

USING HOLISTIC MANAGEMENT STEPS TOWARDS IMPROVING
SOIL AND VEGETATION QUALITY AND
FAMILY RESILIENCY IN MONGOLIA

by

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ABSTRACT

Mongolian herders are still practicing traditional nomadic pastoralism as their main source of life. In the last 100 years Mongolians have been experiencing dramatic political and economic change. The democratic revolution in 1990 let the herders own herds, but not the pasture. Livestock numbers increased from 25 to 47 million within last 20 years, all grazing on common land. Due to climatic and grazing practice changes and socio-economic issues, more than 70% of Mongolian pasture has been classified as degraded (UNDP, 2012). Since land privatization is not suitable for the traditional herding system, Mongolians are searching for solutions for pasture degradation by attempting to define the optimum-stocking rate for sustainable pasture use.

The objectives of this study are to assess the Holistic Management (HM) application at family level decision-making and compare soil and vegetation quality at high and low stocking rate pastures. Application of HM allows us to integrate both traditional and scientific knowledge of pasture to help improve the pasture management decision-making by effectively addressing the pasture degradation within its whole socio-economic and ecological scenario.

This project included learning about one family's decision-making process to document it as a pre-HM application, conducting HM workshops with the family, documenting their new decision-making processes, and with the study team and participant family to build the Resource Base Profile (RBP). After 6 months we compared the major changes and implementations of HM application, revised the RBP, and compared the two RBPs to assess changes.

We sampled soil and vegetation at the herder's pastures of high and low stocking rate at the peak of growing season (July). We then compared those characteristics with the soil and vegetation quality that they prefer at their pastures. The two pastures differed significantly for both soil and vegetation parameters depending on the slope and aspect of the sampling point.

In conclusion, for the study families, higher stocking rate has negative effects on pasture quality and it is contributing to pasture degradation in Mongolia. Herders using HM decision-making process and learning to assess soil and vegetation quality on their pastures are changing their pasture management decisions more sustainably.

CHAPTER ONE

INTRODUCTION

History

Nomadic herding culture has sustained Mongolia for thousands of years (Cosmo, 1994) and continues today. In the last century, Mongolia has undergone massive social, political and economic changes. From a country of nomads it became a communist country with herders' collective system in 1920, and after 70 years, the democratic revolution emerged in 1990. For more than 20 years the country has been in the process of transforming into a free market economy (Bathishig Baival, Fernandez-Gimenez, & Fernandez-Gimenez, Maria E, 2012).

The current social-economic climate is intertwined with the past; human remains found in a Western Mongolian cave document that ancient humans lived in Mongolian lands as early as 750,000 years ago, and archeologists are still connecting the dots between human history and the Mongolian landscape (Natural History Museum of Mongolia, 2008). Many of these connections point to the eminent Mongol ruler, Chinggis Khan (King).

By the end of the 13th Century AD, Chinggis Khan had established the Great Mongol Empire, which stretched across Asia from the Black Sea to the Japanese Sea (Baabar, History of Mongolia, 1996). Several political collapses occurred after the death of the king, and from the 17th to the early 20th century the Manchurian Empire along with China and other Asian counties ruled Mongolia. The Russian people's socialist revolution

in 1921 led to the founding of the Mongolian People's Republic in 1924. The Socialist government attempted, unsuccessfully, to collectivize animals of the nomads in the early 1930s. Actual collectivization started in the 1950s, when all the animals became state-owned livestock (Bathishig Baival et al., 2012). The recent Democratic revolution, initiated by a few young Mongolian journalists and fresh graduates of European Universities in the early 1990s, resulted in the dismantling of all state collective farms, and the state-owned livestock were privatized. The number of herder households consequently increased from about 75,000 in 1990 to more than 150,000 in 1993, and the number of livestock in Mongolia almost doubled from 25 million in 1990 to almost 45 million in 2013 (Government Mongolia, 2013).



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Figure 1.1 Map of Mongolia and USA compared by size and latitude.

This stands in contrast to the 3 million people of Mongolia on 1.5-million km² land, an area that is approximately four times the size of Montana or three times the size

of France (Figure 1.1). The population density of Mongolia is one of the lowest in the world, 2 person/km². The Central Asian Grassland is one of the four major global grassland systems (along with the North American Great Plains, the Serengeti, and the Pampas) and stretches across Mongolia.

Land is still common property in Mongolia. The traditional nomadic lifestyle demands to have land under public ownership because the arid and fluctuating climate and pasture conditions require long distance migrations to keep herds alive. Private ownership of livestock resulted in a rapid increase in animal numbers. Now Mongolia is facing land degradation due to overgrazing (X. Zhou, Wang, Hao, & Wang, 2010). This degradation and the resultant loss of pasture health directly affect the 40% of the Mongolian population who are nomadic herders and dependent on their animal products for wellbeing.

Tradition and Lifestyle

Mongolia is a culturally rich developing country with 35 ethnic groups with a single national identity connected largely with the dominant Khalkh majority. A little over a million people live as herders. The rest of Mongolians—almost two million people—live modern lives of 21st century people in high-rises in the capital city (Ulaanbaatar). With few people on open land and dependent on nature and the harsh climate of Central Asian Plateau, practicing their nomadic lifestyle makes people more practical and they build a closer relationship to each other. Religion plays an important role in the everyday life of nomadic people. Shamanism is the earliest religion, which

basically worships human connection to the earth. Traditionally the religion of Mongolia was shamanism, and in the 13th century it became the state religion that everyone practiced as they wish. Chinggis King was open and democratic about the religion; he had places for every religion to practice in his capital city next to each other peacefully. In the 16th century, the Dalai Lama of that time introduced Buddhism to Mongolia (Lattimore, 2008). Buddhism and shamanism existed interwoven into nomadic life on Mongolian land, and it was a very important part of Mongolian culture and tradition until the socialist revolution in 1921. The overall change that socialism brought was drastic and overwhelming. During the 70 years of the Russian Cultural Revolution, religion was outlawed. From 1924-1985 over 50,000 of the smartest and wisest people of Mongolia who practiced any religion or had ideas that did not fit into socialism were killed in political persecution as “communism protestors” (Kollmar-Paulenz, 2003).

No religions or traditions were practiced during the socialist period and multiple generations of Mongolians lived without it. Horloo says in the schools, children were taught that “*Tradition is remainder of ancient superstition, religion is a drug that handicaps the brain*” (personal communications, June 2013). Elders used to practice their religion secretly by lighting their yak butter candle for their sky spirit in the barrel of butter and keeping their spiritual shrine high up in the mountains to avoid being caught and prosecuted. For those who became victim of the purge, the people of Mongolia built a monument next to Government House in capital of Mongolia in 1998 (Figure 1.2)



Photo by Eagle.mn

Figure 1.2. Political Purge Memorial (Man Captured in the Black Box)

After the 1990 democratic revolution, people were free to practice their religion or traditions as they saw fit. The traditional Mongolian lifestyle was still alive in the butter barrels of Mongolian herders like my grandfather. Now Mongolians practice Buddhism, Shamanism and some Christianity, while Kazakh people of western Mongolia practice Islam. The common religion that herders practiced was and still is shamanism, and the spiritual respect and relationship with nature are paramount. There is strong recognition of the spirits of the mountains and rivers, and the traditions related to them. There are no written rules and laws about land use or daily herders' lives, but still people maintain their pasture and its borders using their unique traditional knowledge and morals.

For Mongolians, traditional lifestyle is not merely a subject of identity or a subject for tourist attraction. It is a solid basis for the guaranteed survival of Mongolian herders.

Because it is a principal economic sector, pastoralism is not greatly affected by international market volatility. When we talk about tradition in general terms, we need to recognize that tradition is not static nor “frozen” and unyielding. It has its own constant dynamic (Batjargal & Enkhjargal, 2013). Batjargal & Enkhjargal (2013) have further implied that in the face of huge and rapid change, the daily traditions of Mongolians continue to serve as a basis for relating positively with environment and society. The nomadic lifestyle has survived and is still evolving as we keep practicing our traditions, while innovating and diversifying the way of life as society develops. The traditional knowledge and religion that ties the people into land were lost during the time of changes and animal privatization was the added force to imbalance the stocking rate and lead to pasture degradation.

General Problem Statement

One main problem for Mongolian people and land is that private animals are grazing on public pasture with little attention to managing or controlling the size of populations and the timing of use. Overgrazing and pasture degradation in Mongolia are a complex ecological and human situation, which requires adaptive management and systems thinking approaches. The strategy is to establish relationships with herders willing to work collaboratively on improving the situation through demonstration case study examples. We use Holistic Management (HM) as a systems-thinking and problem-solving framework to learn with herding families about their situation and help them find and demonstrate tools and actions to improve their environmental, social, financial, and

infrastructure base. In this project we seek to determine if HM can be used to improve the pasture condition as a function and result of a holistic approach to herder decision-making and resiliency.

Our research will approach land degradation using the HM framework, working with two families with different-sized herds. Munkhbat's family has 600 animals - a low stocking rate – and the family is participating in the HM process. The other family is Jamsranbat's family with 3000 animals - a high stocking rate - and they are not participating in HM process. This work has two main objectives: 1) within the HM framework, we will document HM applications at the family level and its effect on decision making towards family resiliency; and 2) focusing on a single component of a whole that herders are trying to manage, we will measure stocking rate effects on soil physical properties by comparing low and high rate of last 10 years at winter pastures of our volunteer families.

Proposed Hypothesis

Problem Statement for HM

There is a need for herder families to increase resiliency in the face of climate, economic, and other changes. Resiliency is defined as the potential of a particular configuration of a system to maintain its structure/function in the face of disturbance, and the ability of the system to re-organize following disturbance-driven change. Adaptive capacity is a component of this resilience that reflects a learning aspect of system behavior in response to disturbance (Walker, 2003).

HM Hypothesis

The HM process helps improve herder family decision making to be more proactive and adaptive, thereby improving the resiliency of environmental quality, social fabric, financial base, and necessary infrastructure.

Methods for HM

We will compare soil and vegetation quality at the two families' winter pastures of low and high stocking rate. We will also compare the decision making process, since one family is using the HM process, another is using conventional decision-making.

Problem Statement for Stocking Rate Study

Degradation of soil and pasture quality in Mongolia is of increasing concern. There is a need to identify management-related causes of pasture degradation. Stocking rate is a main variable causing pasture degradation in Mongolia, along with some climate and land topographical situations. Therefore it is important to measure the stocking rate influence on soil and vegetation properties.

Proposed Hypothesis Stocking Rate Study

In the case of the Munkhbat and Jamsranbat families, pasture and soil degradation is related to differences in stocking rates. Soil and vegetation properties will vary with slope and steepness.

Methods for Stocking Rate Study

We sampled soil and vegetation in each pasture and its subtypes using basic sampling methods. We compared the soil and vegetation properties between the pasture by stocking rate and within the pasture by subtype.

Thesis Structure

This thesis has four main chapters. Chapter 1 is an introduction to this study. Chapter 2 is a review of Holistic Management, its application and documentation of decision-making process, and its influence on one family. Chapter 3 presents the results of the study of soil and vegetation properties at low and high stocking rates on the winter pastures of two herder families. Chapter 4 is a general conclusion with suggestions of further studies.

CHAPTER TWO

HOLISTIC MANAGEMENT AND ITS APPLICATION

Introduction

Mongolian herders are in need of a pasture management and decision-making system, because of the pasture degradation they are experiencing in the last decade or two. There are several types of Community Based Natural Resources Management (CBNRM) tools and applications being applied to Mongolian communities to help improve their social and ecological conditions such as pasture degradation and natural resource user group forming projects. Some of them are relatively successful and some are not. Mainly they have some limitations for fitting into the unique traditional lifestyle and land ownership state of modern Mongolia.

The HM decision-making process is suitable for application to Mongolian pasture use management. The HM decision-making process is where there is systemic and systematic decision-making process with a higher chance of making correct decisions, which accounts for many of the often highly variable parts of the system. It takes account of the resources to be managed and decision makers involved, and people to be affected by the decision. HM is suitable to apply at any level from individuals to a user group and community level. In our case we started at the family level, but the process can be applied to the extended family user group level in the future.

Managing the Commons

Managing common land is one of the most complicated tasks of the natural resources management field. There is empirical and theoretical research stimulated over the past 30 years by Garrett Hardin's famous article, "The Tragedy of the Commons". As it was defined by Hardin, the tragedy of commons is: "*Therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit - in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own interest in a society that believes in the freedom of the commons*". The article points out the tragedies of the commons are real, but not inevitable (Hardin, 1968). Solving the dilemmas of sustainable use is neither easy nor error-free even for local resources (Ostrom, 1999). Especially when it comes to management of natural resources, looking at a single method or multidisciplinary methods of managing natural resources will be likely to leave out different aspects of the problem, because they do not look at the whole situation; instead they single out the problem and try to treat it separately from its whole. In a few examples of common lands management, neither fencing nor land privatization yielded better results. The way that Mongolians kept the land in common showed less pasture degradation compared to neighboring China and Russia, where they fenced off the pasture and intensified the farming with heavy machinery and fertilizers (Sneath, 2003).

The adaptive approach is being widely applied to natural resources management (Holling, 1973; Savory, 1991). Adaptive management is an iterative decision-making process that incorporates formulation of management objectives, actions designed to

address these objectives, monitoring of results, and repeated adaptation of management until desired results are achieved (Briske, Bestelmeyer, and Brown, 2014; Brown and MacLeod, 1996). There are several adaptive management methods in use to help herders manage their pasture more efficiently. They are generally based on the definition above and they are being used for management of complex problems, although they focus on natural resource management problems, they often do not start by describing the whole situation in which the problem exists. However, adaptive management is often criticized because very few projects are ever completed without multiple cycles, resulting in little adaptation and little knowledge gain (Lee, 1999; Walters, 2007). Adaptive management has two major components, the *model* that shows the current situation and dynamic of the problem, and the *monitoring method* that includes main indicators and drivers of the problem that would guide the next steps of the management (Herrick et al., 2012).

There are still some major limitations in the application of adaptive management. The first is that facilitators often give minimal guidance to the participants in how to engage in the two main components of the application, model building and monitoring, which lead to integration of knowledge. Second, they require scientific education and tools such as computer programs, which are often lacking in land users' communities, especially in the case of herders in Mongolia. Because of this limitation, the construction of a whole model lacks user participation and are neither understood nor accepted by the community. Also, different agents use different methods that lead to data that are not comparable across an entire data set. Because of inconsistency of data collection, a relationship between indicators and management actions breaks down. As a result, these

methods are often underutilized and misapplied, sometimes leading to poorly informed decisions that result in undesirable outcomes (Herrick et al., 2012).

The last and most complicated limitation for the adaptive management methods and models is the lack of cultural consideration in the process of design. The projects that are funded by international organizations usually prescribe top-down methods to implement common land management. They involve an inadequate amount of local participation, which should ideally include the cultural or social side of the target community at the beginning and in subsequent modeling and planning stages. That top-down structure often causes those large investment projects that cover the whole country to miss the target communities by not using the effective methods to work with the communities. The projects launch and start implementing their plan using their own predesigned model and monitoring method. The outsider organization's management assistance goal is often different from the management goal of the target community and often leads to conflicting results. Also the data collection and monitoring stage may require specific disciplinary expertise, which makes it hard for the local participants to follow up and perform on their own when the outsider organization's project implementation period ends.

Lack of guidance and consideration of cultural aspects also leads to not only less participation, but sometimes to failure of the whole operation. This was well documented in a Canadian exchange student's report about the failure of a common property and land management project that was implemented in Central Mongolia for a 4-year duration. She concluded that because of the community's values—including kinship ties,

independence and apathy, respect for the environment, money and success—which the program did not consider during the implementation period, the program had a limited role in the community and prevented resilient group formation (Weldon, 2013).

Unlike most adaptive management practices, the Holistic Management approach can be applied at every level from personal management to whole community management, using simple and easy tools that are provided by the initiators of the practice.

Traditionally Mongolians always had ways of managing commons by a system similar to contemporary ‘user groups.’ In the oldest written history of Mongolia, in the 13th century these groups of people were called “Arawt” meaning 10 families (Secret History of Mongolia, 1993). The leader of that group was in charge of managing the migration, pasture, tax payment, and other obligations such as postal duty to be fulfilled for the kingdom, through discussions with the member families. Later as political change occurred, the groups became known as “Hoshyy” meaning few families who live nearby, and “Neg goliinhon” meaning “one river valley people,” then “Hot ail” meaning “family group” that is usually relatives that stay together. Later in the 20th century during the collective time, it became “Suuri” which was referred to the herd of about 300 cattle and 600 head of sheep that are given by the government to be herded (Bathishig Baival et al., 2012; Dulamsuren, Hauck, & Mühlenberg, 2005; Fernández-Giménez, Batkhishig, & Batbuyan, 2012; Hauck & Lkhagvadorj, 2013a; Lkhagvadorj, Hauck, Dulamsuren, & Tsogtbaatar, 2013a). These various forms of user groups represent herder adaptations to increase their resiliency to meet the challenges of the harsh climate of the Central Asian

Plateau, with fluctuations of 70 °C from January to June. With minimal human efforts of feeding and sheltering except during birth time, Mongolian animals graze on pasture all year around (personal communications, June, 2013).

After animals were privatized in 1990, the number grew astronomically and doubled within 20 years, from 25 million head to 45 million (Government Mongolia, 2013; Figure 2.1) while land remained common property to be used as herders needed.

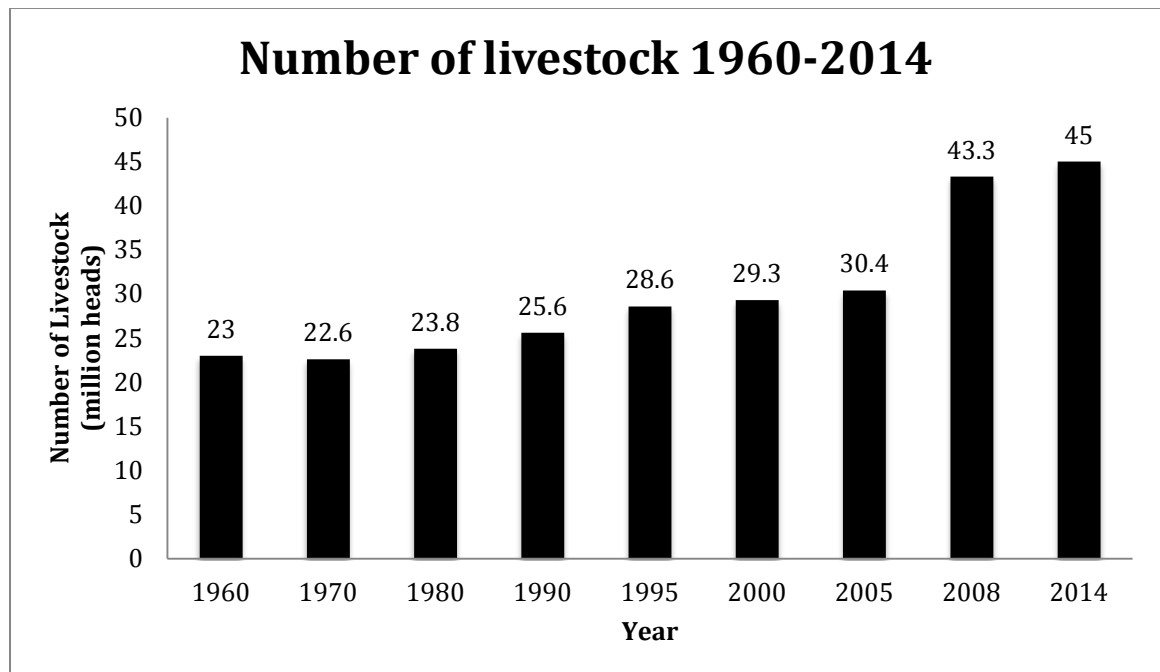


Figure 2.3. Livestock Number of Mongolia (1960-2014; Government Mongolia, 2013)

The tragedy of the commons (Hardin, 1968) has been happening in true form. But it does not mean that we have no other choice than privatization. Pasture privatization will not fit into the cultural and traditional lifestyle of the nomadic herders because they have to move around at least four times a year, for minimum distance of 15km to graze their animals in the semi-arid pastures of Mongolia. Therefore managing the commons

without actual fencing or pasture privatization, which would terminate the nomadic culture and lifestyle of Mongolian herders, is important and vital. In the end, building from the lessons of past experiences of herders traditional knowledge will require forms of communication, information, and trust that are broad and deep beyond precedent, but not beyond possibility. Protecting institutional diversity related to how different peoples cope with Common Pool Resources (CPRs) may be as important for our long-term survival as the protection of biological diversity. There is much to learn from successful efforts as well as from failures (Ostrom, 1999).

Mongolian Herders' Opinion on Reasons for Pasture Degradation

Land managers, researcher, policy makers and program managers are trying to make management decisions for herders but in the end land managers can not fully understand herders' everyday tasks and problems they face. The best people to make decision for herders are herders themselves and they are the people who can integrate their traditional knowledge with realities of current experiences. Land officers and researchers and government officers are there to provide them the right tools to improve their resources and increase their resiliency.

To draw a connection between the local people's reasoning and scientists' research into the causes of degradation, I interviewed herders in the Darhad valley and Shuwuut valley. Herders shared their opinions about the land degradation. In summary, responses from the personal interviews fall into four main reasons: the loss of traditional knowledge, unskilled herders, too many animals, and climate change.

Loss of traditional ecological knowledge (TEK) is the result of the political and social changes over the past 100 years. Herders were organized in the state-owned collectives under the direction of governors and specialists educated in Russia. After 70 years of being told every day what, when and how to do things, and with practice of religion and many traditions prohibited, herders were isolated from traditional herding culture and their former base of TEK. Former champion sheep herder of his collective Mr. Horloo said, no activities were allowed if they were not stated in plans of collectives run by People's Revolutionary Party leaders. For those years most people started to ignore TEK and practices such as "tsagiig shinjih uhaan" (traditional way to diagnose circumstances of pasture and weather). We were workers that worked for others. During the Socialism and Communism era, Mongolia and Bulgaria were called the meat and vegetable farm for Great Red Russia. (Horloo, Personal Interview, June 2013).

Unskilled herders also come from the post-communist political and social changes, and patterns of migration to the city, so that now more of the herders are "Town-born-and-raised herders". Due to the political and social transformation crisis, 70% of government employed people lost their jobs in 1990, except the essential professionals such as teachers and doctors. Food and goods rationing started because of a production deficit. People moved out to the countryside and became herders. Students dropped out of school to herd their animals that came as a share from government, especially boys. This is how Mongolia got the new town-born-and-raised herders. All the freshly converted herders wanted to increase the number of their few privately owned animals, so they could feed their families (Tumur Sharawhuu, personal interview, 2012).

The third reason for pasture degradation was that private livestock ownership encouraged animal population increases, which surpassed the supposedly impossible dream of Communist Mongolian Government to increase livestock population to 25 million. Within a few years of livestock privatization, animal numbers steadily increased, and in 2013 Mongolia counted 47 million head of livestock. The idea of owning their animals was rewarding and unbelievable for herders after 70 years of working for government to build “The Utopian Communism” of sharing the labor and wealth equally (Huuji and Mishig, 2011).

And finally, climate change including drought, dzud, wind and change of precipitation pattern are attributed as causes of pasture degradation. Dzud in Mongolian describes the cumulative consequences of natural hazards that result in mass decimation of livestock due to poor forage and extreme cold temperatures. Precipitation timing and pattern is totally changed from what herders can recall. The change has been speeding up within last 10 years (Enkhtuya and Turbat, personal interview, 2013).

Ways that Mongolians are Mitigating the Land Degradation

Land degradation in the process of political and social transitions and climate related poverty such as loss of massive number of animals in disasters, of Mongolia caught the attention of international organizations and non-governmental organizations (NGO) such as World Bank Asian Development Bank, Food and Agricultural Organization (FAO) and Swiss Development Agency. Through international collaboration and aid program support, these organizations formed Community Based

Natural Resources Management (CBNRM) and other Pasture User Group (PUG) projects. Donor countries have been operating in Mongolia for almost a decade and a half. Bathishig et al. (2012) reasons that “*dzuds*” in 1999 and 2002 were the biggest triggers that initiated and brought the big organizations into Mongolia to facilitate herder user group formation. The question that interests herders and other Mongolians is whether CBNRM is successful in helping herders better manage their resources and solve the problems. Ho et al. (2001) explained the non-equilibrium and equilibrium (dry and unpredictable amount of moisture abundance and stable moisture rich ecosystems respectively(Fernandez-Gimenez and Allen-Diaz, 1999)) state of the pasture and their effects on pasture management. Grazing may not be the biggest trigger for pasture degradation when precipitation and its pattern may drive quality in drier lands such as Gobi and steppe regions of Mongolia. Addison et al. (2010) agree with Ho and clarified that the success of CBNRM depends primarily on regional pasture quality. The reasons for the lack of success of CBNRM in the Gobi regions are the vegetation scarcity and patchiness. The patchiness limits the role of territorial management and usually ends up having significant differences in pasture conditions compared to not using the CBNRM system, because the herders have to move away from their PUG land when there is drought and dzud or when the pasture is grazed and when they move away looking for better pasture herders are not able to manage the pasture that their user group is trying to manage. The need for migration continues across every region of Mongolia: because of scarce vegetation in arid condition of Mongolian pasture they all migrate year around to feed their animals without additional hay or food supplements. In more vegetated areas

like central Mongolian provinces of Uvurhangai and Bayanhongor, Bathishig and Fernandez-Gimenez et al. (2012) argue that CBNRM system is helpful when PUGs are organized based on pasture location rather than the ones that are based on membership choice (people who have similar interest or skills get together and start a user group). They studied the resiliency condition, and management of natural resources at PUGs formed by the Green Gold project, which was funded by the Swiss Development Agency. They found significant differences in the condition of pasture where they introduced irrigation systems and new wells dug and hay fields established, after three years of study. The problems common to most CBNRM projects are that they skip the herders and they start working on pasture quality and pasture problems. In reality herders should be the main drivers of pasture quality as they are the main decision makers. As mentioned in Allan Savory's theory (Savory, 1991), herders don't come up with their goal; they grasp a problem and become more entangled in it as they try harder to solve the problem. All these mitigation attempts treat the symptoms without treating the real reasons behind land degradation. Tragedy of the commons (Hardin, 1968) is what is occurring as a result.

As mentioned earlier, privatization is not the only way to solve the issue related to common pasture in Mongolia, and it is not suitable in terms of Mongolian traditional herding culture and nomadic lifestyle, which requires long distance migration and not pre-determined pasture use. Therefore managing commons using scientific and traditional methods in holistic management (HM) framework of land use should be tested against other CBNRM methods to compare the efficiency to help solve the land degradation

problem. Forming herders' user groups may be the most suitable way to manage pasture while the land is still common property and the culture on it is a traditional nomadic herder's culture. The land degradation is a socio-economic generated situation (Zhang, et al., 2005), which is apparent to anyone who has tried to manage or address the problem of pasture degradation without considering the social and economic factors attached to it. It suggests more holistic approaches to consider the whole situation, not the single factors and symptoms of interest. The land law of Mongolia to keep all pasture common property is taking small steps toward giving more of management powers to user groups formed locally. One of these steps is to encourage herders user groups to have a one-year trial of management and after evaluating the first year's work they get the extension of their user group land management rights. For these reasons the holistic approach is the most suitable way to assist herders at levels of individual family or user group. In conclusion, certain attempts are being implemented to mitigate the land degradation at different levels, some are relatively more successful than others and learning from the previous experiences all are improving the methods of approaching this problem.

Holistic Management Approach

Holistic Management is an approach developed by Allan Savory in the early 1980s, while he was questioning why all the attempts of stopping land degradation were not successful, regardless of the size of land and budget, and the treatments they have in different conditions and locations of the world's degraded lands. He concluded that the process of decision-making had flaws in all cases. When we make decisions, we think

about the problems and keep facing conflicts and therefore are unable to find solutions.

Instead he suggested using four key insights in decision-making processes.

Using the decision-making Mandala (Figure 2.2), we perform six main stages divided into four quadrants or stages of actual decision-making and two additional stages of setting Holistic Goal and Monitoring to complete the process of HM decision-making.

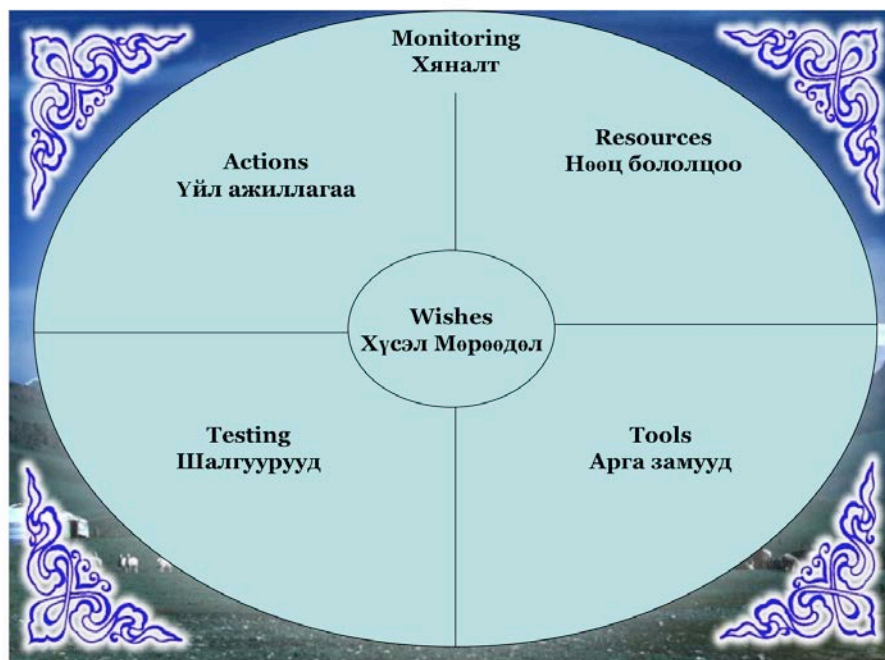


Figure 2.4. Holistic Management decision making mandala (Clifford Montagne, 2009).

The initial task is to define the ‘whole’, consisting of the people involved and the resource base they have to work with. Then, the people involved can create their Holistic Goal statement which explains 1) their quality of life values, 2) the forms of production they engage in to support quality of life, and 3) their vision for how the resource base can be in the future Then we go work with the following 3 quadrants from defining the

resources or whole to be managed. The main considerations for defining the *Holistic Goal* and defining whole resources to be managed are as follows:

- See the situation as a whole entity, rather than just the separated parts.
When we do not see the situation as a whole, and just consider individual parts, we often miss the cause of the problem. Once the ‘whole’ and the Holistic Goal are defined, problem solvers can select appropriate tools and actions.
- In the environmental decision making process, consider the brittleness of the environment that we are managing. Allan Savory classified the environment, based on the moisture near the ground during the seasons when temperature is warm. This is like equilibrium and non-equilibrium environment. This classification is not a solid stable thing. Land can be shifting on the brittleness scale back and forth with changes in climate. At either end the land responds differently to the same disturbance (Savory, *Holistic Management*, second edition, 1999; Figure 2.3). In HM, on brittle land, a tight bunch of big herd for short period of time followed by a rest period can affect the land positively, like the way it was when the herds of ungulates were controlled by predators, which supports our conclusion that TEK may be more sustainable than today’s herder’s grazing habits.
- The third important consideration is the timing. Savory suggested that the amount of time that animals are spending on one particular pasture matters more than the number of animals that are exposed to the soil and plants. In brittle environments, we deal with combination of both stocking rate and timing. So many studies

document degradation when stocking rates are too high, regardless of the timing. But overgrazing can be generated not because of stocking rate but the wrong timing. In some circumstances, under grazing, and lack of disturbance, can result in degradation in some parts of the pasture (Savory, 1991).

- For the ‘ecosystem processes’ of Savory (1991), water cycle, mineral cycle, energy flow and community dynamics, are four complementary ways of understanding and evaluating the condition of the natural resources being managed (Savory, 1991).

Brittleness Scale



Figure 2.5. Brittleness Scale (Savory, 1991)

The remaining three quadrants include brainstorming all possible Tools, asking Testing Questions to more clearly define the problem and select the most appropriate Tools and then planning and taking Actions to manage the resources we defined. When each decision maker and all the people who are affected by the decision are comfortable with the tools, we take *Actions*. The final stage is to *Monitor* the whole process and readjust as. The room with 4 windows is the Ecosystem Processes. HM is the way to look at the whole and the way to manage it holistically. The practice of HM has been in

the developmental process since the 1970's, with applications to many areas of problem solving.

Community Description

Mongolia is divided into 21 provinces called “*aimag*”. Bulgan province is located about 300km northwest of the capital city Ulaanbaatar and an hour drive from Russian built copper mining city Erdenet, the second largest city in Mongolia (Figure 2.4). It was one of the main crop farming regions of Mongolia during the Communist Era. Each province consists of counties that are called “*soum*.” The smallest unit of Mongolian government structure is “*bag*”. Usually there are 4-6 bags in each county. The town of Orhon is 22 km south of Bulgan province and the total territory of the soum is 471,478 ha. Out of that, 5220 ha are used for wheat fields, 329,000 ha are pasture, 4,466 hectares are hay fields, forest covers 79,000ha, 2,406 ha is water, 816 ha is road and infrastructure. The soum has 2900 people, and 940 people of 270 families are living in town and rests are in countryside bags with their 206,000 animals.



Figure 2.6. Bulgan Province Map (mongolinfo, 2010)

One of the major rivers of Mongolia, the Orhon River, flows through the town center and the territory of the soum stretches along the river valley. The area has some Bronze Age deer stone monuments, and this town is in the middle of the crop-farming region of Mongolia that started in 1950s with Russian technology. Herders have moved here from other places because of its convenient location near the province center and mining town markets. The wheat fields have to be left animal free during the growing season, limiting pasture. The area is famous for its good quality “Airag” (mare’s fermented milk).

The study area was located within bag#1 Shuwuut River Valley of Orhon county in GPS location of N 48° 37’ 53”, E 103° 32’ 13”, Bulgan province (Figure 2.5). We worked with two herder families, suggested to us by Orhon county’s vice governor Mr. Tsolmon and governor Mrs. Oyun. The selection was based on their interest to volunteer in the HM application process and new management practices.

The Munkhbat family (Figure 2.6) has 600 animals. Munkhbat and his wife Gereltuya are in their early 30s. Munkhbat is a horse trainer, and he became the best horse trainer of the county in 2012, with 7 of his racehorses finishing in the first 5 places of the regional horse races. He has collected 8 different famous racehorses’ genes by bringing the stallions and mares from other provinces, and his major interest is to breed the best racehorse. Munkhbat’s wife Gereltuya holds a college degree in business and economy, and worked as a bank clerk for two years before she got married. Now they have two children, ages 5 and 3.

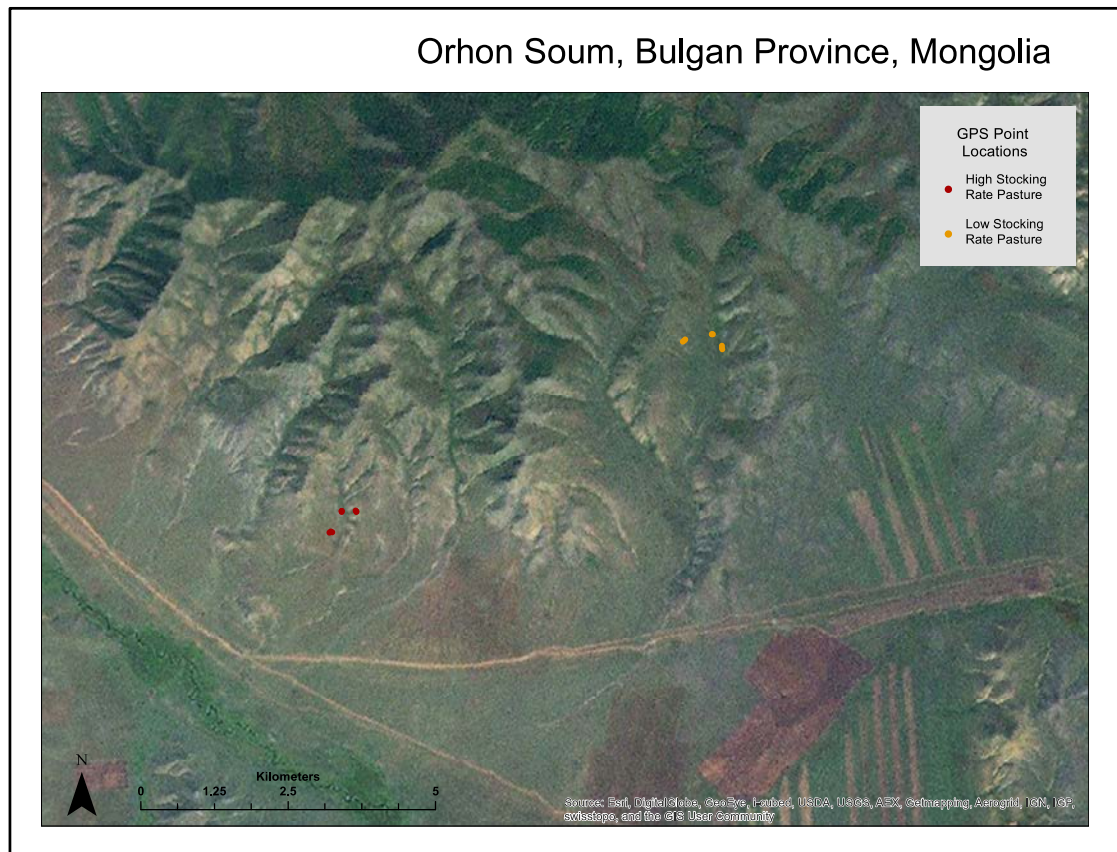


Figure 2.7. Shuwuut River Valley, Orkhon soum (county) Bulgan province
(Monica Berchan, 2014)

They are an example of young herders that have chosen to be herders rather than in-town workers. But they are facing the common problems of being herders and seeking a way to manage their pasture and animals, as well as finding other sources of non-animal-based income.

The second family is Jamsranbat's family. Jamsranbat and his wife are in their late 50s and have two daughters; one is a college student and the other is a herder and a shaman. They own about 3,000 animals and Jamsranbat is also a horse trainer herder. This family wanted to be part of our study because they were concerned about the land

degradation but not interested in applying new practices in their pasture management practices unless they see a difference in Munkhbat's family.



Figure 2.8. Munkhbat and Gereltuya milking mares at their summer pasture.

Methods

The application of the HM process started in the fall of 2011. The governor of Orhon county, Mrs. Oyun, expressed her interest in working with BioRegions International and having a look at a new management practice during visit of “BioRegions International” NGO’s Mongolian director Mrs. Sunjidmaa. With Sunjidmaa’s introduction, BioRegions International NGO’s work trip team visited Orhon County for the first time in summer of 2012 and decided to collaborate after having several meetings about the possible projects and future steps. Then in July 2013, our

team started BioRegions International's new chapter in Orhon county of Bulgan province with the following basic plan:

- To get acquainted with the community through sharing time, while building a Resources Base Profile (RBP) of Orhon county by interviewing participants with various parts and roles in the community. RBP is a profile that we build by interviewing people and finding out about the resources that they have in any type; social, financial and more. The RBP building process is a first quadrant of HM Mandala plan.
- To focus down to family level and start documenting the "Pre HM" application stage decision-making process using discussion methods;
- to introduce the methods of HM and building family level Resources Base Profiles, and to conduct basic soil and vegetation workshops and sampling methods at the winter camp pastures to the family members and local environmental officers;
- To build a first draft of Holistic Management Plan or "Mandala" (Figure 2.2) of Munkhbat's family;
- 6 months later, to follow up with over-the-phone interviews about the progress of participants, and document the decision-making process changes and challenges that they have faced;
- To plan the future steps using the current HM stage of the participant family; and

- To decide on enclosures to experiment with the herd effect at winter pastures of the chosen herders.

Details of HM Application Methods Step

The following tasks were completed within the frame of our research plan.

Step 1. Using Allan Savory's Holistic Management guidelines, we collected baseline information about the Orhon community to build a Resource Base Profile (RBP) of the county (Appendix D). At the beginning of July 2013, field assistant Sam Atkins, an undergraduate soil biology student at MSU, and I spent a week interviewing citizens of the county beginning with local government officials and employees, including the librarian, the cultural center director, and people of the town including a retired teacher, herders visiting the town center, and a shop assistant. In total we interviewed 21 people (Appendix D). The interview had no strict form or prepared suite of questions, and it took from about half an hour up to two hours. The discussion generally included the time span of past and present of Orhon county, overall Mongolian life, their job, what they need and wish to do for their life, and some future plans. In total 45 pages of information was collected and used to build the first draft of RBP of Orhon County (Appendix D).

Step 2. Narrowing down to family level of HM application required a volunteer family or families. With my field assistant Ulziijanlav, a pasture quality specialist of Green Gold Project of Swiss Development Agency in Arhangai province, I collected basic information about Munkhbat's family while living with them for 9 days. During these 9 days we visited their seasonal camps, and looked at the pasture and water

resources while building trust and friendship, which is very important in work with Mongolian rural herders. The materials and information that we have collected from this period were used to document the “Pre-HM” (Appendix D) application state.

Step 3. Our team organized two general HM workshops (Figure 2.7) at Munkhbat’s family ger using HM Mandala (Figure 2.2) and Allan Savory’s Holistic management guidelines.



Figure 2.9. HM Workshops

We held the two workshops (Figure 2.8) on vegetation growth and grazing effects on belowground biomass, and how plants recover after grazing using carbohydrates stored in the roots. We also covered methods for sampling the soil and vegetation at winter camps, with participation of the family members and county’s environmental officer.



Figure 2.10. Workshop on soil and vegetation basics at Munkhbat's family.

Step 4. First the family got to decide who are the decision makers in their family. Then they listed the decision makers and ask them to participate to build HM Mandala. The building decision making plan using HM Mandala uses the Holistic Management Handbook of Allan Savory and Jody Butterfield. First herders have defined their *Holistic Goal*, the things they wish to do to reach the *Future Resources*. In order to get that goal they need to define *Current Resource Base* including their *Form of Production*-the ways and methods that they would produce to obtain the quality of life they want. Then *Test* the methods using testing guidelines. One possible test would be to check if the plan is financially applicable and socially acceptable. For example: for Mongolian herder user group members having a garden is impossible, because they cannot be there to take care of the garden during the growing season. Another component of testing is to identify *weak links* to strengthen in various *chains of production*. This step allows participants to

find the weak links and try to strengthen them. Then after all we get to *Action*. The last step is *Monitoring* to get us to do the next round better.

People find that sticking with the HM decision making-process is the hardest challenge that they face, as it changes the paradigm of decision-making that they had before the HM application (Savory, 1991). Therefore we provided the decision-making Matrix (Appendix D) to assist them with sticking with the new decision making process.

Step 5. After six months of using the HM method, I checked the progress using a prepared question frame, which relates to the decision-making process shown in Holistic Management Monitoring Handbook by Allan Savory and Jody Butterfield (1999). I have documented the main changes in their decision-making and the difficulties that they have been facing during this 6 months' time. The side-by-side comparison of the RBP June 2013, and Feb, 2014 are shown in Appendix D.

Step 6. The final step of this process was to document differences in the decision-making process in Munkhbat's family and compare to (control) Jamsranbat's family decision-making processes and plan the future steps for Munkhbat's family using the last updated HM plan (Appendix D) with Munkhbat's family.

Results and Discussion

In Table 2.1 (Appendix D) I have compared the before and after HM application of decision-making process of Munkhbat's family. The last column shows Jamsranbat's family decision-making process. The time frame of HM decision-making processes

application is from July 2012 until February 2013. Since it was a qualitative study interview, the herder's family members' expression of thoughts were important to help evaluate whether there were changes in their daily life decision-making processes and whether the HM system helped or not.

Parts of Munkhbat's family interviews after 6 months of HM decision-making processes show some changes. The following are parts of their interview, from Gereltuya's interview: "Even though we used to talk and plan our goals we never sat down and put them on paper and saw it on one page. After we built the first RBP in last July I saw how was our family doing in terms of current finance, health, social connection and future resources in real life for the first time. For the first time ever I have thought about what it was that I really want as a family wife and what it was that we want as a family which has two little kids?" The husband Munkhbat added, "It is nice to have a goal and work for that using what I have, and there is so much less stress when you have some guidance, like a RBP that shows what you have and what are working for, for the future..." In addition they both said it is hard to keep using the new way of decision making so the written plan and decision making matrix assist a lot to stick with the method and plan..." Gereltuya added "...also the brainstorming session is very interesting family talk time instead of arguing about the problems like we used to before and blame on each other or other people..." Munkhbat says "... you know my wife holds a degree in finance and it really sparked the light of hers and she is really taking the lead on the planning and discussion..." (personal communications, Feb., 2014).

Table 2.1. Changes in the family decision-making processes before and after HM application.

| Decision making steps | HM Family Munkhbat's (MB) | | Non HM family Jamsranbat's Decision making routine (No HM and No soil and vegetation knowledge) |
|---|--|--|--|
| | July 2013 (HM only) | Feb . 2014, (HM and soil and vegetation knowledge) | |
| 1. Wealth profiling | They think about what they have but never written them down on paper | They have whole RBP now and constantly updating it discussing with the other decision makers | No written description but they know it without putting them on paper, but children of the family don't really have information about what they have |
| 2. Decision makers | MB's father and wife and himself | Munkhbat, Gerlee, 2 daughters, neighbors who share the resources, and parents of both sides | Father and mother sometimes the shaman daughter |
| 3. Decision-making Mandala steps | some | all | some |
| Forming holisticgoal long term short term | No <i>holistic goal</i> , try to improve their livelihood | Holistic Goal Both long and short term goals | Focus only immediate problems without formally considering the whole situation |
| Defining resources base | Look for immediate solutions | Look at their resources | Solution |
| Brainstorming possible tools | Solve the problem | Look at possible ways to solve | Talk with his wife |
| Testing the tools chosen | New problems | Test the methods | Solve the problem using the chosen method |
| Taking action | Look for solutions | Choose the best way and solve | |
| Monitor and re-plan | Go to next problem they have in priority | Find out the mistakes that they made and re-plan the action | Start working on new problem |
| Supporting tools | | | |
| Decision making matrix | NA | They use it to control their unplanned actions and expenses | NA |
| Brainstorming skill | Discussion | Use of mind mapping tool to brain storm | Not much of brain storming with |
| Testing guidelines | Talk with their father | Try to use the guidelines systematically | Questioned by wife sometimes |

During the whole HM application and RBP building part of my study, it was hard to quantify all the information. While I was working with herders on the HM application and use it became apparent that they have no written plan at all about their life and finance and their future. Mukhbat's family has a broad goal of improving their life but lacks guidance and persistence, and they end up not progressing. The lack of progress affects the overall family's quality of life and that turns into even serious environmental problems such as losing their pasture in the near future. Now finally I got a chance to practice with a volunteer family to set a quality of life for their family using HM, which I think is the best way to address the diverse social, financial and environmental problems at any level. I see positive results that strengthen the family resiliency and in future it may lead to better decision making towards the environmental issues that Mongolia is struggling with.

The next steps of this HM application would be the formation of herder's user group that includes Munkhbat and his extended family, which would encourage his father and brother's families to use HM. Another step would be to establish experiment enclosures at winter camps with herd effect treatments to get deeper understanding of stocking rate pressure on pasture quality as well as to evaluate effects of having the herders participate.

CHAPTER THREE

STOCKING RATE EFFECT ON SOIL AND VEGETATION QUALITY

Introduction

Mongolia as a whole is experiencing land degradation, despite regional differences in precipitation. As UNDP indicated that 70% of Mongolia's pastures are now degraded, degradation is defined as the reduction in the capacity of the land to provide ecosystem goods and services and assure its functions over a period of time for the beneficiaries of these services (Nachtergaele & Biancalani, 2010).

Variables Contributing to Pasture Degradation in Mongolia

Several main variables contribute to pasture degradation in Mongolia, some variables are unique to Mongolia, and the rest are common variables in similar ecosystems around the world, such as soil and vegetation quality. Climate can be another variable that is contributing to pasture degradation. The major variables unique to Mongolian ecosystems include: current law of land use, traditional herding knowledge and its evolution and application, management practices of herders, and social and economic drivers. In the following paragraph, each variable will be explained in detail.

First, all the pastureland in Mongolia is common land. There are no fences or designated borders between the pastures of different herders. Controlling animal numbers on each piece of pasture is difficult without any fencing or exclusion methods, unless

landscape and topographical location of the pasture define pasture borders and make them relatively easy to maintain, which is true of our research sites.

It is a challenge to measure grazing-induced impacts on pasture in arid and semiarid rangeland ecosystems with stochastic precipitation (Briske, Bestelmeyer, Stringham, Shaver, & Briske, 2008). The precipitation level in Mongolia is low (mean of 155mm; Wesche et al., 2010), and usually very variable (min 50mm to max 600mm; Mongolian Meteorological Center, 2013) with droughts being common, leading to sporadic collapses in herbivore populations. Therefore, the system has no stable state, and it makes it hard to make management decisions, since animals and precipitation are both drivers of the system.

The third variable is the loss of Mongolian traditional ecological knowledge (TEK). Mongolian herders have been herding their animals on their pasture sustainably for centuries compared to neighboring countries which practice more of settled farming practices (Sneath, 2003). Now land degradation is the issue. Herders attribute the land degradation to the loss of traditional herding knowledge. As mentioned in the introduction, Mongolian herders went through a massive political and social transformation over the last 90 years (Bathishig Baival et al., 2012). This change played a big role reducing the sustainability of herding. But this is not the only reason for pasture degradation issue.

The fourth variable is the social and economic variable. The changes brought about by the free market economy caused many effects that are not always environmentally sustainable. For example, there is the increased interest of herders in

having more cashmere goats because of the cashmere price increase. Goats tend to eat the roots of the plants more compared to sheep and other types of animals. The last 20 years of private animals grazing on public land also brought changes to herding management and practices. People want a better life, and equate that with more animals. Since they do not pay for grazing more animals on the land, they have no responsibility for the land that they degraded. They do not have a designated herder with the herd all day like before and animals graze on their own, with no designated pasture management or grazing schedule. Another change is that many wells have not been maintained after collapse of collectives, so herders cannot use pasture which lacks water supply. Because of the reduction in water resources, herders cannot use certain parts of the pasture where they cannot have water supply. The social and economic changes also resulted in a lack of leadership, which previously organized collective activities such as hay harvest time migration dates and distances including herding practices. Before and during the collective time the traditional user group forms were active such as “Hot ail” or “Neg goliinhon” (Fernandez-Gimenez, 2000). In both cases, herders had a venue for land management. Now, herders are not managing the land at all and just using it without any plan.

In conclusion, pasture degradation is affected by a set of circumstances unique to Mongolia- social, political, and economic, and some climate change effects that people are just beginning to measure. Now that they are realizing the extent of degradation, people are starting to see options of working in groups and managing their pasture with neighboring families.

Management Variables

Ranchers and farmers who want to manage their land sustainably estimate the optimal stocking rate of their pasture before they make their management decisions such as time and duration of the grazing, herd size and recovery time needed. Management decisions also take account of weather, precipitation, soil type and other biotic and abiotic factors.

Mongolian pasture has certain complications, mentioned above, when trying to determine the optimal stocking rate and carrying capacity. But the Mongolian government has estimated the carrying capacity at 0.6 sheep per hectare, using the average vegetation biomass that a single sheep would graze daily and comparing it to the average vegetation production of the central Mongolian pasture during the growing season (Mongolian Government Report, 2009).

The carrying capacity and optimal stocking rate estimation require soil and vegetation quality estimates that vary with location and conditions. Knowledge of soil and vegetation properties along with climate variability will help managers and herders estimate stocking rates.

Our Study Situation and Objective

We have chosen two herding families in Central Mongolia. Their winter pastures have two different stocking rates (high-3000 and low-600 animals) as primary variables. Secondary variables are slope aspect and slope steepness.

Our study objectives were:

- To examine whether stocking rate has effects on designated soil and vegetation properties
- To test whether the topographical location, as expressed by slope aspect and slope steepness, had an effect on the soil and vegetation properties.

Literature Review

Description of Rangelands and Their Environments

Mongolian rangeland varies from north to south as Siberian forest turns into rolling hills and then steppe and finally Gobi desert. West to east, the topography ranges from high mountains that are 4400m to low plains at around 512m in the eastern Mongolian steppe. The climate and vegetation community and herd structure varies greatly along the gradients. In general classification, Central Mongolian pasture is part of Asian meadow steppe dominated by *Leymus chinensis* (Wang et al., 2008) and this is where our study pastures are located.

Effects of Climate Variables on Range Vegetation of Mongolia

Scientists argue about whether Mongolia has an equilibrium or non-equilibrium system, which refers to ecosystems with stable moisture conditions versus dry and unstable moisture conditions. Both views have been challenged as being rather extreme, because real systems often behave in an intermediate manner (Briske et al., 2008). Steppes in Mongolia show gradual, rather than abrupt, transitions between moister equilibrium and drier non-equilibrium systems (Fernandez-Gimenez & Allen-Diaz,

1999). This supports the general notion that direct degradation effects are apparently rare in dry rangelands under non-equilibrium conditions (Wesche et al., 2010).

Moisture and temperature circumstances in northern Mongolia are apparently different (von Wehrden et al., 2006) but these regions are moister and an equilibrium model may be more appropriate (Fernandez-Gimenez, 2000). Our study site area is in a region with higher moisture availability (average of 300 mm; Figure 3.1).

Slope Effect

Where and for how long and how many animals graze are the important variables that lead to positive or negative impacts on rangeland. Moist and nutrient rich pasture showed a positive effect of grazing, especially in valley bottoms where soil moisture and plant growth becomes high with the total coverage over 100%. When dominant plants are grazed the competition among plants is relaxed. Near the ridges and upper slopes are where the soil moisture and plant growth are low, grazing showed negative effects. Because in these more severe sites, removal of plant leaf by grazing allows other plants more access to sun and moisture (Fujita et al., 2009).

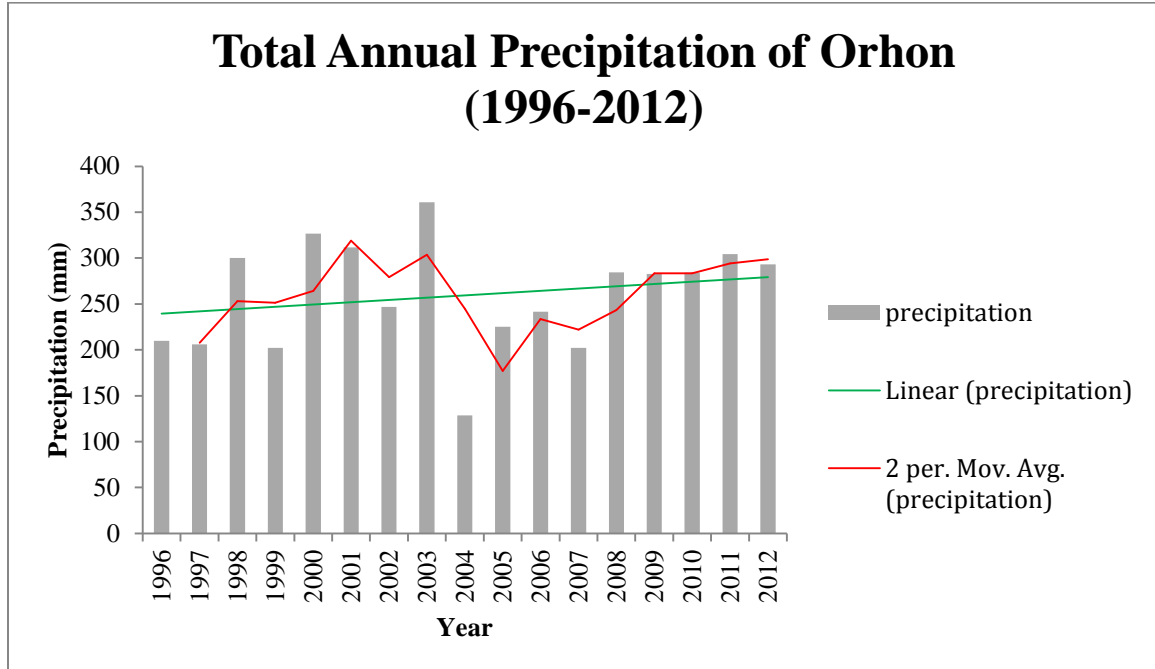


Figure 3.11. Total annual precipitation of Bulgan Province (1996-2012).

Depending on location, livestock grazing of the same intensity can positively influence the species diversity of pasture plants in moist habitats, but have a negative influence in dry habitats. However, it is not clear whether, within the same habitat, different pressures may produce different effects on the species diversity of pasture plants (Fujita et al., 2009). Fujita et al. (2009) further examined the effects of livestock grazing on the annual production and species diversity of pasture plants using mowing experiments in an enclosure with no fertilization. To alter the simulated grazing pressure, they mowed the pasture plants at different heights and intervals. The study sites included a flat valley bottom with high production and an upper slope of the valley with low production. Grazing can more negatively affect steeper slope pastures than less steep or flat pasture sites. It was observed that, for the same vegetative cover, more soil loss

occurred from plots on steep than on gentle slopes, and that gentle slopes could withstand more grazing pressure without seriously affecting the biomass regeneration compared to steeper slopes (Fujita, Amartuvshin, & Ariunbold, 2013; Mwendera & Saleem, 1997).

The same result was reported by Noboru Fujita's study in Mongolian steep slope pastures. Therefore 'slope-specific' grazing management (Fujita et al., 2009) was suggested to herders.

Lichens

Lichens can indicate grazing impact on the pasture, especially in the pasture near the forest edge or up in the river valleys. In the case of Mongolian herders (Hauck & Lkhagvadorj, 2013a) found that the species richness and cover of epiphytic lichens were negatively correlated with the density of nomad summer camps in the forest-steppe of the Mongolian Altai. So lichens are another potential indicator of the severity of the livestock grazing impact (Hauck & Lkhagvadorj, 2013b)

Degradation or Desertification

The Process and Relationship to Grazing

Livestock grazing is a dominant land-use activity in semi-natural and managed rangelands (Söderström & Svensson, 2001). Heavy grazing can disturb rangeland (Yates, Norton, & Hobbs, 2000). Heavy grazing often results in a dramatic decline of plant diversity, vegetation cover, primary production (Fensham, Holman, & Cox, 1999), seed production and seed number in soil (Bertiller, 1996). After heavy grazing, pasture needs a certain amount of time to recover. With vegetation decrease due to consumption of plant

matter exceeding regrowth over the long term, rangeland desertification can occur (Manzano & Návar, 2000; Zhou et al., 2011).

Desertification is mostly caused by grazed pasture losing protective plant cover (Bari, Wood, & Murray, 1993) and leaves the land more vulnerable to outside impacts. When vegetation cover declines, soil bulk density increases and organic matter content and aggregate stability decrease, and the rate of water infiltration decreases (Mwendera & Saleem, 1997). The main reasons for infiltration rate decrease are increased bulk density by the pressure of animal feet and decreased plant matter in the soil component. The pressure under the foot of a standing sheep is about 50–80 kPa (Tongways D, 1996; Willatt & Pullar, 1984) compared with 60–80 kPa under an unloaded tractor or tracked vehicle. These pressures under the grazing animal will be even higher when the animal is moving, due to kinetic energy and the animal's weight being supported on fewer feet. It is not surprising; therefore, that research shows degradation of soil physical properties under pasture due to grazing animals (Greenwood, 1997).

In Mongolian pastures, after the collectives collapsed people started to let animals graze on their own, without herding them tightly everyday by a designated herder. Traditionally keeping animals in tight bunch was highly recommended. When animals are grazing, keeping them in a tight bunch prevents them from moving too fast and losing weight, especially in autumn, which herders call “fat melting time.” Also they graze all the vegetation in equal amounts without choosing the palatable species and leaving out the unpalatable species.

Allan Savory's grazing management technique suggests that a tight bunch grazing heavily, followed by a resting period, can disturb the soil surface which helps it germinate more seeds, while the manure of the animals also fertilizes the pasture (Savory, 1991). The animals' hooves break the top crust of hardened soil and prevents reductions in infiltration. If the top is hardened and not treated with animal trampling, rain water runoff forms and accumulates in depressions after rain-storms, which increase the risk of water-erosion and wind erosion in the bare places, and further affects the heat and water budgets above the community (Li et al., 2000). Our study pasture has the big gullies and remains of floods. The locals tell us these gullies were not there 10 years ago. Some of the gullies are almost 2 meters deep (Appendix B).

Effects of Stocking Rates

The stocking rate effect on soil and vegetation properties has not been extensively studied in Mongolia, although it could be a critical impact on soil and pasture quality. Few scientific data are available on the response of Mongolian grassland vegetation to increasing grazing intensity or the removal of grazing (Lkhagvadorj, Hauck, Dulamsuren, & Tsogtbaatar, 2013b; Tserendash, 1993). One of the few studies was conducted by a Japanese and Mongolian pasture research team including Fujita and Noboru (2009) looking at the stocking rate effect along the slope gradient of Mongolian mountain pastures. One of the reasons that this topic is not well studied is because Mongolian pasture is common land and it is hard to determine how much grazing pressure is on each designated part of the pasture. The effects of different stocking rates have long been

researched in North America, the Middle East and in parts of Africa where, unlike in Mongolia, they can control the number of animals to graze on certain measured land. In a global review of rangeland literature comprising 236 sites, Milchunas and Lauenroth (1993) found that responses of soil organic matter, soil carbon, and soil nitrogen to grazing were “nearly equally divided between negative and positive.”

Plant Cover

Pastor et al. (1993) found that selective herbivory for the higher palatability species often leads to the dominance of lower palatability species with low relative growth rates and higher concentrations of anti-herbivore defense chemicals (Sasaki, Okayasu, Jamsran, & Takeuchi, 2007), and also to the decline in the quality and quantity of litter (Olf & Ritchie, 1998). To avoid unequal grazing pressure on the plant species, Mongolians used to herd the animals in tight bunches and let animals graze on every grass in the patch before moving into a new patch. Now they do not keep a herder with the herd to make sure that they graze in that manner. In large part this is because herders have smaller size families, and also less worry about wolves, another reason they used to have a herder with the herd all the time (Tumur, Personal Interview, 2012).

Soil Surface Changes

The literature suggests that treading by livestock increases soil strength and bulk density and reduces macro-porosity and infiltration rate (Bell et al., 2011). For example in Australia, Warren et al., (1986); Mead and Chan, (1992); Bell et al., (1997); Greenwood and McKenzie, (2001) have shown trampling by livestock can reduce infiltration rates of bare soil by 19–50% depending on stocking intensity. Singleton et al.

(2000) found greater reductions in soil hydraulic conductivity (50–90%) under intensive cattle grazing on wet soils in New Zealand, especially on soils that were previously damaged. Gifford and Hawkins (1978) examined a number of studies in U.S. rangelands and found that infiltration rate is reduced by 43% under light/moderate grazing and 75% under heavy grazing compared to ungrazed controls. Livestock can also increase runoff and sediment loss due to reduced infiltration and degraded surface structure, but it is difficult to separate the effects on the soil surface condition of reduced ground cover associated with grazing from the direct impacts of the trampling (Mwendera & Saleem, 1997; Warren, 2002).

Soil infiltration is especially important in the arid pastures of Mongolia to allow water to enter the soil. Infiltration is the downward entry of water into the soil. The velocity at which water enters the soil is the infiltration rate. Infiltration rate is typically expressed in inches per hour (USDA-NRCS, 2006). High water content, infiltration rate, and surface roughness can increase sediment and nutrient retention, and greatly improve vegetation growth (Jones, 2013). But grazing can reduce soil qualities and furthermore reduce soil infiltration. The heavy stocking rate consistently reduced infiltration during the grazing season (Abdel-Magid, Schuman, & Hart, 1987).

Infiltration rates were measured seasonally to show the effect of stocking rate on infiltration rate in Abdel's study. The average water infiltration rate (equilibrium and cumulative) was significantly less in the fall than in the spring for the heavy stocking rate, but showed no seasonal effect for the moderate stocking rate. The moderate stocking rate had a significantly greater infiltration than the heavy stocking rate at the end of the

grazing season. No significant differences in infiltration between stocking rates existed in the spring, indicating that the freeze-thaw activity each winter alleviated any detrimental soil compaction that reduced infiltration. In 1983, the infiltration rate was less under heavy stocking than under the moderate stocking rate. The heavy stocking rate consistently reduced infiltration during the grazing season, but this appeared to be alleviated during the winter by freeze-thaw activities. (Abdel-Magid et al., 1987)

Long-term simulations show that soil impacts generating large reductions in root growth and infiltration rate are required to reduce subsequent crop yields substantially. Such impacts would be possible on structurally degraded soils where surface cover is allowed to fall below critical levels (Bell et al., 2011). Top soil loss and compaction can lead to an effect called “capping”, which is when the top soil has no vegetation coverage and when it gets rain or precipitation, the soil turns into a hard shell and no moisture can penetrate. This makes the water cycle ineffective and all the precipitation that could not infiltrate the soil becomes a flood and washes away the top soil and plant matter that are supposed to protect the surface from further damage (Savory, 1991).

A two-year field trial was carried out in New Zealand to investigate the influence of cattle, sheep and deer on soil physical quality and the loss of phosphorus (P) and suspended sediment (SS) in surface runoff. While there is limited scope to manage for infiltration-excess surface runoff losses from pasture, with most runoff occurring in winter, these findings reinforce the use of mitigation strategies such as restricted or nil grazing in winter when soil moisture has reached field capacity to minimize P and SS

loss to surface water, regardless of stock type (Cournane, McDowell, Littlejohn, & Condrón, 2011).

Yellowstone and Other Positive Effects

Stocking rate has different effects on different soil and vegetation characteristics. One of the positive effects of stocking rate has been documented in Allan Savory's work. The stocking rate application has to the pasture is critical, but it must be applied for the right amount of time at right moment of the soil and vegetation state (Savory, 1991). There are studies that reported the positive effects of a high stocking rate, such as Frank and Groffman (1998); Holland and Detling (1990); Tracy and Frank et al., (1998). For example, Frank and Groffman (1998) reported that large herbivores increased N cycling in the grasslands of Yellowstone National Park. Similarly, Augustine and McNaughton (2006) found that in glades in central Kenya, the N cycling rate was accelerated with a high stocking rate if there was enough moisture in the soil with high nutrient levels.

In Mongolian grasslands, there is a latitudinal gradient in the degree of aridity. The degree of aridity increases from north to south, and the type of grassland changes from forest steppe to steppe, and further to desert steppe. Therefore, the effects of livestock grazing may change under different climatic conditions.

Grazing is also recorded as an effective treatment in agricultural fields. For example, grazing had a positive impact on crop yield, especially on a non-irrigated cotton yield with less fertilizer inputs, making a more economical crop while utilizing resources year round (George, Wright, & Marois, 2013). The study area is an agricultural part of

Mongolia. Because of the crop fields pastureland is limited and during the growing season herders have to keep their animals away from the fields.

Allan Savory's View

The Allan Savory method of holistic grazing management advises that time of exposure to herbivory is most critical. So time that animals are spending on particular pasture is more important than stocking rate, as long as one stays below utilization rates, which degrade productivity. This leads to another way of looking at the precipitation as one of the main variable of pasture quality. Rather than the annual amount, it is the distribution of precipitation throughout the growing season (Figure 3.2). This graph from precipitation distribution of my study area shows that most of the precipitation is in July, with less distribution towards the spring and fall.

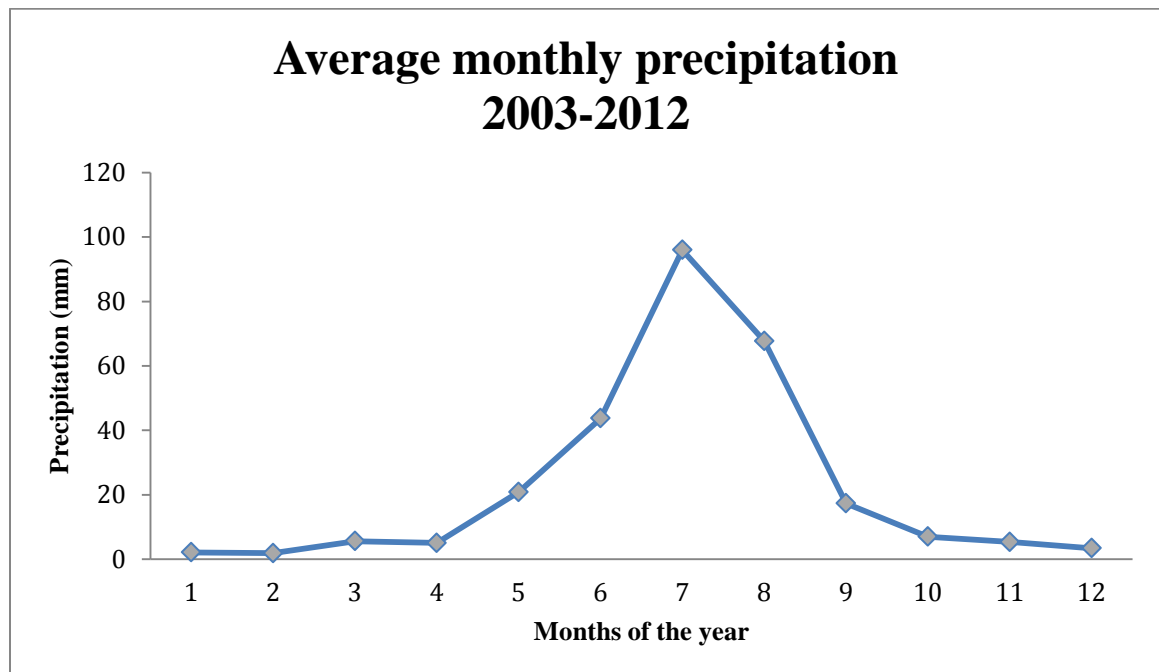


Figure 3.12. Precipitation distribution of Orhon (2003-2012).

Spring is an especially critical time of the year to influence the vegetation growth. So the stocking rate can be defined based on the effectiveness of the water cycle, not the total precipitation that might have been in non-growing seasons and run off as spring floods. Water cycle effectiveness is not equal to aridity index. The poorer the distribution of the rainfall during the growing season the more brittle the pasture is (Savory, 1991). From the last nine year's precipitation data, the distribution of the precipitation is more towards the summer months.

From personal interviews of herders we can conclude that most of them perceive that the precipitation pattern has changed greatly over the last decade or two. This leads us to the question of whether the environment is becoming more brittle than before. If that is the case, it is critical to consider the grazing management to fit into more brittle situations. In such situations Allan Savory suggests a high stocking rate grazing for short period of time followed by a period of rest to recover.

Other studies such as Fujita et al. (2002) showed that intermediate grazing pressure by livestock maximized the species richness of plants in a Mongolian pasture. Both positive and negative effects of livestock grazing on the plant species diversity of pastures with different topographic positions, that is, with different soil moisture conditions, have been reported (Fujita et al. 2009).

Our Study

Stocking Rate

It is important to know the optimum-stocking rate according to the weather and vegetation and soil type of the pasture that is in use, otherwise stocking rate can have negative effects on soil and vegetation qualities. The carrying capacity suggested by the Mongolian government in our study area is 0.6 sheep/ha. Sugita et al. (2007) studied the carrying capacity using enclosures and the results suggest that the maximum sustainable carrying capacity is 0.7 sheep/ha. In Orhon county when the animal number is compared to the pasture size they have, the carrying capacity almost doubled and reached 1.3 sheep/ha (Orhon Governor's Report, 2012).

Observations of Degradation

Mongolian herders have been observing the degradation and they can tell that dramatic changes happened over the last ten years. These include the altered precipitation patterns and flood gullies generated by heavy rains. During this project we noticed many gullies and eroded places on the side of the mountains.

The concept of soil and pasture quality is defined relative to the user (Carter et al., 1997) and interpretations of acceptable levels of soil function are subjective. For example, desired functions are different for rangelands, intensive agriculture, or recreation. A soil quality description must represent the aggregate of all desired functions (Evans, 2011). We used a questionnaire found in Appendix D to find out what is desired

for Mongolian herders who graze their animal year around with minimal hay and food supplement.

Interviews with the herders show they have been observing rapid change in species composition and land surface. Especially after heavy rains, they say that the whole top part of the soil is running down hill and the sides of the mountains erode into gullies (Appendix D). They also mentioned the precipitation pattern change, stating that there is now a long time gap between precipitation events, and that individual precipitation events are now larger. Each of the 16 herders in the interview mentioned the precipitation pattern change.

Methods

Site Description

My study site is located N48°30'10.8"/E103°46'15.7" in Shuwuut River Valley, Orhon soum, Bulgan province. The mean annual precipitation is about 300mm/y (Figure 3.1)

The soil classification of this region is Mountain Chernozem and Mountain Kastanozem according to Dorzgotov's soil classification (2003), soils similar to USA classes of darker Mollisol and lighter Mollisol respectively (FAO, UNESCO soil classification system, 1998; Appendix B). Dorzgotov's classification is the classification system that Mongolia is currently using. The common plants of the study area were identified using Jigjidsuren and Lhangvajav (2010). Both winter pastures are located within a 5 km distance from each other in the same valley, called Shuwuut. The winter

pastures are subsidiary drainage valleys stretching about 6km from northeast to southwest. According to the topography we divided the winter pasture each into three pasture classes:

- South Facing Slope (SS)
- Northwest Facing Steep Slope (NS)
- Lower Plain, the bottom of the valley (LP)

We performed the sampling using the sampling method above.

Study Design

To determine the stocking rate effect on soil and vegetation properties, we chose two winter pastures about the same size of 5x7km. The stocking rate of the first winter pasture is 600 animals and the other is 3000 animals, representing low and high stocking rate pastures, respectively. The stocking rates were about the same for the last 10 years (local government statistics, 2000-2013). The two winter pastures are located within 5km of each other. We sampled soil and vegetation and collected following data.

- GPS location
- Slope
- Aspect
- Horizon depth
- Coarse fragments
- Color (wet and dry)
- Texture

- Structure
- PH
- EC
- HCl reaction
- Root occurrence
- Infiltration rate
- Percent bare ground
- Number of species
- Air dry biomass

To determine the most important quality of soil and vegetation for herders, I prepared a questionnaire listing the soil and vegetation measurements that I collected. Sixteen herders (Appendix D) of the research area and 4 veterinarians who work with these herders answered the questionnaire and listed the qualities in the order of their priority. The result is shown in Table 3.1. We performed interviews with respect to human subject research with methods approved by Institutional Review Board (IRB) of MSU which is in Appendix D.

Table 3.2. Herders' desired soil and vegetation qualities.

| Soil properties | Herders' priority | Veterinarians' priority |
|------------------------------|-------------------|-------------------------|
| Top soil thickness and color | 7 | 2 |
| Degree of compaction | 5 | |
| Moisture | 4 | 2 |

Table 3.1 shows that herders prefer thick, dark, soft topsoil which is moist and not compacted. We used the following soil and vegetation quality parameters in the analysis.

On soil:

- Top soil or A horizon thickness
- Infiltration rate

On vegetation:

- Number of Species
- Percent bare ground
- Vegetation biomass

Slope is the other variable that I assess to determine contribution to the soil and vegetation properties of the pasture.

Sampling Methods

We chose one of each high and low stocking rate winter pastures. Each winter pasture was divided into three pasture subtypes according to their slope and aspect (Figure 3.3).

- South Facing Gentle Slope (SS)
- Northwest Facing Steep Slope (NS)
- Lower Plain (the bottom of the valley) (LP)

In each subtype we have:

- 3 soil pits (top soil horizons)
- 3 vegetation transects (6m long)

- 3 plots with biomass sampling along the transects (50cmx50cm)
- 3 infiltration measurement (35cm and 25cm diameter double ring)

Steps Taken. Three parallel transects of 6m length were non randomly established 15m apart from each other in each pasture subtype along the slope. At the end of each transect we dug one 50cm deep soil pit. Along each transect we had one 50x50cm vegetation clipping site established by randomly throwing a pen over one's shoulder from the end of each transect.

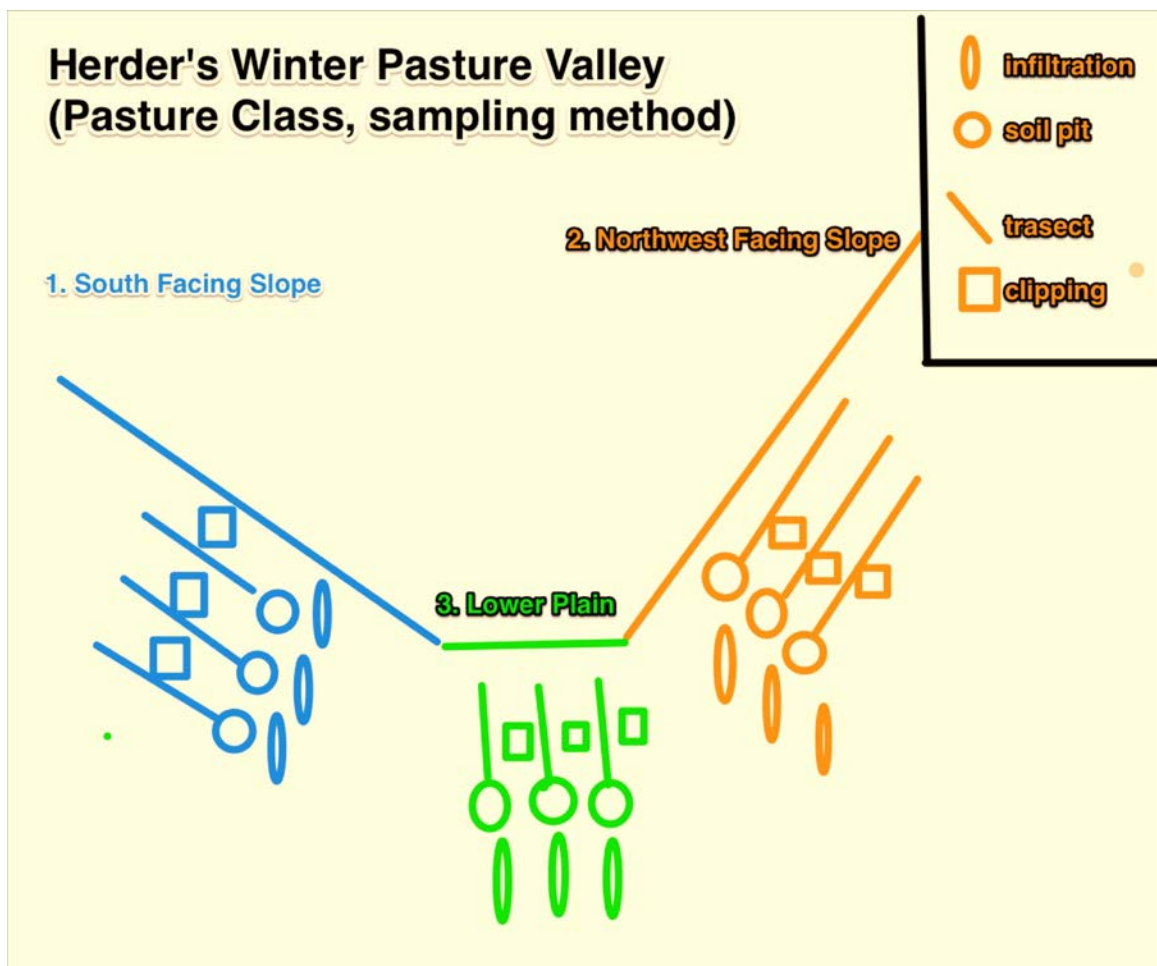


Figure 3.13. Soil and vegetation sampling method at the winter pasture valley.

“Common Plants in Northern Mongolian Pasture” Jigjidsuren S, and Lhangvajav, (2010) was used to identify plant species. Percent bare ground, and biomass of dried clipping were measured using method of Mongolian Pasture Management Guidebooks (MBMX, 2011) for soil and vegetation monitoring. At soil pit we described a soil profile for each pasture class. We measured the depth of the topsoil horizon until it meets the point where it starts reacting to HCl acid. We estimated the soil texture with a hand technique. A sample of each horizon was collected to have OM tested (analysis pending) and root occurrence, coarse fragments, and percent clay estimated. pH was measured in the field using a pH meter (Hanna Instruments HI98128 pH ep 5pH). We identified dry and wet color using Munsell’s Soil Color Chart (2001).

Soil infiltration rate was measured using double ring measurers of inner circle 12.5cm, outer circle 17.5 cm radius. Site litter and other materials were removed and the measuring ring was fit into the soil at 5cm depth using a board and a mallet in preparation of the meter. We had a ruler standing inside the tube and filled the tube to 5cm. We used Nalgene water bottles with ml scale to pour water. Every 3 minutes we measured the water depth in the infiltrometer tube and kept filling water to the level we marked. After 60 minutes or if it was stabilized for the last 4 measurements we stopped the measurements.

The area of the infiltration rate measuring tube was calculated using $A = \pi r^2$. The depth of infiltration (H) was computed as the volume of water (V) divided by the surface area (A) of the infiltrometer, $H = V / A$. Then the infiltration rate (I) was determined by dividing water depth (H) by elapsed time (t).

$I = H / t$ (University of Vermont, 2010).

The Munkhbat family and local environmental officers participated in soil and vegetation sampling. They wanted to be able to perform the sampling so they can do it even after we are done with our study.

Stocking rate was determined using Utah State University's handbook of Determining Stocking Rate (Pratt & Rasmussen, 2001).

Statistical Analyses

I ran two way ANOVA tests on chosen parameters to check for differences in soil horizon thickness, soil infiltration rate, number of species, vegetation biomass and percent bare ground between the two winter pastures and between subtypes within each pasture. To learn whether slope in a particular pasture type had effects on the soil horizon thickness, soil infiltration rate, number of species, vegetation biomass and percent bare ground of two pastures I have performed regression using Excel 2010. The confidence level was specified at 95% ($\alpha=0.05$).

Results and Discussion

First of all, I determined the stocking rate using (Pratt & Rasmussen, 2001) guidelines and dry biomass conversion method of University of Idaho (Idaho, 2006). The optimum-stocking rate using the vegetation biomass at low rate (600 animal) pasture was 977 sheep and for the high rate (3000 animal) pasture it was 720 sheep. I checked if the pasture types (SS, NS, and LP) differ within the winter pastures. The next step was to

check if the two different stocking rate winter camps differ in each variable chosen.

Finally the overall soil and vegetation differences between the two pastures were tested.

Regression tests were performed to check whether there was any relationship with slope aspect and slope steepness to each variable. The error bars in the graphs are the standard deviations.

Soil A Horizon Thickness

The mean thickness of the A horizon was 41 and 17 cm at low and high stocking rate pastures, respectively (Figure 3.4; $p < 0.001$).

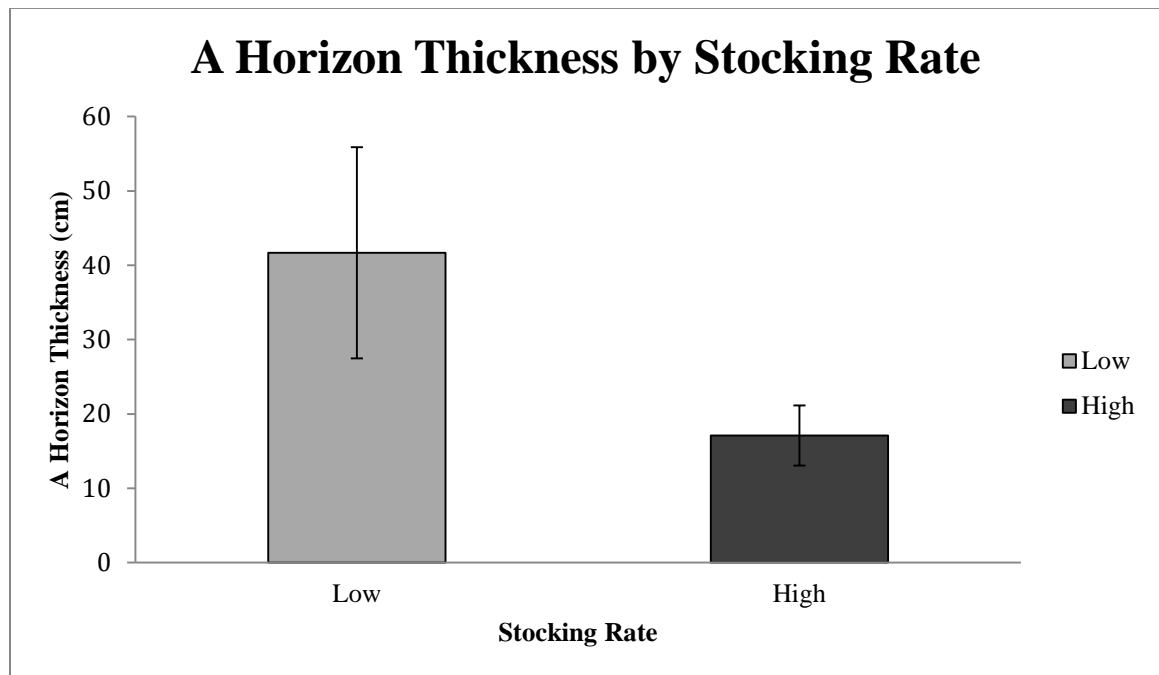


Figure 3.14. Mean A horizon thickness by stocking rate (between the pastures; $p < 0.001$).

The ANOVA result shows that A horizon thicknesses differs significantly by slope of the pasture (SS, NS and LP; $p < 0.001$).

Figure 3.5 shows horizon thickness within both high and low stocking rate on winter pastures.

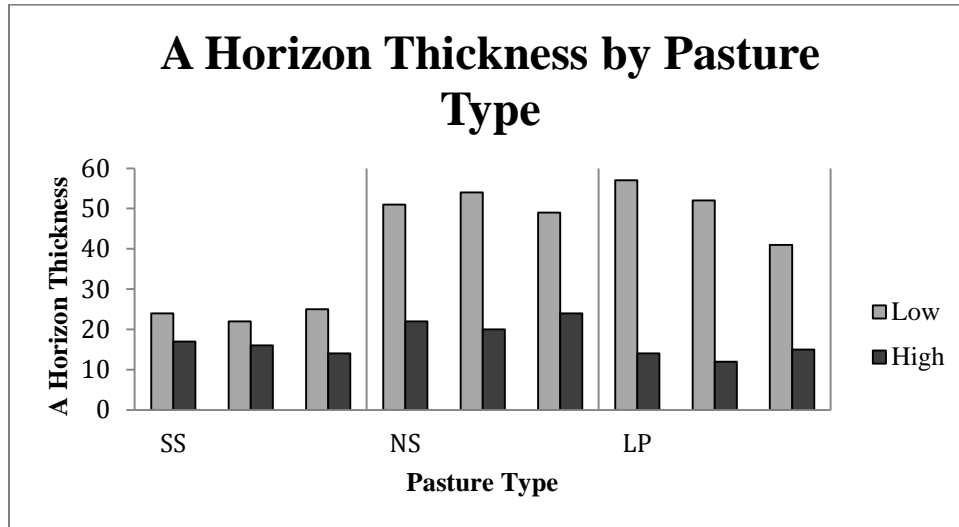


Figure 3.15. A horizon thickness by pasture subtype ($p < 0.01$).

The regression test (Figure 3.6) did not show a strong relationship between the slope and the A horizon thickness with $R^2 = 0.4$.

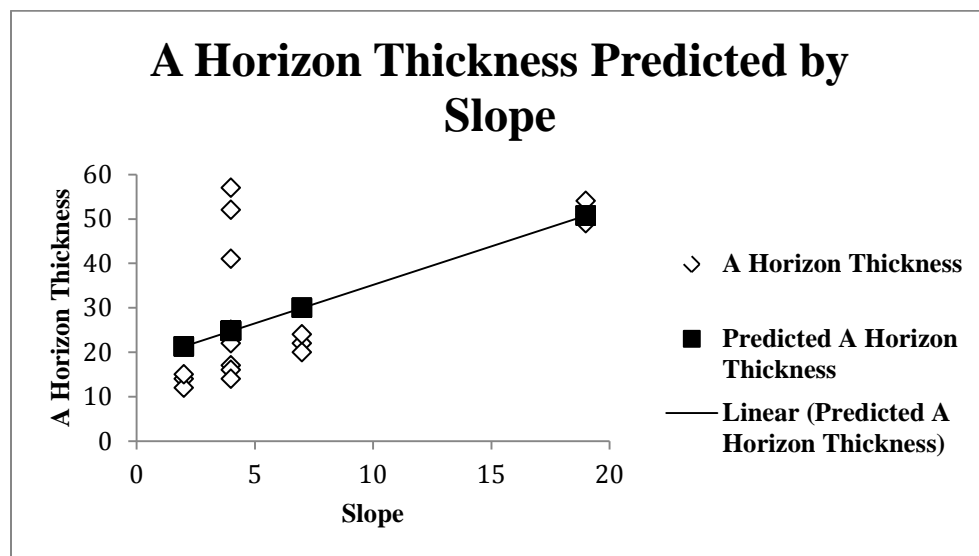


Figure 3.16. Regression fit plot of A horizon thickness and slope ($R^2 = 0.4$).

Soil Infiltration Rate

The mean infiltration rates at the two pastures with low and high stocking rates on winter pastures are 64.5mm/h and 39.2mm/h, respectively (Figure 3.7). There were no significant differences between the high and low stocking rate pastures with $p=0.11$ (Figure 3.7).

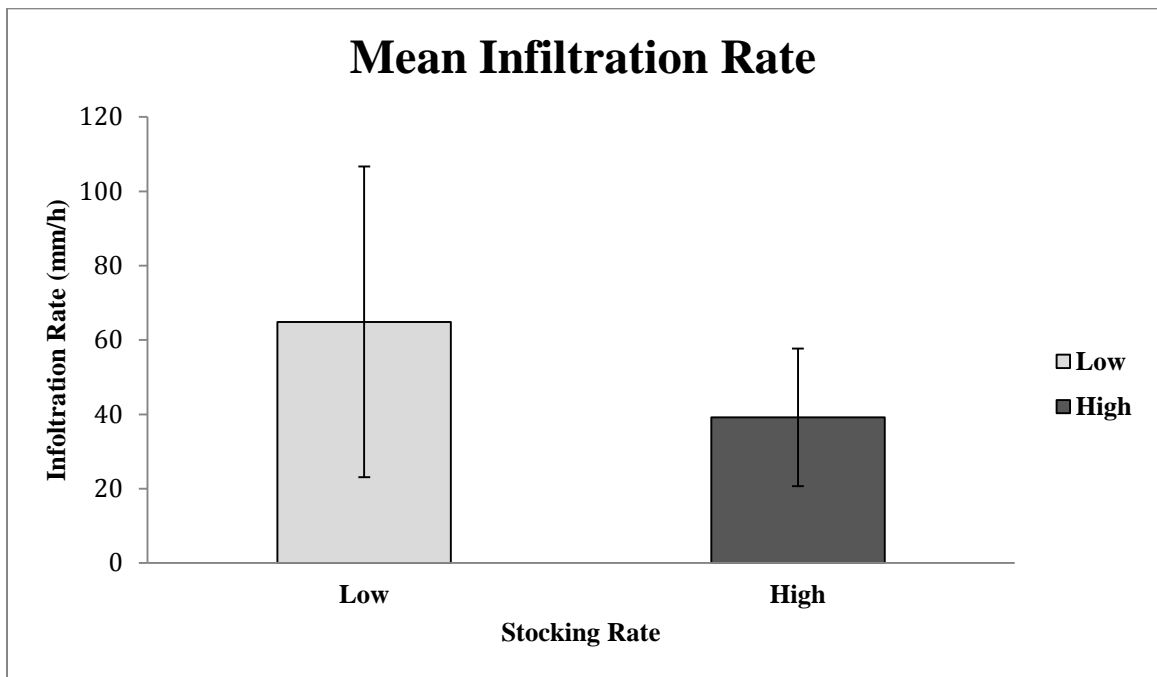


Figure 3.17. Mean infiltration rate at two pastures

The two way ANOVA test result shows no significant by subtype within pastures, with $p = 0.20$ (Figure 3.8).

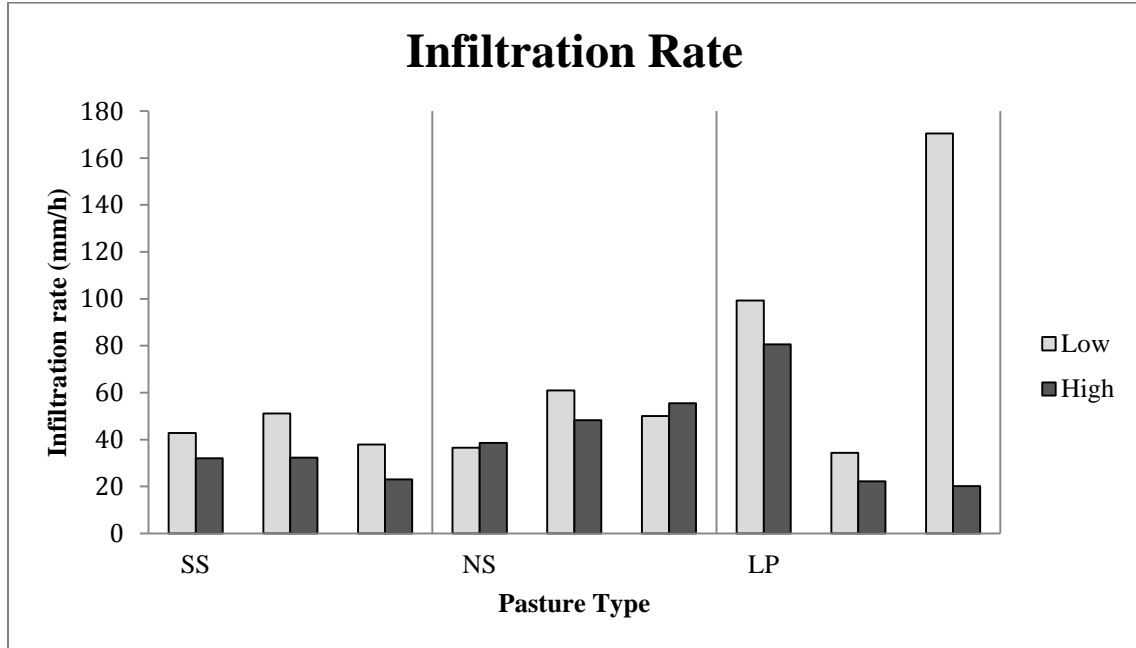


Figure 3.18. Infiltration rate by pasture type $p=0.20$ and by pasture $p=0.11$.

The slope has very weak relationship with the infiltration rate by regression test, with $R^2 = 0.008$ (Figure 3.9).

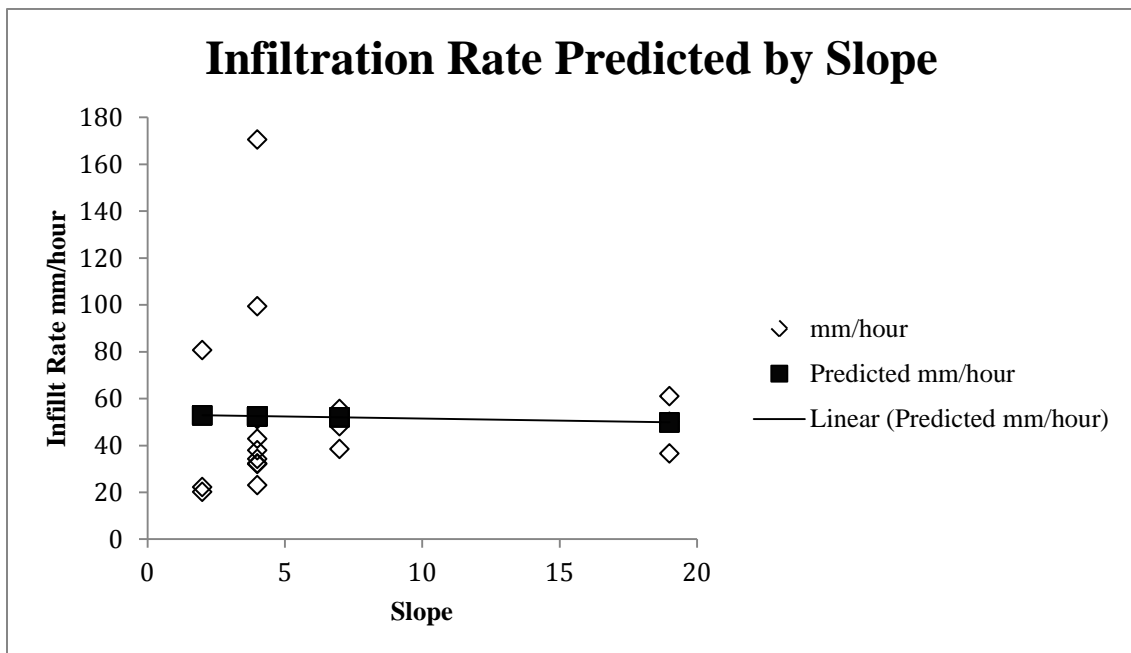


Figure 3.19. Infiltration rate predicted by slope ($R^2 = 0.008$).

Number of Species

The mean number of plant species at low and high stocking rate (Figure 3.10) pastures were 9.8 and 8.1. There were no significant differences either between the two winter pastures ($p = 0.08$) or within the pasture by subtypes ($p = 0.75$) in terms of number of species (Figure 3.11).

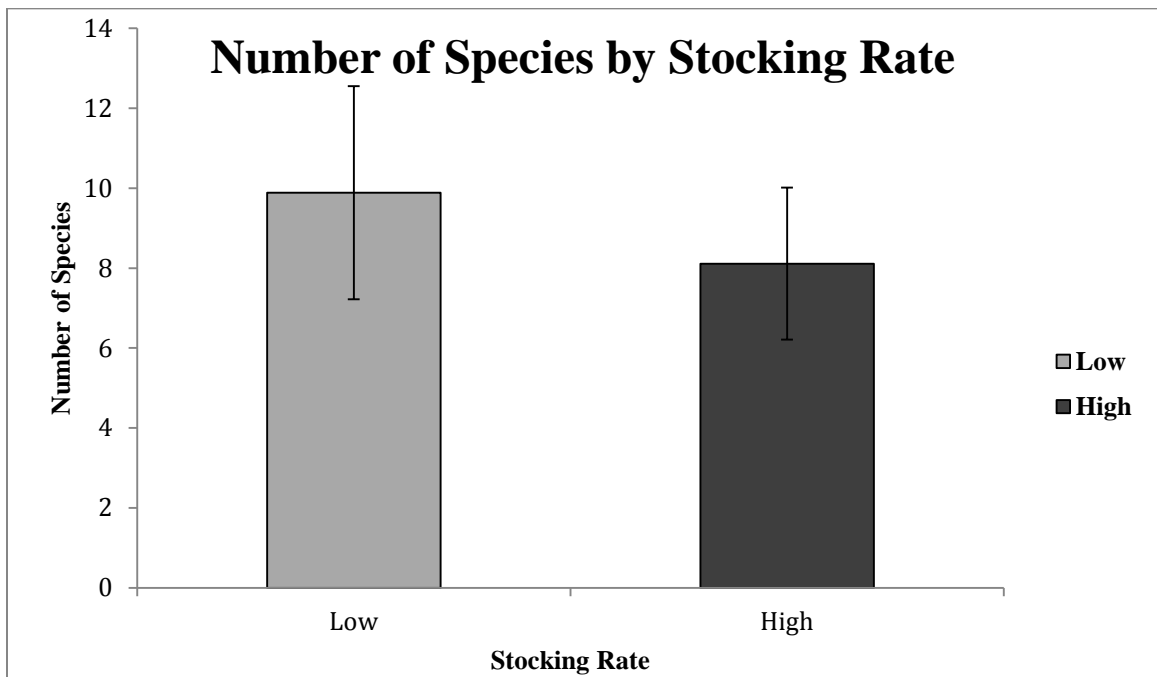


Figure 3.20. Mean number of species at winter pastures ($p=0.08$).

The regression fit plot in Figure 3.12 shows that there is a very weak relationship between slope and the number of species, with $R^2 = 0.27$.

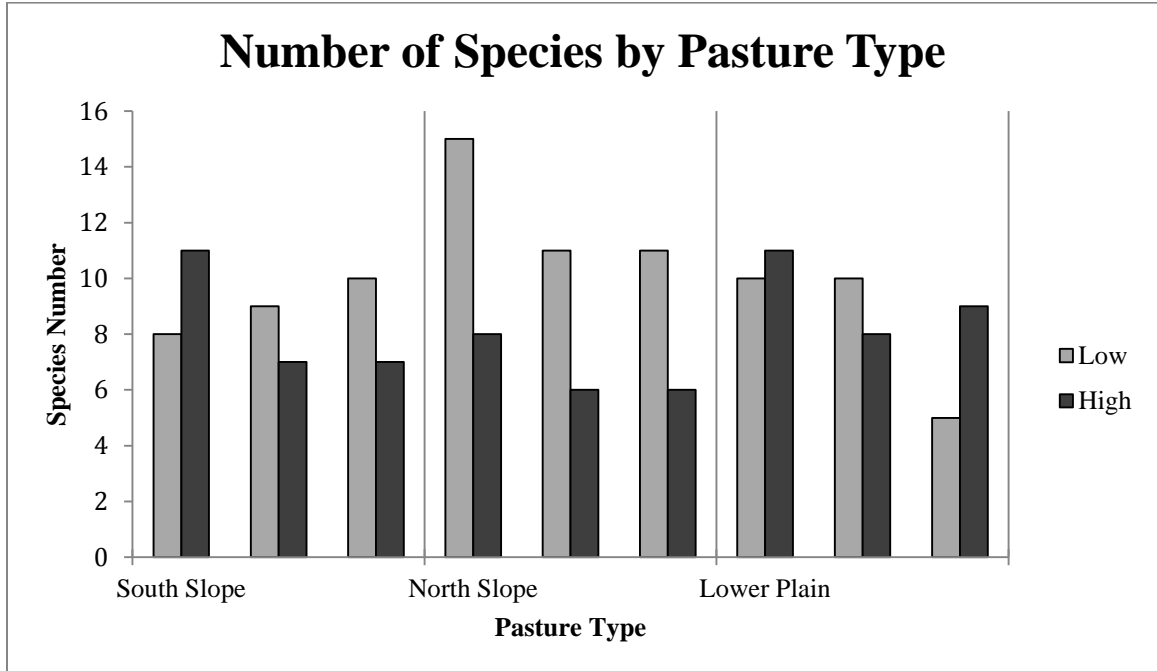


Figure 3.21. Number of species by pasture subtypes $p=0.75$.

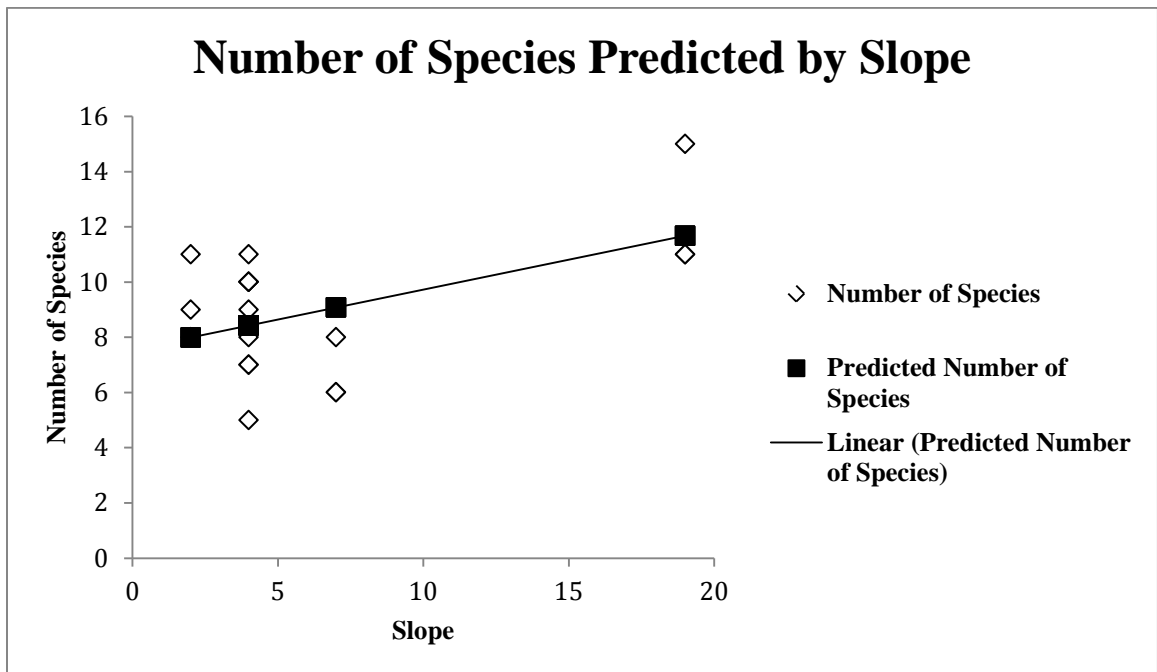


Figure 3.22. Regression fit plot of number of species predicted by slope ($R^2=0.27$).

Vegetation Biomass

The mean vegetation biomass per 0.5 m² area at the peak of the growing season, at low and high stocking rate pastures (Figure 3.13 and Figure 3.14) was 33.8gm and 24.9gm with standard deviation of 15.5 and 12.6 respectively. The ANOVA test shows that between the pastures there is no significant difference with $p=0.07$ (Figure 3.13).

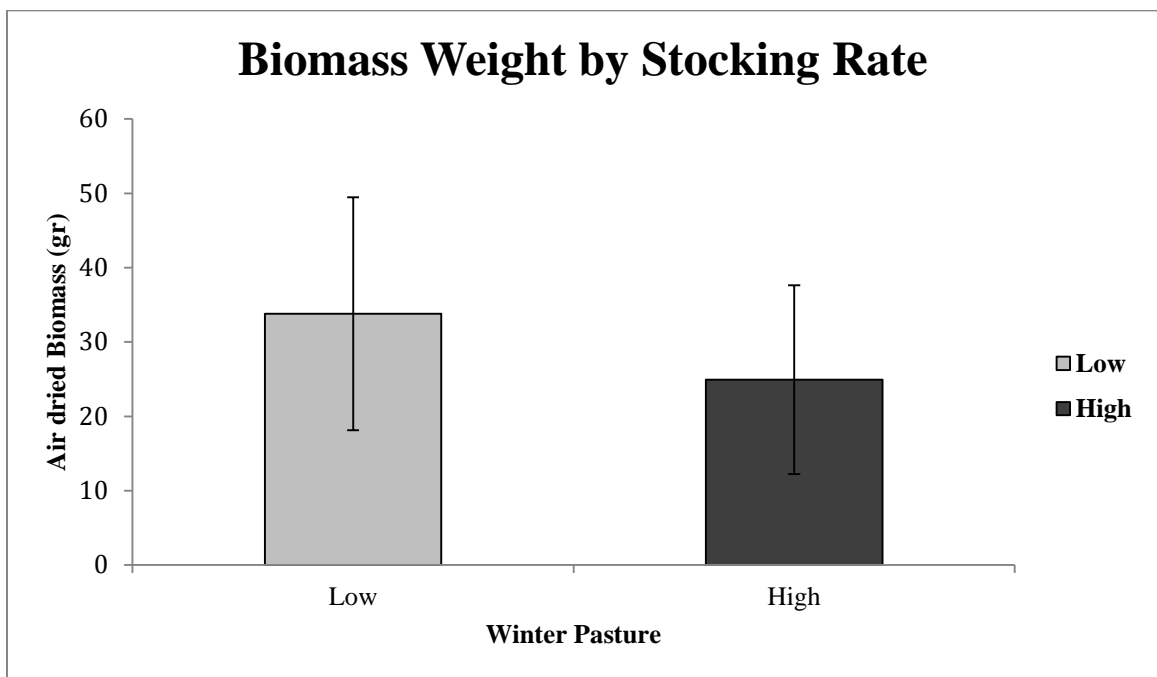


Figure 3.23. Mean biomass by stocking rate ($p=0.07$).

But biomass differed significantly within the pastures by subtype, with $p= 0.002$ (Figure 3.14).

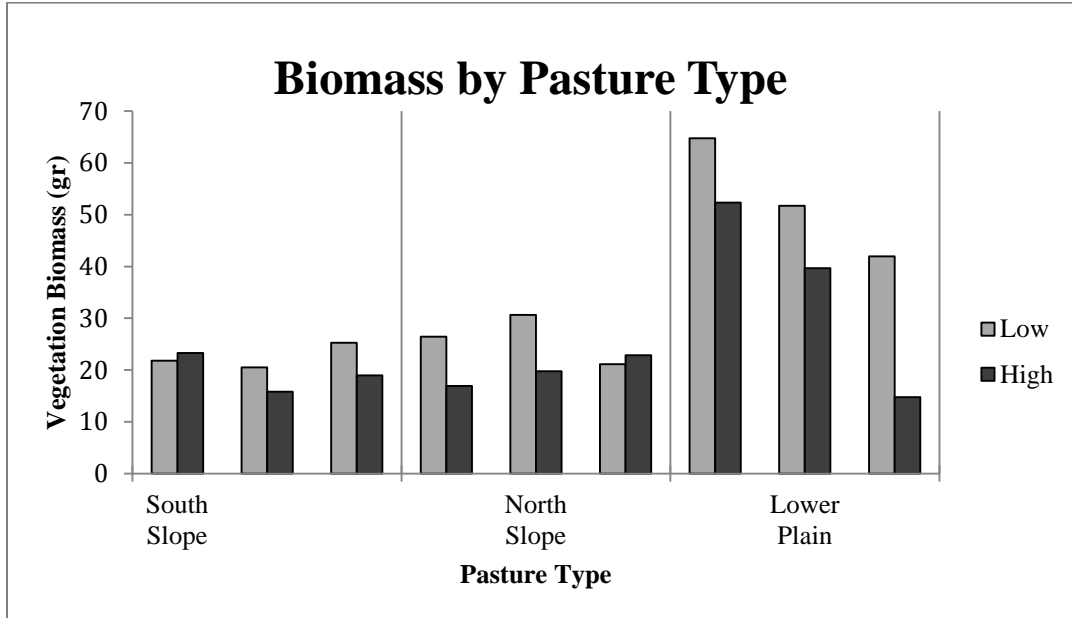


Figure 3.24. Biomass by pasture type ($p=0.002$).

The regression analysis (Figure 3.15) shows vegetation biomass does not have a significant relationship with slope, with $R^2=0.03$ on both winter pastures.

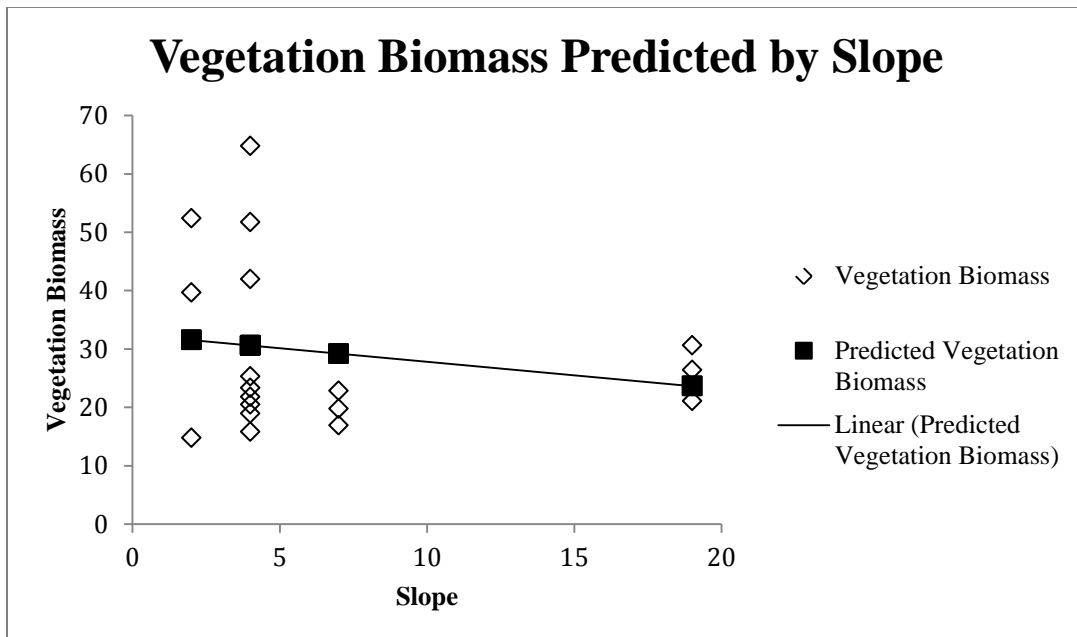


Figure 3.25. Vegetation biomass predicted by slope ($R^2=0.03$).

Percent Bare Ground

The mean percent bare ground is 29.6% and 30% at low and high stocking rate pastures respectively (Figure 3.16). Between the pastures, with the different stocking rate and slopes, percent bare ground does not differ significantly, with $p=0.86$ (Figure 3.16).

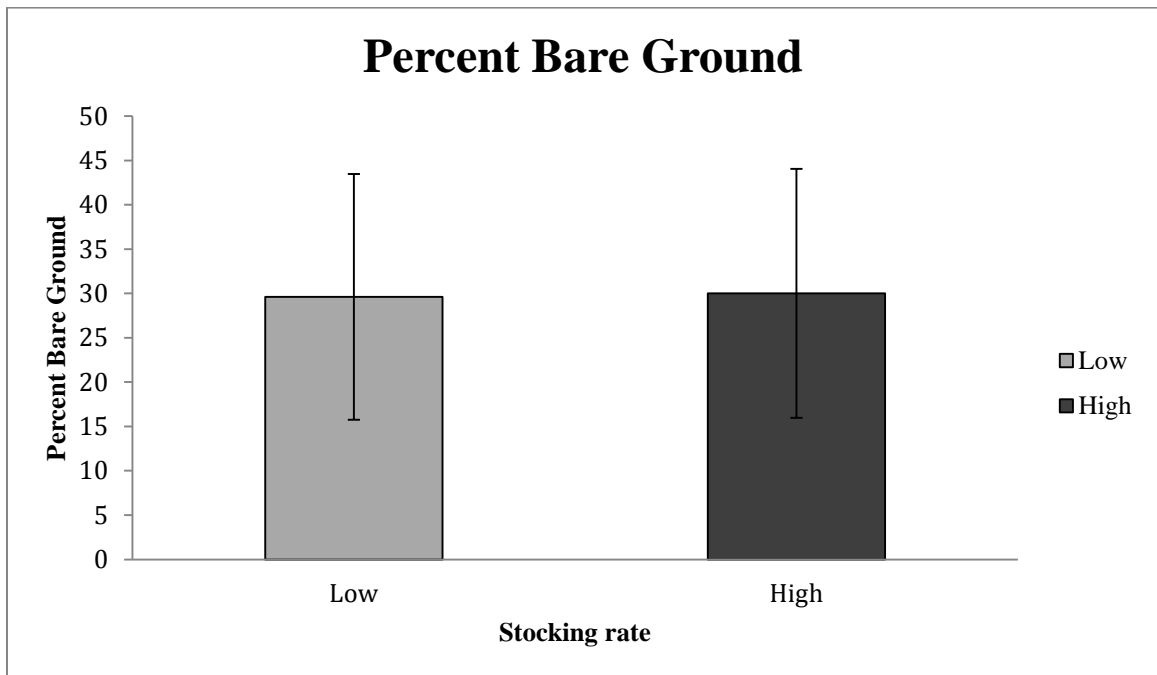


Figure 3.26. Mean percent bare ground (between the pasture p -value= 0.86).

Percent bare ground significantly differs by subtype within the pastures with $p<0.01$ (Figure 3.17).

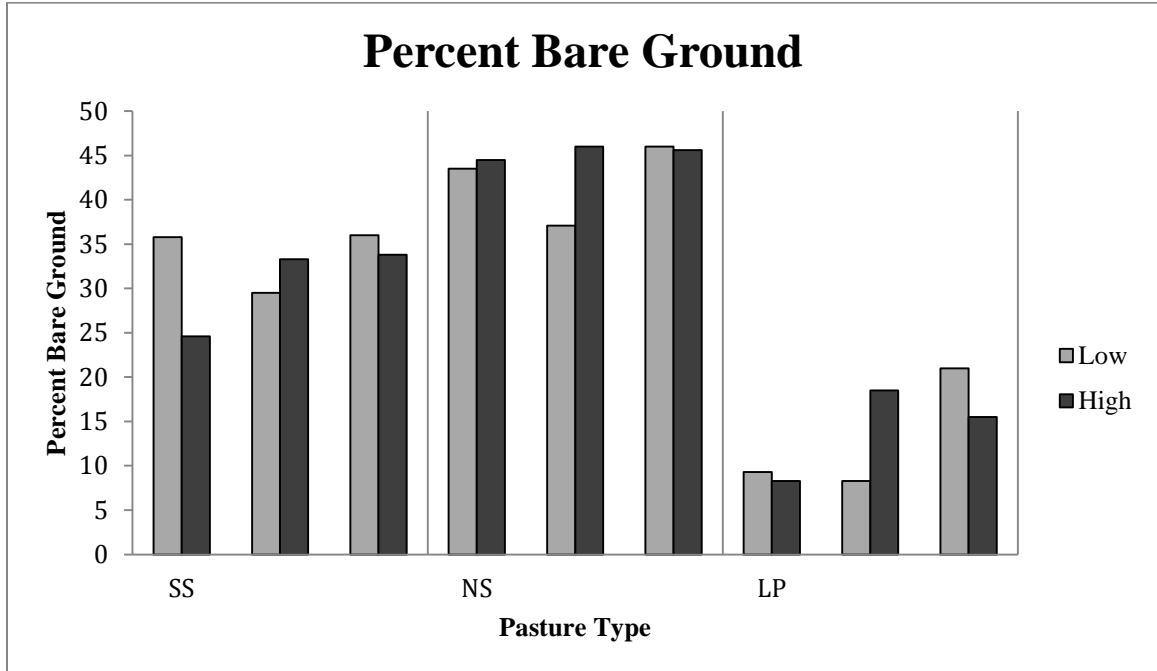


Figure 3.27. Percent bare ground by pasture subtype with $p < 0.01$.

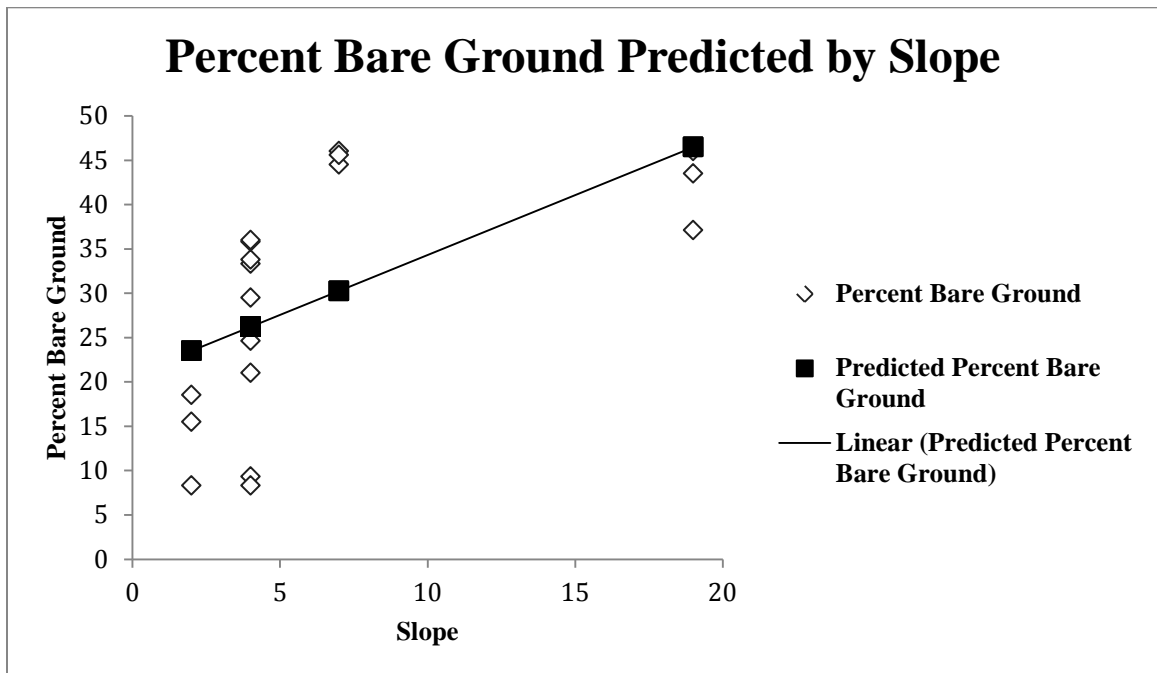


Figure 3.28. Regression fit plot of percent bare ground and slope ($R^2 = 0.34$).

The percent bare ground also has no significant relationship with slope, with $R^2 = 0.34$ (Figure 3.18).

Overall Result of Analysis Between the Two Pastures

The two way ANOVA tests show that, there are significant differences between the pastures with different stocking rates in A horizon thickness and that pastures do not differ significantly in infiltration rate, vegetation biomass, number of species and percent bare ground. Across subtypes the two pastures differ significantly in vegetation biomass, A horizon thickness and percent bare ground, but do not differ significantly in number of species. Although none of them showed statistically significant differences, there was a trend that shows poorer soil and vegetation quality at higher stocking rate pasture and at steeper slopes.

CHAPTER FOUR

CONCLUSION

As most of the Mongolian landscape has been grazed by livestock for millennia, and certainly even longer by wild large herbivores, plant reproduction and the composition of the plant community may also have been subject to evolutionary adaptation to grazing (Mack and Thompson, 1982; Adler et al., 2004; Cingolani et al., 2005). Unfortunately, adaptation to grazing pressure has, to date, hardly been explored (Wesche et al., 2010). Now, with the UNDP report, scientific study results, and herders' complaints of 70% of pasture being degraded, Mongolians have a pasture degradation issue to deal with.

The soil and vegetation study shows that the stocking rate has some negative effects on the chosen variables. So stocking rate may be one of the drivers of pasture degradation. Co-drivers of degradation may include climate change and precipitation patterns although these would not differ between the two winter pastures. Also we have some other suggestion such as loss of traditional herding experiences and methods, as well as overall economic drivers. However, Mongolian herders are in urgent need of managing land in more effective ways. They cannot privatize the pastures and fence them off to manage the land like in most other countries, because of the unique traditional nomadic lifestyle and climate and landscape characteristics.

As pasture degradation is not only an environmental issue, the solution should be some kind of integrated management system. Since we realize it is a socioeconomic

problem that is driving the herders' management decisions, it is a good time to apply a management tool that consider over the whole situation, which in this case is Holistic Management. The first step would be to define the whole to be managed. This step includes the need to determine the current condition of the pasture, which requires a scientific study of soil and vegetation. This would play an important role in finding out what exactly is going on with soil and vegetation on herders' pasture. After determining the pasture quality, recalling traditional knowledge and pasture management techniques could be helpful to solve the problems. Another important step is to support the user group level management and help maintain the use of HM decision-making skills by providing culturally sensitive workshops and trainings on HM, soil and vegetation knowledge, and stocking rate influence on pasture quality for the herders. Application of the entire HM process can help individual families or user groups to improve decision-making.

Regarding the stocking rate study we concluded that stocking rate has a definite influence on the soil and vegetation variables that we tested. Especially the depth of the A horizon was affected both by stocking rate and the subtype within the pasture. By subtype vegetation biomass was also significantly different. The general trend was of better quality soil and vegetation at the lower stocking rate and the less steep areas of the pasture.

As a further step, designing a more robust sampling method and having more samples would help make the results stronger and provide more detailed answers to our questions. Munkhbat's family is interested in continuing to monitor their soil and

vegetation on their winter camp, as is Jamsranbat's family if we provide more technical advice and the methods to collect data.

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APPENDICES

APPENDIX A

VEGETATION

List of Common Plant Species in the Shuwuut River, Zuun Bulag Valley

(Identified by Jigjidsuren S, 2010 and Lhangvajav, 2010)

| | |
|--|--|
| <i>Kobresia belardii</i> (All.)Degl | <i>Vicia cracca</i> L. |
| <i>Ptilagrostis mongolica</i> (Turcz. Ex Trin) | <i>Artemesia changaica</i> Karsch. |
| <i>Carex melananta</i> C.A Mey | <i>Allium bidentatum</i> Fisch.ex Prokh |
| <i>Phleum Phleoides</i> (L) Karst. | <i>Aster alpinus</i> L. |
| <i>Polygonum Viviparum</i> L. | <i>Artemisia frigida</i> Willd. |
| <i>Calamgrostis purpurea</i> (Trin.)Trin. | <i>Sanguisorba officinalis</i> L. |
| <i>Campanula Turczaninovii</i> Fed. | <i>Delphinium grandflorum</i> L. |
| <i>Galium boreale</i> L. | <i>Goniolimon speciosum</i> (L.) Boiss. |
| <i>Orostachys spinosa</i> (L.)C.A.Mey | <i>Leuzia uniflora</i> (L.) Holub |
| <i>Schizonepeta multifida</i> (L.) Briq | <i>Reum undilatum</i> L. |
| <i>Poa pratensis</i> L. | <i>Thymus gobicus</i> L. |
| <i>Poa attenuate</i> Trin. | <i>Stellera chamaejasme</i> L. |
| <i>Bromus inremis</i> Leyss | <i>Veronica incana</i> L. |
| <i>Elymuss chinensis</i> Lam. | <i>Galium verum</i> L. |
| <i>Stippa capillata</i> L. | <i>Bupleurum bicaule</i> Willd. |
| <i>Stipa Krylovii</i> Roshev | <i>Heteropappus hispidus</i> (Thunbg.) Less. |
| <i>Astragalus adsurgens</i> Pall. | <i>Cymbaria dahurica</i> L. |
| <i>Astragalus tenuis</i> Turcz. | <i>Gentiana decumbens</i> L. |
| <i>Vicia amoena</i> Fisch. | <i>Leontopodium ochrodeucum</i> Ldb. Grub |

| | |
|--------------------------------------|---|
| <i>Echinopsis latifolius</i> Tausch. | <i>Serratula centauroides</i> L. |
| <i>Dianthus verticolar</i> Fisch. | <i>Allium senescens</i> L. |
| <i>Scabiosa comosa</i> Fisch. | <i>Stipa sinirica</i> (L.)Lam |
| <i>Carex pediformis</i> C.A.Mey. | <i>Cleistogens soongorica</i> (Roshev.) Ohwi. |
| <i>Artemisia Adamsii</i> Bess. | <i>Allium mongolicum</i> Rgl. |
| <i>Artemisia dracunculus</i> L. | <i>Aster tataricus</i> L. |
| <i>Astragalus galactites</i> Pall. | <i>Corispermum mongolicum</i> Iljin. |
| <i>Filifolium sibiricum</i> Kitam | |

Table A.1. Vegetation data.

| Transect ID | Veg biomass | % bare ground | Species number | Root Occurrence |
|-------------|-------------|---------------|----------------|-----------------|
| MBWCSS#1 | 21.78 | 35.8 | 8 | many F common C |
| MBWCSS#2 | 20.49 | 29.5 | 9 | common F-M |
| MBWCSS#3 | 25.29 | 36 | 10 | common F-M |
| MBWCNS#1 | 26.42 | 43.5 | 15 | common F-M |
| MBWCNS#2 | 30.65 | 37.1 | 11 | many F-M-C |
| MBWCNS#3 | 21.11 | 46 | 11 | many F-M-C |
| MBWCLP#1 | 64.76 | 9.3 | 10 | common F-M-C |
| MBWCLP#2 | 51.71 | 8.3 | 10 | many F-M-C |
| MBWCLP#3 | 41.98 | 21 | 5 | many F-M-C |
| JBWCSS#1 | 23.31 | 24.6 | 11 | common F |
| JBWCSS#2 | 15.81 | 33.3 | 7 | many M-F |
| JBWCSS#3 | 18.97 | 33.8 | 7 | common F |
| JBWCNWS#1 | 16.91 | 44.5 | 8 | few F |
| JBWCNWS#2 | 19.77 | 46 | 6 | many F-M-C |
| JBWCNWS#3 | 22.85 | 45.6 | 6 | many F-M-C |
| JBWCLP#1 | 52.36 | 8.3 | 11 | common F-M-C |
| JBWCLP#2 | 39.67 | 18.5 | 8 | many F-C |
| JBWCLP#3 | 14.79 | 15.5 | 9 | common F |

APPENDIX B

SOIL

| | |
|---|--|
| <i>Mountain soils</i> | |
| 1. Mountain tundra soils | 1.1 Mountain tundra ochro soil 1.2 Mountain tundra peaty-gleyed soil 1.3 Mountain tundra cryoturbated soil |
| 2. Mountain meadow, meadow-steppe soil | 2.1 Mountain meadow brunizem soil 2.2 Mountain meadow dark colored raw-humic soil 2.3 Mountain meadow peaty raw-humic soil 2.4 Mountain meadow-steppe mull-humic soil |
| 3. Mountain forest soils | 3.1 Mountain taiga cryomorphic ochro soil 3.2 Mountain taiga cryomorphic peat-muck humic soil 3.3 Mountain taiga podzolic soil 3.4 Mountain derno-taiga soil 3.5 Mountain forest, dark colored derno soil 3.6 Forest slightly podzolic sandy soil |
| 4. Mountain steppe soil | 4.1 High mountain steppe raw humic soil 4.2 Mountain chernozem 4.3 Mountain kastanozems |
| 5. Mountain desert-steppe and desert soils | 5.1 Mountain semi-desert brown soil 5.2 Mountain desert gray-brown soil |
| <i>Plain and valley soils</i> | |
| 6. Steppe soils | 6.1 Chernozem 6.2 Kastanozem |
| 7. Semidesert and desert soils | 7.1 Semidesert brown soil 7.2 Desert gray-brown soil 7.3 Extra-arid desert "Borzon" soil 7.4 Takyr |
| 8. Hydromorphic soils | 8.1 Meadow dark humic gleyed soil 8.2 Meadow-boggy raw humic gleyed soil 8.3 Boggy peaty gleyed soil |
| 9. Halomorphic soil | 9.1 Solonchak automorphic 9.2 Solonchak hydromorphic 9.3 Solonetz automorphic 9.4 Solonetz hydromorphic |
| 10. Floodplain soils | 10.1 Alluvial boggy gleyed soil 10.2 Alluvial meadow gleyed soil 10.3 Alluvial derno soil |

Figure B.1. Soil classification of Mongolia (Dorzgotov, 2003).

Table B.1. List of soil quality indicators used in questionnaire.

| Soil and Vegetation Qualities (please number them to priority) | # |
|---|----------|
| Top Soil Thickness | |
| Soil Texture | |
| Infiltration Rate | |
| Root Occurrence | |
| Soil Color | |
| Percent Bare Ground | |
| Slope and Aspect | |
| Vegetation Biomass | |
| Number of Plant Species | |

List of Herders Participated in Questionnaire

There were 17 herders and 4 veterinarians and we coded them herder#1, 2.. and veterinarian #1, 2.. for human subject matter.

Table B.2. Soil data used in analysis.

| Transect ID | Stocking Rate | Sub Type | GPS location | Slope | Aspect | Veg Biomass | Species Number | Percent Bare Ground | A Hor Thickness | Inf Rate |
|-------------|---------------|----------|----------------------------|-------|--------|-------------|----------------|---------------------|-----------------|----------|
| MBWCSS#1 | Low | SS | N48°30'10.8"/E103°46'15.7" | 4° | 190°Ss | 21.78 | 8 | 35.8 | 24 | 42.8 |
| MBWCSS#2 | Low | SS | N48°30'10.4"/E103°46'15.1" | 4° | 190°S | 20.49 | 9 | 29.5 | 22 | 51.1 |
| MBWCSS#3 | Low | SS | N48°30'11.2"/E103°46'16.4" | 4° | 190°S | 25.29 | 10 | 36 | 25 | 37.9 |
| MBWCNS#1 | Low | NS | N48°30'8.1"/E103°46'36.4" | 19° | 290°W | 26.42 | 15 | 43.5 | 51 | 36.5 |
| MBWCNS#2 | Low | NS | N48°30'8.9"/E103°46'36.4" | 19° | 290°W | 30.65 | 11 | 37.1 | 54 | 60.9 |
| MBWCNS#3 | Low | NS | N48°30'7.6"/E103°46'36.6" | 19° | 290°W | 21.11 | 11 | 46 | 49 | 50 |
| MBWCLP#1 | Low | LP | N48°30'13.1"/E103°46'31.4" | 4° | 192°S | 64.76 | 10 | 9.3 | 57 | 99.3 |
| MBWCLP#2 | Low | LP | N48°30'13.1"/E103°46'31.2" | 4° | 192°S | 51.71 | 10 | 8.3 | 52 | 34.3 |
| MBWCLP#3 | Low | LP | N48°30'13.1"/E103°46'30.9" | 4° | 192°S | 41.98 | 5 | 21 | 41 | 170.5 |
| JBWCSS#1 | High | SS | N48°29'1.3"/E103°43'1.7" | 4° | 200°S | 23.31 | 11 | 24.6 | 17 | 32.1 |
| JBWCSS#2 | High | SS | N48°29'0.9"/E103°43'1.0" | 4° | 200°S | 15.81 | 7 | 33.3 | 16 | 32.3 |
| JBWCSS#3 | High | SS | N48°29'1.1"/E103°43'2.5" | 4° | 200°S | 18.97 | 7 | 33.8 | 14 | 23 |
| JBWCNWS#1 | High | NS | N48°29'8.7"/E103°43'15.7" | 7° | 280°W | 16.91 | 8 | 44.5 | 22 | 38.5 |
| JBWCNWS#2 | High | NS | N48°29'9.0"/E103°43'15.4" | 7° | 280°W | 19.77 | 6 | 46 | 20 | 48.2 |
| JBWCNWS#3 | High | NS | N48°29'8.5"/E103°43'15.7" | 7° | 280°W | 22.85 | 6 | 45.6 | 24 | 55.5 |
| JBWCLP#1 | High | LP | N48°29'8.8"/E103°43'7.8" | 2° | 203°SW | 52.36 | 11 | 8.3 | 14 | 80.6 |
| JBWCLP#2 | High | LP | N48°29'8.5"/E103°43'7.8" | 2° | 203°SW | 39.67 | 8 | 18.5 | 12 | 22.2 |
| JBWCLP#3 | High | LP | N48°29'8.8"/E103°43'7.7" | 2° | 203°SW | 14.79 | 9 | 15.5 | 15 | 20.1 |

APPENDIX C

CLIMATE DATA

Table C.1. Average air temperature, Orlon, 2003-2012.

| Year/month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|------------|-------|-------|-------|------|------|------|------|------|------|-----|-------|-------|
| 2003 | -22.3 | -17.6 | -9.5 | 5.5 | 12.0 | 19.8 | 19.4 | 16.0 | | 1.1 | -16.1 | -22.0 |
| 2004 | -21.4 | -14.9 | -8.3 | 7.1 | 14.1 | 19.9 | 20.4 | | 11.0 | 2.6 | -9.0 | -17.6 |
| 2005 | -26.4 | -29.1 | -6.4 | 6.6 | 13.1 | 19.6 | 21.4 | 18.9 | | 3.7 | -6.6 | -25.2 |
| 2006 | -22.9 | -17.0 | -5.1 | 1.6 | 11.4 | 18.3 | 19.7 | 17.9 | 11.0 | | -8.4 | -16.6 |
| 2007 | -20.4 | -12.0 | -5.1 | 6.7 | 15.1 | | 23.6 | 18.4 | 13.1 | 0.7 | -9.2 | -17.5 |
| 2008 | -26 | -16.9 | -1.3 | 6.8 | 11.9 | 17.2 | 19.6 | 16.6 | 10.2 | 0.7 | -6.2 | -16.8 |
| 2009 | -21.0 | -16.4 | -7.7 | 6.8 | 14.4 | 17 | 19.1 | 16 | 9.1 | 0.8 | -13.5 | -21.9 |
| 2010 | -27.4 | -23.2 | -12 | -0.1 | 13.8 | 19.8 | 22.2 | 16.9 | 12.2 | 2.6 | -6.9 | -18.5 |
| 2011 | -29.2 | -20.5 | -13 | 5.2 | 10.0 | 19 | 19.4 | 17.2 | 7.1 | 1.0 | -15.2 | -24.6 |
| 2012 | -28.3 | -23.6 | -10.4 | 4.2 | 12.4 | 16.8 | 18.8 | 16.2 | 10 | 0.2 | -11.6 | -26.2 |

Table C.2. Orhon soum precipitation (mm), 1996-2012.

| y/m | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Total |
|------|-----|-----|------|------|------|------|-------|-------|------|------|------|------|-------|
| 1996 | | | | | 1.3 | 30.8 | 75.3 | 76.4 | 16.9 | 4.3 | 2.6 | 2.2 | 209.8 |
| 1997 | 3.4 | 0.4 | 0.3 | 10 | 16.7 | 46.5 | 117.8 | | 6.9 | 0.1 | 2.9 | 1 | 206 |
| 1998 | 1.3 | 3.3 | 1.6 | 5.1 | 2.5 | 38.8 | 86.1 | 106.1 | 46.9 | 5.5 | 1.9 | 1.1 | 300.2 |
| 1999 | 1.6 | 0.9 | 1.8 | 7.8 | 6.7 | 54.1 | 102.6 | | 20.5 | 3.5 | 1.3 | 1.5 | 202.3 |
| 2000 | 3.9 | 0.9 | 9.6 | 16.3 | | 115 | 86.1 | 66.9 | 13 | 8.1 | 6.7 | | 326.5 |
| 2001 | 3.3 | 0 | 3.6 | 20.9 | 63.2 | 54.8 | 61 | 54.7 | 19.7 | 21.9 | 5 | 3.4 | 311.5 |
| 2002 | 2.3 | 0 | 0.7 | 8.5 | 26.3 | 31.9 | 76.2 | 38.6 | 3.4 | 41.5 | 12.9 | 4.4 | 246.7 |
| 2003 | 2.4 | 2.7 | 5.2 | 5.2 | 34.2 | 12.8 | 240.9 | 22.9 | | 9.9 | 21.5 | 3.0 | 360.7 |
| 2004 | 0.5 | 3.4 | 5.0 | 1.2 | 7.5 | 36.6 | 47.7 | | 22.7 | 0.0 | 1.8 | 2.1 | 128.5 |
| 2005 | 4.4 | 2.3 | 1.5 | 0.7 | 46.4 | 30.6 | 89.7 | 40.7 | | 3.6 | 3.4 | 2.0 | 225.3 |
| 2006 | 1.1 | 2.7 | 4.5 | 10.8 | 32.3 | 56.3 | 83.6 | 29.8 | 13.8 | | 6.2 | 0.4 | 241.5 |
| 2007 | 3.6 | 0.2 | 2.9 | 2.9 | 32.9 | | 30.8 | 104.8 | 18.6 | 2.9 | 1.3 | 1.4 | 202.3 |
| 2008 | 1.5 | 0.5 | 10.7 | 4.2 | 7.5 | 80.9 | 102.1 | 43.7 | 18.7 | 11.1 | 0.0 | 3.5 | 284.4 |
| 2009 | 0.0 | 0.7 | 6.8 | 0.5 | 19.6 | 46.6 | 74.9 | 108.4 | 9.7 | 7.8 | 3.5 | 4.2 | 282.7 |
| 2010 | 2.1 | 1.4 | 6.5 | 13.6 | 8.6 | 31.7 | 42.1 | 139.0 | 13.1 | 15.2 | 6.0 | 4.7 | 284 |
| 2011 | 3.6 | 2.7 | 9.2 | 4.7 | 5.2 | 29.9 | 144.0 | 66.2 | 23.5 | 3.1 | 9.1 | 3.0 | 304.2 |
| 2012 | | 2.5 | 3.8 | 7.1 | 14.4 | 68.3 | 104.1 | 53.9 | 18.5 | 9.5 | 0.9 | 10.1 | 293.1 |

APPENDIX D

HOLISTIC MANAGEMENT

Guide to Build a Community Resource Base Profile
(Montagne, 2011)

Community Wealth Profile, C Montagne December 1, 2011

Vision

Community decision-making considers a balance of natural, social, transaction, and infrastructure wealth

Question

How to develop a community wealth profile and apply it to participatory, pro-active decision-making

Methods

Use a holistic process to engage community members, non-profits, agencies, schools, governmental organizations, and academics (scientists, humanists, artists) in defining and characterizing the community resource base through construction of a community wealth profile

Justification

This process can provide the venue for synergies between disciplines and stakeholders and decision makers by focusing on the values (wealth) of the resource base.

This process provides a venue to broaden the scientific process to be more relevant at the community level

Methods

Process which will involve scientists and managers meeting in the field with stakeholders to determine the following

1. Define the natural resource land base and its value
 - Map out the land resources (5-15 variables)
 - Soils, water, forest...
 - Determine current effectiveness of ecosystem processes
 - Is solar energy captured and distributed?
 - Effectiveness of the water and mineral cycles?
 - State of biodiversity
 - Give value to the categories of the land base
 - Harvest value, esthetic value

2. Define the social wealth and its value
 - Societies, organizations, service groups, etc.
 - Determine current effectiveness
 - flow and application of knowledge, state of human motivation

Identify 5-15 indicators

Give value

3. Transaction wealth

Availability of capital, flow of capital, payback on investment

Identify 5-15 indicators

Give value

4. Infrastructure wealth

Similar approach they are the

The resulting Wealth Profile provides a snapshot of the balance of community resources and may encourage action to adjust the future profile to be in accordance with community values.

Resource Base Profile Draft Orhon Soum

RBP indicators (compiled within Bag 1 and the central town)

Description, importance, current versus desired condition, improvement recommendations and projects

Version (1.2)

Edited by Sam, Matthew, Badmaa, Susan, Morgan, Martha Joh – 8/10/13

Compiled by Sam – 8/11/13

Introduction

A community, including the central town and the surrounding countryside, requires various forms of wealth to exist. Natural wealth includes the natural resources which support human needs. Social wealth includes the traditional knowledge and social fabric of the community, as well as human health and well-being. Financial wealth includes the existence of capital to support entrepreneurship and human needs.

The wealth profile assesses the natural, social, and financial resources of a community through a collection of multiple indicators. The indicator categories and values are based on the interviews, observations, and scientific data collected by BioRegions. The wealth profile analysis considers the values of indicators, as well as trends across multiple indicators, which may reveal the balance of resources within a community. For example, a community with healthy soils, vegetation and water supply probably has a high value for natural wealth. A community with high divorce rates, poor social services, and few traditional activities would have a low social wealth.

This analysis can give citizens, officials, and city planners a broad understanding of the distribution of wealth in a community. A community can use this information to construct a 'Holistic Goal' which is the basis for planning and action to improve the community. The Holistic Goal starts with the desired quality of life for members of the community. It includes the activities necessary to support that quality of life, and a vision for how the wealth profile should be in the future. This process answers three questions: 1) *what do we have?* 2) *what do we want?*, and 3) *how do we get there?* with respect to the condition of our natural resources, our social fabric, and our economy.

The following describes some wealth profile indicators for Orkhon soum. Each category contains three parts: an explanation of the importance of that indicator, a report on that indicator's current value, and the desired quality of that indicator in the future—according to the wishes of members of the community.

Natural Wealth

(capture of solar energy, water and mineral cycles, species diversity)

1. Pasture – Healthy pasture lands have nearly 100% vegetation with desirable plants, high rates of water infiltration and storage, and soils high in organic matter; whereas unhealthy pasture lands have lower productivity, excessive soil loss, and more undesirable plants. Pasture land health is the base for successful herding and good watershed quality. Pasture quality can be improved by using appropriate stocking rates and methods (such as herding in close bunches for animal impact, allowing for adequate rest

Current: Pastures are subjectively rated at 70% of optimum by Cliff Montagne based on bare soil, erosion, and undesirable vegetation ***Information from Badmaa about productivity and carrying capacity. In the Orkhon soum, there are 329000ha of pasture, 206,000 Sheep head animal units, and around 580 Herding families.

There is ample visual evidence of pasture degradation, with severe stream bank cutting and a single species 'grazing carpet' occupying much of the low lying areas surrounding streams. According to Munkhbat and his father, Horloo, there used to be three herds (of 800-900 animals each) in their area of Bag 1, and there are now an estimated 30,000 animals. Several herders have expressed concern about the degradation of grassland, but few have taken initiative to address the problem.

Future: ***Unknown

2. Agricultural land ***Introduction to field-crop production and health.

Not yet rated, has a reputation for quality, agricultural land may be underused due to lack of infrastructure

Current: There is 5200ha allocated for cultivation in the soum, of which 1500ha is in production this year (940ha of wheat; 400ha of oil crop; 50ha of potatoes; 32ha vegetables (tomato, cucumber); and 2ha of king berry experiments). There is no irrigation in place, but there used to be an irrigation reservoir south of the soum center. Small-scale horticulture (back yard gardens and greenhouses) in the soum center is common.

Future: ***Unknown

3. Forest – Healthy forests have vigorous natural reproduction, a variety of age classes and diversity of species. They collect snow and slow runoff, properties fundamental to healthy watersheds. It is highly desirable to promote forest reestablishment in these lower elevation watersheds. This can be assisted by training user groups how to harvest dead and live wood in ways which promote establishment of new seedlings. Many Mongolian forest experts say that artificial tree planting has often failed. [BR experience with Tom James and forestry in the Darhad] BioRegions will work with at least one user group to establish ecologically sound harvest and site preparation practices.

Current: Forest health is rated at 50% of optimum by C. Montagne based on visual evidence of deforestation within the lower elevation forests. There are 79,000ha of forests in the soum Much of the soum forest land was burned in 2002 and the recovery is very slow, with many lower elevation watersheds being devoid of forest vegetation. According to Munkhbat and Horloo, the forests are 80% of what they once were. The environmental officer currently permits 11000-14000m³ wood for fuel annually. They are currently spraying (in unknown quantity and concentration) pesticides for Siberian Moth infestation. There are currently 14 Family groups in place in Bags 4 and 2 established by the MCA project over the last three years, but they are not functioning as well as they could be.

Future: Example of Munkhbat's User Group. Possibly learn more from Badmaa about management strategies and plans for the future. ***Otherwise unknown.

4. Water (rated at 70% based on reports of decreasing levels of water in springs and wells)

Ground and surface waters provide critical sources for livestock and people. As these sources are lost, herding and countryside living becomes less efficient. Grazing becomes more concentrated near water sources, leading to more overgrazing. Water flow is influenced by grazing and forestry practices, with more severe flows from damaged and poorly managed forest and pastureland

watersheds. BioRegions is working with several herders to promote improved pasture and forest management.

Current: ample evidence of streams drying up and small water sources disappearing, related to deforestation

Future: ***Unknown

5. Fisheries

***Protection of Taimen in Orkhon River

6. Wildlife

Social Wealth

(motivation, knowledge flow, diversity of knowledge, tradition, health, education, welfare)

1. Frequency and participation in traditional activities

Current: There is currently a cultural center which employs a director (and singing teacher), a horse-hair fiddle and music teacher, a dance teacher, a librarian (library has 8000 books). At the school, there is a horse-hair fiddle and traditional music club. There are bag Youth Festivals in May and June, an Annual Poem Competition

2. Family stability

***Unknown

3. Individual human health

***Health report

Health factors note the soum hospital with four inpatient beds, isolation room, with two doctors but perhaps underutilized due to financial support in lab and diagnostics. The attached clinic rooms and pharmacy are beneficial for improved access. The community appears engaged in preventative medicine as noted by attendance to the public health education seminars weekly. Further review of vaccination rates would be helpful. Existing physical therapy clinic is a useful asset.

Current: Hospital is faced with declining patient numbers, and turnover with two brand new doctors. Our herder interviewees tended not to trust the local clinic, opting instead to visit clinics in Bulgan or Erdenet. Herders also tended not to visit for preventative health care.

Future: ***Unknown

4. Programs to support people in poverty or with disabilities
5. Education level for countryside vocations, citizenship participation
6. Education level for entrepreneurship
7. Primary and Secondary Education

Current: Kindergarden has 78 students and a new building this fall. Grades 1-9 have 120 students, and 32 staff including 14 teachers, one principal, and one director. Teachers are currently stressed, teaching lots of classes, and young/inexperienced. School building will be renovated next year to accommodate for more students.

Future: Specialized programs to attract students from around the soum. Teachers with better skills and less stress. Cooks with more knowledge about dietary needs and recipes.

8. Local Government

Current: Highly supportive of and participatory in BRI activity, but low participation/civic engagement of herders (in Development Officer's experience)

Future: According to Gankhuyan - Gov't could do three things better: offer better equipped veterinary service, offer better support to Co-ops and User Groups, and facilitate better market flow for animal products.

9. Motivation

Current: Many community members are interested in entrepreneurial endeavors. They are looking for information and funding and in some cases coop members to participate. The community is being encouraged to participate in economic development but do not have the tools they need, knowledge, confidence, and experience. Funding is also an issue for them as they are not comfortable completing the Development Funds Proposal Form.

Future: Program or advisors to work as a liason between the development office and the people to help them work through their ideas and to determine viability and fit and to help with completing the proposal.

Financial Wealth

(availability and flow of capital, opportunities for entrepreneurship)

1. Employment

2. Ability to provide for family financial needs (% poverty)

Current: ***Unknown

Future: ***Unknown

3. Availability of capital for business establishment or expansion

Current: 221M Tugrik Soum Development Fund. Distributes loans 3% to applicants whose projects support general development and employ at least one person. Has created 100 jobs since 2011

Future: Martha Joh, Edward, Setsen

4. Ability of government to provide infrastructure for transportation

5. Opportunities for entrepreneurship

Current: The government development office is encouraging the community to explore entrepreneurial opportunities and is offering development funds. The director of this program is new and is learning her job. Although there are funds available, there appears to be no clear direction within the office. They are currently working on their 10 year strategic plan that will help provide direction. The community, although very motivated lacks some of the foundational information that would be helpful to their success.

Future: A holistic strategic plan in place that is understood by the officers to facilitate development direction. A program/advisor to act as a liaison to help the entrepreneurs develop their ideas and begin strong, viable businesses that support the economic development of the soum.

List of Interviewees for Building of Orhon Soum RBP

There were 12 government officers and 9 herders and citizens in this survey we coded them Government officer#1, 2 ... and for others we coded citizen#1,2 ...

Institutional Review Board (IRB)

Human Subject protection protocol.



INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

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Administrator:
 Cheryl Johnson
 406-994-6783
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MEMORANDUM

TO: Susan Gibson and Cliff Montagne

FROM: Mark Quinn *Mark Quinn CJ*
 Chair, Institutional Review Board for the Protection of Human Subjects

DATE: February 17, 2011

SUBJECT: *Sustainable Community Development in Mongolia Through Partnerships in Education, Environment, Health, and Traditional Knowledge and Skill - Montana State University BioRegions Program [SG052509-FC]*

Thank you for submitting the follow-up report on the above research project. Reapproval of this project for an additional year will be reflected in the minutes of the next Institutional Review Board meeting. In the meantime, work on the project may continue. At the end of this approval period you will receive another follow-up form which will be used to evaluate this proposal for renewal. If the project extends beyond five years, you will need to submit a new application. Please keep track of the number of subjects who participate in the study and of any unexpected or adverse consequences of the research. If there are any adverse consequences, please report them to the committee as soon as possible. If there are serious adverse consequences, please suspend the research until the situation has been reviewed by the Institutional Review Board.

Any changes in the human subjects aspects of the research should be approved by the committee before they are implemented

It is the investigator's responsibility to inform subjects about the risks and benefits of the research. Although the subject's signing of the consent form, documents this process, you, as the investigator should be sure that the subject understands it. Please remember that subjects should receive a copy of the consent form and that you should keep a signed copy for your records.

In one year, you will be sent a questionnaire asking for information about the progress of the research. The information that you provide will be used to determine whether the committee will give continuing approval for another year. After initial approval, if the research is still in progress beyond a 5-year period, a completely new application will be required. |

Munkhbat's Resource Base Profiles

Munkhbat's HM Resource Base Profile (June, 2013)

Introduction

(Background, issues)

This herder family lives in bag#1, in Shuwuut river valley, Orkhon soum Bulgan province of Mongolia, which is located about 280km to the north west of Ulaanbaatar. Munkhbat is 29 years old, married 5 years ago to Gereltuya and they have two daughters who are 2 and 4 years old. Munkhbat is a horse trainer and he became the best horse trainer of the Orkhon soum in 2012. So far he has won 9 horse races in 2013. Wife Gereltuya is a bank economist who is a college graduate and worked at a local bank for 4 years prior to her marriage. Now they are year around herder of little over 600 head of animals.

Quadrant One: Whole to be Managed

People involved (decision makers, representative stakeholders)

Husband Munkhbat, wife Gereltuya, Munkhbat's parents Horloo and Otgondawaa, Munkhbat's older brother Munkhtaiwan and Duzee. Gereltuya's father. The main decision is made by Munkhbat and Gereltuya after they discuss the issue with those people above.

Current Wealth Profile

Wealth indicators and current condition

Natural Wealth (capture of solar energy, water and mineral cycles, species diversity)

- *Pasture*- The pasture that they traditionally used for generations in the past is Shuwuut river valley. It is located in southern end of the Orkhon soum bag#1. It is about 35km from the town center. Winter camp pasture is in the mountains and it is starting to be degraded and the overall quality is about 70%, the summer pasture is more overgrazed and overall quality is 50%, if we say the "ideal" pasture is 100%.
- *Agricultural land*-They do not have an agricultural land in meaning of farm or gardening, but they have a 0.28 private land in soum center planning to build a horse barn for the race horses in the future.
- *Forest*-The family is going to have a forest user group formed this September 2013 by "Bag hural" (bag representatives' meeting) to manage the forest on the other side of their winter pasture mountain. The size of the forest that to be managed by the user group is
- *Water*-There is a well in the lower side of the winter camp mountain and it is mechanical well that is rotated by animals. This well's water quality is a good. Another water resource is Shuwuut river at summer camp and Zuun bylag (dried up 13 years ago) in winter camp. Usually water is clear except after rain.
- *Fisheries*- no fishing so far but Orkhon river has fish populations that are fished.

- *Wildlife*-This family has some income from hunting the wolves which costs about 150000tug, when the pelt is sold. Also the oversized herds of the domestic animals are pushing the wildlife away and habitat is too small for them to exist. They have elk, wolf, wild bore, and marmots.

Social Wealth indicators and current condition

Social Wealth (motivation, knowledge flow, diversity of knowledge) (tradition, health, education, welfare)

- *Frequency and participation in traditional activities*-Naadam festival, Tsagaan Sar – Lunar calendar new year festival, different traditional ceremonies like wedding, new ger ceremonies, new baby hair cutting ceremonies.
- *Family stability*-family looks like a strongly bonded and full of love
- *Individual human health*-Munkhbat had a kidney renal artery stenosis replaced by a graft in 1997, and he has some back pain when he rides horses, wife has no health problem. One of the daughter had a bladder infection but got treated with an antibiotic
- *Programs to support people in poverty or with disabilities*- there is no disabled person in this family
- *Education level for countryside vocations, citizenship participation*- wife is college educated, husband is high school.
- *Education level for entrepreneurship*- husband is working hard to get his horse race knowledge updated and find the best practice. Wife is in need of getting her sawing ability improved by training that is offered in UB.

Financial and Transaction Wealth indicators and current condition

Financial Wealth (availability and flow of capital, opportunities for entrepreneurship)

- *Employment*-they are self employed
- *Ability to provide for family financial needs (% poverty)*-They have total of 10.510.000 tug income in animal and its products form such as wool, cashmere, offspring, race horse prize, airag.
- *Availability of capital for business establishment or expansion*-they have over 600 head of animals. Their aim is to raise them up to 1000 so they have 300 mother animals which is enough income for family to start their any kind of business or support their family fully without reducing the actual number of animals.
- *Ability of government to provide infrastructure for transportation*-Munkhbat's family has a Chinese motorcycle. It is fuel efficient and easy to use. They are planning on buying a little track that they can use for their user group and also family use to move around and transport the race horses also to get the dead woods from the forest and sell them in the town as a fuel. Road to soum center and other towns and UB is quite reasonable compared to some remote areas of Mongolia.

Munkhbat's HM Resource Base Profile (Feb, 2014)

Introduction

(Background, issues)

This herder family lives in bag#1, in Shuwuut river valley, Orkhon soum Bulgan province of Mongolia, which is located about 280km to the north west of Ulaanbaatar. Munkhbat is 29 years old ,married 5 years ago to Gereltuya and they have two daughters who are 2 and 4 years old. Munkhbat is a horse trainer and he became the best horse trainer of the Orkhon soum in 2012. So far he has won 9 horse races in 2013. Wife Gereltuya is a bank economist who is a college graduate and worked at a local bank for 4 years prior to her marriage. Now they are year around herder of little over 600 head of animals.

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People involved (decision makers, representative stakeholders)

Husband Munkhbat, wife Gereltuya, Munkhbat's parents Horloo and Otgondawaa, Munkhbat's older brother Munkhtaiwan and Duzee. Gereltuya's father. The main decision is made by Munkhbat and Gereltuya after they discuss the issue with those people above. Additional decision-makers are Altantsetseg and Junai

Resource Base Profile

Wealth indicators and current condition

Natural Wealth (capture of solar energy, water and mineral cycles, species diversity)

- *Pasture*- The pasture that they traditionally used for generations in the past is Shuwuut river valley. It is located in southern end of the Orkhon soum bag#1. It is about 35km from the town center. Winter camp pasture is in the mountains and it is starting to be degraded and the overall quality is about 70%, the summer pasture is more overgrazed and overall quality is 50%, if we say the "ideal" pasture is 100%.
- *Agricultural land*-They do not have an agricultural land in meaning of farm or gardening, but they have a 0.28 private land in soum center planning to build a horse barn for the race horses in the future.
- *Forest*-The family is still planning to have start a forest user group formed June 2014 "Bag hural" (bag representatives' meeting) to manage the forest on the other side of their winter pasture mountain. They need management plan assistant.
- *Water*-There is a well in the lower side of the winter camp mountain and it is mechanical well that is rotated by animals. This well's water quality is a good. Another water resource is Shuwuut river at summer camp and Zuun bylag (dried up 13 years ago) in winter camp. Usually water is clear except after rain.
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- *Wildlife*-This family has some income from hunting the wolves which costs about 150000tug, when the pelt is sold. Also the oversized herds of the domestic animals are pushing the wildlife away and habitat is too small for them to exist. They have elk, wolf, wild boar, and marmots.

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- *Programs to support people in poverty or with disabilities*- there is no disabled person in this family
- *Education level for countryside vocations, citizenship participation*- wife is college educated, husband is high school.
- *Education level for entrepreneurship*- husband is working hard to get his horse race knowledge updated and find the best practice. Munkhbat's planning to work with American Veterinarians to exchange knowledge about race horse care. Wife is getting technical help from her aunt and she sending out learning materials about sawing for her.

Financial and Transaction Wealth indicators and current condition

Financial Wealth (availability and flow of capital, opportunities for entrepreneurship)

- *Employment*-they are self employed
- *Ability to provide for family financial needs (% poverty)*-They have total of 10.510.000 tug income in animal and its products form such as wool, cashmere, offspring, race horse prize, airag.
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Holistic Management Decision Making Matrix

| Decision-Making Matrix | | | | | | | | | | | |
|-------------------------------|--|--------|--|--|---------|--|--|---------|-----------|------|------|
| Date | | Option | | | Remarks | | | Cause & | Weak Link | | |
| | | | | | | | | Effect | Soc. | Bio. | Fin. |
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| E | M | E | M | Sustain | GPA | Marg | Society & Culture | | Early Warning | |
|--------|---|-----|---|---------|-----|-------|-------------------|--|---------------|--|
| Source | | Use | | | | React | Feel | | Monitoring | |
| | | | | | | | | | | |
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Figure D.1. Holistic Management decision-making matrix (Savory, 1991).

Mukhbat's (MB) Decision Making Process Using HM
Mandala and Monitoring as a Bridge

Table D.1. MB family HM decision-making Mandala July 2013.

| | |
|--|---|
| Goals: (Munkhbat) become a state recognized horse trainer, (Gerlee) become a well known seamstress, (joint) Increase the number of animals, buy a little track, | |
| Action | Resources |
| <ul style="list-style-type: none"> • Mb participated in two more races of the region and won. • Going to seamstress training leaving the family behind was hard. • Loan did not work because bank thought it is hard to pay back. | <p>Decision makers: Mukhbat, Gerlee, Horloo (MB's father) Duzee (Munkhbat;s brother), Gerlee's parents.</p> <p>Assets: income from animals and horse race rewards 10.510.000 tugrik (yearly)</p> <p>Land: All the pasture and a land in town center with a fence (0.28 hectare)</p> |
| Testing | Tools |
| <ul style="list-style-type: none"> • Participate in more horse trainings and get increase number of races that MB win • Have Gerlee get the seamstress training she wants in UB, • Get a loan from bank and buy a little track. Monthly payment amount, and how it would pay back | <p>Equipment: motorcycle, chainsaw, a sawing machine</p> <p>Skills: horse training skills, singer, social skills (participate in local festival organizations), college education in finance, skill to make dairy products.</p> <p>Networks: horse trainer friends, BioRegions, banks to loan money,</p> |

Table D.2. Monitoring step that leads to the next Mandala.

| Monitoring | | |
|--|--|--|
| What worked | What did not work | What should be done |
| <p>MB is participating in more races and being successful. They are increasing their livestock not selling too many of them.</p> | <ul style="list-style-type: none"> • Gerlee could not go to training because fall was a bad time to leave the family behind for a month. • Getting loan from bank did not work because they did not meet the qualification • Sticking with the new way of planning things ahead • Forming user group has to was hard without a good management plan. | <ul style="list-style-type: none"> • Wintertime would be good to go and get the training for Gerlee when it is less work to do at home and ask MB's mother to take care of kids. • Bank loan is not an option for them so they would work and form a user group build up a fund and buy a track would pay back getting all the dry woods into towns and selling them • Should know more about the horse care, one of the horse had a health issue <ul style="list-style-type: none"> • Have more female animals to breed • Spend more time on brainstorming with decision makers • Stick with the written plan using DM matrix • User group forming and management help needed. • Ask the local governor to bring facilitators for the first few meetings of user group initiation. |

Table D.3. MB family decision-making Mandala Feb 2014. Parts in italics are the additional parts to the previous Mandala.

| | |
|--|---|
| <p>Goal: <i>Form a user group of an extended family, buy a little track using user group contribution, get the seamstress training, have more races, learn more about horse care so he can take care of the race horses, increase the number of female animals in their herd.</i></p> | |
| Action | Resources |
| <ul style="list-style-type: none"> • Mb participated in two more races of the region and won, <i>having questions and exchange information for American Vets</i> • Going to seamstress training in coming winter or collecting training materials • <i>Swapping the animals and into females</i> • <i>In the stage of finding local government support on forming user group.</i> | <p>Decision makers: Mukhbat, Gerlee, Horloo (MB’s father) Duzee (Munkhbat;s brother), Gerlee’s parents and <i>kids two more families to participate in the user group Altantsetseg and Junai</i></p> <p>Assets: income from animals and horse race rewards 10.510.000 tugrik (yearly)</p> <p>Land: All the pasture and a land in town center with a fence (0.28 hectare)</p> |
| Testing | Tools |
| <ul style="list-style-type: none"> • Participate in more horse trainings and get increase number of races that MB win, <i>have veterinarians of BR trip exchange knowledge about horse care</i> • <i>Increasing number of female animals by exchanging the male animals to neighbors</i> • <i>Start using the soil and vegetation knowledge from last summer into the grazing decision making</i> • Have Gerlee get the seamstress training <i>she wants in UB in coming winter, or have books and materials</i> • <i>Form a user group and get the permit to use the dry wood, use the track to bring wood from the burnt forest.</i> • | <p>Equipment: motorcycle, chainsaw, a sawing machine, <i>training materials</i></p> <p>Skills: horse training skills, singer, social skills (participate in local festival organizations), college education in finance, skill to make dairy products, <i>knowledge about their soil and, vegetation at winter pasture, brainstorming to find a better decision</i></p> <p>Networks: horse trainer friends, <i>veterinarians’ visit from USA, BioRegions, user group member families</i></p> |

APPENDIX E

IMAGES OF THE PASTURES



Figure E.1. Gullies and erosion sites at the sampling area.



Figure E.2.



Figure E.3.