Feasibility Study

Improving Adaptive Capacity and Risk Management of Rural Communities in Mongolia

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Acronyms

CBA	Community Based Adaptation
CBOs	Community Based Organisations
CCA	Climate Change Adaptation
CCE	Climate Change Exposure
CCV	Climate Change Vulnerability
CRVA	Community Risk and Vulnerability Analysis
DEFRA	Department for Environment, Food and Rural Affairs
DRR	Disaster Risk Reduction
EbA	Ecosystem Based Adaptation
ECM	Ecosystem Management and Restoration
EIA	Environmental Impact Assessment
EWS	Early Warning Systems
GCF	Green Climate Fund
GDP	Gross Domestic Production
GCM	Global Climate Model
GEF	Global Environment Facility
GIZ	Gesellschaft für Internationale Zusammenarbeit
GTZ	German Agency for Technical Cooperation
HDI	Human Development Index
IPCC	Intergovernmental Panel on Climate Change
IRIMHE	Inform. and Res. Inst. of Meteorology, Hydrology and Environment
KfW	Kreditanstalt für Wiederaufbau
MET	Ministry of Environment and Tourism
MoFALI	Ministry of Food, Agriculture and Light Industry
NAMEM	National Agency for Meteorology and Environment Monitoring
NAPCC	National Action Programme on Climate Change
NEAP	National Environmental Action Plan
NEP	National Environmental Policy
NEMA	National Emergency Management Agency
NLMP	National Land Management Plan
NSAP	National Strategy and Action Plan
RCP	Representative Concentration Pathway
SME	Small and Medium Enterprise
SDC	Swiss Development and Cooperation
SPM	Sustainable Pasture Management
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WMO	World Meteorological Organization

Executive Summary

Mongolia is a landlocked country in East Asia located between China and Russia. The total land area of Mongolia is 1,564,116 km^2, making it the 18th largest country in the world. With a population of approximately 3 million people it is also the most sparsely populated - population density of 1.9 people per km^2. The country contains very little arable land, and its territory is covered by grassy steppe, with mountains to the north and west and the Gobi Desert to the south. There are six major types of eco regions in Mongolia, namely steppe, desert, semi-desert, taiga, forest, and high mountains (See Figure 1). Ulaanbaatar, the capital and largest city, is home to about 45% of the country's population, and 30% of the population is nomadic or semi-nomadic herders.

The country began simultaneous economic and political transformations in 1990 after the collapse of the Soviet Union. The rapid liberalization and privatization of the economy resulted in serious social differentiation and impoverishment. The transformation from collective socialism to a market economy during the following decade led to the collapse of the agriculture and the food industry, causing considerable disruption to both urban and rural livelihoods. The global economic crisis of 2008 struck the Mongolian economy, seriously affecting the exports of key minerals as well as the agriculture and the livestock sectors. Inequality, poverty and food insecurity are present in the country, especially in rural areas where there are large numbers of herders and households who live at or near the poverty level.

The climate of Mongolia is harsh continental and has distinct four seasons, a wide range of temperature fluctuations and variations, and low precipitation. In the past centuries, the reconstructed surface temperature at hemispheric and global scale for much of the last 2000 years has led to the conclusion that the recent Northern Hemisphere surface temperature increases are likely anomalous in a long-term context, for at least the past 1300 years. The climate change projection for Mongolia indicates that the temperature will continuously increase. Precipitation will increase by a higher percentage in winter, and there will little change in the summer months. The high-intensity of the above-mentioned temperature change is projected in the western and eastern parts of the country in winter and the western part in the summer season. There will be a high-intensity increase in winter precipitation in the central, western and eastern parts, and in the western part in the summer season. Some extreme events such as strong winds, snow and dust storms, heavy rain, heavy snow, freezing rain, wet snow and surface frost cover large areas of territory and may persist for a longer period of time. Therefore, they cause severe damage to the agricultural and livestock sectors. Convective phenomena, which persist comparatively for a short/medium time and cover small areas of territory, include squalls, hail, lightning, thunderstorms and flash floods, and they represent 53.3% of the total atmospheric disasters. In the country, extreme events occur 51 times per year on average. When dividing the number of disasters of the last 20 years into two decades, extreme events averaged approximately 45 per year in the first decade, and that number has increased by 1.5 times in the last decade. The most frequent extreme phenomena are strong winds and storms, thunderstorms, lightning, squalls, hails, heavy rains, heavy snows, frost surface, wet snow and other minor extreme events.

Since 2007, 412 people and 24.5 million livestock were killed due to extreme weather events, resulting in MNT562.7 billion of a total economic damage. During the winter of 2009-2010, almost the entire territory of Mongolia experienced excessive snow and persistently cold temperatures that caused harsh winter conditions (i.e. higher than normal snowfall and/or lower than normal temperatures), referred to as a winter dzud. The 2009-2010 winter dzud affected 80.9% of the total territory (175 soums from 18 provinces). In terms of its extent and damage, this dzud was more disastrous than those in recent years. Nationwide, during the 2009-2010 dzud, 22.4% of total livestock (9.7 million) were lost resulting in economic damage that comprised 93% of the total damage of the last 11 years. In all, the years 2009 and 2010 were the worst years for human death caused by natural disasters.

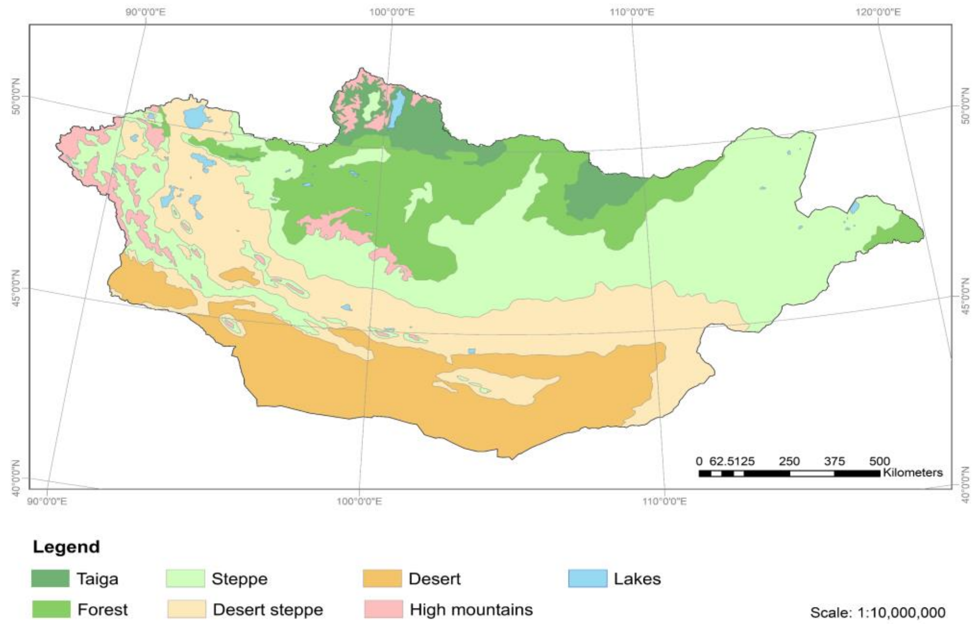


Figure 1 Major ecoregions in Mongolia

Increased intensity and frequency of natural disasters induced by climate change has not only impacted the livelihood of rural population but also poses a greater threat to the society and economy of the country. Natural disasters and dzuds affect daily life, in particular for the most vulnerable. Although poverty alone does not necessarily make people vulnerable to weather events and climate, at the individual or rural level, it deepens the dependency on natural resources and increases the risk of migration to cities due to the loss of permanent income sources such as livestock and rural jobs. In this way, the negative effects of climate change will be felt most in poverty-stricken and vulnerable communities.

The suggested target areas for interventions are four aimags with severe climate conditions, namely Khovd and Zavkhan, in Western Mongolia, and Dornod and Sukhbaatar in Eastern Mongolia (see Figure 2). The climate of the aimags in the western area is extremely cold and dry within this latitude and the region is also the coldest in Mongolia. Consequently, the warming tendency during the last 70 years is higher than the Mongolian average. The projection of climate change in the four target aimags indicates statistically significant changes. In the western mountainous region with desert steppe, where Khovd and Zavkhan are located, the seasonal temperature over the Kharkhiraa-Turgen river basin is projected to increase by 1.7-3.8^{0}C in winter, 0.9-4.6^{0}C in spring, and 0.6-4.9^{0}C in summer and autumn. Seasonal precipitation is expected to increase by 6.5% to 26.3% in winter, and 12.3% to 17.8% in spring, decrease by 0.9% to 12.1% in summer and increase by 4.8% to 23.6% on average during the 21st century. In terms of high-intensity change, the increase of winter precipitation and reduction of summer precipitation are more significant compared to other seasonal variations. Projections of climate change in the eastern steppe and desert-steppe area, where Dornod and Sukhbaatar aimags are located, the annual average air temperature is likely to increase by 0.9-1.3^{0}C in 2011-2030, 2.5-2.8^{0}C in 2046-2065, and 4.2-4.65^{0}C in 2080- 2099 in the Kherlen, Onon and Ulz rivers basins. The seasonal temperature over the Ulz river basin in the region is projected to increase by 1.0-4.0^{0}C in winter, 1.1-4.1^{0}C in spring, 0.8-4.2^{0}C in summer and 1.1-4.2^{0}C in autumn. Seasonal precipitation is expected to increase by 19.6% to 50.7% in winter, decrease by -2.1% to 26.1% in summer, and increase by 10.0% to 12.3% on average during the 21st century. In terms of high-intensity change, the increase of winter precipitation is more significant compared to other seasonal changes.

Figure 2 Mongolia's administrative units and target sites

Herders in Mongolia are more vulnerable to climate change compared to herders in other countries because 100% of animals' feed comes from pastures only, and pastures are exposed to the effects of climate change more than intensive crop productions. The challenge (due to cost and limited accessibility) for herders to access grass and feed concentrate during the winter expose them and their animals to greater risks. On the other hand, well-managed pastures help to protect the environment and natural resources and also continue to sustain ecological functions and services. Pasture herder groups (PHGs) have proven to be an effective mechanism to facilitate collective action for improved pasture land management, livestock management and meat, dairy, wool and cashmere production and processing. The PHGs in many parts of the country have become an institution to facilitate co-management between the government, as the owner of the pastureland, and herders as the users. The link between PHGs and market development could become stronger but PHGs have had limited access to credit and training to start economic activities.

Consultations have identified a number of gaps and barriers that have prevented herders in the four target aimags from achieving climate resilience. The main gaps and barriers were in climate information and forecasting, livestock, land and water management. Detailed gaps include: lack of accurate weather predictions caused by inadequate models and limited capacity of hardware; use of old technology, simple statistical models and inadequate training of personnel; weak livestock and pasture management; lack of access to markets and land tenure issues; distribution and dispersal of water for human and animal consumptions; lack of available water at the locations of the needs; and lack of local surveys and exploration studies to identify water resources for new boreholes.

In light of the gaps and barriers identified in the four aimags in achieving climate resilience, this study recommends an integrated approach of three key interventions: 1) climate-informed medium-to-long-term land and water use planning at the national and sub-national levels; 2) community-level ecosystems-based adaptation approaches to protect land and water resources; and 3) herder capacity strengthening to access markets for sustainably sourced livestock products. Medium- and long-term sustainability is checked through an extensive literature review, discussed through workshops, roundtables, and meetings, and validated through consultations with experts and representatives of central and local government and representatives of rural communities.

1. Introduction

1.1. Background context

Mongolia is very sensitive to climate change due to its geographic location, fragile environment, extreme weather conditions, and socio-economic issues. Mongolian ecosystems have been noticeably altered by increased variability in global climatic conditions. The analysis of meteorological data shows Mongolia's annual mean temperature has risen by 2.07°C between 1940 and 2013[1]. It is expected that during the 21st century Mongolia will be more heavily impacted by global climate change [2]. These impacts include land degradation and desertification, more frequent and intensive natural disasters such as wind-, dust-, and snowstorms, thunderstorms, heavy (higher than normal) rains and snows, hot and cold waves, flash and rain floods, summer droughts and harsh winters (i.e. higher than normal snowfall and/or lower than normal temperatures), increased scarcity of water resources and greater biodiversity loss. Therefore, it is a priority for the country to develop sustainable medium- and long-term solutions to adapt to a changing climate.

1.1.1 Country and population

The total land area of Mongolia is 1,564,116 km^2 and it is the 18th largest and the most sparsely populated country in the world, with a population of around 3 million people (population density of 1.9 people per km^2 in 2015). The country contains very little arable land, and its territory is covered by grassy steppe, with mountains to the north and west and the Gobi Desert to the south. Ulaanbaatar, the capital and largest city, is home to about 45% of the country's population. Approximately 30% of the population is nomadic or semi-nomadic. The majority of the state's citizens are of Mongol ethnicity, although Kazakhs, Tuvans, and other minorities also live in the western part of the country.

1.1.2 Economy

Mongolia began simultaneous economic and political transformations in 1990 after the collapse of the Soviet Union. The rapid liberalization and privatization of the economy resulted in serious social differentiation and impoverishment. The transformation from collective socialism to the market economy during the following decade resulted in the collapse of agriculture and the food industry, causing considerable disruption to both urban and rural livelihoods. The global economic crisis of 2008 struck the Mongolian economy, seriously affecting key mineral exports as well as the agriculture and livestock sectors. All economic indexes collapsed, and its fiscal accounts, the balance of payments, and tax revenue all suffered deterioration. This performance inevitably undermined government investments in agricultural and livestock sectors. However, Mongolia has witnessed significant economic progress in recent years and has recovered quickly from the global financial crisis in 2008-09; the economy recorded double-digit growth in recent years. In coming years, the economy of Mongolia is expected to grow due to large-scale mining and quarrying projects. Still the economy has a narrow base. Mineral commodities account for about 80% of the country's exports and mining provides around 40% of total government revenues, though only 3% of the total workforce. Further, the high percentage of raw materials in exports, and the heavy dependency of these raw materials on world market prices, is contributing to a growing trade deficit. The agricultural sector, which accounted for 15% of GDP in 2010 and provided a livelihood for about 40% of its population, experienced double-digit contraction in 2010 due to high livestock mortality caused by dzud [11].

1.1.3 Social development

The human development index[1] (HDI) of Mongolia is 0.675 and the average human development index of countries in the Asia and Pacific Region is 0.683. The HDI of Mongolia is greater than the average level of human development index of countries that have a middle-level of human development [12]. Although

[1] The human development index is a composite statistic of life expectancy, education, and per capita income indicators, which are used to rank countries for human development.

Mongolia has experienced a relatively high level of economic growth in the last several years, the poverty level has not declined significantly. In 1995, the poverty level based on the national poverty line was 36.3%, and 29.6% in 2016 (an increase from 21.6% in 2014). Unemployment in Mongolia has not significantly declined either, according to population censuses and large-scale surveys [13]. Inequality, poverty and food insecurity are present in the country, especially in rural areas where there are large numbers of herders and households that exist around the poverty level.

1.2. Climate change risks, projections and impacts

Mongolia is one of the countries most vulnerable to climate change. This vulnerability stems not only from its specific geographical and climatic conditions but also from the structure and development of its economic sectors and the lifestyle of its people. The content of this chapter was streamlined with outputs of the assessment reports of the Intergovernmental Panel on Climate Change (IPCC), particularly with the latest Fifth Assessment Report (AR5).

1.2.1. Climate profile of Mongolia

The climate of Mongolia is continental and has a distinct four seasons, a wide range of temperature fluctuations and variations, and low precipitation. Clear geographical patterns of climate variables can be seen depending on latitude and longitude. The annual mean temperature ranges between -8^{0}C and 8^{0}C, the summer average is between 10^{0}C and 26^{0}C and the winter average is between -15^{0}C and -30^{0}C. Annual precipitation ranges on average from 50-400 mm (depending on the region): 300 – 400 mm in the Khangai, Khentii and Khuvsgul mountainous areas; 250 – 300 mm in the Mongol Altai mountainous region and forests; 150 – 250 mm in the steppe zone; and 50 – 100 mm in the Gobi desert zone. Seasons are split into: winter (DJF); spring (MAM); summer (JJA); and autumn (SON). Rainfall falls in the warm season, which extends from April to September, whilst snow mostly falls in the cold season, which extends from October to March. Precipitation mostly (approximately 90%) falls as rain in the warm season (April-September) when intense rainfalls occur through atmospheric convection processes. One of the greatest climate-related impacts in Mongolia is known as Dzuds. These occur when there are reductions of rainfall and increases in evapotranspiration causing drought during the summer (reducing pasture growth and its availability during the winter season), immediately followed by higher than usual snowfall during winter, which increases cold stresses on livestock, reduces accessible pasture on which livestock can graze, and increases requirements for stored fodder harvested at the end of summer. Together, reduced pasture and increased fodder requirements during the following harsh winter (i.e. higher than normal snowfall and/or lower than normal temperatures) are termed 'Dzud' events.

In the Eastern region (Ulz River Basin), annual mean temperatures vary between -0.5^{0}C and 1.5^{0}C. Mean monthly temperatures range widely depending on the time of year; between -20^{0}C and -22^{0}C in January and between 18^{0}C and 20^{0}C in July. Annual precipitation in the basin varies from 270 to 350mm. In summer, low-pressure systems (cyclones) mature in the north-eastern part of the Ulz river basin with relatively higher precipitation downstream of the river basin.

1.2.2. Observed climate change impacts

Historical Climate

This subsection discusses the past climate conditions of Mongolia in the last 2000 years. The reconstructed surface temperature at hemispheric and global scale for much of the last 2000 years, using an expanded set of proxy data, updated instrumental data, and additional complementary methods that tested and validated with model simulation experiments, has led to the conclusion that the recent Northern Hemisphere surface temperature increases are likely anomalous in a long-term context, for at least the past 1300 years [16]. The results of analyses of the surface air temperature variations during the last 100 years (1901– 2003) in mid-latitude Central Asia suggest that temperature variations in four major sub-regions, i.e. the eastern monsoonal area, Central Asia, the Mongolian Plateau and the Tarim Basin, respectively, are coherent and characterized by a striking warming trend during this period [17]. The average annual mean temperature increasing rate for the Mongolian Plateau was 0.23^{0}C per decade while it was 0.18^{0}C for the whole four sub-regions. In Asian mid-latitude areas, surface air temperature increased relatively slowly from the 1900s to 1970s, and it has increased rapidly since 1970s [17]. According to the IPCC Global Climate Change Fifth Assessment Report [18], it is likely that the numbers of cold days and nights have decreased and the numbers of warm days and nights have increased across most of Asia since about 1950, and heatwave frequency has increased since the middle of the 20th century in large parts of Asia [19]. The Mongolian proxy record for temperature extended back over 450 years, based on the tree saplings from the Tarvagatain mountains located in western Mongolia, matches up well with large-scale reconstructed and recorded temperatures for the Northern Hemisphere and the Arctic [7], clearly indicating the increase of temperature over the past hundred years. The longest reconstruction for the past 1700 years, made on the sample taken from the site Solongotiin Davaa (Solongot pass), located in north-central Mongolia [20], also has shown that the 20th century is the warmest period in Mongolian history during the last millennium.

Past observed climate change and climate extremes

According to the instrumental record between 1940 and 2013 from 48 meteorological stations that are almost evenly distributed across the entire country, the air temperature has increased by 2.07°C (Figure 3). This increase has occurred more intensively in the mountainous regions and less so in the Gobi and steppe regions. The warmest 10 years of the last 74 years have all occurred since 1997 [1]. The warming trend is indicated in all ecological zones of the country and for all four seasons (see Figure 4 and 31).

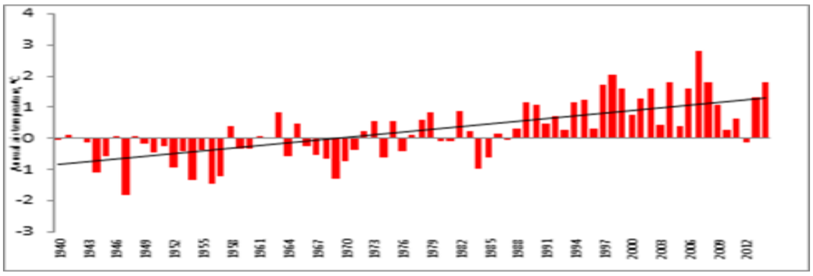


Figure 3 Deviation from the multi-year average (1961-1990) of annual mean temperature average of the entire territory of Mongolia for the period 1940-2014

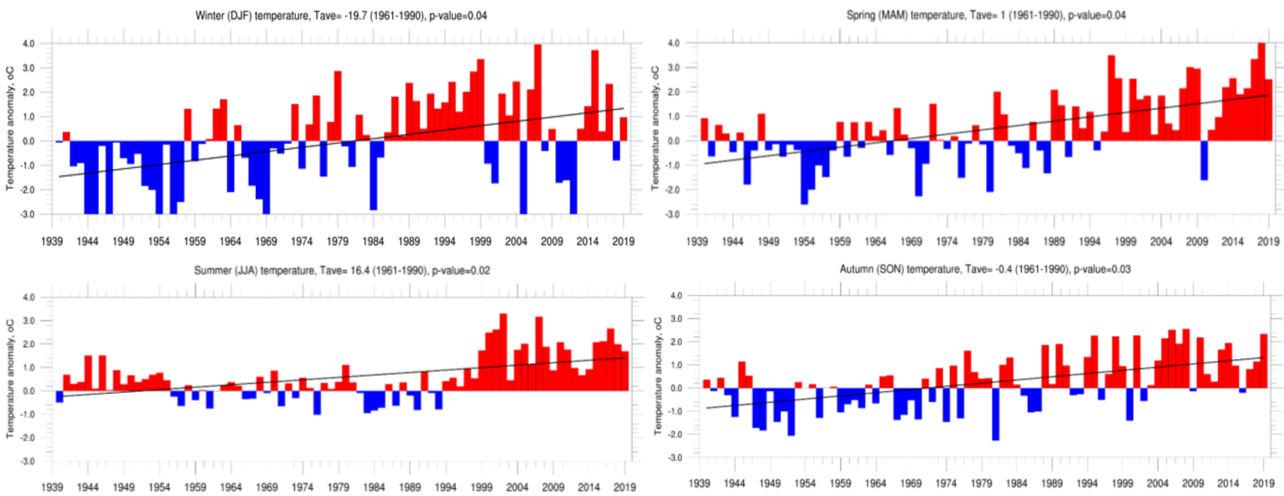


Figure 4 Deviation from the multi-year average (1961-1990) of seasonal mean temperature average over the territory of Mongolia a) wiinter (Dec-Feb) b) Spring (Mar-May) c) Summer (June-Aug) and autumn (Sep-Nov)

The climate extreme indices (Table 1) have been estimated using observation time series form 53 meteorological stations by Climpact 2.0 tool for the period of 1961-2018. Spatial distribution of changes in climate extreme indices over the country's territory and trends of interannual variable in project target areas including Khovd, Zavkhan, Dornod and Sukhbaatar Provinces for the last 58 years are illustrated in graphs following the maps respectively. The red triangles represent increase and blue represent decrease, and *-symbol illustrates statistical significance.

From the climate extreme indices presented below, there are clear indications of warming maximum temperatures and warm spells, and an increasing length of growing season. Whilst cold spell duration has increased in some central parts of the country, it has decreased elsewhere. Clearly related to increases in drought affecting water availability and pasture yield, SPEI trends are consistently negative over most stations on 3, 6 and 12 month timescales and in the four target provinces. Overall, similarity in increasing trend of drought and dzud can be observed in Mongolia. See sections below for more details on climate extreme indices.

In Dornod and Sukhbaatar Aimags in the east, long-term summer temperature has increased by 2.8°C and annual range of air temperature has been widening which results in increased frequency of extreme weather events connected with air temperature. The long-term trend indicates that the totals annual and summer precipitation is lower for the last decade than the long-term average. However, the winter precipitation has increased in the last years which results in prolonged snow coverage and when extreme is characterized as a dzud weather event.

Table 1. Extreme climate indices information, 1961-2018

№	Indices	Name	Definition	Unit
1	FD	Frost days	Annual count when daily minimum temperature < 0°C	Days
2	SU	Summer days	Annual count when daily maximum > 25°C	Days
3	GSL	Growing season length	Annual count between first span of at least 6 days with daily mean temperature >5ºC and first span after July 1 of 6 days with daily mean temperature TM<5ºC	Days
4	Txx	Maximum of daily maximum temperature	Monthly maximum of daily maximum temperature	°C
5	Tnn	Minimum of daily minimum temperature	Monthly minimum of daily minimum temperature	°C
6	WSDI	Warm spell duration index	Annual count of days with at least 6 consecutive days when daily maximum temperture >90th percentile	Days
7	CSDI	Cold spell duration index	Annual count of days with at least 6 consecutive days when daily minimum temperture <10th percentile	Days
8	RX1day	Maximum 1-day precipitation	Monthly maximum 1-day precipitation	mm
9	RX5day	Maximum 5-day precipitation	Monthly maximum 1-day precipitation	mm
10	CDD	Consecutive dry days	Maximum length of dry spell: maximum number of consecutive days with daily precipitation <1mm	Days
11	CWD	Consecutive wet days	Maximum length of wet spell: maximum number of consecutive days with daily precipitation P>1mm	Days

12	SPEI3/6/12	Standardised precipitation evapotranspiration Index	Measure of "drought" using the Standardised precipitation evapotranspiration Index on time scales of 3, 6 and 12 months	Dimensionless

a) Frost days

Frost days have decreased by 3-34 days in Mongolia, especially in central and northern parts in high latitudes (Figure 5). All changes are statistically significant. It means that cold season (October-March) is becoming shorter, while warm (April- September) season is becoming longer. It results in early melting of snow and permafrost, and thawing ice and rivers.

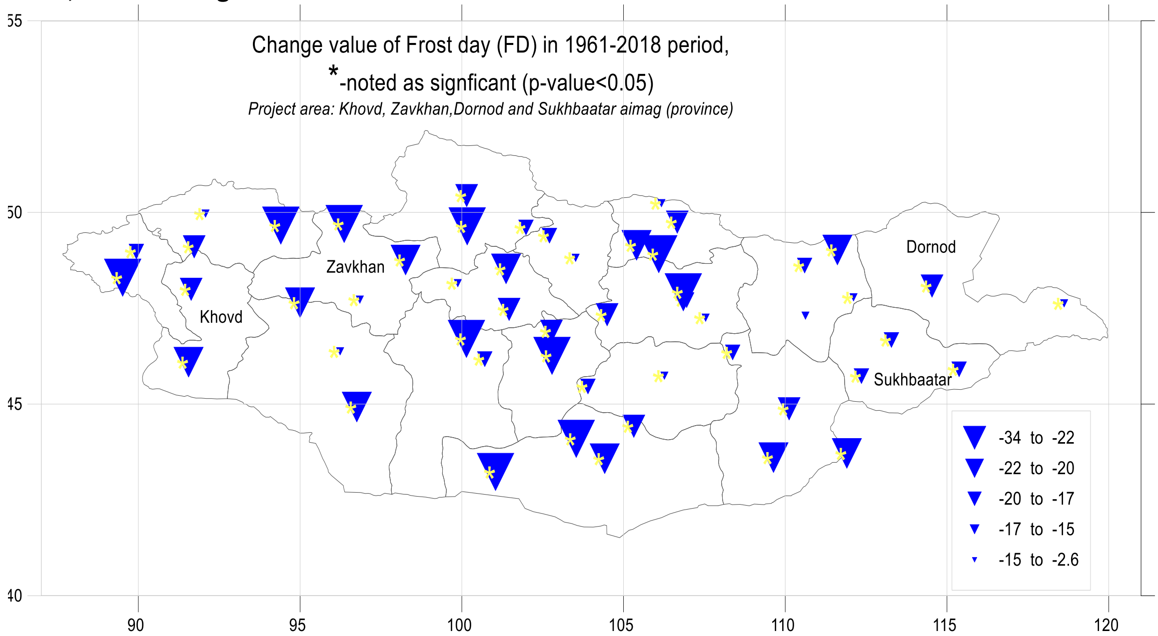


Figure 5. Frost day change (day)

b) Summer days

Summer days have increased by 4.5-49 days in Mongolia, especially in central parts of the country (Figure 6). All changes are statistically significant. It means that hot days and heat stress is becoming increasingly intense.

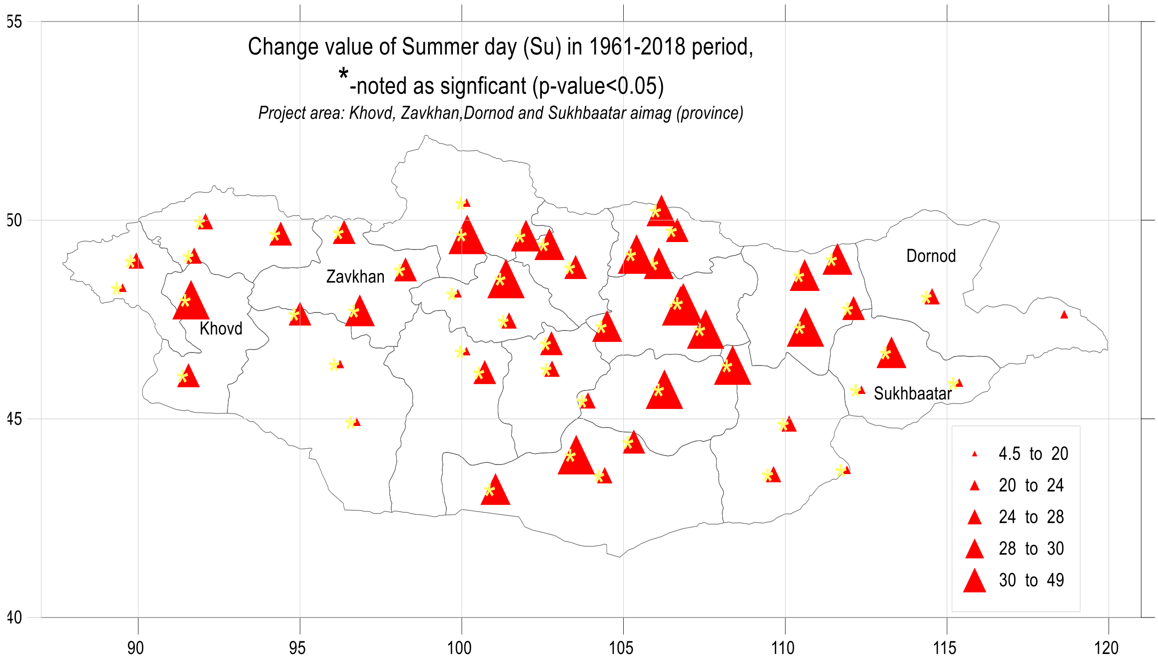


Figure 6. Summer day change (day)

c) Length of growing season

Growing season became longer by 8.8-42 days in Mongolia, especially in central and northern parts of the country (Figure 7). All changes are statistically significant. It means that heat supply for vegetation growth is improving, however transpiration has also been increasing.

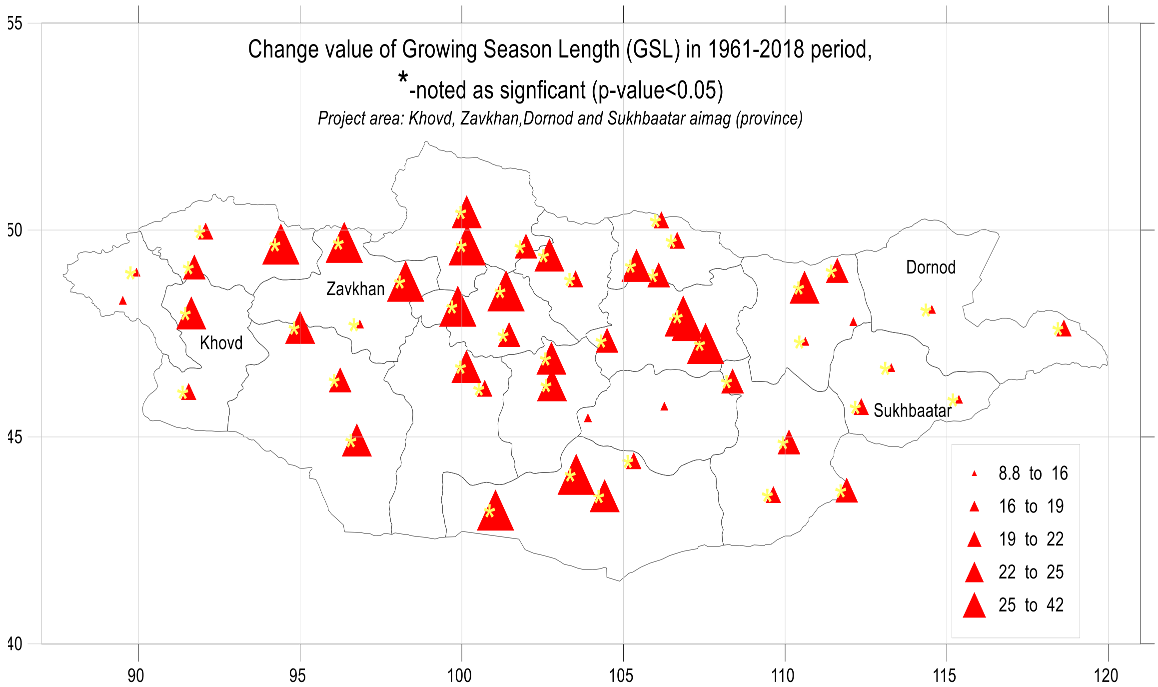


Figure 7. Growing season length (day)

d) Daily maximum temperature

Daily maximum temperatures have increased by 0.6-5.0°C over the territory of Mongolia, especially in central and northern parts of the country (Figure 8). Almost all changes are statistically significant. This shows that records of extreme hot days observed and heat stress is intensifying especially within the central and northern regions of the country. Hottest temperature changes within the project target provinces are shown in Figure 9 with trend slope and p-values accordingly.

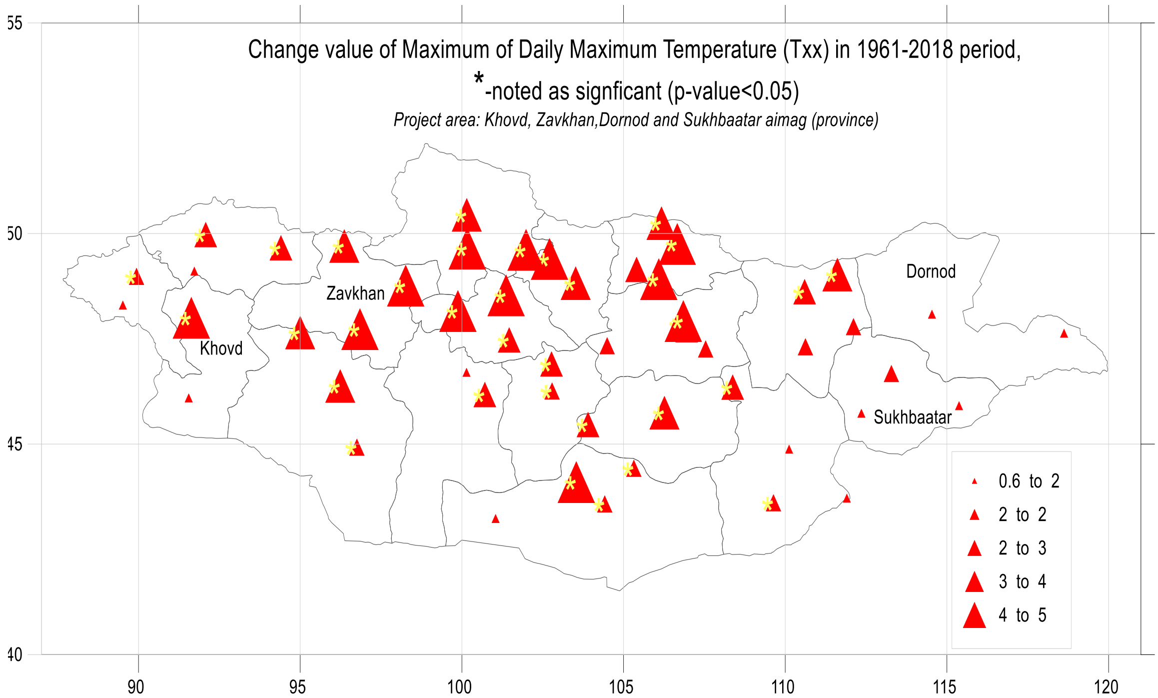
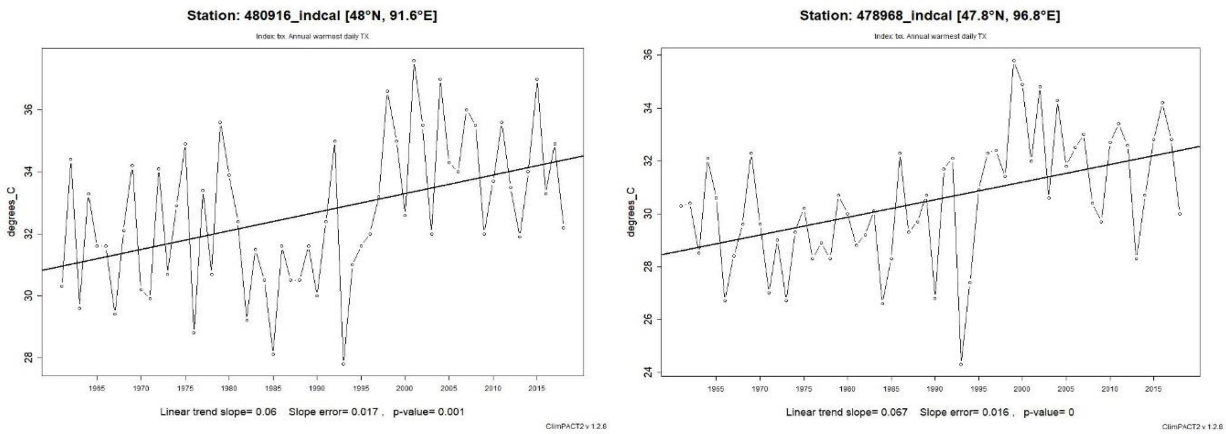


Figure 8. Hottest day temperature change (°C)



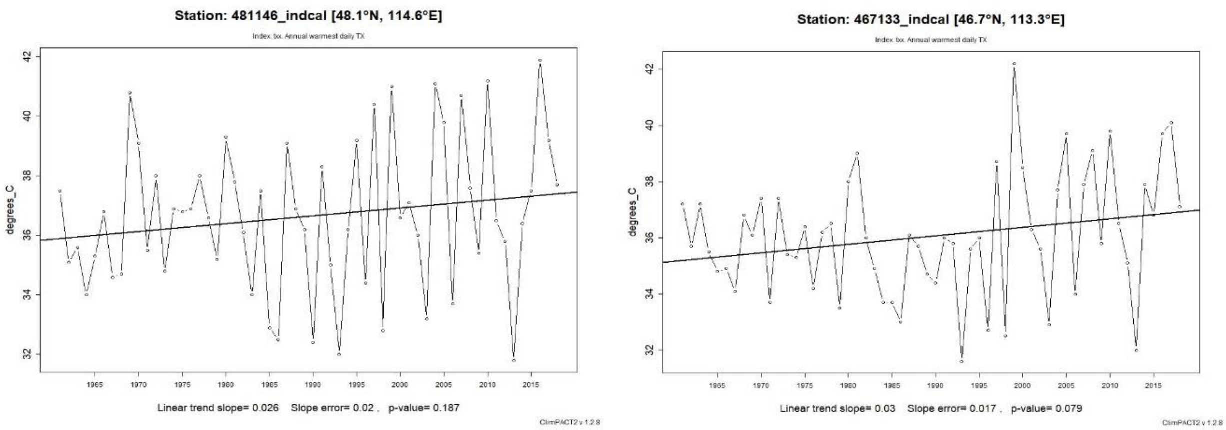


Figure 9. Hottest day temperature (°C) in Khovd (480916), Zavkhan (478968), Dornod (481146) and Sukhbaatar aimag (467133), 1961-2018

e) Daily minimum temperature

Daily minimum temperatures have increased by 1.0-6.0°C in most parts of Mongolia though not as consistently as maximum temperatures. At the same time, there is a decreasing trend up to 4 °C at some stations in the northern parts of the country (Figure 10). The map illustrates that extreme cold period is in general getting milder, while becoming more severe in few regions. Coldest temperature changes within the project target area are shown in Figure 11 with small increasing trends in most target provinces, except Zavkhan and only one target province is the trend statistically significant.

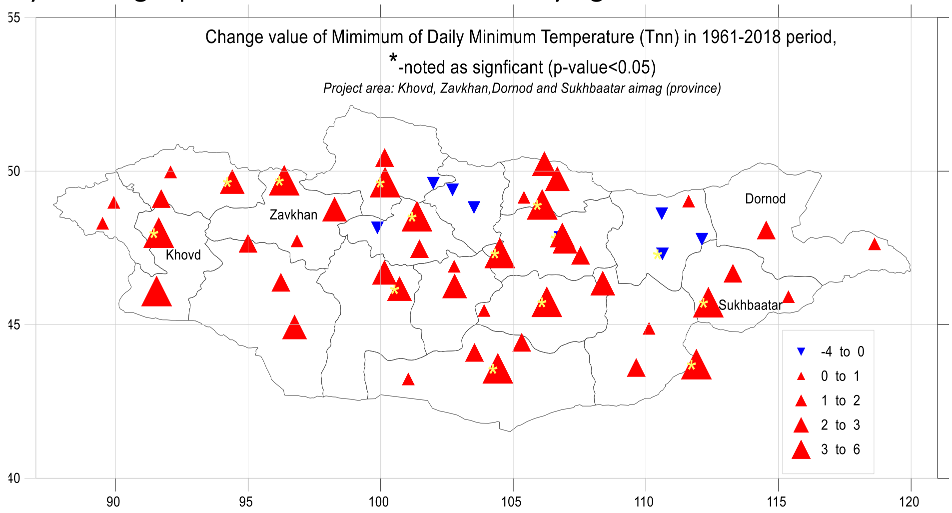
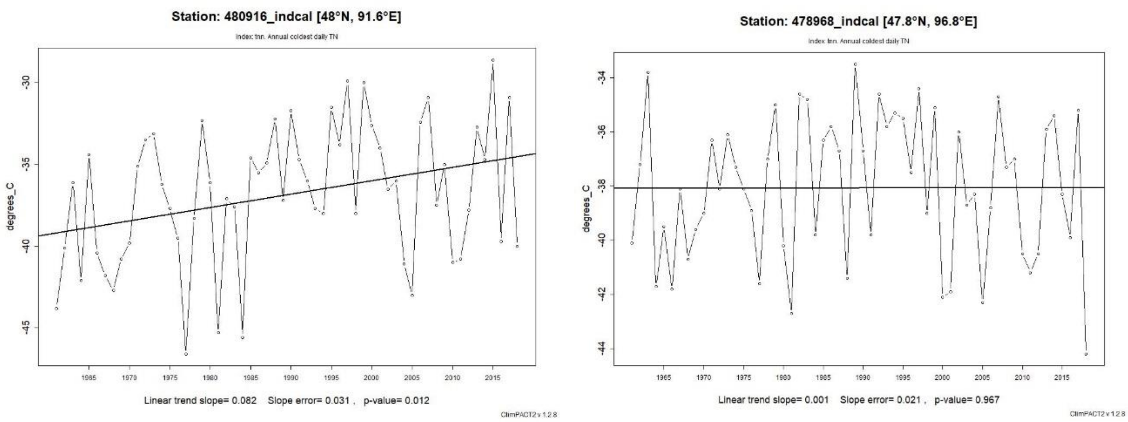


Figure 10. Coldest nights temperature change (°C)



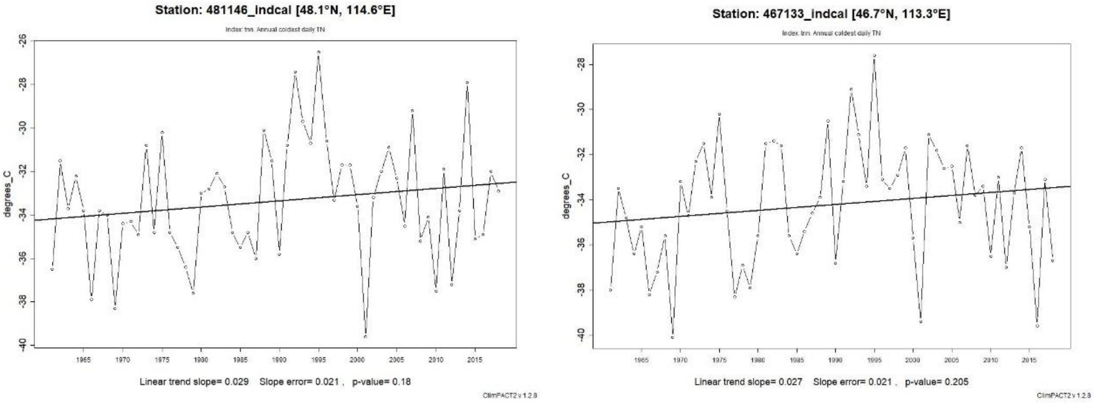


Figure 11 Coldest nights temperature (°C) in Khovd (480916), Zavkhan (478968), Dornod (481146) and Sukhbaatar aimag (467133), 1961-2018

g) Cold spell duration index

Cold spell duration index has increased by 0.5-7.0 days predominantly in central parts of the country, and decreased by 1.4-11.0 days in the northern half of the country (Figure 12). Cold spell duration index change in project target provinces is shown in Figure 13 with trend slope and p-value indicating some reductions, though these are not all statistically significant and some are because of longer cold spells during the 1960/1970s.

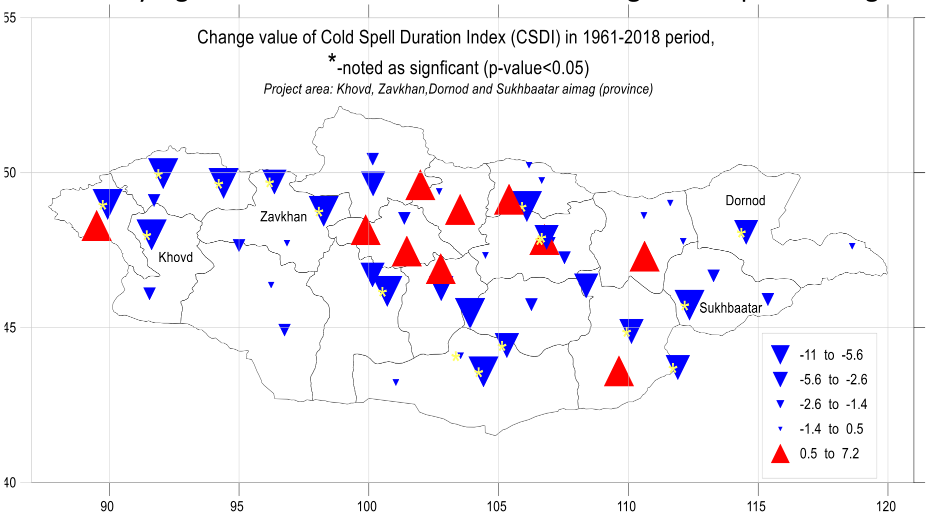
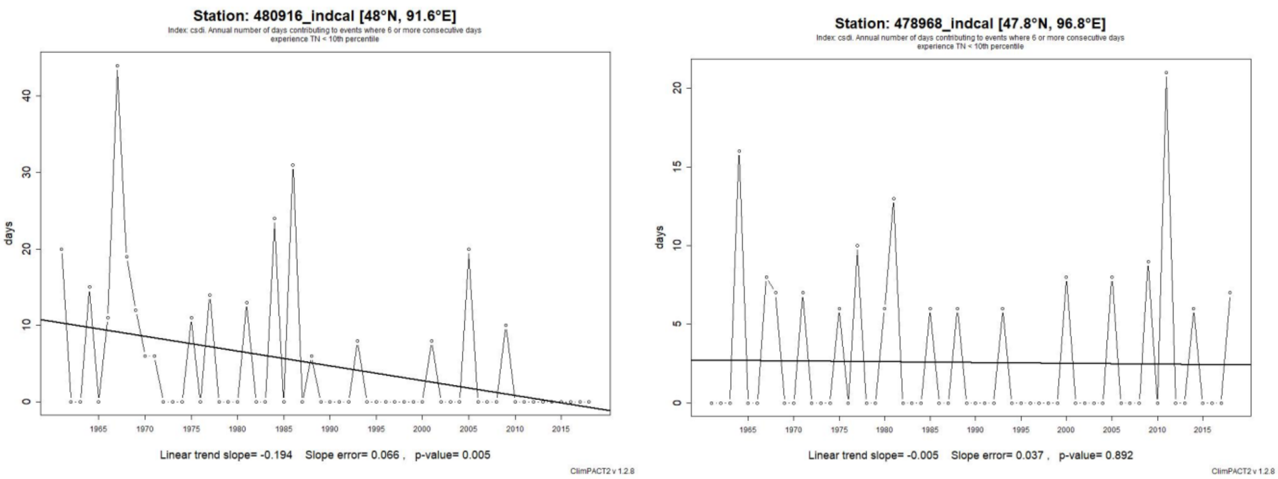


Figure 12. Cold spell duration index change (days)



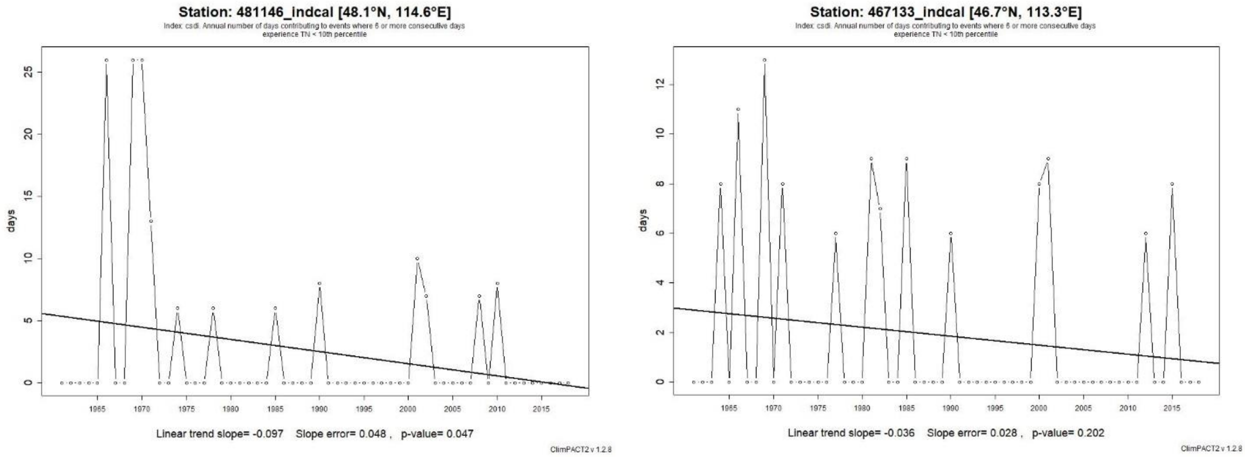


Figure 13 Cold spell duration index (days) in Khovd (480916), Zavkhan (478968), Dornod (481146) and Sukhbaatar aimag (467133), 1961-2018

h) Observed precipitation change and variations.

Over the last 81 years (1939-2019), there has been an average decrease of 17.2mm (7%) in annual total precipitation over the whole of Mongolia, which can be seen from the trend shown in Figure 14. This trend is statistically significant at greater than the 95% confidence interval using Man-Kendall's significance test. Annual mean precipitation averaged over territory of Mongolia (based on standard climate 1961-1990) is 219.8 mm, of which 6 mm falls in winter (December- February) and 156.1 mm in summer (June- August). Ninety percent of Mongolia's precipitation falls in warm seasons (April-September); with 10% falling in cold season (October- March). Therefore, annual precipitation is mostly influenced by precipitation in the warm season, especially by summer precipitation trends, which constitute 70% of annual total precipitation.

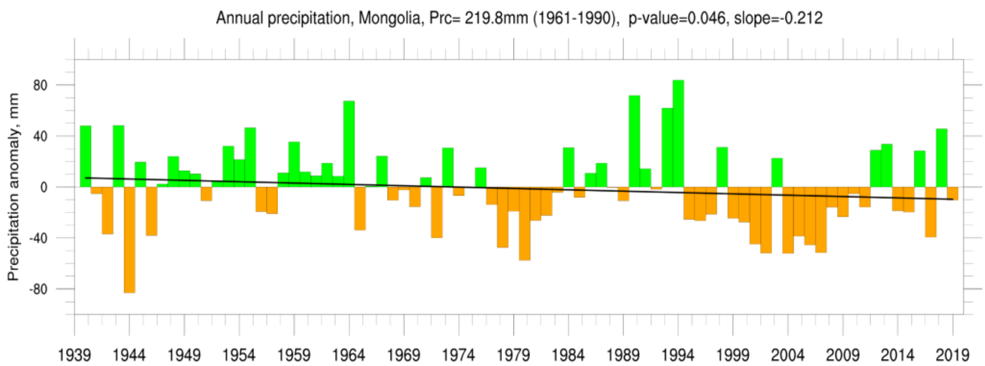


Figure 14 Deviation from the multi-year average (1961-1990) of annual total precipitation of 48 meteorological stations of the entire territory of Mongolia for the period 1940-2019

However, winter snow (precipitation) shows a statistically significant (>99% confidence level) increasing trend (see Figure 15.a) whereas summer precipitation shows a statistically significant (99% confidence level) decreasing trend (Figure 15.c). Since 1939 winter snow has increased by 40% indicating that winter snow has been increasing due to climate change, whilst total precipitation is decreasing due to decreasing summer precipitation.

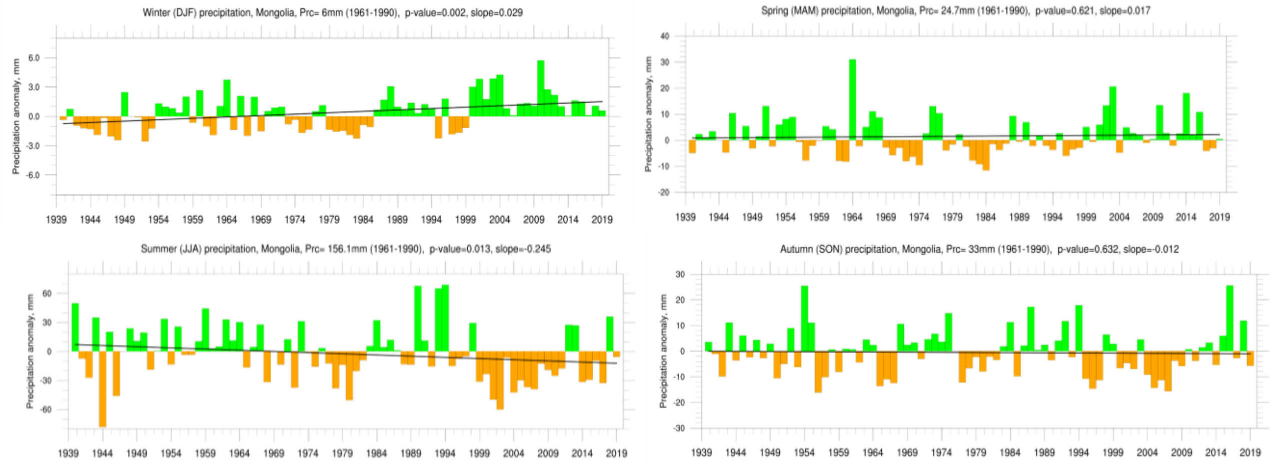


Figure 15 Seasonal precipitation deviation with respect to 1961-1990 climate baseline a) Winter (December-February) b) Spring (March-May) c) Summer (June-August) and d) Autumn (September-November)

i) Maximum 1-day and 5-days precipitation

Spatial patterns of maximum of 1-day and 5-days precipitation are very diverse. It has increasing and decreasing trends as not statistically significant over the whole territory of the country (Figures 16 and 17). It means that there is no significant change.

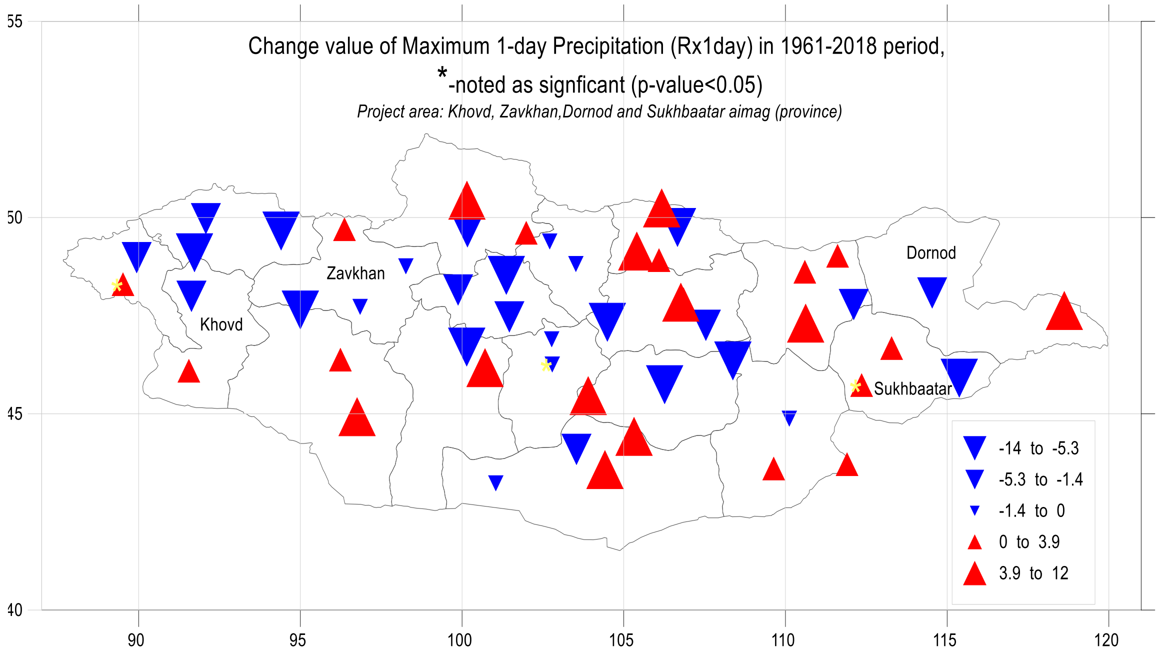


Figure 16. Maximum of 1-day precipitation change (mm)

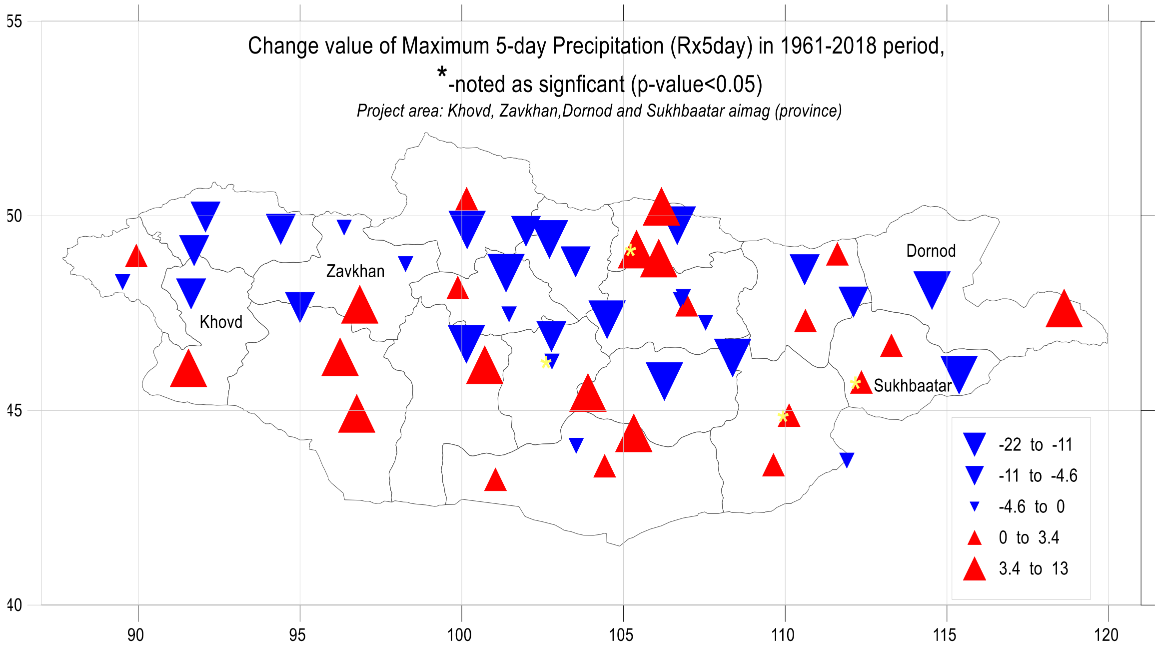


Figure 17 Maximum of 5-day precipitation change (mm)

j) Consecutive wet days

Consecutive wet days has increasing trends predominantly in northern half of the country and decreasing trends in southern half of the country. The largest decrease in precipitation occurred in the central regions of Mongolia, in some places with 95% of statistical significance. In areas where precipitation is increasing, there is 95% statistical significance only by Altai Gobi region. There are very few station data showing statistical significance (Figure 18).

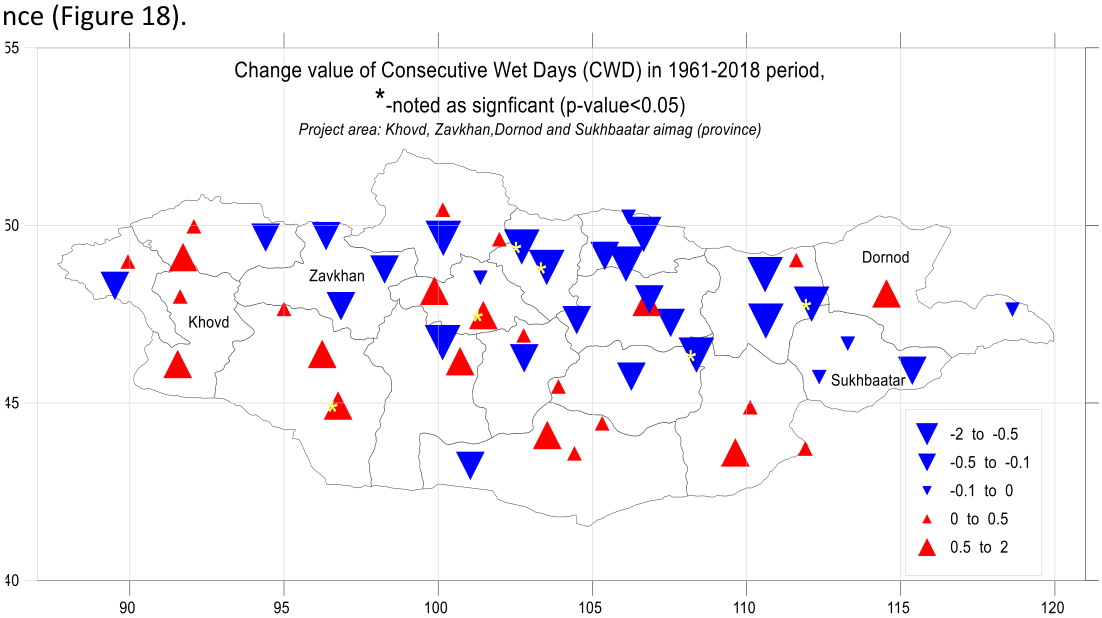


Figure 18 Changes in consecutive wet days (day)

k) Consecutive dry days

In general, the consecutively dry days show decreasing trends over the whole territory of the country, however mostly as statistically significant in southern part of the country (Figure 19). It is associated with increase of winter precipitation in Gobi and desert regions in Mongolia.

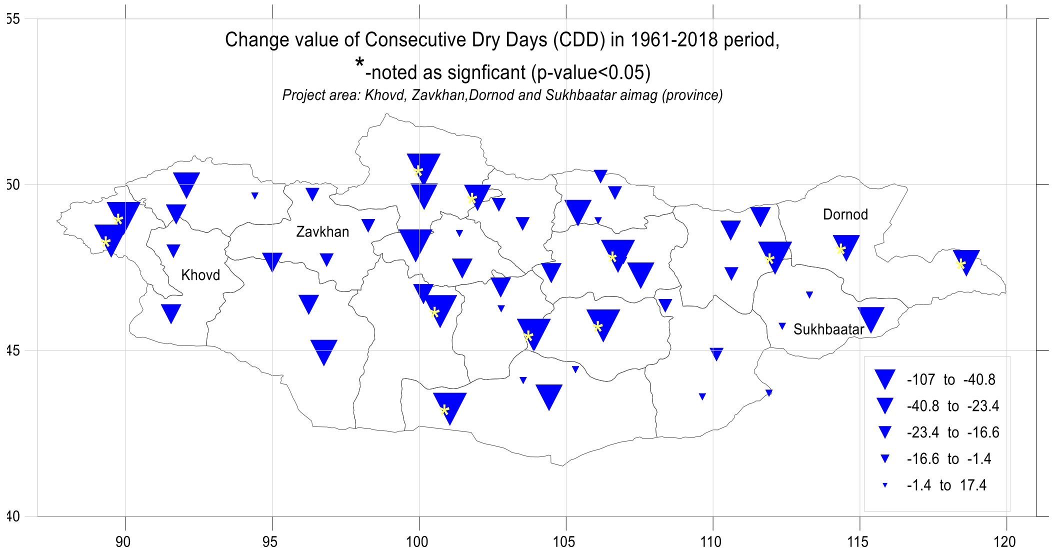


Figure 19. Consecutive dry day change (day)

l) Standardized Precipitation Evapotranspiration Index

Measure of "drought" using the Standardized Precipitation Evapotranspiration Index (SPEI) is applied on time scales of 3, 6 and 12 months (Vicente-Serrano et al., 2010). The time scales for 3 and 6 months are sliding time-based windows and are the most appropriate timescales for drought on seasonal timescales which is the timescale at which summer drought and resulting dzuds occur. A drought is specified using both precipitation and evaporation and it is important for growing vegetation considering both effects into account. SPEI 3/6/12 all have decreasing trends over the whole territory of Mongolia and are as statistically significant (Figure 20-25). It means drought and dryness are becoming intensified over the whole territory, which could lead serous impacts on ecosystem services and functions and country’s socio-economy. SPEI changes within the project target areas are shown below with trend slope and p-values accordingly.

Time-scale of 3 months – SPEI3

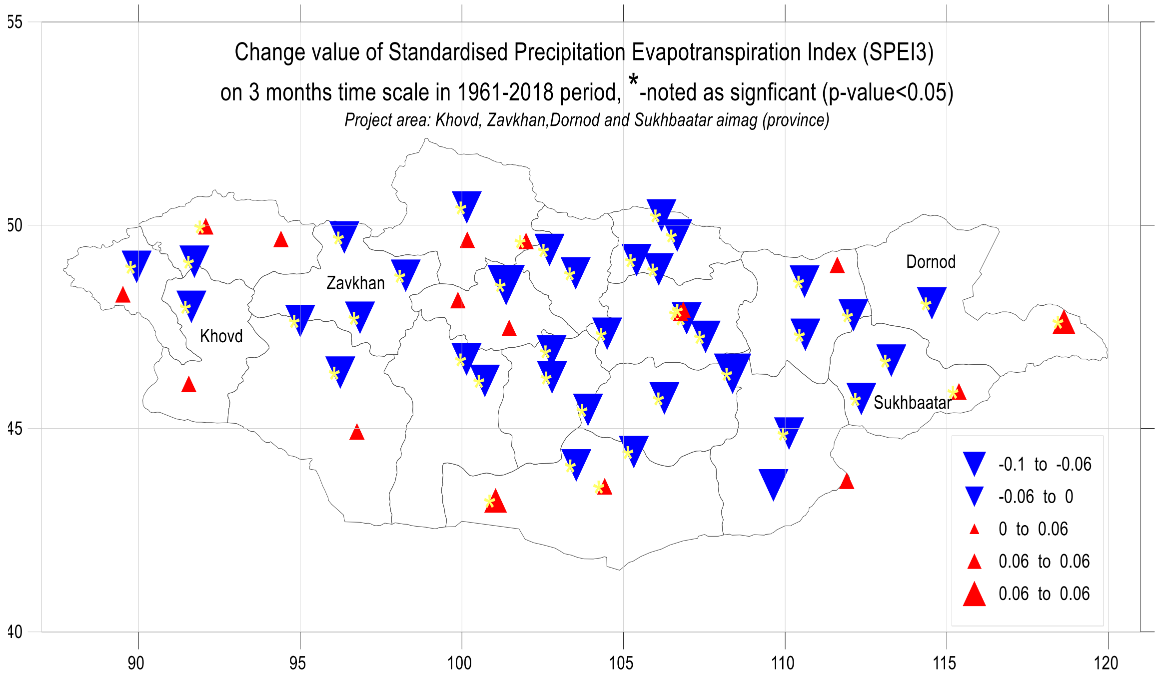


Figure 20 SPEI3 change

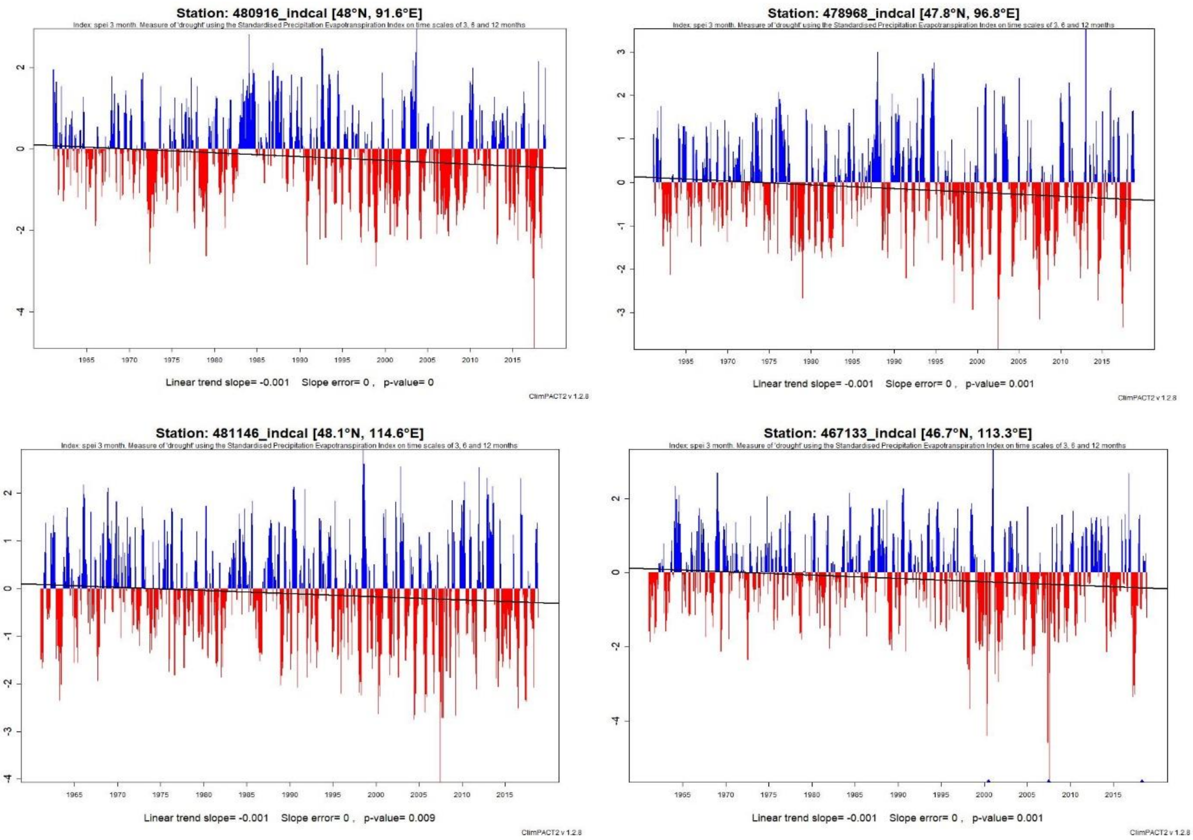


Figure 21. SPEI3 change in Khovd (480916), Zavkhan (478968), Dornod (481146) and Sukhbaatar aimag (467133), 1961-2018

Time-scale of 6 months - SPEI6

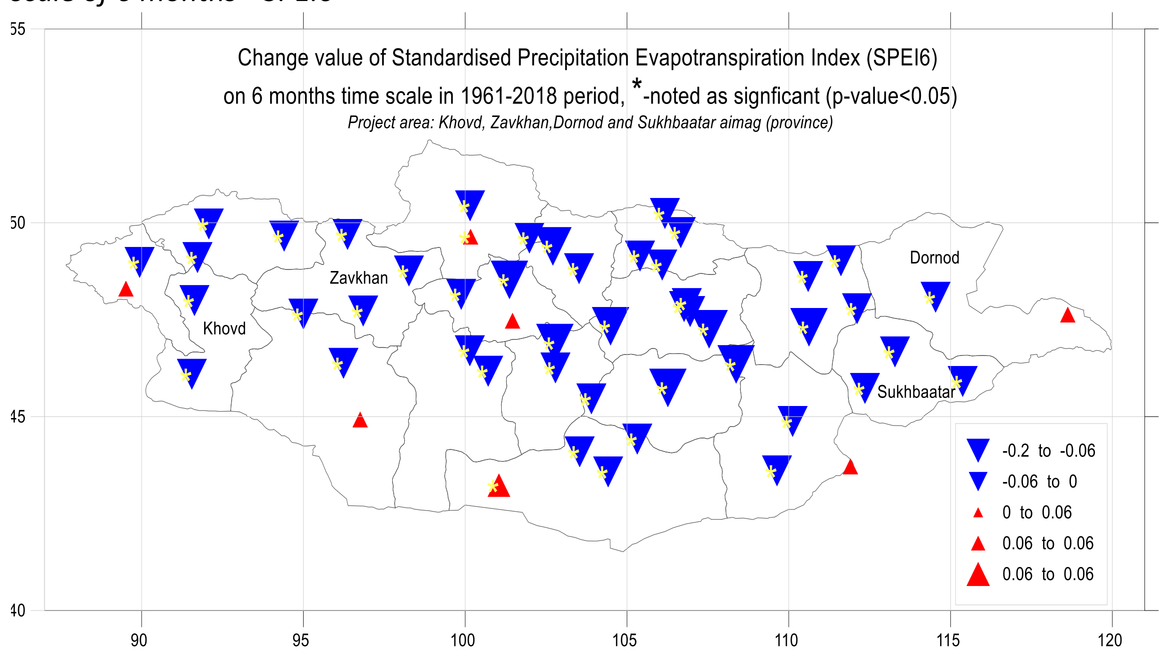


Figure 22. SPEI6 change

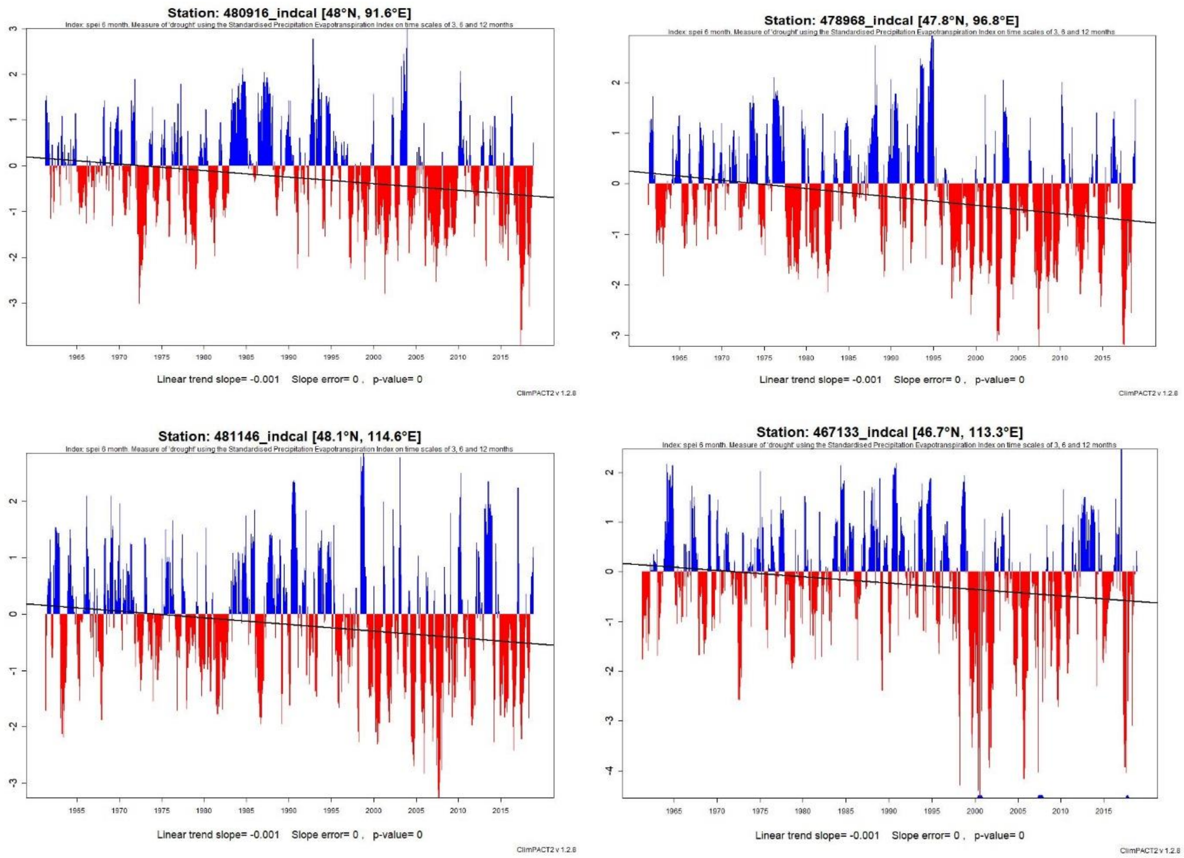


Figure 23 SPEI6 change in Khovd (480916), Zavkhan (478968), Dornod (481146) and Sukhbaatar aimag (467133), 1961-2018

Time-scale of 12 months – SPEI12

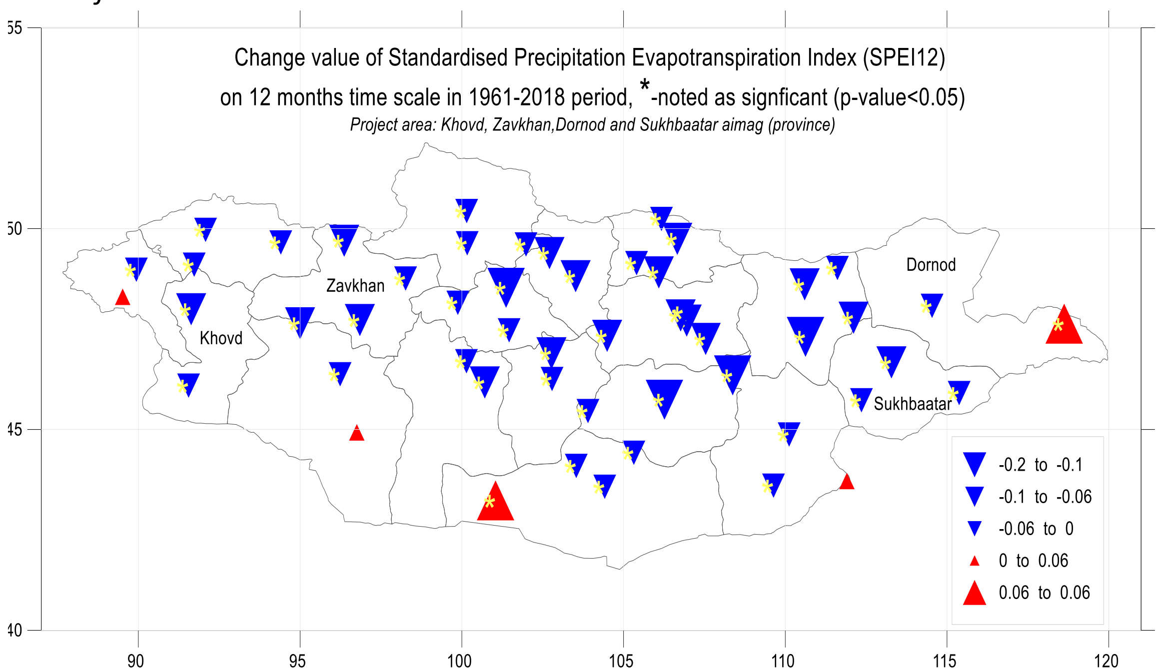


Figure 24 SPEI12 change

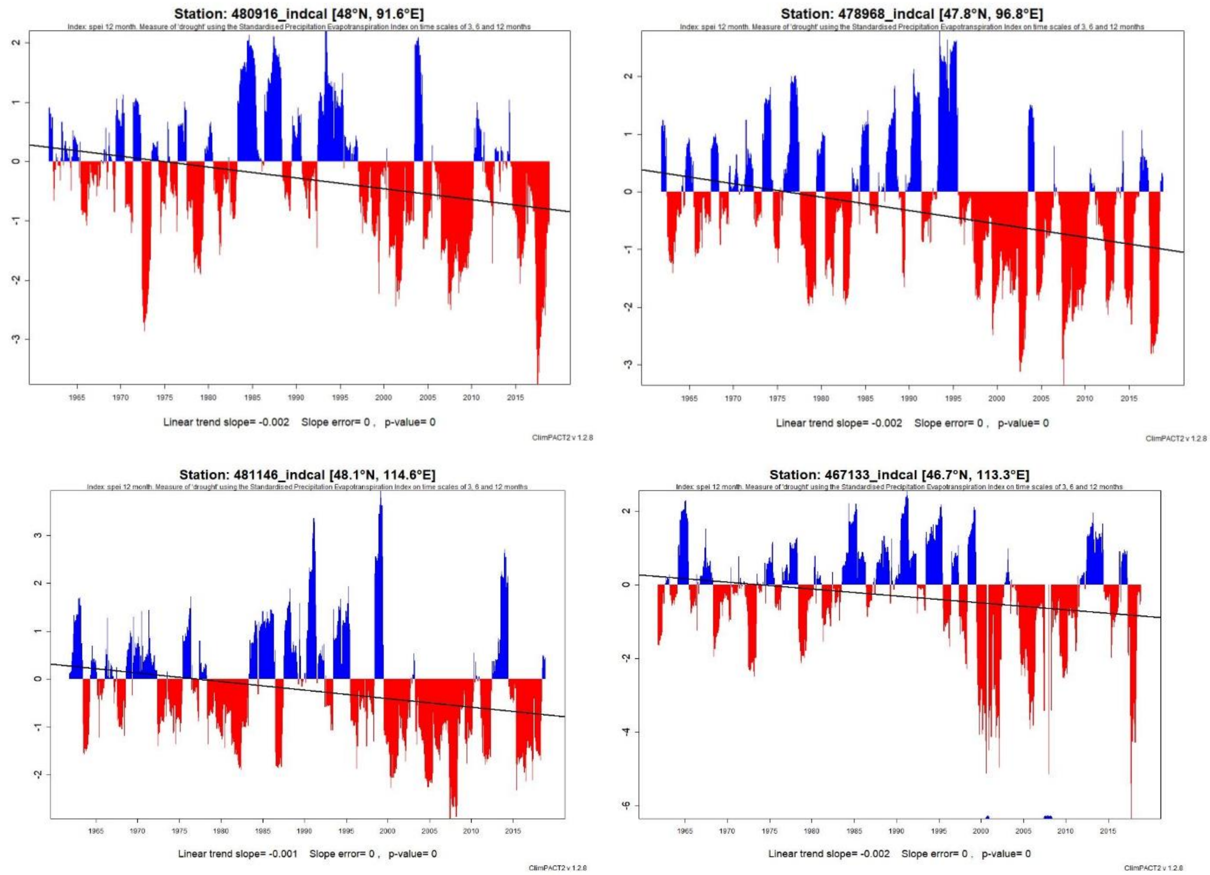


Figure 25 SPEI12 change in Khovd (480916), Zavkhan (478968), Dornod (481146) and Sukhbaatar aimag (467133), 1961-2018

m) Precipitation and evaporation in summmer (June-September)

Summer season (JJA) precipitation and potential evapotranspiration were estimated by Thornthwaite method as represented in Figure 26 for each of the target provinces. Whilst cold season (November to March) evapotranspiration (not shown) is near zero as air temperature is constantly significantly less than -5ºC, high evapotranspiration during JJA affects water supply for pastures to grow and hence drought conditions can develop causing limited biomass availability. There are clear increases in evapotranspiration post 1961 in all four provinces (statistically significant at the 99% confidence level or higher) and this is coupled with reduced precipitation in all 4 aimags (statistically significantly at 96.5% confidence level in Dornod aimag). Over the whole of Mongolia JJA rainfall has been decreasing (at >99% confidence level) and potential evapotranspiration increasing (also at >99% confidence level). These trends of decreasing precipitation and increasing evapotranspiration are consistent with the trends in SPEI for increased drought, as previously shown (Figures 20-25).

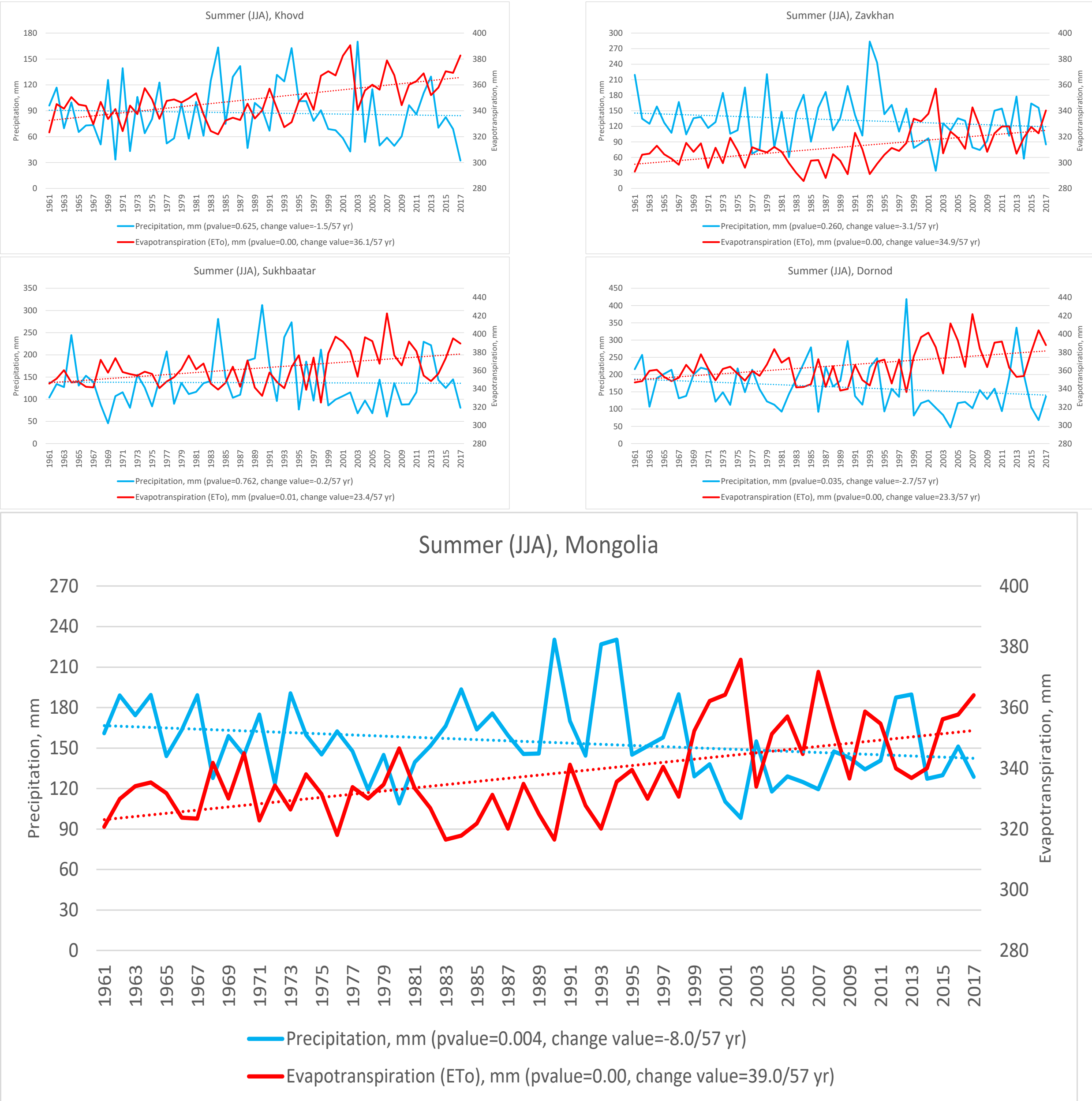


Figure 26 Warm season precipitation and evapotranspiration change in a) Khovd b) Zavkhan c) Sukhbaatar d) Dornod, provinces and e) whole of Mongolia, 1961-2017

n) Changes in summer and winter precipitation and temperature within target provinces

Temporal variation of winter and summer temperature, as well as precipitation are provided below for target provinces (Figures 27-30). The precipitation measurements in Zavkhan and Sukhbaatar aimags were digitized since 1961, which can be seen from the respective graphs. Winter temperature warming is consistent for all provinces, as with the national average. The same with winter precipitation increase which is consistent for all target provinces, except for Khovd Province, where a nominal decrease in winter precipitation and nominal increase in summer precipitation can be observed.

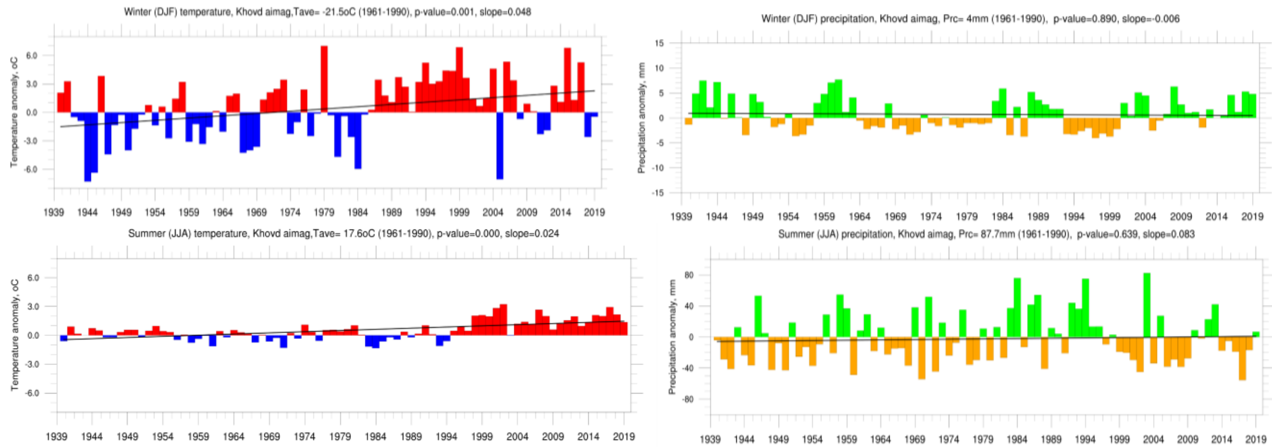


Figure 27 Change in winter and summer precipitation and temperature in Khovd Province a) winter temperature b) winter precipitation c) summer temperature and d) summer precipitation

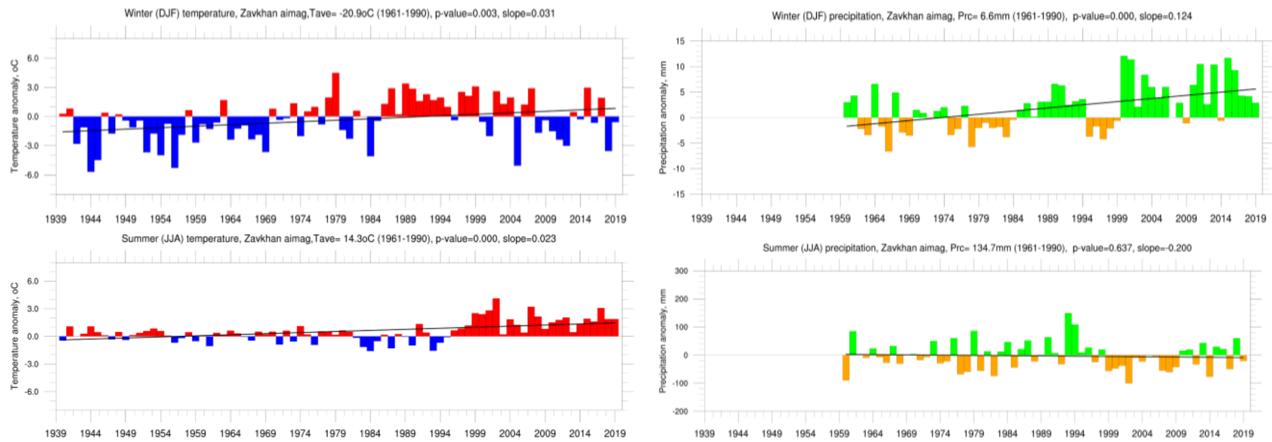


Figure 28 Change in winter and summer precipitation and temperature in Zavkhan Province, a) winter temperature b) winter precipitation c) summer temperature and d) summer precipitation

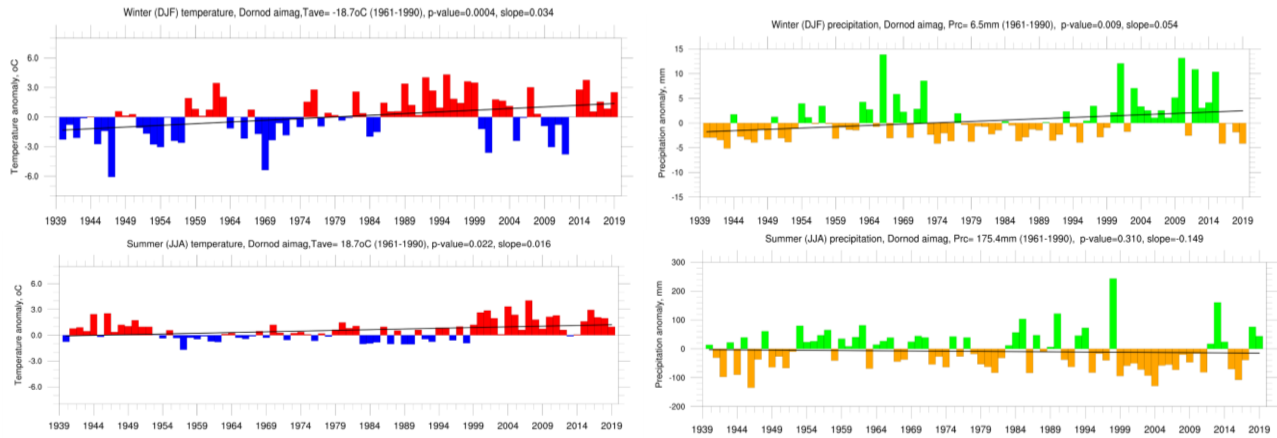


Figure 29 Change in winter and summer precipitation and temperature in Dornod Province, a) winter temperature b) winter precipitation c) summer temperature and d) summer precipitation

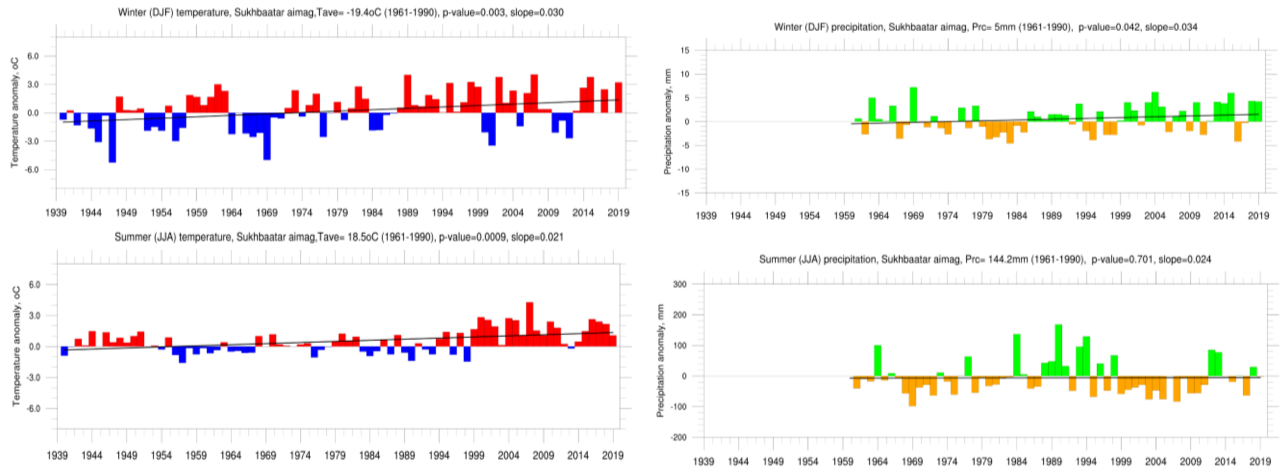


Figure 30 Change in winter and summer precipitation and temperature in Sukhbaatar Province, a) winter temperature b) winter precipitation c) summer temperature and d) summer precipitation

Impact on pastureland conditions and land cover changes

Semi-arid rangeland systems such as Mongolia's steppe ecosystems, are very fragile and vulnerable to external disturbances. The observed pastureland degradation is not solely due to climate change impacts, it is also due to manmade pressures associated with overgrazing by exceptionally high number of animals exceeding pastureland carrying capacity. Mining concessions with poor rehabilitation practices and crop farming using obsolete technologies contribute to a limited extent. The grassland species have shifted in composition due to increasing temperature, declining moisture for plant growth (SPEI), high grazing intensity, or a combination of these factors.

The land cover change maps with 15 years gap (2000-2015) clearly indicate degradation of pastureland quality within the target provinces, with increased portion of scrublands and dry steppe shifting from mostly steppe and mountain steppe landscapes (Figure 31). It should be noted that NDVI was not used for such analysis prior to 2000 in Mongolia. The land cover map is based on NDVI time series of particular year, from which the map is produced using Principal Component Analysis (PCA). Base iso-cluster is derived from Component 1 used to generate the phenology curve per calendar day. The phenology value ranging between 0.18-0.42 during the calendar year is classified as steppe. Closer the phenology value to 0.05 or desert steppe and desert type, the pixels are considered showing dryness or drier types of landcover.

Within the same period, the grazing pressure had increased significantly due to steep increase of animal numbers (See Figure 33 for grazing pressure increase and Figure 53 for animal number increase nationally and within the target provinces for the period of 1980-2019). It is to be noted that the livestock number was not yet posing a great threat to a grazing land until 2000 across the country. The total number of livestock was only 30 Mln in 2000, compared to the current 71 Mln (2019). Similarly, the livestock number increased from 6.1 Mln in 2000 to 13.4 Mln in 2019 for four target provinces. Significant territories within the target provinces are classified as moderately to severely degraded already, as of 2015 (Figure 32). Generally, SPEI and grazing were important drivers of plant species composition in both ecozones, with climate change estimated to present a greater impact than grazing pressure. According to the National report on pastureland health [44], plant species composition in 65% of Mongolia’s pastureland area has changed to a certain extent, mainly with decline in number of perennial species palatable to livestock and increase in unpalatable annual ruderal (forbs) species. Some of the palatable species in the mountains steppe for example, sampled in 1994 and 1995 did not appear at all in the 2013 samples. These are the characteristics that NDVI cannot illustrate, *i.e*. degradation of grazing land quality. A general hypothesis of climate change having a greater impact than animal grazing on plant species composition has been fully supported by comparative research findings across three different steppe ecosystems in Mongolia conducted jointly with Colorado State University [45].

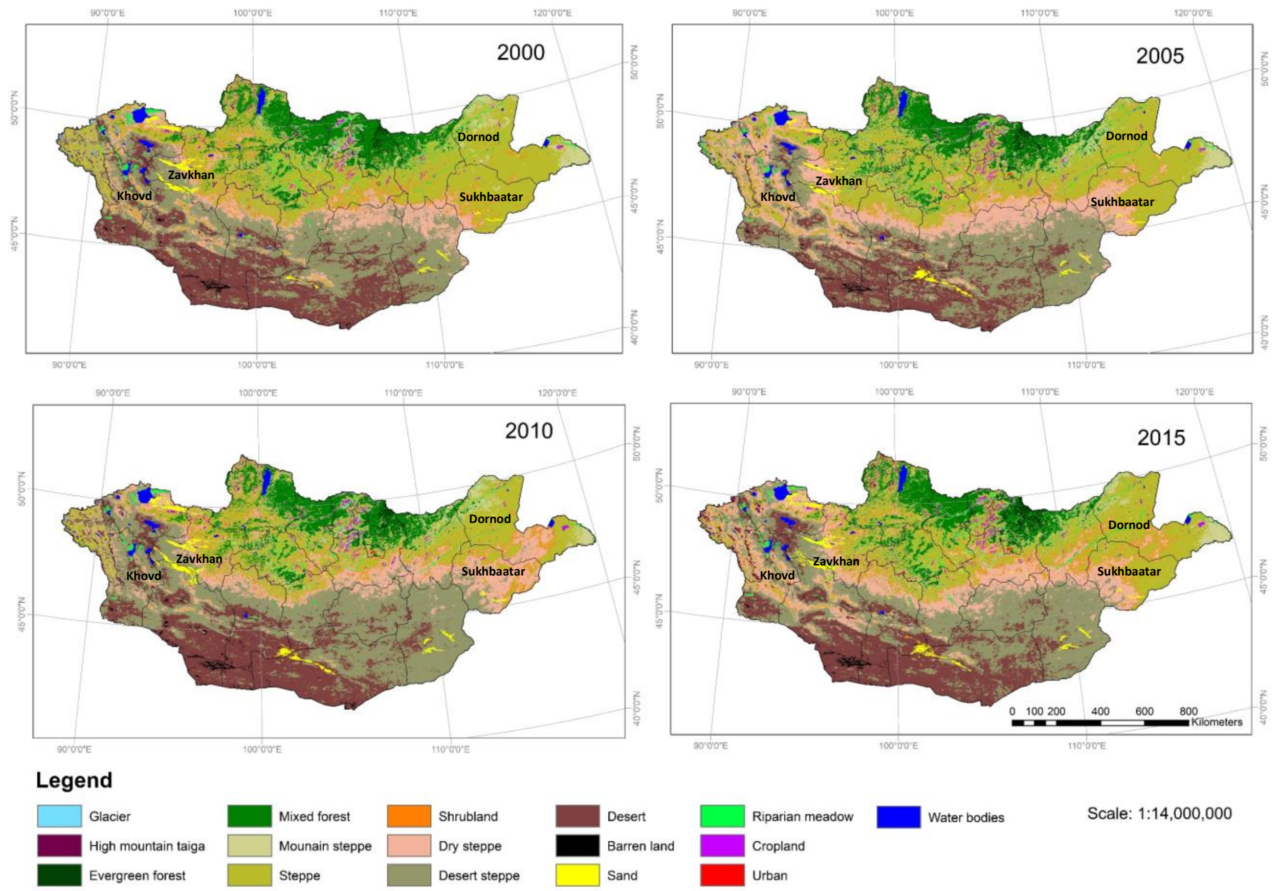


Figure 31 Land cover map for the period of 2000- 2015 (S. Khudulmur)

It is difficult to exactly determine the climate and human-induced factors to (pasture) land degradation, although climate change is estimated to have prevailing impact. A general hypothesis of climate change having a greater impact than animal grazing on plant species composition has been fully supported by comparative research findings across three different steppe ecosystems in Mongolia conducted jointly with Colorado State University [45]. This was a result of 20 years of continuous research on combined and interacting effects of climate and grazing in mountain steppe, steppe and desert steppe ecosystems. Furthermore, other researchers confirm the study findings that climate variability (Wesche et al. 2010) and climate change (Klein et al. 2007, Cheng et al. 2011) effects in Mongolian and other high latitude and altitude rangelands are stronger than grazing influences. Mongolia’s Vision 2050 document that was just approved, refers to an estimation by academic community indicating that 49% of land degradation is likely caused by human activity and 51% by natural factors, i.e. climate change.

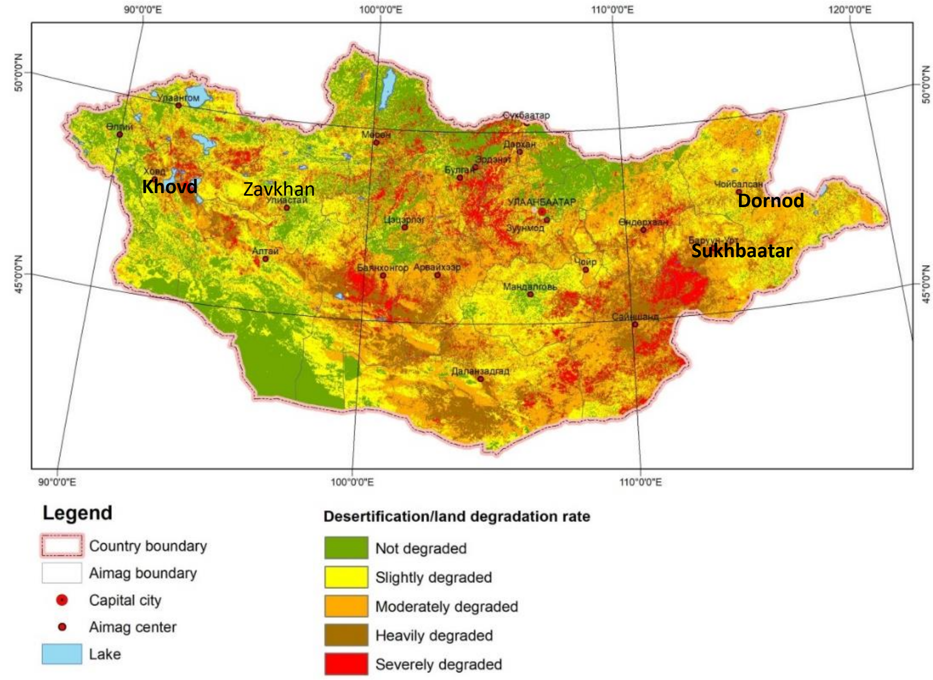


Figure 32. Desertification and land degradation in Mongolia, 2015 (N. Mandakh)

From the map on change in grazing pressure over the territory of Mongolia (see Figure 33), it can be seen that the project target areas experienced increase of animals grazing over per unit of pastureland between 100-200% and Khovd up to 50% in sheep units. Desertification and land degradation map of 2015 shows significant territories in western and eastern regions of the country, where target provinces are located, are classified as from moderately to severely degraded. Land degradation is therefore considered as a combined effects of anthropogenic factor or extensive grazing over carrying capacity of land and the natural factor or changing climate.

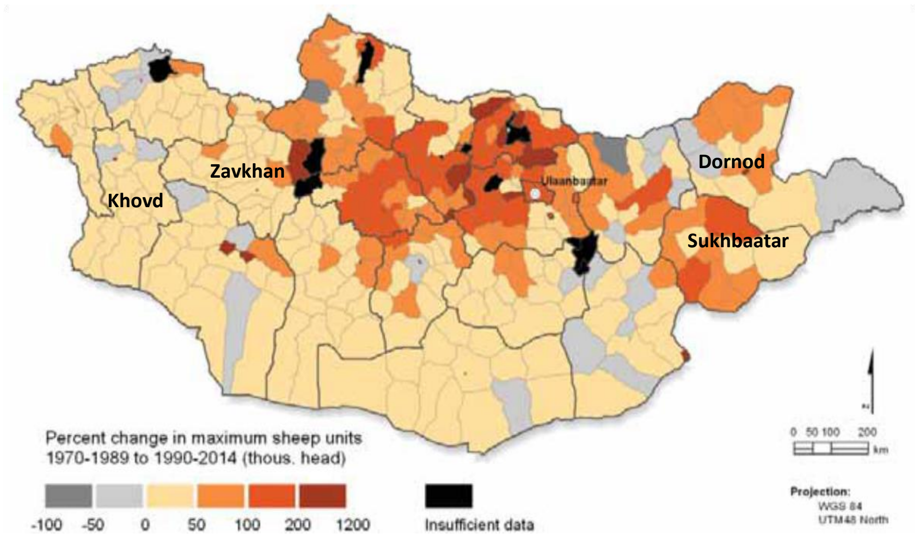


Figure 33 The percentage change in the maximum number of sheep of units observed in years 1970-1989 to the 1990-2014 period, based on data from the Mongolian Statistical Office

Projection estimated by the year 2035 under moderate and high level of grazing pressure scenarios show a rapid decrease of all basic parameters of soil and pasture (see Figure 34), including soil organic carbon, organic nitrogen and above and below ground biomass. Particularly, a sharp reduction is expected of above and below- ground biomass by about 50-80% by 2035.This result demonstrates how harmful the excessive pressure on grazing land is on soil and pasture productivity.

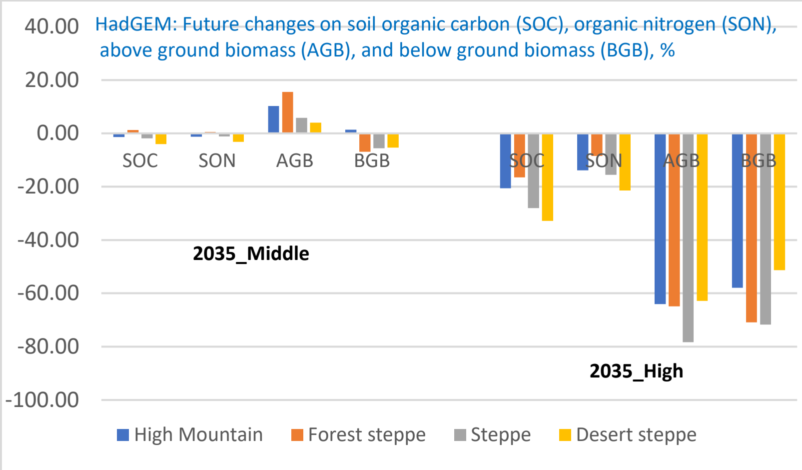


Figure 34 Future changes of some parameters of soil and plants, % (outputs of RegCM4-HadGEM2 models for 2035, pasture use level-under moderate and high scenarios)

1.2.3. Projected climate change impacts

Methodology and assumptions

In the recent years, climate projection research in Mongolia is progressing in the following areas: global climate model results using regional dynamic models, atmosphere and land cover interaction assessment. Regional dynamic downscaling is carried out using regional climate model RegCM3 on the global climate model results to identify region-specific historical trends and to estimate the future climate trends [1]. More specifically, the climate change projection over Mongolia uses an ensemble mean of 10 global climate model (ensemble mean) outputs, which have less error when estimating the past climate. The results of the GCM are the constant increase of temperature in all seasons, an increase of precipitation by a much higher percent in winter, and almost no change in the summer. The high-intensity of the above-mentioned temperature change is projected in the western and eastern parts of the country in winter and in the western part in the summer. There will be greater increases in winter precipitation in the central, western and eastern parts; precipitation will increase in the western regions, as presented below using climate extreme indices. However, to have a better projection of temperature and precipitation, there is a need to downscale the spatial resolution of the projection from the global scale to 10-20 km using the regional climate model. Once downscaled, extreme weather and climate events and trends are analyzed and used to estimate the impact and risks of those events at regional and local levels.

Climate change projections over Mongolia

The IPCC Fifth Assessment Report (AR5) [18] has developed trajectory models using different levels of GHG concentration. Mongolia uses these statistical models to identify future gas trajectories and simulate future scenarios. These pathways describe four possible climate futures, all of which are considered possible depending on the amount of greenhouse gas emissions in the years to come. The four RCPs are RCP2.6, RCP4.5, RCP6, RCP8.5, and are named after a possible range of radiative forcing values in the year 2100 relative to pre-industrial value. Among the RCP scenarios, the RCP 2.6, RCP 4.5 and RCP 8.5, scenarios were selected and estimated the intra-annual change of winter and summer temperature and precipitation over Mongolia for the period from 2016 to 2100 with respect to the 1986-2005 reference periods. Generally, the intensity of temperature change directly depends on the increasing intensity of GHG concentration. However, winter intensity and intra-annual change are a bit higher than summer intensity. In terms of the change of the spatial pattern, the climate change projection over Mongolia in the near future (2016-2035) is shown in Figures 35-36 and far future (2081-2100) in Figures 41 and 42 for winter and summer temperature and precipitation. The projected changes are tabulated below (Table 2) Here only RCP4.5 or Business as Usual (BAU) scenarios are shown because generally all spatial patterns are similar, and the only difference is the intensity.

Downscaled projections from global to regional scales (covering the whole territory of Mongolia) using RegCM4 nested within HadGEM2 are simulated for temperature and precipitation change in near future, covering the period of 2016-2035 under the RCP4.5 scenario (BAU). The simulated changes for the whole of Mongolia are shown below (Figure 35 and 36) demonstrating increases in temperature across all four seasons, except the negative anomalies in south of the country, representing the very dry Gobi desert. Annual changes in precipitation are mixed except for the summer (June-August) with expected decrease everywhere except for the far south of the country.

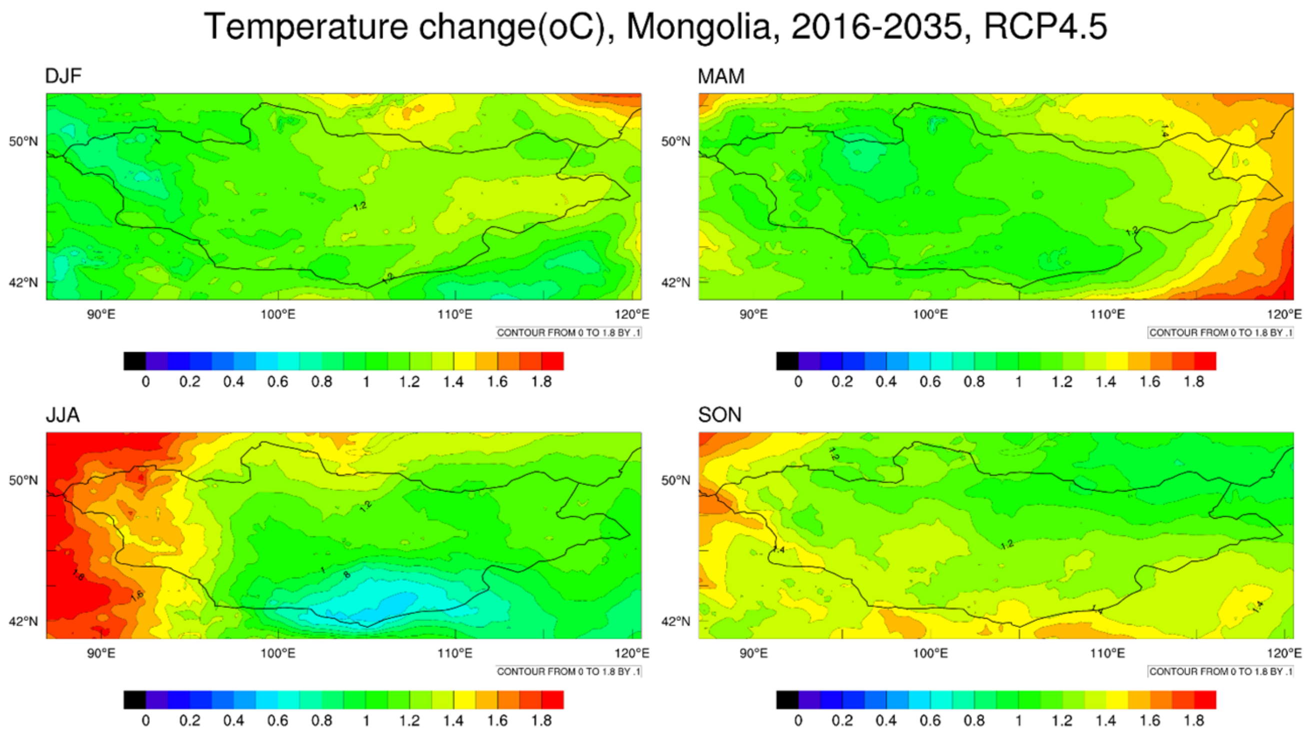


Figure 35 Spatial pattern of projected temperature change, °C, a) winter b) Spring c) summer and d) winter

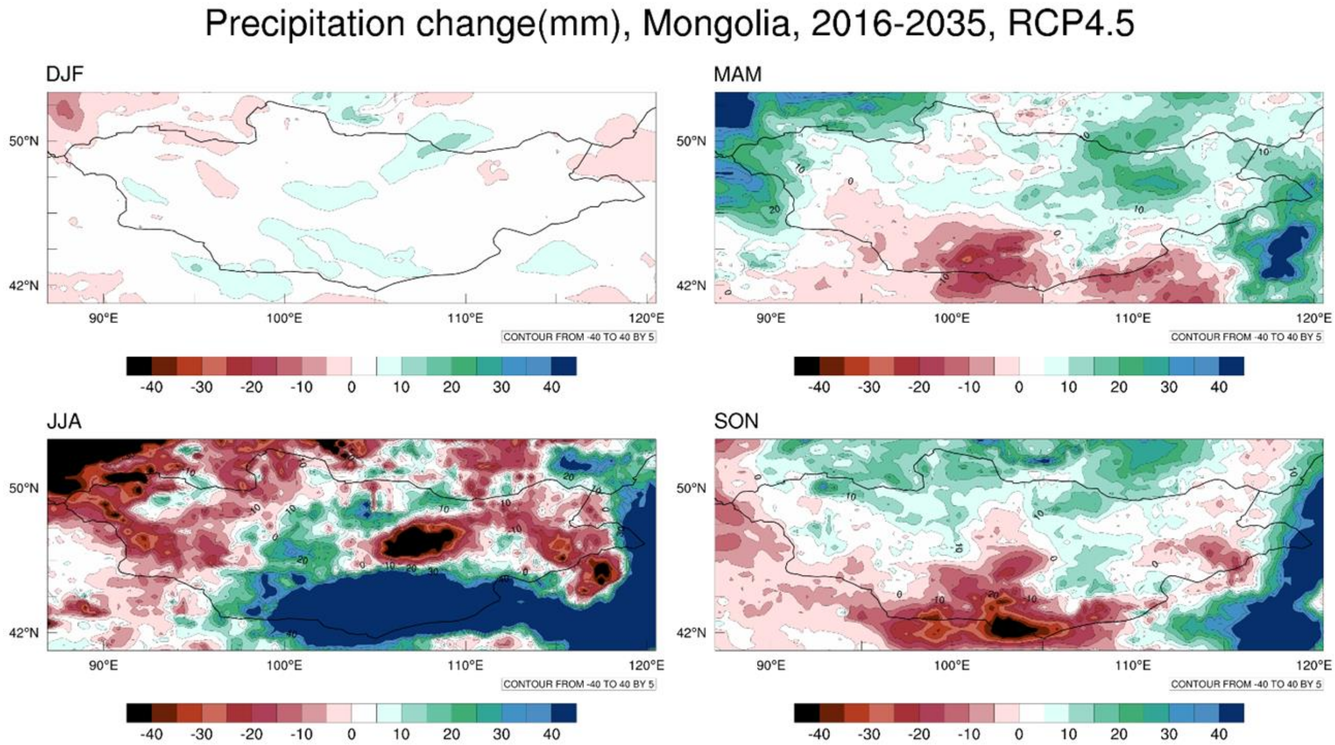


Figure 36. Spatial pattern of projected precipitation change, mms, a) winter b) Spring c) summer and d) winter

When simulations are further downscaled for the target provinces Downscaled projections for each aimag (Khovd, Zavkhan, Sukhbaatar, Dornod) are shown in following Figures for the same periods. The results are similar to those described above, with increasing temperatures and decreasing precipitation during summer season. In Sukhbaatar and Dornod aimags there is also evidence for decreasing precipitation at the end of summer or during autumn (Figures 38-39 and Figures 29-30).

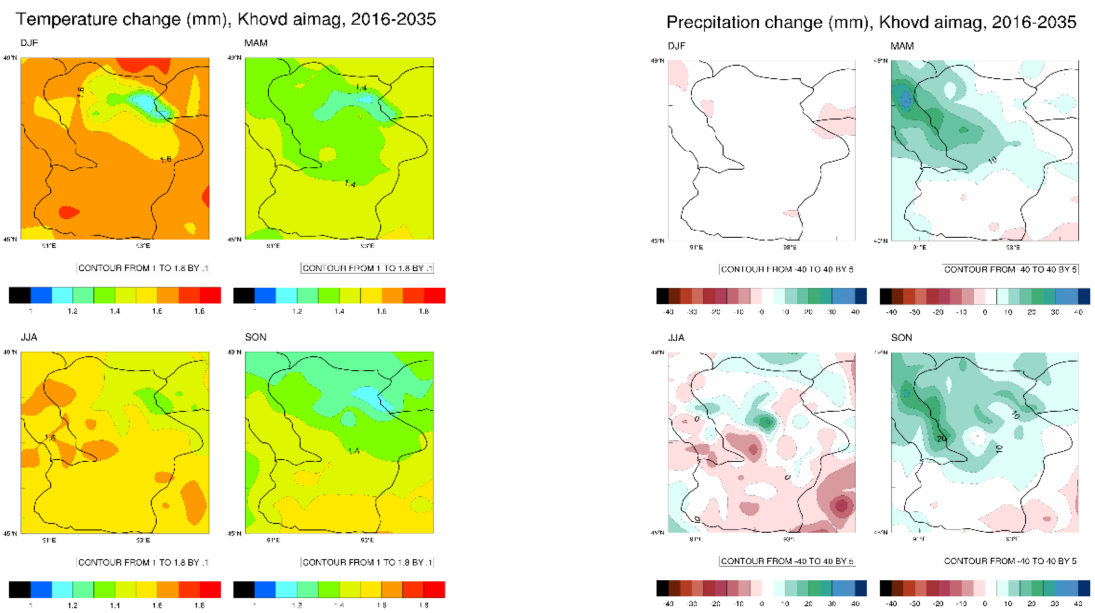


Figure 37 Spatial pattern of projected a) temperature change, ^{0}C and b) precipitation change by four seasons in target area, Khovd province (2016-2035)

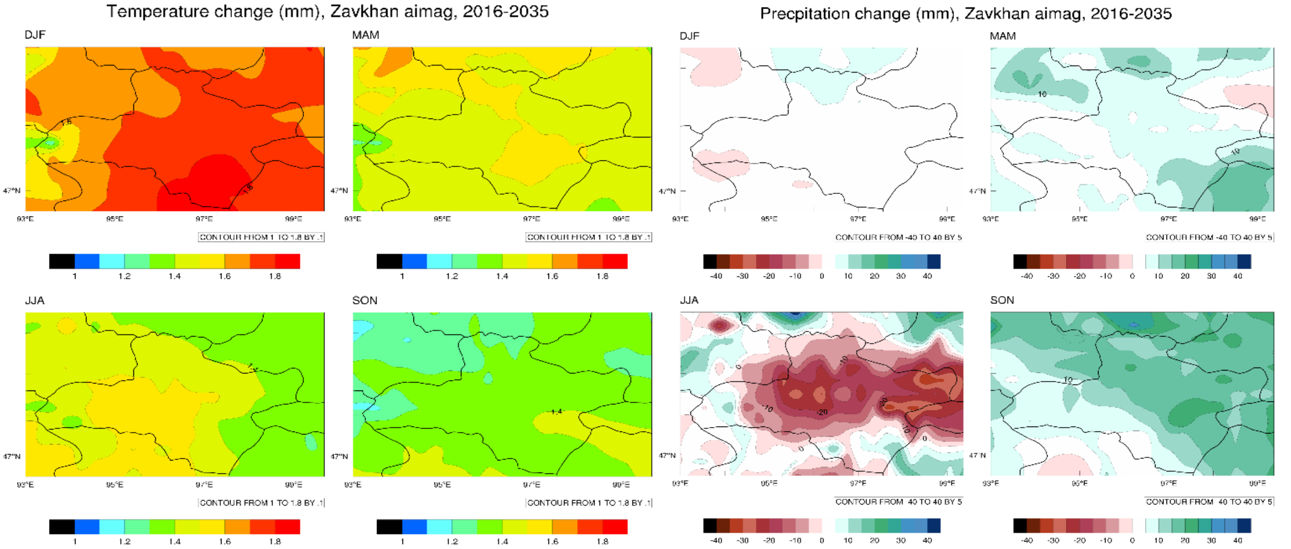


Figure 38 Spatial pattern of projected a) temperature change, ^{0}C and b) precipitation change by four seasons in target area, Zavkhan province (2016-2035)

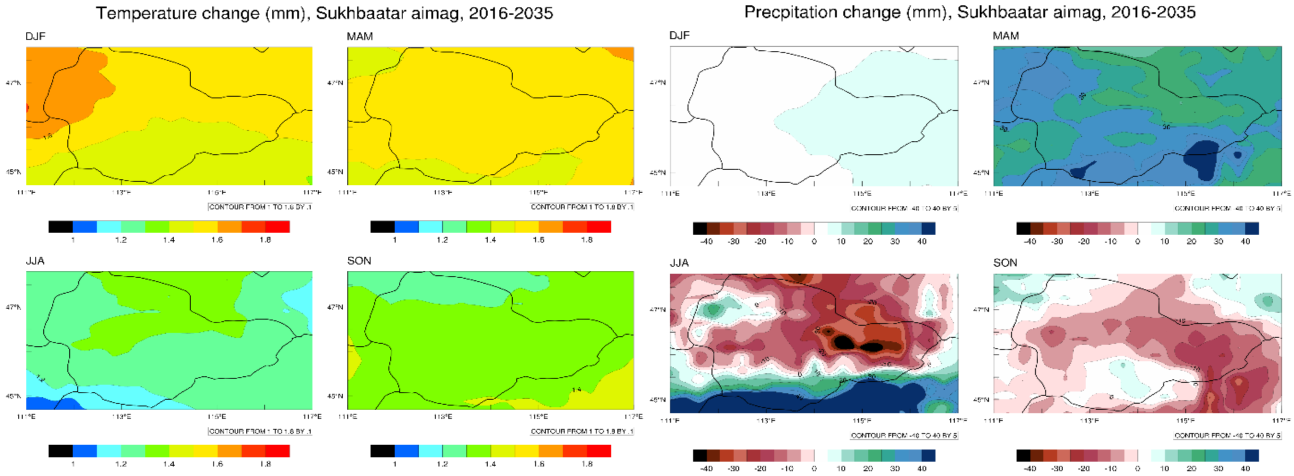


Figure 39 Spatial pattern of projected a) temperature change, ^{0}C and b) precipitation change by four seasons in target area, Sukhbaatar province (2016-2035)

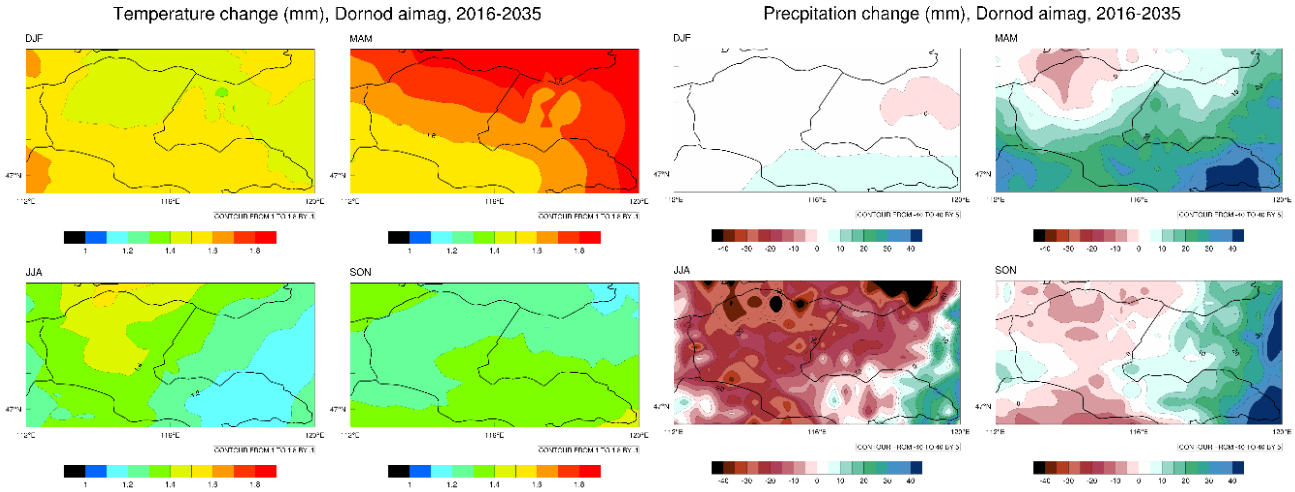


Figure 40 Spatial pattern of projected a) temperature change, ^{0}C and b) precipitation change by four seasons in target area, Dornod province (2016-2035)

The climate change projection assessment of the country is similar to the previous projection assessment based on IPCC AR4 in terms of general trends. All seasonal change values of the climate change projection in the near future (2016-2035) and far future (2081-2100) over Mongolia are shown for every RCP scenario (RCP2.6, RCP4.5, and RCP8.5) in Table 2.

Table 2. Seasonal climate change over Mongolia under different GHG scenarios (by ensemble mean of 10 GCMs)

GHG emission	Season	Near future, 2016-2035		Far future, 2081-2100	
		Temperature change,⁰C	Precipitation change, %	Temperature change,⁰C	Precipitation change, %
RCP2.6	Winter	2.3	10.1	2.5	15.5
	Spring	2.3	9.2	2.4	11.7
	Summer	2.2	6.2	2.5	5.1
	Autumn	2.1	7.6	2.4	7.6
RCP4.5	Winter	2.1	12.3	3.7	28.7
	Spring	2.0	7.8	3.4	17.4
	Summer	2.1	1.1	3.5	7.8
	Autumn	2.0	8.1	3.4	11.7
RCP8.5	Winter	2.2	14.0	6.3	50.2
	Spring	2.2	9.8	5.6	28.6
	Summer	2.2	2.4	6.0	8.7
	Autumn	2.2	6.4	6.1	24.1

1.2.4. Medium to long-term impacts of climate change

Change in weather and other extreme events

Mongolia is affected by various natural and anthropogenic disasters. In Mongolia, climate-induced disasters occur 51 times per year on average. If we divide the last 20 years into two decades, the climate-related disasters averaged approximately 45 per year in the first decade, and that number has increased by 1.5 times in the last decade. Excluding drought and dzud, 15 types of atmospheric disasters where registered in Mongolia [1]. The annual average occurrences of the most frequent extreme phenomena are strong winds and storms, thunderstorms, lightning, squalls, hails, high rains, high snows, frost surface, wet snow and other minor extreme events (Table 3). Also, it should be noted that due to high temperatures and low rainfalls, the occurrence of large forest fires has increased (see Figure 41), averaging 160 per year. The frequency increases significantly in Mongolia during the period 1989-2013.

Table 3. Occurrence of hydrometeorological extreme events over territory of Mongolia, 2001-2015

Extreme events	Wind storm	High snow	High rain	Wind squall	Shower rain and flush	Hail	Thunderstor-	Frost	Cold rain	Wet snow	Spring flood	Avalanche	Forest and steppe fire
Occurrence in year (average in year)	15	3	3	8	15	4	10	3	1	2	2	1	181

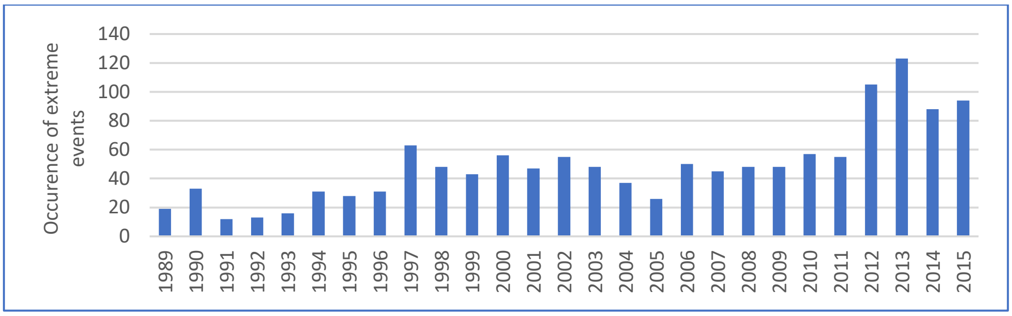


Figure 41 Frequency of hydrometeorological extreme and disastrous events in Mongolia, 1989-2015 (drought and zud are not included)

The observation data over the past 30 years showed that the number of extremely cold days has gone from 8 to 27 days, the growing season has extended from 5 to 24 days, and the number of hot days (26°C and above) has extended from 5 to 28 days as illustrated in previous subsections on climate extreme indices. Some extreme events such as strong winds, snow and dust storms, high rain, high snow, freezing rain, wet snow and surface frost cover large areas of territory and may persist for a long period of time. Therefore, they cause severe damage to the agricultural and livestock sectors. Convective phenomena, which persist comparatively for a short/medium time and cover small areas of territory, include squalls, hail, lightning, thunderstorms and flash floods, and they represent 53.3% of the total atmospheric disasters. Among those phenomena, flash floods comprise 41.1% and are the dominant extreme event following high rain with thunderstorm. A number of studies show that the atmospheric disasters (especially convective disasters) are expected to rapidly increase [43]. In Mongolia, squalls, hail, lightning, thunderstorms and flash floods, and other hazardous events have doubled in the last two decades.

Furthermore, research shows that the percentage of thunderstorms has increased in frequency and intensity and has led to an increase of daily rainfall amount [21]. The number of extreme events have increased dramatically in the recent years and are responsible for an increase in the number of deaths of livestock and people in rural areas.

Losses and damages caused by hydrometeorological hazards
Due to extreme weather events, 412 people and 24.5 million livestock were killed in the last 11 years, with a total economic damage of MNT562.7 billion. During the winter of 2009-2010, almost the entire territory of Mongolia experienced excessive snow and persistently cold temperatures that caused the harshest winter conditions, named winter dzud. The 2009-2010 winter dzud affected 80.9% of the total territory (175 soums from 18 provinces). In terms of its extent and damage, this dzud was more disastrous than those in recent years. Nationwide, during the 2009-2010 dzud, 22.4% of total livestock (9.7 million) were lost resulting in economic damage equivalent of 4% of country’s GDP and that comprises 93% of the total damage of the last 11 years. Unfortunately, the years 2009 and 2010 were the worst years for human death caused by natural disasters.

Long-term trends of extreme weather events in Mongolia
Major long-term extreme weather/climate phenomena are droughts in spring-summer season and dzud (severe weather condition) in the winter-spring season. Figure 42 presents projections of drought and dzud indexes in comparison with current climate conditions during the period of 2016-2100 for scenarios RCP4.5 and RCP8.5 in Mongolia. The projections show that the intensity of those two long-term indices will increase over the period 2016-2100, and in particular, the drought index will increase significantly.

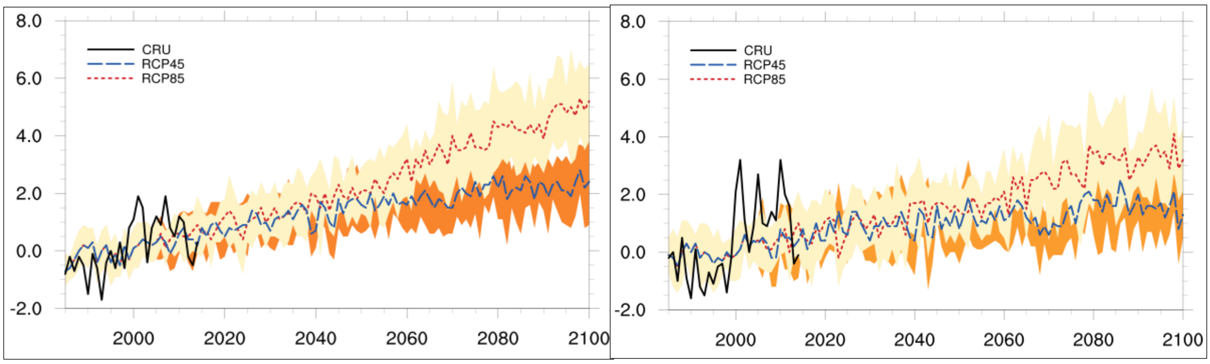


Figure 42 Changes of indexes of summer drought (PDI, left) and dzud (DZI, right) in comparison with current climate (1986-2015) condition under the RCP4.5 and RCP8.5 scenarios for the territory of Mongolia

1.2.5. Vulnerability of lives and livelihoods to climate change impacts

Increased intensity and frequency of natural disasters induced by climate change has not only impacted the livelihood of rural populations but also poses a greater threat to the society and economy of the country. Due to the consequences of drought and dzud, people might be exposed to a risk of malnutrition [22]. In addition, natural disasters and dzuds affect the daily life of people, especially the most vulnerable [12]. Although poverty alone does not necessarily make people vulnerable to weather events and climate, at the individual or rural level, it deepens the dependency on natural resources and any related changes.

With herder livelihoods becoming increasingly difficult or risky, climatic change is contributing to the rural-urban migration due to the loss of permanent income sources such as livestock and rural jobs [1]. Many herders from the countryside settle in the outskirts of Ulaanbaatar, often without access to power or water, introducing a host of other development challenges. Increases in frequency of natural disasters can cause death, distress and homelessness and disrupt the supply of essential medical and health services. Furthermore, the negative effects of climate change will increase frequencies of diseases, including cardiovascular and respiratory diseases such as asthma.

Vulnerability of livestock and herders

In Mongolia, livestock are key assets for poor people, providing multiple economic, social, and risk management functions. The impacts that climate change will bring about are expected to exacerbate the vulnerability of livestock and herders. For rural communities, losing livestock assets might lead to the collapse into chronic poverty with long-term effects on their livelihoods [23].

Among the direct consequences of climate change, for example, will be altered temperature and rainfall patterns, translating to an increased spread of existing vector-borne diseases and macro parasites of animals as well as the emergence and spread of new diseases [24]. Some of the indirect effects, for example, will be brought about by changes in feed resources and in particular the potential shortage of feed especially during the winter period. This shortage indirectly increased the vulnerability of herders and livestock to climate extremes [24]. Four mass mortality events have occurred since 1999 and have thrown many Mongolians into a period of great economic hardship and poverty.

Dzud is the Mongolia-specific term for a combination of summer drought (a combination of reduced rainfall and increased temperatures) and harsh winters (increased snowfall and reduced temperatures) that deprives livestock of grazing and the animals die of starvation. In 2009, the winter snow covered 90% of Mongolian territory. At the end of April 2010, about 22% of Mongolia's livestock died (over 10 million animals), severely threatening over 200 thousand rural herders living in the most affected regions. Depending on their cause, dzuds can be categorized as white or black. White dzud is mainly caused by high snowfall, with an average depth of snow on pasture land from above 21 cm in the mountain areas, to above 10 cm in semi-desert regions. Black dzud is due to shortage of water during summer followed by lack of snow during winter. White dzud occurs once every second year in the Tes river basin, once every third year in the mountain regions of Khangai, Khentei, Khankhokhii, Kharkhiraa, and Turgen, and once or twice every 10 years in the hilly mountainous region at the foothills of the Altai, Khangai, Khuvsgul and Khentii ranges [30]. However, the most exposed are herders and livestock located in the areas with limited access to winter fodder supplies, water and shelters for animals and high frequency of dzuds. In Mongolia, though winter snowfall amounts have been increasing, winter temperatures have also been increasing since 1940 as it was illustrated using climate extreme indices above. Nevertheless, there is an increasing frequency of harsh winters (combination of high snowfall and low temperatures) since the start of the new millennium [1].

Water stress is expected to increase towards the end of the century. As per projection for the period of 2086-2100, the annual mean (Apr-Oct) evaporation from open surface of water and evapotranspiration are expected drastically increase that will lead to an imbalance of water, drying effect will be prevailing in river basins (See Figure 43). This is greater than the rate of increase in winter precipitation.

Vulnerability and exposure to rapid onset disasters
Decreased summer precipitation in Mongolia with non-frequent rainfalls would increase risks of desertification [25]. Increased high snowfall events in winter season would cause added stresses on traditional livestock husbandry and other economic sectors. Climate change will have greater impacts on sectors that are more exposed to weather events, such as water, agriculture, livestock, food security, forestry, and tourism. The major disasters can be ranked by social-economic risks as follows - drought, dzud, forest fires, snow and dust storms, floods and cold surges. In the past 10 years, economic losses from natural disasters have risen from 10 to 14 times when compared to the previous decade [41].

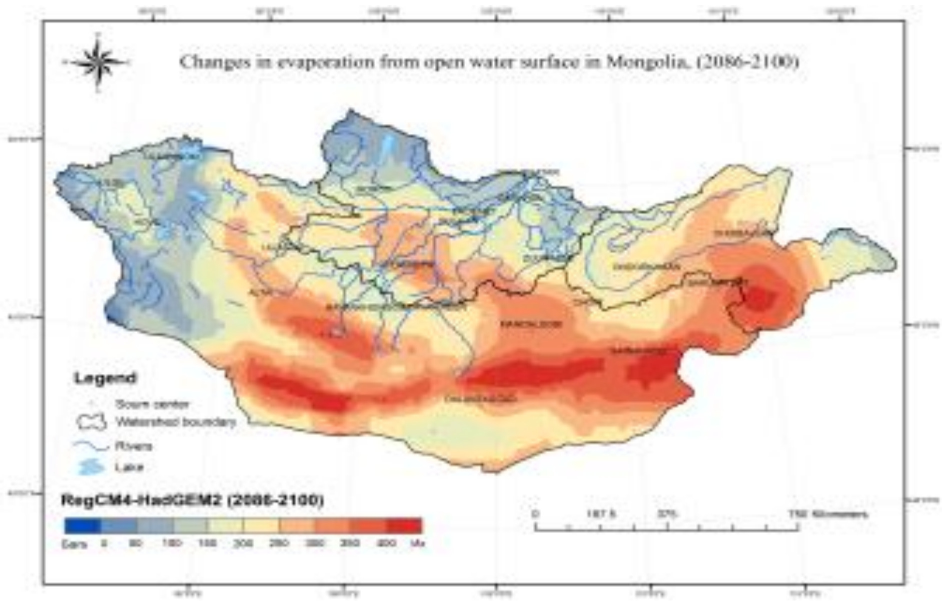


Figure 43 Spatial distribution of annual mean (Apr-Oct) evaporation from open surface of water and its changes, projected by RegCM4-HadGEM2 models

Some extreme events such as strong winds, snow and dust storms, high rain, high snow, freezing rain, wet snow and surface frost cover large areas of territory and may persist for a long time. Due to climate change impacts, those extreme events are expected to increase in time and space distributions in the future [1].

Analysis of data between 1963-2015 shows that a occurrence of forest and steppe fire incidences and size of fire affected area have a relatively strong correlation (0.62) with drought index (see Figure 44). Their negative effects will primarily impact the most exposed which are isolated herders and their families in the marginal rural communities, and the poor who rely mainly on natural resources. Large and small ruminants raised on pasture (which represent the most diffuse form of herd management in Mongolia) are more exposed to extreme weather events than monogastric species (pigs and chicken) raised in stables or in protected areas.

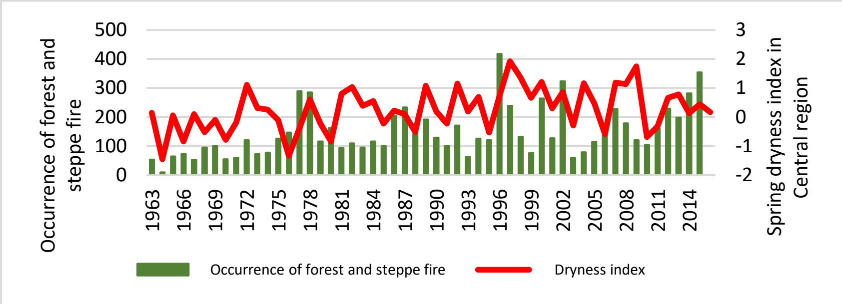


Figure 44 Number of occurrence forest and steppe fire, and spring dryness index, 1963-2015

Vulnerability and exposure to slow onset disasters

The UNCCD defined drought as “the naturally occurring phenomenon that exists when precipitation has been significantly below normal recorded levels, causing serious hydrological imbalances that adversely affect land resource production systems.” This agrees with the common understanding that drought is a seasonal phenomenon caused by a negative combination of weather, temperature and soil factors. The soil moisture reserves are depleted due to loss of water by high evaporation, transpiration, temperature and precipitation deficiencies for prolonged periods of time. The increase in drought stress, as a result of declining rainfall and rising temperatures, will affect the northern Mongolian forest belt during the 21st century [29], and the larch cover will likely be reduced [30]. In the boreal forest region, a longer and warmer growing season will increase vulnerability to fires and expose humans and livestock to a greater risk of death caused by direct and indirect exposure to fire and air pollution. In addition, droughts will negatively affect the quality and quantity of pasture in all Mongolia and this will impact livestock production (e.g. meat, wool and milk productions) [42]. Observations indicate that since 2000, summer droughts are more frequently followed by harsh winters (which may result in a dzud) with high snowfall and cold waves [43].

The long temporal analysis of the Mezentsev humidity index showed that it has a decreasing trend, which means that the climate in Mongolia will become arid. An overall decrease in humidity started to intensify at the end of the 1990s and the humidity index decreased by 4% on average in the last two decades. The greatest decreases within last decade were marked in 2005, 2007 and 2009 when the annual humidity index dropped by 7% to 9% [40].

Mongolia lies mostly in the dry climate zone, and for this reason, it belongs to the drought-prone territory. In the major parts of the high mountain belt region, forest-steppe and steppe zones, the probability of drought occurrences is one or two in a 10-year period. In the desert steppe zone there is a probability of one drought every second year, and in the middle ground (between the steppe zone and desert steppe zones) the probability of drought is one every three years. The drought frequency increases from north to south, east to west, and it is linked with Mongolia’s humidity distribution patterns. The most exposed are the herders with their livestock on pasture all year round with no supplementary dry fodder or easy access to fresh water during the drought periods. The summary table of climate change impacts, risks and vulnerabilities in Mongolia are available in Appendix 4.

When estimating nationwide averaged drought conditions using Ped's drought index (1975) calculated using the equation 1 below, it is very clear that since 1940s, drought conditions have increased (See Figure 45). The long-term trend of PDI of summer drought condition is +1.24 over 77 years and this trend is statistically significant at more than 99% confidence level. It can be seen, that since 1940 drought occurrence has generally increased. This is especially true after 2000 when frequent and consecutive drought conditions can be observed with light (1-2) to moderate (2-3) degrees. Drought occurrence was observed almost every year since 2000. Among them, 2000, 2002 and 2015 droughts have affected the country's socio-economic conditions the heaviest.

$$PDI=\frac{\Delta T}{\sigma_T}-\frac{\Delta P}{\sigma_P} \quad \text{(warm and dry)} \qquad \text{(Eq.1)}$$

where ΔT is the deviation in air temperature (◦C); ΔP is the deviation in precipitation (mm); σT is the standard deviation of the temperature (◦C); σP is the standard deviation of the precipitation (mm);

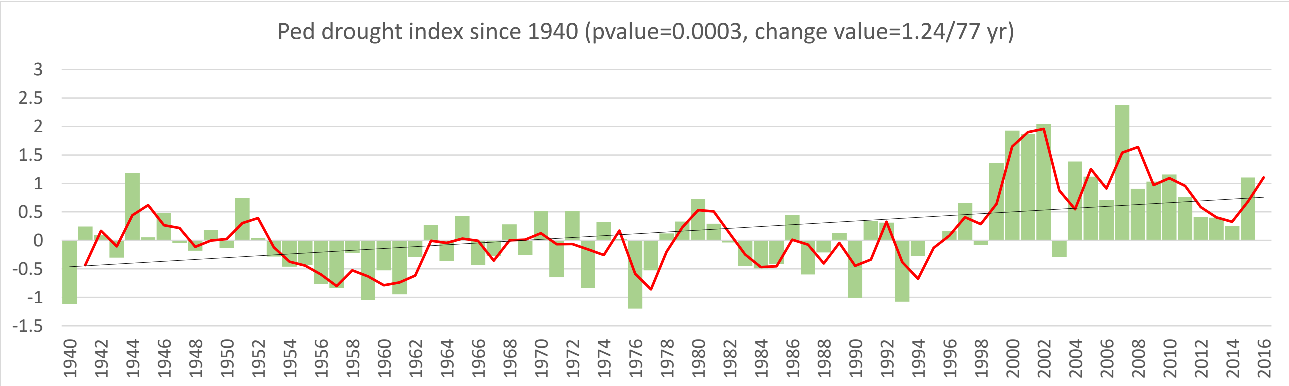


Figure 45 Interannual change of drought-summer condition index (averaged by May-August) over Mongolia (negative value refers good summer condition, while positively refers to drought condition)

Increase in dzud intensity and frequency in Mongolia since 1990, which is estimated using equations 1, 2 and 3 below and is presented in Figure 46. The national trend is +0.51 in 77 years and this trend is statistically significant at the 99% confidence level. As it can be seen, dzuds in years 1999-2000, 2001-2002 and 2009-2010 have been the most severe and consequently, damage and loss to socio-economy were relatively higher compared to other years.

$$WI=-\frac{\Delta T}{\sigma_T}+\frac{\Delta P}{\sigma_P} \quad \text{(cold and wet)} \qquad \text{(Eq.2)}$$

where ΔT is the deviation in air temperature (◦C); ΔP is the deviation in precipitation (mm); σT is the standard deviation of the temperature (◦C); σP is the standard deviation of the precipitation (mm);

$$DZI= PDI+WI \qquad \text{(Eq.3)}$$

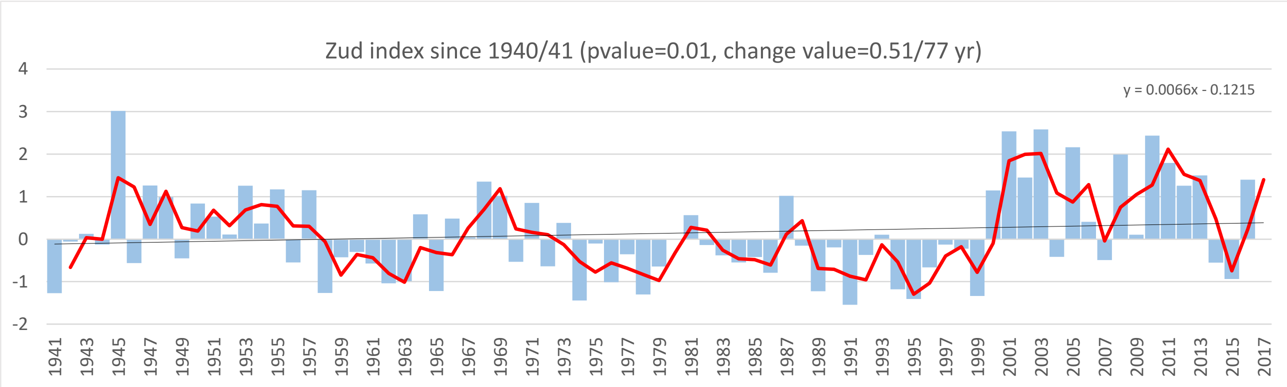


Figure 46 Interannual change of dzud index over Mongolia (positive refers zud condition). Note: horizontal axes take value from 1941 to 2016.

From the Dzud index estimated for the four target provinces from 1961 to 2017 (Figure 47), similar intensifying trends can be observed (all positive trends statistically significant at the 96% confidence level or higher). In all four provicnes, dzud intensity undergoes significant increases after the 1990s. Among later years, dzud events which occur in 1999-2000, 2001-2002 and 2009-2010 have been the most severe, with relatively higher losses and damages compared to other years.

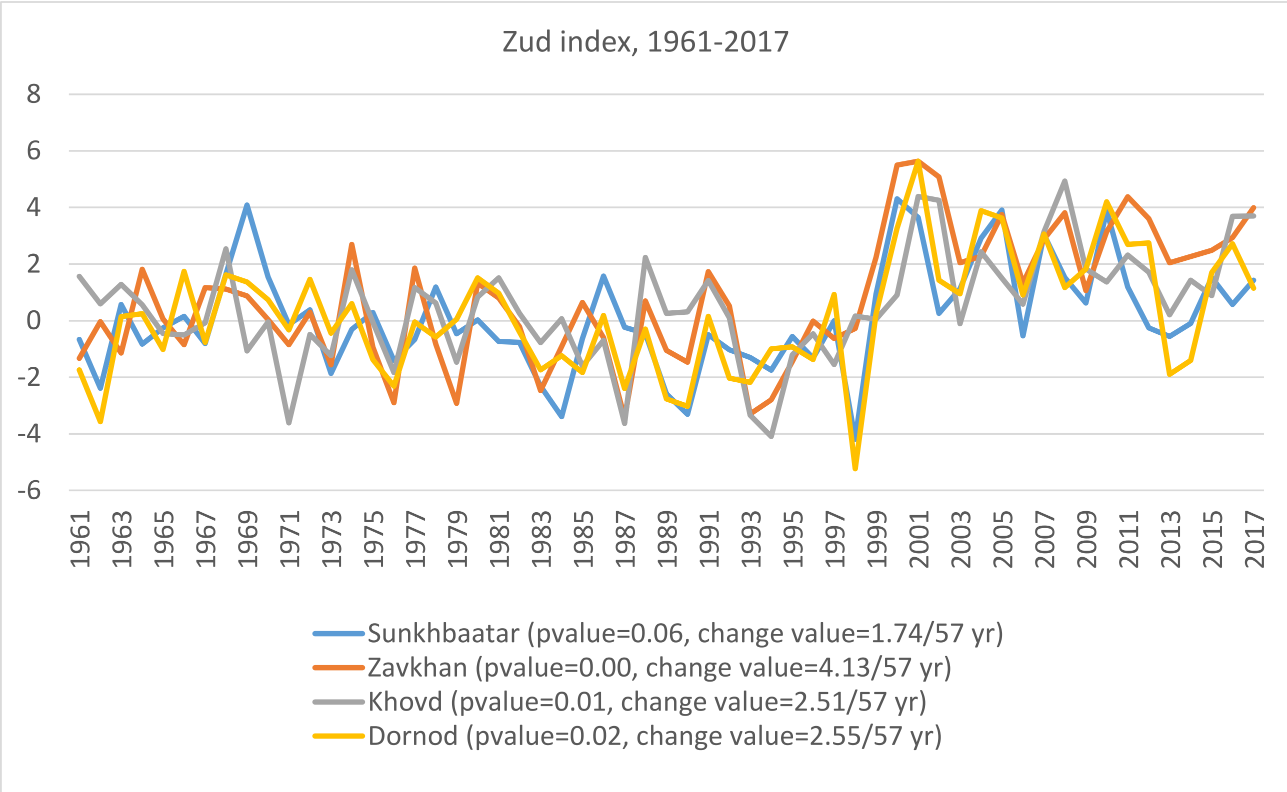


Figure 47 Interannual change of dzud index over target provinces (1961-2017)

Pastureland health and availability of biomass heavily affect lives and livelihoods of herders. According to NAMEM data, the winter pasture yield and grazing capacity following a dry summer (winter of 2017-2018) and a relatively mild summer (winter of 2018-2019) results in significant difference in survival of animals (Figures 48). The 2017-2018 winter suffered exceptionally low pasture yield over the majority of country's territory (white/lighter colors with 0–2 quintal/ha), which is also reflected in grazing land capacity (red territories where carrying capacity is critically exceeded). Accordingly, after the 2017-2018 winter, total animal loss was counted at 2.2 Mln heads. After the winter of 2018-2019, with the improved pasture yield and capacity to graze animals, the total loss of animals was counted at 1.1 Mln heads.

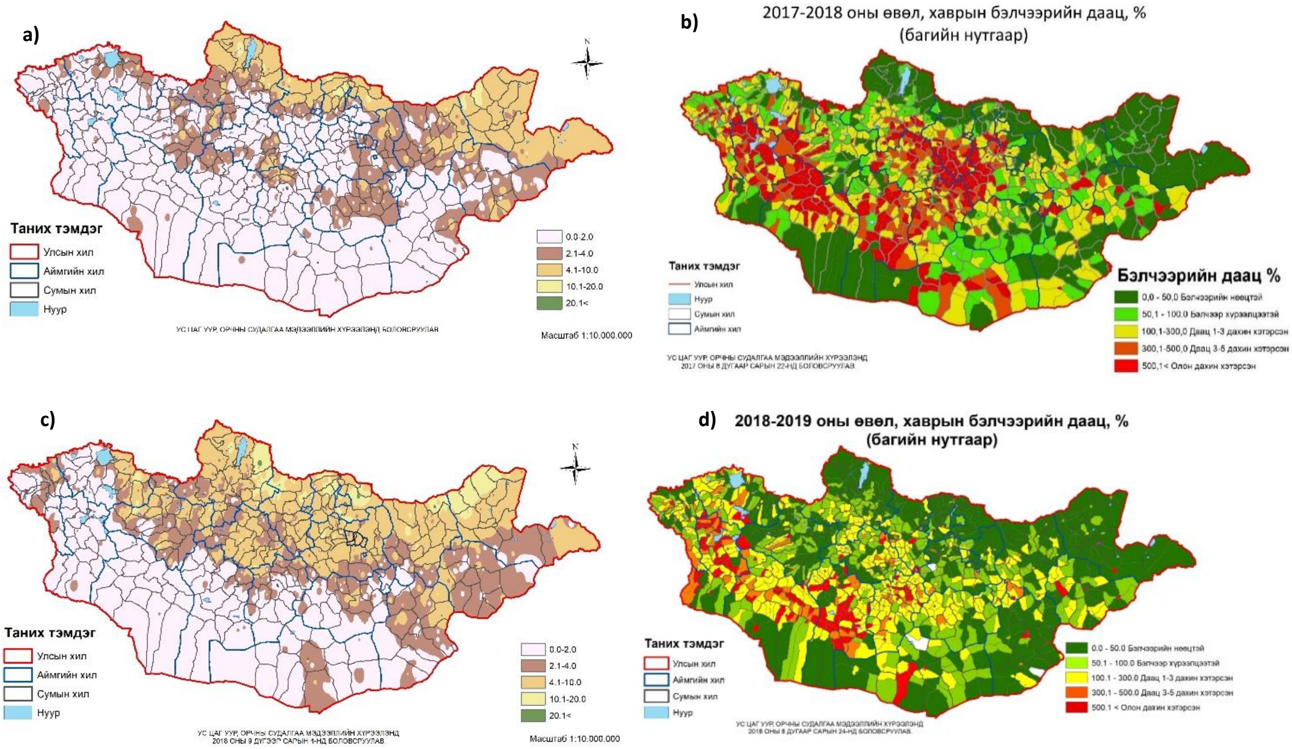


Figure 48 Winter/spring pasture yield (quintal/ha) and grazing capacity (%) a) pasture yield for winter 2017-2018 b) grazing capacity for winter 2017-2018 c) pasture yield for winter 2018-2019 d) for winter 2018-2019

Multidimensional climate vulnerability

Climate vulnerability indices are estimated using representative indicators for multiple categories of ecosystems and socio-economic sectors, including climate, water, forest, arable farming, livestock pasture and soil cover, wildlife and public health. The values for each indicators at provincial and regional levels are then converted into one dimension using normalization method of the UNDP's human development index (HDI, UNDP, 2018). The final vulnerability indices are the average values of the normalized indicators, converted to a value between 0 and 1**.** The index values are divided into five categories, whereby the maximum value of the index (1) represents a highly vulnerable and high future risk conditions (See Table 4). Future vulnerabilities are based on the projected category indicators under future GHG emission scenarios with a certain probability. Therefore, the future vulnerability indices are vulnerability risk indicators.

Table 4. Threshold values used in assessment of vulnerability and risk classification

No	Lower threshold values	Classification Current/Future	Upper threshold values
1	0.81<	Extremely vulnerable/risky	<1.00
2	0.61<	Highly vulnerable/ risky	<0.80
3	0.41<	Vulnerable/ risky	<0.60
4	0.21<	Less vulnerable/ risky	<0.40
5	0.00<	Not vulnerable/not risky	<0.20

Estimated climate change vulnerability and risk indexes considering changes in temperature, precipitation and frequency of natural hazards show that the western aimags are highly vulnerable. The future indexes for the period of 2046-2065 are expected to increase for both provinces, indicating more severe changes in Khovd Province, where vulnerability index will increase from the current 0.5 (vulnerable) to 0.7 (highly vulnerable). For Zavkhan Province, the index will remain as high as 0.7. This is primarily because the western provinces are experiencing pronounced changes in air temperature and melting of glaciers. The eastern target provinces are rated as "vulnerable" in this category (see Figure 49).

When vulnerability is analyzed in multiple dimensions considering environmental and socio-economic factors (Table 5), all four aimags are very vulnerable to the future climate change impacts on water, forest and pasture resources. In particular, very high existing vulnerability index (1986-2005) for Khovd and Zavkhan in terms of water resources (including permafrost) is expected to increase up to 0.9. Pasture vulnerability index is expected to increase for Dornod and much more in Khovd. The current vulnerability index on pasture resources is estimated at 0.7 (very vulnerable) for Sukhbaatar province. Biodiversity is much more vulnerable in western provinces. Livestock sector vulnerability will increase in three target provinces except for Dornod. Vulnerability in forest resources in two aimags with forest are at the highest (1.0). The same applies to crop farming in Dornod, where relatively extensive crop farming fields are located. Another steep increase is noticed in health and well-being of the population in all four provinces.

Table 5. Multi-dimensional climate vulnerability index for target provinces

	Climate	Water res	Permafrost	Forest res	Pasture	Crop farming	Livestock	Biodiversity	Hea
Current vulnerability index (1986-2005)									
Khovd	0.5	0.8	0.7	1.0	0.5	n.a	0.5	0.7	0
Zavkhan	0.7	0.5	0.3		0.3	n.a	0.5	0.8	0
Sukhbaatar	0.4	0.8	0.7		0.7	n.a	0.4	0.6	0
Dornod	0.4	0.7	0.3	1.0	0.5	1.0	0.6	0.3	0
Future vulnerability index (2046-2065)									
Khovd	0.7	0.8	0.9	1.0	0.8	n.a	0.6	0.8	
Zavkhan	0.7	0.6	0.7		0.1	n.a	0.8	0.7	
Sukhbaatar	0.4	0.9	0.6		0.6	n.a	0.5	0.6	
Dornod	0.4	0.8	0.6	1.0	0.6	0.9	0.5	0.3	

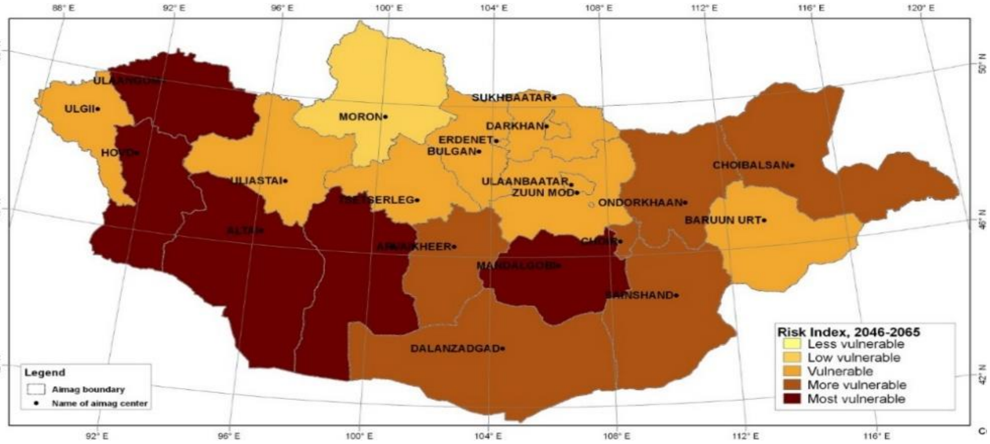


Figure 49. Multi-dimensional climate risk index of Mongolia, 2046-2065

2. Baseline Scenario and Baseline Investment

2.1. Baseline scenario analysis

2.1.1. Biophysical

Water resources

The total surface water resource of Mongolia is estimated at 608.3 km^3 [14] and is composed mainly of water stored in lakes (500 km^3) and glaciers (62.9 km^3), and 10.79 km^3 are underground water reserves. Over 50% of surface water reserve is located in the Western aimags such as Khovd river-Khar-Us lakes in Khovd aimag, Hyargas lakes, Ider river, Zavkhan lakes and Tes river in Zavkhan aimag. The primary responsibility for water resources management lies with the Ministry of Environment and Tourism (formerly the Ministry of Environment and Green Development).

The long-term average annual renewable water resources include 32.7 km^3 of surface water and 6.1 km^3 of groundwater. The agricultural sector is the largest water user in Mongolia; irrigation accounts for 30% and livestock for 23.5% of the total water demand. Mining accounts for 12.7% of the water demand, but is likely to become the major water user in the future. Water consumption is highest in the Tuul and Orkhon water basins, in the center of the country (near Ulaanbaatar) accounting for 27.6% and 13.5% of total water use in Mongolia, respectively [15].

Overall the country's surface water resources have been declining and are expected to continue declining through the drying effects of climate change. At the same time, however, the western mountainous region that contains half of country's surface water resources will have temporary abundance of water resources due to thawing of glaciers and permafrost that supply origin of major rivers. At the national level, glaciers are retreated by 30% in the last 70 years and permafrost areas are shrunk by 5% in last 20 years. As shown in the table below, a national level decline of surface water bodies within the last 6 years, with western mountainous areas (Zavkhan and Khovd aimags) presenting an increase in number of surface water bodies. In eastern region's semi desert area (Sukhbaatar aimags), a decline is present as surface water bodies are not fed by glaciers, while the Dornod aimag in the eastern Steppe, with some rivers originated in Khentii Mountain range showing a slight increase in number of surface water bodies. Water level changes in largest lakes within the target provinces indicate gradual decrease in eastern steppe lakes although fluctuates, whereas water level in Khar Us lake in Khovd province within the Great Lakes depression remained relatively stable (Figure 50), which can be explained by melting glaciers. Overall as detected by remote sensing over Mongolia, there has been a documented decline in the numbers and areas of lakes over the Mongolian plateau since 1999[2]. Further evidence is presented in publications including Mongolia Assessment Report on Climate change (MARCC) and National Communications [1].

Number of rivers and springs in target aimags 2011-2016[3]

Aimag	Category	2016		2014		2011	
		Total	dried up	Total	dried up	Total	dried up
National	Rivers	5 585	263	5 800	387	6 646	607
	Springs	11 420	1 163	10 809	1 091	10 557	1 587
	Mineral water	490	19	450	-	265	-

[2] Zang et al. (2017) Extensive and drastically different alpine lake changes on Asia's high plateaus during the past four decades. Geophysical Research Letters. Vol. 44. Issue 1. pp 252-260. https://doi.org/10.1002/2016GL072033

[3] http://1212.mn/statHtml/statHtml.do#

Aimag	Category	2016		2014		2011	
		Total	dried up	Total	dried up	Total	dried up
	Lakes, ponds	2 214	346	2 738	399	3 613	486
Zavkhan	Rivers	388	-	249	7	249	8
	Springs	703	15	533	7	534	7
	Mineral water	38	-	36	-	7	-
	Lakes, ponds	149	5	108	5	108	5
Khovd	Rivers	272	-	231	12	238	33
	Springs	806	-	925	45	569	2
	Mineral water	47	-	53	-	25	-
	Lakes, ponds	78	-	114	6	121	-
Dornod	Rivers	132	54	N/A	N/A	126	19
	Springs	586	174	N/A	N/A	374	48
	Mineral water	23	-	N/A	N/A	11	-
	Lakes, ponds	524	204	N/A	N/A	426	200
Sukhbaatar	Rivers	48	1	52	3	70	5
	Springs	407	57	326	56	309	16
	Mineral water	12	-	11	-	15	-
	Lakes, ponds	97	17	155	30	157	6

Table 6 Number of rivers and springs in target aimags 2011-2016

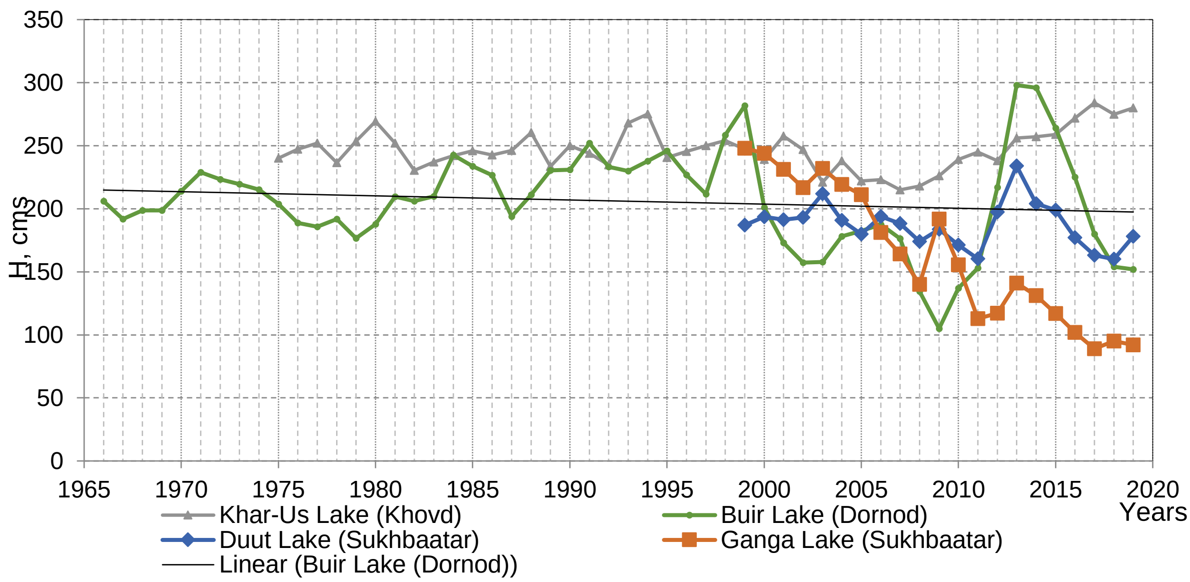


Figure 50. Lake water level changes over time, cms above sea level

Groundwater is available all year-round from shallow and sometimes deep wells. However, functioning watering wells, critical for livestock, have fallen from 39,000 to 31,000. This drop in functioning wells was mainly due the collapse of the state systems to maintain and renovate livestock infrastructure. In 2000 the GoM initiated a new program to construct new wells and rehabilitate existing structures under the Mongolian National Livestock Program but progress has been slow with most investments being close to Ulaanbaatar. In 2009, totally 39.3 thousand wells were operational for livestock watering and from which 26.8 thousand located in the pasture. In addition, around 500 reservoirs and ponds with a capacity of 92,500m^3 are used for livestock water supply. Fewer wells force herders towards other watering points such as rivers, lakes and ponds – putting pressure on those water resources and the land around them.

Pasturelands

The drying up of water sources is progressing rapidly. As rivers, springs, and lakes disappear, the concentration of livestock near the diminishing number of water points intensifies pasture degradation. Pasture yield and plant species diversity are decreasing. About 3,000 water sources, including 680 rivers and 760 lakes, were recorded as having dried up by the beginning of this century. The Gobi Desert steppe zone is moving further northward every year. Scientists predict that more areas will become part of the Gobi Desert, particularly in the eastern region, and the dry steppe zone will probably spread north into the current forest-steppe zone.

Areas affected by desertification at the aimag level (% of territory)

Aimag	% forest, lake, high mountains	% Not desertified	% Slight	% Moderate	% Severe	% Very severe
Dornod	8.0	3.3	22.4	22.9	17.5	26.0
Sukhbaatar	0.6	1.1	33	34.1	9.7	21.4
Khovd	4.2	32.2	36.4	19.3	2.7	5.3
Zavkhan	3.4	27.8	38.9	21.7	3.8	4.6

Table 7 Areas affected by desertification at the aimag level

Source: Desertification Atlas of Mongolia (2010)

In recent years, pasture degradation has increased almost everywhere in Mongolia and pasture yields have decreased. Pasture growth reaches its annual peak in August; currently, this is only about 75% of the peak growth observed 40 years ago. There is less pasture growth in spring when livestock need it most, and hay harvests have decreased. This is due to a combination of factors. While some experts claim that this is happening because traditional pasture use practices have been lost, herders stress that it is caused by a reduction in precipitation. Both factors contribute, and are multiplied by pressure on land resources from increased herd sizes and overgrazing.

Livestock & Herder Livelihoods

Livestock-based agriculture has been a backbone of the Mongolian economy. More than 85% of the agricultural population depends on livestock production. Livestock-based industry contributes to around 10% of all export revenues and 10% of GDP in Mongolia's economy is generated by the livestock sector.

The size of the national livestock herd has been steadily expanding, from 26 million in 1996 to 61.5 million animals in 2016. Similarly, animal number has been doubled for the period of 2000-2019 for target sites as well, significantly increasing grazing pressure on land (Figure 50). Despite the expansion in national herd, roughly 70% of herder households have subsistence-size herds of less than 100 animals. During project consultations, Aimag officials stated that up to 88% of the herder households in Dornod Aimag are indebted. As climate change is impacting the quality and quantity of pasturelands and water sources, on which herders and livestock rely, the sector remains extremely vulnerable to both slow onset climate change as well as extreme events.

Declining quantity and quality of pasturelands and water resources is resulting in animals that are increasingly undernourished and or unhealthy, translating to lower quality livestock products. For cashmere, this means undernourished goats with coarser hairs that are commercially less valuable.

Similarly, average milk yield of a single cow is decreasing in many areas because the quality and quantity of natural pasture and hay grass has declined, and continues to decline. The situation is similar with other livestock and livestock products. In response to the declining value of livestock products some herders have opted to breed larger herds to make up for the economic losses by way of quantity vs. quality. The result is an increase in the number of livestock in Mongolia, which is adding more pressure on the ecosystem, grasslands and water resources.

Animal health is also affected by dzud events, particularly impacting small scale herders. Just a few more centimetres of snow beyond the average locks the forage under a thick frozen layer, and causes high mortality among the livestock. The winter dzud of 1999, 2000 and 2001 reduced the national herd of 34 million by one-third. The dzud of 2009-2010 resulted in the death of over 10 million animals out of more than 43 million, at an estimated cost of more than US$ 340 million. As a result of these two dzuds, more than 20,000 households lost their livelihoods. To avoid a total loss during dzud events, some herder households allow for a larger herd. Given the limited market for meat and underdeveloped value chains for livestock products, herders have opted to raise more goats in order to benefit from the relatively stable raw cashmere market. Goats, however, are more vulnerable to extreme winters than some other animals. In the 2016 dzud, 48% of total animal losses were goats. Where the herd is not adequately diverse, herders are more exposed to potential losses during extreme events.

Animal Losses During Dzud Events (thousands)								
	2000		2003		2010		2016	
Horses	394.0	11.2%	136.6	10.3%	369.7	3.68%	1.6	0.1%
Cattle	630.6	18.1%	215.3	16.3%	581.0	5.6%	64.1	4.4%
Camels	18.2	0.5%	7.2	0.5%	17.0	0.2%	136.7	9.4%
Sheep	1,417.1	40.6%	536.5	40.5%	4,363.8	42.3%	551.6	38.0%
Goats	1,031.5	29.5%	428.5	32.4%	4,988.4	48.3%	698.2	48.1%
Total	**3,491.4**		**1,324.1**		**10,319.9**		**1,452.2**	

Table 8 Animal Losses During Dzud Events

Further, goats in particular, are destructive to the landscape, pulling grass out by the root and keeping it from regenerating – accelerating land degradation. Per traditional knowledge, the ideal ratio within herds is 3 sheep to 1 goat to avoid overstressing land. The two largest groups of animals are represented by sheep and goats representing approximately a 1:1 ratio, followed by cattle, horses and camels.

Livestock Numbers (millions)						
Year	Horses	Cattle	Camels	Sheep	Goats	Total
2012	2.3	2.5	0.3	18	17	40.1
2013	2.6	2.9	0.3	20	19	44.8
2014	2.9	3.4	0.3	23	22	51.6
2015	3.3	3.6	0.4	25	23	55.3
2016	3.6	4.1	0.4	28	26	61.5

Table 9 Livestock Numbers (in million)

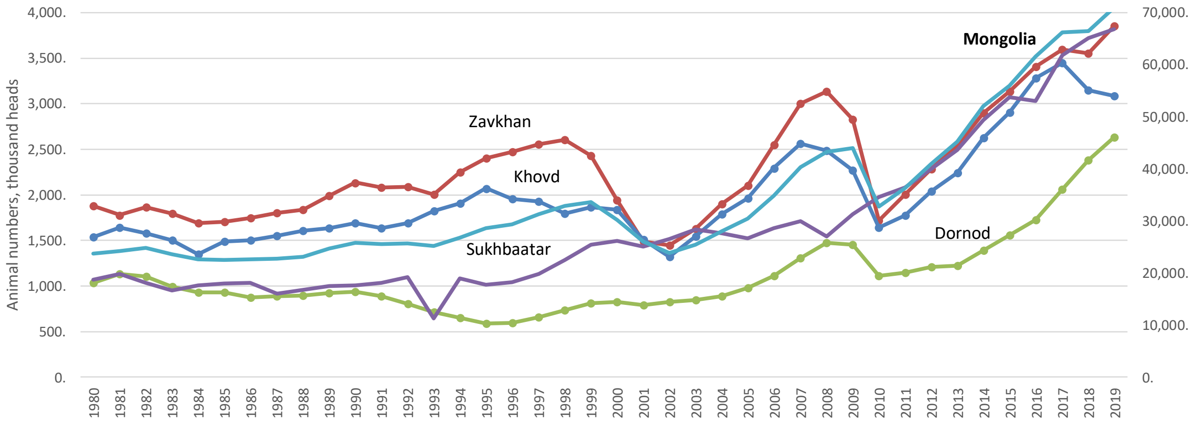


Figure 51. Growth in animal number in target provinces, 1980-2019

The ongoing National Mongolian Livestock Programme (closes in 2021) set herd size reduction and herd structure targets. The target for reduction of small animals acknowledges the impact that large numbers of sheep, and goats especially, have on the landscape, while the increase in large animals seeks to diversify livelihoods. However, as it was developed over 10 years ago, the targets did not adequately take into account the additional stresses that climate change would place on land and water resources. Had the current programme achieved its 2021 herd structure and herd size targets, it would have supported relieving some pressure on land resources, and the demand for water would have increased (see table 10 below[4]). Current livestock figures, however, far exceed the programme's 2021 targets, and pressure on both water and land resources have increased significantly from the 2008 baseline.

	2008 NMLP Baseline				**2021 NMLP Targets**				**Current Figures (2019)**			
	Livestock (000s)	%	Impact on land (000 modified sheep units)*	Daily demand for water (000 Liters)*	Livestock (000s)	%	Impact on land (000 modified sheep units)*	Demand for water (000 Liters)*	Livestock (000s)	%	Impact on land (000 modified sheep units)*	Demand for water (000 Liters)*
Camel	260	0.6%	1,300	18,655	328	0.90%	1,640	23,534	472	0.70%	2,360	33,866
Horse	2,208	5.1%	15,456	65,688	2,990	8.20%	20,930	88,953	4,215	5.90%	29,505	125,396
Cattle	2,511	5.8%	15,066	78,783	5,031	13.80%	30,186	157,848	4,753	6.70%	28,518	149,125
Sheep	18,354	42.4%	18,354	58,274	16,442	45.10%	16,442	52,203	32,267	45.50%	32,267	102,448
Goat	19,956	46.1%	59,868	63,360	11,666	32.00%	34,998	37,040	29,262	41.20%	87,786	92,907
Totals	**43,289**	**100%**	**110,044**	**284,760**	**36,457**	**100%**	**104,196**	**359,577**	**70,969**	**100%**	**180,436**	**503,742**

Table 10 Livestock numbers, impact on land and demand for water – baseline (2008), current figures (2019), and targets (2021) of the National Mongolian Livestock Programme

A national programme, a successor to the Mongolian Livestock Programme, will be developed over the next 2 years. Per the Action Plan for the Agenda for Sustainable Livestock, current livestock

[4] The approximate impact on land of different animals was estimated based on "modified sheep units", used for estimating needs for fodder and grazing land. Generally, these are camel – 5 sheep units, horse – 7 sheep units, cattle – 6 sheep units, goat – 0.9 sheep units. As there is disagreement by experts over the low value attributed to goats, given their harshness on land, 3 sheep units was used for goats in the table. Goats are particularly destructive to the landscape - pulling grass out by the root and keeping it from regenerating, thereby accelerating land degradation. Per traditional knowledge, the ideal ratio within herds is 3 sheep to 1 goat to avoid overstressing land – this ratio was maintained until end 1990s. Similarly, different animals put different pressure on water resources. It is estimated that daily consumption of water is as follows per adult animal: camel 60-90L, horse 20-42L, cattle 26-36L, sheep 2.0-3.7L, goat 2.0-3.7L. The range represents the different water demand across seasons. (https://www.mongoliajol.info/index.php/MJAS/article/view/790/837). For the purpose of estimation, the average daily consumption of water across seasons for adult animals was used.

numbers exceed pastureland carrying capacity by 25 million sheep units. The plan recommends to reduce sheep unit pressure to 74 million by 2033. The indicative 2033 target for total livestock is 51.2 million – a 28% reduction from the 2019 figure. Indicative herd structure targets for the new programme are not yet available. To illustrate the impact and importance of herd structure, the NMLP herd structure targets were set against the target of 51.2 million animals. See table below. If the NMLP herd structure targets are maintained and the target of 51.2 million is achieved, this would represent a reduction of 34 million modified sheep units and an increase in 1 million liters of water in daily consumption.

NMLP Herd Structure Against Indicative 2033 Livestock Reduction Target			
Livestock (000s)	**NMLP Herd Structure Targets**	**Impact on Land (000 modified sheep units)***	**Daily Demand for water (000 Liters)***
461	0.90%	2,304	33,062
4,198	8.20%	29,389	124,902
7,066	13.80%	42,394	221,683
23,091	45.10%	23,091	73,315
16,384	32.00%	49,152	52,019
51,200	**100%**	**146,330**	**504,982**

Table 11 Herd Structure Scenarios

Further development of the national programme, a successor to the Mongolian Livestock Programme, will require targets informed by current and projected climate impacts on natural resources, as well as information on the state of natural resources in related geographical areas (e.g. availability of seasonal surface water, the related condition of catchment areas and groundwater). It is critical also to find an appropriate balance between national economic development priorities and sustainability, while also ensuring that policies and incentives for herders are in place, to support overall sustainable livestock management and sustainable use of natural resources.

2.1.2. Socio-Economic Impacts

The overall poverty rate in Mongolia was 29.6% in 2016, with a higher rate of 34.9% in rural areas. The poverty rate in rural areas declined by 11.7 percentage points in 2014 from the 2012 levels, but resumed back by 10.1 percentage points in 2016 – indicating the fragility of those earlier gains and vulnerability of those near the poverty line to minor socio-economic difficulties and weather conditions. The 2016 Household Socio-Economic Survey shows that those who were just above the poverty line in 2014 have slipped back into poverty in 2015-2016.

Poverty level of the year 2010-2016 (Mongolia National Statistics Office/World Bank, 2017)					
	2010	**2011**	**2012**	**2014**	**2016**
Poverty line (minimum consumption of the person per month, by tugrik)	92,072	99,729	118,490	146,650	146,145
Poverty rate (by percent)					
State average	**38.8**	**33.7**	**27.4**	**21.6**	**29.6**
City	33.2	28.7	23.3	18.8	27.1
Rural area	49.0	43.2	35.4	26.4	34.9
Region					
Western	52.7	40.5	32.3	26.0	36.0
Khangai	51.9	49.1	38.5	25.3	33.6
Central	29.9	28.1	28.2	22.2	26.8
Eastern	42.3	40.0	33.4	31.4	43.9
Ulaanbaatar	31.2	25.8	19.9	16.4	24.8

Table 12 Poverty level 2010-2016 (Mongolia National Statistics Office/World Bank, 2017)

Herder households make up the majority of the rural population. Livestock accounts for 90% of the agriculture sector and represents 85% of all 332 soum economies in the 21 provinces of the country. Herder households in the target aimags are particularly vulnerable. The target aimags of the proposed project are in the Western and Eastern regions, which have consistently been among the poorest in the country.

As herder livelihoods become increasingly difficult and risky, many herders opt to migrate to urban areas in search of other opportunities. This migration has contributed to the 70% growth in population in Ulaanbaatar over the past 20 years. 40% of the population now lives in Ulaanbaatar, with many arrivals from the countryside settling in ger areas on the outskirts of the city. These sprawling ger areas often lack access to access to improved sanitation services, including water, and have poor connectivity to the city's electrical grid, central sewage, and heating systems. As these settlements are unplanned, and lacking access to services, inhabitants remain vulnerable to extreme events.

On the other hand, subsidy and dzud relief programmes for the livestock sector are available to herders, though they only provide short term financial support and generally do not contribute to improved long term viability. Further, as these programmes generally do not consider environmental consequences, including ecological carrying capacity, and the long term sustainability of pasture resources, such programmes if not informed by climate change may inadvertently contribute to the growing national herd size.

There is, however, great potential in the livestock sector in Mongolia, which through targeting investment can reduce volatility of herder livelihoods, and eventually both boost the sector's gains as well as improve livelihoods of herders. Despite the large quantity of livestock, Mongolia has been unable to benefit from 1) the value addition of domestic processing of livestock products and 2) access to the international market.

Most meat in Mongolia comes from animals slaughtered outside the abattoir system, and this meat cannot be exported due to lack of sanitarian controls and traceability. The average export price for Mongolian meat has been in the region of $1.00/kg, which is three to four times lower than the price received by Australian meat exporters. Mongolia's contribution to world meat exports is only about 0.5% and, therefore, it is a very small player with huge upside potential [11]. Similarly, dairy farming faces challenges related to animal health, hygiene, food safety and animal productivity. Value chain analyses (see Annexes) indicate a need to improve animal health, sanitary standards related to processing and to strengthen competitiveness of small enterprises operated in rural areas via establishment of conditions to link with local producers group/cooperatives.

The National Mongolian Livestock Program (2010-2021) is investing in animal health and traceability with the aim developing a livestock sector that is able to adapt to climate change and social development trends and create an environment where the sector is economically viable and competitive in the market economy, to provide a safe and healthy food supply to the population, to deliver quality raw materials to processing industries, and to increase exports. There are five specific objectives to improve livestock sector governance, animal breeding and veterinary service standards, to develop climate and risk resilient livestock sector and create favorable marketing conditions. Within the objective to develop climate and risk resilient livestock sector, the interventions include:

- Improved pasture management through establishment of regulatory framework for pastureland management and introduction of pasture use fee, improved pasture use planning system, keeping optimal herd structure and size to pasture carrying capacity, as well as improved rodent and pest control;
- Increased hay and fodder production through both promoting natural hay making and good quality fodder plantations;
- Improved livestock water supply through establishment and rehabilitation of groundwater wells and rain and snow water harvesting;
- Create livestock risk management capacity by improved monitoring of changes, developing risk insurance system, developing innovative training methods and train herders on adaptation to climate and ecological changes including breeding of livestock for meat production

For the implementation of the programme, the Government pledges to allocate 3% of the state budget annually. Specific targets by the year 2021 include:

- Increase the number of large livestock camel 0.3%, horse 3.1%, cattle 8%, and sheep 2.70%. Reduce number of goat by 14.1%.
- Increase meat export volume to 50,000 tons.
- Be free from animal diseases, including brucellosis, glanders, anemia, leucosis and brucellosis and achieve a low risk status for contagious bovine pleuropneumonia, foot and mouth disease and sheep pox
- Establish 2,686 new wells

Niche value chains are also underdeveloped for livestock products, keeping herders from benefiting from the market for higher end processed livestock products. Through targeted support to value chains, there is also the opportunity to obtain greater value from livestock products. For instance, 90% of the total cashmere produced in Mongolia is exported, while only 10% is made into final products. The Government of Mongolia's Cashmere Program seeks "to increase the level of deep processing up to 60%, increasing the production of final end garments and exports of such goods, and an international level competitive capacity of such products.” This investment in local processing could yield significant gains.

Processing Stage	Output Price (USD)	Value Add (USD)
Raw/Greasy Cashmere	25-30/kg	N/A
Sorting	27-32/kg	2-5/kg
Washing/Dehairing (50% yield)	58-74/kg	7-10/kg
Dyeing/Spinning (95% yield)	66-90/kg	8-15/kg
Knitting	80-150/kg	12-40/kg

Table *13* Value Add – Cashmere Processing
Source: MICC Analysis

The four-year Cashmere Program (2018-2021) is expected to increase Mongolia’s production and export of final cashmere products 5.7 times. The program fund will be generated from the state and local budgets and foreign loans and aid. The Cashmere Program will be implemented with two stages, maintaining 5,500 jobs and newly creating about 3,600 jobs in the national cashmere industry. Mongolia’s goat population counts to 27 million, and annual cashmere capacity is 9,400 tons. However, about 90 percent of the total cashmere is exported and 10 percent are made into final products. It has been calculated that Mongolia can export 19.8 million knitted and textile products to earn about MNT 2 – 4 trillion per annum, if cashmere is fully processed domestically.

Investments in animal health, meeting international sanitation and hygiene standards, and investments in value chains can not only result in a broader market and greater value of livestock products – benefiting the sector and herder households – but it can also incentivize a shift towards quality vs. quantity, i.e. a large herd is not necessary if the animals are healthier, more resilient to extreme events, and greater value can be attained from quality livestock products, thereby reducing over time the total number of livestock. That notwithstanding, it is critical the such programmes consider climate change, integrate risks and ensure collaboration with other sectors or programmes. For instance, incentivizing cashmere production without linking to herd structure, carrying capacity and sustainable land use, can inadvertently exacerbate related challenges in Mongolia.

2.1.3. Policy and legislation

National Action Programme on Climate Change

As a party to the UNFCCC, Mongolian Parliament approved the National Action Programme on Climate Change (NAPCC) in 2000 and updated it in 2011 (Resolution Number 02, Feb 2011) to include concrete measures in response to climate change covering all principal sectors of economy. The goals of the program are to ensure environmental sustainability, development of socio-economic sectors adapted to climate change, reduction of vulnerabilities and risks, and mitigation of GHG emissions as well as promoting economic effectiveness and efficiency and implementation of ‘green growth’ policies. The implementation of the NAPCC to 2021 will help Mongolia create the capacity to adapt to climate change and establish a foundation for green economic growth and development. Strategic objectives were defined in order to achieve the goal of the action program, and implementation phases of the program were developed as well. The action program on climate change will be implemented in two phases over the period from 2011 to 2021 (the first phase is from 2011 to 2016, and the second phase is from 2017 to 2021). In the second phase (2017-20121), will be implemented climate change adaptation measures and GHG mitigations actions.

Government Action Program 2016-2020
The newly formed Government of Mongolia has developed its own Action Program to be implemented for the period of 2016-2020. This program reflects Mongolia's Sustainable Development Vision 2030, is supported by the Election Platform of the Mongolian People's' Party, and incorporates proposals from civil society organizations and citizens as well as the relevant provisions of international treaties and conventions. According to the newly formed action program, measures to be taken on ensuring a sustainable ecosystem and virgin nature, and green growth are developed. The newly formed government action program will ensure sustainable use of water, land and pasture mentioned in sections section 2.35, 2.36 and 4.2.1- 4.2.9 of this action program. Constructing pasture wells and improving its usage and monitoring with a view to expanding water supply for the rural population are indicated in section 2.35. Moreover, based on the regional ecosystem, issues to improve pasture user groups and pasture user agreements, rehabilitation and decreasing degradation and desertification through increasing herders' involvement are reflected in section 2.36. The whole section of 4.2 (sections 4.2.1-4.2.9) entitled "Measures to be taken on ensuring a sustainable ecosystem and virgin nature" ensures reform of regulation of specially protected areas, implementation of integrated water management to protect water resources and support of wastewater recycling technology. Sections 4.2.4 and 4.2.8 describe actions on protecting sources of rivers, streams and springs, collecting water from rivers, rain, snow and ice and creating water reservoirs and pools to increase water supply at national level, and supporting improving legal regulation on environmental protection and sustainable use of natural resources to raise their use efficiency.

Mongolian Action programme for 21st century
MAP-21 is the country's national agenda on sustainable development for the 21st century. It covers activities at the national and provincial levels. It provides an overall framework for the 21st century (MAP- sustainable development activities based on the country's natural resources, ecosystems and climate). MAP-21 document was formulated with assistance from UNDP and approved by the government in November 1995. MAP 21 is structured into four main subjects: i) sustainable social development, ii) sustainable economic development, iii) proper use of natural resources and protection of nature, the environment and reduction of negative effects of climate change, and iv) development of adaptation measures to combat climate change. Other Action Plans such as the National Environmental Action Plan (NEAP), Biodiversity Action Plan (BAP), and the National Plan of Action to Combat Desertification (NPACD) are complementary to MAP-21 and can be found in Appendix 3.

Sustainable Development Vision 2030
In February 2016 the parliament approved the 'Sustainable Development Vision 2030' (SDV). This vision is anchored in the 2030 Agenda for Sustainable Development and seeks to address the development challenges described above. The SDV envisions that Mongolia in 2030 will lead the region by its economic growth, reach upper middle income group countries based on its GNI per capita, ensure a diversified and stable growing economy, build a society dominated by upper middle income class, free of income inequality and poverty, have accountable and democratic governance, have a transparent business environment built on fair competition, preserve its mother nature and ecological balance and value green development. While the SDV already reflects many of the SDGs, gaps remain. The SDV has few quantified goals and targets and policy coherence and trade-offs are inadequately reflected".

Green development policy

The green development concept aims to transform Mongolia into a developmental model that ensures the improved well-being and prosperity of Mongolian citizens by safeguarding the sustainability of ecosystem services, increasing the effective consumption of natural resources, reducing the negative effects of climate change, and ensuring economic growth that is inclusive and environmentally sound. Based on its concepts and the purpose, the following strategic objectives will be achieved to ensure green development through the policy. The strategic objectives are:

- Promote a sustainable consumption and production pattern with efficient use of natural resources, low greenhouse gas emissions, and reduced waste generation.
- Sustain the ecosystem's carrying capacity by enhancing environmental protection and restoration activities and reducing environmental pollution, degradation and the negative effects of climate change.
- Increase investment in natural capital, human development and clean technology by introducing financing, tax, lending and other incentives for supporting a green economy.
- Engrain a green lifestyle by reducing poverty and promoting green jobs.
- Encourage education, science, and technology to serve as the catalyst for green development, and develop cultural values and livelihoods that are in harmony with nature.
- Develop and implement a population settlement plan in accordance with climate change while considering the availability of natural resources and the resilience of regions.

Environmental protection policy

This national law (approved in 1995 and amended in 2012) regulates individuals, organizations and the government on environmental protection and sustainable use of natural resources such as water, forest, pastureland, plants and animal biodiversity. A recent amendment to the Environmental Protection Law creates a more favorable condition for engaging local communities in sustainable natural resource management by providing security of tenure and giving Community Based Organizations (CBOs) legal status. CBOs that re-emerged on the pastoral commons to revive pastoral mobility were recognized in the civil law of Mongolia, a manifestation of the recognition by government of the crucial role that resource users, local communities and customary institutions play in sustainable land management and NRM in the vast territory of the country. Another amendment to the Law on Environmental Protection regulates the organizational form, tenure rights and responsibilities of pasture user groups and the development of pasture user agreements. An extensive review of policy, action plans and programs for other relevant sectors (e.g. livestock, water, soil, pasture, desertification, food security, agriculture etc.) can be found in Appendix 3.

2.2. Baseline investment analysis

Mongolia's primary development partners for dealing with climate projects issues are the Global Environmental Facility (GEF), the Asian Development Bank (ADB), the World Bank (WB), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and the Governments of Japan and Germany. As with other middle income countries (MICs), Mongolia has received limited adaptation support, though some projects do have adaptation benefits (e.g. natural resources management, cooperative livestock practices).

2.2.1. Overview of past and on-going investments/projects

International, nation organizations, and NGOs in past and on-going projects

UN support to Mongolia. Since 1963, Mongolia has received from the UN organizations financial, technical assistance to support economic and social development in the country. One of four priority areas for UN interventions in the development efforts (2012-2016) of Mongolia backed with the financial commitments is: “Improved sustainability of natural resources management and resilience of ecosystems and vulnerable populations to the changing climate.” Also UN agencies in Mongolia have been strongly supporting the implementation of MDG-based National Development Strategy (NDS) through technical guidance on needs assessment approach.

The United Nations Development Programme (UNDP). The Government of Mongolia and the UNDP have entered into a basic agreement to govern UNDP’s assistance to the country, which was signed by both parties on 28 September 1976. For climate change adaptation and mitigation, UNDP supports the implementation of the national action programs for climate change and combating desertification, nationally appropriate mitigation actions (NAMAs) and capacity development of the Climate Change Coordination Authority. Adaptation measures have included to maintain ecosystem functionality and minimize vulnerabilities of local communities, including protection and sustainable management of forest and livestock assets. UNDP’s support also extends to formulation of appropriate pro-poor policies and strategies in the energy sector. Additional work is undertaken on disaster preparedness and response, and local work with herders offers a range of livelihood support systems including land, water and forest management and biodiversity conservation. Mongolia was a pilot country in the Economics of Climate Change Adaptation (ECCA) programme which training government technical staff to assess costs and benefits when designing and evaluating climate change adaptation projects. UNDPs’ climate change related ongoing projects at national level are a) Nationally Appropriate Mitigation Actions in the Construction Sector in Mongolia, b) Ecosystem Based Adaptation Approach to Maintaining Water Security in Critical Water Catchments in Mongolia and c) Strengthening Local Level Capacities for Disaster Risk Reduction, Management and Coordination in Mongolia.

The Global Environment Facility (GEF). Since joining the GEF, Mongolia received GEF grants for a total of US$ 32 million that leveraged US$ 342 million in co-financing resources for 27 national projects in the areas of biodiversity, climate change mitigation, biodiversity, chemicals and persistent organic pollutants. Similarly, Mongolia participated in 13 regional and global projects of which 2 were in climate change. All projects financed by the GEF totalling US$ 155 million, leveraged US$ 827 million in co-financing resources. The main GEF implementing agencies on climate change issues in Mongolia are UNDP, ADB and WB. The main National Executing Partner on climate change with GEF is the Ministry of Environment and Tourism.

Asian Development Bank (ADB). Since Mongolia joined the ADB in 1991, ADB has been Mongolia’s largest source partner of multilateral official development assistance, playing a key role in the country’s transformation to a market-based economy. Within ADBs’ support in Mongolia, 10 climate change related projects at national and sub-regional levels have been implemented and of these projects 6 were technical assistances, 2 were grants and 2 were loans. Current ongoing projects in cooperation with Ministry of Environment and Tourism at national level are i) Establishment of Climate-Resilient Rural Livelihoods and Energy Efficiency (grant), and ii) Energy Efficiency and Urban Environment Improvement (loan). Recent discussions have revealed that ADB is now keen to help Mongolia access climate funds.

World Bank (WB). Mongolia became a member of the World Bank Group in February 1991. Since then, the World Bank has provided US$ 701.7 million to Mongolia. The World Bank has focused its activities on the Climate Investment Funds (CIF) in relation to the UNFCCC. However, these are not yet being applied to climate change in Mongolia. Climate change is not a significant focus directly by the Bank, but rather it is supporting energy efficiency and improving resilience projects which can be labeled as climate change mitigation. It did support establishing the Designated National Authority (DNA) for the CDM. Currently the Bank is focusing on livestock grazing management and the National Sustainable Livelihoods for Rural Communities project.

Global Green Growth Institute (GGGI). Mongolia became a member of GGGI in Incheon city (Republic of Korea) in 2013. GGGI and the MEGD signed a MoU in November 2011 to cooperate in programs and joint activities that foster the promotion of green growth. Sector-specific green growth projects in the agriculture, livestock, transport, energy, and rural development sectors were launched in 2012. After initial scoping work and a Consultation Workshop in February 2012, the transport and energy sectors emerged as priority areas on which to focus green growth planning. As a result, the Strategies for Green Public Transport and Strategies for Green Energy Systems were developed in 2013. GGGI aims to continue assist the Mongolian government in green growth activities, particularly with respect to its National Strategy on Green Development Policy. The Republic of Korea, as donor country, is supporting substantially the implementation of the Mongolian National Green Wall Program.

The German Agency for International Cooperation (GIZ). GIZ has been represented in Mongolia since 1991. GIZ Mongolia works in priority areas of Sustainable Economic Development and Environmental Policy including Energy Efficiency. GIZ is looking to raise US$ 4-5 million for the Climate Readiness REDD+ project to create a national inventory. GIZs' climate change related ongoing projects at national level are: a) efficiency of grid-based energy supply schemes, and b) biodiversity and adaptation of key forest ecosystems to climate change. GIZ's Mongolia program supports the strengthening Climate Change Coordination Office (former), newly established within the Ministry of Environment and Tourism, providing technical and financial assistance in implementation of activities and events organized by the office.

Mongolia-Japan Low-Carbon Development Partnership (JCM). The Ministry of Environment of Japan and the Ministry of Environment and Tourism of Mongolia made a joint statement on environmental cooperation, climate change and Bilateral Offset Crediting Mechanism (BOCM) in Doha (Qatar) during the 18th session of the Conference of Parties (COP18) to the United Nations Framework Convention on Climate Change. A Memorandum of cooperation was signed between the Ministry of Environment of Japan and the Ministry of Environment and Tourism of Mongolia on environmental cooperation in 2011 to strengthen, facilitate and develop mutual cooperation in the fields of environment and climate change. The list of cooperative actions primarily included activity on climate change mitigation and adaptation and feasibility studies, and capacity building. The JCM will contribute to reduction and absorption of greenhouse gas emissions in partner countries through transferring Japan's low-carbon technology. The GHG emissions are calculated and evaluated as credits for contribution.

Non-governmental Cooperation. In addition to official government cooperation, there are many forms of cooperation between academic institutions, non-governmental organizations, foundations, and the private sector which have often contributed to climate change adaptation and mitigation actions. On a practical level, the CCCO under the MET manages stakeholder engagements (including pasture agreements) and provides leadership by providing ongoing informal working groups on the livestock, water and forestry sectors from experts from universities, private companies, and banks. Non-governmental and private sector cooperation programs such as the Swiss development cooperation (SDC) has been taking the lead for various range management on pastureland programmes.

The SDC Green Gold Project and the IFAD PMPMD

The Swiss Agency for Development and Cooperation (SDC)'s Green Gold Project. With the support from the Green Gold Project a rangeland health monitoring and assessment approach based on ecological potential is being adopted by the National Agency for Meteorology and Environmental Monitoring and the Agency of Land Affairs, Geodesy and Cartography. Such an approach enables assessment of the current health of rangeland identifying and differentiating the state of degradation more accurately. According to the 2015 national assessment of rangeland health 65% of Mongolian rangelands are in degraded condition. Fortunately, 90% of those still have the capacity to regenerate naturally with improved grazing management and reduced stocking rates.

To improve grazing management at the herders' level the Green Gold project has promoted the formation of Pasture User Groups (PUG) among herders. A PUG is a voluntary union of herder households with shared access to communal rangelands. The main functions of the PUGs are to define and agree on grazing boundaries of communal rangelands, develop seasonal rotational grazing plans and schedules, adopt rules to pursue the seasonal rotational grazing plans, schedules and access to communal rangelands, and undertake a community based monitoring to ensure the compliance with the rule by members. There are currently 1,100 PUGs have been formed in 126 soums of seven western aimags (Arkhangai, Bayanhongor, Uvs, Bayan-Olgy, Hovd, Zavkhan, Gobi Altai). There are functioning Soum Associations of PUGs in about 100 soums and in 7 aimags. A National Federation of PUGs was established In February 2014 by the Aimag Federation.

The Green Gold project has also supported the establishment of Rangeland-User Agreements (RUA) between PUGs and soum governments. The goal is a mechanism for improved responsibility for the prevention of rangeland degradation. There are two levels of RAU's, the first enforces seasonal rotational grazing and resting schedules agreed upon PUGs and soum governments, and the second works to agree on long-term maintenance of rangeland health and plans to adjust and reduce stocking rates to rangeland carrying capacity. As of June 2016, 670 PUGs have been established RUA's with local governments.

In its last phase, the project worked extensively in the aimags of Khovd and Zavkhan. It initiated its support in Dornod in 2016 and will support the establishment of PUG's within the consolidation phase 2017-2020 in a total of 7 aimags.

Next phase: For 2016-2020, Green Gold aims for cooperation with ALAGC and aimag governments to up scale the PUG and RUA approach to remaining aimags. It foresees cooperation on the development of the model in 5 soums and has local land departments and aimag governments upscale to remaining soums with technical support from Green Gold Project. Finally, at the request of herders, PUGs and APUGs supported the creation and development of primary marketing cooperatives at the soum level.

The International Fund for Agricultural Development Project for Market and Pasture Management Development (IFAD PMPMD). The IFAD Project for Market and Pasture Management Development (PMPMD) in Mongolia was approved by IFAD Executive Board in May 2011 and became effective on 26th August 2011. The PMPMD goal is to contribute to empower poor rural women and men to achieve higher incomes and sustainable improvements in their livelihoods. Its objective is to reduce poverty, improve livelihoods of poor herder and soum and aimag centre households, which is in line with the Mongolian government's "Mongol Livestock" and "Cooperative Development" programmes. The PMPMD consists of 3 components: (i) Market Development to improve the livelihood development of poor households through small- and micro-enterprise development and through value chain development; (ii) Pasture Management and Climate Change Adaptation to increase the capacity and resilience of herders to cope with climate change impacts and to establish grassroots herder institutions for sustainable pasture management; and (iii) Project Management and Policy Development. The PMPMD target area covers the following five aimags: Arkhangay, Bulgan, Gobi-Altai, Huvsghul, and Khentii. Within those 5 aimags, the Pasture Management and Climate Change Adaptation component is being implemented in 15 soums, and the Market Development component is being implemented in 45 soums. Some of these soums are common to both components. The target groups include: (i) poor producers, herders, and women living in project-supported soums, soum centres and bags, as well as (ii) existing emerging micro- and small enterprises and cooperatives that have backward linkages with PMPMD target groups.

Key lessons from the PMPMD are the following: a) The current mechanism of enabling project beneficiaries to access commercial bank loans through developing micro-businesses has been effective. Eighty-eight percent of project beneficiaries accessed a loan compared to 66% of non-project beneficiaries. Also 62% of project beneficiaries used the loan for income generation activities while only 14% of non-project borrowers invested for income-generation activities; b) Successful work with Women's Groups (WGs) have encouraged other stakeholders to modify or adapt their policy; c) PHG organization has proved to be an effective approach to facilitate collective action for improved pastureland management, whereby group members collaborate better among themselves and with the soum government on pasture management issues; d) Transformation of WGs into cooperatives has not yet been achieved on a large scale (only 4 groups out of around 450 supported by the project), indicating that groups have not yet seen the added value of becoming a cooperative. Sustainability of the model will be achieved with the participation of commercial banks in the financing of WGs or women's cooperatives from their own resources; e) A lack of adequate sources of funds for emerging SMEs and cooperatives has hampered the implementation of project activities. The project's financial mechanism of dedicated credit lines and a loan guarantee facility (LGF) has demonstrated their pertinence as instruments to enable access to finance and graduation process. The PMPMD model supports emerging SMEs and cooperatives to become drivers of sustainable livelihood development. It should be institutionalized to provide financial assistance to the emerging entities; f) The link between PHGs and market development could become stronger. PHGs have had limited access to credit and to training to start economic activities.

Next phase: The additional financing will be used to consolidate and scale up successful PMPMD activities and to introduce innovative approaches to the PMPMD model that would contribute to greater efficiency and sustainability of the value chain. It will develop synergies with donors' projects operating along the same objectives and in the same commodities but in different areas. In addition, and as part of the project's next phase, its interventions will increase the ability, through capacity building, of the relevant government and local institutions to monitor, supervise and replicate in other aimags and soums all project activities.

Table 14 Past and on-going projects on climate change and policy development

Project title	**Fund, Duration and Budget**	**Initiatives / Interventions**	**Areas for Potential Collaboration**
Strengthening Local Level Capacities for Disaster Risk Reduction, Management	Funded by: UNDP and National Emergency Managemen t Agency	The main objectives are to facilitate decentralized disaster management through sustainable prevention, response and	This project is covered the analysis of Mongolian disaster protection policy and legislation on the past ten years. The analyses have revealed gaps in its coordination and other shortcomings. In response and in order to develop national disaster management in line with international best

and Coordination in Mongolia (SLLC-DRR)	Duration: 2013-2016 Budget: 1,500,000 USD	coordination mechanisms, thus reduce vulnerabilities of urban and rural poor communities.	practice, the project conducted a comparative study and analysis of disaster management legal documents and disaster risk management functions of relevant stakeholders. Based on the findings of the study, the drafts of the Reformulated Law on Disaster Protection and Law on Legal Status of Disaster Management Organizations have been drafted and have been submitted to NEMA. In the framework of coordinating disaster management at local level, the model disaster preparedness plan for soum and khoroo level was developed and piloted considering natural and geographical conditions, population distribution, infrastructure as well as current disaster management needs. The baseline study on local disaster risk management mechanism and budget allocation for disaster risk reduction activities was conducted at soums and khoroos with the purpose of identifying feasible mechanisms for local disaster risk management and mainstreaming disaster risk reduction into local development program.
Economics of Climate Change and Low Carbon Growth Strategies in Northeast Asia (ECC-LCG)	Funded by: Asia Development Bank Duration: 2010-2014 Budget: 1,800,000 USD	The project addresses climate change issues in the countries of Northeast Asia, covering the People's Republic of China, Mongolia and other countries through conduct of studies and dialogue and suggest growth strategies aimed at achieving "green growth" and low carbon societies	The main aim of this project is the analysis of climate change in Mongolia. It conducts (i) assessments and analysis of future climate change impacts on major sectors at the local level; (ii) develop regional modelling of climate change by an integrated assessment model; and (iii) conduct cost and benefit analysis of a climate change information system. In addition, an important outcome of this ADB project is policy development. This project has developed a 'Climate Policy Simulation Tool (CPST)'. A concept note on the CPST was prepared. The CPST is a web-based application allowing for data and policy simulations. A beta-version website was presented at the East Asia Climate Partnership Forum in Seoul, Republic of Korea (9 March 2012) and the project website is being used to disseminate project findings by ADB and other national and international organizations.
Establishment of Climate-Resilient Rural Livelihoods (ECRRL)	Funded by: Asian Development Bank and the Ministry of Industry and Agriculture Duration: 2010-2014 Budget:	This regional project has two main goals. It wants to help herders located in the marginal areas of the country, that are also the most vulnerable by the climate change, to strengthen their preparedness for recurrent dzud, and,	The outcomes of this project are the creation of the basis for the development of an information system to support rural communities to combat dzud, droughts and other negative effects of climate change. Furthermore, the project seeks to improve the livelihood of herders, by ensuring sustainable pasture management. The project supports the objectives of the National Mongolian Livestock Program 2010 2015, which aims at developing a livestock sector that is

	2,500,000 USD	rehabilitate and/or improve their livelihoods and their income.	resilient to climate change, and economically viable. The proposed assistance will promote a holistic approach to sustainable herding and livelihood diversification in candidate project soums, namely, Buutsagaan, Khureemarel, and Dzag in Bayanhongor aimag. For both activities, smooth formation of HGOs is crucial. Sustainable herding will comprise collective pasture management, water point management, hay preparation, and management of herd sizes through effective marketing. This project provides opportunities for value-added activities, and other income-generating activities to help them diversify their income sources. Income diversification is considered as a means of climate change adaptation by lessening their reliance on the weather-sensitive herding.

Table 15 Past and on-going projects on climate vulnerability, EBA, land and water

Project title	**Funded body, duration and budget**	**Initiatives / Interventions**	**Areas for Potential Collaboration**
Ecosystem Based Adaptation Approach to Maintaining Water Security in Critical Water Catchments in Mongolia (EBA-Water)	Funded by: Adaptation fund and UNDP Duration: 2012-2017 Budget: 5,500,000 USD	UNDP's project wants to implement landscape strategies for land and water management to increase resilience and reduce the vulnerability of the local communities and their livelihoods.	EBA project is one of few innovative projects taking a rigorous ecosystem approach to climate risks and at the same time is fully coherence with the climate change adaptation strategy of the country. Under the project implementation, integrated strategies and management plans for target landscapes and river basins have been developed and are under implementation already in 3 Aimags and 17 Soums.
Green Gold project (GG)	Funded by: Swiss Development Cooperation Duration: 2013-2016 Budget: 9,880,880 CHF	The Green Gold project is implemented in the western region of Mongolia (Zavkhan, Uvs, Khovd, Bayankhongor and Bayan-Ulgii, Gob-altai, Arkhangai). The project aims to contribute to improved livelihood of herders and households by ensuring the sustainable management of rangelands and securing better access to technological knowledge	Through the project implementation and interventions, CBO of herders (PUGs) have been promoted for sustainable use of rangeland resources and for improved economic opportunities. As of 2014, 960 PUGs and 67 herders' marketing cooperatives have been formed in 96 soums in the western provinces, involving 53,000 households (30 percent of all herder households). Under the project implementation, 130 PUGs (23 soums) rehabilitated 5.6 million ha of degraded rangelands. A total of 6,200 ha of hay fields were fenced for improved yields and production. Eighty hectares have been cultivated for fodder productions. Annual sales for livestock production (meat, milk, skin, wool) have reached to MNT 1.6 billion. Currently, under the name of Green Gold and Animal health consolidation project, new project

		management and markets.	has been started from 2016-2020 funded by SDC. The project aims to replicate and scale up the previous projects' best practices and initiatives through other parts of Mongolia.
Sustainable Land Management for Combating Desertification (SLMCD)	Funded by: UNDP and GEF Duration: 2008-2012 Budget: 4,150,000 USD	SLMCD project was implemented by MoFA and MET. It successfully piloted and scaled up sustainable land management practices based on a collaborative management approach. This project was implemented in 13 Soums of 4 Aimags. The objective of the project was to strengthen and enabling environment for sustainable land management by building capacities in appropriate government institutions and user groups and demonstrating good practice in SLM through on-ground interventions that are integrated with national economic and social development policies.	Core activities were land and pasture management, water management, combating desertification measures (including pasture and forest), strengthening institutional capacity, community based natural resource management, and alternative income generation in 4 target aimags. The project successfully piloted a series of practices for sustainable pasture use, (re)-introducing rotation and resting, fodder production, rehabilitation of water sources, protection from soil erosion, establishment of windbreaks, intercropping, and cultivation of trees and bushes. The project's technical reports inform on species for fodder production windbreaks, soil protection feasible for different zones, and the project published a series of educational pamphlets for agricultural extension. Knowledge on herders' institutions for pasture management and income generation, and processing and marketing generated by the SLM project, has been much expanded in recent years, with contributions by other projects supported by the UNDP, World Bank ("Sustainable Livelihoods Project", now phase 3), SDC (Green Gold Project), and IFAD (Project for Market and Pasture Management Development) and all of which share approaches of collective action by herders.

Table 16 Past and on-going projects on herders' income and vulnerability

Project title	Funded body, duration and budget	Initiatives / Interventions	Areas for Potential Collaboration
Market and Pasture Management Development (MPMD)	Funded by: IFAD Duration: 2012-2016 Budget: 11,500,000 USD	The objective of the project is to reduce poverty, improve livelihoods of poor herder and households in the Soums and Aimags project areas.	The main aim is to increase the capacity and resilience of herders to cope with climate change impacts and to establish grassroots herder institutions for sustainable pasture management through assistance to herders' communities for the formation of pasture herder groups (PHGs) and in the development of pasture management plans that will be consolidated at soum level, financial and nonfinancial support to PHGs. The project supported the participatory definition of geographic Pasture Units and their approval by

			the soum administration, and the establishment, registration and training of about 135 Pasture Herder Groups. As of 2013, 60 herders pasture groups have been established. Furthermore, this project wants to implement Market Development activities through: i) selection of service providers; and ii) a loan guarantee facility. The Value Chain development outcome target is to assist 5 500 households in the project area to increase their sales and profits in 15 value chains. In addition, it seeks to assist 500 households to enter into collective commercial arrangements that share risk and profit with private sector partners.
Mongolia Livestock Sector Adaptation Project (MLSAP)	Funded by: GEF, IFAD and Ministry Industry and Agriculture Duration: 2010-2016 Budget: 13,105,000 USD (with soft loans)	The project wants to increase the resilience of Mongolian livestock system and mitigate the negative effects of climatic by strengthening the adaptive capacity of the livestock system as well as the capacity of herders' groups to cope with negative effects of climate change	This project wants to increase the resilience of Mongolian livestock system to changing climatic conditions by strengthening the adaptive capacity of the livestock system as well as the capacity of herders' groups to address climate-induced changes. In addition it wants to strengthens the herders' income and improve the herders' capacity to develop new small and medium business. Furthermore, this project wants, i) to improve the correct management of natural resources and increase their resilience to climate change, ii) improve water supply in the pastures, iii) build the capacity of herders' groups to address climate change .
Livestock and Agriculture Marketing Project (LAMP)	Funded by: World Bank and implemented by FAO Duration: 2013-2017 Budget: 11,500,000 USD	The project goal is to improve rural livelihoods and food security in selected aimags and soums through investments in enhancing productivity, market access and diversification in livestock-based production systems.	This project aims to remove market constraints and provide market access to herders, and householders in rural areas. In addition, it wants to improve the price-quality relationships and increase livestock production keeping into consideration animal health, animal breeding, genetics and nutrition that need to be treated in an integrated manner. The demonstration of these integrated, market-driven approaches in a small geographic area (pilot) will provide successful models that the GOM can replicate through the National Livestock Program (NLP). The project will also support pro-poor income growth and nutrition diversification through the production of agriculture products at the household level.

2.2.2. Analysis of best practices and lessons learned

Best practices and lesson learned in climate change information, EBA and livestock

Many of the best practices and lessons learned from past and present projects are presented in Table 16 and can be applied in the four aimags targeted for intervention.

Table 17 Summary of best practices and lessons learned from past and on-going projects

Best practices/lessons learned	Tried through which projects	Applicable to which sectors
An extensive analysis of climate change impacts in Mongolia was conducted in the livestock and agriculture sectors at the aimag and soum levels. The use of advance regional modeling has revealed the vulnerability of Mongolia to climate shocks in the medium- and long- term.	ECC-LCG, ECRRL, partially also in SLLC-DRR	Sectors of application: Early warning system, analysis of weather and climate, and livestock sector.
A cost and benefit analysis for the development of a climate change information system has revealed that an investment in improving the EWS is extremely important because it can save human lives as well livestock and goods.	ECC-LCG, SLLC-DRR, and ECRRL	Sectors of application: Early warning system, investments in the EWS, economic and social impact of climate change.
Climate policy, EWS policy, environmental policy and any policy that mitigates the negative effects of climate or increases the resilience of local populations should be developed in Mongolia. Particular attention should be devoted to the practical application of the environmental policies. For this reason, the analysis of gaps in the legislation and the correct application should be investigated carefully.	ECC-LCG, partially in LAMP and GG, SLLC-DRR, ECRRL, and EBA-Water security	Sectors of application: Early warning system, EBA, and policy development,
Improvement of herders' livelihood, (who are largely poor and vulnerable), is the priority of many projects in Mongolia. Risk reduction, vulnerability and exposure to extreme climate events (dzud, drought etc) as well reducing unemployment in the rural areas and increasing income for the herders are an important priority for the country. This	*ECC-LCG,* GG, EBA-Water, *SLMCD, MPMD, MLSAP and LAMP*	Sectors of application: herders' income, risk reduction, vulnerability and exposure.

importance is also reflected in the national legislation.		
It has been demonstrated that a correct management of ecosystems can mitigate the negative effects of climate. A correct management of basins, water, pastures, and forests can reduce the impact of extreme events. A common element among many projects is an integrated strategy approach where a healthy ecosystem interacts with animals and humans and contributes to mitigate the negative climate effects.	EBA-Water, GG, *SLMCD, MPMD, MLSAP and LAMP*	Sectors of application: EBA, climate change, integrated strategy.
The creation of herders groups and herders' marketing cooperatives have created new sustainable jobs in rural areas, alleviated poverty and generated 'green' income. Many projects have promoted with success the creation of aggregations among herders for sustainable use of rangeland, forest and water resources in all Mongolia. In addition, the creation of agreements around specific areas (water, pasture, forest etc) has reduced the conflicts among people.	GG, EBA-Water, SLMCD and LAMP	Sectors of application: EBA, Rangeland Use Agreement, Watershed use and management agreements, Community Infrastructure development and management agreements, and Forest management agreement
Dairy and meat value chains are weak in Mongolia and improvement can increase herders' income, improve profit for the industry and reduce sanitation risks for consumers. The export of products of animal origin (meat, milk, cheese etc) is limited and this area should be developed in the future. Lack of knowledge and lack of technology are the main obstacles for the export of meat.	*MPMD, MLSAP and LAMP*	Sectors of application: Value chain, livestock productions, market, export and organic productions

The internal market must be modernized with a reduction of intermediaries and an improvement of the cold chain. Lack of international certifications, in particular for the organic productions, is another area that needs to be developed.		

The importance of a participatory approach.
A major lesson learned from the past projects is that herders' participation in planning, design and implementation of such projects is very important to ensure the sustainability and cost effectiveness. In the MPMD project, the pasture user groups (PUG) organizations have proved to be an effective approach to facilitate collective actions for improved pastureland management, water management and livestock management, whereby group members collaborate better among themselves and with the soum government on pasture, water and livestock management issues. First, PUGs tend to be better prepared to propose actions and request support for pasture, water and livestock management beneficial for their member households in bag meetings; the conclusions and proposals of which inform the soum level pastureland plan. Second, PUGs act as institutions through which the soum pasture land management plan can be implemented more effectively. Bag governor and soum level officers work more easily and efficiently with herder households that are organized in groups and have a leader. PUGs have become an institution to facilitate co-management between the government as the owner of the pastureland and herders as the users.

PUGs members improve pastures and collaborate together for hay making, well digging/rehabilitation, building winter shelters, and dividing tasks in herding of large and small livestock. Organization in groups also promotes several mechanisms from which poor households benefit. Poorer households are able to undertake seasonal moves, access equipment (such as for hay making), engage in paid labor, engage in herding activities, social inclusion, access to information, and access to small credits[5]. In traditional herder households, gender roles tend to be distinctive; men are more engaged with pasture management, and women play a key role in social organization of the group and exploration of economic opportunities, both in the livestock and non-livestock sector. Joint activities as group members suggest that women's workloads are reduced and financial incentives have increased, for example through increased opportunities for dairy processing.

Pasture User Groups
Community based organizations of herders (PUGs) have been promoted for the sustainable use of pasturelands and for improved economic opportunities under the Green Gold project of SDC. The main functions of the PUGs are to define and agree on grazing boundaries of communal rangelands and develop seasonal rotational grazing plans. In addition, PUGs are responsible for the adoption of rules to pursue the seasonal rotational grazing plans and access to communal rangelands. Furthermore, its role includes monitoring the correct application of rules by all members. Currently, there are 1,100 PUGs in 126 soums of seven western aimags (Arkhangai, Bayanhongor, Uvs, Bayan-Olgy, Hovd, Zavkhan, Gobi Altai) to rehabilitate degraded pasturelands, improve yield, and cultivate fodder [30]. These PUGs and cooperatives will be key partners for some activities undertaken by the

[5] According to stakeholders and project staff, herders who participated in the project suffered significantly fewer herd losses in the 2009-2010 dzud than did other herders in the same region. Assessment for Development Results, UNDP Mongolia 2011

project. Since 2010, the establishment of Rangeland Use Agreements between PUGs and Soum governments for improved responsibility mechanisms for rangeland degradation has been introduced by the Green Gold project of SDC. There are two levels of rangeland use agreements. The first level is to enforce the seasonal rotational grazing and resting schedule agreed between PUGs and soum government, and the second level is to agree on long-term maintenance of rangeland health and plan to adjust and reduce animal numbers to a correct pasture carrying capacity. As of June 2016, 670 PUGs have established rangeland use agreements with local government [31].

Integrated adaptation strategies and the role of ecosystems

An important best practice is the 'Integrated Adaptation Strategies' necessary to maintain ecosystem functions and water provisioning services in Mongolia. The EBA-Water project [30] adopted an integration approach including together the ecosystem in the broad sense, water and the poor (who are the most vulnerable to climate change). The main approach applies the principles of Ecosystem-Based Adaptation to reduce climate change risks, which also involves to strengthening the policy and legal frameworks for increased adaptation, enhanced stakeholder participation as well as capacity building of rural capacities in decision making, and trainings in various adaptation skills of communities and governmental entities.

The outcome of this best practice is that taking an integrated ecosystem approach is one of the most appropriate strategies to enhance climate resilience. The major successes of this best practice can be seen in the improved natural capital of rehabilitated creeks, rangelands and protected areas. In addition, improved incomes and livelihoods have been established mainly through enhanced agricultural productivity and wool processing units.

Forecasting weather and climate events to at-risk communities

Investing in risk reduction is costly and a challenge for a nation that has limited resources and so many competing development priorities. However, given the impact on infrastructure, animals and humans lives, and the cost to livelihoods, risk reduction measures can often be justified. The following lessons were learned from literature surveys and stakeholder consultations:

- The lesson that can be learned from the current use of weather forecasts issued by the SLLC-DRR, ECC-LCG and ECRRL projects in Mongolia is that the dissemination of forecasted medium- and long-term seasonal weather information to herders is technically feasible, but technical capacity enhancement of the officials of both the government and local authorities is urgently needed. The accuracy of the forecasts has to be improved to ensure acceptance and timely action at the local level. For this reason, training of technical personal at local and national levels is required together with an upgrade of hardware and software for better weather and climate predictions.
- The experiences already gained in Mongolia suggest that climate-related information should come with a ready-to-apply set of solutions including what crops/vegetables to cultivate and when, carrying capacity of land and water availability for livestock and how to access the markets (e.g., prices, location where to sell the products).
- Interventions should be carried out in a participatory manner, to enable addressing the community needs and NGOs, private sector and the communities have a role to play in weather information provision and data sharing.
- Timely and unrestricted sharing of information and meteorological data between the many different agencies and private sector that collect such information is essential to ensure optimum results from the investments in this field.

3. Gaps, Needs and Barriers

This section presents and discusses three main topics: i) climate forecasting and planning, ii) ecosystem-based adaptation and water resources, iii) herder livelihoods, livestock and vulnerability. Each section includes a description of the current situation needs (baseline), the gaps and barriers of the current systems that impede the full development of these three areas of intervention.

EWS, weather and seasonal forecasting and planning

According to current legal framework, only the Government of Mongolia is directly responsible for weather, climate and hydrological monitoring and warnings in Mongolia. However, there are limits to the existing technical capacity, storage size and computing speed of the current system.

General circulation models (GCM) or global climate models are the main tools to predict atmospheric dynamics on a monthly, seasonal and annual basis. Ensemble prediction is required for operational weather forecasting that allows for more rapid and scientifically based comparisons of multiple model forecasts. Ensemble prediction system has the advantages of reducing uncertainties and dealing with the nonlinearity of atmosphere. Specifically, they have been applied to high-impact weather and climate forecasting including drought and dzud.

These forecasts are disseminated via NAMEM aimag bureaus to aimag governments, soum governments and directly to herder households via radio, TV and mass mobile phone Short Message Services (SMS). In cases of extreme events, NAMEM collaborates with the National Emergency Management Agency (NEMA) to mobilize relevant government departments at both the central and aimag levels to allocate resources and implement response measures.

Current status of investments in EWS, weather and seasonal forecasting in Mongolia.

From the mid-1960s, the National Agency of Meteorology, Hydrology, and Environment Monitoring (NAMEM) started to provide a monthly weather forecast to the public. At present, NAMEM releases a monthly weather and seasonal outlook. Based on the current legal framework, only the Government of Mongolia is responsible for weather, climate and hydrological monitoring and warnings in Mongolia. The private sector, universities and academic institutions are not officially involved in these activities. Therefore, NAMEM, including early warning systems, weather and seasonal forecasting activities are funded fully by the public budget. The budget allocation for the agency has remained constant over the last 5 years at approximately USD8.7 million per annum, sufficient for operational costs, but not for the enhancements or upgrades needed for NAMEM to respond to existing and emerging needs.

NAMEM, the central Government agency in charge of overall environmental monitoring, has a relatively advanced weather forecast system. It has a well-established Numerical Weather Prediction (NWP) modeling software installed on its High-Performance Computing (HPC) system. NWP leads to dozens of downstream products and services, ranging from daily, weekly and monthly weather forecasts, air pollution monitoring and seasonal and long-term climate prognosis. Seasonal forecasts include hydrological and drought forecasts, harsh winter and summer forecasts, as well as early warning based on forecasts.

NAMEM receives data from the National Center for Remote Sensing and international satellites to collate and disseminate information across the country via the 21 NAMEM bureaus (one in each aimag). At present, over the territory of Mongolia, a total of relatively evenly distributed 137 synoptic stations are operational and collect weather and environmental data every 3 hours and additional 181 monitoring posts that collect data every eight hours. The hydrometeorological network operates 24 hours with 5-6 employees, and automatic data loggers are coupled with traditional (analogue) data collection system in 95 of the stations. The network also includes 181 monitoring posts with 1-2 employees each. There are 7 upper-air, as well as 147 hydrological and 152 agro-meteorological observation posts. The hydrometeorology agency employs 1,979 individuals at central and local (aimag and soum) levels.

A radiosonde is launched once or twice a day at four upper air stations. Data collected from these stations are fed into the weather forecast models. One Doppler Weather Radar is available in Ulaanbaatar, the capital city, the effective range can reach 300 kms.

All forecast models are simulated at the forecast and prognosis division of the NAMEM Head office in Ulaanbaatar, the Capital city and disseminated to 21 local branches at the aimag centers. In the short- and medium-term forecasting and prognosis division, a total of 5 technology engineers and 12 synoptic engineers work on shifts without interruption (24x7). Long-term prognosis division operates with one technology engineer and one synoptic engineer. The prognosis division also provides technical backstopping to the local branches on needs basis. Local (aimag) branches are in the process of learning to run forecast models for their respective territories to further refine the results obtained from the central office.

NAMEM started to utilize its HPC system in 2005, after which the accuracy of short- and medium-term weather forecasts improved significantly. The accuracy rate is estimated at approximately 90% for weather forecasts up to three days of lead time. The NWP models simulates numerous models that include several different domains at four different grid sizes (resolution). With the existing HPC, four different prognosis models are being simulated with five days of lead time. The simulation takes three hours for each of these prognosis models and therefore the HPC capacity is fully and continuously utilized for short- and medium-term forecasts. For seasonal to long-term forecasts, the accuracy of modelling, as well as capacity of HPC to simulate such models is challenged. Accuracy rate is approximately 60% when lead time is one to three months.

NAMEM had a small range high-performance computer (HPC) installed in 2011, with which the agency can assess regional atmospheric models with 30 km grid resolution for short range forecast with an advance time of 48 hours. Since then the grid resolution was increased up to 9km and forecast advance times can vary according to all or some of following information: monthly mean temperature anomaly, precipitation ratio anomaly and wind speed. There are three categories: below normal, near normal, and above normal. The lower and upper limits are –10C and +10C from normal temperature and 80% to 120% from normal precipitation. The monthly weather outlook is issued at the end of each month. The monthly weather forecast includes more detailed information about change of weather condition both in time and place. The seasonal forecast includes temperature anomaly and precipitation ratio by category for each month during the season. The seasonal forecast is issued two times a year, in late March (warm season) and in late August (cold season). The seasonal prediction is mostly based on old statistical methods, which are using old and not updatable technology.

The three hours computing time with the current HPC system would decrease to one hour with the an upgraded HPC with the lead time of five days. The proposed HPC will allow extension of lead time to 10 days without huge challenges. A dynamic forecast model with a month of a lead time requires three days of simulation time with the current HPC, whereas with the proposed HPC, it will be reduced to 10 hours only. In order to run long-term prognosis models, starting from seasonal (three months) to hundreds of years on different scenario, the regular short-term forecasting exercise need to be put on hold. Due to these challenges, the dynamic forecast models are not being used as often as required. The memory extension of the current HPC through the installment of extra hard disks is no longer possible, as the manufacturer is not producing the same model anymore.

Gaps and Barriers in EWS, weather, seasonal forecasting and planning
The main gap is the lack of accurate weather predictions caused by old meteorological models, old technology and limited capacity of hardware to process and store large quantities of data in a relatively short time. The report on Technology Needs Assessment for Climate Change Adaptation in Mongolia [31] has identified that the highest prioritized technology for the animal husbandry sector is to improve seasonal prediction and Livestock Early Warning System (SPLEWS). Improving seasonal prediction and longer term forecasting could support climate-informed planning and adaptation.

The short- and medium-term extreme weather events, such as high rain, high snowfall, wind-dust-snow storms, squalls, thunderstorms, floods (rain and flash) cause significant economic losses and social consequences. Therefore, weather, seasonal forecasts and early warnings of the medium- and long-term weather conditions could inform preparedness measures to the impacts of disasters and adaptation planning.

Next steps: The general circulation models (GCM) or Global climate models are the main powerful tools to predict atmospheric dynamics a month, a season, and years in advance. Forecasters have always understood the value of examining multiple NWP forecasts to help produce a more reliable public forecast. They have done this by comparing several different NWP forecasts. Ensemble prediction is a relatively new tool for operational forecasting that allows for more rapid and scientifically based comparisons of multiple model forecasts. Ensemble prediction systems have the advantage in beating the uncertainties and dealing with the nonlinearity of atmosphere. Specifically, they have been applied to high-impact seasonal forecasting including slow onset disasters, *i.e.* drought and dzud. However, to apply and develop GCM and ensemble prediction systems require computing power, storage capacity, and adequate training of technical staff that are not currently available.

Gaps and Barriers in capacities for forecasting
Under ongoing climate change scenarios, the predictability of the climate system is a challenge. The region is associated with the largest warming rate over the past century. Accurate forecasts are essential to ensure acceptance and timely action at the local level. Training of technical personnel at local and national levels together with an upgrade of hardware and software for better weather and climate predictions are vital for efficient and effective protection of herders and their livestock.

Statistical prediction systems in Mongolia are limited. There are needs for strengthening climate forecasting using comprehensive dynamic prediction systems for medium- (monthly) and long-term (seasonal) weather outlooks to forecast and predict extreme weather and climate events. An improved system is required for short-term, monthly and seasonal weather outlooks, which are provide useful information to herders and farmers. Due to limited resources, the training of the technical staff on modern methodologies, advance statistical systems, multidimensional analysis and data sharing techniques have been postponed indefinitely. Today, there is a need for long- and short-training courses for the technical staff in the central headquarters, in the aimags, and in the soums. Lack of training and lack of a modern dynamic prediction system are two important barriers that drastically limit the medium- and long- term prediction capacity.

Storage capacity is also a limitation. While existing computing and storage capacity is sufficient to use the data for current application (i.e. daily to weekly weather forecasts), investment is needed in order to expand beyond this. With the existing system, 536 out of the available 768 cores are used for short term weather forecast models, prohibiting expansion towards longer forecasts with finer grids for higher accuracy, particularly for a country covering 1,564,116 km2. Upgrades in the computing and storage capacity would allow for more accurate projections to better inform planning and adaptation measures (i.e. land and water resources management, livestock, rangeland, arable farming, health, infrastructure, disaster management, water resource, forest, permafrost, wild animals, ecosystem etc.). Applying this information to planning and for climate-resilient policies, will also require strengthening capacity of technical staff to develop the necessary models and analyses, as well as sensitization of decision-makers to the impacts of climate change on natural resources and thus herder livelihoods. Adding more storage capacity to the existing system is not an option as compatible cores are not available.

Livestock, Pasture Management and Herder Livelihoods

The herders, livestock and pasture sectors are key sectors for the national economy because they provide food, work, and social stability for the entire country. At the same time, these sectors are exposed and vulnerable to the negative effects of climate change. The national authorities and the international community have recognized the importance of reducing the vulnerability of these sectors, and a number of important projects and funds have invested in herders, livestock, and pasture management activities and are summarized in Table 17. The financial investments in this sector are mainly for local activities and are from the government budget.

Table 18 Policies on livestock, herders and pasture management and current status of implementation

Sector	Current undertakings	Strategy or programmes name	Current status of implementation
	The aim is to align the number of animals with pasture carrying capacities at regional and local levels. This can be done by coordinating a number of herders' groups.	"Mongolian Livestock" National Programme, (2010-2021)	The government has proposed amendments to Mongolian law on land and developed guidelines for pasture land usage taxation based on the number of animals, types and regional contexts.
	The aim is to improve an effective coordination of pasture usage. It was decided that during disasters, a reserve of at least 10% of pasture for otor movement must be guaranteed.	"Mongolian Livestock" National Programme, (2010-2021)	There are 7 sites of reserve otor pasture for special purposes at provincial level which occupy 783.3 thousand ha (0.6% of the total pastureland). At soum level, there is 6.3 million ha pasture (4.7% of soum land) which can be used as reserve pasture during disasters.
	With the purpose of water supply in pasture, 410 new engineering wells are established annually.	"Mongolian Livestock" National Programme, (2010-2021)	Annually MNT 7.5 billion are spent from the State budget on establishing new wells in rural areas.

Pasture, herds, livestock, EBA	The aim is to improve water supply in pastures. Exploration studies on water points are conducted in 500 points in rural areas of Mongolia.	"Mongolian Livestock" National Programme, (2010-2021)	A total of MNT 600 million were spent for exploration study for 500 water points.
	The aim is to use environmentally, human and animal-friendly technologies against pasture insects and rodents.	"Mongolian Livestock" National Programme, (2010-2021)	Every year, the Government budgets USD 1 million and facilitates the application of environment-friendly measures based on monitoring and surveys.
	The aims are i) to extend pasture and desertification monitoring systems, ii) to conduct systematic pasture pests and insects observation and, iii) to develop guidelines for pasture health assessment.	The first phase of NAPCC, (2011-2016)	The National Agency for Meteorology, Hydrology, Environment and Monitoring has implemented projects funded by donor agencies and developed technical guidelines for pasture and soil monitoring. This practice is conducted in 1500 points in the areas covered by the national monitoring network. The database has been established and a National Pasture Status report is produced annually.

Source: Intended Nationally Determined Contribution, 2015

As of 2015, there are 7 sites of reserve otor pasture for a special purpose were fenced at provincial levels, which occupy 783.3 thousand ha (0.6% of the total pastureland). At soum level, there is 6.3 million ha pasture (4.7% of soum land) which can be used as reserve pasture during disasters as well. As reported by the MoFA, the country needs to extend areas for reserve pasture to decrease livestock mortality during harsh winters and improve livestock quality.

Current needs for improving livestock and pasture management. Pasture degradation and desertification are among the most serious environmental problems in Mongolia. In the countryside, pasture degradation is widespread and occurs in all ecosystems at different intensities. Pasture degradation in the country has manifested in several ways: decreased biomass production, soil fertility decline, and desertification, fewer palatable plants and more unpalatable plant species.

In addition, physical damage by human activities has increased extensively pasture ecosystem degradation. At present, about 70% of pastureland is degraded in some form. Overgrazing, off-road driving, mining, global warming, low precipitation and lack of land management skills are causing more and more problems for the ecosystem rangelands in Mongolia. Thus it is becoming increasingly difficult to provide the necessary amount of fodder for the livestock that are the main source of income for more than one third of the population.

There can be different categories of pastures depending on usage.

- Otor pasture is reserved pasture to where herders move when faced with a critical situation such as changing pasture or weather conditions. They differ from seasonal pasture moves because the movement of the animals is not regular and usually does not include the entire herd and the household.
- Transit pasture is used temporarily while animals are moving to other locations.
- Peri-urban pasture.
- Pasture for intensified livestock settled in a fixed location.
- Pasture for nomadic livestock.

Gaps and Barriers in livestock, pasture management and herders livelihoods. Pasture is the main source of livestock feed in Mongolia, while in other countries, crop production (e.g. corn, silage, soya) plays an important role as sources of protein and energy. Herders in Mongolia are more vulnerable to climate change than herders in other countries because 100% of animals' feed comes from pastures only, and pastures are exposed to the effects of climate change more than intensive crop productions. The impossibility (due to cost and limited accessibility) for herders to access grass and feed concentrate during the winter, expose them and their animals to greater risks. On the other hand, well managed pastures helps to protect the environment and natural resources and also continue to sustain ecological functions and services. The report on Technology Needs Assessment for Climate Change Adaptation in Mongolia has identified gaps along the value chain, and one important barrier in the animal husbandry sector is the insufficient sustainable pasture management (SPM) [32]. SPM helps sustain healthy soils and restore degraded pastures, which bring many benefits including ensuring sustainable animal husbandry, alleviating rural poverty and building resilience to major environmental challenges. For sustainable pasture management it is essential to restore degraded land while preventing further degradation and ensuring continued ecosystem health.

In addition, gaps and barriers that are limiting the development of these important sectors are included below.

- Lack of laws, policies and coordination on pastoral livestock husbandry. Technical capacities of land managers to plan land use, including sustainable pasture management, remains low. While customary rules still apply, they are not sufficient to address the new challenges of increased livestock numbers. Institutions for managing pasture use and livestock movements have been unable to confront the challenges of private herds on state-owned pasture land, with unclear rules of pasture use.
- Poor enforcement of land use contracts and responsibilities at soum levels. In May 2016, the Law on Pastureland was approved by the Cabinet, which will allow pasture user groups to obtain possession rights over pastureland they reside in. Although supported through development partner projects, participatory planning for managing pasture use is not often practiced.
- Development of Sustainable Pasture Management. In order to appropriately manage pasture for winter and spring, information about drought, summer pasture production, pasture capacity, number of animals and predicted winter weather needs should be correctly analyzed, processed and delivered to the final beneficiaries. Associated risks should be assessed and based on public information, recommendations should be disseminated. Better organization of functions, responsibilities and organization of work is required. Participation of herders and the local community should be ensured in pasture management at all levels.
- Lack of otor coordination. There is a lack of coordination among otors, competent authorities and herders. In addition, herders are not coordinated with rural communities and this exposes the otor to overgrazing and desertification risks.

- Producing supplemental feed for winter and spring. Fodder storages with a capacity of 100 ton were built in the western region Zavkhan and Gobisumber aimags. There are many locally known methods for producing supplemental feed for animals. These methods should be studied and the technology for producing supplementary feed should be standardized and tested. This technology requires 6-8 years to be introduced in all soums and aimags, and it represents an import barrier to future improvement of this technology.
- Planting of forage perennials resistant to drought for fodder production. These measures are not undertaken yet at the national level due to lack of financial support.
- Forage production. During 1986-1990, Mongolia produced circa 1 million tons of forage a year. Since 1990, forage production has decreased by about 65% due to privatization of livestock [32]. Thirteen big cooperatives and 27 small factories which produced animal fodder at the local level were closed down. At the same time, the livestock numbers have increased significantly and reached 56 million in 2015. However, natural resources are limited, because about 70% of pasture has been classified as degraded to a certain extent, production of hay has decreased and the diversity of plants has declined. The main barrier is the lack of sufficient seed productions adapted to resist the drought and frost of the Mongolian environment. On the other hand, importation of seeds from abroad exposes the country to the risk of introducing alien species.
- Production of supplementary forage with bacterial enzymes for livestock. There are about 2600 plants growing in pastures in Mongolia and 600 of them are eaten by livestock [32]. Pasture biomass varies greatly due to soil characteristics and seasons. During winter, pasture biomass decreases significantly, its energy content is reduced by 50%-70%, and protein content by 60%-70% compared to summer. Therefore, animals cannot graze sufficient forage during winter and they lose 25%-30% of live weight. Due to malnutrition and increased of frequency of diseases, many animals die during winter. For example, in Mongolia during the winter of 2010 circa 10.2 million animals died due to malnutrition and diseases. Enzymes can help improve the digestibility of forage. For this reason, adding specific enzymes or ammonia to low quality forage or straws can increase digestibility and reduce methane production [33].
- Rain and snow water harvesting for herder groups. This technology is not implemented widely at the national level. Because of global warming and climate change, rainfall in summer is expected to decrease and winter precipitation is expected to increase. The decrease in summer rain will lead to drying of rivers, streams, and pasture water, and consequently impact the production of pasture biomass for forage production. Rain and snow water harvesting is a particularly suitable technology for areas where there is limited surface water, or where groundwater is deep or inaccessible due to hard ground conditions. The incapacity of melting and transporting winter and spring snow represents an important barrier particularly in marginal areas of the country. This technology can be used efficiently for the production of drinkable water from spring snow for animals and human consumption.

Water resources

The water sector in Mongolia is institutionally complex. At least six ministries are involved in the management of the water sector: the main ministries are the Ministry of Environment and Tourism (MET), The Ministry of Construction and Urban Development (MCUD), The Ministry of Mineral Resources and Energy (MOME) and The Ministry of Food and Agriculture, and Light Industry (MoFALI). A number of efforts on water management have been undertaken by the government of Mongolia under national priority programs and invested funds. Water management activities are briefly summarized in Table 18.

Table 19 Water resources and national strategic programmes

Sector	Current undertakings	Strategy or programmes names	Current status of implementation
Water resources, water points and strategies	The aim is to forbid mineral exploration and exploitation in 30% of the area of upstream rivers, where at least 70% of water and runoff are accumulated.	"Law to prohibit mining exploration and exploitation in areas of upper streams of rivers and water sources and forestry", 2009	In 2014, state protected areas reached up to 17.4% of the total land, including the upper stream of rivers and water sources, in order to maintain wildlife and ecosystems balance.
	The aim is to improve water resource and correct use of water.	"Water" National Programme, (2010-2020)	Integrated water basin management plans were implemented in 7 river basins in 2015.
	Improvement of water supply on pastures. 410 new engineering wells are established every year.	"Mongolian Livestock" National Programme, (2010-2021)	Every year MNT 7.5 billion are spent from the state budget on establishing new engineering wells in rural areas.
	Improvement of water supply on pastures. An extensive exploration study on water points is conducted in 500 water points in rural areas of Mongolia	"Mongolian Livestock" National Programme, (2010-2021)	A total of MNT 600 million were spent for exploration studies in 500 water points.
	In 2014-2016, new water drilling machines were purchased and provided in 8 provinces.	"Mongolian Livestock" National Programme, (2010-2021)	The government has invested in new and modern water drilling machines.
	The aim is to integrate ecosystem based adaptation measures in river basins.	*'Ecosystem Based Adaptation Approach to Maintaining Water Security in Critical Water Catchments in Mongolia"* project (2012-2017)	The project is implemented in Kharhiraa-Turgen rivers basin in the western region, and Ulz river basin in the eastern region. The goals are strengthening national and local adaptation capacity through conservation of riparian and basin ecosystems in these areas.

Source: Intended nationally determined contribution, 2015

Current status of water availability

The latest study commissioned by MET/UNDP shows that the permafrost distribution shrank by 5% over the entire national territory [3]. The overall conclusion is that changes in water availability are expected to continue in Mongolia. The Technology Needs Assessment report [32] confirms that the vulnerability of the water sector is rated higher than that of human health, forestry and infrastructure sectors. Currently, the biggest water use is the agricultural sector and in the future mining will be a major water user, as shown in Table 19. Projected water demand with high scenarios would be agriculture, including livestock and irrigation. Consequently, ecosystem-based water saving technologies such as drip irrigation and rain and snow water harvesting are crucial measures to build resilience of the arable farming and livestock subsectors.

Table 20 Overview of water use (2008, 2010) and projected water demand (2015, 2021) in low, medium and high scenarios

Sectors	Sub-sectors	Total water demand (million m^3/year)							
		2008	2010	2015			2021		
				low	medium	high	low	medium	high
Domestic	Urban	46.9	51.9	66.4	70.9	78.6	67.2	72.9	81.8
	Rural	2.6	3.2	4.1	4.0	4.0	5.9	6.0	6.0
Agriculture	Livestock	94.7	76.9	90.2	94.9	109.4	103.1	108.6	117.3
	Irrigation	83.5	98.7	125.0	169.8	203.2	165.5	260.8	360.0
Industries	Mining	49.4	41.5	52.5	81.1	103.5	61.8	111.1	187.8
	Heavy Industries	1.3	1.3	1.6	1.8	2.3	2.0	2.7	4.7
	Manufacturing	2.2	3.6	4.4	5.1	6.6	5.6	7.6	13.5
	Construction	1.0	1.2	1.6	2.0	2.4	2.1	3.2	4.5
Energy	Power plants	35.2	33.4	37.8	44.7	54.3	43.9	63.5	97.3
Municipal	Commercial services	3.7	3.9	4.8	5.6	7.7	6.3	8.7	17.2
	Public services	5.3	5.5	5.8	5.9	6.7	6.0	6.5	8.5
	Green areas	0.3	2.5	2.6	2.6	2.7	2.7	2.9	3.0
Tourism		0.6	0.8	1.2	1.4	1.6	2.7	3.4	9.0
Road transport		2.3	2.7	3.2	3.6	4.1	4.1	4.5	5.0
Total		329	327.1	401.2	493.4	587.1	478.9	662.4	910.6

Source: IWMP, 2013

Gaps and Barriers in the water sector.

The country as a whole does have a tremendous potential of fresh water resources, but there are gaps in the distribution (for human and animal consumption) and much water is dispersed across a vast area. The main barrier (and a big water management challenge) is to make the water available at the locations of the needs. Furthermore, at some specific locations in the country, economic activities are rapidly intensifying (e.g. mining) and urbanization is growing fast. The water use is rising sharply, going hand in hand with increased production of waste and wastewater. Water resources are being polluted in the process, harming ecosystems and the environment and rendering the source unfit for consumption and other uses. Current gaps and barriers of each sub-sector are discussed below:

Water supply for livestock

Agriculture is an important economic sector in terms of employment, export revenues and contribution to GDP. In 2015 the sector accounted for 13.6% of the country's GDP and 28.4% of the population was engaged in agriculture. Due to a lack of maintenance and unresolved ownership, engineering-type wells have degraded and the number of operational wells has sharply declined in the last 20 years [34]. Main gaps related to water availability for livestock are:

- grazing areas cannot be used due to a lack of sufficient operating water points;
- grazing pressure is unacceptably high near urban and rural centers and isolated water points;

- problems with operation and maintenance of boreholes and ponds has resulted in a decline of operating water points;

Water for irrigation
In Mongolia the area irrigated is relatively small, and irrigation is used only when precipitations are insufficient to sustain the crop productions. After 1990, the irrigated area declined sharply and only in recent years has started to increase again. In 2010, 37 thousand ha (12%) agricultural land was irrigated out of a total sown area of 315 thousand ha [34]. The main gaps related to water for irrigation are:

- Irrigation infrastructure is generally poorly maintained in Mongolia. Since 1990 the irrigation infrastructure deteriorated due to lack of maintenance and unresolved ownership issues. Water use in crop irrigation is inefficient due to old techniques and equipment.
- Crops, vegetables and fruits are irrigated in a minimal part.
- Water saving technologies such as drip irrigation and rain and snow water harvesting are not diffused.
- The government wants to set-up new crop irrigation infrastructures to increase the area of irrigated crops. As a result, the irrigation water demand will increase considerably due to limited use of water saving technology.
- Limited herders' financing capabilities is one of the major barriers that impede the development of irrigation of pasture and agriculture areas.

Water for the environment
Depriving the environment of clean water would lead to a rapid deterioration of the natural ecosystem and its environmental services. Therefore, adequate quantity of good quality water should remain available for the natural environment. As stated in the Integrated Water Management Plan [34], the following gaps are analyzed and discussed for a sustainable provision of water for the environment:

- The protection of watersheds and water bodies is insufficient to preserve water quality.
- The hydrological regime of rivers is deteriorating due to deforestation, changing soil and vegetation cover, mining activities, hydropower generation, urbanization and the long-term negative effects of climate change.
- Increase of irrigated agriculture, combined with an intensification of the use of fertilizers and pesticides is a potential threat to water quality of lakes and rivers.
- Discharge of untreated water from mining operations often pollutes the receiving water bodies, e.g. with heavy metals, and increases total suspended solid loads.
- Mining activities, especially gold mining and open pit mining, have significant adverse environmental and water impacts. These activities change the landscape and the directions of rivers, and create temporary settlements that are often not restored after closing the mines.

The establishment of ponds, water wells and boreholes in rural areas and remote pastures are essential to increase water availability in the livestock sector. As stated in the National Water Program, a total of 800-1000 new wells should be constructed per year in the country (wells that should be rehabilitated are excluded from these numbers). Lack of local surveys and exploration studies to identify water resources for new boreholes, ponds and reservoirs in rural areas are a barrier for access to clean water. The construction of new and renovation of existing water sources (boreholes, ponds) in rural areas are essential for the harmonic development of animals and humans in these areas.

Conservation of water resources

In recent years, the hydrological regime of rivers is deteriorating and the protection of watersheds and water bodies is insufficient. As stated in the report of Integrated Water Management Plan [34], large amounts of water leave the country unused, and water is used inefficiently in manufacturing and mining operations.

Therefore, to remove the above gaps, the use of forest can be a valuable resource. Forests located in the upper parts of the basins are important as (water) runoff forming areas, but these areas are not well protected. Only 30.5% of the (water) runoff forming areas is located inside registered national or local protected areas [34]. An increase in (water) runoff forming areas inside the protected areas together with an improved enforcement of the protection measures will improve the conservation of water resources.

Restoration of water resources
Pollution of rivers usually is caused by mining activities and urban waste water discharge. Restoration of the water resources requires cleaning of the river sediments and termination of the pollution source. Such activities have not been started yet. Removing this barrier is a complex work but the competent authorities could start with an inventory of the existing pollution areas and can identify options for cleaning. In addition, another barrier is the lack of efficient and effective coordination among agencies and overlapping of functions. This key barrier has a negative impact in the management of the water resources at national and local levels. Shortages of adequately capable staff, cuts in the budget, and equipment are gaps particularly important and they require immediate actions [34].

Land and soil resources
The Government of Mongolia has undertaken a number of important national strategic programs on land management, soil conservation and restoration (Table 20). The financial investments for national programs in this sector are mainly for local activities and are from the government's budget. These investments are consistent but unfortunately are not sufficient to restore all degraded soils.

Table 21 Land management, soil conservation, restoration and national strategic programmes

Sector	Current undertakings	Strategy or programmes names	Current status of implementation
Land management, soil conservation and restoration	The aims are combating desertification and soil conservation at local level. A demonstrative approach is taken. The level of financial investments for soil conservation is increased every year.	In 2010, the National program for combating desertification is updated and approved. Under this program, sub-programs were developed at the local level. Law on soil conservation and combating desertification was approved in 2012.	The total financial support for soil conservation and combating desertification was MNT 2.6 billion in 2013, and increased to MNT 3.0 billion in 2014.
	In 2014, the total land affected by mining explorations and operations at national	Under the governmental law	The financial budget for the total land affected by

	level was 24,636.8 ha, of which 10,263.1 ha was technically restored and 6,781.5 ha was biologically restored. The rest of the land will be restored during the period 2014-2020 by mining companies.	of environmental protection areas.	mining operations was MNT 79,647.7 million in 2014
	A total of 720,000 ha of land, were conserved of which 600,000ha of land were for combating rodents and 120,000 ha of land for combating pest and insects.	Under the government action plan 2016-2020 and the Law on soil conservation and combating desertification.	Annually MNT 1.8 billion from the state budget is spent for combating rodents, pests and insects.
	In 2014, the land for the state special needs including special protected areas was expanded from 25,687.3 ha in 2011 to 27,199.3 ha in 2014.	Under the implementation of Green development Policy 2030	In 2014, the annual budget for land for the state special needs was MNT 6.4 billion including operational expenses. The annual budget increased by 9.6% compared to 2013.
	The government developed soil eco-regional assessments in coordination with TNC and other development partner organizations. This includes land use planning based on eco-regional assessment of 3 aimags in the Eastern-steppe, 6 aimags in Gobi region, and 5 aimags in the western and central regions.	Under the Governmental law of environmental protection areas.	A financial investment for the eco-regional assessment was USD 600,000 for the Eastern eco-region, USD 870,000 for the Gobi region, USD 150,000 for the western region, and USD 500,000 for the Central region. These funds were accumulated with the support of international organizations, including UNDP.

[a] The Mongolian Government has undertaken efficient measurements on land management and soil degradation. In 2015, MNT 1.8 billion from the state budget was spent for combating rodents, pests and insects, reported by MoFALI. Areas for land for special needs at national level are extending. These areas covered 24,877.4 thousand hectares (15.9 % of Mongolian territory) in 2010, however it reached 25,228.9 thousand hectares in 2014. The areas of the land for special needs increased by 351 thousand hectare during the last four year as a result of amendments to the relevant laws on specially protected areas.

Land management is a cross-sectoral issue, which involves multi-sector interventions involving soil, crop, pasture, livestock, forest, mining and ecosystem. Therefore, coordination mechanisms of land management are implemented as follows in Mongolia:

Land use planning. In Mongolia, land use plans are produced at three different levels. The first level is the 'National Land Management Plan', and it covers the whole territory of Mongolia. The second level is 'Aimag and Capital City Land Management Plan' and it covers in detail all aimags and Ulaanbaatar. The third level is 'Soum Land Management Plan' and it covers in detail all soums. Mongolia is divided into two administrative levels: the aimag level and the soum level. Land use plans are available for each administrative level.

National Land Management Plan (NLMP). The plan is produced for the period of twenty years, i.e. 2004-2023. NLMP is a long-term plan reflecting the strategic objectives and development of the country. It is developed through cooperation of all ministries and other relevant organizations and it reflects all estimated demand and supply of resources from the land. The governmental agency that is responsible for the coordination and development of NLMP is the Administration of Land Affairs, Geodesy and Cartography of Mongolia (ALAGAC), under the Ministry of Construction & Urban Development. In addition, the NLMP is also responsible to follow up the implementation of the plans at national, aimag, and soum levels.

Aimag land use plan (ALUP). Currently, Mongolia has 21 aimags and the capital city, Ulaanbaatar. These administrative units must produce their long-term Land Use Plans. The plans shall be based on and in accordance with the National Land Management Plan. These plans are produced for 12 – 15 years. At the moment, 20 aimags have developed their Land Use Plans and the remaining aimag (Zavkhan) will complete the plan very soon. ALUPs are produced by all aimags in coordination with the central ALAGAC. The local ALAGAC offices, located in each aimag, support the aimags in the development of the ALUPs. Each local ALAGAC has the responsibility of monitoring the correct implementation of the plan. ALUPs are approved by the Aimag's Parliament.

Soum land use plan (SLUP). The 21 aimags are divided into 329 soums. These 329 soums are obliged to produce annual Land Use Plans. These plans should be developed in accordance with ALUPs, and the planning at soum level includes detailed information about land management and land development issues of the soum. Currently, all 329 soums have produced their annual SLUPs. The SLUPs are developed by the soum government in coordination with the aimag land office. Aimag's land office, through its land officers, monitors the implementation of the annual SLUP.

The Government of Mongolia is taking measures to provide land use planning systems based on the eco-regional assessments. Such measures will help ensure that ecologically valuable and irreplaceable locations are kept away from any human development activities, including mining, manufacturing, road construction, etc. The Nature Conservancy (international NGO), has been supporting the government in undertaking eco-regional assessments in Mongolia. The eco-regional assessment covers some important parts of the country (Eastern-steppe eco-region, Gobi region, and western eco-region) and it is now completed. The findings provide good scientific and technical backgrounds for governmental decision making. The government wants to replicate this assessment in other parts of the country, starting with the central region.

<u>Gaps and Barriers in land and soil resources</u>

- Ecosystem-based land use planning is not sufficiently integrated with land use planning at national, aimag, and soum levels.
- At the national level, the major barrier is that the technical staff in charge of guiding, developing and implementing regional land use and management plans have limited knowledge and experience. They have insufficient capacity to integrate landscape planning, management and ecosystem services.

- Land planning and management issues such as land, water and forest resources are regulated by several Government Ministries and Agencies and the coordination is not optimal. For instance, the Ministry of Construction and Urban Development is responsible for land use planning and management issues, the Ministry of Industry and the Ministry of Agriculture are responsible for pastureland management and the Ministry of Environment and Tourism is responsible for biodiversity and desertification. The barrier in this case is a lack of an efficient overall coordination mechanism among the relevant bodies.
- At the local level, capacity and technical experience are also lacking. This includes also insufficient experience in integrating land use planning and conflict resolutions, lack of data, insufficient information regarding direct and indirect impacts of planning in other sectors, etc.
- Climate change, with its shifts in seasonal weather patterns and declines in water resources, has exacerbated the challenge of sustainable pasture management. Public institutions for managing pasture and livestock are unable to confront the challenges of private herds on state-owned pasture land. In May 2016, the Law on Pastureland was approved by the Cabinet which will allow pasture user groups to obtain possession rights over pastureland they reside in. Although supported through development projects, participatory planning for managing pasture use and creating pasture user groups agreements are not extensively practiced.

Current needs, gaps barriers and vulnerability of herders and the livestock sector

Agriculture and animal husbandry. The Mongolian Government has implemented several programs to improve sanitary conditions of animals, veterinarian services, identification of animals, and labelling of final products (milk, meat, wool etc.). In addition, it has built wells on pasture to support the development of intensive livestock farming to increase animal farming and reduce importation of feed products from abroad. In this regard, the number of intensive farms has increased hence; the economic turnover generated from these large intensive farms in this sector has increased accordingly. In 2014, the total number of intensive farms was as follows: 1,554 dairy cattle farms, 351 beef cattle farms, 236 sheep farms, 476 pig farms, 405 poultry farms, 299 bee farms, and 30 rabbit farms. A brief statistical summary of the current livestock and agriculture situations in the country is available in Appendix 1. Furthermore, the government has a policy to support agriculture and livestock SMEs by providing long-term loans with low interest rates to farmers and herders that want to buy agriculture machineries, equipment, feed, fodder and medicines.

Agriculture is the traditional sector that produces about 14% of gross domestic products in Mongolia, and it is the main source of food and supply of raw materials to the domestic industries. Dairy and meat productions are the most important sectors in Mongolia's food chain. It has been estimated that 67.9 million litres of milk and dairy products for 52.5 trillion Tugriks were produced in 2015. Mongolian livestock farming relies on pasture, therefore the majority of meat production and processing is done seasonally. Over the last three years an average of 11.6 million animals were slaughtered yearly and that resulted in the production of approximately 200,000 tons of meat, which fully met the domestic needs. This indicates that Mongolia has a great potential to export meat and meat products. Therefore, some certain measures are being implemented to support meat export. The Mongolian Government opened the borders for meat and bio-products at the border points of Bichigt of Sukhbaatar aimag, Shiveehuren of Umnogovi aimag, Burgastai of Govi-Altai aimag. Since then, 5,200 tons of meat and meat products were exported in 2015.

Flour and patisserie productions play an important role in food (human consumption) and feed (animal consumption) in Mongolia. Wheat grain is considered the main raw material of flour production and is included in the strategic foodstuff categories. In 2015, a total of 936,000 tons of flour were produced in 61 flour mills and shops in Mongolia. In 2016, a total of 460.7 thousand tons of wheat, 153.7 thousand tons of potatoes, 93.5 thousand tons of vegetables, 19.6 thousand tons of oil crops, 50.6 thousand tons of fodder crops, and 2.04 thousand tons of fruits were harvested. Residuals of these cultivations are an important source of energy and protein for animals. Most of these residuals were processed (fresh or dry) and used to feed animals (mainly large ruminants). As estimated, national customers demand was satisfied 100% for potatoes, 46% for vegetables, and 2%, for fruits last year. Mongolia's government has prioritized the campaign of Virgin Land 3 Program in order to support the policy of healthy and safe food supply stated in the resolution number 2.18 on government action plans between 2016 and 2020. A total of 377.3 billion Tugriks will be required for this campaign.

Animal health. Several training activities on combating human and animal brucellosis, TBC, and foot-and-mouth diseases were organized by SDC and by MoFALI. Many veterinarians and other specialists attended international seminars and trainings for protecting animals from highly contagious zoonotic diseases. These seminars and training were organized in Nepal, China and Thailand. In addition, many veterinarians and farmers were allowed and supported to attend domestic trainings on veterinary activities (vaccinations, inseminations, small clinical interventions etc.). Mongolian farmers and breeders attended many domestic and international trainings for animal breeding activities with the support of local universities, research institutes. Such training included animal identification, animal biotechnology, new techniques of animal breeding, data collection and IT in livestock.

Meat and hide production: In Mongolia, most meat is produced by herders found throughout the country. Meat is currently produced with limited or no hygiene standards exposing the population to an increased health risk. Slaughterhouses would provide safe healthy meat and by-products for the internal market that is currently consuming low standard meat and by-products produced by small freeholders and herders. Slaughterhouses need animals with high standards of meat quality, tenderness and marbling as well as homogeneity in size and age. This important set of requirements will stimulate the internal demand for better fed and more carefully selected animals that will meet the slaughterhouses' standards. The hide of livestock animals (in particular goats) is not considered an economic resource. Hides are often destroyed.

Mongolia has good potential to increase the quantity, quality, safety and health of meat and by-products (i.e. leather and cashmere) produced, although there are some constraints associated with the limited number of slaughterhouses available. It is essential that farm animals be slaughtered only in authorized slaughterhouses. This will eliminate the current habit of slaughtering animals with no or limited hygiene standards, reducing the risk of contamination, increasing the health and safety standards of food and allowing for the creation of a traceability system for the entire meat chain. There is demand for animals for the slaughterhouses. Supporting investors and herders that want to breed selected livestock will make better animals more widely available for the slaughterhouses and reduce the risk of discrepancies between demand for and supply of livestock. It is important to take into account that the development of the meat and by-products chain (i.e. skin of goats) is closely linked with the development of other sectors such as the cold chain and the leather and cashmere products used in the domestic and international markets.

Gaps and Barriers in agriculture, animal husbandry, meat and hide productions. The country faces the following gaps and barriers:

- Policy incentives not supporting adaptation, i.e. no pasture use fee
- The animals and agriculture products are not identified, registered and traced according to international quality standards. This is an important barrier because it limits the possibility of

exportation, in particular to countries (USA, Australia, Japan and Europe) where international quality standards are mandatory.

- Lack of a cold chain system is another important barrier and is particularly important for processed food (yogurts, cheeses, sausages, ham, etc.).
- Disease outbreaks (e.g., brucellosis, TBC, avian influenza) limit the movement and commercialization of animals and in many cases animals are killed and their carcasses are burned. Sanitation and state interventions are necessary in these cases.
- Correct animal husbandry requires knowledge, financial investments and trained people. These barriers represent an obstacle to modernization of this strategic sector.
- Slaughterhouses, meat processing plants and adequate infrastructures are essential for the improvement of meat safety and meat security.
- An increase of meat standards will increase the exportation of meat and have a direct and positive impact on the income of the herders.
- There is limited training available in slaughterhouse management, butchering and livestock breeding. Plans to create panels of experts that can work in close collaboration with investors and farmers in those areas should be considered.

Herders' vulnerability, associations and cooperatives. Rural herders in Mongolia are most vulnerable to climate change because of their risk exposure and low adaptive potential. Rural livestock plays a crucial role in supporting the livelihoods and food security of rural communities. Livestock also provides a safety-net against the effects of agricultural product price unpredictability. In this sense, livestock could, depending on local circumstances, support adaptation of some marginal and most vulnerable communities. Region-specific ecosystem-based approaches are needed to address climate change impacts on herders in rural communities. While it is important to have an understanding of both regional and global impacts that climate change will have on herders and rural communities, it is essential that context-specific vulnerability assessments are carried out to inform the development of locally tailored strategies to support herder communities to adapt to a changed environment.

Associations and cooperatives. Pasture herder groups (PHGs) have proved to be an effective approach to facilitate collective action for improved pastureland management, whereby group members collaborate better among themselves and with the soum government on pasture management issues. The PHGs in many parts of the country have become an institution to facilitate co-management between the government, as the owner of the pastureland, and herders as the users. These groups have further expanded from a production group to a true community group. The PHGs are not only working together to improve fodder production but also made group decisions together through creating and managing funds which allows financing small loans to members. The link between PHGs and market development could become stronger. PHGs have had limited access to credit and to training to start economic activities.

Cooperatives can be formed by two or more PHGs for activities related to livestock (dairy processing, fiber processing, textile etc.) or agriculture (vegetable processing, fruit processing, berries etc.). It is important that the competent authorities i) provide adequate training and technical assistance on business and cooperative management, which will facilitate and support transformation of groups into cooperatives on a voluntary basis; ii) finance production-related investments for cooperatives such as collection points, storage facilities, processing and packaging units; iii) facilitate the identification of new (niche) markets; and iv) develop financial incentives (e.g. tax reduction system for cooperatives formed by woman or young people).

The investment decision can be based on the business plan developed by project-supported cooperatives and a review of business profitability, viability and nutritive benefits. Smaller investments such as processing units or packaging units can be financed through small credit lines. Storage facilities and large collection points can be financed based on economic and financial analysis through national support loan plans (the pre-financing/RF methodology developed by PMPMD for tractors and large investments).

Gaps, and Barriers of associations, cooperatives and markets.

- Herders are rarely organized in cooperatives and this represents a barrier when they have to negotiate the market prices of their products. For example, one USD per one kg of meat is a very low price. Evidences from other countries in similar conditions suggest that the organizations of herders (groups or, even better, cooperatives) can negotiate the price and received from the same product from USD 2 to 4 per kg of meat.
- The transformation of PHGs into cooperatives is in progress but has not yet been achieved on a large scale, indicating that groups have not yet seen the added value of becoming a cooperative. A lack of adequate source of funds for emerging SMEs and cooperatives is one of the major barriers.
- The domestic market is saturated by domestic meat and possibilities for export are limited. Agreements with neighbourhood countries can increase exports and stimulate the development of cooperatives specialized in export.

The costs of well rehabilitation and establishment, and rangeland investment, as a part of ecosystem-based adaptation measures have been approximately estimated/averaged by the local government agencies at each of the target aimags based on the long-term average within their locality. Costs are consistent with the pricing approach that was applied with the previous programmes that are implemented in the similar target areas, including the ecosystems-based adaptation project which was implemented in the similar ecoregions (i.e. UNDP/Adaptation Fund, Ecosystem Based Adaptation Approach to Maintaining Water Security in Critical Water Catchments in Mongolia).

Estimated budget to address required investments to support water and rangeland resources in the four aimags are detailed below.

Table 22 Estimated budget to address required investments to support water and rangeland resources in the four aimags are detailed below.

Description	Khvod			Dornod			Sukhbaatar			Zavkhan		
	Qty	Cost (GCF) USD	Cost (Aimag) USD	Qty	Cost (GCF) USD	Cost (Aimag) USD	Qty	Cost (GCF) USD	Cost (Aimag) USD	Qty	Cost (GCF) USD	Cost (Aimag) USD
Water Resources Investments[1]												
Rehabilitate Existing Wells	30	67,830	3,570	15	29,925	1,575	30	52,868	2,783	35	75,810	3,990
Construct New Wells	25	256,757	13,514	10	71,820	3,780	10	71,820	3,780	40	454,860	23,940

Rehabilitate Existing Livestock Hand Wells	15	8,820	3,780	0	0	0	25	3,675	1,575	15	11,025	4,725
Construct New Livestock Hand Wells	10	11,760	5,040	0	0	0	20	8,820	3,780	10	11,760	5,040
Natural Spring Protection[2]	20	17,640	7,560	20	23,520	10,080	28	24,696	10,584	20	17,640	7,560
Water Harvesting Structures (incl. engineering designs)[3]	7	176,400	0	4	100,800	0	5	126,000	0	2	50,400	0
Subtotal		**539,207**	**33,464**		**226,065**	**15,435**		**287,879**	**22,502**		**621,495**	**45,255**
Rangeland Investments												
Catchment Reforestation	1200ha	1,071,000	189,000	400ha	285,600	50,400	300ha	214,200	37,800	600ha	963,900	170,100
Haymaking and pasture reserve areas	1200ha	907,200	0	900ha	642,600	113,400	720ha	457,531	80,741	400ha	1,058,400	0
Emergency fodder storage facilities	15	220,500	0	9	132,300	0	9	132,200	0	15	119,700	0
Subtotal		**2,198,700**	**189,000**		**1,060,500**	**163,800**		**804,031**	**118,541**		**2,142,000**	**170,100**
Totals		**2,737,907**	**222,464**		**1,465,800**	**179,235**		**1,091,910**	**141,042**		**2,763,495**	**215,355**

[1] Orientation for water harvesting structures in target areas, as referred in the Water National programme (second stage 2016-2021)
[2] fences, bunds, livestock access points
[3] Small reservoirs and contour bunds, including those at high altitudes

4. Recommendations for Interventions

4.1. Proposed Interventions

Developing climate resiliency in the herder sector requires the following additions:

- Climate change informed landscape level planning by integrating proven rangeland management practices with River Basin and Watershed Planning.
- Informed by planning, develop community based water resources infrastructure to reduce the risk of drought events and dissipate grazing pressure.
- Develop rangeland infrastructure required to de-risk herder livelihoods when exposed to extreme climate events.
- Promote climate smart technology innovations and markets for livestock sector that would enhance income while reducing vulnerability.

4.1.1. Proposed Approaches

<u>Anticipating Climate Change</u>: Strengthen the capacity of NAMEM through upgrades to computing and technical training. NAMEM needs to be able to produce more accurate and timely medium- and long-term weather and climate forecasts to anticipate slow onset disasters and inform integrated water resources management and land-use planning.

<u>Planning for Climate Change</u>: Based on the weather forecasts and climate predictions local government need to develop their capacity to improve climate informed local land and water development plans (aimag and soum level development plans).

<u>Managing for Climate Change</u>: In line with local land and water development plans, herders should be mobilised into groups to promote legally binding agreements to help herders manage their land and water resources in sustainable and climate resilient ways.

<u>Investment in infrastructure measures are required</u> including wells, community groundwater recharge ponds and tanks, as well in land management measures such as fences and fodder cultivation to reduce the impact of prolonged dry spells, droughts and slow onset disasters, including dzud. Once systems for sustainable and climate resilient land and water management are established, further investments in value chain and market access can be developed to reduce the grazing pressure and enhance income towards reducing vulnerability of herder livelihoods.

<u>*National Agency for Meteorology and Environment Monitoring (NAMEM).*</u> NAMEM needs to have the technology and the capacity to perform climate modelling to produce monthly and seasonal forecasts as operational strategy, and climate projection for mid-term planning and strategy. By upgrading computing capacities, the NAMEM would be able to increase spatial resolution of the models up to 1-3 km for mid- and short-range weather forecasts and 10-30 km for long-range climate prediction.

<u>Dynamic seasonal forecasting</u>. Funds are required to develop and streamline the National Emergency Management Agency's response and preparedness capacity both at the national level and at the local level in the four aimags. With this investment, NEMA will be better equipped to assess forecast information provided by NAMEM and to develop response plans to reduce livestock mortality and de-

risk herder livelihoods. It should equip Mongolia to anticipate and avoid catastrophic losses such as those experienced in the 2009 - 2010 dzud which resulted in the loss of 8.5 million heads of livestock which was more than 20% of total livestock population.

Ecosystem services. To address the additional challenges presented by climate change, there is an urgent need to conserve and rehabilitate the ecosystem services upon which Mongolia's rural economy, traditional culture, and rich biodiversity depend. This requires a paradigm shift to ensure that the very foundation of human livelihood - ecosystems and their services - is sufficiently resilient to climate change pressure, and to enable communities to adapt to climate change. Reaching this solution requires setting in place capacities and tools to remove barriers currently hindering climate risk from being actively integrated within land and water resource planning and management. Potential approaches include improving the capacity of government decision-makers and private resource users to conserve and rehabilitate natural ecosystems. Stakeholders at all management levels should be able to identify, assess, and internalize climate change risks into water and land resource management. To reduce the vulnerability of communities to increasing water scarcity induced by climate change, the natural facilities of grasslands, forests, wetlands, peatlands, aquifers and riparian areas to enhance water quality and quantity resilience must be strengthened.

Development plans. Currently aimag and soum level development plans do not include land and water use plans informed by climate change projections. To promote a climate resilient livestock sector, land use management at the pasture level needs to incorporate adaptation measures to current variability and future climate change. The plans should include the identification of key investments and seek funding from public resources (e.g. local budgets, Soum development budget, pasture management fund). This would result in a transformative departure from the current land and water management practices being implemented at the local level in Mongolia. Long-term adverse impacts of climate change on herder livelihoods will be reduced by well-placed and better designed investments and management practices.

Herders' organization Strengthening of herders' organizations is required to establish group pasture "boundaries", within the context of mobile pastoral practice in Mongolia. A baseline of pasture condition in project areas/Soums needs to be established, as well as training to the local pasture monitoring officers (line officer of NAMEM) and land managers (line officer of the Administration for Land Affairs, Geodesy and Cartography (ALAGaC)) for rangeland health and land quality monitoring as well as land use planning. The climate informed soum level development plans, the baseline determined here, will help identify and place key investments (wells, water harvesting, fodder storage, winter shelters) and reserve pasture areas.

Market access for herders Enhancing market access will reduce vulnerability of herder livelihoods i) by enhancing and de-risking income and ii) by increasing the off-take of animals thereby stabilizing numbers closer to the carrying capacity of the environment. Presently the natural and organic quality of Mongolian livestock products, significant idle production capacity, availability of educated workers and relatively low labour costs, agro-processing and other value addition for primary agricultural products together provide an opportunity to reduce the vulnerability of not only herder livelihoods but also the overall economy of Mongolia. Current government policies consider agro-processing as one of the priority sectors for development for transforming the Mongolian economy from low-value-added to high-value-added production. Successful agro-processing needs to emphasize balanced regional development and the engagement of rural communities. It also must start from real growth opportunities based on sufficient primary production, existing physical capacities, skills and local knowledge, readily available technical innovation, and upgrading solutions and marketing opportunities. The GoM should be supported to develop value addition facilities and infrastructure as well as developing and strengthening the skills and capacities of producer organizations in its effective use.

Value chains Building on methodologies piloted by the World Bank, SDC and IFAD, investments in measures are needed to improve the efficiency of livestock markets and strengthen marketing arrangements in selected value chains. Supporting "productive and fair partnerships" between producers (organized in groups or cooperatives) and processors is vital. This approach reduces the risks faced by agribusinesses who are considering investing in more remote agricultural production regions, it also increases the quality of produce from herders. Partnerships should be identified through a competitive process and be supported with technical assistance to prepare full business plans and matching grants would be used to help finance investments at the soum level to support the achievement of the business plan objectives (for instance to support improved quality of product, value adding activities or a more consistent supply). This support will create more efficient commercial connections between buyers and sellers and facilitate transparent price discovery. The support provided to the producer groups will include assisting in processing of their primary products and value addition, to the degree that opportunities exist, product development and capacities in packaging, branding and labelling, collective action to deliver appropriate products in sufficient quantity and quality to meet the requirements of national and international buyers, niche market production of gourmet, organic, and fair trade products, support to access to national and international markets for food and agricultural products due by complying with food safety and quality standards for entering the higher-value (e.g. European) markets.

Blockchain Powered Cashmere Value Chain Traceability

UNDP in Mongolia is exploring the development of a technical solution to support the implementation of a certified cashmere value chain which adheres to multi-organizational sustainability standards. The desire is to create a secure, transparent "certified" value chain for market participants who adhere to these standards, providing various incentives for participation.

The envisioned benefits to the participant include:

- Higher prices for goods;
- Access to advanced payment and loan options; and
- Access to processors and premium brand house buyers who wish to purchase certified cashmere;
- Transparency in market should also help generate fairer prices for herders.

The envisioned benefits to premium buyers include:

- Gain assurances that cashmere products were sustainably sourced by platform participants who must adhere to sustainability standards ("certified" mark can be marketed) ensuring sustainability of the supply chain; and
- Gain greater visibility into the supply chain for planning purposes, look for new buying opportunities amongst program participants.

The first phase of a project, it makes sense to focus on modelling a simple but broad system flow to allow us to uncover as much information as possible about any challenges we'll face in the end-to-end process of a larger project. A flow that starts with the herder / cooperative selling a shipment directly to a processor and that processor then selling a processed product directly to a buyer would meet that criteria.

A detailed description of the envisioned process is illustrated below:

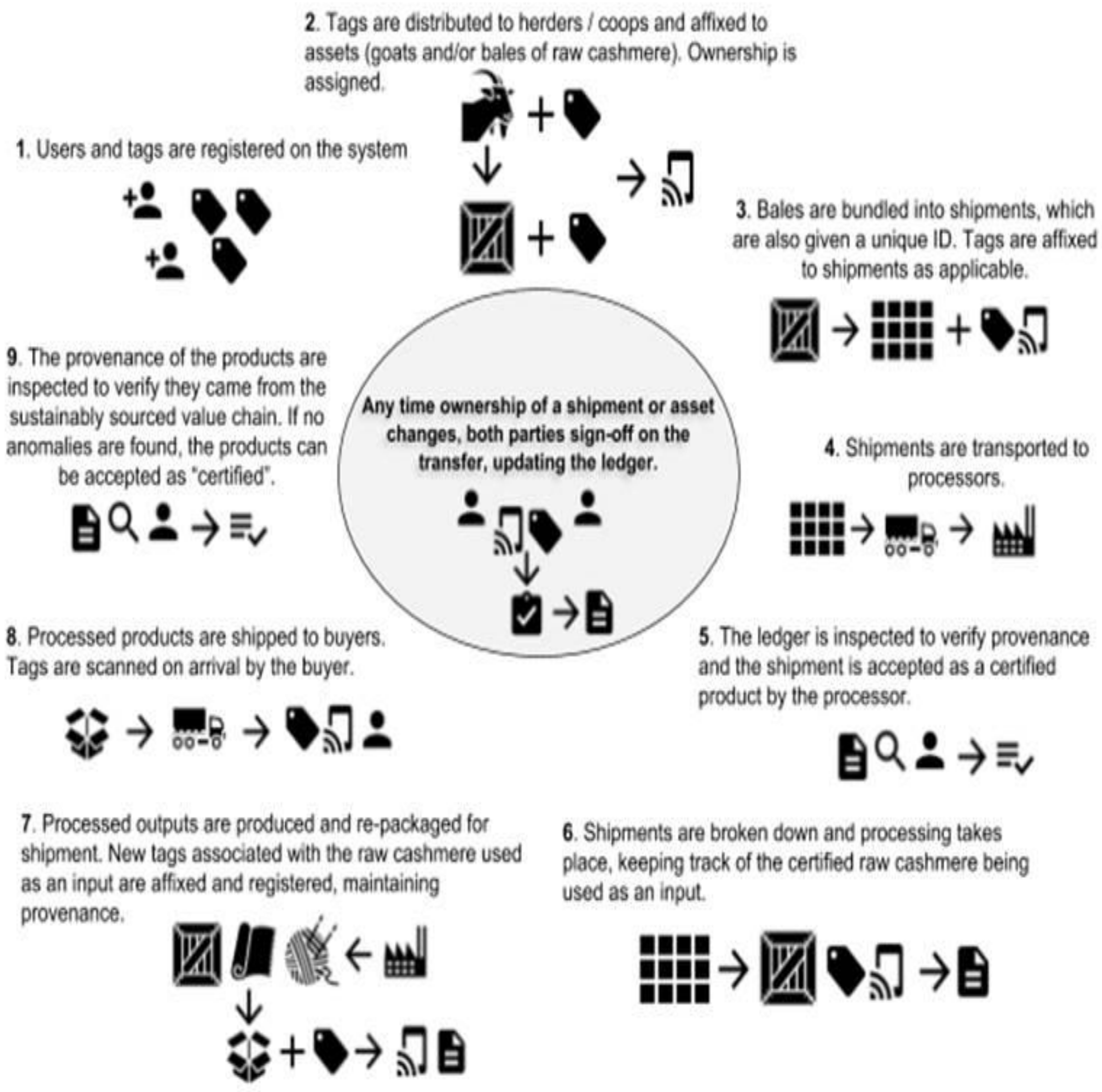


Figure 52 Proposed System Flow

4.1.2. Target sites and beneficiaries

Four aimags, two in the East and two in the West (see map below), have been identified as priority areas. Airmags Zavhkhan, Khovd, Dornod and Sukhbaatar have been chosen based on the following general criteria:

- High vulnerability to climate change and slow onset disasters.
- Isolation or distance from the central area and support.
- Availability of previously generated best practices in similar ecoregions.
- Representation of diverse ecological zones to maximize the impact of interventions.
- Government priority regions for livestock sector development

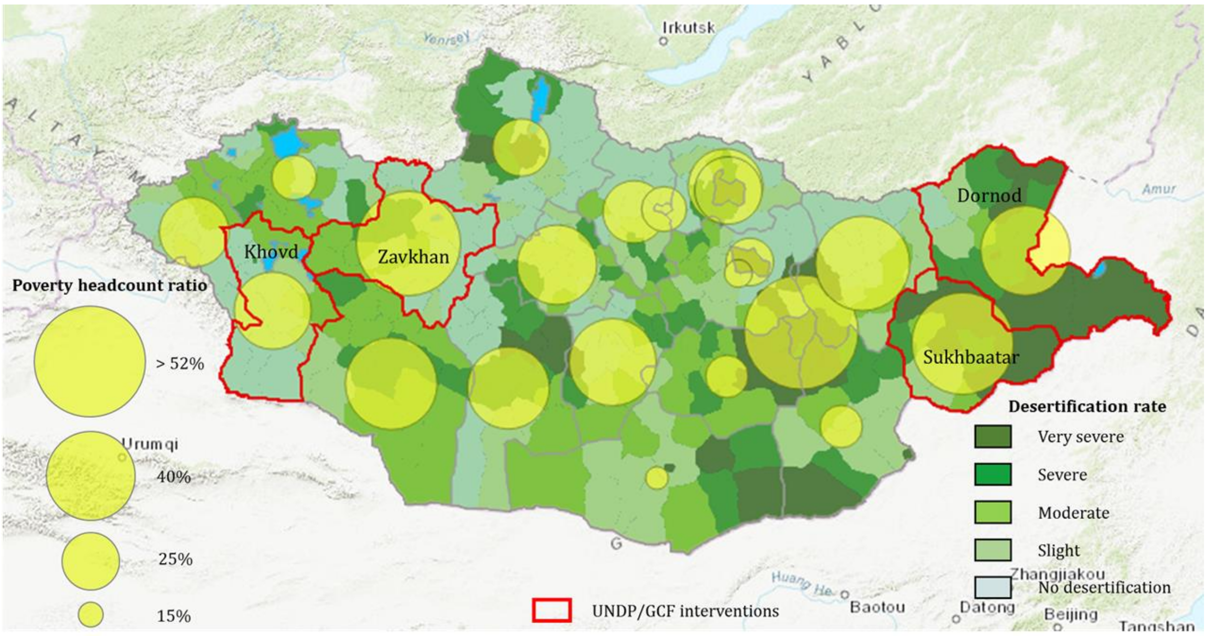


Figure 53 Target sites: poverty headcount ratio and desertification ratio

Observed climate changes in the target aimags

Zavhkhan and Khovd aimags represent the western mountainous region with high altitude lakes and the Dornod and Sukhbaatar aimags in the eastern region represent low-laying plateau with vast steppe grasslands. Although a comprehensive climate change study is not available for these aimags, there are several case studies on current climate and its projections in both the western and eastern regions of the country. The study conducted for the Integrated Water Resource Management Plan of the Kharkhiraa and Turgen sub-river basin and the Ulz river basin under the “UNDP/AF project for “Ecosystem-based Adaptation for maintaining water security in critical water catchments of Mongolia” [26], included an assessment of observed climate effects for the western and eastern areas.

Observed climate changes in the Western area

This area is located at the border of the uppermost northern edge of Mongolia’s desert and southern border of permafrost. The climate of this region is extremely harsh and dry within this latitude. The region is the coldest area of Mongolia. Zavhkhan and Khovd aimags are not only the coldest region in Mongolia but also where recent temperature changes have been the most pronounced. The warming tendency during the last 70 years is higher than the Mongolian average. For instance, the annual mean temperature has increased by 2.26-4.0^{0}C and, in particular, mean July temperature has increased significantly (up to 4.0^{0}C). However, cold season air temperature, which increased until the mid-1970s, has been decreasing to date. Average air temperature has dropped by 5^{0}C since 2000 in January and February and by 2-3^{0}C in December and March. Warm season temperature has strong warming tendency since the 1980s. Precipitation amounts have large fluctuations and variations in the region. At Ulaangom station, precipitation fell from the late-1940s to mid-1970s and climbed intensively until the mid-1980s, but over the last 25 years it has been decreasing again [27].

There are significant fluctuations in precipitation in this region as well. Recorded precipitation has been decreasing for the last 25 years. Winter precipitation will increase by 28-118% in the whole region while summer precipitation will decrease in Great Lakes Depression area. Overall, it is projected to decrease by 17% in almost whole area at the end of this century. This will result in warmer winter with higher snowfall during and a summer that is drier and hotter. Mountain snow cover and glaciers are melting significantly in this region during the last decades.

Observed climate changes in the Eastern area

In the Eastern Mongolian Steppes, where Dornod and Sukhbaatar aimags are located, average air temperatures increased by 1.3^{0}C from 1976-2011 over the region. It was warmer for 19 years between 1989 and 2008 than the previous decades. Annual range of air temperature has been widening which results in an increased frequency of extreme weather events connected with air temperature. The long-term winter and summer air temperature data shows that the summer temperature increased by 2.8^{0}C while the winter temperature has decreased by -0.4^{0}C over the last 36 years. The annual range of air temperatures has been rising, resulting in an increased frequency of extreme weather events connected with air temperature. According to the long-term trend, total annual and summer precipitation is lower for the last decade than the long-term average. However, winter precipitation has increased in the last years. The study showed that the frequency of less intense rain has decreased while the frequency of intense rain has increased, which caused an increase of frequency of floods [28].

There is need for lowering competitive grazing between domestic and wild ungulates, improve water quality for endemic fish species, and maintain internationally important migratory bird habitat. Nearly two million gazelle wander freely across the Mongolian steppe. The studies show that Mongolia's fragile steppe ecosystem is degrading at a rapid rate because of climate change. A changing climate and increased grazing pressure have intensified the threat of desert expansion from south Mongolia towards the central and northern grasslands.

Projection of climate change in the target aimags

Projections of climate change used two computer models, the RegCM4-ECHAM5 and the RegCM4-HadGEM2 for annual air temperature and annual precipitation in the western and eastern areas.

Projection of climate change in the Western area

The western region's 21st century climate change projection is estimated by dynamically downscaling results of global climate models of ECHAM5 (Max Plank Institute of Germany). According to projections of regional climate model results, seasonal temperature over the Kharkhiraa-Turgen river basin western Mongolia is projected to increase by 1.7-3.8^{0}C in winter, 0.9-4.6^{0}C in spring, and 0.6-4.9^{0}C in summer and in autumn. Seasonal precipitations are expected to increase by 6.5% to 26.3% in winter, and 12.3% to 17.8% in spring, decrease by 0.9% to 12.1% in summer, and increase by 4.8% to 23.6% on average during the 21st century. In terms of high-intensity change, the increase of winter precipitation and reduction of summer precipitation are more significant compared to other seasonal changes.

Projection of climate change in the Eastern area

The eastern region's 21st century climate change projection is estimated by dynamically downscaling results of global climate models of ECHAM5 (Max Plank Institute of Germany). Compared with 1981-2000, the annual average air temperature is likely to increase by 0.9-1.3^{0}C in 2011-2030, 2.5-2.8^{0}C in 2046-2065, and 4.2-4.65^{0}C in 2080- 2099 in the Kherlen, Onon and Ulz rivers basins. The seasonal temperature over the Ulz river basin in the region is projected to increase by 1.0-4.0 ^{0}C in winter, 1.1-4.1 ^{0}C in spring, 0.8-4.2 ^{0}C in summer and 1.1-4.2 ^{0}C in autumn. Seasonal precipitation is expected to increase by 19.6% to 50.7% in winter, decrease by -2.1% to 26.1% in summer, and increase by 10.0% to 12.3% on average during the 21st century. In terms of high-intensity change, the increase of winter precipitation is more significant compared to other seasonal changes.

Vulnerability and exposure to water resources and floods in the target aimags
Water represents an important resource in those aimags. Climate change has major and unpredictable effects on the water systems, including an increase in floods and droughts. Water scarcity is expected to be a big challenge in many Asian regions, including the four aimags, because of increasing water demand from population growth and shrinkage of glaciers [19]. Glaciers are important stores of water and any changes have the potential to influence downstream water supply in the long-term, as for instance in the western part of Mongolia [29]. The most vulnerable are herders with large livestock living in the rural areas with limited access to fresh water. Herders in the four aimags can, however, limit the exposure to the negative effects of floods by building their houses and stables far from the rivers banks. Detailed information about water resources and floods in the western and eastern areas of the country are limited.

4.1.3. Recommendations for potential interventions

The recommendations outlined below are designed to enable Mongolia to strengthen the climate resilience of resource-dependent rural populations through ecosystem-based adaptation measures and protection of land and water resources.

A wide variety of potential ideas and options to best achieve the objectives were examined and explored. An integrated approach to addressing the impacts of climate change on natural resources, as well as supporting the necessary changes to the livestock sector through planning, policy reforms and adaptive herder practices.

Enhanced technical capacity for long-term climate resilient development planning, and medium-term response planning capacity.

In order for Mongolia to strengthen climate resilience it needs to move beyond the status quo of emergency response to climate-informed planning. To do this Mongolia will need to develop the technical capacity to forecast medium-to-long-term climate change, then apply that information to predict related changes and impacts to water and land resources.

To develop the capacity to conduct seasonal and long-term climate change forecasts, NAMEM needs to acquire weather and climate forecasting and prediction software and equipment including computing facilities (servers and workstations). NAMEM's current capacity only allows them to run regional dynamic models such as MM5 and WRF for short and medium range forecasts, which are not sufficient for long-range climate information and projections. By acquiring additional computing capacity NAMEM will be able to build on existing capacity enabling them to provide key long-term weather and climate change models and projections, as well as improve the accuracy and spatial resolution of atmospheric models (GCMs, RCMs) and use dynamic models for forecasting. Assuming

NAMEM acquires new technology it will require capacity building to use within NAMEM is required in order to effectively use the upgraded equipment. Investments will be required to strengthen human resource capacity of relevant staff. More

Training of local governments at the aimag and soum levels to recognize and understand climate change impacts, vulnerability and risk assessments, and how to integrate these factors into planning is needed. Such training should be cross-sectoral.

The State Emergency Commission Secretariat is in need of training to improve medium-term response planning. This training should include technical support for emergency planning and coordination. Improved guidelines and procedures for seasonal planning and coordination of national and international responses are needed as well.

Integration of climate change into aimag and soum level development plans

There are existing Integrated River Basin Management Plans (IRBMP) for the 12 river/lake basins in the target aimags. They should be built-on to include climate risks and adaptation considerations. Such an approach would result in both a top down (IRBMP) and a bottom up (RUA) feedback mechanism. These profiles will serve as a reference source for guiding soum level officials and the communities to better integrate climate resilience in the development of soum Level Development Plans and RUA's. If this is done, it will create an interactive Information and Communication Technology (ICT) platform that future project can access when developing additional RUAs.

It is recommended that Mongolia develop a Water Use and Management Plans for each soum. These should be comprehensive multi-year management and investment plans that include monitoring and evaluation tools. Effectively, they will set the baseline for the use and management of the hydrological and land assets of the watershed and serve as a road map for the implementation of subsequent project activities and investments. They should include a rapid resource mapping, water budgeting and ecological site descriptions to guide investments in infrastructure, integrated water resources management and sustainable pasture management. Also, these plans will serve as a road map for the development of RUAs by the Resource User Groups.

External technical agencies should be recruited to provide technical input for the development of the Water Use and Management Plans. These external agencies should help define watersheds, conduct surface and groundwater balance assessments, link watershed plans to river basin management plans and recommend a suite of management options and infrastructure options. The Water Use Plans will undergo a rigorous quality review and validation process before being used to select and place investments.

Analytical products to support policy and regulatory reform that promote sustainable land and water management and resilient herder livelihoods.

A focus on enhancing income and creating more secure livelihoods for herder households by reducing their vulnerability to climate change and reversing maladaptive policy incentives is recommended. To achieve this a demand driven business advisory services to both herder groups and early stage companies should be provided. Newly formed herder groups should be linked with established market leaders and be also be provided training and technical assistance to develop the value chains.

Community-level ecosystems-based adaptation to protect land and water resources

There is an urgent need to conserve and rehabilitate the ecosystem services upon which Mongolia’s rural economy, traditional culture, and rich biodiversity depend on. To address these climate risks, efforts should be focussed on investments that protect land and water resources and strengthen mechanisms required for sustainable management of community land and water resources.

Riparian degradation is a major contributor to the vulnerability of water provisioning ecosystem services. Structural investments in enclosures along riparian areas to enhance and restore watershed health are recommended. These enclosures should be located in severely degraded riparian areas of high biological value to restore function. Within the enclosures, native woodland and grassland species should regenerate. lsdo, the replanting native vegetation along riparian areas and degraded lands to increase water retention and grassland productivity should be performed. Where gully erosion is problematic, small-scale erosion controls should be put in place.

Enhanced cooperation among herders on sustainable use and stewardship of shared land and water resources, formalized through Resource User Agreements.

Investments should be made in infrastructure including wells, community groundwater recharge ponds and tanks, as well as land management measures as well as fences and fodder cultivation to reduce the impact of prolonged dry spells and slow onset disasters. Community-based Rangeland-User Groups are already being used to enforce seasonal rotational grazing and resting schedules, establish long-term agreements for the maintenance of rangeland health, and plan stocking reduction rates.

Build herder capacity to access markets for sustainably sourced livestock products

Interventions are needed to drive behaviour change of herders away from unsustainable herding practices. The livestock sector exacerbates the risks of ongoing climate-driven land degradation and water scarcity. At the same time, the livestock sector can play a vital role in the sustainable land use and water management. As such, the livestock sector should be engaged to develop sustainable practices.

Most herders in the identified aimags struggle to market livestock products, leaving them with neither the capital nor the incentive to invest in sustainable herd management that is focused on quality and a manageable quantity. Additionally, they fail to insert themselves into value chains that provide consistent off-take because they are either unable to supply or lack incentives to supply consistent, quality product. Improvement of efficiencies along the value chain of selected livestock products such as meat, cashmere, wool, leather and milk is recommended.

Public-Private Community Partnerships for Climate Resilient Agricultural Development could play a pivotal role in the development of a climate resilient livestock sector. These agreements should facilitate cooperation between the private sector and herder cooperatives as well as Herder Producer Organizations. This should enable herders to move from passive price takers to entrepreneurs with the skills and collective bargaining power to negotiate deals with private sector off-takers and in doing drive transformation of livestock herders from subsistence pastoralists to profitable producers.

Herder Producer Organizations

The basis for engagement with the private sector will be through PPCP-CRAD’s and Herder Producer Organizations. Support to both of these organizations should include general business and market specific training in production, post-harvest processing, post-harvest value addition and on-site storage specific to the commodity value chain. The goal should be to promote backward vertical integration and develop viable value chains. There is existing demand for high quality cashmere and yak wool. Moving herders away from raw, low-quality cashmere, which is contributes to the growing herd size in Mongolia.

Herder groups should be supported in their negotiations with the private sector to ensure that an equitable and fair outcome is achieved. Business advisory support should be provided to all parties so that the agreements incorporate sound climate-resilient business models.

Build herder capacity to access markets for sustainably sourced livestock products
Private sector investments can serve as a catalyst to drive the integration of climate-smart projects in the agricultural sector. Partnership and a higher level of cooperation between private sector players and herder producer groups will promote backward integration in key selected value chains. To do so, the provision of technical assistance to herder groups that will enable them to strengthen their capacities to enter into sustainable and equitable partnerships with the private sector is needed.

An Impact Investment Fund
The establishment of an impact investment fund that focuses on investing in companies that have sustainable business practices will enhance Mongolia´s value chain. This would have an additional benefit of creating an enabling environment to support investments in private Mongolian companies that require quality, consistent supply of primary and value-added products for domestic and international customers.

The establishment of an impact investment fund should also serve to demonstrate the viability and profitability of investing in Mongolia's livestock sector, and would further drive additional private sector investment. It is believed that by improving the value chain by investing in it will unlock pent-up domestic and international demand for high quality and sustainably produced raw materials, and semi-finished and fully finished products. Doing so will have the additional benefit of reducing the need for publicly-funded development interventions and technical assistance. Initial indications are that there is significant interest among development finance institutions, multilateral development banks, large apparel manufacturers for funding an impact investment fund.

4.2. Need for Additional Climate Financing

Mongolia is classified as a lower-middle income country by the World Bank, its economy is characterized by persistent economic imbalances. GDP growth slowed down to 1.2% in 2016 due to declining exports from the weakening commodity market and slower growth in the key export market of the People's Republic of China. The economy has become increasingly reliant on the mining sector— representing 20% of GDP, twice the ratio a decade ago—and the lack of diversification amplifying the impact of changes in commodity prices.

Mongolia's adaptation needs are expected to increase significantly as climate change impacts increase. The ABD estimates that Mongolia will incur annual expenditures ranging from $50 million to $560 million per year. This ranks Mongolia as having the highest maximum relative cost of adaptation (8.5% of baseline expenditure) compared to other east Asian countries. The Mongolia NDC estimates that based on current adaptation undertakings and gaps, Mongolia will need approximately USD 3.4 billion in technology and capacity building to meet the adaptation shortfall by 2030. The required investments estimated for the livestock, water and disaster management sectors are USD 46 million, 2.4 billion and 65 million respectively.

Mongolia’s government currently does not have the financial capacity to undertake the necessary investment needed to strengthen climate resilience of resource-dependent rural population through ecosystem-based adaptation measures and protection of land and water resources. Government revenues were US$2.868 billion in 2016 while total expenditures were estimated at US$4.035 billion. With a GDP of US$11.16 billion, this means a government deficit of 10.5%. Public debt was at an estimated 60% of GDP in 2016. The current account shows a deficit of US$449 million or 4% of GDP. From these figures, it is clear that opportunities for domestic and international financing by the government are limited. A significant constraint for private sector financing is the cost of capital: the prime lending rate of commercial banks is 19.3% (31 December 2016 est.) and the central bank discount rate is 12% (14 January 2016). This clearly demonstrates the country’s vulnerability and its limited capacity to cope, and emphasizes the need for additional sources of financing in the form of grants to undertake projects with significant public welfare positive externalities.

4.3. Project Sponsor and Implementation Partners

Ministry of Environment and Tourism
The Ministry of Environment and Tourism (MET) of Mongolia is a core ministry and the lead government agency for environmental management with responsibilities including climate change, biodiversity, protected areas, forests, environmental impact assessments, water and tourism. Institutionally, upgrading a leading ministry and relatively strong environmental legislation provides a central position for the ministry within policy development and oversight across sectors. The MET is structured in departments and divisions that have undergone several changes in recent years. The key departments include the Department of Environment and Natural Resource Management, the Department of Forest Policy and Coordination, the Department of Green Development Policy and Strategic Planning, the Department of Strategic Policy and Planning, and other sub-units. The description of each of them is included below.

Department of Green Development Policy and Strategic Planning (DGDPSP) has a mandate for developing both sector and national policies and legislation. The elevation of the MET to a general ministry also provides it with a stronger institutional mandate over other line agencies. It is also a central body within MET that can manage the cross sector policy review process ensuring that strategic environmental assessments are undertaken for different policies.

Department of Environment and Natural Resource Management (DENRM) is responsible for the organization, coordination and implementation of legislation, policies and programs on minimizing and mitigating environmental degradation and pollution. It is also responsible for promoting the protection, restoration and correct use of natural resources. In addition, it provides methodologies, advices and management expertise. It has a mandate to undertake environmental impact assessments (EIA) on relevant development projects and produces a bi–annual state of the environment report bringing together available data on the state of the country’s environment.

Department of Forest Policy and Coordination (DFPC) has a mandate for the development and oversight forest policy, its implementation, and the collection of information on the status of forest areas. It achieves this through working with subnational bodies including Forest Units and local offices. It is also responsible for the development of policies and measures to address forest change and forest management. It has strong linkages with the Forest Research and Development Center (FRDC) and with Forest Universities in Mongolia. The director of the DFPC has been the operational focal point for the UN-REDD program. The Forest Research and Development Centre (FRDC) is mainly responsible for the implementation of policy and regulations on forests. The Centre also is responsible for forest inventory, research, and for pest control.

Division of Climate Change and International Cooperation (DCCIC) was recently upgraded into a department. The department is responsible for overall management of climate change policy and coordination of response measures against climate change challenges as well as implementation of multilateral climate change agreements in the country and reporting the implementation status. The department supervises and coordinates international projects and programs in climate change. Another important task of the department is strengthening international cooperation in the field of environment protection.

Department of Special Protected Areas Administration (DSPAA) is responsible for the implementation of laws and regulations concerning "Special Protected Areas". Its functions include coordinating activities related to the expansion of the "Special Protected Areas" network and the implementation of associated programs, projects and actions, as well as providing professional and practical assistance to the administrative authorities. It focuses on assuring an integration of policies and actions promoting sustainable natural resource use and ecological balance. These responsibilities are carried out by developing partnerships with all organizations engaged in policy implementation, ensuring the effective allocation of resources, and organizing and coordinating their activities in line with government policy, programs and plans.

National Agency for Meteorological and Environment Monitoring (NAMEM)
The mission of the National Agency for Meteorology and Environment Monitoring of Mongolia (NAMEM), a government implementing agency, is to provide government organizations and the public with forecasts and warnings of weather, climate and hydrology with the aim of protecting human life and property from natural disasters and enhancing the socio-economic conditions of the country. Mongolia's meteorological service was founded in 1924 and the first meteorological station was established under the research branch of Astrology and Meteorology of Institute of Sudra Scripts. Meteorological stations in Mongolia started providing weather information on a permanent basis in 1936. Today, NAMEM has 1,979 employees throughout its headquarters, its central and local branch offices and its monitoring stations in Ulaanbaatar and in the aimags. The people working in NAMEM mostly graduate from Mongolian national universities and other national colleges. More recently, young staffers have an international background because many of them graduate from foreign universities in Japan, Korea, China and Russia.

Table 23 Total employees of the NAMEM and IRIMHE (as of 2017)

Name of organizations	Total	NAMEM	Weather Forecasting Department	IRIMHE	Branch institutions in Ulaanbaatar	Branch offices in aimags and soums
Employees	**1,979**	61	20	100	NA	1,651
Managerial level staff		9	1	11	15	103
Researchers		NA	NA	14	1	NA
Engineers, Officers, Experts, others		72	19	75	125	272
Observers and Operators at monitoring sites		NA	NA	NA	27	1,276

Note: NA= information not available

Currently, NAMEM's annual budget (Table 23) is covered 100% by taxes (public budget) and private support is absent. Due to economic crises and government cuts, the budget of NAMEM has been reduced in the last 2 years. Unfortunately, the future tendency is toward reduced allocation of the public budget for NAMEM, and the support of GCF is essential to upgrade computing and technical capacity for climate-informed planning.

Table 24 NAMEM budget, 2014-2017*

Year	2014	2015	2016	2017*
Total budget [(a)]	**21,887,782.8**	**21,886,241.4**	**20,982,388.2**	**21,056,235.0**
1.Investment	1,558,767.1	0	0	0
-equipment and instrument	1,558,767.1	0	0	0
2. Flow budget	20,329,015.7	21,886,241.4	20,982,388.2	21,056,235.0
-salary, social insurance	16,838,555.5	18,353,499.8	17,250,721.9	17,166,618.0
-equipment and instruments	1,216,196.3	1,043,848.0	1,211,214.5	1,305,241.6
-others	2,274,263.9	2,488,893.6	2,520,451.8	2,584,375.40

Note: * - expected budget, 1US$ =2495 Tugrugs, Source: NAMEM, [(a)] Thous. Tugrugs

Information and Research Institute of Meteorology, Hydrology and Environment

The Information and Research Institute of Meteorology, Hydrology and Environment, (IRIMHE) is the research and operational branch institution of NAMEM and a leading organization in research field of weather, climate, hydrology, agro-meteorology and environment in Mongolia. The institute is responsible for the National Meteorological Telecommunication Center and it collects and processes meteorological, hydrological and environmental observation data from national monitoring networks, and global and regional centre of the World Meteorological Organization (WMO). IRIMHE is also responsible for the National Remote Sensing Center. A detailed description of the activities of the National Remote Sensing Center is available below. In addition, IRIMHE is a key organization that deals with assessment of the current and future state of climate, water resources, water quality, pastures, ecosystems and natural disasters in the whole country. This organization plays a leading role in management and monitoring networks, trainings, and capacity building in hydro-meteorological and environmental sectors. Currently, operational and research activities of the IRIMHE cover seven sectors: weather forecast, meteorology, agro-meteorology, hydrology, numerical weather prediction, climate change research, and environmental research. There are over 70 engineers, researchers and scientists in the institute. The institute's main goal is to provide governmental and private organization as well as the public with weather, hydrological and environmental data, information and forecasts, and outlooks and projections of the climate of Mongolia.

The strategic goals of IRIMHE are:

- Provide governmental and private organizations as well as the public with real time weather, hydrological and environmental data, information and forecasts.
- Control meteorological, hydrological and environmental national networks and provide them with methodological and theoretical guidance.
- Provide and maintain homogeneity of meteorological, hydrological and environmental data, and develop and integrate databases
- Carry out research and development projects in the field of meteorology, hydrology and environment and implement their outputs.

Remote Sensing in NAMEM

The National Remote Sensing Centre in Mongolia was created in 1987. The responsibilities of this centre are the coordination of all activities related to remote sensing in the country. In addition, the centre is responsible for the development of local capability for using efficient methods of investigating, classifying and monitoring natural resources by using modern space research and remote sensing technology. Furthermore, the National Remote Sensing Centre conducts monitoring of environmental and natural disasters, such as dzud, drought, cyclones, wildfire, hurricanes, severe snow cover, vegetation, land surface temperature, dust storms and air pollution on the territory of Mongolia. The centre is particular specialized in the fields of natural resource and natural disaster risk monitoring. It receives and analyses satellite data from MODIS-Terra/Aqua, NOAA 15-19, Suomi-NPP, FY2-C,D,E and it generates maps, climate projections, and distributes processed data and other information. Unfortunately, the Remote Sensing Technology in Mongolia is facing multiple problems:

- The current hardware storage system is very old. The server was purchased in 2003, installed in 2004, and the disk capacity is very low and the processors are very slow.
- There is a need to archive large amounts of datasets from Meteorological and Environmental satellites, but the current capacity is very limited. In addition, there is an urgent need to upgrade the technology for large data storage systems and portable weather stations for satellite data calibration for Disaster Early Warning System.

National Emergency Management Authority

Based on the Parliament law of Mongolia on Disaster Protection, which was passed in June 2003, the National Emergency Management Agency (NEMA) was established with the duty to conduct nationwide activities for disaster protection. All the 21 aimags and the capital city have a NEMA emergency management division and department. As the government regulatory agency responsible for the disaster management activities in Mongolia, NAMA implements disaster prevention, response and recovery activities within its specialized departments such as Disaster Management Department, Firefighting Department, State Reserve Department, as well as its firefighting units and rescue teams. NEMA's main duties are to develop environmental legislation on disaster protection, provide strategic management, evaluate disaster risk and vulnerability, and implement activities on disaster prevention, disaster reduction, and disaster preparedness. In addition, it must organize search and rescue work, respond to disasters by restoring and rehabilitating the main infrastructures, strengthen capacity of national disaster protection, and cooperate with foreign countries and international organizations in the disaster protection field. Furthermore, it is also responsible for coordinating the activities of different stakeholders who are involved in the disaster response; this includes non-governmental and governmental organizations, the private sector, community groups and international organizations.

The annual budget of NEMA is given in Table 24. The table shows that the total budget is decreasing; in particular, the investments are dropping dramatically and this happened mainly in the last two years due to the economic crisis of the country. This has a negative impact primarily on new equipment (e.g. HPC, software, hardware, meteorological stations, etc.) that cannot be purchased with the current budget. The total numbers of employees of NEMA are given in Table 24, which includes all staff of NEMA at the headquarters and in the branch offices located in Ulaanbaatar and aimags. It should be noted that in the last three years the number of local organizations has increased and now cover the entire national territory, but the number of employees (in particular the executing staff) has increased only marginally while the number of managing staff (i.e. directors and managers) has decreased.

Table 25 Annual Budget of the NEMA

Budget category and Staffing	Approved Budget	Approved Budget	Approved Budget	Approved Budget	Estimated Budget

	2013	2014	2015	2016	2017
GRAND TOTAL	**86,841,680.0**	**83,136,293.4**	**91,751,323.8**	**72,164,575.2**	**71,477,195.0**
Flow Budget	50,968,582.0	50,252,395.4	53,783,981.6	60,425,733.0	58,663,952.8
equipment, services and activities	47,767,015.3	47,355,794.3	51,282,932.7	57,209,682.5	45,411,652.5
Salary and social insurance	33,745,094.7	35,815,891.0	38,952,973.0	41,132,902.5	41,658,586.1
Property and Investment	35,873,098.0	32,883,898.0	37,967,342.2	11,738,842.2	12,813,242.2
Internal investments	18,569,100.0	19,579,900.0	25,537,600.0	3,659,100.0	4,733,500.0
Investment from other resources	17,303,998.0	13,303,998.0	12,429,742.2	8,079,742.2	8,079,742.2

Table 26 Total employees at NEMA

Organizations and employment	2013	2014	2015	2016	2017
Number of organizations	62	61	71	71	71
Total employees	**3,926**	**3,921**	**3,937**	**4,169**	**4,281**
Managing staff	88	85	83	74	74
Executing staff	3,415	3,401	3,430	3,673	3,783
Supporting staff	212	212	207	203	204
Contractors	211	223	217	219	220

Ministry of Agriculture, Food and Light Industry

The Ministry of Food, Agriculture and Light Industry (MoFALI) was recently reformed after the new parliament election in July 2016. The major aim of MoFALI is to support productivities of food, agriculture, light industrial sectors, small and medium-sized enterprises and cooperatives by improving their competitive nature in international markets and domestic trades. MoFALI consists of eight departments such as Strategic Planning, Public Administration and Management, Livestock Policy and Coordination, Crop Farming Policy and Coordination, Light Industry Policy and Coordination, Small and Medium-Sized Enterprises Policy and Coordination, Food Industry Policy and Coordination, and Monitoring, Evaluation and Internal Audit. The description of each of them is included below.

Department of Strategic Planning (DSP)

The DSP plays a major role in preparing policies, programs and developing projects that are directly implemented by the minister. In addition, DSO provides policy guidance and professional and technical advice in order to support planning and budget allocation. This department has two divisions: the division of Strategic Planning and the Finance Division. The division of Strategic Planning consisted of a department head and eight specialists who are responsible for policies related to animal husbandry, veterinary, crop farming, light industry, small and medium-sized enterprises, food industry, agricultural marketing and stock exchange, science and innovation. A director and a general accountant with six specialists are in duty under the Division of Finance.

Department of Public Administration and Management (DPAM)

The major duty of DPAM is to provide state administration in order to conduct internal management and services, planning of the sector's human resource policy, and implementation of laws and regulations. In addition, DPAM is responsible for the development of administrative normative, acts, and agreements, and provides legal assistance and guidance for the development of international cooperation. The DPAM has a department head, four specialists and two other staffers responsible for project and program implementation and reports. The areas covered are: local and state organizations, corruption, conflicts of interest, gender, human rights, human resources, training, fulfilment of government resolutions, public-private partnership, publication and media. In addition, a senior accountant, a procurement officer, a specialist for archives as well as a medical doctor are part of this department. This department has two divisions: Division of Legacy and Division of International Cooperation, where ten specialists and staffers are in duty.

Department of Livestock Policy and Coordination (DLPC)
This department is responsible for all livestock in Mongolia. In particular, DLPC is in charge of implementation of policy and regulation for livestock farming and management. The DPLC consists of a department head and nine specialists and they are responsible for the follow areas: pasture protection and management, pets, risk and disaster management policy, animal production, animal health and veterinary, water reservoir and management, fodder and hay production, and intensive animal breeding policy.

Department of Crop Farming Policy and Coordination (DCFPC)
The DCFPC is responsible for organizing and implementing agricultural production policies and regulations. It consists of nine specialists and a department head. The specialists' duties are: cereal, oil and fodder, crop production, potato and vegetable production, storage management, plant protection and soil fertility management, plant cultivation, fruit production, supply of agricultural machinery and irrigation system, and information technology on land utilization.

Department of Light Industry Policy and Coordination (DLIPC)
The major duties of the DPLIPC are developing policies and regulations on light industry, domestic trade, and implementation of public food services in the agricultural sector. The DPLIPC has a department head and seven specialists for production of wool, cashmere, leather, textile, electrical devices, wood furniture, package and recycling, building materials and other issues relevant to light industry development.

Department of Small and Medium-Sized Enterprises Policy and Coordination (DSMEPC
This department is responsible for the implementation of policies and regulations for small and medium-sized enterprises. The DSMEPS consists of a department head and six specialists, each of whom is responsible for cooperative research, registration, financial services, loans, leasing, insurance policies, and training for SMEs. In addition, they are responsible for business development, incubation regulatory issues, science and innovation, as well as export and marketing.

Department of Food Industry Policy and Coordination (DFIPC)
The DFIPC is responsible for food policies and regulations for the food industry sector. Eight specialists and staffers work at this department under a department head. The duties of those specialists are: production of organic food, brewery and beverage, milk and milk products, food export and import, tariff management, meat and meat products, plant-based food productions and supply, food safety and registration, food production and services.

Department of Evaluation and Internal Audit (DEIA)

Responsibilities of the DEIA are legislation, policies, monitoring programs, projects and resolutions, and implementation of decisions. In addition, DEIA is responsible of risk analysis, risk management, evaluation, and auditing, as well as data analysis and data distribution to end users. This department has a department head and nine specialists, and they are responsible for animal and crop farming, light industry, SME, food production, internal auditing, data collection, statistics, and information technology services.

Provincial framework- Aimag Government
The Aimag Government has the highest authority at the aimag (provincial) level. The aimag government is responsible for coordination, administration, support, and ensuring policy and planning consistency at provincial level. The aimag government has the following divisions: State Administration and Management, Policy Development, Social Development, Finance and State Budget, and Monitoring and Evaluation. In addition, there are two important departments that can be linked to this project.

Department of Land Relation, Construction and Urban Development. This department organizes land possession and land utilization for herders, citizens and legal entities and provides land ownership to local citizens. The department has a number of divisions responsible for land policy, land management, ownership, cadastre, geodesy and cartography, land evaluation, land fees, information technology, and internal matters. Typically, the departments in all aimags have two divisions (division of land management and division of construction and urban development) and approximately 15-18 officers are working at the departments. The department will be a key target for capacity building for integrated land management planning based on the eco-regional and ecosystem assessments.

Department of Environment and Tourism (DET). DET has usually in all aimags two divisions: the Environmental Policy Division and the Environment and Natural Resources Division. The department is mainly responsible for the organization of activities for implementation of environmental laws in their respective provinces and the development plans for environmental protection and sustainable use of natural resources. Its main areas of interventions are environmental conservation, restoration, and appropriate use of resources at local level. On average, eight officers are working at the department. The environmental rangers at local levels and herder groups have close cooperation with the department. The department will also be a key target for capacity building and training of herders and knowledge sharing for ecosystem based-adaptation, land and water management of local communities and herder groups.

Local framework- Soum Government
The Soum Government is responsible for the preparation, implementation, monitoring and evaluation of local policies and provides administrative services such as civil registration, civil services, licenses, and permits. Their roles include issuing certificates for use of natural resource, implementing and monitoring conservation activities, sustainable use of natural resources (including pasture and water), and rehabilitation, obliging those causing damage to the environment for payment or remedy, to halt or to inform the respective authorities on damage to the environment. At the soum level, typically there are three key officers representing three key areas. They are: (i) Agricultural officer, (ii) Land officer, and (iii) Environmental inspector. Soum governments (where applicable through Soum Environmental Units), under technical guidance of Aimag Department of Nature, Environment and Green Development, they must support herder groups in their formation and development. In addition, they are responsible to allocate pasture areas to herder groups for livestock management for a long period (usually 5-10 years).

Aimag and soum Citizen Representatives Khurals. There are the representative bodies of the people. They approve regulations for their jurisdictions, monitor local administrative bodies, approve local budgets, and control their execution. The following duties are relevant to the project: approval of budget for activities on environmental protection, sustainable use of natural resources, and protection and rehabilitation of water sources.
Bagh and khoroo citizens Khurals. They have a key role in addressing the use of pasture and water points, monitoring environmental protected area, hearing soum governor's reports on environmental protection and delivering their proposal on environmental issues on behalf of soum communities.

Other relevant national entities

Government Agency of Land Affairs, Geodesy and Cartography

This government agency within the Ministry of Construction and Urban Development (MCUD) is responsible for supporting sustainable development and rural livelihoods through implementation of the state policy on land management, cadastre, geodesy and cartography. There are four main divisions: Cadastre Division, Geodesy and Cartography Division, Information Technology Division and Land Management Division. The specific activities of these four division are: i) organizing and implementing general land management planning at the national level, ii) technical guidance concerning land ownership, possession, utilization, rehabilitation, protection and land management, iii) network for land quality and characteristics monitoring, and ensure sustainable use of land, iv) supervision of utilization of land in accordance with established primary and secondary land use classification code and develop and implement management plan for land protection, and v) resolving land conflicts. The agency has very close cooperation with Nature Conservancy (international NGO subcontracted by GoM) over the eco-regional assessments.

The National Water Committee

The National Water Committee (NWC) is responsible for all national water issues. It provides integrated management plans and strategy at the national level, and it is responsible for monitoring the implementation of the National Water Program. Under its role, the committee will i) protect underground fresh water sources, ii) protect origin and water areas where rivers and stream flows are created, and iii) introduce efficient water utilization and new technology based on water resource and research. In addition, iv) it ensures the implementation of action plans on water, and v) provides environment policies for underground water. The NWC is composed of members including representatives from the State Administration Central Organizations (including environment and green development, defence, infrastructure, foreign relations, finance, economy, industry and agriculture, mining, energy, health, road and transportation, education and science members), as well as representatives from the National Security Council of Mongolia and the Water Service Organizations. The NWC has established its branch committees in aimags and the capital city. Respective aimag governors and mayors are the chief of branches of the National Committee. The branch chief is responsible for approving the management structure and rules and regulations of the branch activities annually.

River Basin Administrations

MET established the boundaries of 29 river basins covering the whole territory of Mongolia (Ministerial Order no 332, 2009). Currently, there are only 23 River Basin Administrations (RBA) in Mongolia and they draft and implement the river basin management plans, provide professional guidance on water issues, review requests for water use, monitor water resources and control the water use. They are key project stakeholders as activities that promote sustainable use of water resources as well as capacity building. Table 26 includes the list of all RBA's in Mongolia.

Table 27 List of the River Basin Administrations (RBA) in Mongolia and in green the RBA in the project target aimags

N	Name of Basin Administration	Office location	N. of staff
1	Tuul river	Ulaanbaatar city	22
2	Khyargas lake-Zavkhan river	Zavkhan province, Ulaisatai city	10
3	Khar lake-Khovd river	Khovd province, Khovd city	8
4	Selenge river	Orkhon province, Erdenet city	8
5	Haraa-Yeroo river	Selenge province, Yeroo soum	7
6	Ongi-taats river	Uvurkhangai province, Arvaikheer soum	6
7	Onon-ulz gol river	Khentii province, Batshireet soum	6
8	Ubs lake-Tes river	Uvs province, Ulaangom city	8
9	Orkhon -chuluutriver	Arkhangai province, Erdenebulgan soum	10
10	Khuvsgul lake-Eg river	Khuvsgul province, Murun city	8
11	Buuntsagaan-baidrag lake-Baidrag river	Bayanhongor province, Bayanhongor city	7
12	Buir lake-menengin talKhalkh river	Dornod province, Choibalsan city	7
13	Kherlen river	Ulaanbaatar city, Baganuur district	n.a.
14	Umard gobi Guveet-Khalkh Dundad Tal	Govisumber province, Sumber soum	12
15	Altain Uvur gobi	Umnugobi province, Dalanzadgad city	12
16	Galba-Uush-Dolood gobi	Dornogobi province, Sainshand city	12
17	Bulgan river	Khovd province, Bulgan soum	6
18	Khanui river	Bulgan province, Bayan-Agt soum	6
19	Orog lake-Tui river	Bayanhongor province, Bayanhongor city	6
20	Delgermurun –shished	Khuvsgul province, Murun city	6
21	Khuis gov-Tsetseg lake	Gobi-Altai province, Altai city	6
22	Ider river	Zavkhan province, Tosontsengel soum	n.a.
23	Uyench-Bodonch river	Khovd province, Altai soum	n.a.

n.a.= not available Source: IWMP, 2013, MET

4.4. Multi-Stakeholder Engagement

Country ownership and engagement of NDA

The Mongolian government has an ongoing strategy to increase resilience and improve and protect the livelihoods of herding communities from the impacts of climate change. In recent years, Mongolia has aligned national policies and strategies to focus on addressing climate risks. The NDA has been actively engaged in exploring solutions and has been actively engaged in all stakeholder consultations.

Stakeholder engagement and consultations

A key objective of the GoM is to strengthen the climate resilience of resource-dependent rural population through ecosystem-based adaptation measures and protection of land and water resources. As such, any approach will only succeed if the targeted herder groups fully buy-in and participate in the interventions.

Extensive consultations have been held since 2016 to ensure that the challenges and perspectives of herder communities are well understood, embraced and incorporated into future projects. In addition to consultations with communities, consultations were also held with the FAO, SDC, IFAD, WB, ADB, GIZ, as well as those responsible UNDP's other ongoing projects in areas of climate change adaptation, pasture/land management and disaster risk reduction. NGO's and academia consultations included the Institute of Research Institute for Animal Husbandry, Mongolia Water Forum, Environmental Consulting and Research Company, Mongolian Farmer's Association for Rural Development and

Center for Policy research at the central level. Individual and small group consultations with government stakeholders included representatives from the MET, NAMEM, MOF, MoFALI, NEMA, ALAGaC, Aimag level representatives, and local governments.

The first stakeholder consultation took place in November of 2016 in Ulaanbaatar. The more than 70 in attendance represented the MET, MoFALI, NAMEM, NEMA, as well Governors of several provinces (Dornod, Sukhbaatar, Zavkhan and Khovd) who represent suggested areas.

A private sector roundtable was co-organized by FAO and UNDP with 17 individuals representing leading meat processors, producers and exporters. Representatives from the meat processing sector shared their views on the proposed interventions. Their views were made with a view to improve the output of the meat processing industry. Specific recommendations were made by representatives of from various stages of value chain regarding improvement of the policy environment, enforcement of animal disease control, and the importance of building strong relations with local herders.

A second stakeholder consultation was held in Choibalsan soum of Dornod Aimag with more than 50 participants from local governments, civil society organizations, herders and natural resource users. This consultation focused on the local level so as to build a closer relationship with the local administration, agricultural organizations, herders and natural resource users, and also to get their views for incorporating into the formulation of the project. Discussions were centered on (i) the effect of climate change in their daily activities as herders and natural resource users; (ii) the effect of climate change on soil structures, pasture grass composition, and water resources, (iii) how herders and local people incorporate early warnings and forecasting information into their daily life

Consultations were then held a number of herder households in the Dornod province to directly collect information and seek the views of primary beneficiaries on required interventions as well as get a sense of their understanding of the impact of climate change on their livelihoods. These herder households represented were a mix of subsistence level herders (with less than 200 heads of livestock), as well as those who were small-scale but operating at a level above subsistence.

From July 31st to August 4th, 2017 there were additional local level consultations held in the Khovd Province and Ulaanbaatar. These consultations focused on Sustainable Value Chains. Joining the consultation was a development finance expert and a representative from the UNDP International Centre for Private Sector Development. These consultations are viewed as being very important as they gathered key information as it relates to developing sustainable value chain and social impact investment opportunities.

5. Conclusions and Recommendations

Mongolian rural communities are extremely vulnerable to expected impacts of climate change, which include: greater intensity of storm surges; increased exposure to flooding; loss of life from extreme weather events such as dzud; marked declines in the productivity of livestock and agriculture; and major reductions in the supply of goods and services from pasture and land ecosystems. In terms of extent and damage, dzud is the most disastrous weather event in the history of this country. Nationwide, during the 2009-2010 dzud, 9.7 million animals were lost resulting in economic damage that comprises 93% of the total damage of the last 11 years. Adaptation to these climate change threats will require restoration of an efficient and effective early warning system, management of pasture and land ecosystems, and support of rural communities.

Barriers to effectively maintaining and expanding ecosystems, predicting climate change and diversifying rural livelihoods relate primarily to shortfalls in institutional capacity, technical knowledge, access to finance, and lack of cooperation. Previous experiences from programs and projects in Mongolia have shown that investments in weather forecasting and improvement of agriculture, livestock, pastures, land, water and rural livelihoods require frequent, direct, well-facilitated engagement with local communities. Involving rural communities and their traditional knowledge invariably assists project managers in inter alia selecting appropriate intervention sites and organisms for ecosystem restoration. Past experiences have also shown that a strong focus on community engagement often leads to increased livestock markets, which in turn threatens the ecological sustainability of the newly developed livelihoods. This highlights the importance of developing coordinating agreements between local government, herders and local groups.

To address the above barriers, this study proposes various integrated areas of intervention, including: Climate-informed, medium- and long-term agriculture and land use planning; Climate vulnerability of herder livelihoods reduced through ecosystem based land and water management; and Herder household income increased and de-risked to reduce vulnerability of agriculture-based livelihoods. Integration of these various components and others should take place through medium- and long-term planning, ecosystem based adaptation, water and land management at the community scale. In particular, potential interventions could aim to forecast long-term climate change impacts, enhance social and natural capital to withstand the added climate change stressors, enhance income and promote more secure livelihoods for herder households to reduce vulnerability, and develop a climate smart policy environment. The collaboration between international organizations, national and local authorities, combined with implementation of investments is expected to catalyze a transformational change in terms of how national and local governments approach climate change adaptation in Mongolia. This change will enhance the resilience of the rural communities and the livestock sector to climate change in Mongolia.

References

1 MARCC (2014) Mongolia Second Assessment Report on Climate Change 2014. *Minist. Environ. Green Dev. Mong. pp. 1-302.*

2 Dagvadorj, D. (2012) The Climate Change Policy and Measures in Mongolia. In *Integration of Climate Change Adaptation into Sustainable Development in Mongolia* (IGES, ed), pp. 12–17.

3 UNDP (2015) Pre-feasibility study. In *Concept note: Improving adaptive capacity and risk management of rural communities in Mongolia* (UNDP, ed), pp. 1–37.

4 Demberel, D. (2011) The State Great Khural of Mongolia: National action programe on climate change. *Mong. Parliam. Resolut. No.02, Febrary 2011, pp. 1-27.*

5 Demberel, D. (2010) The State Great Khural of Mongolia: The water national program. *Mong. Parliam. Resolut. No. 24 May 2010, pp.1-17.*

6 UNDP and Government of Mongolia (2012) Inclusive sustainable growth Country Programme Action Plan 2012-2016 Government of Mongolia, and the UNDP, pp. 1-39.

7 Batima, P. *et al.* (2005) Observed Climate Change in Mongolia. *AIACC Work. Pap. pp. 12-35.*

8 Christensen, L. *et al.* (2004) Vulnerability of the asian typical steppe to grazing and climate change. *Clim. Change* 63, 351–368.

9 Angerer, J. *et al.* (2008) Climate Change and Ecosystems of Asia With Emphasis on Inner Mongolia and Mongolia. *Rangelands* 30, 46–51

10 Simões, M. (2016) *Stakeholder consultations and development of a GCF proposal*, UNDP, pp. 1-7.

11 World Bank (2013) , Livestock and agricultural market project (LAMP). , *Report No: 73827-MN*. [Online]. Available: http://www.gafspfund.org/sites/gafspfund.org/files/Documents/Mongolia PAD.pdf

12 UNDP (2012) Mongolia Human Development Report 2011 | UNDP in Mongolia. *United Nations Dev. Program.* at <http://www.mn.undp.org/content/mongolia/en/home/library/National-Human-Development-Reports/mongolia-human-development-report-2011.html>

13 GoM (2013) The Fifth National MDG Report | UNDP in Mongolia. *Gov. Mong.* at <http://www.mn.undp.org/content/mongolia/en/home/library/National-MDG-reports/TheFirthNationalMDGReport.html>

14 Dorjsuren, D. (2011) The Government policy on water and priority areas in water sector. In *Water resources, water use and management in Mongolia. November 2011, Ulaanbaatar, Mongolia.*

15 Banerjee, R. *et al.* (2014) Mongolia: Targeted Analysis on water resources management issues. *2030 Water Resour. Gr.* 1, 1–60.

16 Mann, M.E. *et al.* (2008) Proxy-based reconstructions of hemispheric and global surface temperature variations over the past two millennia. *Proc. Natl. Acad. Sci. U. S. A.* 105, 13252–7.

17 Chen, F. *et al.* (2009) Rapid warming in mid-latitude central Asia for the past 100 years. *Front. Earth Sci. China* 3, 42–50.

18 IPCC (2014) Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. *Clim. Chang. 2014 Synth. Rep.* DOI: 10.1017/CBO9781107415324

19 WGII (2014) *Climate Change 2014: The Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

20 D'Arrigo, R. *et al.* (2001) 1738 years of Mongolian temperature variability inferred from a tree-ring width chronology of Siberian pine. *Geophys. Res. Lett.* 28, 543–546.

21 Natsagdorj, L. (2008) Desertification in Mongolia. Geo-ecological issues in Mongolia. *Pap. geoecology 7,* pp, 7–15.

22 MEGD (2014) *Mongolia Second Assessment Report on Climate Change 2014*, Ministry of Environment and Green Development of Mongolia, pp. 1-302.

23 IFAD (2015) Livestock and climate change. *Livest. Themat. Pap.* 1, 1–26.

24 Rao, M.P. *et al.* (2015) Dzuds, droughts, and livestock mortality in Mongolia. *Environ. Res. Lett.* 10, 74012

25 IG/EIC (2014) *Desertification atlas of Mongolia*, Institute of Geoecology/Environmental Information Centre (IG/EIC).

26 Bunchingiv, B. *et al.* Ecosystem-based Adaptation Approach to Maintaining Water Security in Critical Water Catchments in Mongolia | UNDP in Mongolia. . [Online]. Available: http://www.mn.undp.org/content/mongolia/en/home/operations/projects/environment_and_energy/Ecosystem-based-Adaptation-Approach-to-Maintaining-Water-Security-in-Critical-Water-Catchments-in-Mongolia.html

27 UNDP/AF (2014) Study compilation for development of integrated water resource management plan for the Kharkhiraa and Turgen river basin. *Proj. Ecosyst. based Adapt. Crit. water catchments Mong.*

28 UNDP/AF (2014) Study compilation for development of integrated water resource management plan for the Ulz river basin. *Proj. Ecosyst. based Adapt. Crit. water catchments Mong.*

29 Davaa, D. (2011) The surface water resources of Mongolia and a potential for use. *Water Resour. water use Manag. Mong.* 1, 1–120.

30 Yasanjav, N. and Hartmann, I. (2015) Midterm review. Ecosystem-based Adaptation Approach to Maintaining Water Security in Critical Water Catchments in Mongolia. *UNDP* 1, 1–91

31 MEGDM (2013) Technology needs assessment. Vol 2: Climate Change Mitigation in Mongolia. *Minist. Environ. Green Dev. Mong.* 2, 1–238

32 MEGDM (2013) Technology needs assessment. Vol 1 - Climate change adaptation in Mongolia. *Minist. Environ. Green Dev. Mong.* 1, 1–286

33 Forabosco, F. *et al.* (2017) Methane, nitrous oxide emissions and mitigation strategies for livestock in developing countries: A review. *S. Afr. J. Anim. Sci.* 47, 268–280.

34 MEGDM (2013) Integrated water management plan of Mongolia. *Minist. Environ. Green Dev. Mong. pp 1-341.*

35 Natsagdorj, L. and Sarantuya, G. (2011) Extreme cold may result big loss of livestock. *Pap. Meteorol. Hydrol.* 32, 7–17.

36 Natsagdorj, L. (2014) Consideration of climate change in assessment of drought and dzud. Research document (in Mongolian language). In *IMHE*

37 MEGDM (2015) Mongolia's Intended Nationally Determined Contribution (INDC) to the 2015 Agreement under the United Nations Framework Convention on Climate Change (UNFCCC). *Minist. Environ. Green Dev. Mong.* 3, 1–82

38 GoM Mongolian law on land, provision 52.1 of article 52.

39 GoM Mongolian law on land provision 52.2 of article 52

40. Natsagdorj, L *et al.*, (2019) Climate biocapacity of Mongolia and its change, Proceedings of the Mongolian Academy of Sciences, Vol. 59 No 02 (230)

41. NEMA Mongolia, UNDRR and ADPC, (2019) Disaster Risk Reduction in Mongolia: Status report

42. Batima P., *et al*, (2006) Evaluation of Adaptation Measures for Livestock Sector in Mongolia, AIACC working paper No. 41

43. GoM, (2018) Third National Communication to UNFCCC

44. GoM, (2015) National Report on rangeland Health of Mongolia

45 Kh. Jamiyansharav, María E. Fernández-Giménez et al., (2018) Plant community change in three Mongolian steppe ecosystems 1994–2013: applications to state-and-transition models, Ecosphere Journal

Appendix 1

Mongolia has an estimated 61.5 million livestock in an area of 1.1 million km^2 of rangeland. Pastureland is critical for the livestock sector in Mongolia, and 70% of the total land in the country is covered by pasture [37].

Table 28 Basic statistics for the livestock sector in Mongolia, year 2015

	Country	Aimags			
	Mongolia	Zavhan	Khovd	Dornod	Sukhbaatar
NUMBER OF LIVESTOCK FARMERS	153,085.0	8,258.0	7,188.0	4,043.0	6,858.0
NUMBER OF HOUSEHOLD WITH LIVESTOCKS	216,734.0	12,176.0	11,358.0	6,342.0	9,492.0
NUMBER OF COOPERATIVES, HERDERS GROUPS AND MEMBER OF PASTURE USERS					
Cooperatives,	115,047.0	9,681.0	6,060.0	2,183.0	4,160.0
Herders group,	17,425.0	1,061.0	780.0	654.0	82.0
Member of pasture user households	22,160.0	2,739.0	1,332.0	523.0	323.0
SOME INDICATORS OF HERDING HOUSEHOLDS					
Source of electricity	140,251.0	7,792.0	6,615.0	3,960.0	6,389.0
Solar energy	130,452.0	7,765.0	6,518.0	3,277.0	6,169.0
Wind energy	1,338.0	3.0	3.0	203.0	71.0
Small-sized generators	1,325.0	3.0	-	62.0	13.0
Central power system	7,076.0	21.0	94.0	406.0	132.0
Satellite antenna	104,158.0	6,969.0	5,478.0	2,914.0	5,086.0
Television	119,034.0	7,098.0	5,925.0	3,372.0	5,757.0
Radio	48,545.0	1,985.0	1,235.0	1,826.0	2,494.0
Sewing-machine	93,575.0	6,646.0	5,250.0	2,332.0	3,853.0
Mobile phones	151,169.0	9,852.0	8,102.0	4,398.0	6,342.0
Hand-made felt	41,090.0	1,352.0	4,479.0	29.0	66.0
NUMBER OF HOUSEHOLD FARMING ANIMALS					
Pork	33,491.0	100.0	134.0	886.0	160.0
Poultry	805,107.0	1,148.0	2,229.0	16,832.0	125.0
Bees	8,038.0	-	23.0	837.0	8.0
Rabbit	517.0	-	-	5.0	-

NUMBER OF LIVESTOCK					
Horse	3,295,336.0	163,112.0	107,594.0	196,537.0	259,590.0
Cattle	3,780,402.0	158,860.0	156,096.0	16,365.0	214,478.0
Sheep	24,943,127.0	1,562,653.0	1,098,929.0	745,322.0	1,511,835.0
Goat	23,592,922.0	1,241,673.0	1,520,986.0	445,008.0	1,076,042.0
Camel	367,994.0	6,720.0	21,836.0	4,908.0	8,309.0
NUMBER OF LOST ANIMALS					
Horse	31,164.0	1,095.0	1,083.0	574.0	1,250.0
Cattle	41,191.0	890.0	1,329.0	666.0	985.0
Camel	1,858.0	31.0	141.0	25.0	82.0
Sheep	269,588.0	22,249.0	6,301.0	3,083.0	6,115.0
Goat	281,802.0	9,369.0	8,388.0	2,785.0	6,662.0
NUMBER OF WELL, RESERVOIR AND AQUIFER					
Total wells	42,098.0	700.0	2,429.0	3,329.0	2,726.0
Deep drilling wells	8,335.0	397.0	206.0	425.0	475.0
Short pipe wells	1,849.0	17.0	59.0	97.0	240.0
Simple mining wells	26,705.0	252.0	2,089.0	2,514.0	1,958.0
Other type of wells	5,209.0	34.0	75.0	293.0	53.0
PRODUCTION OF AGRICULTURE					
Meat, ton	294,962.8	14,535.8	11,221.4	10,345.1	17,697.8
Milk, ton	765,376.3	41,232.2	29,294.4	27,211.1	31,524.6
Wool, ton	22,318.7	1,745.2	871.0	684.5	1,116.0
Cashmere, ton	7,726.9	472.1	475.0	119.0	350.7
Skin, thousand	9,196.1	554.3	442.4	230.9	522.3

Appendix 2

Summary of climate change impacts, risks and vulnerabilities in Mongolia.

The second assessment report on climate change in Mongolia [1] and Third National Communication (TNC) to UNFCCC [43] summarized current observed climate change, and projected climate change on nature, socio-economic sectors, mutli-dimensional vulnerability and risk assessment in Mongolia.

Although, there could be some positive impacts of climate change for Mongolia, the negative impacts are likely to dominate and pose serious threats to the sustainability of the socio-economic systems. Table 28 summarizes impacts and risks caused by climate change on natural resources and socio-economic sectors. Observed changes date back to 1930's and onwards, when national hydromet system was established. Based on the assessment and projections the until end of the century, continuous warming in all seasons and decreased precipitation (especially in summer season) will lead to intensified droughts and dryness, which will adversely affect environmental and socio-economic sectors. Projected increase of winter precipitation will increase the risk of natural hazards such as dzuds , and harsh weather in the country.

The assessment of current and future impacts of climate change confirms that animal husbandry, arable farming, human health, and natural resources including water, forest, pasture and soil are the most vulnerable sectors in Mongolia, and also reinforces the importance of natural disaster management.

Table 29 Summary of climate change impacts, vulnerability and risk assessment

No	Changes in climate and risk factors	Affected area/sector	Observed impacts in related areas/ sectors (1930's onwards)	Projected future impacts, vulnerability and risk assessment (up to 2100)	Priority adaptation measures	
					Short-term	Long-term
	1. Natural resources and ecosystems					
1.1	-Increased temperature in warm season which led to higher potential evapotranspiration and decreased precipitation with SPEI trends consistently negative for the last 58 years. -Extended duration of hot spells, -Increasing trend of droughts index and longer dry spells.	Pastureland and soils	- Pasture production has decreased by 20-30% in the past 40 years based on pasture observation data, -About 70% of pastureland is degraded to certain extent; - Total annual precipitation decreased by 7% over last 70 years -Pasture plants composi-tion has changed over the last 30 years, with decline in palatable species and increase in unpalatable species, ecosystem zones have shifted and plants tolerant to droughts have become dominant, -Soil fertility and quality has degraded.	-Results from "Century" ecosystem model showed that for aboveground biomass, net primary production and pasture above and below- ground biomass by about 50-80% by 2035 from current levels, -Soil organic carbon is estimated to be reduced by 6.3-9.5% in the 2050s in the forest steppe and the steppe regions. - Total annual precipitation is projected to decrease by 17% across almost entire territory by 2100.	-Climate-informed planning system for sustainable management of pastureland and water, -Community-based adaptation measures for enhancing ecosystem services and functions; -Enhanced planning and use of pasture, restoration measures through rotational use.	- Water harvesting and storage reservoirs to address water stress - Introducing mechanisms for payment for ecosystem-services and pastureland carbon purchase to reduce anthropogenic impacts
1.2	-Decreased precipitation in warm seasons, and evapotranspiration rates, -Extended dry periods, and intense and longer droughts, -Warmer soil depth temperatures,	Forest ecosystems	-Area covered by forests has decreased by 4.1% in the period of 1999-2012, -Frequency of forest fires has increased and area burnt by forest fire has expanded by 13.3% in 1999-2012,	-In 2050, area affected by harmful forest insects will expand by 1.4–13 times higher than current level, -Forest fire will cover more areas by 512 thousand hectare in 2030	-Sustainable forest management that allows sustainable use, not only protection, -Promote community-based	- Promote community-based forest management - Exploring forest concessions

	-More visible warming in the high mountains zones. - Daily minimum temperatures have increased by 1.0-6.0°C in most parts of Mongolia over last 58 years		-Recurrent drought and dry spells affect negatively the forest biomass accumulation and biomass annual growth tend to be slower, -Forest insects and pests tend to cover more areas.	without any measure against fires, -Areas of the high mountains and the forest steppe will decrease by 70-80% and 8-41% respectively, -Permafrost will continue to melt and forest strips border in the high mountains would shift toward the top of mountains.	forest management - Expand forest cover and plantations.	- Introdcing Results-based payment system for REDD+.
1.3	-Increase in average temperature in the cold season, --Frost days decreased by 3-34 days in last 58 years; -Reduced precipitation in warm season and increased evapotranspiration, -Snow cover and ice melting occur earlier and river ice duration has shortened, -An intensity of rainfall increased.	Water resources, glaciers and permafrost	-Surface water regime is being changed. Lake areas are decreasing and drying up of small lakes especially in steppe region, springs and even some rivers; -Negative mass balance and shrinkage of glaciers occur and total glacier area has reduced by 27.8% in last 70 years, -Duration of ice cover period and ice thickness have decreased by 20 days and by 35cm respectively in rest of rivers draining from no glacier areas. Water temperature has increased by 2°C, - A ground water table is tending to decrease.	-The average water temperature of the period of April to October will increase by 3.1-4.2^{0}C by 2080, -River run-off would increase by 8-13 mm in 2080, while potential evaporation will increase several fold, -The annual glacier melt rate or narrative mass balance will increase by 67% compared to melt rate of 1982-2010 period, -Temperatures in the ground depth of 10 and 15m have been increasing in the northern permafrost region and it tends to decrease and disappear in the southern region of the country.	-Water harversting and storage in high-altitudes; -Construction of water reservoirs for river flow regulation, -Integrated water resources management of river basins (Water law, 2012).	- Invest in water recycling technologies and grey water use
1.4	-Intensified atmospheric phenomena caused by convection,	Natural disasters	-Frequency of disastrous phenomena in the last two decades were compared: annually, about 75 phenomena were observed in the	-Frequency of atmospheric hazardous phenomena will increase by 23-60% than current level in the middle of the century,	- Early warning and early action system in view of natural disasters,	- Introducing Natural disaster/hazard insurance system

	-Re-current anomalies of atmospheric circulation. - Since the year 1940, winter precipitation was increased by 22% and 40% since 1961 increasing risk of dzud.		previous ten years and it has doubled in the last decade, -Rapid onset phenomena such as heavy rain, flash flood, strong wind, thunderstorm, and hail have been more frequent and intense and economic loss due to disasters has doubled, -Frequencies of drought and *dzud* are incresing and the biggest *dzud* occurred in winters of 2002/2003 and 2009/2010 when GDP has decreased by at least 6%, -About 77.8% of the total land of Mongolia has experienced degradation and desertification at the certain extent.	-Livestock loss due to drought and *dzud* is expected to increase by 9.4% in 2050 which is about 2.1% as of 1981-2000, -Land degradation and desertification would lead to increased evapotranspiration and decreased rainfall as a result of reverse feedback mechanism.	- Forecast based planning and budgeting -Index based insurance, -Contingency plan/ Guideline for Emergency Evacuation.	
2. Major socio-economic sectors						
2.1	-Increased winter precipitation, -Frequent droughts and *dzud,* -Increased temperature and evapotranspiration in warm season and decreased precipitation, -Longer hot spells and heat waves. - Cold spell duration index has increased by 0.5-7.0 days in central parts of the country, and decreased by 1.4-11.0	Animal husbandry	-Current level of animal loss is about 2% and this rate has increased by 0.25% per year in the period of 1991-2011, -The average animal weight has decreased, - Pasture production has reduced and number of hot days which make grazing difficult for livestock have increased, -Dates for goat cashmere and sheep wool shearing have advanced by 5-10 days,	-Animal losses caused by drought and *dzud* will increase and have been estimated at 8.2% and 9.4% in 2020 and 2050 respectively, -Snow in winter is predicted to increase by 40-50% and heavy snow will cause negative impact on grazing and decreased animal weight, -Due to animal weight loss, the total meat production is expected to decrease by 5.4% in 2050s,	- Climate-informed planning system - Improved animal breeds, -Regulate and manage animal numbers in alignment with pasture carrying capacity, -Integration of traditional pastoral livestock with	- Invest in etchnology advancements in increasing export of sustainable livestock commodities

	days in the northern half of the country		-In the last years, 26 new diseases, 8 re-occurring and 6 extending infectous diseases of animals have been recorded in the country.	-Pasture water supplies will be challenging because of decreased small lakes and water ponds caused by intensified dryness.	intensified farming of animals, -Maintain appropriate ratio between types of animals and herds composition.	
2.2	-Longer hot spells and heat waves, -Increased dryness and decreased soil moisture, -Intensifying drought index. - Longer growing season	Arable farming	-Growing season became longer by 8.8-42 days over last 58 years - Hot spells (above 26^{0}C) inhibit photosynthesis process in crops and reduce production, -Dryness process has been intensified in the arable farming region in the last 70 years. Productive moisture in 1m layer of soil has reduced by about 30%, -Although, cumulative heat has been sufficient, moisture has become lacking for crop growth and development.	-Results of DSSAT 4.0 crop production model demonstrated that wheat production per hectare is estimated to decrease by 13% in the 2030s.	-Increase investment in water saving technologies, - Two to three times Appropriate crop rotation systems, -Increase minimum tillage for crops, -Introduce drought resistant crop varieties.	- Explore options for fast growing crop types and harvesting twice a year - Invest in researching winter crops
2.3	-Longer hot spells and heat waves, -Intensified frequency of natural hazards, - Intensifying records of extreme hot days and heat stress - - Daily maximum temperatures have increased by 0.6-5.0^{o}C over the territory	Human health	-Cardiovascular disease has increased in the last 31 years (Burmaajav B. et al., 2010), -Cardiovascular diseases cases in Ulaanbaatar city has increased while the number of hot days above 30 ^{0}C has been increased, -A number of affected population by natural disasters tend to increase.	-Cases of cardiovascular diseases will continue to increase due to hot spells and hot waves, -Vector-borne infectious diseases would increase. - Increases in frequency of natural disasters can cause death, distress and homelessness and disrupt the supply of	-Research and development (R&D) in health care system for climate related morbidity and mortality, -Early warning from hot spells and hot waves.	- Invest in robust healthcare service provision and connectivity

	of Mongolia over last 58 years,			essential medical and health services.		
2.4	-Increased number of incidents of heavy snow and rains, -More frequent strong snow and dust storm.	Infrastructure	-Frequency of extreme events and their magnitude has increased significantly in the last 20 years.	-Increased heavy rainfalls and floods will cause damages to roads, buildings, bridges and constructions thereby reducing their useful lifespan, -Electricity transmission cables and systems can be broken down by heavy snow and ice freezes, -Flood protection canals, hydro plant constructions and normal working regime can be damaged by water regime changes.	- Invest in enhanced stability and robustness of infrastructure	

Appendix 3

National Laws

Land Law

This law (approved in 2002) regulates possession, use of land by a citizen, entity and organization, and other related issues. The primary responsibility for implementing the Land law rests with aimag and soum officials, and interpretation and application of the Land law in allocating pastoral resources, particularly winter camp sites and winter pastures to users, have been varied, random and unregulated in terms of group size, length of possession and arrangements on access by others.

According to provisions 52.1 and 52.2 of article 52 of the law on Land, issues on pastureland, rational use and protection were focused and local communities have an access to use the land upon relevant agreement and terms.

Provision 52.1. Citizens Representatives' Khurals of soums and districts, taking into consideration land use traditions, rational land use, conservation and rehabilitation requirements and specifics of pastureland, shall reflect land management activities to the general schedule with pasture separation for winter, spring, autumn and summer settlements and reserve rangelands [38].

Provision 52.2. Summer and autumn settlements and rangelands shall be allocated to baghs and hot ails (neighboring families) and shall be used collectively. Terms for letting or prohibiting animals graze in winter and spring pastures shall be set forth by soum and district Governor taking into account citizens' proposals and hay yield of the particular year, and shall be pursued by Governors and citizens of bags and khoroos. In order to prevent certain areas of winter and spring pastures from over-grazing during summer and autumn, land use traditions, pasture capacity and regional specifics shall be taken into account, and based on agreement with soum Citizens Representatives' Khural, the soum Governor may allow collective use of land for herders upon relevant agreements and terms [39].

Special Protected Area Law

This law (approved in 1994) regulates relations concerning utilization of and taking areas under special protection, preservation and protection of natural landscape in order to keep particular features of natural zones and belts, their peculiar formation, forms of rare and threatened fauna and flora, historical and cultural sites and natural sightseeing as well as studying and identifying their evolution. The law provides the establishment of protected area systems at national and local level, and establishes management regulations for nationally protected areas (State SPAs). According to Article 28, whether tourism is permitted within Local SPAs appears to be determined on a case-by-case basis by the relevant Citizens' Representative Khural. Comprehensive legislation framework on SPA in Mongolia is required to provide coherence with requirements of extension of the SPA network, building capacity of SPA networks, and supporting National network on SPA and sustainable finance mechanism on SPA network.

Pasture Management, draft law

Mongolia's constitution places pastureland under state ownership for communal use. This legal status of pastureland and the need to maintain pastoral mobility, to provide for seasonal migrations and for traditional pastoral coping strategies in extreme weather events, drought and dzud (winter disasters) and for reciprocity among pastoral resource users, are the reasons and rationale for not extending tenure rights over pastureland to pastoral user groups, so far.

The emerging lessons learnt from donor-supported programs and recent policy studies re-confirm the need to maintain common property use and point out the crucial role of pastoral grassroots institutions and of local bodies for collaborative management of grassland (and other) resources. The Pasture Law has been drafted and discussed by related experts and members of the Parliament, but as of yet has not been passed. The bill was submitted in 2011 to the Parliament and a survey poll from 15,060 herders in 118 soums was done according to the suggestion by the Parliament. Sixty-eight percent of the total participants in the survey agreed a separate "Pasture Law" is required (18% responded that there is no need and 14% that they don't know). But the bill was not discussed at the Parliament. Pasture-related articles were included in the Land Law and submitted to the Parliament in 2013. However, pasture law has been under an uncertain condition, pasture-related articles such as pasture usage taxation, and using funds for pasture conservation were included in a draft of the "Asset Law" by experts and government officers of related ministries and agencies for the Parliament discussions.

Land Fee Law

The purpose of this law (approved in 2007) is to charge fees to citizens, business entities, and organizations using state-owned land, and to regulate the fees paid to the state budget. Mongolian citizens, business entities, or organizations possessing or using land based on contracts made according to the terms and conditions of the Land law, and foreign diplomatic missions and consular offices, representative agencies of international organizations, foreign legal bodies and citizens can all enter agreements for the use of state land by paying land fees. This law is used extensively at the local level by aimags and soums to assess and collect land fees from tour operators operating ger camps (traditional tents) and other resort facilities.

Water Law

The law was approved April 2004 by the Mongolian Parliament and regulates relations pertaining to an effective use, protection, and restoration of water and water basin. The Law on Water has introduced the legal basis for basin management and the legal mandate of Water Basin Organizations is described in Article 19. The Law is quite specific on the composition of the Basin Council, as it is called. The modified law, the Law on Water (2012), further clarifies a number unresolved issues and introduces Water Basin Authorities, which are technical offices operating with professional support and guidance from the Water Authority and responsible for implementation of all water management activities within the respective water basins. It has five chapters, inlcuding Chapter 5: Protection of Water Resources and its Quality, Habitat Restoration. Through the law, protection of water resource and quality, protection and effective use of water resources during drought and desertification periods and incentives for water protection and restoration are reflected in article 31, 32, and 35. The above articles are more consistent with implementation of integrated water management to be undertaken to project target areas under the task of Component 2.

National Plans

National environmental action plan

Mongolia initiated a National Environmental Action Plan (NEAP) in 1993. The NEAP covers environmental actions to the year 2010. The Plan focuses on the following three major parts:

• Principal environmental issues: environmental protection, management of natural resources, conservation, and natural disaster mitigation.
• Social and economic dimensions; and
• Other mechanisms and responses.

The NEAP raised issues that include: land degradation; the wildlife population decline; eco-tourism promotion; and institutional capacity, including regulations, co-ordination, and human resources. The NEAP calls for the integrated development of natural resource law to support Mongolia's efforts in sustainable development. Currently, the Government is formulating NEAP covering the period up to 2020.

National action plan for combating desertification
The first National Program for Combating Desertification in Mongolia (NAP) was approved by the Government in 1996 and updated in 2010. Since then, a number of activities have been undertaken in the areas of policy development and planning, capacity building of local community groups, strengthening collaborative management over pastoral lands, improving livestock quality and enhancing non-livestock income sources for the rural population. In 2003, the UNCCD-NAP was revised and updated. The goals of the "new' NAP are to: mitigate the negative impact of desertification caused by climate change and inappropriate human activities, define adaptation mechanisms, and elaborate policy and action plans to combat desertification differently in response to the natural conditions. The formulation of the goals are reflected not only in the reinforcement of the national policy and social environment but also reflected by globally agreed upon concepts on adaptation to drought and desertification.

National Programs

Water national program of Mongolia
The Water National Program is approved according to Resolution no 24 of the State great hural (Parliament) dated May 20, 2010 and roadmap to implement the program was approved by the Resolution no 304 of the Government of Mongolia dated to November 23, 2010. The objective of the program is protection of water resources from deterioration and pollution, proper use of available resources, and to enhance the implementation of government policy on water. According to the objective of the program, six strategic goals are developed including (i) protect the water resources of Mongolia (section 2.2.1); (ii) establish a water resource quality-monitoring network (section 2.2.2); (iii) create conditions for the accumulation of water resources, provide potable water (section 2.2.3); (iv) take comprehensive measures towards proper use of water resources and water conservation (section 2.2.4); (v) improve water resource use and management, and develop the legislative environment and institutional development for coordinating multiple requirements for water use, and capacity building (section 2.2.5); and (vi) promote community participation (section 2.2.6). The above strategic goals are aligned with actions to be undertaken under component 2 of the proposed project such as development and implementation of water management plans at targeted areas (actions 2.2.1 and 2.2.2). Under the strategic goals of the program, action plans are developed with two stages, the first, or intensive development stage is 2010-2015, and the second or stable development stage is 2016-2021, and this plan is demonstrated in chapter 3 of the program entitled with orientation for activities and measures for implementation of the Water National Program.

The national program on protected areas
The National Program on Protected Areas was developed and approved by the Parliament (Ikh Program on Khural) in 1998 with the main objectives of achieving the establishment of more protected areas. The National Program on PAs recognized this goal and aims to establish and maintain comprehensive, effectively managed, and ecologically representative networks of Pas covering 30% of Mongolia by 2015. The Program provides 10 key elements for its implementation such as the establishment of a national program and, the necessary legal framework, as well as targeting needs related to governance, human capacity, management, research, public awareness and education, public participation, funding and infrastructure, and international cooperation. These elements align with the goals of the CBD Program of Work on PAs. The Government of Mongolia has elaborated and adopted also "The Action Plan for the Implementation of the National Program on PAs" in 1999.

National program for food security

Mongolian Government has issued the National Food Security Program by Resolution no 32, 2009 with two implementation stages. The main objective of this program is to provide the entire nation with secure supplies of accessible, nutritious and safe food to ensure healthy livelihoods and high labour productivity and to support production of organic food that has domestic and international market value with participation of people, government, and the public and private sectors.

National program for livestock

The Mongolian Livestock National Program has been issued by Resolution no 23 of Mongolian Parliament in 2010. This program is implemented in two stages; the first stage from 2010 to 2015 and the second stage from 2016 to 2021. In the first stage, an Action Plan shall be prepared to initiate its implementation. The Government aimed to provide professional and technical services in order to coordinate and monitor the activities related to veterinary, animal breeding services and training. The Government stated that this program should be financed by national and international organizations and the annual budget plan should align with the Mongolian socio-economic development. The five following objectives are the main goal of this national program:

- Improve the legal environment of livestock sector
- Improve the quality of animal breeding techniques and training of herders
- Protect animal health and develop disease eradication plans
- Develop livestock resistant to environmental harsh conditions
- Improve sustainable processing technologies for the production of animal raw materials

Appendix 4

Table 30 Preliminary studies of climate change in project target aimags

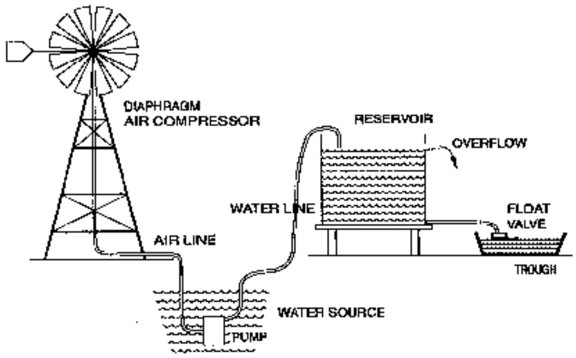
Aimag and soum centers	Time series (years)	Air temperature changes (^{0}C)	Annual precipitation amount (mm)	Other weather phenomena	Frequency of Extreme weather events
Dornod aimag	2001-2013	0.3	-4.6% decrease, number of days with precipitation is decreased, but heavy rain days are increased	n.a.	n.a.
Choibalsan	1971-2015	1.22	decrease	n.a.	n.a.
Matad		1.34	increase	n.a.	n.a.
Dashbalbar		0.2	decrease	n.a.	n.a.
Bayan-Uul		-0.48	n.a.	n.a.	n.a.
Khalkhgol		-0.12	increase		
Sukhbaatar aimag			Warm season precipitation is decreased and cold season precipitation is increased during last 10 years	Numbers of days with less 30% are increased	Numbers of days with air temperature above 30 ^{0} C and with air humidity with less 30% are increased;
Baruun-urt		1.1			
Bayandelger		1.2			
Erdenetsagaan		1.0			
Khovd aimag	27 years	2.0	-Decrease in Gobi and steppe areas -Increase in mountainous areas	Air relative humidity is decreased by 5%	Number of days with sand/dust storms is increased
Khovd		1.3-1.6			
Zereg		1.3-1.6			
Baitag		0.1			
Must		0.2			
Chandmani		0.2			
Zavkhan aimag	70 years	1.49 – 2.46 Annual: 2.04 Winter: 2.89 Summer: 1.39	- (8-15%) decrease in mountain areas, ~+10мм increase in Gobi areas	Has increasing tendency	n.a.
Uliastai	70 years	2.43			
Tosontsengel	50 years	2.43			
Durvuljin	50 years	1.56			

Note: n.a.=not available

Appendix 5

Output 2 – Technical specifications

<u>New engineering wells</u>



An engineering water well is a structure created in the ground by drilling to access groundwater in underground aquifers. The well water is lifted by a mechanic pump that moves with the energy generated by wind or electricity. The modern method for construction is called *caissoning* and uses pre-cast reinforced concrete well rings that are lowered into the hole.

Driven wells can be created in all types of soil, even in unconsolidated soil, with a well hole structure, which consists of a hardened drive point and a screen of perforated pipe, after which a pump is installed to collect the water. The point is simply hammered into the ground, usually with a tripod and driver, with pipe sections added as needed. A driver is a weighted pipe that slides over the pipe being driven and is repeatedly dropped on it. When groundwater is encountered, the well is washed of sediment and a pump installed.

Drilled wells are cased with a factory-made pipe, typically steel or plastic/PVC. The casing is constructed by welding, either chemically or thermally, segments of casing together. If the casing is installed during the drilling the drills will drive the casing into the ground as the bore hole advances. Some machines allow for the casing to be rotated and drilled into the formation in a similar manner as the bit advancing just below. PVC or plastic is typically welded and then lowered into the drilled well, vertically stacked with their ends nested and either glued or splined together.

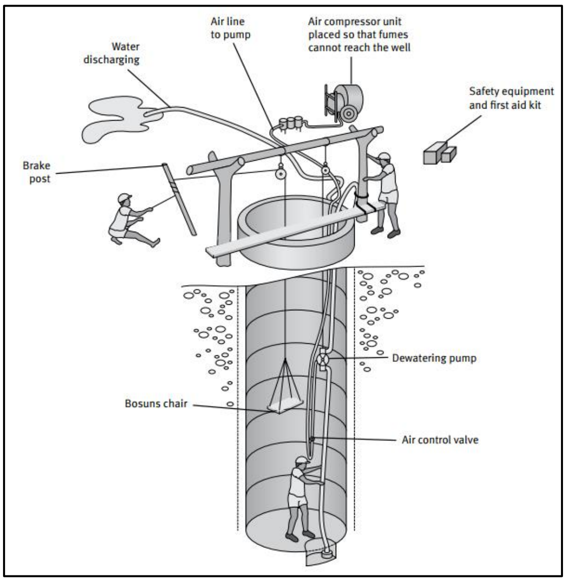
Drilled wells with electric pumps are used throughout the world, typically in rural or sparsely populated areas, such as the pastures in Mongolia. Most shallow well drilling machines are mounted on large trucks, trailers, or tracked vehicle carriages. Water wells typically range from 3 to 18 m deep, but in some areas can go deeper than 900 m. The deepness of the wells depends on the location of underground water and the type and composition of soils.

Rehabilitate engineering wells

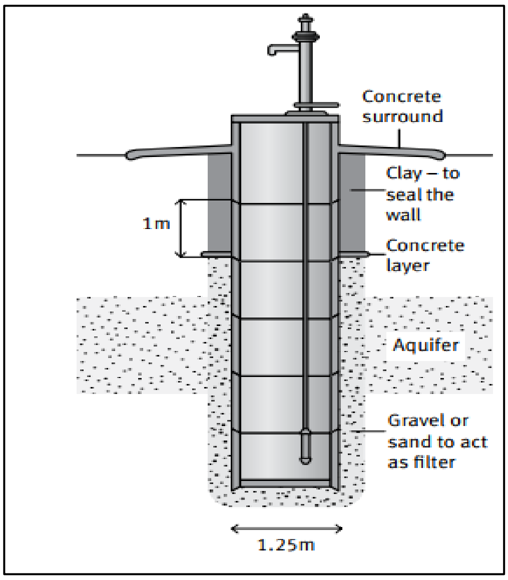
Some examples of engineering wells not in use anymore. In the large majority of cases, they no longer function due to lack of maintenance. Many of those wells have access to groundwater in underground aquifers. For this reason, the project wants to rehabilitate the engineering wells to provide to herders and rural communities fresh water.

Hand wells and hand pumps

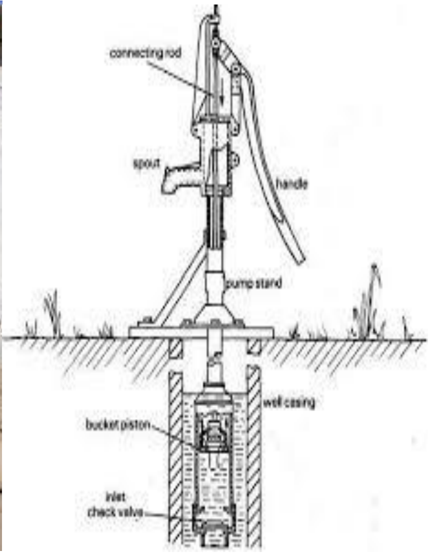
Construction of hand well in pasture area



Hand well fitted with hand pump



Hand pump in a rural area of Mongolia



The traditional method of obtaining groundwater in rural areas of Mongolia, and still the most common, is by means of hand-dug wells. However, because they are dug by hand, their use is restricted to suitable types of ground such as clays, sands, gravels and mixed soils where only small boulders are encountered. Some rural communities use the skill and knowledge of local well-diggers, but often the excavation is carried out, under supervision, by the villagers themselves. The volume of the water in the well below the standing water table acts as a reservoir which can meet demands on it during the day and should replenish itself during periods when there is no abstraction.

There are several methods of supporting the sides of the excavation while digging proceeds but the safest method is to excavate within pre-cast concrete rings which later become the permanent lining to the sides of the well. The first ring has a cutting edge, and additional rings are placed on it as excavation proceeds. As material is excavated within the ring, it sinks progressively under its own weight and that of the rings on top of it. This method is used in unstable ground. When construction has finished, the joints between the rings which are above the water table should be sealed with cement mortar.

After construction of the well shaft has been completed, the bottom is plugged with gravel. This helps to prevent silty material from clay soils, or fines from sandy materials, being drawn into the well. Any annular space between the pre-cast caisson well rings and the side of the excavation is filled with gravel; such filling behind the rings which are below the water helps to increase water storage and to prevent the passage of fine silts and sands into the well.

Hand pumps are manually operated pumps. They use human power and mechanical advantage to move water from one place to another. They are widely used in Mongolia in particular in rural areas for a large variety of livestock, agriculture and leisure activities. There are many different types of hand pump available for this project and are mainly operating on a piston, diaphragm or rotary vane principle with a check valve on the entry and exit ports to the chamber operating in opposing directions. Most hand pumps have plungers or reciprocating pistons, and are positive displacement. Hand pumps are commonly used in Mongolia for both community supply and self-supply of water and can be installed on boreholes or hand-dug wells.

Deep well hand pumps are used for high lifts of more than 15 m. The weight of the column of water is too great to be lifted directly and some form of mechanical advantage system such as a lever or flywheel is used. High lift pumps need to be stronger and sturdier to cope with the extra stresses. The installation, maintenance and repair of deep well hand pumps is more complicated than with other hand pumps. A deep well hand pump theoretically has no limit to which it can extract water. In practice, the depth is limited by the physical power a human being can exert in lifting the column of water, which is around 80 m.

Rehabilitate hand wells

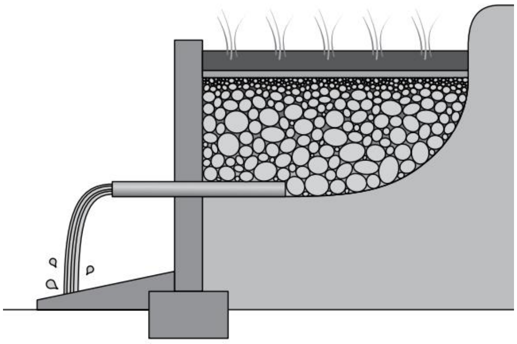

Some examples of hand wells not in use anymore. In the large majority of cases, they no longer function due to lack of maintenance. Many of those hand wells have access to groundwater in underground aquifers. For this reason, the project wants to rehabilitate the hand wells to provide to livestock, herders and rural communities fresh and safe water.

<u>Protect head of springs</u>

A spring is a natural situation where water flows from an aquifer to the Earth's surface. The groundwater travels through a network of cracks and fissure from intergranular spaces to large caves. The water eventually emerges from below the surface, in the form of a karst spring.
The forcing of the spring to the surface can be the result of a confined aquifer in which the recharge area of the spring water table rests at a higher elevation than that of the outlet. Spring water forced to the surface by elevated sources are artesian wells. Non-artesian springs may simply flow from a higher elevation through the earth to a lower elevation and exit in the form of a spring, using the ground like a drainage pipe. Still other springs are the result of pressure from an underground source in the earth, in the form of volcanic activity. The result can be water at elevated temperature such as a hot spring.

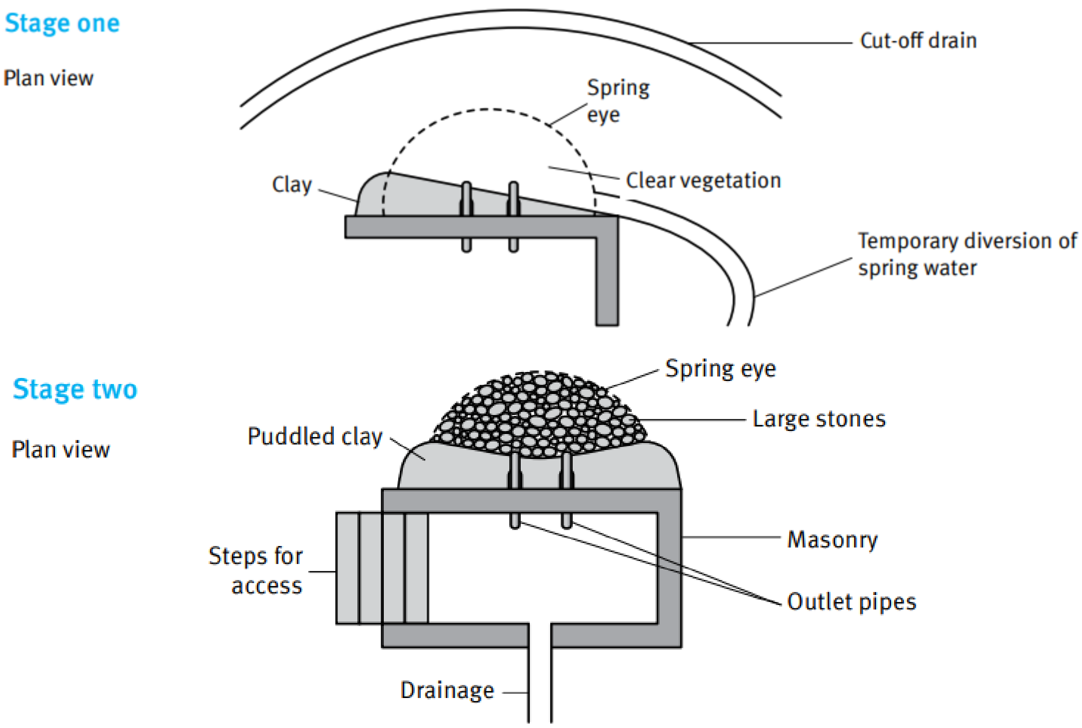
The project wants to protect those important sources of fresh water with fences, canals and proper infrastructures. Many different methods exist for getting the clear spring water from its source into the bucket or pipeline. The essential matters are to protect the catchment of the spring and the springhead from pollution and to arrange for the spring water to be delivered at a suitable height so that it falls with gravity directly into a container. An inspection of the ground upstream (catchment) of the spring is essential to ascertain that there is no danger of pollution or, if there is, what measures can be taken to prevent it. A spring source can be used either to supply a gravity scheme or to provide a single outlet, running continuously, which is set at a sufficient height to allow a bucket or container to be placed below it. With the latter, to prevent waste, any flow which is surplus to that required for domestic and livestock use can be used for irrigation.

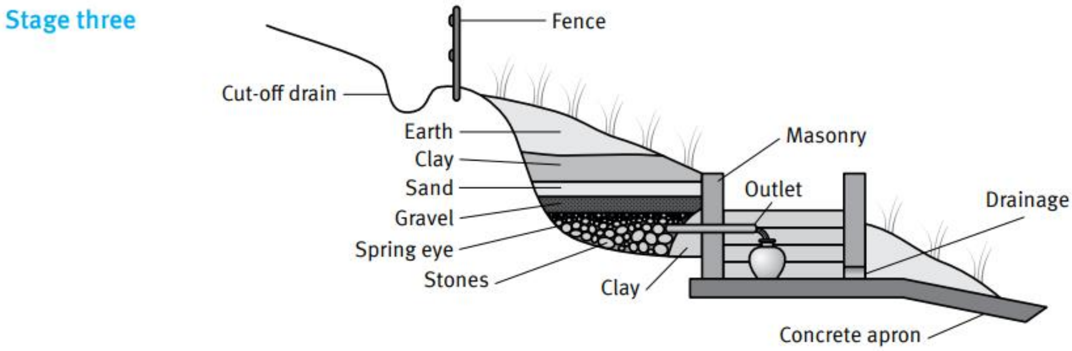
Protect head of spring, example 1



Protect head of spring, example 2

The following three diagrams illustrate the stages in the construction of a collecting chamber.
Stage one:
• Clear vegetation above the head of the spring
• Build a cut-off drain to divert surface water
• Divert the spring water temporarily to allow construction of the collection chamber





Reference: http://www.wateraidamerica.org/sites/default/files/attachments/Protection%20of%20spring%20sources.pdf

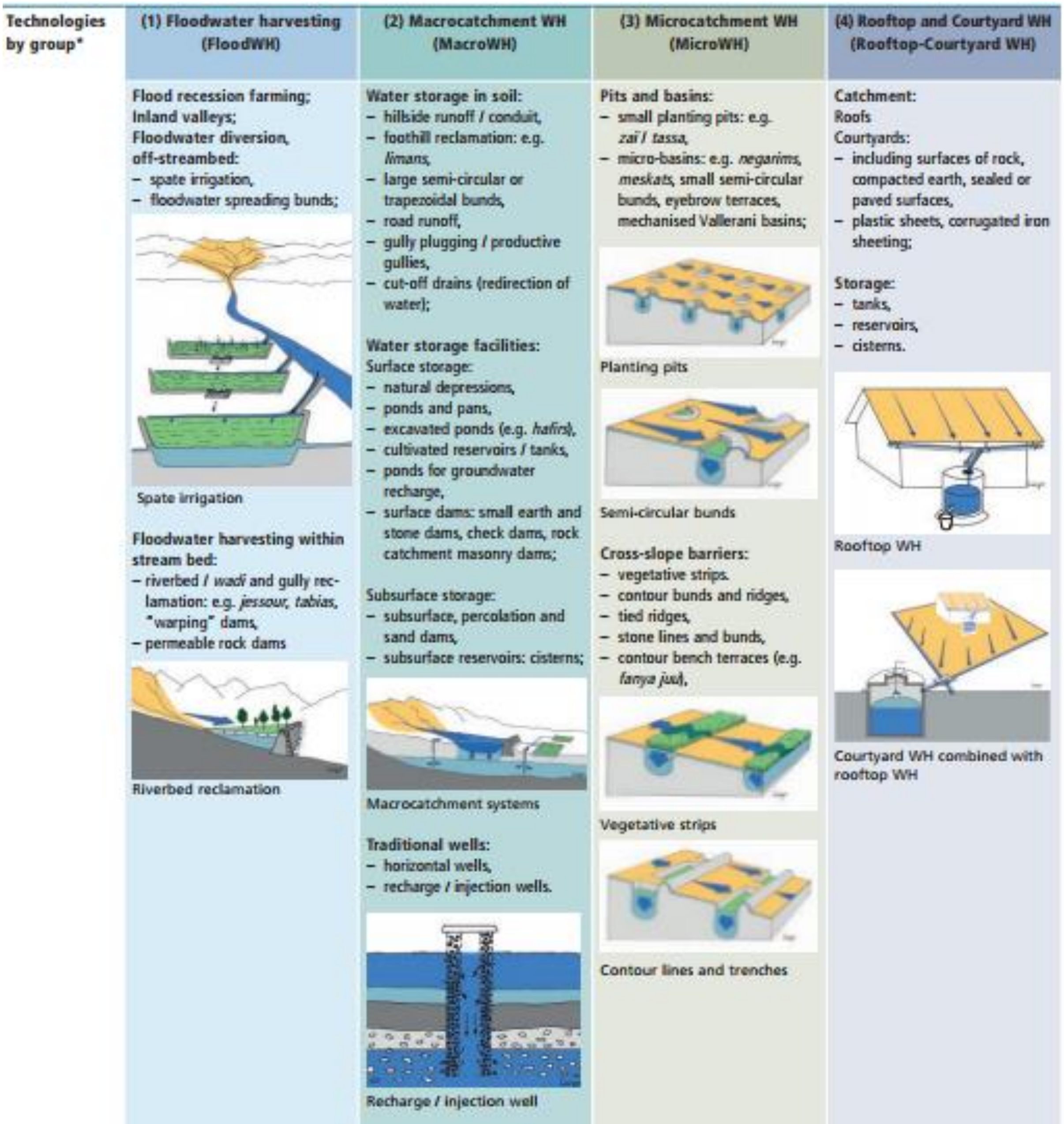
Water harvesting and ponds

The water harvesting is the collection and management of floodwater or rainwater runoff to increase water availability for livestock, domestic and agricultural use. The main aim of water harvesting is to collect runoff or groundwater from areas of surplus or where it is not used, store it and make it available, where and when there is water shortage. This results in an increase in water availability by either impeding and trapping surface runoff, and maximising water runoff storage or trapping and harvesting sub-surface water. Water harvesting makes more water available for domestic, livestock and agricultural use by buffering and bridging drought spells and dry seasons through storage. Thus water harvesting deliberately reallocates the water resource within a landscape, and over time.

Different types of water harvesting based on type of water

	Water Harvesting			
	Floodwater	Rainwater runoff		
Group	**(1) Floodwater harvesting (FloodWH)**	**(2) Macrocatchment WH (MacroWH)**	**(3) Microcatchment WH (MicroWH)**	**(4) Rooftop & Courtyard WH (Rooftop-CourtyardWH)**
Strategy	Capture excess water from outside farm or field and spread floodwater	Trap runoff from outside farm or field	Trap localised runoff within field	Trap runoff from settlements
Agroclimatic zone	Dry sub-humid, semi-arid and arid climates; Dry areas with ephemeral watercourses and few heavy events	Dry sub-humid, semi-arid and arid climates; Where few runoff events expected per rainy season	Dry sub-humid and semi-arid climates; Where rainfall is more reliable but scattered and/or poorly distributed within the season	All climates; With dry spells and where rainfall is seasonal
Catchment	External: Large catchments or watersheds; Distinction between hilly catchment zone and cultivated fields in plain; One system with one catchment area	External: Small catchments or watersheds; Catchment and application area clearly separate; One system with one catchment area	In-field; Catchment and application area distributed evenly over field; System replicated many times with identical designs	Household / settlement; One system with one catchment
Runoff water	Channel flow with more or less well-defined course	Sheet and rill flow (turbulent overland runoff), short channel flow	Sheet and some rill flow	Sheet flow from rooftops and sealed surfaces
Storage	Soil moisture in root zone; Groundwater recharge	Soil moisture in root zone; Groundwater recharge; Reservoirs: dams and ponds; Tanks (surface and subsurface)	Soil moisture in root zone; Pits, trenches and bunds for planting	Tanks (surface and subsurface)
Use of water	Crop production: Supplementary irrigation, high groundwater recharge, improve soil moisture	Multiple use: domestic use, water for livestock, crop production: improve soil moisture, groundwater recharge and water storage for supplementary irrigation	Crop, fodder and tree production: improve soil moisture, limited groundwater recharge	Multiple use: domestic use, water for livestock, small-scale crop and horticultural tree production: water storage for supplementary irrigation of kitchen gardens / backyard crops; agro-processing no groundwater recharge

Type of technology that can be used in Mongolia under each water harvesting group



Technologies by group*	(1) Floodwater harvesting (FloodWH)	(2) Macrocatchment WH (MacroWH)	(3) Microcatchment WH (MicroWH)	(4) Rooftop and Courtyard WH (Rooftop-Courtyard WH)
	Flood recession farming; **Inland valleys;** **Floodwater diversion, off-streambed:** – spate irrigation, – floodwater spreading bunds; Spate irrigation **Floodwater harvesting within stream bed:** – riverbed / *wadi* and gully reclamation: e.g. *jessour, tabias,* "warping" dams, – permeable rock dams Riverbed reclamation	**Water storage in soil:** – hillside runoff / conduit, – foothill reclamation: e.g. *limans,* – large semi-circular or trapezoidal bunds, – road runoff, – gully plugging / productive gullies, – cut-off drains (redirection of water); **Water storage facilities:** Surface storage: – natural depressions, – ponds and pans, – excavated ponds (e.g. *hafirs*), – cultivated reservoirs / tanks, – ponds for groundwater recharge, – surface dams: small earth and stone dams, check dams, rock catchment masonry dams; Subsurface storage: – subsurface, percolation and sand dams, – subsurface reservoirs: cisterns; Macrocatchment systems **Traditional wells:** – horizontal wells, – recharge / injection wells. Recharge / injection well	**Pits and basins:** – small planting pits: e.g. *zaï / tassa,* – micro-basins: e.g. *negarims, meskats,* small semi-circular bunds, eyebrow terraces, mechanised Vallerani basins; Planting pits Semi-circular bunds **Cross-slope barriers:** – vegetative strips, – contour bunds and ridges, – tied ridges, – stone lines and bunds, – contour bench terraces (e.g. *fanya juu*), Vegetative strips Contour lines and trenches	**Catchment:** Roofs Courtyards: – including surfaces of rock, compacted earth, sealed or paved surfaces, – plastic sheets, corrugated iron sheeting; **Storage:** – tanks, – reservoirs, – cisterns. Rooftop WH Courtyard WH combined with rooftop WH

Source: https://www.wocat.net/fileadmin/user_upload/documents/Books/WaterHarvesting_lowresolution.pdf

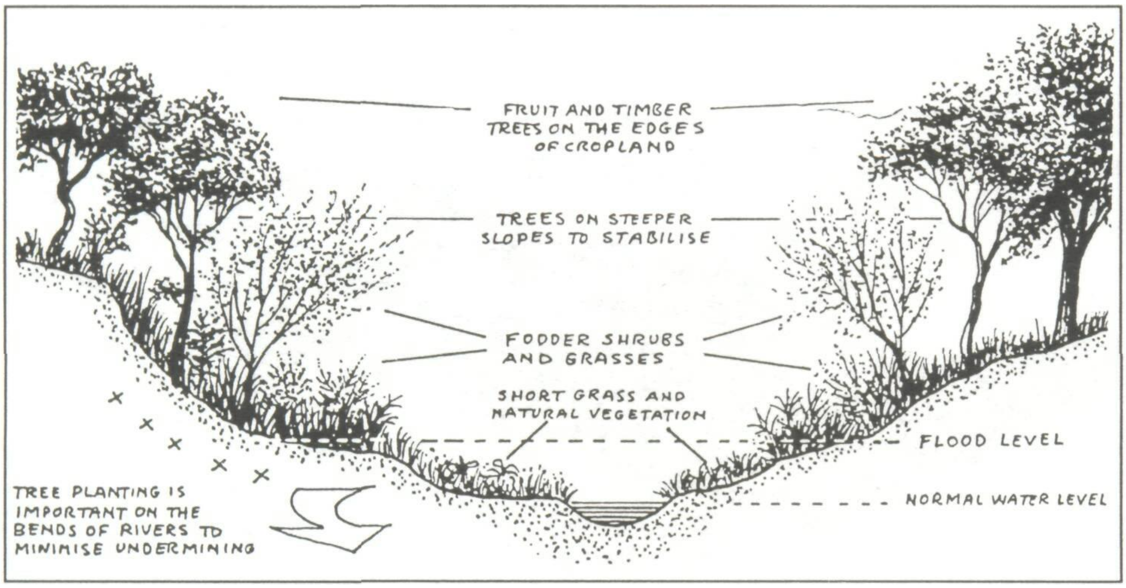
<u>Plant trees alongside rivers and forest restoration</u>

Trees are a key component of a healthy river and an important factor in creating resilience in the ecosystem to floods, droughts and pollution. River banks are prone to erosion if they are not well covered with vegetation. Furthermore, many important indigenous trees are riverine, i.e. they occur naturally only or mainly along water courses. Thus vegetation along rivers is important both from an environmental point of view and for the production of special commodities, e.g. medicine or fruits.

If trees need to be actively planted or sown, priority should be given to indigenous trees since they are generally better conservers of water than exotics. Spacing will depend on species and purpose, but usually no large pieces of land should be put under trees. Hence, normally a few trees will be planted at selected places and a fixed spatial arrangement will not be relevant.

In brief, trees are important for rivers because:

- Tree roots stabilise river banks and can reduce the rate of bank erosion.
- Trees create an important buffer zone, reducing the amount of run-off that enters the river directly during periods of heavy rain.
- Fallen trees have a major role in creating a dynamic river. A fallen tree can trap sediment, create scour pools and clean gravels.
- Trees provide shade during periods of low flows and high temperature, reducing water temperatures and helping to maintain oxygen levels in the water.
- Trees provide shelter for aquatic animals.



Reference: http://www.worldagroforestry.org/Units/Library/Books/Book%2006/html/8.14_trees_along_stream_river.htm?n=95

Forest restoration at river heads is the establishment of a forest in an area where there was previous tree cover. This forestation occurs near or in the vicinities of a river head. The forest can clean the water and provide a reserve of fresh water. In addition, it can mitigate the negative effects of the excess of rain because the roots of the trees and the soil reach in organic material can keep the water and release it slowly. This reduces the risk and magnitude of floods.

<u>Haymaking and pasture reserve areas</u>

Haymaking. Dry hay from natural pasture is by far the most important source of winter fodder for Mongolia livestock. Most of the production of hay is mechanized or semi-mechanized. North Mongolia, the better-watered part of the country, is the most favored for hay production.

Methods of increasing production have been studied over many years, but results are not very encouraging: fertilizer has a highly positive effect, but because of unreliable rainfall, high cost of fertilizer, and negative impact on the environment, it is not economically and environmentally sustainable. A gradual decrease in hay yields over time occurs when the same field is cut year after year: research indicates that rotating of the cutting dates on the same plot will, after several years, lead to an improvement in hay yield of 10%-30%.

In Mongolia, livestock is raised throughout the year in open pastures. The availability of forage decreases in July and the grass dries off from mid-August. After October, feed is deficient in both quantity and quality, but the indigenous cattle, sheep and goat breeds survive in normal winter condition. Hay produced during spring and beginning of summer is accumulated and used during the winter to feed the animals. In order to avoid excessive winter losses, some hay is fed to weaker groups of stock to increase their chances of survival.

Pasture reserve areas are large areas that can provide feed for animals during winter. Those areas are particularly important during dzuds or harsh winters because they can provide feed for the animals. “Otor” is a traditional practice of migration to specially-reserved areas (otor areas) in times of winter disasters like dzud or other extreme events.

Emergency fodder storage facilities. These facilities are particularly important during emergency situations (e.g. dzud, droughts etc.) when fodder for the animals is not available in the pastures. During the emergency periods, herders can receive fodder for their animals that is stored in these facilities. The constitutionality of such facilities is under the responsibility of the State. There are now three levels of feed/fodder reserves held in Mongolia:

- National Strategic Reserve facilities under NEMA. These reserves are categorized ‘National Strategic Reserves’ under NEMA and for this reason the locations and inventory volumes are considered state secrets.
- Aimag reserve facilities: Aimag reserves were established under the direction of MOFALI and supported by government resolution in 2010 in response to the dzud of 2009/2010. Procurement is supported by state and local budgets. Inventory may be locally produced or procured from other regions.
- Soum reserve facilities: Soum reserves were established in 2010 under the same resolution as aimag reserves. The national government requires all soums and bags to keep enough hay/fodder for 3 days. Soum reserves are locally produced and may physically be at the soum or bag. Total reported inventory may include private holdings by herders. In 2010/2011 soums were directed to hold 100 mt hay and 50 mt fodder. These can be sold to herders during emergencies. No budget is allocated for these reserves. Soums use their own budget and sometimes cost share with herders. When natural growth is not sufficient, reserves may be purchased from other areas.

There is inadequate storage at all levels of these reserves. Most of the national reserve facilities are old facilities. Many have had no maintenance since the time they were built in the 1970s. The improvement of these facilities is important to guarantee fodder for the animals during dzud or other extreme weather events.