment to support implementation. Using ecosystem services thinking to empower local communities is essential. It is also important to address the key risks associated with top down approaches to local planning and helpful to improve efficiencies in plan implementation.

8.4. Significance of the findings

This thesis has made several contributions to research and practice concerning ecosystem services approaches in the context of climate change adaptation. In response to the main goal of the thesis – *to investigate climate change adaptation in the Mongolian steppes using an ecosystem services approach – this study reveals* diverse ways in which climate change is affecting different ecosystem services and people's livelihoods. For example, water shortages are leading to reduced nomadic movement, which in turn is causing pastureland degradation along the river and early harvesting, and this is leading to a decline in productivity per hectare. In contrast to the aggregate data used when describing large scale shifts in ecosystem services,

this local study illustrates how subtler aspects of climate change, such as variations in the timing of precipitation experienced by herders, were more important for their livelihoods than the variations focused upon in national and regional case studies, such as total precipitation. The impacts of these fine-grained aspects of climate change on livelihoods illuminates how and why Mongolia is one of the countries most vulnerable to climate change.

The study also *highlights the contribution that* nomadic knowledge of ecosystem services transmitted over many generations makes in guiding herders' efforts to sustain their livelihoods and protect the open steppe pasturelands, and how this informs ongoing adaptation. Local knowledge and practices proved to be reliable sources of information about diverse topics; this is of particular value when looking at impacts and adaptation in data-scarce regions.

The study demonstrated how the use of ecosystem services thinking alongside engagement with traditional ecological knowledge can improve planning for climate change adaptation at the local level. Engagement with local knowledge, and traditional ecological knowledge, is also essential for adaptation plans to have local legitimacy. The study recommends engaging traditional knowledge of ecosystem services when developing adaptive management strategies to support nomadic livelihoods in Mongolia, and generally in traditional rural communities in developing countries.

For ecosystem services researchers, the thesis demonstrates that a local case study based on data drawn from a mixed-methods approach is useful for investigating the opportunities and risks of using an ecosystem services approach to support local decision-making in a rural setting in a developing country. With respect to cultural ecosystem services, the thesis illustrates how engaging with local stakeholders is crucial to understanding the non-material contributions of landscapes to human well-being in communities where a high, direct dependence on nature is the norm. Specifically, it contributes to debates regarding cultural ecosystem services assessment by addressing the importance of memories and aspirations of local communities for cultural and historical heritage, and spiritual and inspirational values of pasturelands. The daily lives of herders and their ways of understanding nature to sustain their livelihoods shape their collective identity as nomads, and understanding this is central to understanding cultural ecosystem services in Northeast Mongolia.

Finally, these findings also speak to professional practice in environmental management and planning. The process findings of the thesis about how to use ecosystem services thinking

appropriately are useful for policymakers in rural areas in developing regions generally. The empirical results of this thesis are an input to local planning in Northeast Mongolia.

8.5. Limitations of the current study and recommendations for future research

The thesis raises a variety of questions that appear to be promising avenues for further research. A critical issue worthy of quantitative investigation is consideration of changes to animal productivity and quality. As one herder described (Chapter 4),

> *There is a big difference between the live weight of the animals, compared with when I was a kid and at present. For instance, the live weight of sheep was 30-40 kg before, and is 20-25 kg at present; the weight of live cattle was 500-600kg, now 300-400kg (H5, Dadal).*

From first principles, pastureland degradation and water shortages would be contributing to this, however, we do not have enough data to assess the extent of these changes in livestock quality in Mongolia. It is a critical issue from a livelihood perspective, and quantification would help focus effort appropriately.

Secondly, there are tensions between herding and mining that the research reported here does not address. Quantitative research on mining impacts on water resources and pastureland is needed in order to support local livelihoods and protect the pastureland ecosystems.

Thirdly, to investigate climate change adaptation in the Mongolian steppes using an ecosystem services approach, this study looked at provisioning services, particularly grassland and water resources, and investigated the cultural ecosystem services provided by the pasturelands. This study demonstrates that benefits from the pastureland ecosystems are declining. Further research to explore the possible long-term effects of climate change on ecosystem services at a finer resolution through modelling, mapping, or further quantitative analysis to inform future adaptation planning would strengthen understanding of local climate change adaptation challenges. Current work (Gomboluudev.P, 2017a; MARCC, 2014) provides a useful overview of possibilities at a coarse spatial resolution, but more fine-grained examination of alternative scenarios may support more astute local adaptation.

Fourthly, during the discussion of the impact of climate change on local livelihoods and ecosystem services, herders raised concerns about cloud seeding. Cloud seeding has been actively conducted in Mongolia since 2006. Herders believe it has made the weather more unstable and has been harmful to traditional weather forecasting practices. So, herders perceive

that cloud seeding has negative impacts on adaptation to variations in weather (details in Chapter 4). Cloud seeding is a common practice in the northern dryland regions (particularly in Mongolia, China, Kazakstan and Russia), so it may make sense to investigate the effect of cloud seeding on weather patterns and on subtler matters such as the efficacy of traditional ways of reading weather patterns. A better underdstanding of its benefits and costs could emerge from this.

8.6. Concluding remarks

In conclusion, this thesis investigated the applicability of ecosystem services approaches to support climate change adaptation in the case of Mongolian nomadic livelihoods as a representative local case from the dryland region. Nomadic herders obtain multiple benefits from pastureland ecosystem services which have played an essential role in their nomadic livelihoods. However, nomadic herders' livelihoods have changed due to socio-economics forces. Climate and socio-economic changes are adversely impacting the provisioning services of the pasturelands at the local level. The study found that if engaging properly with local knowledge, ecosystem services approaches can help inform an improved understanding of local livelihoods and ways of adapting to the changes. The study investigated cultural ecosystem services provided by pastureland and their importance for human well-being, and showed that TEK and associated practices play a central role in understanding people’s relations with place. The study suggests that TEK should play a key role in applying ecosystem services approaches to understanding local environmental management issues. Nomadic herders have practised various adaptation strategies to cope with the effects of climate change. The study shows that where data is limited, nomadic herders' traditional knowledge of ecosystem services provides valuable information about climate and environmental change and how to adapt to changes. Such information can combine with scientific evidence to inform policy about best practice for building the adaptive capacity of nomadic communities in arid environments.

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Appendices

Appendix 1: Human Ethics approval letter

Final Approval - Issues Addressed_5201800162(R)

Faculty of Arts Research Office <artsro@mq.edu.au>

Greg Walkerden;
Navchaa Tugjamba (HDR);
Arts Research Office

Ethics Application Ref: (5201800162) - Final Approval

Dear Dr Walkerden,

Re: ('Investigating an Ecosystem Services approach to supporting local adaptation to climate change: a case study from Mongolia.')

Thank you for your recent correspondence. Your response has addressed the issues raised by the Faculty of Arts Human Research Ethics Committee. Approval of the above application has been granted, effective (10/04/2018). This email constitutes ethical approval only.

If you intend to conduct research out of Australia you may require extra insurance and/or local ethics approval. Please contact Maggie Feng, Tax and Insurance Officer from OFS Business Services, on x1683 to advise further.

This research meets the requirements of the National Statement on Ethical Conduct in Human Research (2007). The National Statement is available at the following web site:

http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/e72.pdf.

The following personnel are authorised to conduct this research:

Dr Greg Walkerden
Mrs Navchaa Tugjamba

NB. STUDENTS: IT IS YOUR RESPONSIBILITY TO KEEP A COPY OF THIS APPROVAL EMAIL TO SUBMIT WITH YOUR THESIS.

Please note the following standard requirements of approval:

1. The approval of this project is conditional upon your continuing compliance with the National Statement on Ethical Conduct in Human Research (2007).

2. Approval will be for a period of five (5) years subject to the provision of annual reports.

Progress Report 1 Due: 10 April 2019
Progress Report 2 Due: 10 April 2020
Progress Report 3 Due: 10 April 2021
Progress Report 4 Due: 10 April 2022
Final Report Due: 10 April 2023

NB: If you complete the work earlier than you had planned you must submit a Final Report as soon as the work is completed. If the project has been discontinued or not commenced for any reason, you are also required to submit a Final Report for the project.

Progress reports and Final Reports are available at the following website:
https://www.mq.edu.au/research/ethics-integrity-and-policies/ethics/human-ethics/resources

3. If the project has run for more than five (5) years you cannot renew approval for the project. You will need to complete and submit a Final Report and submit a new application for the project. (The five year limit on renewal of approvals allows the Committee to fully re-review research in an environment where legislation, guidelines and requirements are continually changing, for example, new child protection and privacy laws).

4. All amendments to the project must be reviewed and approved by the Committee before implementation. Please complete and submit a Request for Amendment Form available at the following website:

https://www.mq.edu.au/research/ethics-integrity-and-policies/ethics/human-ethics/resources

5. Please notify the Committee immediately in the event of any adverse effects on participants or of any unforeseen events that affect the continued ethical acceptability of the project.

6. At all times you are responsible for the ethical conduct of your research in accordance with the guidelines established by the University. This information is available at the following websites:

https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central
https://www.mq.edu.au/research/ethics-integrity-and-policies/ethics/human-ethics/resources/research-ethics

If you will be applying for or have applied for internal or external funding for the above project it is your responsibility to provide the

Macquarie University's Research Grants Management Assistant with a copy of this email as soon as possible. Internal and External funding agencies will not be informed that you have approval for your project and funds will not be released until the Research Grants Management Assistant has received a copy of this email.

If you need to provide a hard copy letter of approval to an external organisation as evidence that you have approval, please do not hesitate to contact the Faculty of Arts Research Office at ArtsRO@mq.edu.au

Please retain a copy of this email as this is your official notification of ethics approval.

Yours sincerely

Dr Mianna Lotz
Chair, Faculty of Arts Human Research Ethics Committee
Level 2, The Australian Hearing Hub
16 University Avenue
Macquarie University
NSW 2109 Australia
Mianna.Lotz@mq.edu.au

Appendix 2: Consent form

Department of Geography and Planning
Faculty of Arts
MACQUARIE UNIVERSITY NSW 2109
Phone: +61-2-9850 7991

Email: greg.walkerden@mq.edu.au

Chief Investigator's / Supervisor's Name & Title: Dr. Greg Walkerden

Participant Information and Consent Form –Interview with herders

Name of Project: *Investigating an Ecosystem Services approach to supporting local adaptation to climate change: a case study from Mongolia*

Welcome and thanks for showing your interest in this research. Navchaa Tugjamba, who is doing a PhD at Macquarie University, in Sydney, and Dr Greg Walkerden (greg.walkerden@mq.edu.au; +61 2 9850 7991) of the Department of Geography and Planning, who is supervising the research project, are interviewing people for the project. Baljnyam Batjargal, WWF Nature Resource Manager, based at Dadal soum, is assisting to conduct this interview as a research assistant. We are researching the options for climate change adaptation for herder communities, and how helpful it is to use an Ecosystem Services approach to support climate change adaptation in Mongolia. The data collected from this interview will help with completion of Navchaa's PhD in Geography and Planning, and it will be used in conference presentations and academic articles.

This research is exploring impacts of climate change on herders' livelihood and environment, the nomadic herders' perception, knowledge and practice of adaptation to climate change. We are also investigating how helpful an ecosystem services approach is for supporting climate change adaptation.

If you agree to participate in this research, you will be asked to answer questions what we prepared. These questions should take approximately 30 minutes to 1 hour complete. If you do not wish to answer any of the questions asked, you may move on to the next question. The interviews will be analysed without using any names of interviewees; no personal details will be linked to individual responses. We will use general categories (e.g. "local herder" or "local citizen"). However, interviewees will have the option to have their names used, if they want. Only the investigators mentioned here - Navchaa Tugjamba and Greg Walkerden and research assistants - will have access to the interview note. A summary report of the information that we get from this research will be made available at the Tourism Information Centre, Dadal soum, Khentii province, Mongolia. Before October 2019, you can call Baljnyam Batjargal (mobile: 98322398; 98887144) to inquiry about the interview results and other related issues. You can get an electronic copy from Navchaa by emailing her at navchaa.tugjamba@hdr.mq.edu.au in October 2019, or afterwards.

Participation in this research is entirely voluntary. It is your choice whether to participate or not. If you choose to participate, you are free to pull out of the study and withdraw consent at any time and are not obliged to offer a reason. Each interviewed herder will be given a gift for

his/her contribution to the research study and timing. And your participation is likely to help us contribute to improvements in climate change adaptation in soum (village) level.

I have read (*or, where appropriate, have had read to me*) and understand the information above and any questions I have asked have been answered to my satisfaction. I agree to participate in this research, knowing that I can withdraw from further participation in the research at any time without consequence. I have been given a copy of this form to keep, if I requested it.

Participant's Name:

(Block letters)

Participant's Signature: Date:

Investigator's Name: NAVCHAA TUGJAMBA

Investigator's Signature: Date:

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Chief Investigator's / Supervisor's Name & Title: Dr. Greg Walkerden

Participant Information and Consent Form –Key informants interview

Name of Project: *Investigating an Ecosystem Services approach to supporting local adaptation to climate change: a case study from Mongolia*

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Participant's Signature: Date:

Investigator's Name: NAVCHAA TUGJAMBA

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Chief Investigator's / Supervisor's Name & Title: Dr. Greg Walkerden

Participant Information and Consent Form - Focus Group Discussion I

Name of Project: *Investigating an Ecosystem Services approach to supporting local adaptation to climate change: a case study from Mongolia*

Welcome and thanks for showing your interest in this research. Navchaa Tugjamba, who is doing a PhD at Macquarie University, in Sydney, and Dr Greg Walkerden (greg.walkerden@mq.edu.au; +61 2 9850 7991) of the Department of Geography and Planning, who is supervising the research project, are organizing this Focus Group Discussion (FGD) for the project. Baljnyam Batjargal, WWF Nature Resource Manager, based at Dadal soum, is assisting to organize the FGD as a research assistant. We are researching the options for climate change adaptation for herder communities, and how helpful it is to use an Ecosystem Services approach to support climate change adaptation in Mongolia. The data collected from this FGD will help with completion of Navchaa's PhD in Geography and Planning, and it will be used in conference presentations and academic articles,

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If you agree to participate in this research, you will be asked to sign in sign-in sheet what we prepared. Focus Group Discussion (FGD) should take approximately 3 hours complete.

Focus group data and information will be analysed without using any names of respondents; no personal details will be linked to individual responses. Only the investigators mentioned here - Navchaa Tugjamba and Greg Walkerden - will have access to the discussion materials and recording files. A summary report of the information that we get from this research will be made available at the Tourism Information Centre, Dadal soum, Khentii province, Mongolia. Before October 2019, you can call Baljnyam Batjargal (mobile: 98322398; 98887144) to inquiry about the FGDs. You can get an electronic copy from Navchaa by emailing her at navchaa.tugjamba@hdr.mq.edu.au in October 2019, or afterwards.

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I have read (*or, where appropriate, have had read to me*) and understand the information above and any questions I have asked have been answered to my satisfaction. I agree to participate in the FGD carried out by Navchaa Tugjamba of Macquarie University, to aid with the research of climate change adaptation. I have read the information sheet related to the

project and understand the aims of the project. I am aware of the topics to be discussed in the focus group. I am fully aware that I will remain anonymous throughout data reported and that I have the right to leave the focus group at any point. I agree to have the focus group discussions recorded, so it can be transcribed after the focus group is held. I have been given a copy of this form to keep, if I requested it.

Participant's Name:

(Block letters)

Participant's Signature: Date:

Investigator's Name: NAVCHAA TUGJAMBA

Investigator's Signature: Date:

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Chief Investigator's / Supervisor's Name & Title: Dr. Greg Walkerden

Participant Information and Consent Form - Focus Group Discussion II

Name of Project: *Investigating an Ecosystem Services approach to supporting local adaptation to climate change: a case study from Mongolia*

Welcome and thanks for showing your interest in this research. Navchaa Tugjamba, who is doing a PhD at Macquarie University, in Sydney, and Dr Greg Walkerden (greg.walkerden@mq.edu.au; +61 2 9850 7991) of the Department of Geography and Planning, who is supervising the research project, are organizing this Focus Group Discussion (FGD) for the project. Baljnyam Batjargal, WWF Nature Resource Manager, based at Dadal soum, is assisting to organize the FGD as a research assistant. We are researching the options for climate change adaptation for herder communities, and how helpful it is to use an Ecosystem Services approach to support climate change adaptation in Mongolia. The data collected from this FGD will help with completion of Navchaa's PhD in Geography and Planning, and it will be used in conference presentations and academic articles,

This research is exploring impacts of climate change on herders' livelihood and environment, the nomadic herders' perception, knowledge and practice of adaptation to climate change. We are also investigating how helpful an ecosystem services approach is for supporting climate change adaptation.

If you agree to participate in this research, you will be asked to sign in sign-in sheet what we prepared. Focus Group Discussion (FGD) should take approximately 2- 3 hours complete.

FGD results will be analysed without using any names of respondents; no personal details will be linked to individual responses. Only the investigators mentioned here - Navchaa Tugjamba and Greg Walkerden - will have access to the discussion materials and recording files. A summary report of the information that we get from this research will be made available at the Tourism Information Centre, Dadal soum, Khentii province, Mongolia. Before October 2019, you can call Baljnyam Batjargal (mobile: 98322398; 98887144) to inquiry about the FGDs. You can get an electronic copy from Navchaa by emailing her at navchaa.tugjamba@hdr.mq.edu.au in March 2020, or afterwards.

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I have read (*or, where appropriate, have had read to me*) and understand the information above and any questions I have asked have been answered to my satisfaction. I agree to participate in the FGD carried out by Navchaa Tugjamba of Macquarie University, to aid with

the research of climate change adaptation. I have read the information sheet related to the project and understand the aims of the project. I am aware of the topics to be discussed in the focus group. I am fully aware that I will remain anonymous throughout data reported and that I have the right to leave the focus group at any point. I agree to have the focus group recorded, so it can be transcribed after the focus group is held. I have been given a copy of this form to keep, if I requested it.

Participant's Name:

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Participant's Signature: Date:

Investigator's Name: NAVCHAA TUGJAMBA

Investigator's Signature: Date:

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Chief Investigator's / Supervisor's Name & Title: Dr. Greg Walkerden

Participant Information and Consent Form – A workshop

Name of Project: *Investigating an Ecosystem Services approach to supporting local adaptation to climate change: a case study from Mongolia*

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This research is exploring impacts of climate change on herders' livelihood and environment, the nomadic herders' perception, knowledge and practice of adaptation to climate change. We are also investigating how helpful an ecosystem services approach is for supporting climate change adaptation.

If you agree to participate in this research, you will be asked to sign in sign-in sheet what we prepared. The workshop will continue approximately 2-3 hours.

Workshop information and data will be analysed without using any names of respondents; no personal details will be linked to individual responses. Only the investigators mentioned here - Navchaa Tugjamba and Greg Walkerden - will have access to the discussion materials and recording files. A summary report of the information that we get from this research will be made available at the Department of Geography, MSUE, Mongolia. You can call Dr.Batchuluun Yembuu (mobile: 99091640). And you can get an electronic copy from Navchaa by emailing her at navchaa.tugjamba@hdr.mq.edu.au in March 2020, or afterwards.

Participation in this research is entirely voluntary. It is your choice whether to participate or not. If you choose to participate, you are free to pull out of the study and withdraw consent at any time and are not obliged to offer a reason. There will be no compensation or direct benefits to you, but your participation is likely to help us contribute to improvements in climate change adaptation in soum level.

I have read (*or, where appropriate, have had read to me*) and understand the information above and any questions I have asked have been answered to my satisfaction. I agree to attend the workshop carried out by Navchaa Tugjamba of Macquarie University, to aid with the research of climate change adaptation. I have read the information sheet related to the project

and understand the aims of the project. I am aware of the topics to be discussed during the workshop. I am fully aware that I will remain anonymous throughout data reported and that I have the right to leave this workshop at any point. I agree to have the discussions recorded, so it can be transcribed after workshop is held. I have been given a copy of this form to keep, if I requested it.

Participant's Name:

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Participant's Signature: Date:

Investigator's Name: NAVCHAA TUGJAMBA

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Chief Investigator's / Supervisor's Name & Title: Dr. Greg Walkerden

Participant Information and Consent Form –A household survey

Name of Project: *Investigating an Ecosystem Services approach to supporting local adaptation to climate change: a case study from Mongolia*

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This research is exploring impacts of climate change on herders' livelihood and environment, the nomadic herders' perception, knowledge and practice of adaptation to climate change. We are also investigating how helpful an ecosystem services approach is for supporting climate change adaptation.

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I have read (*or, where appropriate, have had read to me*) and understand the information above and any questions I have asked have been answered to my satisfaction. I agree to participate in this research, knowing that I can withdraw from further participation in the research at any time without consequence. I have been given a copy of this form to keep, if I requested it.

Participant's Name:

(Block letters)

Participant's Signature: Date:

Investigator's Name: NAVCHAA TUGJAMBA

Investigator's Signature: Date:

Investigator's Name: BALJNYAM BATJARGAL

Investigator's Signature: Date:

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Appendix 3: Semi-structured interviews

3.1. Interview questions for herders

I. Household

1. Can you tell me about a little about your household? Who lives here? How many? How long have you lived here?
2. How many years have you been herding? What was your parents' occupation? Where are they from? (Originally from this soum or moved here from a different place?)

II. Livestock

3. How much livestock do you have? A variety of livestock? (Horses, cows, sheep and goats, maybe camels). Which animals are dominant? Why? What do you use your livestock for (fibers, meat, dairy, riding, etc.)?
4. Who herds the animals each day? How (e.g. horse, motorcycle)?

III. Moving

5. How many times has your family moved per year? Has anything led you to change how often you move, or where you move to?
6. Does your family have its own winter/summer place for your yurt and corrals? (Is it certified). How many families share that place? Why do you choose that place?
7. What is important when you are choosing a settling place?

IV. Grassland and other natural resources

8. Have you noticed the climate changing? If "yes" How do you notice climate change? Do you notice any changes in natural environment?
9. "How could we cope with climate and environmental change?"
10. How sufficient is grass land for herding? Seasonal differences? Does your family harvest grass for winter?
11. What is main source of water? Surface water bodies (rivers, lakes) or wells? How often do you water animals? Water quality? Have there been any changes in amount of water, or its quality?
12. How do you get information on climate and environmental change? (TV, newspapers etc).
13. Do you attend a "bag[i]" (soums are divided into "bags") meeting? What do they discuss during the meeting? What gets discussed about grassland and other natural resources? How often does a "soum citizen representative" meet with the herders?
14. Does your family harvest wild fruits and vegetables for food? If "yes", are the plants growing in the same way as many years ago, or have there been changes? If "yes", what has changed?
15. Do you hunt? What? When? Has this changed?
16. What type of fuel do you use for fire? How do you gather and prepare it?
17. Have you noticed any long term changes in frequency of droughts and harsh winters on your pastureland?
18. Have you know taken any actions to adapt/cope to climate change?
19. What have you done already to adapt to/deal with/cope with climate change?
20. Traditional adaptive pathways? Future plan for adaptation

V. Culture and tradition

21. Are there any sacred mountains or places and cultural heritage in the soum and bag? If “yes” do local people have any special customs or traditions regarding to the sacred places? Are there any songs or stories about that places?
22. Are there any springs with medicinal or special properties?
23. Can you share with me any story, songs or poems about this area?
24. During the summer time your family is your family involved in any tourism activities?
25. What are your main sources of income? Have there been any significant changes? How important financially is herding for your household? How important is tourism?

3.2. Key informants interview (KII) questions

I. Climate change and adaptation

1. What are the main changes experienced in the area (e.g. grassland degradation, increase in frequency of droughts, water degradation, etc.)?
2. In your opinion, how does climate change impact on herders' livelihood and nature?
3. What is done to remedy this / these change(s)? What are the methods used to improve grassland, and to manage water resources? Has there been adoption of new practices and / or changed management patterns?
4. Has the quality of the grassland changed over the last 20 years? How and why?
5. How many and what type of livestock are supported (no./ha/annum) (this may need estimation of herd size and common grazing area) and what are the trends (e.g. over the last (approximately) 10 years)?
6. What are the main livestock products (milk, meat, hides), yields/annum and trends?
7. How frequent and severe are drought periods?
8. Has drought caused any changes in land use over the last (approx.) 10 years?
9. Is there any drought coping strategies? If "Yes" who participated to develop the coping and adaptation strategies?
10. How frequent and severe are "dzud" periods?
11. Has "dzud" caused any changes in land use over the last (approx.) 10 years?
12. Are there any "dzud" coping strategies? If "Yes" who participated to develop the coping and adaptation strategies?
13. Traditional adaptive pathways?

II. Natural resources management and livelihood

1. What type of natural resources are common used in this area? What for? How?
2. What are main income sources for local herders?

3. What would you say about local herders' livelihood? Is it improved year by year? or not? What are main reasons of those changes?

III. Environmental decision-making and public participations

1. How local herders involve and participate in natural resources management and decision-making? Do you think that their participation is important? If "yes"? Why?
2. What are main promotions and motivations to improve local herders' participation in local decision-making processes?

Appendix 4: Focus group discussion

4.1. Focus group discussion (FGD I)

"ECOSYSTEM SERVICES AND LOCAL LIVELIHOODS IN A CHANGING CLIMATE: LOCAL ADAPTATION"

Objective:

- To identify local people' perceptions concerning environmental services and benefits provided by nature
- To assess the trend in local environment services' and benefits' provisioning through time
- To understand the link between nature and environmental services and grassland cover from a local citizens' perceptions
- To capture local people's ability to identify drivers of change in pastureland: both grassland degradation and grassland recovery
- To better understand the possible motivations and incentives that could lead to decrease grassland degradation
- To understand local culture and tradition
- To understand local adaptation strategies and practices to climate change

Participants: 5-8 participants. As well we address climate changes that have occurred for several decades, we will select people that have lived in the soum (village) for a long time. The group will be made up of mixed representatives, such as men, women, herders, soum governor officers, teachers, local citizens. Facilitator will have to make sure that everybody equally participated in the discussion.

Duration: 3 h

The materials that need for FGD: List of participants, consent forms, sign-in sheet, notepads and pencils, flip charts, tape recorder, markers, tape.

Introduction

Facilitator (Navchaa Tugjamba) will introduce herself and assistant. Then would give a brief introduction about the research project, aim, purpose of organizing this FGD, why they will be invited and will explain the FGD guideline. Facilitator will introduce the prepared I&C and ask for their consent and get it with signatures before proceeding.

General guidelines:

- There would be no right or wrong answers, only differing points of view
- We're tape recording, one person speaking at a time
- We're on a first name basis
- You don't need to agree with others, but you must listen respectfully as others share their views
- My role as moderator will be to guide the discussion
- So, talk to each other

1. Mapping local natural resources

Let's start to produce map of local natural resources. Facilitator will explain how to draw local map and provide paper, pencil and markers.

Duration: 20'

2. Benefits from the grassland and nature

Objective: To capture local people's perceptions and understanding of different types of environmental services provided by nature and the importance/benefits of these services for the life and livelihoods of the local people (direct/indirect).

Duration: 15-20’

Indicators:

- Dependency on natural resources
- Common knowledge

Questions: We would like to know what benefits natural environment gives you, your household and your soum?

Facilitator will provide them a flip chart paper. Encourage participants to go beyond *grassland, forest products e.g. clean water, clean air, tourism, microclimate regulation, land reserve for future, cultural values, aesthetic values etc.* Why would you say these are beneficial?

Table.1. List of natural environment benefits

n	Benefits of grassland and nature	Why?	Direct/indirect
1	Pasture land	We herd our livestock, etc.	
2	Source of water	Use for drinking and watering animals, etc.	
3			
4			
5			

As these various natural services may have evolved in different ways through time, we will address the grassland services the soum people identified as the 5-10 most important. These services will be chosen after consultation with the participants.

3. Grassland ecosystem usage/benefit trends

Duration: 30’

Questions:

1. How would you describe the current quality of this grassland?

2. How would you describe its quality in 2000? Was it better/worse/similar than now?

3. How would you describe its quality in 1990? Was it better/worse/similar than now?

Table.2. Trend of natural environment benefits

n	In 1990	2000	The current situation
1			
2			
3			

4. Linking changes in grassland and livelihood. Reasons of changes

Duration: 30’

Once the time frame is filled, we’ll highlight the changes in grassland ecosystem services that have occurred.

- Based on this observation and for each grassland ecosystem service individually, the facilitator shall ask to the participants if these trends are linked to herders’ livelihood. If yes, participants will be asked to explain of this change trend.
- What has induced these changes in pasture land cover? And how do you explain these changes in pasture land cover?

- Participants should represent those causes on a sheet of paper. The facilitator could help by writing or drawing the changes that happen in the pasture land. Beneficial and negative causes will be written on paper of different colors.
- Have you noticed any human-caused changes to your pastureland? (E.g. Impacts from mining, logging companies, wheat/vegetable plantations, tourism activities etc.)
- Are there any local, regional or national environmental regulations?
- Are there any natural extreme events occurring every year that can be identified as causes of the changes? (Floods, droughts, "dzud" harsh winter, forest and steppe fires, animal migration, etc.) How often do these events occur? How do you deal with these events?

5. Which natural environmental benefits recognized and valued?

Duration: 20'

'Does everyone in the community benefit from these ES? Who benefits more? Who benefits less or does not benefit? Why? Why not?

Table 4. Natural resources benefits

Benefits from nature	Access (can everyone use/benefit from this resource/ecosystem)	Trends (changes and future outlook)	Governance (institutions that affect resources)

Table 5. Full list of ES, linked to resources / ecosystems mentioned as being important

Ecosystem Service (ES)	Resources / ecosystems mentioned	Priority (number of color spots)

6. Seasonal calendar of soum

Duration: 20'

Facilitator would ask the participants to describe seasonal calendar of their soum. Seasons, weather conditions, indicators and main herding and cultural events should be described in the table.

Season	When does it start?	How do you know/feel it?	Actions: herding and use of natural resources	Traditional cultural events
Spring			- Collecting wool of goats - Planting wheat etc	

7. Adaptation Question(s)

Duration: 30’

If you feel and notice climate change impacts on livelihood and natural environment, what actions do you take? How do you adapt? Make list and scheme on Adaptation practices and knowledge and describe. Facilitator will explain how to Make scheme map and provide paper, pencil and markers.

After producing adaptation scheme and list, facilitator will ask them evaluate which adaptation strategy/practices are most effective? Why do they consider those strategies are most effective than others?

4.2. Focus group discussion (FGD II)

"ECOSYSTEM SERVICES AND LOCAL LIVELIHOODS IN A CHANGING CLIMATE: LOCAL ADAPTATION"

Objective:

- To explore adaptation options, testing / exploring the usefulness of an ESs approach.
- To explore how helpful an Ecosystem Services approach at a local level to support climate change adaptation

Participants: 5-8 participants. As well we address climate changes that have occurred for several decades, we will select people that have lived in the soum (village) for a long time (at least 10 years). The group will be made up of mixed representatives, such as men, women, herders, soum governor officers, teachers, local citizens. Facilitator will have to make sure that everybody equally participated in the discussion.

Duration: 2-3 h

The materials that need for FGD: List of participants, consent forms, sign-in sheet, notepads and pencils, flip charts, tape recorder, markers, tape.

Introduction

Facilitator (Navchaa Tugjamba) will introduce herself and assistant. Then would give a brief introduction about the research project, aim, purpose of organizing this FGD, why they will be invited and will explain the FGD guideline. Facilitator will introduce the prepared I&C and ask for their consent and get it with signatures before proceeding.

General guidelines:

- There would be no right or wrong answers, only differing points of view
- We're tape recording, one person speaking at a time
- We're on a first name basis
- You don't need to agree with others, but you must listen respectfully as others share their views
- My role as moderator will be to guide the discussion
- So, talk to each other

1. Climate change adaptation practices at a local level

Let's start to make list of local adaptation practices. And then we need to evaluate the importance and effectiveness of those practices.

Duration: 30'

2. Possibilities of using the Ecosystem services approach to support adaptation in soum level.

Objective: To assess local people's perceptions and understanding of different types of environmental services provided by nature and the importance/benefits of these services for the life and livelihoods of the local people.

Duration: 30'

Indicators:

- Dependency on natural resources
- Common knowledge
- Using new term

Facilitator will provide them a flip chart paper. Encourage participants to go beyond *grassland, forest products e.g. clean water, clean air, tourism, microclimate regulation, land reserve for future, cultural values, aesthetic values etc.*

3. Participation in the local decision-making. Adaptation Question(s)

Duration: 30’

How can we improve local citizens’ participation in natural resources management related decision-making, effectively?

Facilitator will lead discussions and make note.

Appendix 5: A policy workshop

A WORKSHOP ON "ECOSYSTEM SERVICES AND LOCAL LIVELIHOODS IN A CHANGING CLIMATE: LOCAL ADAPTATION"

Objective:

- To discuss adaptation options, testing the usefulness of an ESs approach.
- To assess how helpful an Ecosystem Services approach at a local level to support climate change adaptation

Participants: approximately 15-20 stakeholders (including academicians, decision-makers, policy makers, NGOs representatives and local citizens)

Where: MSUE, Ulaanbaatar, Mongolia.

Duration: 2.30'-3h

The materials that need for workshop: List of participants, consent forms, sign-in sheet, notepads and pencils, flip charts, tape recorder, markers, tape.

General guidelines:

- Chair will give an opening speech.
- Facilitator will introduce the prepared I&C and ask for their consent and get it with signatures before proceeding.
- Facilitator will introduce and present the findings of last year field work and recommendation/suggestions for climate change adaptation strategies/options at soum level.
- Participants would be divided in 3 tables.

Organizers:

Chair of the workshop:

Facilitator: Navchaa Tugjamba, PhD student. Department of geography and Planning, Macquarie University, Australia

Tentative topic of the workshop

Opening Session:

Chair will open a workshop (10'). The purpose of organizing this workshop, why they will be invited and will introduce the workshop objective and content.

Main presentation: "Findings and recommendations on climate change adaptation at soum level". Navchaa Tugjamba (30')

Questions & answer (10')

Discussion session: 50' of discussion at each table is scheduled.

Each table will select its own Rapporteur. The Chair or facilitator can ask the table to discuss the following:

- Please turn to one other person and share in two minutes the most interesting thing you heard in the presentation.
- Within your table groups, please take 15 minutes and share effective practices that you are familiar with that possible to improve local climate change adaptation strategies.
- 15 minutes to discuss the possibilities of using Ecosystem services approach to support local adaptation strategies. The advantages and disadvantages of the concept.

- 15 minutes will be allocated for the Rapporteur/s of one of the tables to present in plenary a summary of conclusions

Following comments from the participants (20')

Closing session (20'): Chair and facilitator

Appendix 6: Household Questionnaire

Survey Questionnaire for Herder Households

Enumerator: Time:	Date (DD/MM/YY): ___/___/
1.4. Head of household's marital status: Married/ single/ divorced/ widowed	1.6. Members in family: 1.6.1. Number of adults (16 plus): 1.6.2. Number of children:
1.5. Education level:	
1.7. Does the household have electricity?	1. No; 2. Yes
1.8. What is the source of electricity for your household?	1. Solar panel; 2. Electricity grid; 3. other / please specify:
1.9. How many hours of electricity do you have in a day?	hours
1.10. Does the household have a telephone/mobile phone?	1. No; 2. Yes
1.11. Is the household connected to the internet?	1. No; 2. Yes
1.12. What is the primary occupation of the head of the household, by income?	1. Herder; 2. Agriculture (farm) laborer; 3. Artisan; 4. Office worker; 5. Civil Servant; 6. Teacher; 7. Health worker; 8. Trader; 9. Student;10. Unemployed; 11. Not in labor force; 12. Other non-agriculture worker
1.13. Which people make decisions about the herd?	1. Head of household; 2. Husband; 3. Wife; 4: Child; 5. Grandchild; 6. Parents; 7. Siblings; 8. Other family members (includes household helpers);

1. GENERAL HOUSEHOLD INFORMATION

2. CLIMATE CHANGE AND HERDER PERCEPTIONS

2.0.	How long have you been a herder?	Years
2.1.	**Have you noticed any long-term shifts in temperature on your pastureland?** *If respondent answered "No" to 2.1., go to 2.2.*	1. No; 2. Yes
2.1.1.	Has it become cooler or warmer?	1. Cooler; 2. Warmer
2.1.2.		
2.1.3.	Alter livestock mix	1. No; 2. Yes
2.1.4.	Invest in new breeds	1. No; 2. Yes
2.1.5.	Build winter, spring, autumn shelter for animal	1. No; 2. Yes
2.1.6.	Made investment for water (such as, digging well)	1. No; 2. Yes
2.1.7.	Build storage for hay and fodder	1. No; 2. Yes
2.1.8.	Migrate to new pasture	1. No; 2. Yes
2.1.9.	Purchase livestock insurance	1. No; 2. Yes
2.1.10	Other (please specify):	1. No; 2. Yes
2.2.	**Have you noticed any long term shifts in precipitation on your pastureland?** *If respondent answered "No" to 2.2., go to 2.3.*	1. No; 2. Yes
2.2.1.	Has it become drier or wetter?	1. Drier; 2. Wetter

2.2.2.	What kinds of adaptations have you made for precipitation shifts?	
2.2.3.	Alter livestock mix	1. No; 2. Yes
2.2.4.	Invest in new breeds	1. No; 2. Yes
2.2.5.	Build winter, spring, autumn shelter for animal	1. No; 2. Yes
2.2.6.	Made investment for water (such as, digging well)	1. No; 2. Yes
2.2.7.	Build storage for hay and fodder	1. No; 2. Yes
2.2.8.	Migrate to new pasture	1. No; 2. Yes
2.2.9.	Purchase livestock insurance	1. No; 2. Yes
2.2.10	Other (please specify):	1. No; 2. Yes
2.3.	**Have you noticed any long term changes in frequency of droughts on your pastureland?** *If respondent answered "No" to 2.3., go to 2.4.*	1. No; 2. Yes
2.3.1.	Has the frequency of droughts increased or decreased?	1. Increased; 2. Decreased
2.3.2.		
2.3.3.	Alter livestock mix	1. No; 2. Yes
2.3.4.	Invest in new breeds	1. No; 2. Yes
2.3.5.	Build winter, spring, autumn shelter for animal	1. No; 2. Yes
2.3.6.	Made investment for water (such as, digging well)	1. No; 2. Yes
2.3.7.	Build storage for hay and fodder	1. No; 2. Yes
2.3.8.	Migrate to new pasture	1. No; 2. Yes
2.3.9.	Purchase livestock insurance	1. No; 2. Yes
2.3.10.	Other (please specify)	1. No; 2. Yes
2.4.	**Do you use past weather to predict next year's weather?** *If respondent answered "No" to 2.4. go to 2.10.*	1. No; 2. Yes
2.4.1.	How many years back do you consider?	Number of years
2.4.2.	Do you rely on expert opinions?	1. No; 2. Yes
2.4.3.	Do you rely on newspaper, radio or TV	1. No; 2. Yes
2.4.	**Have you noticed any long term shifts in frequency of dzud on your pastureland?** *If respondent answered "No" to 2.3., go to 2.4.*	1. No; 2. Yes
2.4.1.	Has dzud (harsh winter) frequency increased or decreased?	1. Increased; 2. Decreased
2.4.2.	What kinds of adaptations have you made to shifts in frequency of dzud?	
2.4.3.	Alter livestock mix	1. No; 2. Yes
2.4.4.	Invest in new breeds	1. No; 2. Yes
2.4.5.	Build winter, spring, autumn shelter for animal	1. No; 2. Yes

2.4.6.	Made investment for water (such as, digging well)	1. No; 2. Yes
2.4.7.	Build storage for hay and fodder	1. No; 2. Yes
2.4.8.	Migrate to new pasture	1. No; 2. Yes
2.4.9.	Purchase livestock insurance	1. No; 2. Yes
2.4.10	Other (please specify)	1. No; 2. Yes
2.5.	What method do you use to predict the weather next season:	

3. LIVESTOCK ACTIVITIES

3.1. LIVESTOCK (YEAR 2018)

Type	Number currently owned	Number animals born	Number of animals lost	Number of animals purchased	Number of animals sold
1. Cattle (for meat- male)					
2. Cattle (for milk- cows)					
3. Horse					
4. Sheep					
5. Goat					
6. Camel					
7. Other (specify):					
Table Key	Number	Number	Number	Number	Number

3.2. MOVING and TRANSPORTATION

3.2.1.	How many times your family moves? How far?		Kilometers
3.2.2.	What transport do you use to move?		1. Cart; 2.Truck or other motorized vehicle; 3. Other (specify)
3.3.3.	How far must you travel to sell your livestock/livestock product (distance)?		Kilometers

4. PARTICIPATION in DECISION MAKING

4.1.	Do you involve in any bag/soum decision making communities?		1 = No, 2 = Yes
4.2	Do you participate in any activities by bag or local communities?		1 = No, 2 = Yes
4.3	Have you utilized any kind of advisory or extension service that provides technical livestock input ?		1 = No, 2 = Yes
4.4	Do you get information and advice from local specialists/vet/ for livestock health and production?		1 = No, 2 = Yes
4.5	If you get any technical assistance and advice from other sources apart from official extension workers, from where do you receive the necessary information?		

4.5.1.	Media		1 = No, 2 = Yes
4.5.2.	Neighboring herders		1 = No, 2 = Yes
4.5.3.	From other experienced herders		1 = No, 2 = Yes
4.5.4.	Other		1 = No, 2 = Yes

5. USES OF THE NATURAL ENVIRONMENT

What do you use from natural environment? From where?

5.1.	Provisioning services	Use	Importance	Any marks
5.1.1	Grassland for herding			
5.1.2	Harvesting grass for herding			
5.1.3	Wild plants and their outputs			
5.1.4	Wild animals and their outputs			
5.1.5	Surface water for human and livestock consumption			
5.1.6	Ground water for human and livestock consumption			
5.1.7	Fibers and other materials for direct use or processing			
5.1.8	Surface water for non-drinking purposes			
	OTHER			

6. What are non-material/indirect benefits provided by forests, wetlands, grassland and river basin? For example: tourism, education, spiritual values etc.

6.1.	Regulating services	Use	quantity	Importance	Any marks
6.1.1.	Physical use of landscapes in different environmental settings				
6.1.2.	……				

7. What are non-material benefits that you get from this area? How do you evaluate and feel living in this area?

7.1.	Cultural services	Use	quantity	Importance	Any marks
7.1.1.	Natural beauty				
7.1.2.	Education				
7.1.3.	Heritage, cultural				
7.1.4.	Entertainment				
7.1.5.	Scientific				
7.1.6.	Symbolic				

7.1.	Cultural services	Use	quantity	Importance	Any marks
7.1.7.	Sacred and/or religious				
7.1.8.	Other:				

8. Can you share with us your opinion about changing environment? We would like to know how you feel and evaluate your living environment.

	Benefits/usage	Trend	Reasons for change	Impacts on livelihood
8.1.	Drinking water			
8.2.	Water for herding			
8.3.	Fuelwood			
8.4.	Grassland capacity			
8.5.	Harvesting grassland			
8.6.	Edible plants (fruits, vegetables)			
8.7.	Religious and cultural importance			
8.8.	Tourism			
8.9.	……..			
8.10.				

Trend: if “decreasing” =- 1; no change=0; if “increasing” = 1
Impact: negative=-1; no impact=0; positive=1