# Annex 15 - Detailed Climate Change Assessment

ADB

# Technical Assistance Consultant's Report

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# Climate Change Assessment: Annex 15 to the ASDIP funding proposal to the GCF

## Preparing the Aimags and Soums Green Regional Development Investment Program (ASDIP)

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## ABBREVIATIONS

| | |
|---|---|
| ADB | Asian Development Bank |
| AF | Adaptation Fund |
| AGB | Above-Ground Biomass |
| ASAP | Adaptation for Smallholder Agriculture Program |
| ASDIP | Aimag and Soum Centers Green Regional Development Investment Program |
| BGB | Below-Ground Biomass |
| CCFPS | Canadian Climate Fund for the Private Sector |
| CDD | Consecutive Dry Days |
| CWD | Consecutive Wet Days |
| CDM | Clean Development Mechanism |
| CSDI | Cold Spell Duration Index |
| DJF | December-January-February (winter) |
| EB | Executive Board |
| FD | Frost Days |
| FP | Funding Proposal (to GCF) |
| GCF | Green Climate Fund |
| GCPF | Global Climate Partnership Fund |
| GDP | Gross Domestic Product |
| GEF | Global Environment Facility |
| GHG | Greenhouse Gas |
| GIRAF | Green Inclusive Regional Agri-Business Fund (ASDIP funding, Output 3) |
| GNI | Gross National Income |
| GSL | Growing Season Length |
| HG | Heavy Grazing |
| ICF | International Climate Fund |
| ICI | International Climate Initiative |
| IMF | International Monetary Fund |
| IPCC | Intergovernmental Panel on Climate Change |
| JJA | June-July-August (summer) |
| JCM | Joint Crediting Mechanism |
| JFJCM | Japan Fund for the Joint Crediting Mechanism |
| JICA | Japan International Cooperation Agency |
| LCLVC | Low-Carbon Livestock Value Chain |
| LDN Fund | Land Degradation Neutrality Fund |
| LG | Light Grazing |
| LULUCF | Land use, land-use change, and forestry |
| MAM | March-April-May (spring) |
| MARCC | Mongolia Assessment Report on Climate Change |
| MFF | multi-tranche financing facility |
| MG | Medium Grazing |
| MNT | Mongolian Tögrög |
| MOFALI | Ministry of Food, Agriculture and Light Industry |
| NAMA | Nationally Appropriate Mitigation Action |
| NAPCC | National Action Programme on Climate Change |
| NDA | National Designated Authority |
| NDC | Nationally Determined Contribution |
| NEFCO | Nordic Environment Finance Corporation |
| NMLP | National Mongolian Livestock Program |
| PDD | Project Design Document |
| PUG | Pasture User Group |

| | |
|---|---|
| PV | Photovoltaic |
| RX1day | Maximum 1-day Precipitation |
| RX5day | Maximum 5-day Precipitation |
| RUA | Rangeland Use Agreement |
| RUC | regional urban cluster |
| SCCF | Special Climate Change Fund |
| SDC | Swiss Agency for Development and Cooperation |
| SHU | Sheep Head Unit |
| SOC | Soil Organic Carbon (also OC) |
| SON (month) | September-October-November (autumn) |
| SON (soil) | Soil Organic Nitrogen (also ON) |
| SPEI3 | Standardized Precipitation Evapotranspiration Index (3 months) |
| SPEI6 | Standardized Precipitation Evapotranspiration Index (6 months) |
| SPEI12 | Standardized Precipitation Evapotranspiration Index (12 months) |
| SU | Summer days |
| TNA | Technology Needs Assessment |
| TNC | Third National Communication |
| Tnn | Minimum of daily minimum temperature |
| TRTA | transaction technical assistance |
| Txx | Maximum of daily maximum temperature |
| UNFCCC | United Nations Framework Convention on Climate Change |
| USD | United States Dollar |
| WSDI | Warm Spell Duration Index |

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# EXECUTIVE SUMMARY

1. As stated in the NDC of Mongolia, the annual mean air temperature over Mongolia has increased by 2.07°C from 1940 to 2014. The ten warmest years in the last 70 years have occurred after 1997. In this period, annual precipitation has decreased slightly, and the seasonal rainfall pattern has changed: winter precipitation has gradually increased and summer rain has decreased in some regions (including the regions targeted by the project). Climate projections show intensification of these changes in the first half of the 21st century. Some of the key impacts and vulnerabilities are:
- Approximately 70% of pastoral land has degraded, while changing plant composition.
- The winter dzud (heavy snow, cold waves, storms etc.) risk is likely to increase leading to more livestock losses.
- Non-irrigated crop production is becoming more unstable. Assessments show that wheat production might be decreased by 15% by 2030 due to climate change.
- The intensification of dry climatic conditions causes the increase of the frequency of forest and steppe fires.
- The frequency of extreme weather phenomena has doubled in the last two decades. This is expected to increase by 23-60% by the middle of the century as compared to present conditions.

2. Rangelands are one of the world's predominant ecosystems, representing about 70% of the earth's land surface excluding Antarctica. As confirmed in the literature review as part of this Climate Change Assessments, rangelands offer a large mitigation potential through better rangeland management, estimated at 1.1 billion $tCO_2$/year globally. However, rangelands are vulnerable to climate change and human activities, such as animal husbandry, especially in arid regions where they can turn into desert if not well managed. Despite the large surface areas involved and the significant adaptation concerns and mitigation potentials, little climate finance support has so far been provided to better rangeland management.

3. In Mongolia, rangelands are the most common land type, covering 82% of the country, while animal husbandry is one of the main sectors of the Mongolian economy in terms of employment. Both are under sever threat of climate change, which has reduced the productivity of rangelands and has exposed the animal husbandry sector to extreme shocks and climate-related natural disasters. In response to these threats, herders have increased the size of their herds to unsustainable levels (66.46 million in 2018, compared to 25.86 million in 1990), leading to severe degradation of rangelands. While increases of soil carbon thanks to reversing rangeland degradation and restoring rangeland health are limited on a per hectare basis, the vast area means that improved rangeland management offers a very large mitigation potential, estimated in this Climate Change Assessment at over 440 million tCO2 country wide over a 40 year period.

4. Both aspects, adapting to climate change and mitigation of greenhouse gas emissions, require that the grazing pressure on rangelands is reduced by improved grazing method and limiting the number of animals, which in turn will lead to a reduction of animal-related methane and nitrous oxide emissions. However, it is a multi-dimensional problem that cannot be solved with piece-meal solution but that requires a fully integrated program of interventions. To make reduction in animal numbers a viable option for herders, output and value added per animal needs to be increased, which requires a series of interventions to establish supply of quality fodder, processing facilities, create low carbon and climate resilient value chains, and provide services to support the climate resilient and low carbon development of the animal husbandry sector. This requires healthy cities that are well adapted to climate change and attractive for private sector to invest in, and financial mechanism to support green and climate sensitive agri-business based on sustainable use of natural resources are a paramount condition to ensure the rangeland health improvement mechanisms are sustainable.

5. These aspects are reflected in the Aimag and Soum Centers Green and Resilient Regional Development Investment Program (ASDIP) which demonstrates a unique integrated approach to better rangeland management in Mongolia. ASDIP is based on a close link between ecologic, social, geographic and economic approaches and between rangeland, agri-business and urban areas. It is a 10 years investment program, delivered in 3 Tranches, linking green urban development, resilient and low-carbon rangeland management, and sustainable green agrobusiness value chain into an overall green and resilient agro-territorial development framework. The program has four outputs:

**(i)** Climate-resilient, low-carbon, and attractive aimag and soum centers developed;
**(ii)** Rangelands managed for climate-resilience, high carbon sequestration, and sustainable herding;
**(iii)** Low-carbon and climate-resilient livestock value chains created and strengthened through accessible finance; and
**(iv)** Capacity and policy reforms for low-carbon and climate-resilient agro-territorial development improved.

7. This Climate Change Assessment provides the climate change mitigation and adaptation background to ASDIP and quantifies the mitigation benefits from ASDIP. ASDIP will provide the following key quantitative outcomes:

- Sustainable low carbon and climate-resilient management of an estimated 28.8 million hectares of rangeland,
- 39,785 herder households benefitting from diversified, climate resilient livelihood options.
- 552,300 people benefiting from more resilient rangelands and improved food security
- 112.40 million tCO2e of net emission reductions. Based on GCF guidance on GWPs and time periods over which emission reductions can be claimed, GHG mitigation results are as follows:

| **GHG source of emissions / emission reductions** | **Cumulative emissions / emission reductions (ktCO2e)** |
|---|---|
| Carbon sequestered in rangelands | 94,046 |
| Emission reductions from animals (CH4 and N2O) | 17,223 |
| Urban emission reductions | 4,621 |
| Emission reductions from avoided transport | 396 |
| Emission reductions from wastewater treatment | 91 |
| ***Subtotal emission reductions*** | ***116,378*** |
| Leakage emissions from construction | -149 |
| Leakage emissions from ASDIP improved roads | -2,557 |
| Leakage emissions from ASDIP enterprise investments | -912 |
| Leakage emissions from agricultural investments (Output 2) | -372 |
| Leakage emissions from rangelands / livestock | 0 |
| ***Subtotal ASDIP leakage emissions*** | ***-3,980*** |
| **Net ASDIP emission reductions** | **112,398** |

These estimates are calculated based on conservative estimates of the lifetime of the various investments (shorter lifetimes than actual lifetimes, thus underestimating the total amount of GHG emission reductions).

# I. INTRODUCTION

1. The government of Mongolia and the Asian Development Bank (ADB) intend to implement a proposed investment program, titled *Mongolia: Aimag and Soum Centers Green Regional Development Investment Program* (ASDIP). ASDIP is a multi-tranche financing facility (MFF) which aims to improve environmental urban services and promote the local economy in priority aimag (province) capitals and soum (subunit of an aimag) centers of Mongolia based on the low-carbon and climate-resilient sustainable management of rangelands. Urban and rural elements are interlinked, with the urban investments needed to make the processing of sustainable livestock products and their marketing possible.

2. From the outset, it is useful to emphasize that the targeted aimag and soum centers are small, with population in the range of 2,000-30,000; that ASDIP does not propose to relocate herders; and that the population density in the targeted aimags is low, less than 2 persons per $km^2$.

3. At the start of the assignment of the Climate Change Specialist (see below), ASDIP was formulated as follows: The geographically targeted and integrated approach of ASDIP will focus on priority regional urban clusters (RUCs) that have the potential to promote a more resilient and diversified economy to deliver inclusive and sustainable growth. The program will be aligned with the following impact: more sustainable development in Mongolia driven by multi-sector economy and ecological balance achieved. The outcome is population and private sector in targeted RUCs benefitted from improved urban and economic facilities and services. The outputs of the program have initially been described as (i) municipal infrastructure and urban services in targeted areas improved, (ii) economic infrastructure and facilities in targeted areas improved, (iii) road linkages within targeted urban regions increased, and (iv) capacity in program and institutional management strengthened.[1]

4. A transaction technical assistance (TRTA) team has been mobilized under TA-9451 MON: Preparing the Aimags and Soums Green Regional Development Investment Program to support the development of ASDIP. The TRTA team will help the Government of Mongolia to prepare the investment program, which is a complex and multi-sector undertaking that requires full scale due diligence in technical, economic, financial, social, resettlement, environmental, and institutional aspects, including in-depth local urban and socioeconomic assessments.

5. ASDIP requires co-financing and given the climate change mitigation benefits of the program as well as its paradigm-shifting potential, the mobilization of concessional climate finance is one of the possibilities for arranging co-financing for ASDIP. An International Climate Finance Specialist has been mobilized initially through a separate TA (MON: Climate Finance Specialist [CIF]) and subsequently as part of the TRTA team to assist in the selection of suitable climate funds and to support the formulation of concept notes and funding proposals to attract co-finance. Tasks of the International Climate Finance Specialist include the preparation of a funding proposal for the selected climate finance sources (see the next section, the Green Climate Fund (GCF) was selected) and the preparation of a Climate Change Assessment (this report) to support the TRTA final report, the GCF funding proposal and the ADB approval process.

[1] ASDIP has a very strong climate change mitigation impact. To reflect these, the International Climate Change Specialist has proposed a reformulation of among others the outputs and structure of ASDIP and quantified the greenhouse gas (GHG) mitigation results, both to better emphasize the climate change mitigation impacts of ASDIP.

6. To explain the contents of this report, it is useful to describe briefly the evolution of the thinking on ASDIP and it climate-related contributions. Originally ASDIP was designed as a climate change mitigation project, based on the opportunities to reduce GHG emissions and increase carbon sequestration, both mainly in the animal husbandry and rangeland management sectors. However, as pointed out by the Mongolian National Designated Authority (NDA), achieving these potentials through the proposed reduction in animal numbers carries with it a significant adaptation contribution. This is highlighted in the insert below. Given this dual benefit nature, the NDA suggested that the ASDIP would be better presented as a crosscutting program.

**Insert 1. The key lever – reducing the number of animals.**

To address the twin problem of climate change mitigation and adaptation in the livestock sector, reducing the animal numbers is key. Climate change causes the resources available for the livestock sector to diminish, as water availability decreases, rangeland availability decreases (desertification), and rangeland's productivity (as measured by production of edible biomass) decreases. Coping with these climate change impacts primarily hinges on a reduction of the number of animals, while increasing the ratio of output to herd. This limits the amount of (water, biomass from rangelands) resources that are needed to produce a given output and hence makes better use of the diminishing resources, which is important to provide food security to the population of Mongolia. Of course, this is not the only measure to deal with climate change – increasing water resources, water efficiency measures, breeds that are more resistant to droughts, and improved feed availability in winter through fodder production each have their role to play as well. These also have an impact on reducing the sector's vulnerability to climate change, which in turn limits the increase of the herds as a coping measure[2], which is discussed in more detail as part of Section 3 and in Section B.1 of the funding proposal.

Mitigation also hinges on the animal numbers. Overgrazing due to ever increasing herd sizes reduces the amount of carbon stored in grassland sinks and increases the amount of GHG emissions from CH4 and N2O. A reduction in the number of animals combined with an increase in the output per animal will, with a constant output, reduce direct GHG emissions from N2O and CH4 and through the reduction of overgrazing improve carbon sequestration in rangelands.

The key idea is that energy in the form of biomass is required for the herd and is converted into N2O and CH4 emissions upon digestions, while if the amount of biomass consumed exceeds the carrying capacity, carbon sinks will decline. Energy is required to maintain the animals and to produce the livestock outputs (meat stored in the animal, wool, dairy, …). From a production perspective, the energy needed to maintain the animal is "overhead". Therefore, an increase of the output to herd ratio will reduce the GHG emissions per unit of output, and will increase carbon sinks in the rangelands, again while maintaining the same output level.

7. To reflect the adaptation benefits and at the request of the Mongolian NDA, ASDIP therefore was initially presented to the GCF as a cross-cutting program, focusing approximately equally on mitigation and adaptation.

8. In the GCF review process, it was determined that the underpinnings of the adaptation components of the funding proposal, relying mostly on literature sources, were insufficient. The funding proposal was then reformulated as mitigation only, and the same was done for

[2] Such interdependencies mean that measures to reduce climate change vulnerability, such as fodder production and investments related to water availability, allow a reduction in animal numbers and hence also have a mitigation impact. The Mongolian NDA's request to present ASDIP as a crosscutting program is easy to appreciate given such interdependencies.

this Annex 15, then submitted as a Climate Change Mitigation Assessment, taking out the analysis of the climate change adaptation rationale.

9. Subsequently, the GCF review process determined that the adaptation elements were too much an integral part to ASDIP and the funding proposal, and that these elements had to be reinserted, presenting ASDIP again as a cross-cutting project. It was also suggested to follow the approach taken by a GCF-approved UNDP project, "*Improving Adaptive Capacity and Risk Management of Rural communities in Mongolia*" (FP141), in describing the climate change rationale. This has been done, both in the funding proposal and in this Annex 15, renamed Climate Change Assessment. To do so with a modicum of efficiency, however, meant that for practical reasons the climate change adaptation rationale was best inserted at the back of the document, as Section 10.

10. This Climate Change Assessment also contains some other parts that respond to issues raised during the GCF review process.

- Section 3 discusses the historical development of the Mongolian animal husbandry sector and Mongolian government responses, with a particular focus on the National Mongolian Livestock Program (NMLP). This responds to some interpretation issues regarding Mongolia's long-term policies for the sector. The analysis has been confirmed through two separate letters from the NDA and the Ministry of Food, Agriculture and Light Industry (MOFALI). The section concludes that ASDIP is fully in line with the long-term government policies of the past, the present and the future, to bring the livestock population in line with the carrying capacity of the rangelands. So far, the Mongolian government has been unable to do so. As pointed out in the funding proposal, Section B.1 and B.2, ASDIP has both the resources to provide and maintain the necessary incentives[3], and the comprehensive coverage to coordinate actions by different actors that are relevant to achieve these goals – herders, enterprises in the value chains, infrastructure decisionmakers and policymakers in the local government and policymakers in central government.
- Section 8 discusses leakage emissions due to ASDIP, responding to GCF concerns that leakage may undo a large part of the mitigation results of the project. The discussion shows how the key sources of leakage emissions have been estimated, and why some other sources of emissions are deemed to be zero in the *ex ante* estimates, in line with the available methodologies for estimating such leakage emissions.
- Annex 4 discusses possibilities for afforestation and agroforestry. Investments in afforestation and agroforestry are in principle eligible for funding under ASDIP. However, the local conditions for afforestation and agroforestry investments need to be right. Annex 4 summarizes the result of literature and earlier assessments of ADB on forest investments.

11. This report is set up as follows. Section 2 provides the longlist of climate finance options and presents a more targeted shortlist. Section 3 provides an analysis of the livestock sector and the National Mongolian Livestock Programme. Section 4 provides the Mongolian context and introduces the ASDIP approach. Section 5 discusses the literature on rangeland management and GHG emission reductions. Section 6 discusses GHG mitigation by ASDIP in rangelands and animal husbandry systems. Section 7 discusses urban GHG mitigation by ASDIP. Section 8 discusses leakage emissions from ASDIP. Section 9 discusses MRV. Section 10 discusses the adaptation rationale.

12. The emphasis of this climate change assessment is on Sections 5-10 which develop the rationale for seeking GCF funding based on the mitigation and adaptation benefits from the project. These sections may also be the most relevant for the GCF.

[3] See Table 3 and Box 10 of the funding proposal.

13. It is our believe that ASDIP is crucial project with wide-ranging benefits, and that it is of strategic importance to ADB and GCF. Some of the key strengths of ASDIP have been summarized in the following insert.

**Insert 2. Key strengths of ASDIP**

Some of the key strengths of ASDIP are the following:

- ASDIP provides over 112 million tCO2 in emission reductions. Using the World Bank shadow price for carbon (low price scenario) and a discount rate of 2.25%, a $175 million GCF contribution will trigger a $735 million project, leading to **$4.5 billion in global mitigation benefits** (measured by NPV).
- Climate change threatens the viability of herding in Mongolia, which is crucial to Mongolia in terms of employment. ASDIP is key for the **successful adaptation of the animal husbandry sector to the climate change threat by maintaining production through a combination of an increase in production and a reduction in the number of livestock.**
- ASDIP anticipates and provides the basis for the Partnership for Low-Carbon and Climate-Resilient Rangelands in Asia, **a key mechanism for long-term funding for the scaling up and replication of ASDIP not relying on the GCF or the Mongolian public sector.**
- Rangelands are the most common ecosystem on earth, yet the comprehensive treatment of mitigation and adaptation in rangelands has hardly been present in the GCF portfolio so far. **ASDIP would fill an important gap in the GCF support portfolio**.

## II.CLIMATE FINANCE

14. As an earlier part of the assignment, the International Climate Finance Specialist was tasked to write a report on possible climate funding sources that can be utilized by ASDIP.[4] This report provided an overview of how these funding sources can contribute to ASDIP's investments and financing scenarios. The report also served as a guide to the identification of the most appropriate climate funding source for ASDIP.

15. To determine the most suitable climate finance sources (and throughout taking into account the above-mentioned previous report), a comprehensive list of climate finance sources and their characteristics was produced, focused on any project or program in Asia. Then, a selection was made by considering the following:

- Project location
- Sector and climate change field addressed
- Size of the contribution
- Predictability of funding

16. Next, a priority ranking was introduced considering the amount of financing each source might contribute, as well as the fit between the funding source priorities and characteristics with ASDIP. On this basis, the shortlisted funding sources were divided into top priority, high priority and medium priority funding sources:

**Top Priority**

- GCF. Most significant source of funding, regular opportunities to submit proposals, ability to handle large amounts.

**High Priority**

- Global Environment Facility (GEF) Trust Fund - Climate Change focal area (GEF-7). Sustainable cities and land degradation are priorities of GEF-7.
- Global Climate Partnership Fund (GCPF). This could be a source of funding for a credit line (on-lending mechanism)
- International Climate Fund (ICF). Could be a source of grants.
- Land Degradation Neutrality Fund (LDN Fund). Land degradation reversal focus.

**Medium priority**

- Adaptation for Smallholder Agriculture Program. (ASAP). For project components that focus on grassland degradation and resilience.
- Adaptation Fund (AF). For all resilience components.
- Canadian Climate Fund for the Private Sector in Asia II / ADB (CCFPS II). Small fund; on the other hand, Canada has shown a past interest in building energy efficiency. In-house fund. For private sector involvement.
- Clean Energy Fund / ADB. Small fund, but in-house.
- International Climate Initiative (ICI). Project might be big in relation to the annually available budget.
- Japan Fund for the Joint Crediting Mechanism (JFJCM) / ADB. Should be seen together with possibilities to use the JFJCM. Also, Japan partly funds the PPTA.

[4] Van der Tak. C. (2019) *Mongolia Aimag and Soum Centers Regional Development Investment Program (ASDIP): Report on Climate Finance Sources*.

- Leading Asia's Private Infrastructure Fund. For private sector involvement.
- Nordic Environment Finance Corporation (NEFCO) Carbon Finance and Funds. Smaller size, and likely not the type of contribution needed.
- Special Climate Change Fund (SCCF) / GEF. Seems smaller sized in contributions.

17. Usually these funds require ASDIP to include measures to remove barriers and distortions that prevent the uptake of economically attractive green investments with climate benefits. The structure of ASDIP as a MFF program could provide an optimal framework for incorporation of such measures.

18. It is proposed to consider GCF as the key ‘anchor’ source of climate finance for ASDIP, and in addition to check the potential to obtain co-financing from the high priority opportunities (GEF-7, GCPF, ICF and LDN Fund). Initially LDN Fund was considered a top priority, but the challenge of using LDN Fund for co-funding is that it is a private sector oriented fund that makes decision on specific investments – and therefore is difficult for ASDIP to integrate in the overall funding approach. It could, however, be a co-funding opportunity for specific private sector investments under ASDIP.

# III.ANALYSIS OF THE LIVESTOCK SECTOR AND THE NMLP

## A. Historical context

19. Prior to the establishment of the Mongolian People's Republic in 1924, livestock, with a total population of 13.8 million, was mainly owned by common people (50-80%), with monks and noblemen owning the remainder. After the establishment of the Mongolian People's Republic, livestock expanded to a maximum of 27.5 million in 1941, reflecting war production needs.[5] After that, livestock numbers decreased to a quite stable level of 22.5-26 million heads, with a fairly stable composition with sheep dominating (59.1%), followed by goats (19.2%), cattle (10.3%), horses (9.0%), and camels (2.5%).[6] Ownership of livestock was to a large collectivized, with collectives owning in 1985 70.1%, state farms owning 6%, other state organizations 1.7% and private ownership 22.2% of the animals. In this period the animal husbandry sector was recipient of significant state support, including supply of water through water wells and supply of food through fodder production.[7]

20. The data for 1990 (the earliest year for which comprehensive data are published in recent statistical yearbooks published by NSO) are typical for this period and provide a useful baseline to describe the impact of the changes in the sector after the abolishment of the Mongolian People's Republic and the establishment of modern Mongolia in 1992.[8]

21. In 1990, the total number of livestock (sheep, goats, horses, cattle, camels) was 25.86 million, with the composition sheep (58.3%), goats (19.8%), cattle (11.0%), horse (8.7%), and camels (2.1%). The number of herder households was 74,710, and the number of herders was 147,508. The average number of animals per herder household was 346. The number of households with herds (defined as herder households plus households with a primary means of living other than animal husbandry but nevertheless holding herds) in 1991[9] reached 288,930, and the average herd of households with herds reached 88.

22. In 1999, these number had changed dramatically. The total number of livestock (sheep, goats, horses, cattle, camels) increased to 33.57 million, at an average annual growth rate of 2.94% per year between 1990 and 1999. The composition of the herds was sheep (45.3%), goats (32.9%), cattle (11.4%), horses (9.4%), and camels (1.1%), showing in particular a large increase in the share of goats in the total number. The number of households with herds was 269,950. The average number of animals per household with herds was 124.

23. The changes between 1990 and 1999 reflected a complete privatization of herds and a collapse of the Mongolian economy outside the agricultural sector. Between 1990-1993, Mongolia's GDP fell by 25%. The animal husbandry sector acted as a safety valve and absorbed a significant part of the surplus from the other sectors, offering a livelihood to people who lost their previous jobs.

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[5] For the period before 1990, see Worden, R.L. and A.M. Savada (eds) (1991), *Mongolia: A Country Study*. Library of Congress. Federal Research Division

[6] Based on data downloaded from Mongolian Statistical Information Service, http://1212.mn/.

[7] Worden and Savada (1991).

[8] The first elections were held in July 1990. The constitution was amended in 1992, which can be seen as the end of the abolishment of the Mongolian People's Republic and the establishment of modern Mongolia.

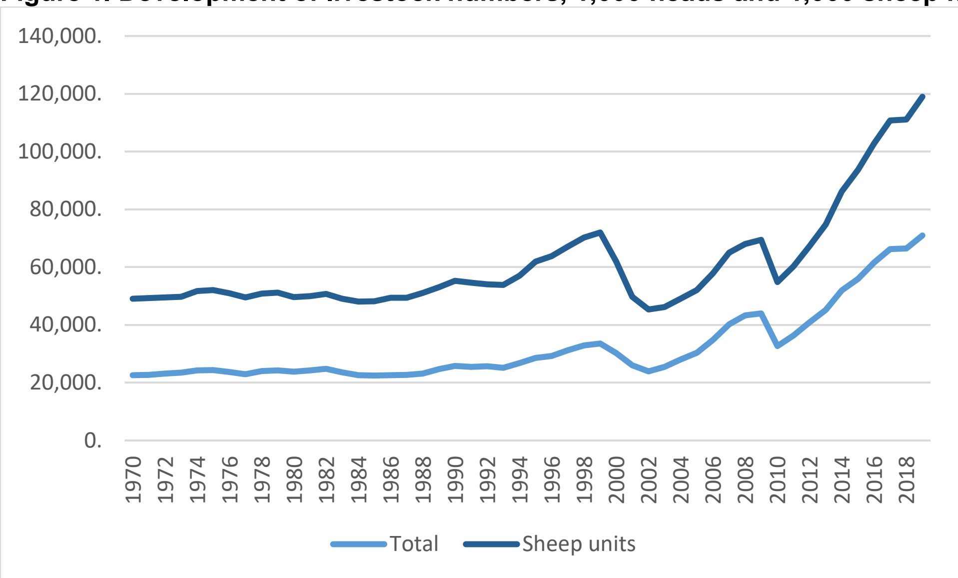
[9] No data were available for 1990 on http://1212.mn/. For this indicator ("household with herds"), 1991 is the earliest year for which data are available. It can be assumed that in 1990, the number of households with herds was similar to the number in 1991, and that hence the number of herder households is significantly lower than the number of households with herds.

24. The period from 1999 to 2002, comprising three winters was characterized by a series of devastating *dzuds*, resulting in a massive decline of the animal population from 33.57 million in 1999 to 23.90 million in 2002. Parallel to this the number of households with herds declined to 243,230 from 269,950. The recovery of the animal numbers after the *dzud* was especially rapid, and in 2008 the number of animals had reached 43.29 million, for an annual growth rate over the period 2002 to 2008 of 10.4%. The composition of the herd was goats (46.1%), sheep (42.4%), cattle (5.8%), horses (5.1%), and camels (0.6%), demonstrating a further increase of the share of goats in the total animal composition in the total population. Since the period 1970-1990, the share of goats had more than doubled, while the share of large animals (horses, cattle, camel) was reduced to almost half, from 21.8% to 11.5%. The number of households with herds reduced to 227,550, and the average number of animals per household with herds increased to 190.

25. The National Mongolian Livestock Program (NMLP), discussed in more detail in Section C, was formulated against this background and adopted in 2010. The NMLP uses 2008 as a baseline but took into account the *dzud* of the winter of 2009-2010, which killed about 8.5 million animals (affecting 769,000 people or 28% of Mongolia's human population). The NMLP of 2010 builds in a gradual process of rebuilding animal numbers.

26. Animal numbers again restored rapidly after the major *dzud* period of 2009-2010. By 2019, total animal numbers had increased to 70.97 million, at an animal growth rate of 9.0% (2010-2019). Figure 1 provides an overview of the development of livestock numbers between 1970 and 2019 (total numbers and in sheep head units, see the discussion in Section D below).

**Figure 1. Development of livestock numbers, 1,000 heads and 1,000 sheep head units**




27. By 2019, the composition had changed to sheep (45.5%), goat (41.2%), cattle (6.7%), horses (5.9%), and camels (0.7%), implying a slight correction relative to 2008 (decrease in the share of goats, increase in the share of large animals), although nowhere near to returning to the values of 1970-1990. The number of households with herds slightly increased to 233,317, and the average animal number held by a household with herds reached 304. The percentage of households with herds holding less than 50 animals dropped from 27.9% in 2012 to 19.9% in 2019, while the percentage of households with herds holding less than 100 animals dropped from 43.8% in 2012 to 31.9% in 2019. This demonstrates a shakeout of smaller herders.

28. After both *dzud* periods, the increase in animal numbers was much faster than in the period 1990-1999. Moreover, the increase in animal numbers was in both cases almost completely the result of an increase in the number of animals per household with herds, and not the result of an increase in the number of households with herds.[10] This is consistent with the often made observation (what follows is not controversial in Mongolia, and is often expressed by different experts, officials and observers) that herders have increased their herds to build in a safety margin in case of a natural disaster (such as a *dzud*) and retain a viable herd size.

### B. Overgrazing and the government reaction

29. The Mongolian approach to animal husbandry is dictated by the climate with limited, variable and uncertain precipitation. It values mobility to make the best of variable and vulnerable resources, offer pastures the chance to recuperate while searching for the best possible resources to feed the animals. This strategy takes into account the vulnerability of the grassland resources and is caused by it. Other sedentary land use patterns are not proper given the variability in resources over time and space.

30. Of course, Mongolians have been fully aware about the constraints the environment and climate poses on their society. Availability of resources and the threat of overgrazing are well known problems, and indeed, overgrazing was one of the environmental concerns that led to the establishment of the Ministry of Environmental Protection in 1986. Since 1986, Mongolia has had an environmental ministry, although admittedly under a variety of names.

31. Overgrazing has been a concern of the Mongolian government for many years, at least from the 1980s onwards. Below we summarize some of the key national reports to the UNFCCC and documents that show this long standing government concern, before discussing in Section C in more detail the NMLP and how this document is referred to in later reporting and policies.

*First National Communication to the UNFCCC, 2001*

32. The first national communication of Mongolia[11] to the UNFCCC (NC1) mentions that about 97.4% of Mongolia's territory – some 125.7 million hectares – are used for pasture and that seventy percent of this land is overgrazed to some extent. The potential GHG mitigation options in the animal husbandry sector mentioned in NC1 are (1) to limit the increase of total livestock numbers; (2) to decrease the number of cattle, which is the main source of methane emission in the livestock sector; and (3) to increase productivity of each animal[12]. One of the other potential measures mentioned (Ministry of Nature and Environment 2001:83) is "*Improve the income tax system in order to regulate the number of livestock and volume of crop production according to the real capacity of pasture and arable land*", which again shows that limiting the number of animal was one of the measures considered by the government of Mongolia.

[10] There are two dzud recovery periods. In the first recovery period (2002-2009), the number of households with herds dropped from 243,230 to 226,650 while the number of animals increased from 23.9 million to 44.0 million. In the second recovery period (2010-2019), the number of households with herds increased from 216,570 to 233,317, while the number of animals increased from 32.7 million to 71.0 million. Aggregating over the two period, the number of households with herds increased with 167 (less than 0.1% from the 2002 level), while the number of animal increases by 58.4 million (244% of the 2002 level).
[11] Ministry of Nature and Environment (2001), Mongolia's Initial National Communication.
[12] Productivity should be measured at the level of the total herd – amount of useful product by an animal species, divided by the total number of animal of that species in the herd.

*State of the Environment (2002)*

33. The State of the Environment report[13] pays considerable attention to overgrazing. It states that "*overgrazing is particularly severe near settlements and administrative centers where herdsmen are settling in order to have access to markets under the new free market economy. Increased freedom of movement has resulted in people moving to better grazing land, especially in the central regions, that are now becoming overcrowded. (…) Traditional grazing-land management was abandoned during the years of the cooperative campaign, even then, large numbers of cattle were kept near the administrative centers without consideration of carrying capacity.*" It also mentions the concentration of overgrazing near water points due to the scarcity of functional water points.

*NAMA submission under the Copenhagen Accord (2010)*

34. In 2010, Mongolia made a National Appropriate Mitigation Actions (NAMA) submission to the UNFCCC[14], which among others includes the following text, in anticipation of the NMLP, under the heading: "*Limit the increase of the total number of livestock by increasing the productivity of each type of animal, especially cattle.*"

35. The NAMA submission further elaborates: "*Mongolia is one of the few countries with a pastoral nomadic economy with historical traditions of animal husbandry. Pastureland is the primary source of the forage and feed needed to support extensively managed livestock in Mongolia. One of the features of Mongolian animal husbandry is seasonal movement among different pastures so the manure of the animals is managed under aerobic conditions or just as a solid on pastures and ranges. Animal breeds are small and less productive than breeds in other countries. Mongol livestock program is under discussion at the parliament. The program includes five directions such as ensuring sustainable development and creating a good governance at animal husbandry's sector by arranging a good environment of economics and infrastructure for the sector; making products and raw materials of biological high quality and improving the market competitiveness by refining upon livestock breeding and service in accordance with social needs; ensuring health of Mongolian livestock and protecting the social health by bringing the veterinary works and service into international standards; developing livestock husbandry adapted to various changes of climate, nature and ecology and improving the abilities of bearing risks; creating a network of meat procurement and sale by developing the goal-directed market of livestock, livestock raw materials and products, and accelerating the economic circulation.*"

## C. NMLP and references to NMLP in other government documents

36. The NAMA submission above contains a reference to the NMLP which was approved later in 2010. The NMLP is concerned about overgrazing, productivity, species composition, diseases, and others. The Rationale of the NMLP contains the following text: "(…) *in recent years despite of the livestock growth, Mongolia is facing a bouquet of challenges that needs immediate interventions, including overgrazing and misbalance of the livestock species. Infectious animal diseases are expanding resulting in increasing rates of illness for both human and animal populations. In addition to signs of expansion, instances of new highly contagious disease and recurrence of previously controlled diseases are occurring, which is*

[13] UNEP (2002), Mongolia: State of the Environment 2002.
[14] Government of Mongolia (2010), Mongolia: *Nationally appropriate mitigation actions of developing country Parties*. Downloadable from: https://unfccc.int/files/meetings/cop_15/copenhagen_accord/application/pdf/mongoliacphaccord_app2.pdf

*creating conditions that limit the supply to market of raw materials and livestock products. Aside of this, as the livestock sector is based primarily on households" activities, herders are scattered, the herders" productivity is decreasing, efficiency is lost, herders" ability to withstand the market competition and weather-associated risks is weakened.*"

37. To address these issues, the NMLP, from 2010 to 2021, was planned to target the following main directions:

1) Drawing special attention from the State to the livestock sector as the main traditional economic activity of the country, to assist in the formulation of a favorable legal, economic and institutional environment for sustainable development, and to develop a good governance in the livestock sector;
2) Improving animal breeding services based on social need/demand, increasing the productivity and production of high quality, bio-clean livestock products and raw materials and increasing market competitiveness;
3) Raising the veterinary service standard to international levels and protecting public health through securing Mongolian livestock health;
4) Developing livestock production that is adaptable to climatic, environmental, and ecological changes with strengthened risk management capacity; and
5) Developing targeted markets for livestock and livestock products; establishing proper processing and marketing structures and accelerate economic turnover through an incentive system.

38. For our purposes, the most important targets relate to the second and fourth priority area.

- Indicator 2.3 is to "Maintain livestock number at the beginning of the year, by herd type", and includes a table that has been reproduced as Table 1.
- Indicator 4.2 is to "Define maximum livestock numbers based on herd type and pasture carrying capacity."

**Table 1. Baseline and targets of the NMLP**

| Indicator | Unit | Baseline (2008) | Target (2012) | Target (2015) | Target (2021) |
|---|---|---|---|---|---|
| **Total number** | **1,000 heads** | **43,288** | **33,343.4** | **35,298.9** | **36,457.6** |
| Camel | % of total | 0.6 | 0.8 | 0.8 | 0.9 |
| Horse | % of total | 5.1 | 6.4 | 6.8 | 8.2 |
| Cattle | % of total | 5.8 | 7.7 | 9.6 | 13.8 |
| Sheep | % of total | 42.4 | 44.9 | 45.4 | 45.1 |
| Goat | % of total | 46.1 | 40.2 | 37.4 | 32.0 |

39. The purpose of indicator 4.2 is clear – ensure that livestock numbers stay within carrying capacity. This clearly points towards limiting herd sizes for reasons of sustainability. Indicator 2.3 is potentially more problematic, as from the formulation of the indicator taken on its own, it is not clear whether the targets are limits of aspirational levels to be exceeded. The rationale cited above (see Paragraph 27), with its emphasis on overgrazing, strongly suggests that these targets are intended as limits, not to be exceeded, and certainly not as aspirational levels, preferably to be exceeded. Further statements by the Mongolian government support this interpretation.

*Second National Communication, December 2010.*

40. The Second National Communication[15] (NC2) to the UNFCCC was submitted shortly after the approval of the NMLP. In the section on policies and measures for mitigation of GHG emissions in agriculture, NC2 refers to the NMLP as follows: "*Recently, the National Mongolian Livestock Programme has been approved by the Parliament of Mongolia. The objective of the Programme is to ensure the sustainable development of the livestock sector and create a legal environment that would promote economic development. According to the programme, the number of livestock is expected to reduce from 44 millions in 2008 to about 36 millions in 2021 as a result of improving animal breeding services based on social needs and increasing the productivity and quality of livestock products to increase the competitiveness of the sector.*" (Ministry of Nature, Environment and Tourism 2010:80)

*Preparation of a NAMA with support from ADB (2013)*

41. Within the context of ADB's multi-year "Strengthening Carbon Financing for Regional Grassland Management in Northeast Asia", a regional TA covering Mongolia and the People's Republic of China, ADB carried out significant research into mitigation possibilities related to the animal husbandry and rangeland management in Mongolia. This research culminated into several publications, including a report on making grasslands sustainable[16] and a NAMA report.[17] The latter of these discussed the formulation of a NAMA based on the NMLP. A policy brief[18] was also prepared, co-authored by Damdin Dagvadorj[19]. One of the key points of the policy brief was that "Mongolia's NAMA for the management of its grassland and livestock sectors should be based on its National [Mongolian] Livestock Program".

*First Nationally Determined Contribution (2015)*

42. Mongolia's first nationally determined contribution[20] (NDC1) contains a clear reference to mitigation actions in the animal husbandry sector to the NMLP. As one of the mitigation policies and measures for implementation up to 2030, it mentions "*Maintain livestock population at appropriate levels according to the pasture carrying capacity*" and references the "Mongolian national livestock programme, 2010" (i.e., the NMLP). NDC1 additionally mentions that some adaptation activities under these goals will also have mitigation co-benefits and provides among others the example that *"Improving pasture management would increase the carbon sink of CO2 equivalent to 29 million tons per year*".

*Biennial Update Report (2017)*

43. The first Biennial Update Report[21] (BUR1) of 2017 contains in Table 3-12 an overview of the various policies and measures to mitigate GHG emissions in livestock sector (Ministry of Environment and Tourism 2017:55-56). For the Mongolian Livestock National Program 2010 (i.e., NMLP), it mentions the reduction of number of livestock from 43,288.0 thousand

[15] Ministry of Nature, Environment and Tourism (2010), *Second National Communication of Mongolia under the United Nations Framework Convention on Climate Change*. Ministry of Nature, Environment and Tourism, Mongolia

[16] ADB (2013), *Making grasslands sustainable in Mongolia: Adapting to climate and environmental change*. Asian Development Bank.

[17] Tennigkeit, T. and A. Wilkes (2013), *Nationally Appropriate Mitigation Actions for Grassland and Livestock Management in Mongolia*.

[18] Dagvadorj, D., T. Tennigkeit, A. Wilkes and C. Yeager (2013), Nationally Appropriate Mitigation Actions for Grassland and Livestock Management in Mongolia. *ADB Brief No. 13*, May 2013.

[19] At the time, Chair of the Climate Change Coordination, Office of the Ministry of Environment and Green Development of Mongolia.

[20] GoM (2015), *Intended Nationally Determined Contribution (INDC) Submission by Mongolia to the Ad-Hoc Working Group on the Durban Platform for Enhanced Action (ADP)*. Government of Mongolia.

[21] Ministry of Environment and Tourism (2017), *Mongolia's Initial Biennial Update Report under the United Nations Framework Convention on Climate Change*. Ministry of Environment and Tourism.

(2008) to 35,298.9 thousand (2015) and 36,475.6 thousand (2021). It also mentions the planned change in the composition of the herds, with the planned increase in the share of larger animals, in line with the requirement to increase meat and milk production.

*Third National Communication (2018)*

44. The third national communication[22] of 2018 again mentions the Mongolian Livestock National programme (i.e., NMLP) as a mitigation policy in the agricultural sector. It states "*The objective of the Programme is to ensure the sustainable development of the livestock sector and create a legal environment that would promote economic development. Per the programme, the number of livestock is expected to reduce from 44 million in 2008 to about 36 million in 2021 as result improving animal breeding services based on social needs, increasing the productivity and quality of livestock products to increase the competitiveness of the sector.*"

*GCF Country Programming (2019)*

45. The GCF country programme[23] does not refer to the NMLP as such, but mentions in several places the need to limit livestock numbers, both for adaptation and mitigation objectives.

46. The above clearly demonstrates that the NMLP has always been intended for mitigation purposes, and that the aim is to limit the number of animals. However, as noted by iTAP, the NMLP also includes a change in composition of the herds, with an increase in the share of large animals (which more significant feed and water needs). The next section contains a more in-depth analysis and discussion based on the differentiated feed requirements of livestock species.

## D. In-depth analysis of the NMLP and grazing pressure

47. It is necessary to convert grazing behavior of different livestock species to a common denominator to better understand the policies of the government of Mongolia. The commonly used unit is the sheep head unit (SHU, also sheep unit is used as term), which converts the grazing impact of animals to a sheep equivalent, in the same way as the global warming potentials (GWPs) are used to convert emissions of different greenhouse gases to a common denominator, $tCO_2e$. The following conversion coefficients are used in Mongolia:

- Sheep: 1 sheep equals 1 SHU
- Goats: 1 goat equals 0.9 SHU
- Horses: 1 horse equals 7 SHU
- Cattle: 1 animal equals 6 SHU
- Camel: 1 camel equal 5 SHU

**Table 2. NMLP targets in SHU and actual herd size.**

| Year | Actual herd size (SHU) | NMLP limit (SHU) | Actual growth rate | NMLP targeted growth rate |
|---|---|---|---|---|
| 1970 | 49,117,142 | - | 1970-90: 0.60% p.a. | - |
| 1980 | 49,578,630 | - | | - |
| 1990 | 55,311,630 | - | 1990-99: 2.97% p.a. | - |
| 1999 | 71,991,530 | - | | - |
| 2002 | 45,351,020 | - | 2002-08: 6.98% p.a. | - |

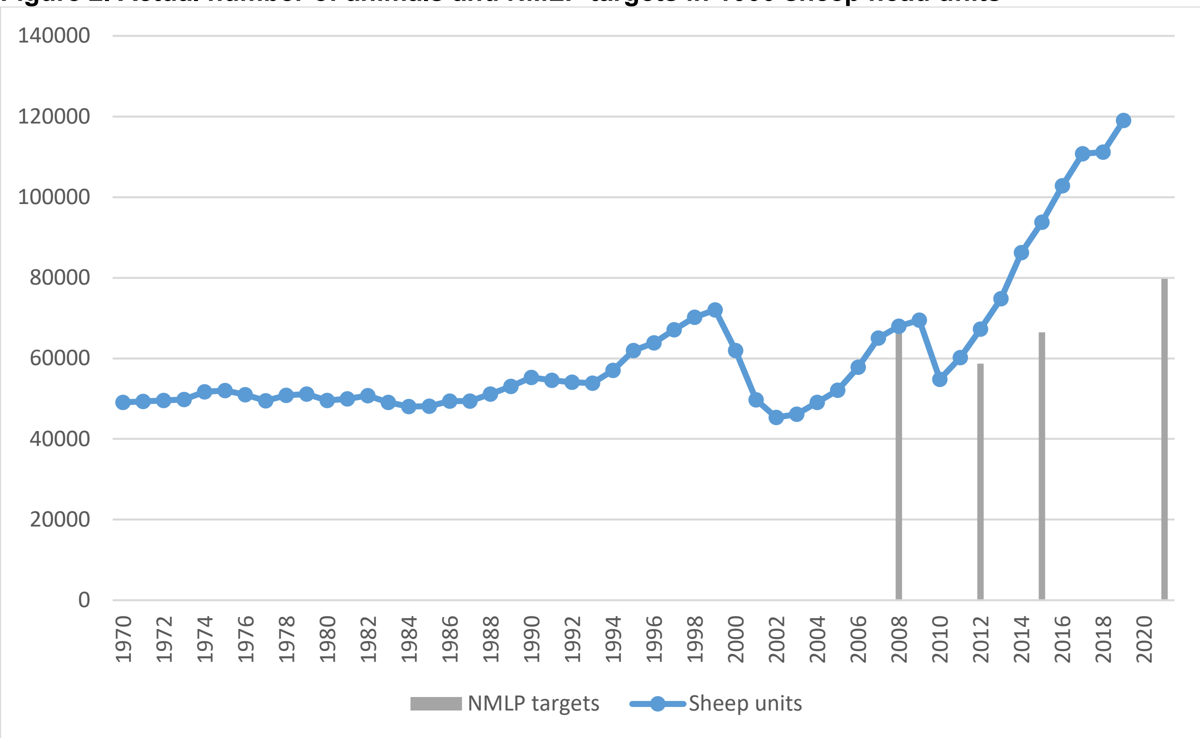
[22] Ministry of Environment and Tourism (2018), *Mongolia Third National Communication under the United Nations Framework Convention on Climate Change*. Ministry of Environment and Tourism.
[23] GCF (2019), *Country Programme Mongolia*. Green Climate Fund.

| Year | Actual herd size (SHU) | NMLP limit (SHU) | Actual growth rate | NMLP targeted growth rate |
|---|---|---|---|---|
| 2008 | 67,995,460 | Baseline 68 million[24] | | - |
| 2009 | 69,490,950 | - | | - |
| 2010 | 54,821,380 | - | | - |
| 2012 | 67,294,061 | 58,711,059 | 2012-19: 8.48% p.a. | 2012-21: 3.45% p.a. |
| 2015 | 93,766,491 | 66,453,709 | | |
| 2019 | 118,987,533 | - | | |
| 2021 | 140 million projected | 79,696,314 | | |

48. This conversion, as the conversion to $CO_2e$ for greenhouse gases, is not perfect. Goats for example are more destructive than the conversion to SHU accounts for, because grazing by goats destroys grassland more than the biomass intake on its own would indicate. This is due to goats' tendency to pull out plants completely, including the roots, instead of eating plants partly. Moreover, different animal species favor different plants, which means that is general, some variety in the herds is good for the grasslands, with the optimal composition differing from location to location, and indeed from time to time. Notwithstanding these shortcomings, conversion to SHU gives a good idea how grazing pressure has developed over time.

49. Table 2 presents the development of the total livestock expressed in SHU for selected years, while Figure 2 provides data for the same period in a graph.

**Figure 2. Actual number of animals and NMLP targets in 1000 sheep head units**




50. A few points jump out. Between 1970 and 1990, the number of livestock expressed in SHU was almost completely flat. Only in the period 1988-1990 did the number of SHU curve upwards. Between 1990 and 1999, the number of SHU went up by about 3% per year. The consecutive dzud of 1999-2002 caused a massive drop in SHU, which was followed by a fast recuperation at a growth rate of about 7% per year between 2002-2008. The winter 2009-2010 provided for another collapse due to a dzud, reducing animal numbers before the

[24] There is a slight deviation between the data used in the NMLP and the data available from NSO, probably due to later corrections in the latter. Based on the data in the NMLP, the baseline can be calculated as 68,130,983 SHU.

approval of the NMLP. After the dzud, there was an extremely rapid growth in SHU, at an annualized growth rate of 8.5% between 2012-2019 and 9% between 2010-2019.

51. Compared to this, the increase in SHU foreseen in the NMLP is a drastic drop relative to the business-as-usual (BAU) scenario. Between 2012 and 2021, the increase in SHU from 58.7 million to 79.7 million implied an annual growth rate of 3.5% only, while relative to the 2008 baseline, the implied annual average growth was only 1.2%. In other words, while the NMLP did not impose a reduction in animal numbers, it imposed a strong (intended) limitation vis-à-vis the very rapid increase in the BAU scenario.

52. Another feature of the NMLP is the inclusion of measures that increase the rangeland productivity and the animal population that can be sustained. Example are the establishment of country, aimag and soum level reserved (*otor*) grazing areas (indicator 4.1), increasing fodder production (indicator 4.6), increasing hay and fodder storage facilities (indicator 4.3) and the establishment of new wells[25] (indicator 4.4).

53. The NMLP simultaneously includes targets for 2021 to decrease, relative to the 2008 baseline, the number of small animals (sheep and goats) and increase the number of large animals (camels, cattle, horses) to bring about a better ecological and economic balance while limiting the unrestrained growth in animal numbers. Overall, the NMLP limits overall grazing pressure to much below the BAU scenario. Furthermore, the NMLP seeks to bring animal numbers in balance with the carrying capacity and includes measures to increase the carrying capacity of Mongolian rangelands, to compensate for the net increase in grazing pressure relative to 2008.

The NMLP as envisaged in 2010 limits overall grazing pressure to much below the BAU scenario while modifying the herd composition for better ecological and economic balance. At the same time, the NMLP seeks to increase the carrying capacity of the Mongolian rangelands and to achieve a better balance between carrying capacity and herd sizes and composition.

54. As an aside, one of the reasons why reducing the animal numbers is not feasible is provided in the GCF country programming for Mongolia: "*local herders have been opposed to reducing livestock in order to mitigate methane emissions due to their traditional, cultural way of life, and livelihood constraints, which necessitates maximum herding capacity.*" (GCF 2019:9) The proposed ASDIP addresses this issue through increasing the value added and profit per animal for those herder households that reduce and limit their herd sizes.

55. The rapid growth of animal husbandry since 2010 means that current numbers far exceed the targets in the NMLP. While the 2021 target of the NMLP is equal to 79.7 million SHU, the number in 2019 was 119.0 million, exceeding the target by 49%. Moreover, the current rapid growth means that the total project number for 2021 is 140 million SHU, exceeding the target by 75%. The animal reduction objectives of ASDIP are therefore clearly in line with the goals of the NMLP.

56. Table 3 provides an overview of the animal numbers per species. It provides data for 2012 and 2019, the annualized growth rate between 2012 and 2019, the projected number for 2021 (based on a constant annual growth rate), the targets for 2021, and the numbers in 2019 respectively projections for 2021, expressed as a percentage of the 2021 targets of the NMLP.

**Table 3. NMLP targets and actual numbers per animal species.**

[25] This is important to avoid a concentration of animals near to a limited number of watering points, leading to a local concentration of grazing pressure.

| Animal species | Actual number of animals (heads) | | Growth rate p.a. | Projection | Target | Actual number as % of 2021 target | Projection as % of 2021 target |
|---|---|---|---|---|---|---|---|
| | 2012 | 2019 | 2012-2019 | 2021 | 2021 | 2019 | 2021 |
| Horse | 2,330,428 | 4,214,818 | 8.83% | 4,992,355 | 2,989,523 | 141% | 167% |
| Cattle | 2,584,621 | 4,753,192 | 9.09% | 5,656,946 | 5,031,149 | 94% | 112% |
| Camel | 305,835 | 472,379 | 6.41% | 534,853 | 328,118 | 144% | 163% |
| Sheep | 18,141,359 | 32,267,265 | 8.57% | 38,037,951 | 16,442,378 | 196% | 231% |
| Goat | 17,558,672 | 29,261,661 | 7.57% | 33,858,872 | 11,666,432 | 251% | 290% |
| Total | 40,920,915 | 70,969,315 | 8.18% | 83,080,977 | 36,457,600 | 195% | 228% |

57. Table 3 clearly shows that by 2019, all animal population targets, with the exception of cattle, had surpassed the 2021 target of the NMLP. For goats, the difference is especially remarkable, with actual numbers exceeding the 2021 target by 150%. Table 3 also shows that if the trends are continued to provide a projection for the actual numbers in 2021, all animal numbers will exceed the NMLP targets. This illustrates that the ASDIP objective of reducing animal numbers is fully in line with the NMLP[26].

The rapid growth in herd size since 2010 means that by 2021, each of the animal species will have excess animals relative to the 2021 NMLP targets. Achievement of the NMLP therefore requires that each animal species will be reduced in number.

58. The recent government policies are fully in line with this observation. For example, the recent Action Plan of Mongolian Agenda for Sustainable Livestock[27] in criteria 1.1 mentions the need to reduce the excess of livestock over the pastureland carrying capacity from 25 million sheep head units (2017) to 20 million sheep head units (2020).

59. Accompanying the Action Plan is a Situation Analysis of Livestock Sector in Mongolia, which highlights that the livestock sector has been challenged with pastureland degradation, reduction of productivity per head, livestock diseases, and herders' social problems.

60. Recently the Ministry of Food, Agriculture and Light Industry (MOFALI) confirmed that the long-term objective is to indeed reduce the total number of livestock to more sustainable levels in line with the carrying capacity of Mongolian rangelands. The government's policy is to reduce the overall number of livestock, with special emphasis on small ruminants, and increase the diversity of animals in the herd to enhance pasture-management. The reduction in number of animals is therefore expected to be especially sharp for sheep and goats, while targets for large animals (cattle/yaks, horses, and camels) will show more flexibility.

61. In a letter, MOFALI recently confirmed the long term policy target to reduce the number of livestock number 51.2 million heads or equivalent to 74 million sheep head units by 2033 to maintain optimal carrying capacity of rangelands. MOFALI also confirmed that the second NDC will seek to reduce emissions from animals by 23.4% against baseline by 2030.

ASDIP also supports the long-term government objective of reducing grazing pressure and changing the herd composition towards large ruminants.

[26] One aspect is that in our projections, we have assumed an equal reduction in all animal numbers. The reason for this simplifying assumption was that market conditions and based on that, government priorities regarding herd composition may be subject to change. During actual implementation, reduction targets will be differentiated, under the constraint that both the reduction in grazing pressure and the CH4 and N2O emission reductions are at least as significant as currently projected.

[27] Ministry of Food, Agriculture and Light Industry (2018), *Action Plan of Mongolian Agenda for Sustainable Livestock*. Ministry of Food, Agriculture and Light Industry.

62. Since the approval of the NMLP, the Mongolian government's objective has been to reduce overall livestock numbers to keep them at sustainable levels. However, this objective has so far been elusive because the government has not been able to develop the agriculture and livestock sector more systematically, including the whole value chain and increasing herd productivity. Without increasing the commercialization of the livestock sector and without supporting rural agri-businesses and ultimately increasing herder incomes, it will be extremely hard to reduce livestock numbers. For Mongolian herders, livestock serves a multitude of purposes. Under the current circumstances, having large herds primarily serves the purpose of having insurance and a safety net against potential shocks, such as *dzuds*.

### E. Conclusions

63. The NMLP as envisaged in 2010 limits overall grazing pressure to much below the BAU scenario while modifying the herd composition (increasing the share of large animals vis-à-vis sheep and goats) for better ecological and economic balance. At the same time, the NMLP seeks to increase the carrying capacity of the Mongolian rangelands and to achieve a better balance between carrying capacity and herd sizes and composition.

64. The rapid growth in herd size since 2010 means that by 2021, each of the animal species will have excess animals relative to the 2021 NMLP targets. Achievement of the NMLP therefore requires that each animal species will be reduced in number.

65. The long-term government objective is to reduce grazing pressure and changing the herd composition towards large ruminants, with specific targets for the period after the end of the NMLP still to be determined.

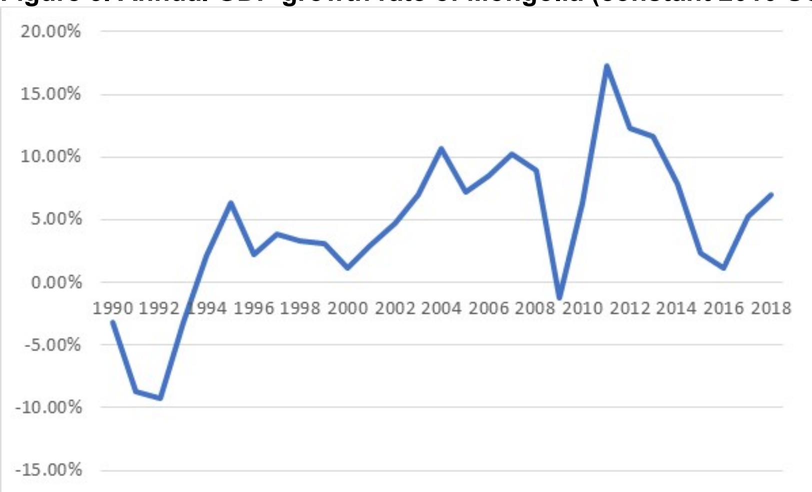
66. The animal reduction objectives included in ASDIP are therefore in line with the NMLP and the long-term objectives of the Mongolian government. ASDIP addresses address exactly the gaps identified by the Mongolian government. ASDIP creates the enabling environment for the Mongolian herders to actively pursue quality instead of quantity by increasing the commercialization of the livestock sector by supporting rural agri-businesses and ultimately by increasing herder incomes from a more limited number of animals.

# IV.CONTEXT FOR RANGELAND AND ANIMAL HUSBANDRY GHG MITIGATION.

## A. Macroeconomic restrictions on Mongolia's ability to address overgrazing

67. Mongolia is classified by the World Bank (June 2019) as a lower middle income country, indicating a limited ability to cope. Mongolia GNI per capita for 2018 was USD3,580. The Government of Mongolia is currently not able to step in and support in cases of calamities, due to constrained government finances. For example, the government budget deficit has been persistent and stood at -6.4% of GDP in 2017, while public debt was 91.4% of GDP, demonstrating a limited capacity to increase expenditures to deal with calamities.

**Figure 3. Annual GDP growth rate of Mongolia (constant 2010 USD)**




*Source*: Calculated based on World Development Indicators data

68. In general, Mongolia's economy is dependent on a limited number of products, and hence open to sharp shocks through developments in commodity prices and or decisions from specific investors to discontinue or restart specific projects, as illustrated by Figure 3. This factor further limits the capacity of the Mongolian government to cope with external shocks.

## B. Greenhouse gas emissions in Mongolia

69. Total GHG emissions in Mongolia in 2014 were 34,482.73 Gg CO2e (excluding LULUCF). This represented 57.09% increase from the 1990 level of 21,950.73 Gg CO2e and 5.49% increase from the 2013 level with 32,687.27 Gg CO2e. Net GHG emissions in 2014 were 10,030.80 Gg CO2e (including LULUCF).

**Table 4. Emission inventory of Mongolia**

| Sector | Emissions and Removals (Gg CO2e) 1990 | Emissions and Removals (Gg CO2e) 2014 | Change from 1990 (Gg CO2e) | Change from 1990 (%) |
|---|---|---|---|---|
| Energy | 11,091.14 | 17,267.79 | 6,176.64 | 55.69 |
| IPPU | 218.66 | 328.06 | 109.39 | 50.03 |
| Agriculture | 10,585.30 | 16,726.98 | 6,141.68 | 58.02 |
| Waste | 55.62 | 159.91 | 104.29 | 187.49 |
| Total (excluding LULUCF) | 21,950.73 | 34,482.73 | 12,532.00 | 57.09 |
| LULUCF | -23,024.18 | -24,451.93 | -1,427.75 | 6.20 |
| Net total (including LULUCF) | -1,073.46 | 10,030.80 | 11,104.26 | 1,034.44 |

*Source*: Ministry of Environment and Tourism (2018), Third National Communication of Mongolia Under the United Nations Framework Convention on Climate Change.

## C. ASDIP's GHG mitigation approach

70. Although Mongolia's policies to reverse overgrazing and restore grasslands have been in place for a long period, these policies have not been successful in reducing overgrazing, restoring grasslands, and mitigating animal GHG emissions – to the contrary (see Section III for a discussion). The main reason for this lack of success is the perceived reduction of herders' income when animal numbers are reduced. In this section we elaborate on this and introduce the ASDIP approach to solve this issue.

71. The first question is whether reducing the number of animals, without accompanying measures, will indeed reduce the income of herders. In the short term, this will definitely be the case. In the medium to long term, rangelands will restore, increasing the amount of food that rangelands will offer to animals. Moreover, as livestock are selective grazers, they will be able to forage species that are more digestible. Hence animal tend to become more productive, which compensates for the reduction in animal numbers. Whether this is enough to compensate for the reduced number of animals depends on a number of factor, including the depth of the cut in animal numbers[28]. Logically, herders will be skeptical about these mechanisms and how long they will take to result in (partial or complete) compensation for initial income losses. Hence our emphasis on *perceived* income losses.

72. What is certainly true is that herders cannot act individually. Herders will need to coordinate decisions on the stocking of rangelands with other herders that use the same rangelands. If not, reduction in animal numbers by one herder will not matched by similar reductions from other herders and will not lead to a restoration of grasslands and higher food availability for their animals. This means that actions will need to be based on groups of herders using the same rangelands. Using the examples set by other projects, especially the methods developed by the Swiss Development Cooperation, ASDIP focuses on the Pasture User Groups (PUGs) and the Rangeland Use Agreements (RUAs) as a vehicle for collective action. Output 2 and Output 4 of ASDIP provide financial and technical support for the PUGs.

73. Even in the case of collective action based on PUGs and RUAs, herders need to be convinced that reducing animal numbers is in their best interest. This is done through a combination of incentives (Output 2 of ASDIP) for reducing animal numbers and ensuring that maintaining lower animal numbers is compensated for through long term and sustainable increases in income per animal[29].

74. The latter is among others[30] achieved through investments in the low-carbon livestock value chains (LCLVC) that increase the output and value added per animal as well as the share of the herders in the total value added in the LCLVC (Output 3). LCLVC investments include investments in processing (deeper processing, using more parts of the animal and modern technologies resulting in higher quality) and through investments in inputs that allow herders to achieve higher output per animal and hence lower GHG emissions and grazing pressure per unit of output. Annex 3 provides an overview of several investment options that have been identified and analyzed in-depth by ADB as well as some management methods that can reduce GHG emissions and grazing pressure.

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[28] For an indepth discussion of all these points, see Wilkes, A. and N. Batjargal (2015), *Mainstreaming Climate Technology in Mongolia: Report for the Agriculture sector*. Report prepared under TA-8109, Integration of Climate Technology Financing Needs into National Development Strategies, Plans, and Investment Priorities.

[29] In both cases, the support is conditional on reducing the number of animals in accordance with agreements reached.

[30] Another approach that ASDIP follows is certification, which allows products resulting from the LCLVCs to be differentiated from others and to charge a higher price.

75. LCLVC investments require sufficient infrastructure and the presence of professionals at the location of these investments, close to the point of need. This requires a strengthening of the aimag centers, soum centers and intersoum centers in the ASDIP locations, the small rural cities close to the rangelands. Significant urban infrastructure gaps have resulted from a lack of funds and investments since the 1990s, which means that current infrastructure is insufficient to both provide the basis for the processing facilities and attract professionals. Output 1 seeks to address these infrastructure gaps by using low-carbon technologies where possible.

76. As sketched above, ASDIP has several components that together aim to achieve a transformational change to the animal husbandry sector – reversing trends to ever increasing numbers of animals and degradation of rangelands through a combination of reduction of the number of animals, increased output per animal, increased quality of outputs, reduced emissions per animals and restoration of grasslands. To achieve this, ASDIP combines investments in rural cities (Output 1), the animal husbandry sector (Output 2) and the industrial sector providing inputs and processing (Output 3). Replication of this approach requires the building the capacity to formulate policies and the formulation and dissemination of lessons learned and experiences gained. ASDIP addresses this through Output 4. Moreover, ADB will launch the Partnership for Low-Carbon Rangeland Management in Asia which will use result-based payments to support the replication of the ASDIP approach and results in Mongolia and other parts of Asia.

77. Based on the above, ASDIP has the following structure:

- Output 1. **Low-carbon and livable Aimag and Soum Centers developed**. Financing and design support to create low-carbon rural cities created to anchor low-carbon livestock value chain investments.
- Output 2. **Rangelands managed for carbon sequestration and sustainable herding**. Incentives and organizational support for the introduction of transformational low-carbon rangeland management practices.
- Output 3. **Low-carbon livestock value chains created and strengthened through accessible finance**. Innovative mechanisms created to provide financing for low-carbon livestock value chain investments to sustain low-carbon rangeland management.
- Output 4. **Capacity building and policy development for low-carbon integrated urban-rural development improved**. Building capacity for the preparation of low-carbon development plans and policies targeting rural cities and animal husbandry; formalting knowledge and lessons learned feeding into policy dialogues especially on the successor of the NMLP, establishing MRV systems and establishing the Partnership for law-carbon rangeland management.

# V. REVIEW OF RELEVANT LITERATURE ON RANGELAND GHG MITIGATION

## A. Introduction

78. Rangelands occupy about half of the world's land area and contain more than one-third of above- and below-ground C reserves. Any changes in C storage in rangeland ecosystems have the potential to modify the global cycles and potentially influence climate change. Since the Kyoto Protocol opened the possibility of using the biosphere as a carbon sink, the management of rangeland, especially by restoring degraded rangeland through improved land management, should be part of C sequestration programs (Han et al, 2008).

79. The process through which rangelands interact with soil carbon are relatively well understood. As explained by Wilkes et al. (2013) as plants photosynthesize, they assimilate $CO_2$ from the atmosphere. As grasses grow, dried and dead leaves and stems ('litter') fall to the ground and decompose. Roots (which often have more biomass than above ground biomass) also grow, and some proportion of below ground roots dies and decomposes each year. Soil microorganisms assist in the decomposition of organic matter. Carbon from these sources is assimilated into soil carbon stocks. In rangelands, below ground carbon stocks are several times larger than aboveground carbon stocks. Some carbon is also emitted from soils to the atmosphere.

80. Management practices can increase soil carbon stocks by increasing inputs of organic matter to soils or by decreasing carbon losses. As rangelands degrade, soil carbon is generally lost to the atmosphere. Conversely, restoring degraded rangelands can sequester carbon. Livestock also emit methane created by ruminant digestion processes, and methane and nitrous oxide (also greenhouse gases) are emitted from animal manure. Because the density of livestock in extensive grazing systems is low, the amounts of soil carbon that can be sequestered are often many times higher than the amount that can be reduced from enteric fermentation. (Wilkes et al, 2013).

81. Apart from the link of rangelands to climate change mitigation, there is also a significant link with climate change adaptation. Past and future climate change reduces the productivity of rangelands and decreases food availability in winter, so that sustainable rangeland management becomes a critical adaptation issue and is included as such in Mongolia's Technology Needs Assessment under the UNFCCC, (Ministry of Environment and Green Development, 2013) along with other adaptation approaches promoted by ASDIP such as selective breeding and disease management. In general, there is a strong overlap between the ability to cope with climate change and the mitigation of greenhouse gas emissions in the livestock sector, as both hinge on better resource efficiency.

82. One reason to select the Western region of Mongolia for the first tranche of ASDIP is that the area relies on glacier melting for most of its water supply. Due to climate change, glaciers are melting off, resulting in a temporary increase of glacier water availability that partly compensates for reductions in other water sources. However, after the glaciers are melted, the region will face a water shortage. The ASDIP projects proposed reductions in livestock numbers will help to cope with the expected future reductions in water availability, and furthermore, the project will pilot technical approaches to enhance water availability (such as selective breeding for drought resistance, snow and water harvesting). However, it should be noted that there are also several other reasons for selecting the Western region of Mongolia for the first tranche, including the existence of the right pre-conditions for the ASDIP approach through the work carried out by SDC un pasture user groups and rangeland planning – as further described in the funding proposal and the main text of this feasibility study.

83. Section B discusses the literature on rangeland management and carbon sequestration in general, while Section C discusses the literature on rangeland management and carbon sequestration in regions with climatic and soil conditions similar to Mongolia. Section D discusses estimates of soil carbon sequestration by rangelands in Mongolia. Section E brings an added climate change adaptation perspective to rangeland management.

## B. Literature of grazing and rangeland carbon sequestration

84. Globally, rangelands account for a considerable carbon sink. Estimates are that 3.7 billion ha of rangeland and rangeland globally contain 306–330 billion tC in organic form and 470–550 billion tC in inorganic form (about 20–25% of the global terrestrial carbon (Kimble et al., 2001) with the potential to increase sequestration to as much as 1.1 billion $tCO_2e$/year (Lal, 2004).

85. While a reasonable summary, this statement does not give full credit to the differences in findings for different regions and ecosystems. As emphasized by He et al. (2011), across rangelands, the effects of livestock grazing on soil C storage are variable and inconsistent; depending on the system, these herbivores may facilitate or depress C sequestration rates. The different effects of grazing on soil C storage or sequestration may reflect variations in climate, soil, landscape location, plant community type, and grazing management practices. Moreover, changes in soil C levels over time during biotic community development may be strongly linked with soil N levels. Thus, the influence of grazing on soil C storage in grasslands varies by region.

86. The above suggests that in order to predict the impact of the proposed rangeland management practices including the reduction of herd sizes on soil carbon sequestration rates, it is necesary to more narrowly evaluate the literature on rangeland management and carbon sequestration in comparable circumstances.

## C. Rangeland soil carbon sequestration in Inner Mongolia

87. Both Han et al. (2008) and He et al. (2011) provide data on soil carbon sequestration from different grazing regimes in Inner Mongolia, China, with climatic conditions that are comparable to those encountered in the ASDIP project locations in Mongolia, although the ASDIP locations are somewhat colder and drier.

88. Han et al. (2008) consider dairy production systems involving light grazing (LG), medium grazing (MG) and heavy grazing (HG). They found that grazing and sampling depth affected soil organic carbon content. The soil organic carbon content was highest with LG (35.5, 25.2 and 21.7 g/kg soil for 0–10, 10–20 and 20–30 cm soil depths, respectively) and lowest for HG (29.5, 14.9 and 15.0 g/kg soil). The soil organic carbon content values for MG were in between those for LG and HG, but overall similar to LG (34.2, 24.6, and 20.8 g/kg soil).

89. Han et al. (2008) conclude that proper management of existing rangelands, or restoration of degraded rangelands through improved management, can sustain or increase soil C sequestration and contribute to mitigation of atmospheric $CO_2$ increases. They consider that in their study, the MG treatment could be construed as properly managed to sustain soil C stocks, whereas the HG treatment might be viewed as rangeland that could benefit from restoration and the LG treatment might even be regarded as underexploited.

90. He et al. (2011) focus on sheep grazing with seven sheep stocking rates, 0, 1.5, 3.0, 4.5, 6.0, 7.5, and 9.0 sheep per ha (hereafter designated SR0, SR1.5, SR3.0, SR4.5, SR6.0, SR7.5, and SR9.0, respectively) during a 5-year period.

91. The study showed that C sequestration rates (0–30 cm depth) were 59.6, 74.8, and 27.5 gC per $m^2$ per year in plots SR0, SR1.5, and SR3, respectively, demonstrating that light grazing may contribute to soil carbon sequestration over no grazing, but also that light grazing increases soil carbon sequestration over medium and heavy grazing. Note that the study's findings indicate that there exists a system transformation from soil C sequestration under low grazing to C loss under heavy grazing, and that the threshold for this transformation was 4.5 sheep per ha (grazing period from June to September).

92. These results mean that soil carbon sequestration from better rangeland management could be in the order of 50gC per $m^2$ per year (or 0.5 tC per hectare per year). This is more than 9 times the soil carbon sequestration rate assumed in the ASDIP project, which therefore makes quite conservative assumptions.

## D. Grassland sequestration projects in Mongolia

93. Wilkes et al. (2013) conducted a feasibility study for a rangeland carbon sequestration project in Tariat soum in Arkhangai aimag. Using a model calibrated for the region, they work through the carbon sequestration resulting from a 20% reduction in livestock numbers. Based on an area of 47,872 hectare, the study calculates annual emission reductions of 45,000 $tCO_2e$ per year, of which 88% due to soil carbon sequestration and the remained from avoided methane emissions. The corresponding soil carbon sequestration rate is 0.226 per hectare per year, or about 4 times the sequestration rate ASDIP assumes.

94. The '*Pastures, Conservation and Climate Action, Mongolia*' program is a program registered under Plan Vivo, managed by the Mongolian Society for Range Management, and developed by University of Leicester, Darwin Initiative, and Mongolian Society for Range Management. For the assessment of the carbon sequestration from better rangeland management practices it uses the approved Plan Vivo monitoring methodology '*Carbon sequestration through improved grassland and natural resources management in extensively managed grasslands*', which is annexed to the Project Design Document (Upton et al. 2015).

95. The predicted climate benefits in the PDD, modeled over a 4-year period, are about 109,569 $tCO_2$ from 77,482 hectares, for an expected sequestration rate of 0.096 tC per hectare per year, 1.75 times the projected carbon sequestration rate in the ASDIP project.

96. The projections in the '*Pastures, Conservation and Climate Action, Mongolia*' program can be assessed against actual performance, using the monitoring reports of the project (Mongolian Society for Range Management 2016 and 2018). Over a 3-year time period, 77,536 $tCO_2$ of carbon was sequestered in the program's area of 77,482 hectares, for a carbon sequestration rate of 0.091 tC per hectare per year, 1.65 times the assumed sequestration rate of the ASDIP project.

97. It is possible to conclude that the proposed ASDIP project activities are likely going to result in carbon sequestration, and that the assumptions made by ASDIP are conservative, underestimating the expected soil carbon sequestration thanks to the project.

# VI. ASDIP'S GHG MITIGATION IN RANGELANDS / ANIMAL HUSBANDRY SECTOR

## A. Introduction

98. This section contains a calculation of GHG emission reductions due to ASDIP's rangeland management activities. Calculations include (1) the impact on GHG emissions due to reduced methane emissions, (2) the impact on GHG emissions due to reduced nitrous oxide emissions and (3) the impacts on GHG emissions due to increased soil organic sequestration. For the first (methane) and third (soil carbon), two calculation methods have been used, one based on simple coefficients, and one based on the best possible application of the IPCC methodology. In both cases, the calculation with the lowest outcome (based on aimags targeted in the first tranche, Bayan-Ulgii, Khovd and Uvs) has been used as the most conservative estimate of the emission reductions due to ASDIP. For the selected calculation methods, this note also provides the estimates per aimag and the emission reductions from expanding ASDIP into potential "new" aimags during tranche 2 and 3 (Dornod, Govi-Altai, Sukhbaatar and Zavkhan, each under the assumption that 50% of the aimag's rangelands will be covered and assuming that within the area covered, 2/3$^{rds}$ of the mitigation potential will be realized).

## B. Methane emission reductions – coefficient approach

99. To calculate the impact of ASDIP on animal methane emissions in the livestock sector, livestock was converted to Sheep Head Units (SHUs) Mongolia's standard conversion:
1 Sheep = 1.0 SHU
1 Goat = 0.9 SHU
1 Horse = 7.0 SHU
1 Cattle = 6.0 SHU
1 Camel = 5.0 SHU

100. In the coefficient approach it was assumed that GHG emissions due to methane from livestock are approximately linear in the number of SHUs. This assumption undoubtedly is a simplification but enables a first order estimation of emission reductions due to reduced methane emissions resulting from ASDIP's implementation. The methane emission coefficient calculated based on the third national communications and the livestock data from the Mongolian Statistical Yearbooks published by the national statistical office equal 0.18 $tCO_2e$/SHU per year (with methane converted to carbon equivalent).

101. The first tranche of ASDIP will take place in three western aimags (Bayan-Ulgii, Khovd and Uvs). The latest Mongolian Statistical Yearbook gives the three western region's aimags animal numbers as follows:

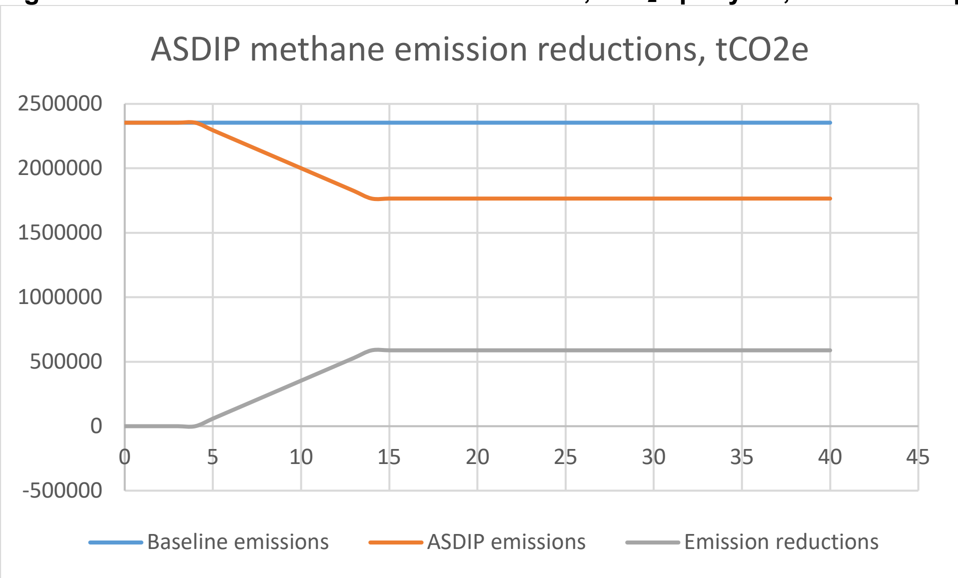
**Table 5. Animal numbers in the three western aimags, 2018.**

| Animal | Number | Conversion to SHU | In SHU |
|---|---|---|---|
| Sheep | 3,721,796 | 1.0 | 3,721,796 |
| Goat | 3,830,466 | 0.9 | 3,447,419 |
| Horse | 347,674 | 7.0 | 2,433,718 |
| Cattle | 532,519 | 6.0 | 3,195,114 |
| Camel | 56,145 | 5.0 | 280,725 |
| **Total** | 8,488,600 | | 13,078,772 |

*Source*: Statistical Yearbook 2018 and ADB consultant calculations.

102. The corresponding methane emissions are 2,354,179 $tCO_2e$ per year. For the baseline, it is assumed that livestock numbers stay at the 2018 level (and hence also methane emissions at about 2.35 million $tCO_2e$ per year). The ASDIP is expected to gradually reduce animal numbers, by 2.5 percentage point during a 10-year period (i.e. a 25% reduction overall), starting from the 5th year in. Eventually annual methane emissions in the three western aimags will then be reduced to 1,765,634 $tCO_2e$ per year, for annual emission reductions of 588,545 $tCO_2e$ per year. Figure 4 provides the baseline emissions, project emissions and emission reductions over a 40-year period. The accumulated number of GHG emission reductions due to avoided methane is 18.5 million $tCO_2e$.

**Figure 4. ASDIP methane emission reductions, $tCO_2e$ per year, coefficient approach.**




### C. Methane emission reductions – IPCC Tier 1 approach

103. An alternative calculation of the methane emission reductions is based on the IPCC Tier 1 approach as described in the IPCC Guidelines[31], using defaults that are applicable to Asia and cold climates. Methane emissions are the sum of emissions due to enteric fermentation and due to methane from manure. Defaults were taken from Tables 10.10 and 10.11 for enteric fermentation and Tables 10.14 and 10.15 for manure management.

104. The same numbers for herd sizes as above are used for the calculations, with the proviso that we have assumed that 10% of cattle is producing dairy. In this Climate Change Assessment we have used the 100-year global warming potential for methane, as reported in the fifth assessment report (28), but in the Funding Proposal and the attached emission reduction calculation sheet we have used the same GWP as used in Mongolia's latest reporting (the GWP from the second assessment report, (21). Table 6 summarizes the calculation results.

105. The corresponding methane emissions are 2,086,719 $tCO_2e$ per year. For the baseline, it is assumed that livestock numbers stay at the 2018 level (and hence also methane emissions at about 2.09 million $tCO_2e$ per year). The ASDIP is expected to gradually reduce animal numbers, by 2.5 percentage point during a 10-year period (i.e. a 25% reduction overall), starting from the 5th year in. Eventually annual methane emissions in the three western aimags will then be reduced to 1,565,039 $tCO_2e$ per year, for annual emission

[31] See IPCC's 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 10: Emissions from Livestock and Manure Management, in Volume 4, Agriculture, Forestry and Other Land Use, as amended from time to time.

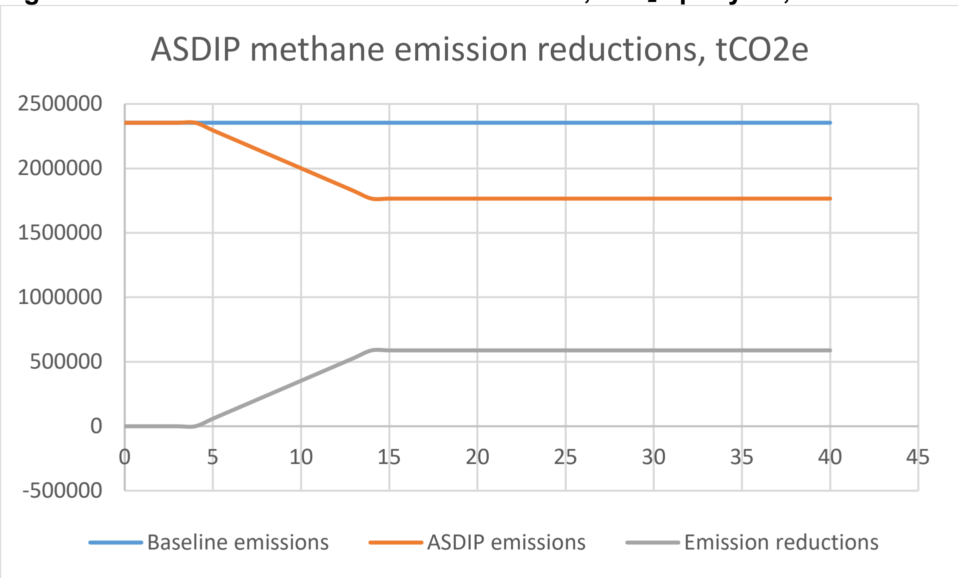
reductions of 521,680 $tCO_2e$ per year. Figure 5 provides the baseline emissions, project emissions and emission reductions over a 40-year period. The accumulated number of GHG emission reductions due to avoided methane is 16.4 million $tCO_2e$.

**Table 6. Methane emissions, baseline, IPCC Tier 1 method**

| Animal | Number | EF Enteric[32] | $tCH_4$ | $tCO_2e$ | EF manure[3] | $tCH_4$ | $tCO_2e$ | Total, tCO2e |
|---|---|---|---|---|---|---|---|---|
| Sheep | 3,721,796 | 5 | 18,609 | 521,051 | 0.10 | 372 | 10,421 | 531,472 |
| Goat | 3,830,466 | 5 | 19,152 | 536,265 | 0.11 | 421 | 11,798 | 548,063 |
| Camel | 56,145 | 46 | 2,583 | 72,315 | 1.28 | 72 | 2,012 | 74,327 |
| Horse | 347,674 | 18 | 6,258 | 175,228 | 1.09 | 379 | 10,611 | 185,839 |
| Cattle, diary | 53,252 | 68 | 3,621 | 101,392 | 1.00 | 53 | 1,491 | 102,883 |
| Cattle, other | 479,267 | 47 | 22,526 | 630,716 | 1.00 | 479 | 13,419 | 644,135 |
| ***Total*** | | | | ***2,036,966*** | | | ***49,753*** | ***2,086,719*** |

*Sources*: Mongolian Statistical Yearbook 2018, IPCC (2006) as amended, ADB consultant calculations.

**Figure 5. ASDIP methane emission reductions, $tCO_2e$ per year, IPCC Tier 1 approach.**




106. As the IPCC Tier 1 approach leads to the lower estimate of the emission reductions, we will use it throughout for the calculation of emission reductions resulting from reduced methane emissions, rather than the alternative coefficient approach.

## D. Nitrous oxide emission reductions – IPCC Tier 1 approach

107. The calculation of the nitrous oxide emission reductions is based on the IPCC Tier 1 approach as described in the IPCC Guidelines[33], using defaults that are applicable to Asia and cold climates. The nitrogen excretion rate is from Table 10.19 (data for Asia), and the animal weight is from Table 10A-9.

108. The same numbers for herd sizes as above are used for the calculations as for methane. We have used the 100-year global warming potential for nitrous oxide, as reported

[32] Expressed as $kgCH_4$ per head per year.
[33] See IPCC's 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 10: Emissions from Livestock and Manure Management, in Volume 4, Agriculture, Forestry and Other Land Use, as amended from time to time.

in the fifth assessment report (265) , but in the Funding Proposal and the attached emission reduction calculation sheet we have used the same GWP as used in Mongolia's latest reporting (the GWP from the second assessment report, (310). Table 7 summarizes the calculation results.

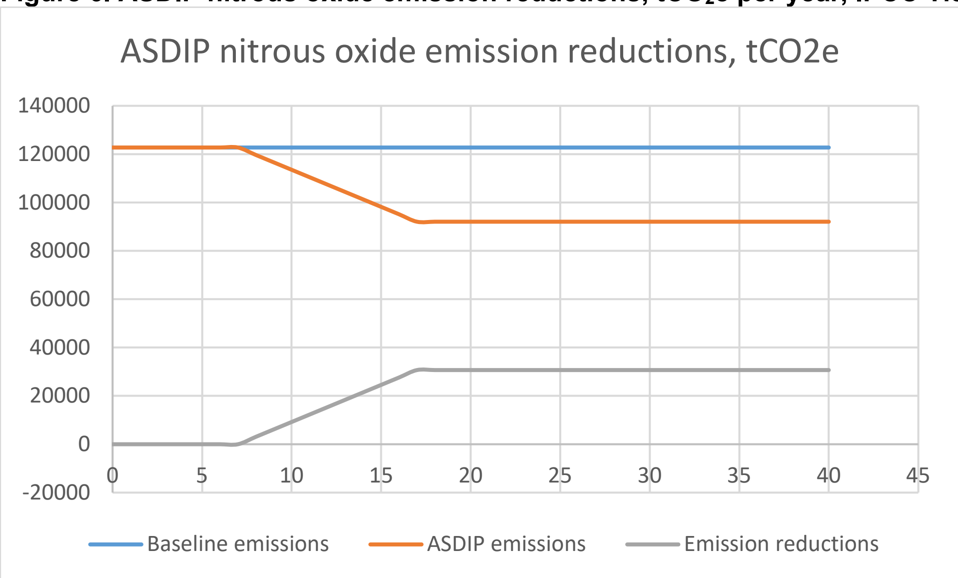
**Table 7. N2O emissions, baseline, IPCC Tier 1 method**

| Animal | Number | N excretion rate[34] | Typical animal weight (kg) | $N_2O$ per year per animal, t | $tN_2O$ emissions | $tCO_2e$ |
|---|---|---|---|---|---|---|
| Sheep | 3,721,796 | 1.17 | 28 | 0.000188 | 699 | 185,323 |
| Goat | 3,830,466 | 1.37 | 30 | 0.000236 | 903 | 239,291 |
| Camel | 56,145 | 0.46 | 217 | 0.000573 | 32 | 8,518 |
| Horse | 347,674 | 0.46 | 238 | 0.000628 | 218 | 57,855 |
| Cattle, diary | 53,252 | 0.47 | 350 | 0.000944 | 50 | 13,315 |
| Cattle, other | 479,267 | 0.34 | 319 | 0.000622 | 298 | 79,010 |
| ***Total*** | | | | | | **583,312** |

*Sources*: Mongolian Statistical Yearbook 2018, IPCC (2006) as amended, ADB consultant calculations.

109. The corresponding nitrous oxide emissions are 583,312 $tCO_2e$ per year. For the baseline, it is assumed that livestock numbers stay at the 2018 level (and hence also methane emissions at about 0.58 million $tCO_2e$ per year). The ASDIP is expected to gradually reduce animal numbers, by 2.5 percentage point during a 10-year period (i.e. a 25% reduction overall), starting from the 5th year in. Eventually annual methane emissions in the three western aimags will then be reduced to 437,484 $tCO_2e$ per year, for annual emission reductions of 145,828 $tCO_2e$ per year. Figure 6 provides the baseline emissions, project emissions and emission reductions over a 40-year period. The accumulated number of GHG emission reductions due to avoided nitrous oxide is 4.6 million $tCO_2e$.

**Figure 6. ASDIP nitrous oxide emission reductions, $tCO_2e$ per year, IPCC Tier 1 approach.**




## E. Soil carbon sequestration due to ASDIP, coefficient approach

110. The calculations of the amount of soil carbon sequestration (in tCO2) presented during the GCF concept note phase have been based on a coefficient approach. Based on several ADB TA projects, the experience-based coefficient of 0.05454 tC per hectare per year, over a

[34] In kg N per 1000 kg animal mass per day.

20 years period, has been used. After the 20 year period a steady state is reached, and no further emission reductions are assumed to occur.

111. This coefficient approach has been developed in 2013 within the Climate Technology Finance Center (a cluster TA of the ADB) based on several technical assistance reports prepared for TA 7534-REG Strengthening Carbon Financing for Regional Grassland Management in Northeast Asia and underlying academic literature at the time. As part of a wider assessment of the rangeland sequestration potential in north Asia, studies available at that time on rangeland soil carbon potentials in areas that are similar to Mongolia and the northern part of PRC (arid and semi-arid climates with cold winters) have been collected and analyzed.

112. Based on the data collected, it was found that lowest boundary of the available studies corresponded to 4tCO2/hectare in sequestration before the onset of a new steady state (after which soil carbon stabilizes and no further sequestration occurs. To provide a conservative estimate of the potential, this number has been used for planning purposes.

113. In the coefficient approach as it was crystalized over time, two further adjustments have been made. In line with the IPCC and reflecting the fact that carbon is not stored in the ground as $CO_2$ but as different forms of carbon, the coefficient approach was reformulated as tC/hectare.

114. Secondly, originally a conservative assumption was used that the steady state would be reached after 40 years, reflecting the slow pace of biogeochemical processes in cold climates. Later this was revised to 20 years, to be in line with the IPCC methodology. While this change in assumption on the dynamics of the adjustment processes does not affect the total estimate of the carbon sequestration potential, it does affect the annual emission reductions during the period of adjustment.

115. Based on the assumptions outlined above, the coefficient approach can be summarized as a sequestration during 20 years, equal to a sequestration per hectare of 4 (= total sequestration potential in $tCO_2$) divided by 44/12 (conversion to tC) divided by 20 (period of adjustment to new steady state). 4 / (44/12) / 20 = 0.05454 (rounded downward).

116. Subsequently this coefficient approach has for instance been used in reports prepared under TA 8109-REG, Integration of Climate Technology Financing Needs into National Development Strategies, Plans, and Investment Priorities, and among others has been used in the first projections of soil carbon sequestration potentials included with the first drafts of the Partnership for Rangeland Management note (see Box 10 of the FP for a current draft).

117. Sequestration potential can be estimated by multiplying area with coefficients, taking into account how reductions in animal numbers (and hence reduction of grazing pressure) are phased in over time. This is a straightforward calculation.

118. Applying this coefficient to the pastureland area of Bayan-Ulgii, Khovd and Uvs (12,894,000 hectares) leads to an estimate of soil carbon sequestration of 51,570,842 $tCO_2e$ over a 20 years period from the full implementation of ASDIP. The annual soil carbon sequestration is, at its peak, close to 2.6 million $tCO_2e$.

119. It should be mentioned that because of the way this approach has been developed, it should be expected that projected sequestration potentials using this approach form a lower boundary, and that emission estimates using alternative approaches (see for example section F) will result in substantially higher estimates. Furthermore, the discussion in Section 6

confirms that the intended conservativeness of the approach is still maintained, even with new information and studies becoming available.

## F. Soil carbon sequestration due to ASDIP, IPCC Tier 1 approach

120. In this section, we provide an estimate of soil carbon sequestration due to ASDIP rangeland's activities using IPCC Tier 1 methodology using IPCC defaults.[35] The central equation used in the Tier 1 methodology are equations 2.24 and 2.25 of the IPCC,[36] replicated and renumbered below for convenience, while splitting 2.25 into two (equations 2a and 2b respectively).

$$\Delta C_{Soils} = \Delta C_{Mineral} - L_{Organic} + \Delta C_{Inorganic} \quad \textbf{(1)}$$

In which:

| | | |
|---|---|---|
| $\Delta C_{Soils}$ | = | annual change in carbon stocks in soils, tC per year |
| $\Delta C_{Mineral}$ | = | annual change in organic carbon stocks in mineral soils, tC per year |
| $L_{Organic}$ | = | annual loss of carbon from drained organic soils, tC per year |
| $\Delta C_{Inorganic}$ | = | annual change in inorganic carbon stocks from soils, tC per year |

121. $\Delta C_{Inorganic}$ is assumed to be 0 unless using a Tier 3 approach, and hence will be assumed zero here. Furthermore, $L_{Organic}$ is irrelevant because we are focusing on mineral soils.

$$\Delta C_{Mineral} = \frac{(SOC_0 - SOC_{(0-T)})}{D} \quad \textbf{(2a)}$$

In which:

| | | |
|---|---|---|
| $\Delta C_{Mineral}$ | = | annual change in organic carbon stocks in mineral soils, tC per year |
| $SOC_0$ | = | soil organic carbon stock in the last year of an inventory time period, tC |
| $SOC_{(0-T)}$ | = | soil organic carbon stock at the beginning of the inventory time period, tC |
| T | = | number of years over a single inventory time period, yr |
| D | = | Time dependence of stock change factors which is the default time period for transition between equilibrium SOC values, yr. Commonly 20 years, but depends on assumptions made in computing the factors FLU, FMG and FI. If T exceeds D, use the value for T to obtain an annual rate of change over the inventory time period (0-T years). In our calculations below, D and T are 20 years. |

122. $SOC_0$ and $SOC_{(0-T)}$ are calculated using equation 2b where the reference carbon stocks and stock change factors are assigned according to the land-use and management activities and corresponding areas at each of the points in time (time = 0 and time = 0-T)

$$SOC = \sum_{c,s,i} \left( SOC_{REF_{c,s,i}} \cdot F_{LU_{c,s,i}} \cdot F_{MG_{c,s,i}} \cdot F_{I_{c,s,i}} \cdot A_{c,s,i} \right) \quad \textbf{(2b)}$$

In which:

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[35] See IPCC's 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 6 Grassland, in Volume 4, Agriculture, Forestry and Other Land Use, as amended from time to time, and including references therein.

[36] See IPCC's 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 2 Generic Methodologies Applicable to Multiple Land-Use Categories, in Volume 4, Agriculture, Forestry and Other Land Use, as amended from time to time.

c, s, i represents the climate zones, the soil types, and the set of management systems that are present in a country respectively.
$SOC_{REF}$ = the reference carbon stock, tC per hectare (Table 2.3 in Chapter 2 of Volume 4 of the IPCC Guidelines)
$F_{LU}$ = stock change factor for land-use systems or sub-system for a particular land-use, dimensionless
$F_{MG}$ = stock change factor for management regime, dimensionless
$F_I$ = stock change factor for input of organic matter, dimensionless
A = land area of the stratum being estimated, ha. All land in the stratum should have common biophysical conditions (i.e., climate and soil type) and management history over the inventory time period to be treated together for analytical purposes.

123. The application of these equations is simplified by the limited variation in climate zones and sole types in the three western aimags. Referring to Table 2.3 of the IPCC guidelines, only cold temperate, dry climate and sandy soils are relevant. Hence $SOC_{REF}$ = 34 tC/hectare. For the baseline, we make the assumption that $F_{LU}$, $F_{MG}$, $F_I$ and A all stay constant. Hence the begin and end stock of soil carbon will be equal, and emissions zero. This is a conservative assumption (ignoring ongoing land deterioration and the impact of the forecasted water scarcity in the three western aimags) that will underestimate the impact of the ASDIP intervention on additional sequestration.

124. For the ASDIP intervention, we need to specify the current state and the forecasted end state, 20 years in the future. $F_{LU}$ equals 1.0 at the begin and end of the period, based on Table 6.2 in Chapter 6 of the IPCC methodology. $F_I$ has been set to 1.0 for both timepoint as well, not taking into account some irrigation and water management activities of ASDIP which could be considered improvements (see also the discussion of $F_{MG}$ where this is even more pertinent). Again, this underestimates the impact of ASDIP.

125. The total area of rangelands in the three western aimags covered by ASDIP is 12,894,000 hectares. In our projections, we assume that this total amount remains constant, but that there will be a shift in management, and as a result of that, a shift in the applicable stock change factor for management regime, $F_{MG}$. The following table provides the relevant excerpts from Table 6.2 in Chapter 6 of the IPCC guidelines, which define the type of information on the rangelands of the three western aimags needed to implement this assessment strategy.

**Table 8. Excerpts from Table 6.2, IPCC, in relation to $F_{MG}$.**

| Factor | Level | Climate regime | IPCC default | Error | Definition |
|---|---|---|---|---|---|
| Management ($F_{MG}$) | Nominally managed (non-degraded) | All | 1.00 | NA | Represents non-degraded and sustainably managed grassland, but without significant anagement improvements. |
| Management ($F_{MG}$) | Moderately degraded grassland | Temperate / boreal [a] | 0.95 | ±13% | Represents overgrazed or moderately degraded grassland, with somewhat reduced productivity (relative to the native or nominally managed grassland) and receiving no management inputs. |
| Management ($F_{MG}$) | Severely degraded | All | 0.70 | ±40% | Implies major long-term loss of productivity and vegetation |

| Factor | Level | Climate regime | IPCC default | Error | Definition |
|---|---|---|---|---|---|
| | | | | | cover, due to severe mechanical damage to the vegetation and/or severe soil erosion. |
| Management ($F_{MG}$) | Improved grassland | Temperate / boreal [a] | 1.14 | ±11% | Represents grassland which is sustainably managed with moderate grazing pressure and that receive at least one improvement (e.g., fertilization, species improvement, irrigation). |

[a]: data for tropical climates left out as not relevant for our purposes.

126. The best source of data on rangelands in Mongolia is the National report on the rangeland health of Mongolia of 2018.[37] This source defines 5 levels of rangeland health, and reports what percentage of Mongolian rangelands fit with each category. The following table summarizes:

**Table 9. Summary of rangeland categories in the Mongolian rangeland health assessment report**

| Category | Definition | % of rangelands (2016) |
|---|---|---|
| I | **Non degraded** - All dominants are in place. | 42.30% |
| II | **Slightly degraded** - Key dominant are still dominating, some grazing sensitive forbs are in decline and grazing resistant species are in increase. | 13.50% |
| III | **Moderately degraded** - Dominants are in decline and replaced by other subdominants, number of species drops down. | 21.10% |
| IV | **Heavily degraded** - Remnants of key species are thinning, and abundance of degradation indicator species increases. | 12.80% |
| V | **Fully degraded** - Total vegetation cover is reduced or dominated by very few degradation indicator species. | 10.30% |

127. It should be noted that the rangeland health assessment report paints a relatively rosy picture of the health of the Mongolian rangelands. For example, the third Mongolian national communication to the UNFCCC mentions that 76.8% of Mongolian territory has been affected by desertification and land degradation and that 82% of Mongolian land is natural pastureland, which means that a much lower percentage of the rangelands are assumed to be non-degraded than in the health assessment report (less than 30% non-degraded).

128. In using the data from the Mongolian health assessment for our calculation, we assume that the description for Mongolia as a whole is also representative for the three western aimags (noting also the expected water shortage due to disappearance of glaciers, this is a conservative assumption), and that the health assessment categorization 'matches' the IPCC classification as follows:

129. Finally, we assume that in the ASDIP scenario, because of the ASDIP interventions to restore rangeland health, nominally managed rangeland (non-degraded rangeland) will remain non-degraded rangeland, that moderately degraded rangeland will improve to non-degraded rangeland, and that severely degraded rangeland will improve to moderately

[37] Densambuu, B., S. Sainnemekh, B. Bestelmeyer, U. Budbaatar. 2018. National report on the rangeland health of Mongolia: Second Assessment. Green Gold-Animal health project, SDC; Mongolian National Federation of PUGs. Ulaanbaatar.

degraded rangeland. We will assume that no rangeland will be upgraded to improved rangeland, ignoring the irrigation and improved water management components from the project, and so underestimating soil carbon sequestration thanks to ASDIP.

**Table 10. Matching rangeland health assessment and IPCC categories**

| Rangeland health assessment | IPCC category |
|---|---|
| I | Nominally managed (non-degraded) |
| II and III | Moderately degraded grassland |
| IV and V | Severely degraded |
| No match found | Improved grassland |

130. Based on the above, the calculation of soil carbon sequestered at the begin and end of the 20-year period assumed (D = T = 20) proceeds as in Table 11.

**Table 11. Calculation of soil carbon sequestration, in tons of carbon**

| Begin of period | | | | | End of period | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Percentage | Hectares | $F_{MG}$ | $SOC_{REF}$ | tC | Percentage | Hectares | $F_{MG}$ | $SOC_{REF}$ | tC |
| 42.30% | 5,454,162 | 1.00 | 34 | 185,441,508 | 42.30% | 5,454,162 | 1.00 | 34 | 185,441,508 |
| 13.50% | 1,740,690 | 0.95 | 34 | 56,224,287 | 13.50% | 1,740,690 | 1.00 | 34 | 59,183,460 |
| 21.10% | 2,720,634 | 0.95 | 34 | 87,876,478 | 21.10% | 2,720,634 | 1.00 | 34 | 92,501,556 |
| 12.80% | 1,650,432 | 0.70 | 34 | 39,280,282 | 12.80% | 1,650,432 | 0.95 | 34 | 53,308,954 |
| 10.30% | 1,328,082 | 0.70 | 34 | 31,608,352 | 10.30% | 1,328,082 | 0.95 | 34 | 42,897,049 |
| **100.00%** | **12,894,000** | | | **400,430,906** | **100.00%** | **12,894,000** | | | **433,332,526** |

131. As a result of ASDIP, the total amount of carbon sequestered into the three western aimags of Mongolia will increase from 400,430,906 tC to 433,332,526 tC (see the bottom row in Table 11), an increase of 32,901,620 tC over a 20-year period, or an annual sequestration of 1,645,081 tC/year. In the more commonly used figures of $tCO_2$, the total sequestration is 120,639,273 $tCO_2$ and the annual sequestration 6,031,964 $tCO_2$/year.

132. Using the same approach country wide and setting $F_{MG}$ on the right side of the table to 1.00 throughout, leads to an estimate of the total shortfall of carbon sequestration compared to the theoretical potential (1.12 billion tCO2e).

133. As the coefficient approach described in Section E leads to a lower estimate of the emission reductions, we have used this approach to make conservative projections of the amount of emission reductions due to soil carbon sequestration.

134. Using this assumption, the total soil carbon sequestration potential of Mongolia's rangelands can be calculated as over 440 million $tCO_2e$, from over 110 million hectares of rangelands.

135. It should be noted that our method leads to a conservative assumption of the reduction potential per hectare over the 40 year period: 4 tCO2/hectare in the ASDIP projections using the coefficient, 9.4 when using IPCC Tier 1, and for comparison in the case of the approved GCF funding proposal FP116 (Kyrgyz Republic), over 23. The reasons that nevertheless the GHG sequestration projections come out so high is because of the very large area of rangelands in Mongolia (even when concentrating solely on three Western aimags). It should be noted that the high sequestration potential confirms information from literature, as summarized in an earlier section of this Climate Change Assessment.

## G. Total GHG emission reductions from rangelands and livestock due to ASDIP

*Breakdown of emission reductions by Tranche 1 aimag*

136. The following table provides a breakdown of basic data per aimag. On the basis of these data, Tables 13 and 14 provide the estimates of annual emission reductions at full scale and the emission reductions over a 40 year period respectively, using the IPCC Tier 1 method for methane and nitrous oxide (as described in Sections C and D, see in particular Tables 6 and 7, in which the first column is replaced with data from Table 12, with the proviso that we have assumed that 10% of cattle is producing dairy) and using the coefficient method for carbon sequestered in grasslands, as described in Section E.

**Table 12. Input data per aimag**

| Variable | Bayan-Ulgii | Khovd | Uvs |
|---|---|---|---|
| Rangeland area (hectares) | 3,538,800 | 5,063,400 | 4,291,800 |
| Sheep (number) | 979,601 | 1,174,233 | 1,567,962 |
| Goat (number) | 930,404 | 1,624,603 | 1,275,459 |
| Horse (number | 95,349 | 128,538 | 123,787 |
| Cattle (number) | 155,914 | 193,683 | 182,922 |
| Camel (number) | 5,649 | 25,351 | 25,145 |

*Sources*: Animal numbers are from Mongolian Statistical Yearbook 2018, rangeland area MOFALI-JICA data.

**Table 13. Annual greenhouse gas emission reductions at full scale, in thousand $tCO_2e$**

| Variable | Bayan-Ulgii | Khovd | Uvs |
|---|---|---|---|
| Soil carbon sequestration | 708 | 1013 | 858 |
| Avoided methane emissions | 138 | 194 | 191 |
| Avoided nitrous oxide emissions | 38 | 55 | 53 |
| ***Total*** | ***883*** | ***1261*** | ***1102*** |

*Source*: ADB consultant calculations

**Table 14. Project greenhouse gas emission reductions, in thousand $tCO_2e$, 40 years**

| Variable | Bayan-Ulgii | Khovd | Uvs |
|---|---|---|---|
| Soil carbon sequestration | 14,154 | 20,252 | 17,165 |
| Avoided methane emissions | 4,333 | 6,096 | 6,004 |
| Avoided nitrous oxide emissions | 1,186 | 1,723 | 1,684 |
| ***Total*** | ***19,673*** | ***28,070*** | ***24,854*** |

*Source*: ADB consultant calculations

137. The projected 40-years greenhouse gas emission reduction estimates take into account the gradual introduction of measures to reduce the number of animals, as described in Section C.

138. Figures 7-9 present the emission reductions in Bayan-Ulgii, Kovd and Uvs graphically, while Figure 10 shows the development of the accumulative emission reductions in the three aimags.

**Figure 7. ASDIP annual emission reductions, Bayan-Ulgii, 1000 $tCO_2e$.**

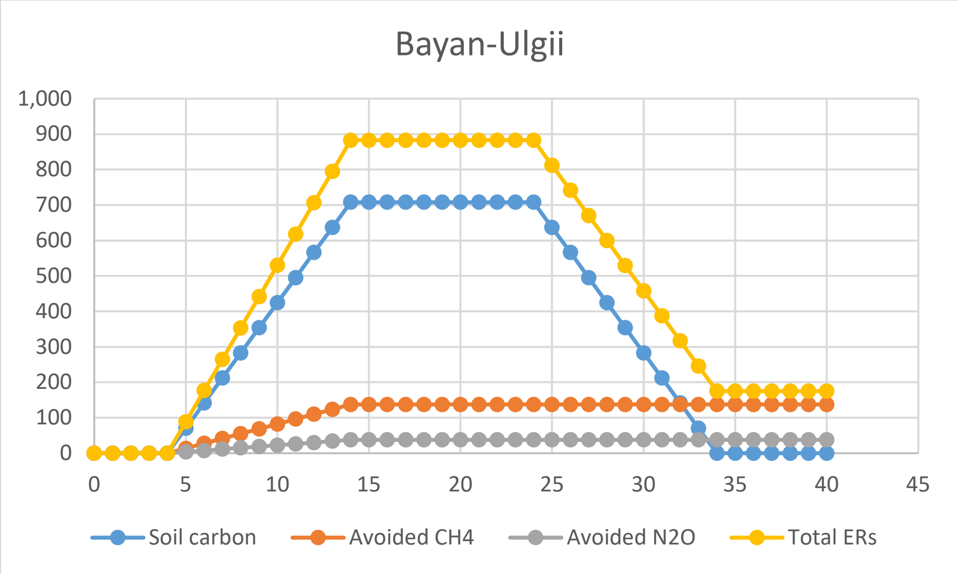



**Figure 8. ASDIP annual emission reductions, Khovd, 1000 $tCO_2e$.**

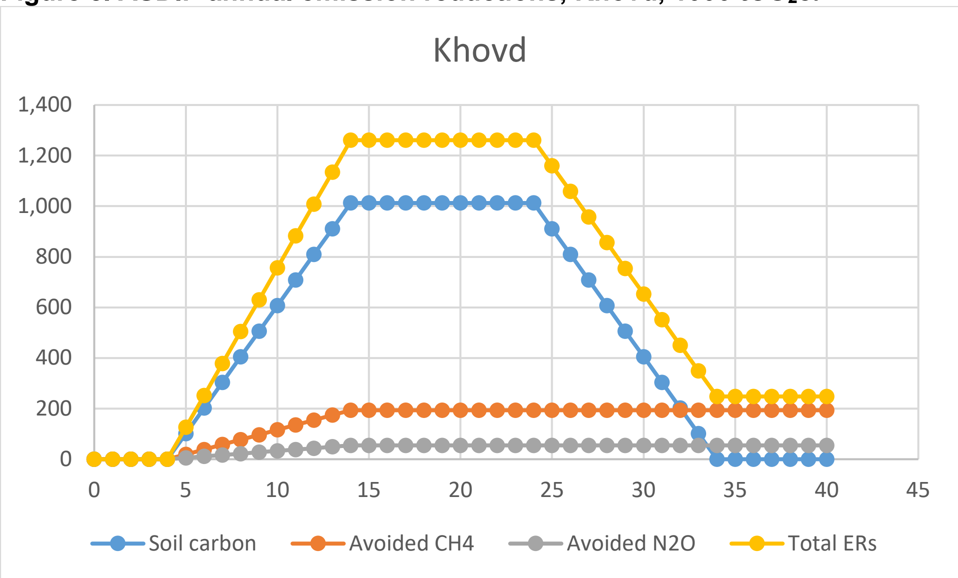


**Figure 9. ASDIP annual emission reductions, Uvs, 1000 $tCO_2e$.**

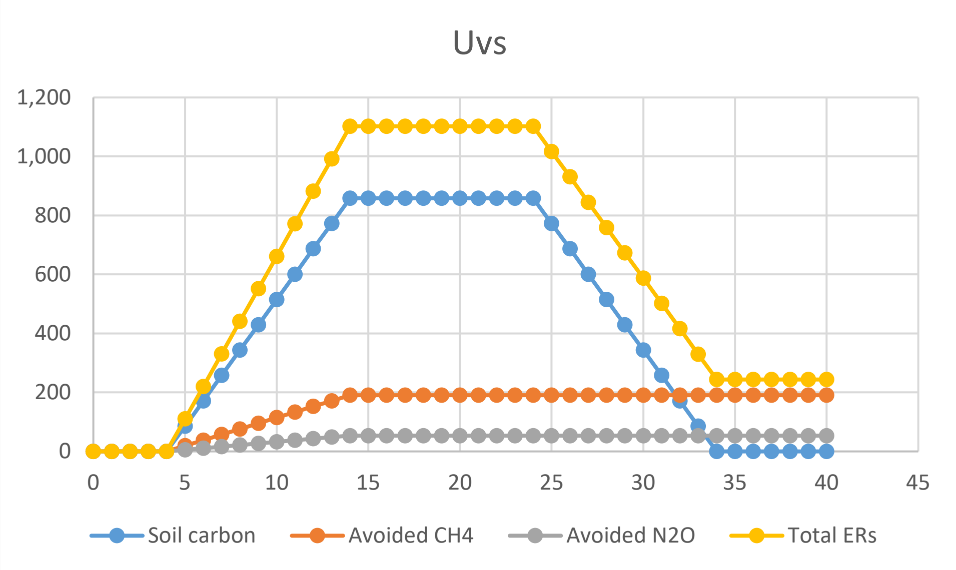
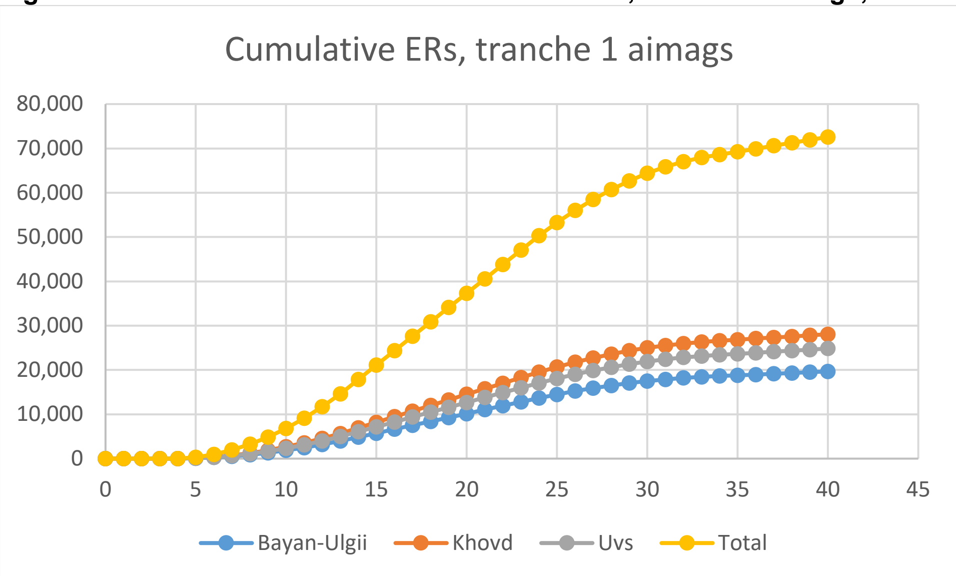



**Figure 10. ASDIP cumulative emission reductions, tranche 1 aimags, 1000 $tCO_2e$.**




*Emission reductions from potential tranches 2 & 3 aimags*

139. During the 2nd and 3rd tranches, ASDIP will among others seek to capitalize on work carried out by development cooperation partners that ASDIP could build on and help to scale up. The aimags were such follow up activities will be carried out by ASDIP have not been determined yet. The final selection will be based on the initial work that has been done and the conditions for successful support by ASDIP. To get a handle about the potential emission reductions from the activities in these additional aimags, this section concentrates on Dornod, Govi-Altai, Sukhbaatar and Zavkhan.

140. It is assumed that ASDIP will only be able to target 50% of the animal numbers and grassland areas and reach 2/3 of the potential GHG emission reductions. Table 15 provides the input data used, Table 16 the annual emission reductions, and Table 17 provides the greenhouse gas emission reductions, assuming that the changes in animal numbers are phased in from the 8th year onwards, at 2.5 percentage point per year, reaching a reduction of 25% in animal numbers (as before).

**Table 15. Input data per aimag, replication aimags**

| Variable | Dornod | Govi-Altai | Sukhbaatar | Zavkhan |
|---|---|---|---|---|
| Rangeland area (hectares) | 8,653,700 | 8,609,100 | 7,671,000 | 6,925,700 |
| Sheep (number) | 1,147,685 | 1,057,674 | 1,922,127 | 1,827,458 |
| Goat (number) | 702,084 | 2,196,797 | 1,207,486 | 1,292,671 |
| Horse (number | 278,811 | 129,999 | 327,342 | 222,534 |
| Cattle (number) | 243,140 | 85,225 | 251,639 | 204,995 |
| Camel (number) | 6,063 | 43,670 | 8,217 | 7,753 |

*Sources*: Animal numbers are from Mongolian Statistical Yearbook 2018, rangeland area MOFALI-JICA data.

**Table 16. Annual GHG emission reductions at full scale, in thousand $tCO_2e$, replication aimags**

| Variable | Dornod | Govi-Altai | Sukhbaatar | Zavkhan | Total |
|---|---|---|---|---|---|
| Soil carbon sequestration | 577 | 574 | 511 | 462 | 2,124 |
| Avoided methane emissions | 64 | 59 | 82 | 72 | 277 |
| Avoided nitrous oxide emissions | 14 | 17 | 20 | 18 | 69 |
| ***Total*** | ***655*** | ***651*** | ***614*** | ***552*** | ***2,472*** |

*Source*: ADB consultant calculations

**Table 17. Project GHG emission reductions, in thousand $tCO_2e$, 40 years, replication aimags**

| Variable | Dornod | Govi-Altai | Sukhbaatar | Zavkhan | Total |
|---|---|---|---|---|---|
| Soil carbon sequestration | 11,537 | 11,478 | 10,227 | 9,233 | 42,475 |
| Avoided methane emissions | 1,811 | 1,691 | 2,342 | 2,049 | 7,893 |
| Avoided nitrous oxide emissions | 452 | 553 | 642 | 583 | 2,230 |
| ***Total*** | ***13,800*** | ***13,722*** | ***13,211*** | ***11,865*** | ***52,598*** |

*Source*: ADB consultant calculations

141. The total Tranche 1 amount of GHG emission reductions from rangelands due to ASDIP is the sum of the amount of sequestration (in $tCO_2$), the avoided methane emissions (in $tCO_2e$), each calculated in the most conservative manner, and the avoided nitrous oxide emissions (in $tCO_2e$): 51.6 million plus 16.4 million plus 4.6, 72.6 million $tCO_2e$. The total GHG emission reductions from animal husbandry and carbon sequestered in rangelands in tranche 2 & 3 is 52.6 million $tCO_2e$. The total amount of GHG emission reductions in the sector is therefore equal to 72.6 million tCO2e + 52.6 million tCO2e = 125.2 million tCO2e.

142. Note that the number reported in the funding proposal is lower, due to different GWP assumptions requested by GCF (use of GWPs reported in AR2 rather than AR5) and due to a reduction in the time period over which emission reductions are claimed (up to 20 years after the investments have been completed leading to the emission reductions instead of the economic lifetime). Under these assumptions, the amount of carbon sequestered in rangelands is 94.05 million tCO2e and the amount of emission reductions thanks to reduce GHG emissions from animals (methane and nitrous oxide) is 17.22 million tCO2e. Total emission reductions from the sector is 111.3 million tCO2e. Details of the emission reductions and carbon sequestration calculations are provided in the ER calculation spreadsheet (Annex 17 of the Funding Proposal).

# VII. MITIGATION THROUGH NON-AGRICULTURAL INVESTMENTS

143. ASDIP has a series of components that will lead the GHG mitigation, including solar streetlighting, solar panels on rooftops, improved insulation, efficient heat supply (together urban projects), avoided transport movements thanks to relocation of processing facilities closer to the point of need, and wastewater treatment. In addition, ASDIP includes several construction activities, which will give rise to construction emissions, road improvements, which may lead to increased emissions from road transport, and commercial investments, which may result in increased emissions during their use.

144. The paragraphs below outline how the GHG emission reductions and emissions from these non-agricultural mitigation components of the project will be calculated. Details are provided in the Emission Reductions Calculation spreadsheet (Annex 17).

## A. Urban emission reductions

*Solar rooftops*

145. ASDIP will involve the installation of about 10 MW of solar rooftop capacity. To calculate GHG emission reductions thanks to this component of ASDIP, we make the following assumptions:

- Lifetime 20 years
- Effective operating hours 1000
- Emission factor 1.272 tCO2/MWh.[38]

146. Based on the above assumptions, the lifetime emission reductions can be calculated as 20 x 10 x 1000 x 1.272 = 254,400 tCO2e.

*Solar streetlights*

147. ASDIP also involves the installation of 0.209 kWp solar streetlights. The assumptions for the calculation of the lifetime GHG emission reductions are the same as above. The GHG emission reductions can therefore be calculated as 20 x 0.209 x 1000 x 1.272 = 5,317 tCO2e.

*Improved insulation*

148. ASDIP furthermore includes improved insulation for an estimated 204,331 $m^2$ of buildings. Baseline energy consumption is 300 $kWh/m^2$ per year, which will improve to 140 $kWh/m^2$ per year in the ASDIP case. Energy supply is through lignite, with an average efficiency of 50%. Lignite has a CO2 coefficient of 101. Lifetime of the insulated buildings is 40 years. Therefore, the GHG emission savings can be calculated as 40 x 160 x 204331 x 3.6 x 101 / (1000000 * 0.5) = 950,973 tCO2e.

*Efficient heat supply*

149. ASDIP also includes efficient heat supply, improving from 50% efficiency to 80% efficiency. The total capacity installed is 90.46 MW (thermal). Operating hours is 4380. Fuel used is lignite with emission coefficient 101. Lifetime is 40 years. Annual emission reductions are (90.46 * 4380) / 50% * 3.6 / 1000 * 101 - (90.46 * 4380) / 80% * 3.6 / 1000 * 101 = 108,000 tCO2. Over a 40 year period, emission reductions are 4.3 million tCO2.

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[38] IFI Technical Working Group on GHG Accounting (2019), *The IFI Dataset of Default Grid Factors v.2.0*.

150. Summing, the total GHG emission savings through the urban components of the project equals 5.5 million tCO2e. Taking into account a maximum time horizon of 40 years (which cuts of some of the emission reductions from ASDIP investments, as these are implemented over a number of years and not all completed in year 0), the urban emission reductions are 4.62 million tCO2e.

## B. Other non-agricultural emission reductions

*Avoided transport movements.*

151. ASDIP involves the construction of processing facilities closest to the point of need. This leads to a reduction of transport movements, because instead of animals, products can be transported. The total number of kilometers of transport avoided per year is 23.3 million km (rounded). Mileage is 0.18 liter/km, diesel density is 0.832 kg/l, net calorific value is 42.6 GJ/t and the emission coefficient is 74.1 tCO2/TJ. Annual emission reductions are calculated as 23,300,000 * 0.18 * 0.832 * 42.6 * 101 / 1000000 = 11,010 tCO2/y. Economic lifetime of the investments is 50 years, however, for ADB emission reductions have been curtailed at year 50, and for GCF at year 40. Taking into account the phasing in of the investments, total GHG emission reductions are 506,490 tCO2 (ADB) respectively 396,383 tCO2 (GCF).

*Avoided GHG emissions from wastewater treatment*

152. ASDIP involves the construction of aerobic wastewater treatment plants, avoiding GHG emissions from anaerobic lagoons. Wastewater treatment capacity for 900 $m^3$/day will be constructed in agroparks (mainly dealing with slaughterhouse waste, restricted to a 72 days slaughtering period). At aimag centers, wastewater treatment capacity of 21900 $m^3$/day will be constructed, with mean daily temperatures above 15°C during 91.25 days. For the agropark, chemical oxygen demand (COD) of inflow and outflow are assumed to be 5000 and 125 mg/l, for the aimag centers, 250 and 25 mg/l. The methane correction factor is 0.8, uncertainty correction 0.94, the methane producing capacity for the wastewater is 0.21 kg CH4/kg COD, and the GWP of methane is 21 (AR2).

153. For agroparks, annually avoided emissions can be calculated as 900 * 72 * (5000-125) * 0.8 * 0.94 * 0.21 * 21 / 1000000 = 1,048 tCO2e/y. For the aimag centers, annually avoided emissions can be calculated as 21900 * 91.25 * (250-25) * 0.8 * 0.94 * 0.21 * 21 / 1000000 = 1,491 tCO2e/y. The total is 2539 tCO2e/y. Economic lifetime of the investments is 50 years, however, for ADB emission reductions have been curtailed at year 50, and for GCF at year 40. Taking into account the phasing in of the investments, total GHG emission reductions are 116,783 tCO2 (ADB) respectively 91,395 tCO2 (GCF).

# VIII. LEAKAGE EMISSIONS DUE TO ASDIP INVESTMENTS

154. Leakage emissions are, according to the IPCC[39]:
*“Phenomena whereby the reduction in emissions (relative to a baseline) in a jurisdiction/sector associated with the implementation of mitigation policy is offset to some degree by an increase outside the jurisdiction/sector through induced changes in consumption, production, prices, land use and/or trade across the jurisdictions/sectors. Leakage can occur at a number of levels, be it a project, state, province, nation or world region. [Formatted and our emphasis added]*
*In the context of Carbon Dioxide Capture and Storage (CCS), CO2 leakage refers to the escape of injected carbon dioxide (CO2) from the storage location and eventual release to the atmosphere. In the context of other substances, the term is used more generically, such as for methane (CH4) leakage (e.g., from fossil fuel extraction activities) and hydrofluorocarbon (HFC) leakage (e.g., from refrigeration and air-conditioning systems).” {WGIII}.* The text referring to physical leakage of GHGs has been added for completeness and is not relevant for our purposes.

155. Potential leakage effects considered by ASDIP are: 1) leakage effects through non-agricultural activities catalyzed by the project (including emissions during construction, emissions from the use of roads, and emissions from business activities and infrastructure supported by ASDIP), 2) leakage effects within the rangeland targeted by the project, and 3) leakage effects due to expansion of herds outside of project areas. Below we discuss each in turn.

*Leakage emissions from construction*

156. ASDIP contains several construction activities. Emission from the construction activities have been calculated according to a methodology that has been described in Annex 2. Total emissions due to constructions have been estimated as 149,202 tCO2e.

*Leakage emissions from use of investments in enterprises (GIRAF)*

157. To estimate emissions from the use of investments in enterprises, we have used a detailed feasibility study for a slaughtering house, calculated the expected emissions, and related the emissions to the investment needed. Assuming a fixed ratio between investments and annual emissions, we get annual emissions from the use of ASDIP enterprise investments of 25,342 tCO2/y. Economic lifetime of the investments is expected to be 50 years and this time horizon has been used by ADB. However, for the GCF emission have been curtailed at year 40 to be in line with the emission reductions calculations (according to GCF recommendations), resulting from rangeland and animal husbandry related activities of ASDIP. Accounting for the phasing in of the investments, total GHG emission from enterprise investments are 1,191,066 tCO2 (ADB: 50 years) respectively 937,647 tCO2 (GCF: 40 years).

*Leakage emissions from output 2 investments*

158. To estimate emissions from the use of investments in the agricultural sector in output 2, we have conservatively assumed the same coefficient between the total investment amount and annual emission reductions as for the enterprises through GIRAF. This is quite

[39] IPCC (2014): Annex II: Glossary [Mach, K.J., S. Planton and C. von Stechow (eds.)]. In: *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, pp. 117-130. It should be noted that the CDM uses a very similar definition, as stated in Section D.1 of the funding proposal.

conservative (hence overestimating emissions), because many of the investments will have no energy needs for operations (e.g., shelters) or will rely on renewable energy sources (e.g., solar pumps for water wells). This is contrary to the slaughterhouse on which the coefficient used has been based (coal use for heating, power use from the grid). Assuming a fixed ratio between investments and annual emissions, we get annual emissions from the use of ASDIP agricultural investments (Output 2) of 10,042 $tCO_2/y$. Economic lifetime of the investments is expected to be 50 years and this time horizon has been used by ADB. However, for the GCF emission have been curtailed at year 40 to be in line with the emission reductions calculations (according to GCF recommendations), resulting from rangeland and animal husbandry related activities of ASDIP. Accounting for the phasing in of the investments, total GHG emission from agricultural investments of Output 2 are 471,961 $tCO_2$ (ADB: 50 years) respectively 371,544 $tCO_2$ (GCF: 40 years).

*Leakage emissions from ASDIP road improvements*

159. ASDIP will improve 226.7 km of roads. To arrive at an estimate of emissions due to use of roads improved by ASDIP, a coefficient was calculated of the average road transport emissions in Mongolia per km improved road. Data from 2014 was used: Road transport emissions were 1,674.49 $ktCO_2$ (Third National Communication), while the total length of improved roads was 9,428.2 km (Statistical Yearbook 2016). Average emissions per km of improved road was 117.6 $tCO_2/km$. This amount has been assumed to grow by 2% per year, to get an annually increasing amount of GHG emissions per km of improved road, with which the ASDIP length of roads improved by ASDIP has been multiplied.

160. Economic lifetime of the investments is expected to be 50 years, however, for ADB emission have been curtailed at year 50, and for GCF at year 40. Taking into account the phasing in of the investments, total GHG emission from roads improved by ASDIP are 3,697,723 $tCO_2$ (ADB) respectively 2,557,167 $tCO_2$ (GCF).

161. It should be noted that this calculation method overestimates the amount of emissions. Compared to Mongolian averages, the ASDIP project locations have few people and few cars, and the roads are mostly improved existing roads rather than new roads. No allowance has been made of lower emissions from existing traffic resulting from improved roads. Finally, historically the emissions per km of improved road have been decreasing rather than increasing by 2% as assumed in our calculations. For all these reasons, actual emissions from the use of ASDIP approved roads is likely to be lower than estimated, and the net emission reductions from ASDIP have been conservatively underestimated.

*Leakage emissions from rangeland management / animal husbandry – targeted rangelands*

162. Potential leakage within targeted PUG rangelands is prevented though the signing of the RUA by all the PUG herder households that are traditionally using the same pasture (see Box 1 for background information on rangeland boundaries). The RUA is enforced by the PUG members and the local government. It is a binding agreement among herders who are traditionally sharing a same rangeland resource. Enforced RUA will allow to stop conflict between herders, define more sustainable grazing practices, and set a destocking schedule and herd composition based on the rangeland carrying capacity. The rangeland area ruled by the RUA is not open to other herders who cannot bring their herds in the PUG's rangeland. Also, with the RUA, non-participating herders and herders in participating PUGs cannot use rangelands unaccounted for in ASDIP. Within the project areas, all rangeland use is covered. Finally, ASDIP will not lead to excess animals that can/will be grazed elsewhere (excess animals will be slaughtered, while an additional measure to reduce population is a change in reproduction strategy).

**Box 1. Elaboration of the project boundary of the carbon sequestration activities.**

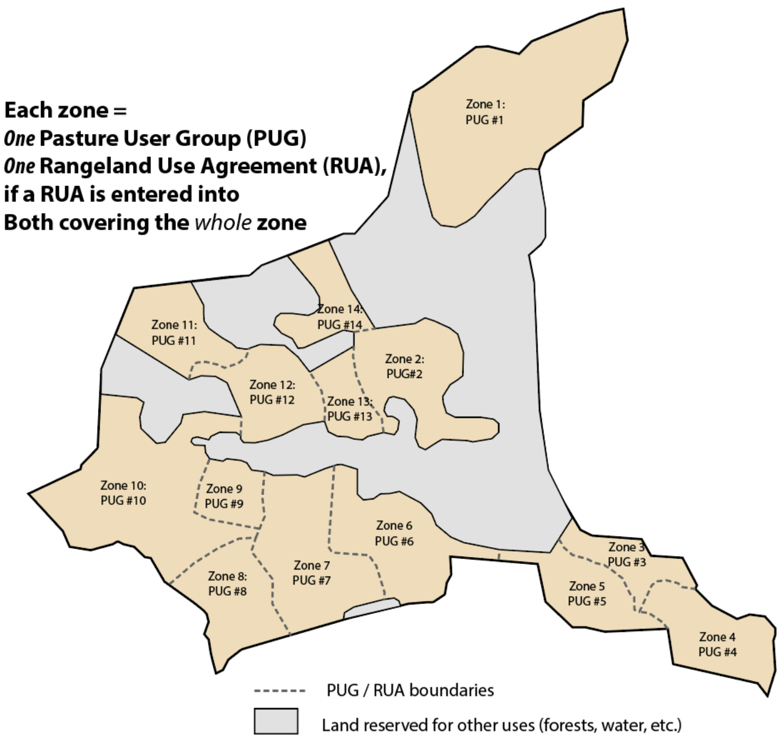
Only rangelands in the participating aimags/provinces for which Pasture User Groups (PUGs) have signed rangeland use agreements (RUAs) are part of the project boundary for carbon sequestration activities. The project boundary corresponds to all rangelands that belong to a PUGs with signed RUAs in the participating aimags and soums. Within the areas covered by the ASDIP, all rangelands that are covered by a specific RUA belong in their entirety within the given project boundary; all rangelands for which no RUA has been signed belong in their entirety outside the given project boundary.

The PUG boundaries are defined based on traditional practices as well as geographic constraints. Traditionally, herders constitute “saakhalt ails”, meaning, “group of neighboring herders”, which share common rangelands. The constitution of a PUG is a formalization of these traditional herder groups, and the RUAs are based on these territorial divisions by PUGs.

The soum (administrative sub-division of a Province/Aimag) is the first territorial administrative entry point for rangeland use management. The area of available rangeland in a soum is divided into several zones, each zone being attributed to one PUG as may be formalized through a RUA.

In the sketch 1 below, the soum is divided into 14 PUG zones. Each PUG zone is clearly delineated and altogether the 14 PUG zones cover all the soum’s rangelands; in other words, all rangelands of the soum are attributed to PUGs.  Each zone corresponds to one PUG and one RUA (if a RUA is entered into). For further discussion, it is useful to define each zone as a rangeland.

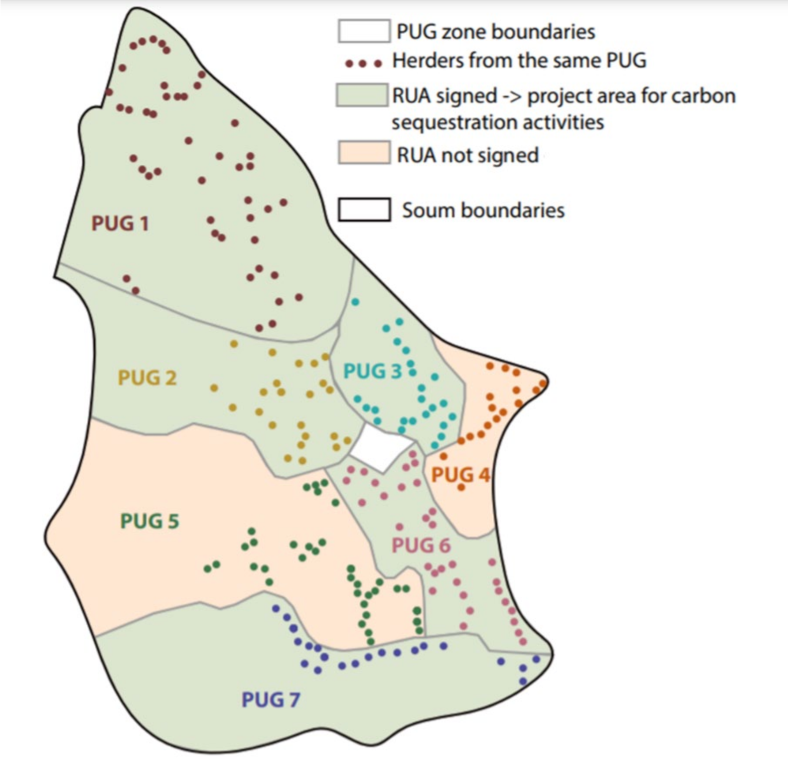
<u>Sketch 1– Land management</u>




The allocation of land is made in a way that any rangeland is used by a PUG, and each PUG has rangeland.

Within ASDIP, as a first step, a similar map of the PUG territories will be obtained or realized by the technical assistance, clearly identifying PUG boundaries, based on Green Gold work at the grassroots level. Following this step, the participation of all the herder households of a given zone in the formal PUG establishment, and subsequent the signing of the RUA by all herder households of the given zone, will provide the basis for the carbon sequestration activities to operate.

Sketch 2 – Illustration of possible area for carbon sequestration activities




*In sketch 2 above, PUGs number 1, 2, 3, 6 and 7 sign RUA. They benefit from carbon sequestration activities. PUGs 4 & 5 do not sign RUAs and receive technical assistance only. These PUGs do not benefit from carbon sequestration activities. As a result, in green is the project area for carbon sequestration activities, and in orange is the project area for TA support and output 2 activities, related to animal health control.*[40]

As such the full mitigation and adaptation impact is obtained when the RUA are signed, implemented and sustained. ASDIP has activities and mechanisms to initiate, incentivize, enforce and sustain the establishment of PUG and the signing of RUA. These activities/mechanisms are implemented at various level depending on the level of readiness of each PUG, going from low to high levels of readiness.

The rangelands belonging to a soum targeted by ASDIP form a mosaic of rangeland zones (zones indicated in sketch 1). Each zone is defined as a rangeland. As mentioned above, the allocation of rangeland use is made in a way that any rangeland is used by one PUG only (only one PUG has the enforceable use rights over that rangeland), and each PUG has a rangeland. Therefore, any rangeland within the targeted ASDIP soums:

[40] Animal health related components must cover the entire aimags to prevent from animal disease outbreaks. These activities cannot be limited to the project area for carbon sequestration activities, as any animal disease outbreak in adjoining territories would have negative impacts on the targeted territories for carbon sequestration activities too. It can be noted that there are two levels of interventions regarding veterinary services: at the PUG level, one Community-based Animal Health Worker (CAHW) will be trained to deliver veterinary assistance and raise herders' awareness. At the intersoum and aimag center level: Veterinary laboratories (for animal health control and food safety) will be built, to be used by private veterinary clinics, as well as veterinary inspection equipped rooms for animal health check prior to animals' admission in the disease-free establishments. These services will benefit all herders from targeted aimags. Traceability systems will also be implemented at the aimag level.

(i) Either belongs in its entirety to the project boundary for carbon sequestration activities, in the case where the PUG has signed a RUA for this rangeland;
(ii) OR is in its entirety outside the project boundary for carbon sequestration activities, in the case where the PUG has not signed a RUA for this rangeland (but still will benefits from technical assistance support and animal health activities – see footnote 40 below sketch 2).

For all the rangelands of a soum to be considered as project boundary for carbon sequestration activities, it is required that each PUG of this soum has signed a RUA. However, the signing of RUA will be done on a voluntary basis, through a consultation and negotiation process to ensure buy-in by the herder communities. This process will be phased-in, depending on the willingness and the readiness of each PUG to participate.

**Prevention of usage of RUA rangelands by outside herder groups.**

As explained above, the project boundary is specifically defined by the signing of the RUA. Therefore, within the ASDIP targeted areas the project boundary corresponds to the boundary of PUGs with signed RUAs. This solidifies the use rights of participating herder and clearly prevents the use of the rangeland within the RUA by outsider herders. **Specific clauses in the RUAs prevent uses of the rangeland by non-PUG herders or other activities** (such as extractive industries). Through the Rangeland Use Agreement, the State remains the owner of the land, the PUG members gain long-term use rights, and the State's responsibility is to enforce the RUA and to prevent uses by other (non-signatory) herders / other uses of the land. The RUAs are legally recognized documents, which means that there are legal recourses if the RUAs are violated, i.e., if one of the two parties (PUG and/or the soum government) does not comply with the stated duties, for example, if the soum government does not take action against trespassing by migrating herders.

Templates and existing examples of RUAs wherein these details are outlined are provided in the TRTA Final Report, Volume III. Some relevant sections in the RUAs are highlighted below:

In the RUA section "rights and duties of the state":
"- To take measures to migrate out outsider-herders out who brought his/her livestock to contracted pasture area without permission;
- To make sure that the pasture is or shall not be allocated to, and used, by others"

In the RUA section "rights and Duties of the User":
"-Demand stopping trespassing by others into pasture or long stay/grazing without official permission or agreeing;

In the RUA section "Prohibitions"
"-The user shall be prohibited to (…) either permitting to enter or subletting for grazing of the pasture by livestock owned by non-member person/s;
- Without decision by the general meeting, no Parties shall sublet or assign the land under the winter and spring campsite/s and the pasture allocated under this Agreement or part of it to pledge for income generation as collateralizing, selling, giving away or renting;
-No Parties shall assign, pledge, rent or sell the pasture and other assets and equipment accompanied as a whole or part of them".

In summary, the RUA will serve to protect the PUG members and recognize them as users of the rangelands, that should not be used by other herders, or for other uses such as mining.

For more details, please refer to TRTA Final Report, Vol III, Annex 1 and its appendices.

163. Perhaps it is again useful to reiterate the point made in the funding proposal (Table 3, and Annex 19 to the funding proposal) – the set of incentives is comprehensive and in the case of several mechanism permanent (e.g. protection of rights to rangeland through a signed and binding RUA, access to marketing channels, profit sharing in processing facilities funded through GIRAF). It is not a piecemeal approach that covers only a small percentage of the herders in the targeted areas, in which case the possibility of leakage might be more plausibly

argued. Rather, it is comprehensive and cover all user of a given set of rangelands, through the PUGs and the signed RUAs.

*Leakage emissions from rangeland management / animal husbandry – non ASDIP areas*

164. Autonomous increases in herd populations in areas not covered by ASDIP are not leakage because these are changes that are not induced by ASDIP. It should be noted that if these occur, the government can take action, and furthermore, taken action becomes easier because of the demonstration of economically and commercially viable ways to reduce herd sizes (within the project area), together with a method for potentially mobilizing funding to address the issues (The Partnership for Low-Carbon Rangeland Management in Asia).

165. Only induced increases in herd populations in areas not covered by ASDIP can be considered leakage emissions. So only increases in herd populations that are somehow triggered by ASDIP could result in leakage emissions. However, this does not apply to Mongolia. ASDIP does not result in increased or more favorable opportunities for non-beneficiaries outside of the project area. In this context there are no rational reasons for herders outside the project area to expand their herds because of ASDIP. No additional animals become available for grazing outside the ASDIP areas, because excess animals will be slaughtered. No additional land becomes available for grazing. Indirect impacts through demand and supply are negligible, because the reduction in animals is compensated for by an increase in productivity of the herd, so that supply remains roughly constant. There is no drop in supply that could trigger a price increase for output and hence spark increased grazing elsewhere.

166. These considerations made ASDIP confident that a fair *ex ante* estimate of leakage emissions in the rangelands and animal husbandry sector would be zero. However, this initial assessment was then checked against the treatment of leakage in the various Clean Development Mechanism (CDM) baseline and monitoring methodologies. Nothing in the review changed the *ex ante* estimate, rather the original assessments were confirmed. It is notable for example that CDM EB (2013), in discussing leakage in afforestation and reforestation projects, notes that:

*"Leakage emission attributable to the displacement of agricultural activities due to implementation of an A/R CDM project activity is estimated as the decrease in carbon stocks in the affected carbon pools of the land receiving the displaced activity. (…)*
*Increase in GHG emission occurring outside the project boundary attributable to the secondary effects of the A/R CDM project activity (e.g. changes in demand, supply or price of goods) is considered insignificant for the purpose of this tool and hence accounted as zero."*

167. The quote above confirms and strengthens our assessment that such secondary effects, working through supply and demand, may be considered zero in the context of the ASDIP project. Note that in the case of A/R CDM projects the impacts on markets are several orders of magnitude larger than in the case of ASDIP, because a certain area of land will be taken out of agricultural production, hence causing a significant change in supply, whereas in the case of ASDIP, rangelands remain in production, admittedly with a lower stocking rate, but with a higher herd productivity, so that the impact on supply is much more marginal (and unclear in sign).

168. Another point is experience in implementing similar projects. For example, the much smaller-scale Plan Vivo Project "*Pastures, Conservation and Climate Action, Mongolia*" did not encounter any occurrence of leakage during the 4-years period for which monitoring results are available. It would therefore seem very reasonable to use an *ex ante* leakage estimate of zero.

169. It can be concluded that nothing in ASDIP affects the decision calculus of herders outside of the project area, no matter whether this calculus is based on subsistence considerations, on commercial considerations, or on a mix of these two. Herders outside the project area (whether it is in the same rangeland or in another rangeland outside the project rangeland, but see Box 12), will NOT increase herd size because of the ASDIP project. Any increase in herd size that will occur in those herder groups will be the normal baseline increase since they are not receiving benefits from ASDIP. Therefore, based on IPCC definition of leakage, this source of leakage emissions does not apply here.

170. On the contrary, ASDIP will result in increased herd productivity and a change in quality, controlled by the certification system, that will incentivize other areas to adopt the same model to access to more profitable commercial value chain through knowledge transfer and financial and market incentives created by the GIRAF. More knowledge will become available on the profitability of reducing herd sizes, Mongolian government will have access to an improved toolkit to achieve animal reduction goals and the GIRAF will support commercial investments conditioned to compliance with low carbon and resilient sustainable rangeland management practice.

171. A final point to emphasize is that the emission reduction and leakage emissions have all been carried out in a conservative manner, underestimating the mitigation impacts of ASDIP. For example, apart from assuming a rather low sequestration per hectare (see Section VI), also a conservative effectiveness factors has been included, which further downward adjusts emission reduction estimates.

172. While we are confident in our assessment of zero leakage, it is something that needs to be monitored and confirmed. In the MRV section below we have included provisions for the monitoring of leakage.

*Summary*

173. The following table summarizes the emissions and emission reductions thanks to ASDIP according to the GCF requirements. Rangeland carbon sequestration is 94.0 million $tCO_2$, reduction of methane and nitrous oxide emissions from animals is 17.2 million $tCO_2e$, urban emission reductions are 4.6 million $tCO_2e$, and total emission reductions 116.4 million $tCO_2e$. Leakage emissions are 4.0 million $tCO_2$. Net emission reductions are 112.4 million $tCO_2e$.

**Table 18. Summary of emissions and emission reductions resulting, GCF requirements.**

| **GHG source of emissions / emission reductions** | **Cumulative emissions / emission reductions ($ktCO_2e$)** |
|---|---|
| Carbon sequestered in rangelands | 94,046 |
| Emission reductions from animals ($CH_4$ and $N_2O$) | 17,223 |
| Urban emission reductions | 4,621 |
| Emission reductions from avoided transport | 396 |
| Emission reductions from wastewater treatment | 91 |
| ***Subtotal emission reductions*** | ***116,378*** |
| Leakage emissions from construction | -149 |
| Leakage emissions from ASDIP improved roads | -2,557 |
| Leakage emissions from ASDIP enterprise investments | -912 |
| Leakage emissions from agricultural investments (Output 2) | -372 |
| Leakage emissions from rangelands / livestock | 0 |
| ***Subtotal ASDIP leakage emissions*** | ***-3,980*** |
| **Net ASDIP emission reductions** | **112,398** |

# IX. MRV

174. All MRV procedures that ASDIP intends to use are based on existing methodologies that have been developed and documented in detail. Rather than copying and pasting the detailed instructions here, we have prepared a zip-file with the documentation of the MRV methods ASDIP proposed to use.

175. MRV of rangeland related GHG emission reductions can be based on a variety of approaches, including the IPCC guidelines and the use of existing monitoring methodologies such as those included in the Plan Vivo PDD (see Appendix 8), which ADB intends to use, or alternatively the very comparable Verra (previously called VCS) methodology, Approved VCS Methodology VM0026, Version 1.0, dated 22 April 2014, Sectoral Scope 14: “Sustainable Grassland Management”. **The reason for selecting the Appendix 8 of the Plan Vivo PDD as proposed monitoring methodology is that it has been developed for Mongolia and has already been successfully applied to a project in Mongolia**. A summary of the monitoring methodology has been included as an Annex to this Climate Change Assessment (Annex 1). Notably, the monitoring methodology includes a module concerned with monitoring leakage (Module 3). In addition to this module, the monitoring will also collect and analyze statistical data to identify potential occurrences of leakage (see below)

176. Significant infrastructure exists that can be used for monitoring purposes. The National Agency for Meteorology and Environmental Monitoring (NAMEM) is the institution responsible for nationwide rangeland monitoring covering 1516 monitoring sites representing all baghs in Mongolia. NAMEM has achieved significant progress to i) institute measurement of internationally-accepted core indicators that are standardized nationally; ii) develop a reference database of different rangeland types that provides a basis for interpreting monitoring data and determining what is “healthy” or “degraded”(ecological site descriptions); and iii) build capacity to produce a timely outlook on rangeland health based on monitoring data.

177. Comparisons of existing rangeland monitoring methodologies used by different Mongolian institutions (Research institutes; Universities; Ministry of Environment and Tourism; Ministry of Food, Agriculture and Light Industry; National Agency for Meteorology and Environmental Monitoring and the Agency for Land Management, Geodesy and Cartography led to an agreement on unified set of core indicators that will reduce controversy in assessments of rangeland health into the future. Core indicators include foliar canopy cover, species composition, and basal gaps of perennial plants, plant height, and biomass. Measurement methods include line-point intercept, gap intercept, air dry biomass at 1 cm clipping height, and photo points. A methodology for rapid characterization of soils to identify ecological sites and a concept for developing simplified ecological site descriptions that match existing herder concepts (see below) were also agreed upon. The newly standardized methodology is repeatable, precise, and simple enough for easy use. The method can not only be used to report rangeland health at a point in time (assessment), but also provide precise estimates of rangeland change over the long-term (monitoring). As of 2011, the new methodology and indicators were approved by the Government as a nationwide monitoring methodology of rangeland health.

178. Additionally, extensive information is collected on rangeland use, grazing patterns, stock composition, etc. These data are collected through the monitoring of the Rangeland User Agreements signed with the Pastureland User Groups.

179. What has been missing so far is the link between the monitoring of rangeland health and the monitoring of rangeland management on the one hand, and soil carbon stocks on the other hand. Models such as the Century model can play a role in this regard, but it is important to calibrate the model based on local data. Additionally, it is important to link data from

rangeland health monitoring points with soil carbon. To complement the existing data collection methods, it is therefore important to measure soil carbon at a sample of the monitoring points established by NAMEM, both inside and outside the project boundary, and throughout the project implementation. For this purpose, the methodology described in He et al (2011)[41] can be used.

180. ASDIP, in its 4th output, provides considerable attention to the question of proper monitoring of soil carbon sequestration, and will ensure that accurate numbers are collected and reported. This is also important given the objective to crowd in result-based funding from non-GCF sources for improved rangeland management.

*Statistical analysis to identify leakage*

181. In addition to the leakage monitoring provisions in the Plan Vivo methodology, ASDIP will also collect and analyze statistical data on livestock population by soum through Mongolia. Potential leakage would show up as an increase in livestock population in soums not included in ASDIP relative to the baseline (a trendline based on historical data). A positive deviation from the trend which is stronger in soums that are in closer proximity to ASDIP signal potential leakage, which can then be confirmed through further surveys. On the other hand, a negative deviation from the trend which is stronger in soums that are in closer proximity to ASDIP signal potential *negative leakage*, a replication of project results outside the ASDIP area. Such potential *negative leakage* would be an added source of emission reductions, but for reasons of conservativeness will be reported separately and not as an ASDIP emission reduction.

182. For MRV of livestock related emissions (as opposed to grassland soil carbon sequestration), ADB proposes to use the relevant equations contained in Chapter 10 of Volume 4 of the IPCC Guidelines. Mongolia collects extensive data on livestock, ensuring that accurate calculation of emissions and emission reductions are possible.

183. For urban mitigation components, we propose to use:

- For solar rooftops and solar streetlighting, the JCM methodology mentioned above. Main monitoring requirements include the installed capacity and the power generation.
- For insulation, MRV will be conducted in line with the approved small-scale CDM methodology Energy efficiency and fuel switching measures for buildings Version 10.0.[42]
- It is proposed not to monitor the emission reductions resulting from the wastewater treatment plants and the avoided transport, as these are less than 1% of the overall net emission reductions. We will report these as zero which is conservative. If this is not acceptable to the GCF, applicable CDM methodologies will be used for monitoring (e.g., ACM14, AMS-III.BO).

[41] He, N. P., Y. H. Zhang, Q. Yu, Q. S. Chen, Q. M. Pan, G. M. Zhang, and X. G. Han (2011). Grazing intensity impacts soil carbon and nitrogen storage of continental steppe. *Ecosphere* **2** (1)

[42] See CDM EB. 2007. AMS-II.E *Indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories Energy efficiency and fuel switching measures for buildings* Version 10.0. CDM EB of the UNFCCC. Bonn.

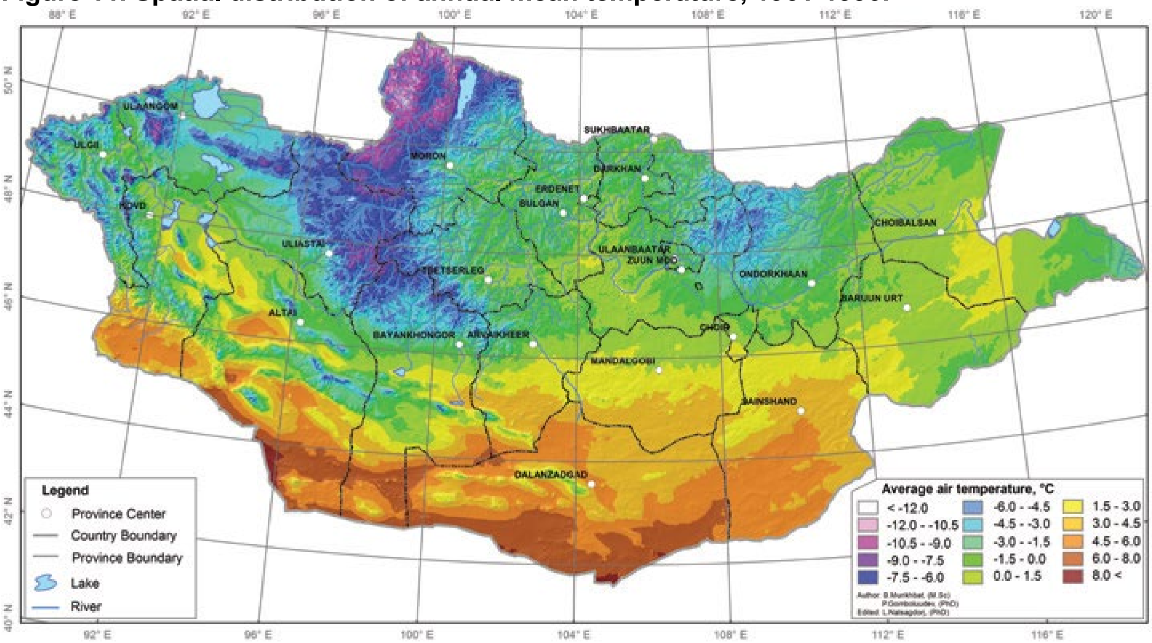
# X. CLIMATE CHANGE ADAPTATION RATIONALE

## A. Introduction: Mongolia's climate[43]

184. Mongolia has a harsh continental climate due to its geographic location in the central Eurasian continent far away from the tempering influence of seas. It is a large landlocked country (Mongolia's total land area is 1,564,116 km2); surrounded by high mountains with an average altitude of 1.5km. It has high seasonality with four very distinct seasons. The annual mean temperature is between -8℃ and 6℃, and the annual mean precipitation is between 50 mm (Gobi Desert) and 400 mm (Northern mountain district).

185. The spatial distribution of the annual mean temperature in the period 1961-1990 is included in Figure 11, while the spatial distribution of monthly mean temperature in January and July is included in Figure 12 respectively Figure 13.

**Figure 11. Spatial distribution of annual mean temperature, 1961-1990.**




*Source*: Ministry of Environment and Tourism (2018), *Mongolia Third National Communication under the United Nations Framework Convention on Climate Change*, p. 55.

186. The annual mean air temperature is about -4°C in the Altai, Khangai, Khentii and Khuvsgul mountains ranges, -6-8°C in the depressions between mountains ranges and along the valley of big rivers, 2°C in the steppe-desert region, while the mean annual temperature exceeds 6°C in the southern part of Mongolia.

187. The monthly mean temperature in the coldest month, January, is about -30-34°C in the valleys of Altai, Khangai, Khuvsgul and Khentii mountains, -20-25°C in the steppe region and -15-20°C in the south of Mongolia.

188. The warmest month is July and its mean temperature is slightly lower than 15°C in Altai, Khangai, Khuvsgul and Khentii mountain ranges, 15-20°C in the Great Lake depressions

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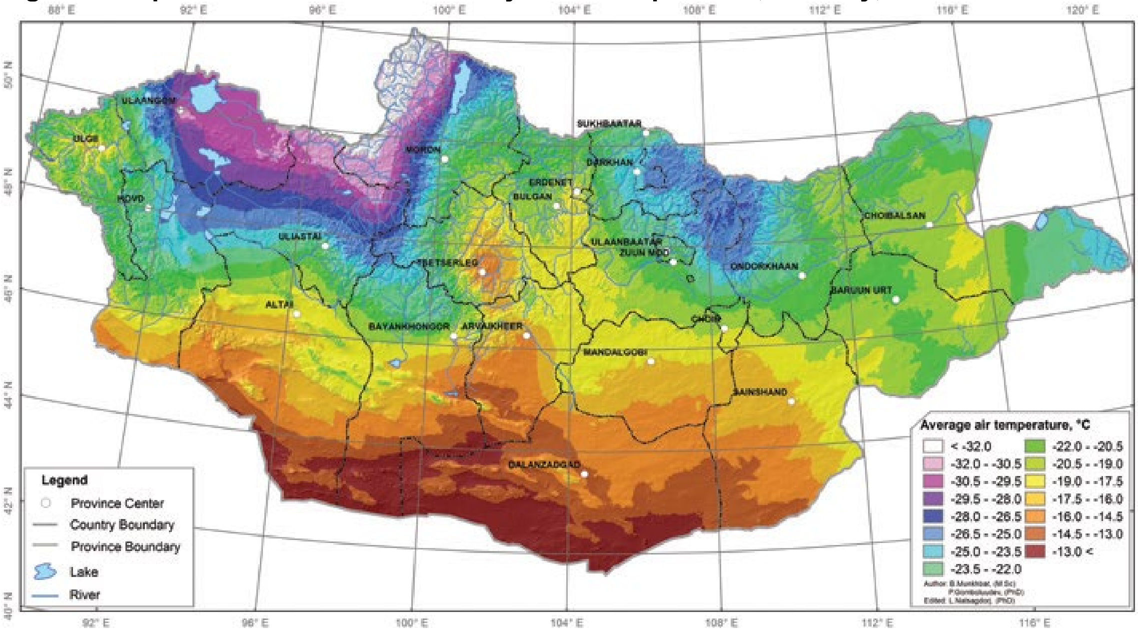
[43] This section draws on Mongolia's third national communication to the UNFCCC. See Ministry of Environment and Tourism (2018).

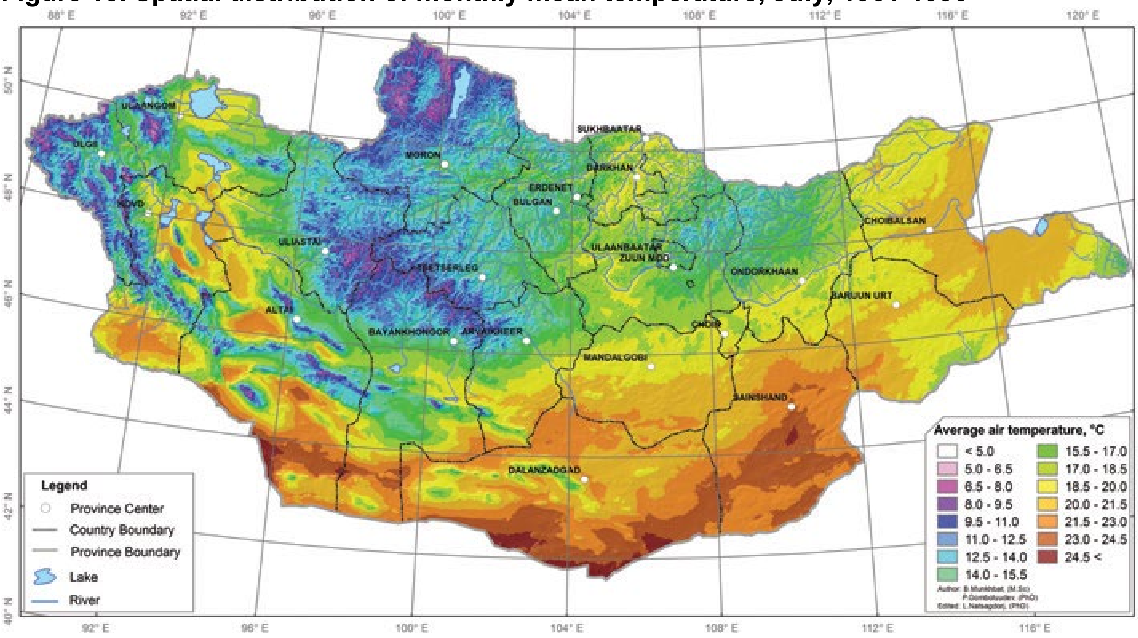
and valleys between Altai, Khangai and Khuvsgul mountains and also Orkhon-Selenge river basins and 20-25°C in eastern steppe and southern Gobi and desert regions.

**Figure 12. Spatial distribution of monthly mean temperature, January, 1961-1990**




*Source*: Ministry of Environment and Tourism (2018), *Mongolia Third National Communication under the United Nations Framework Convention on Climate Change*, p. 56.

**Figure 13. Spatial distribution of monthly mean temperature, July, 1961-1990**

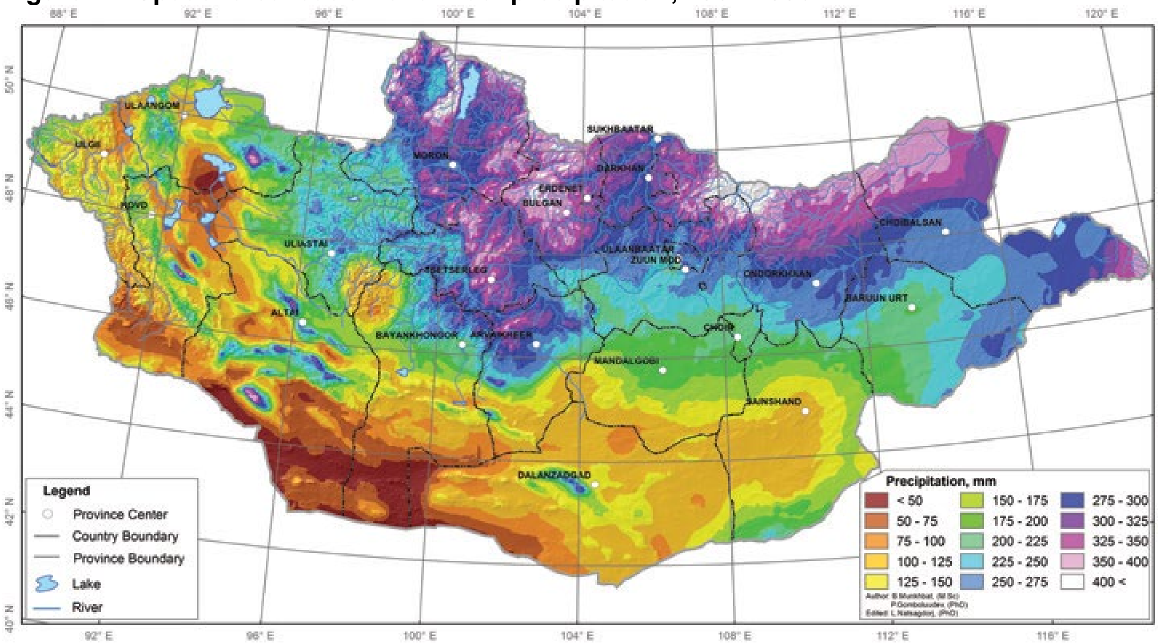



*Source*: Ministry of Environment and Tourism (2018), *Mongolia Third National Communication under the United Nations Framework Convention on Climate Change*, p. 56.

189. The mean annual precipitation varies considerably in Mongolia. It exceeds 400 mm at high mountain belts, is between 300-400 mm in the Khangai, Khuvsgul and Khentii mountains and the Khalkh river basin in the Eastern region, between 250-300 mm in Mongol Altai and forest-steppe, between 150-250 mm in steppe and between 50-150 mm in Gobi and desert region. In the south-inner area of the Altai Mountains, annual precipitation is even less than 55 mm. Typically, precipitation decreases from north to south and from east to west; however, surface roughness and mountain ranges have considerable impact on the spatial distribution

of precipitation (Figure 14). While the amount of precipitation is limited, the intensity is high, with 40-65mm rain per hour not uncommon.

**Figure 14. Spatial distribution of annual precipitation, 1961-1990**




*Source*: Ministry of Environment and Tourism (2018), *Mongolia Third National Communication under the United Nations Framework Convention on Climate Change*, p. 57.

190. There is a marked difference in precipitation between summer and winter. About 85% of the annual precipitation is recorded during the months from April to September with the majority falling in July and August. Precipitation during winter is very low, with total precipitation in the cold season ranging between 10-30mm. Generally, the snow cover depth is limited, about 5 cm in mountains on average with a maximum of up to 30 cm, while in the steppe region the average depth is 2-5 cm and the maximum depth up to 15-20 cm.

191. Mongolia's climate is very variable and unpredictable. Its low temperatures and limited rainfall promote the growth of grasses and rangelands, and while grain may be grown in Mongolia, unless it is anchored on a specific resource, periodically a full year's harvest will be lost. Under these circumstances, animal husbandry is the best alternative, and one that allows responding to uncertain resource availability by moving, within a limited area, towards those parts where resources are more abundant or less scarce[44].

192. Nevertheless, Mongolia's climate poses also challenges to animal husbandry. These challenges include, in particular, summer droughts which reduces the productivity of the rangelands; extreme heat, which reduces the animals' capacity to graze[45] and increases the amount of water required by the animals[46], and in particular, a combination of drought in summer with a harsh winter, characterized by more than usual snowfall. Summer drought prevents the animals to produce sufficient reserves in the form of fat, and a deeper than usual snow cover during winter prevents animals from grazing, which taken together mean that food may not be sufficient and that animal die from starvation. This phenomenon, called *dzud*, occurs at irregular intervals and can result in severe losses of animals, as noted earlier in this document.

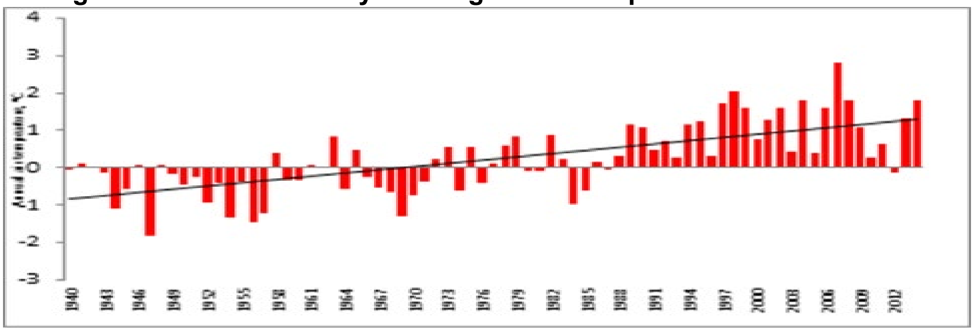
[44] This paragraph and the next one are based on Worden and Savada (1991).
[45] Ministry of Environment and Tourism (2018).
[46] Freer, Dove and Nolan (2007).

## B. Mongolia: Observed Climate Change

193. GCF (2019) provides an excellent summary of observed climate change: "*Near-surface temperature in Mongolia increased by 2.24°C between 1940-2015, according to observation data of the 48 meteorological stations. Annual precipitation during last 76 years decreased by 7% in average. However, precipitation in winter increased significantly since 1961. According to trends of some extreme climate indices, frost days have been decreased by nearly 15 days, while summer days have been increased by 19 days during 1971-2015 period. Associated with these changing climate conditions, Mongolia experienced recently high tendency of drought in summer and heavy snow (dzud) in winter since 1990s. Among them, the dzuds in 1999-2000, 2001-2002 and 2009-2010 were the most severe with regards to socio-economic impact and cost.*" The text below elaborates on some of these points.

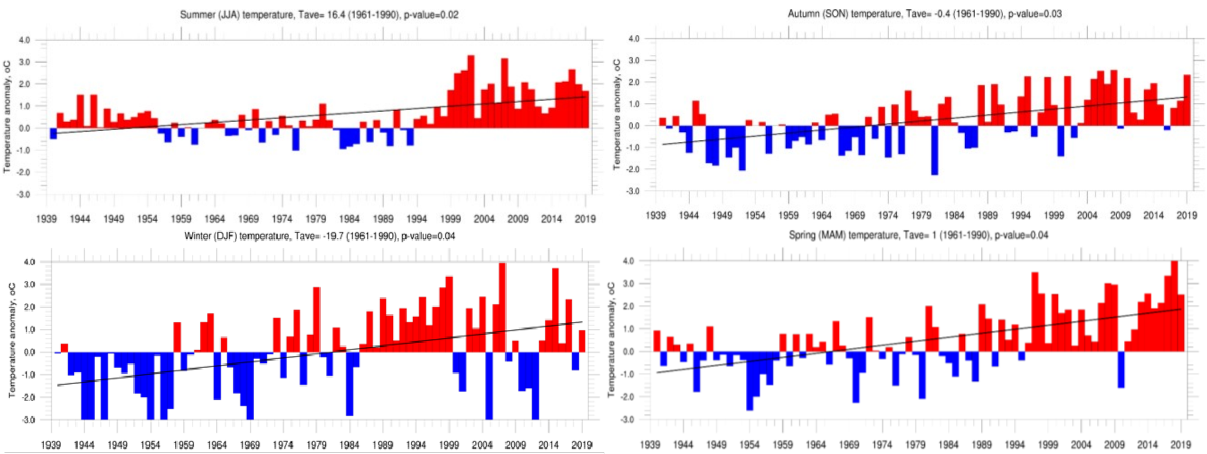
194. The warming intensity is higher in a mountainous region and less in the steppe and Gobi region. The warmest 10 years in last 76 years occurred since 2000. One clear change is a sudden increase of hot and consecutive days and a decrease of frozen and cold days. The change in temperate is apparent for the whole year and each of the seasons.

**Figure 15. Deviation from the multi-year average (1961-1990) of annual mean temperature average of the entire territory of Mongolia for the period 1940-2014**



*Source*: UNDP (2020)

**Figure 16. 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)**




*Source*: UNDP (2020)

195. For the purposes of ASDIP, a discussion of climate extremes is more relevant[47]. The following standard climate extreme indices (Table 19) have been estimated using observation time series from 53 meteorological stations by the Climpact 2.0 tool for the period of 1961-

[47] The remainder of this subsection B is based on Gomboluudev (2020).

2018. The spatial distribution of changes in climate extreme indices over the country's territory is illustrated in maps. The red triangles represent increase and blue represent decrease, and the asterix-symbol illustrates statistical significance. Section E below presents in graphs the trends of selected interannual variables in Uvs and Bayan-Ulgii for the last 58 years, focusing on the same indices of climate extremes.

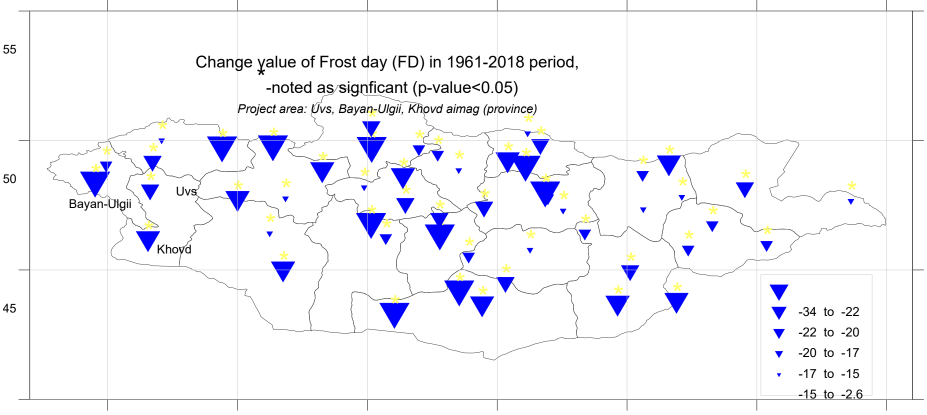
**Table 19. Extreme climate indices information, 1961-2018**

| № | Indices | Name | Definition | Unit |
|---|---|---|---|---|
| 1 | FD | Frost days | Annual count when daily minimum temperature < $0^{O}C$ | Days |
| 2 | SU | Summer days | Annual count when daily maximum > $25^{O}C$ | 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 | $^{O}C$ |
| 5 | Tnn | Minimum of daily minimum temperature | Monthly minimum of daily minimum temperature | $^{O}C$ |
| 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 | Standardized precipitation evapotranspiration Index | Measure of "drought" using the standardized precipitation evapotranspiration Index on time scales of 3, 6 and 12 months | NA |

*Frost days*

196. The number of frost days per year has decreased by 3-34 days in Mongolia, especially in central and northern parts in high latitudes (Figure 17). All changes are statistically significant. It means that cold season (October-March) is becoming shorter, while the warm season (April-September) is becoming longer. It results in the early melting of snow and permafrost, and thawing ice and rivers.

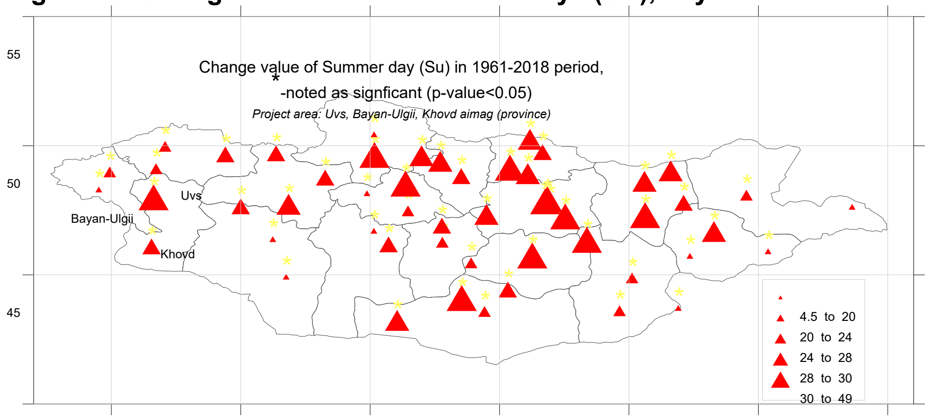
**Figure 17. Change in number of frost days (FD), days**



*Summer days*

197. The number of summer days per year has increased by 4.5-49 days in Mongolia, especially in central parts of the country (Figure 18). All changes are statistically significant. It means that hot days and heat stress is becoming increasingly intense.

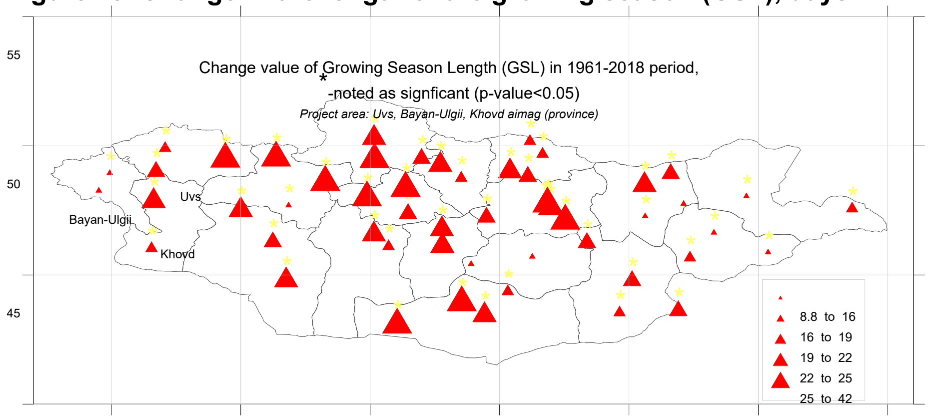
**Figure 18. Change in number of summer days (SU), days**




*Length of growing season*

198. The growing season became longer by 8.8-42 days in Mongolia, especially in central and northern parts of the country (Figure 19). All changes are statistically significant. It means that heat supply for vegetation growth is improving, however transpiration has also been increasing.

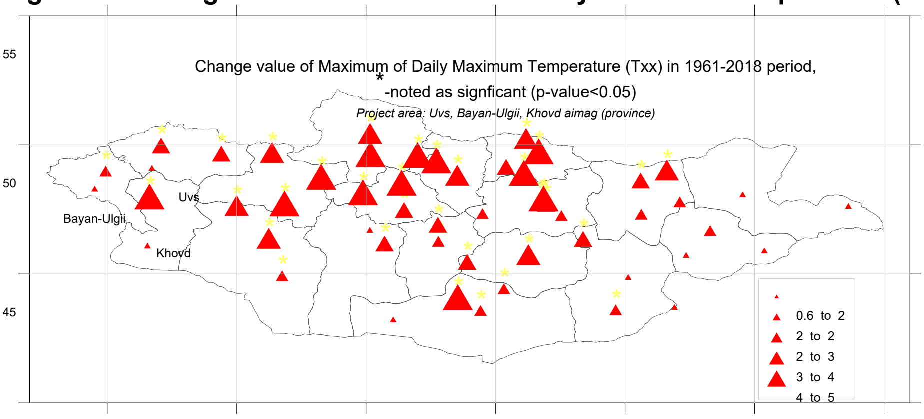
**Figure 19. Change in the length of the growing season (GSL), days**




*Annual maximum of daily maximum temperature*

199. The annual maximum of daily maximum temperatures has increased by 0.6-5.0°C over the territory of Mongolia, especially in central and northern parts of the country (Figure 20). 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.

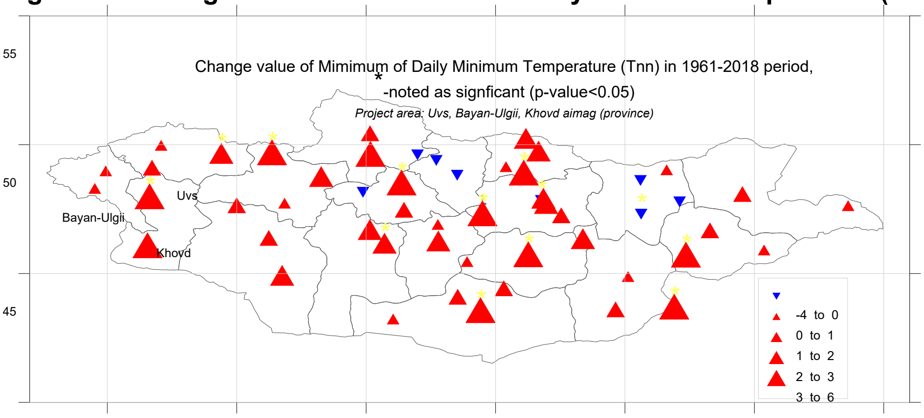
**Figure 20. Change in annual maximum of daily maximum temperature (Txx), days**




*Annual minimum of daily minimum temperature*

200. The annual minimum in daily minimum temperatures has increased by 1.0-6.0°C in most parts of Mongolia, although the change is not as consistent as for the 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 21). The map illustrates that extreme cold period is in general getting milder, while becoming more severe in few regions.

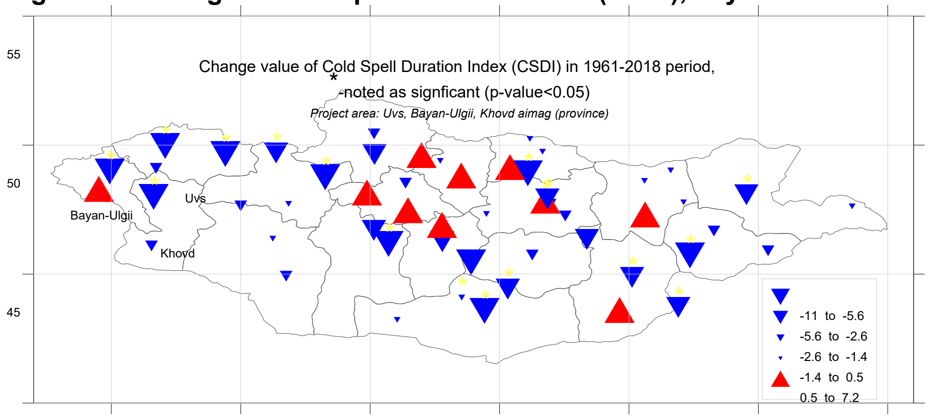
**Figure 21. Change in annual minimum of daily minimum temperature (Tnn), days.**




*Cold spell duration index*

201. The 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 22).

**Figure 22. Change in cold spell duration index (CSDI), days.**




*Maximum 1-day and 5-days precipitation*

202. The spatial patterns of maximum of 1-day and 5-days precipitation are quite diverse. Some areas have increasing trends while others have decreasing trends, and many of these are not statistically significant (Figure 23 and Figure 24). It means that there is no clear overall trend. Within the project areas, most of the data show decreasing trends.

**Figure 23. Change in annual maximum of 1-day precipitation (RX1day), mm**

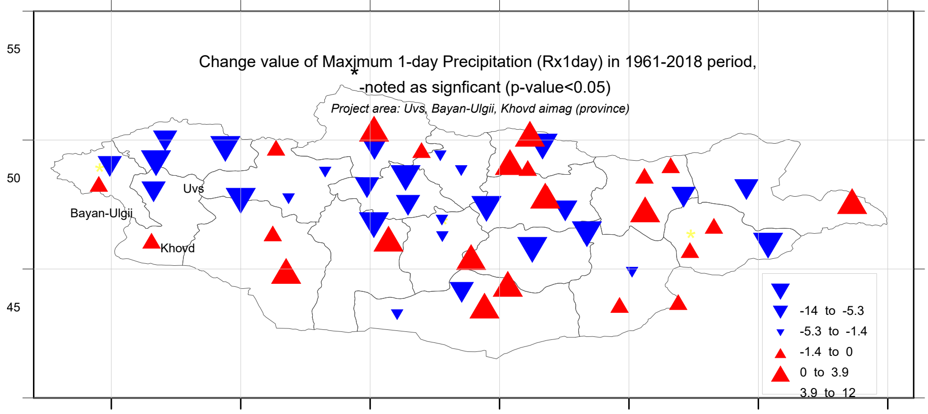
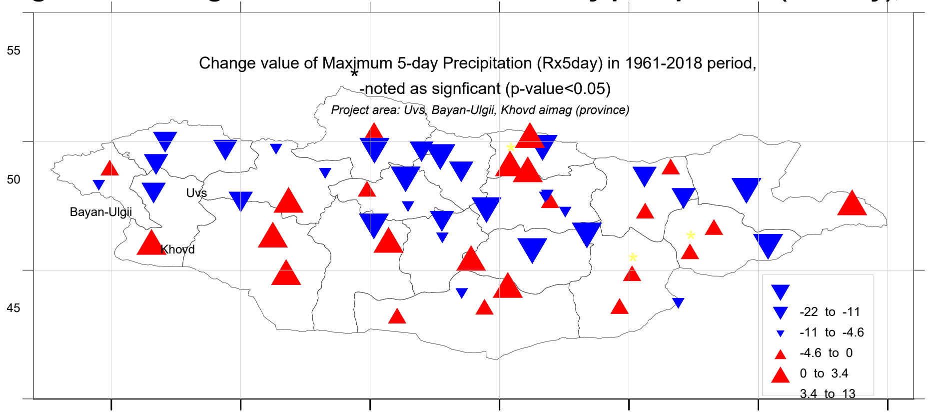



**Figure 24. Change in annual maximum of 5-day precipitation (RX5day), mm**

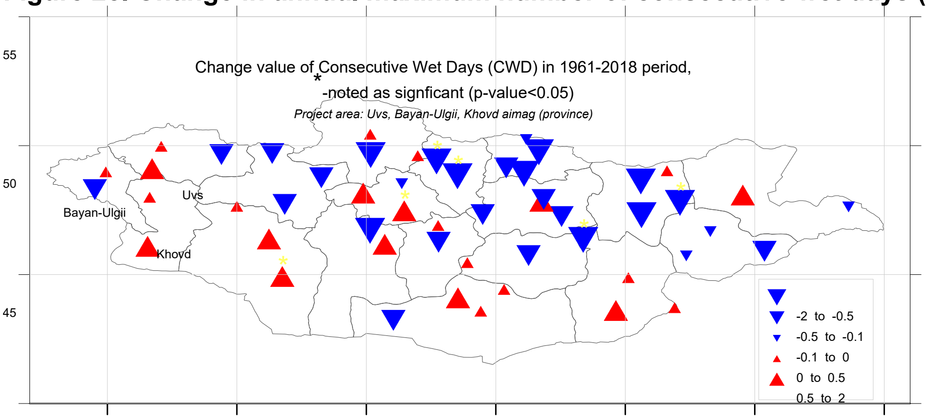



*Consecutive wet days*

203. The annual maximum of 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 in the Altai Gobi region. There are very few station data showing statistical significance (Figure 25).

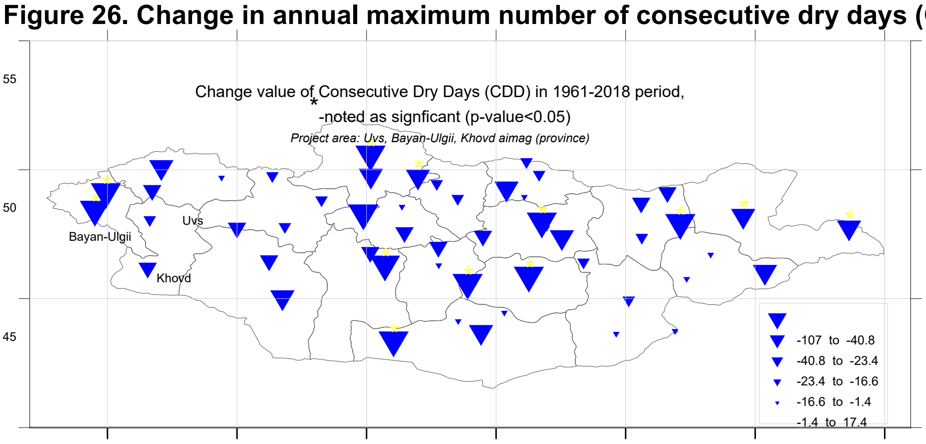
**Figure 25. Change in annual maximum number of consecutive wet days (CWD), days.**




*Consecutive dry days*

204. In general, the annual maximum number of consecutive dry days shows a decreasing trend over the whole territory of the country, however mostly as statistically significant in southern part of the country (Figure 26). It is associated with increase of winter precipitation in Gobi and desert regions in Mongolia.

**Figure 26. Change in annual maximum number of consecutive dry days (CDD), days.**




*Standardized Precipitation Evapotranspiration Index*

205. The Standardized Precipitation Evapotranspiration Index (SPEI) is a measure of drought. It 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 27-Figure 29). 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.

**Figure 27. Change in Standardized Precipitation Evaporation Index, 3-months (SPEI3)**

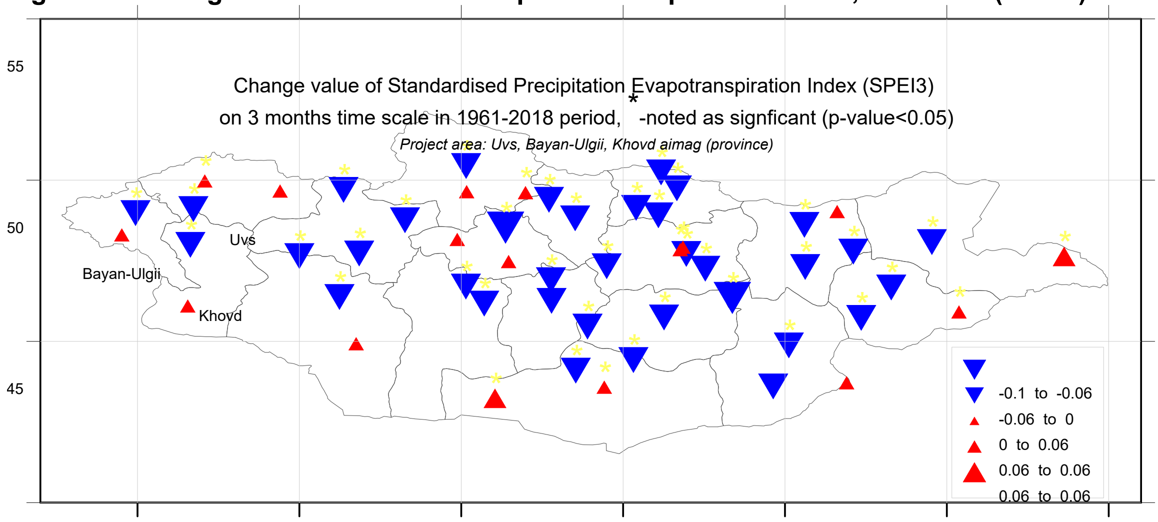



**Figure 28. Change in Standardized Precipitation Evaporation Index, 6-months (SPEI6)**

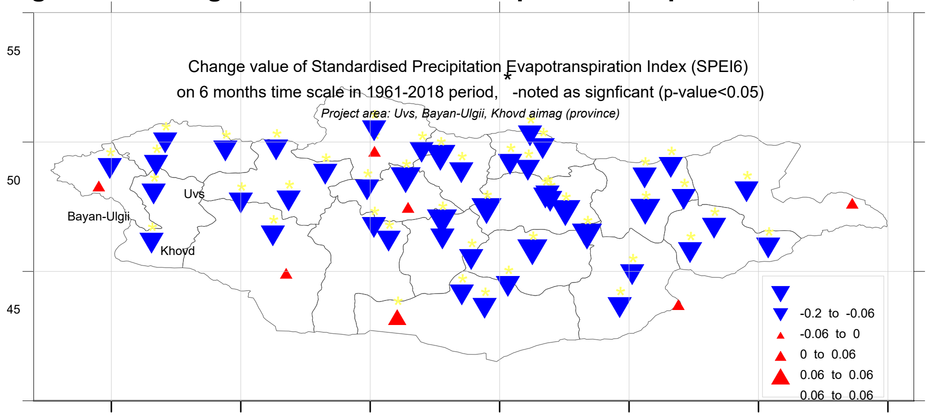
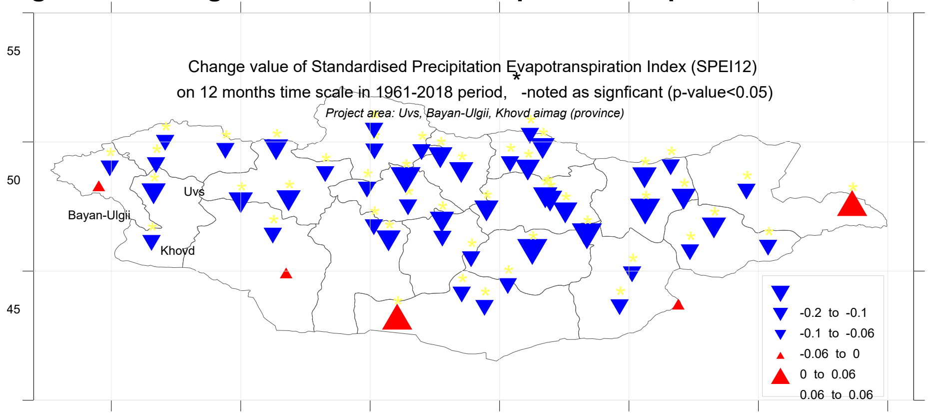



**Figure 29. Change in Standardized Precipitation Evaporation Index, 12-months (SPEI12)**

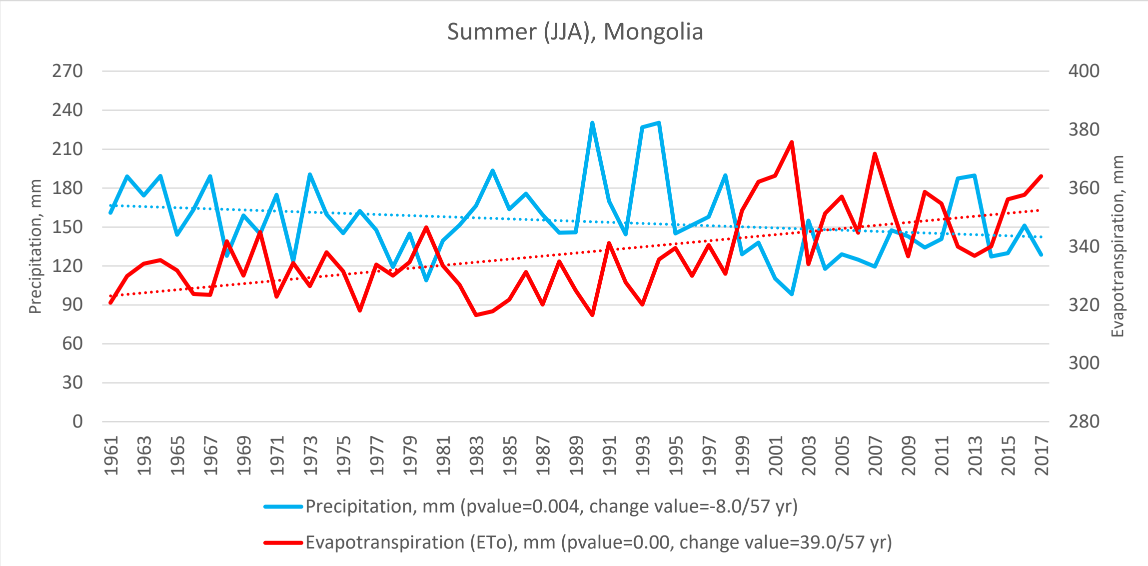



*Precipitation and evaporation during the warm season (June-August)*

206. The summer season precipitation and potential evapotranspiration were estimated by Thornthwaite method (Figure 30). The summer season is defined by the period from June to August (JJA). The winter season (December to February) evapotranspiration is near zero as the air temperature is constantly significantly less than -5°C. However, the high evapotranspiration during the summer affects the water supply for pastures to grow and hence drought conditions can develop causing limited biomass availability. Over the whole of

Mongolia the warm season rainfall has been decreasing (at 95% confidence level) and potential evapotranspiration increasing (at >99% confidence level). The trend of increasing differences between precipitation and evapotranspiration is consistent with the trends in SPEI for increased drought, as previously shown.

**Figure 30. Summer season precipitation and evapotranspiration in Mongolia, 1961-2017**




## C. Projected climate change in Mongolia

207. Ministry of Environment and Tourism (2018) provides a clear summary of projected climate change which has been included here with limited editing. The future projections of winter, summer and annual mean of temperature and precipitation over Mongolia were estimated by ensemble mean of 10 GCMs from 2016 to 2100 under high (RCP8.5), mid (RCP6.0) and low (RCP2.6) GHG emission scenarios.

208. Generally, temperature change directly depends on the intensity of GHG emission. However, winter temperature change slightly low and interannual variability is higher than compared to summer temperature change. The intensity of temperature changes are similar for all RCP's scenarios until the first half of this century and then it gives diverting results while increasing year to year.

209. In near future 2016-2035, the seasonal temperature change will range only 2.0-2.3°C, but it will be expected as 2.4-6.3°C depending on each RCP scenarios in far future 2081-2100. For precipitation change, winter snow is expected to increase and summer rainfall has no significant change, there is only a slight increase with less than 10% for all scenarios. Winter snow will increase by 10.1-14.0% depending on each scenario in near future and by 15.5-50.2% in far future respectively. The following table summarizes the results.

**Table 20. Seasonal climate change over Mongolia under different GHG scenarios**

| RCP Scenario | Season | Near future, 2016-2035 | | Far future, 2081-2100 | |
|---|---|---|---|---|---|
| | | ΔTemperature, °C | ΔPrecipitation, % | ΔTemperature, °C | ΔPrecipitation, % |
| 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 |

| RCP Scenario | Season | Near future, 2016-2035 | | Far future, 2081-2100 | |
|---|---|---|---|---|---|
| | | ΔTemperature, °C | ΔPrecipitation, % | ΔTemperature, °C | ΔPrecipitation, % |
| | 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 |

*Source*: Ministry of Environment and Tourism (2018)

210. Gomboluudev (2020) provides downscaled projections from global to regional scales (covering the whole territory of Mongolia) using the regional climate model RegCM4 nested within global climate HadGEM2, simulating temperature and precipitation changes in near future, covering the period of 2016-2035 under the RCP4.5 scenario Business as Usual (BAU). The simulated changes for the whole of Mongolia are shown in Figure 22 and 23 demonstrating increases in temperature across all four seasons, except the relative low 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 31. Projected temperature change, °C, a) winter b) spring c) summer and d) winter**

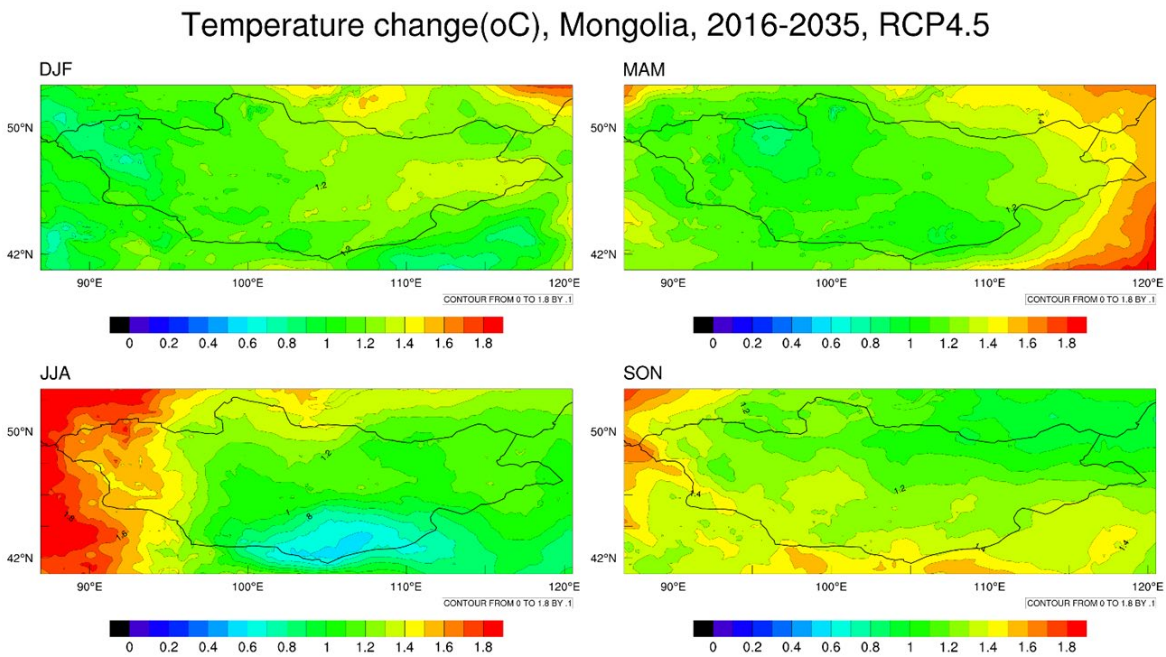
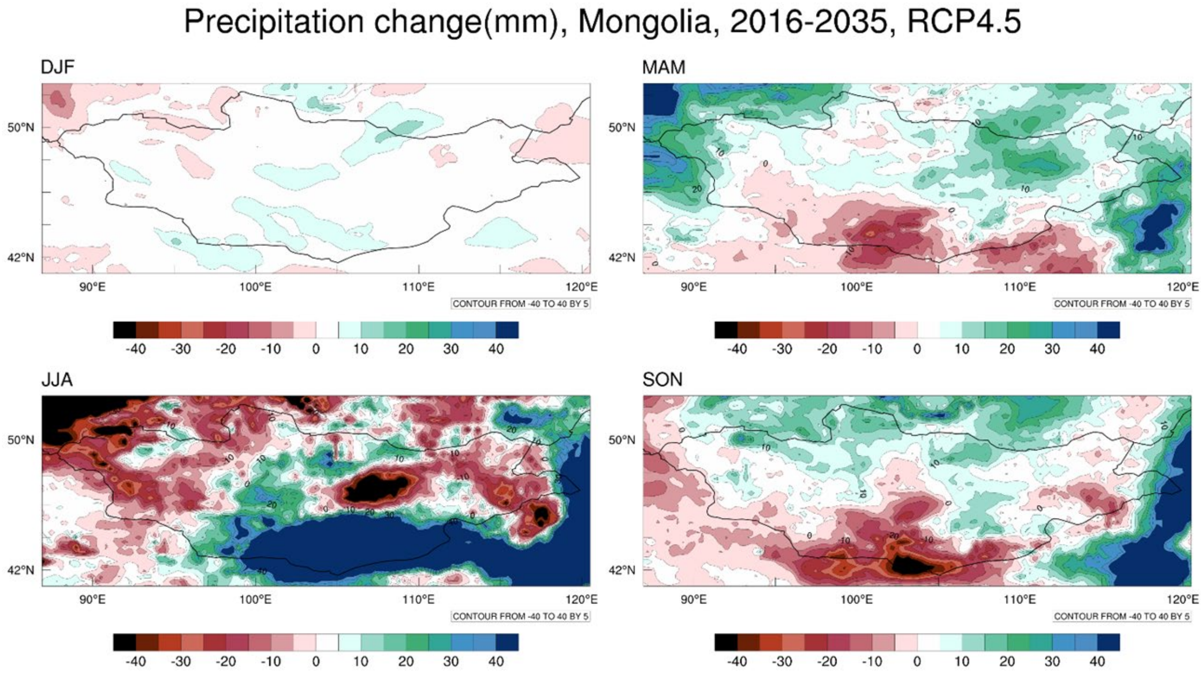


**Figure 32. Projected precipitation change, mm, a) winter b) spring c) summer and d) winter**

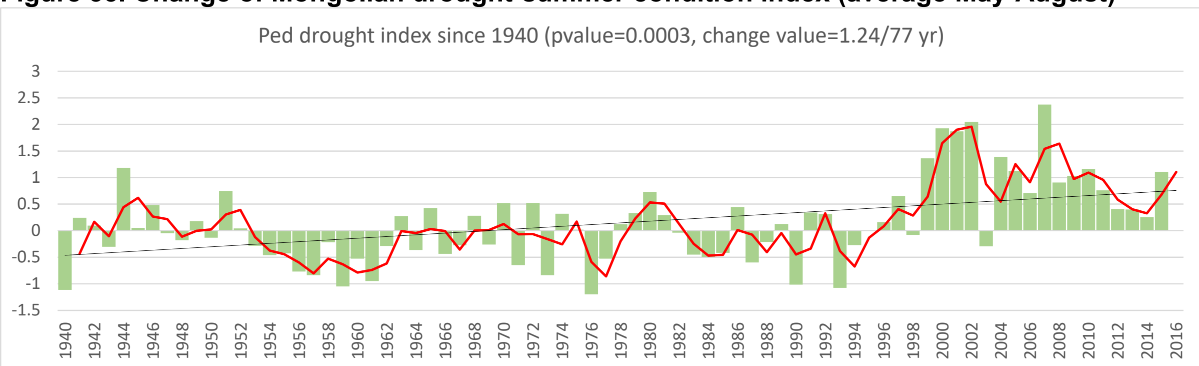



## D. Main climate change impacts on rangelands and animal husbandry

*Drought*

211. 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.

**Figure 33. Change of Mongolian drought-summer condition index (average May-August)**




*Negative values denote good summer conditions, positive values denote drought conditions.*

212. When estimating nationwide averaged drought conditions using Ped's drought index (Ped, 1975) calculated using (3) below, it is clear that since 1940s, drought conditions have increased (See Figure 33). 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, the 2000, 2002 and 2015 droughts have affected the country's socio-economic conditions the heaviest.

$$\text{PDI}=\frac{\Delta T}{\sigma_T}-\frac{\Delta P}{\sigma_P} \text{ (warm and dry)} \quad \textbf{(3)}$$

In which:
$\Delta T$ is the deviation in air temperature (◦C);
$\Delta P$ is the deviation in precipitation (mm);
σT is the standard deviation of the temperature (◦C);
σP is the standard deviation of the precipitation (mm);

*Dzud*

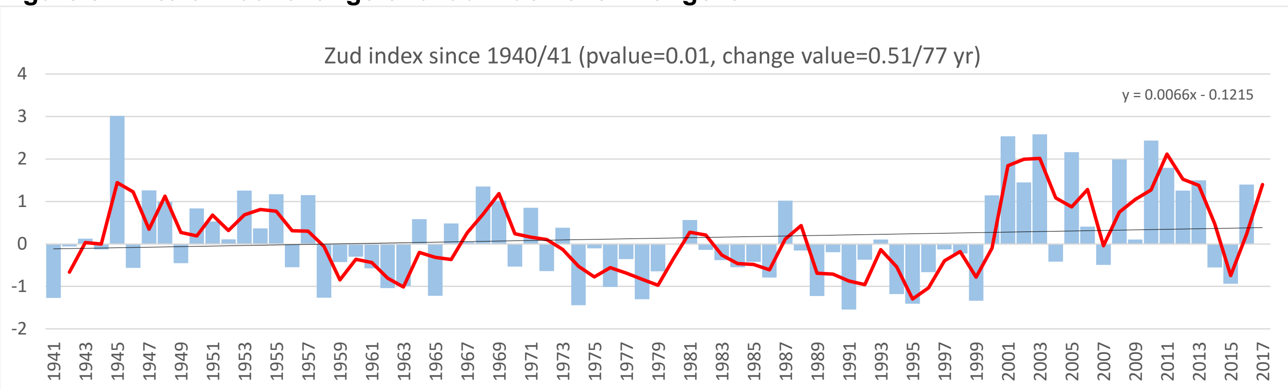
213. The development of the *dzud* intensity and frequency in Mongolia is estimated using equations (3)-(5) and is presented in Figure 34. The national trend is +0.51 in 77 years and this trend is statistically significant at the 99% confidence level, demonstrating an increase in *dzud* frequency and intensity. The *dzuds* in the years 1999-2000, 2001-2002 and 2009-2010 have been the most severe and consequently, damages and losses to the economy were especially severe in these years.

$$\text{WI}=-\frac{\Delta T}{\sigma_T}+\frac{\Delta P}{\sigma_P} \text{ (cold and wet)} \quad \textbf{(4)}$$

In which:
$\Delta T$ is the deviation in air temperature (◦C);
$\Delta P$ 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 **(5)**

**Figure 34. Interannual change of dzud index over Mongolia.**




*Positive values denote dzud conditions.*

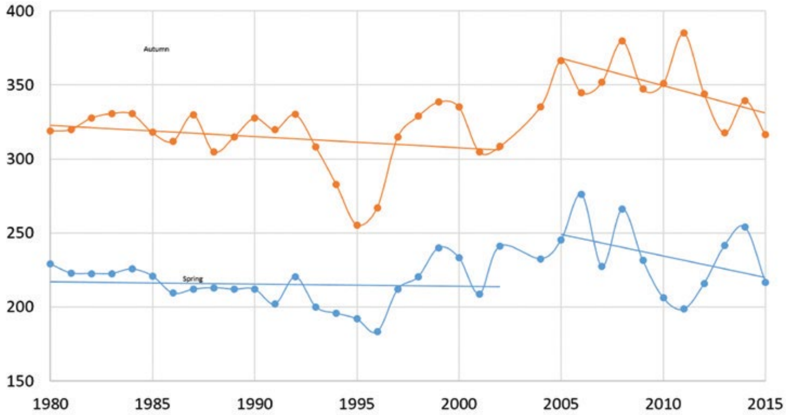
*Extreme heat*

214. The number of extremely hot days is considered an unfavorable condition for animal grazing. The number of extremely hot days has increased, negatively impacting fat gains during the summer season and causing a loss of productivity. (Ministry of Environment and Tourism, 2018, Ministry of Environment and Green Development, 2013)

*Observed livestock changes*

215. The third national communication to the UNFCCC discusses the impacts of extreme heat (see above) on animal productivity in terms of output yield (weight, meat, wool)[48]. For example, a decline in weight of cows can be observed (Figure 35).

**Figure 35. Live weight of mature cows, in Orkhon soum, Bulgan province.**




Red denotes autumn weight, blue denotes weight in spring.
*Source*: Ministry of Environment and Tourism (2018), p.197.

*Projected rangeland impacts*

216. The impacts of climate rangelands are twofold. On the one hand, there is an increase in the length of the growing season and an increase of the energy available for biomass growth, both of which would tend to favor biomass growth in the rangelands. On the other hand, there is the increase in the droughts occurrence, resulting from the increase in evapotranspiration (see above), which disfavors biomass growth. These two influences interact with each other and rangeland management (grazing intensity).

217. Computer models are necessary to provide projections for the likely impacts of climate change on rangelands. Mongolia's third national communication uses the well-respected Century model for this purpose, using future climate change projection data from the REGCM4-ECHAM5 and RegCM4-HadGEM2 models.

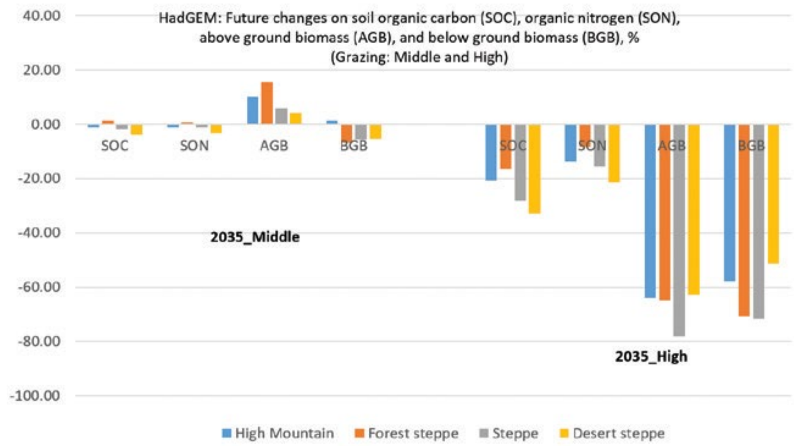
218. Data are projected for soil organic carbon (SOC), nitrogen (SON), above-ground biomass (AGB), and below-ground biomass (BGB), using both a high-grazing (baseline) and moderate-grazing scenario. Four different rangeland types are covered: high mountain, forest steppe, steppe, and desert steppe. Results of the analyses are included in Figure 36-Figure 38.

219. In all cases, a clear reduction in soil organic carbon, nitrogen, and below-ground biomass is projected, which is more significant farther in the future and in the high-grazing (baseline) scenario. For above-ground biomass, the baseline scenario (high-grazing) shows a marked decline (right-hand of Figure 36; Figure 38), and hence a reduction in feed available for livestock. In contrast, the moderate-grazing scenario (left-hand of Figure 36, Figure 37) shows an increase in above-ground biomass and an increase in feed for livestock.

220. It may therefore be concluded that climate change in the baseline will result in a loss of feed and productivity for the animal husbandry sector, but that with a shit towards moderate grazing, this will be turned around into an increase in availability of feed.

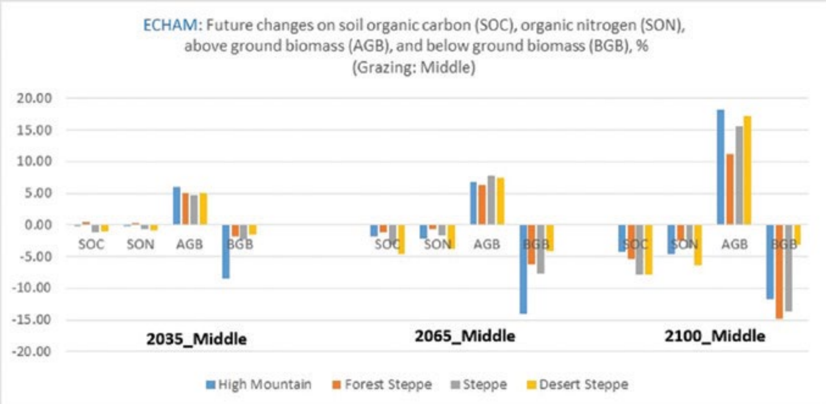
[48] Ministry of Environment and Tourism (2018), p.196-198.

**Figure 36. Impact of climate change on rangelands, Century-RegCM4-HadGEM2 model 2035, %.**



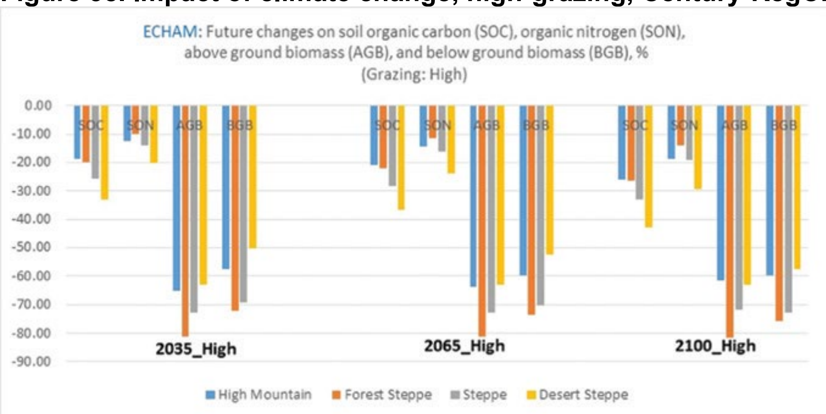

*Source*: Ministry of Environment and Tourism (2018), p. 175.

**Figure 37. Impact of climate change, moderate-grazing, Century-RegCM4-ECHAM5 model, %.**




*Source*: Ministry of Environment and Tourism (2018), p. 176.

**Figure 38. Impact of climate change, high-grazing, Century-RegCM4-ECHAM5 model, %.**




*Source*: Ministry of Environment and Tourism (2018), p. 176.

**Insert 3. Climate change and rangeland productivity in Mongolia**

In the high-grazing baseline, the impacts of climate change on drought dominate, and the productivity of rangelands will steadily decline, reducing the total amount of biomass per hectare available for feeding livestock. In the moderate grazing scenario, this result will be turned around, and the increased length of the growing season and increased energy delivered to the rangelands will dominate, resulting in an increase of biomass production and feed for livestock. It may therefore be expected that moderate grazing will lead to significant increases of output to herd ratios.

*Projected livestock changes and losses*

221. Ministry of Environment and Green Development (2013) provides projections for the loss of meat output in sheep-raising due to climate change (increased summer heat and drought), which illustrates the impact mentioned in Insert 3. See Table 21.

**Table 21. Changes in sheep live-weight in summer-autumn period, %[49].**

| Land type | 2011-2039 | 2040-2069 | 2070-2099 |
|---|---|---|---|
| Forest steppe | -10.68 | -34.40 | -57.75 |
| Steppe | -12.85 | -31.67 | -39.50 |
| High mountains | -2.92 | -3.05 | -9.03 |
| Gobi Desert | +2.02 | +3.87 | -0.18 |

*Source*: Ministry of Environment and Green Development (2013), p. 34.

222. Ministry of Environment and Tourism (2018) discusses the percentage of animal losses due to *dzud* and drought in near future under moderate GHG emissions scenario, RCP4.5, based on the results of 10 global climate models (ensemble mean) which provide best simulation of the past climate of Mongolia. Losses are estimated based on the projected intensity of drought and *dzud* indexes and the estimated relationship between these and animal losses. In the period 1940-1960 such losses were on average 2.8% and in the period 1991-2015, 4.0%.

223. The estimation shows that about 5.5% of the livestock which counted at the beginning of a year, will be lost by 2050 and this percentage will reach to 7.6% at the end of this century. Thus, livestock loss is expected to increase by over 40% in the middle of this century compared to the present situation and loss will be almost doubled by end of the century compared to the present loss rate (which already includes an increased loss rate due to climate change.

**Insert 4. Climate change and animal husbandry in Mongolia**

Climate change will have a strong impact on animal husbandry, an important sector of the Mongolian economy and a source of employment for a large and vulnerable part of the Mongolian population. Projections show that the impact of drought and heat may result in over 30% loss of output in the main rangeland types, and that the impact of drought and dzud on animal losses will dramatically increase, almost doubling the premature death rate by the end of the century from 4.0% (1991-2015) to 7.6%. Reducing animal numbers will have a major impact on feed availability (with moderate grazing rather than high grazing, projections show an increase of above-ground biomass rather than a decline) and improve the use of scarce resources, resulting in stronger animal entering the winter, which in itself will provide protection against the impact of *dzud*. Increasing water availability and fodder will additionally help to cope with *dzud* conditions during winter.

## E. Observed climate change in the ASDIP region

224. The preceding subsections A-D of this Section X discussed Mongolia's climate and the observed and projected climate change, including its impacts on rangelands and animal husbandry. It was demonstrated that for Mongolia as a whole, increased drought and

[49] HadCM3 model, SRES A2 emission scenario.

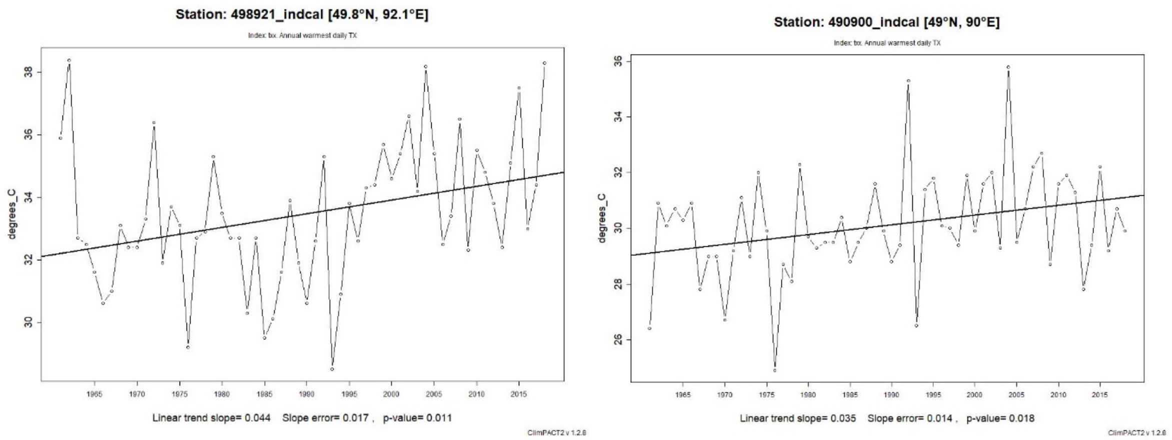
increased incidence of *dzud* may be expected to have severe consequences for rangelands and animal husbandry, especially in the high-grazing scenarios which represent business as usual (Insert 3 and Insert 4). One of the key questions is whether the same also applies to the areas targeted by ASDIP.

225. To address the question of the likely climate change impacts on the ASDIP project area, Sections E-G focus on the Tranche 1 aimags Bayan-Ulgii and Uvs. In this and the following sections, we follow the general approach as included in subsections B-D for these two aimags. The third Tranche 1 aimag, Khovd, has already been analyzed in UNDP (2020), and it has been concluded that climate change, through its projected impacts on drought and dzud, poses a considerable climate change challenge. Tranche 2 and 3 aimags remain to be determined, and when these have been selected, a similar analysis as done here will be performed to confirm the relevance of climate change challenges to these aimags.

226. For the discussion of frost days, summer days and length of the growing season, we refer to Section A. All reported changes are significant for Baya-Ulgii and Uvs, with the exception of length of the growing season in Bayan-Ulgii.

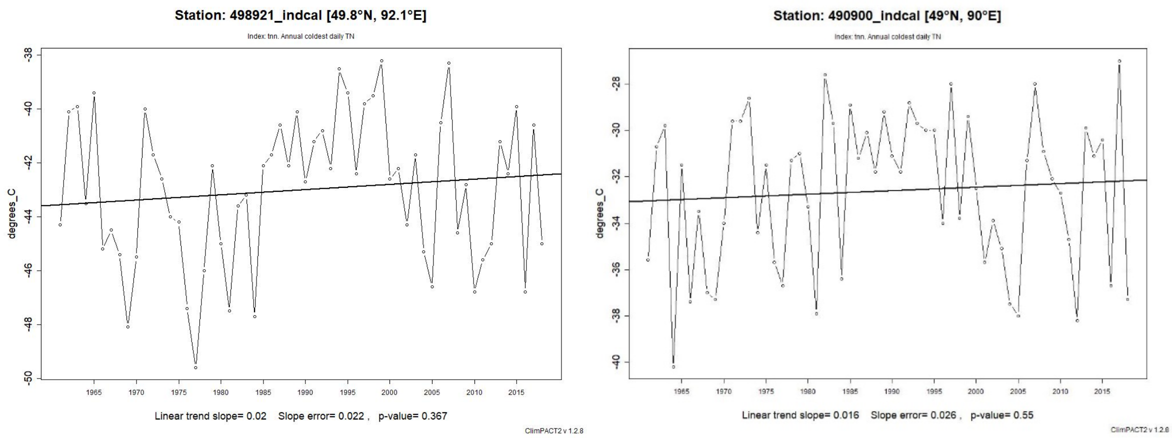
227. The annual maximum of the daily maximum temperature (Figure 39) shows a clear increasing trend for both Uvs (left) and Bayan-Ulgii (right). Both extreme hot days observed and heat stress are intensifying in Uvs and Bayan-Ulgii and the changes are significant.

**Figure 39. Annual maximum of daily maximum temperature (°C) in 1961-2018.**




*Uvs (left) and Bayan-Ulgii (right)*

**Figure 40. Annual minimum of daily minimum temperature (°C) in 1961-2018.**

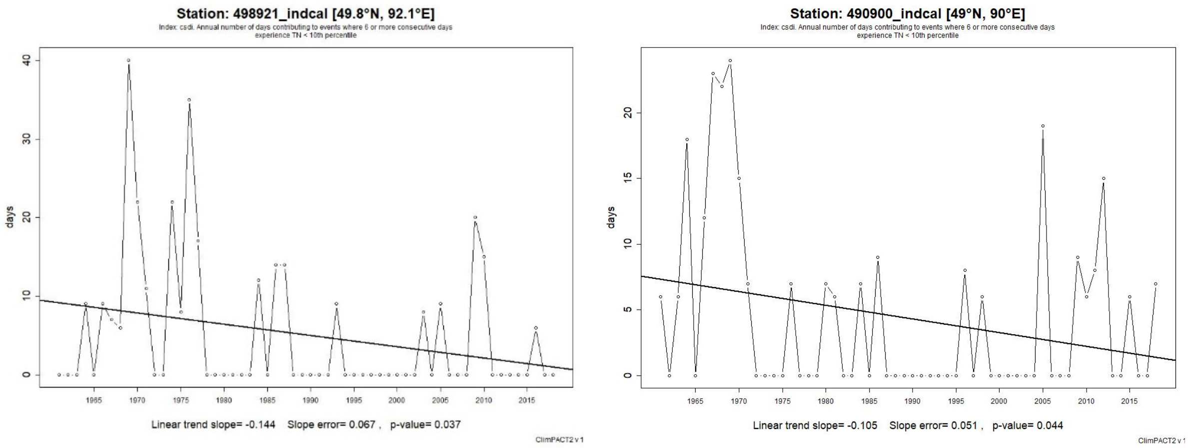



*Uvs (left) and Bayan-Ulgii (right)*

228. The annual minimum of the daily minimum temperature (Figure 40) shows an increasing trend for both Uvs (left) and Bayan-Ulgii (right), which hover is not significant.

229. The cold spell duration index (Figure 41) shows a decrease for both Uvs (left) and Bayan-Ulgii (right), which is significant at 5%.

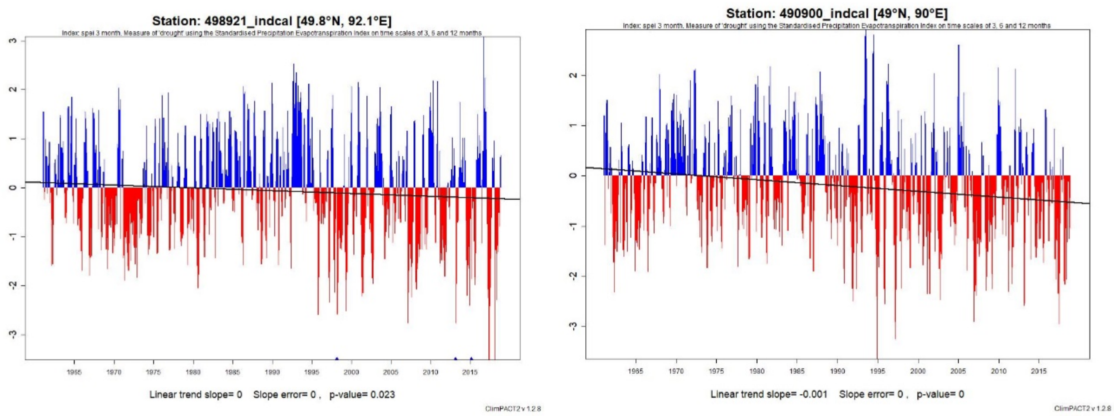
**Figure 41. Cold spell duration index (days), 1961-2018.**




*Uvs (left) and Bayan-Ulgii (right)*

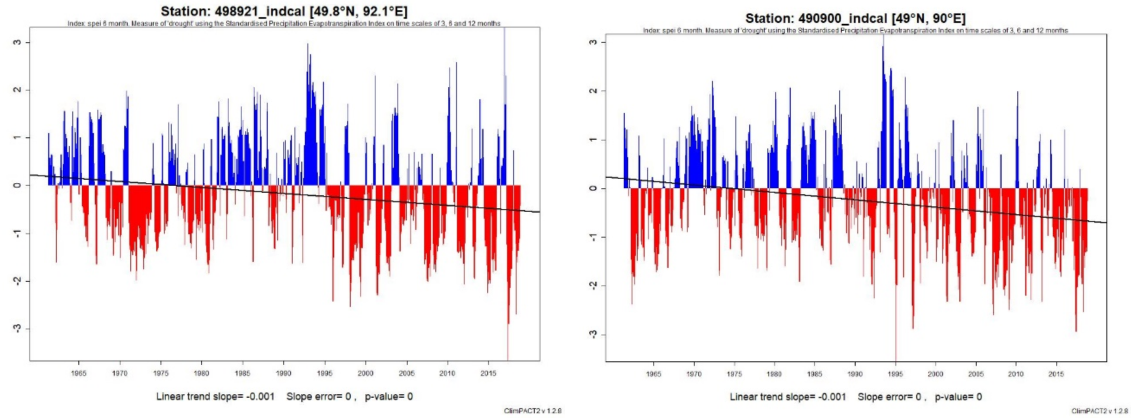
230. The Standardized Precipitation Evapotranspiration Index (SPEI) for 3, 6 and 12 months show a significant decrease for both Bayan-Ulgii and Uvs (Figure 42-Figure 44), implying an increase in the occurrence of droughts.

**Figure 42. Change in SPEI3, 1961-2018.**



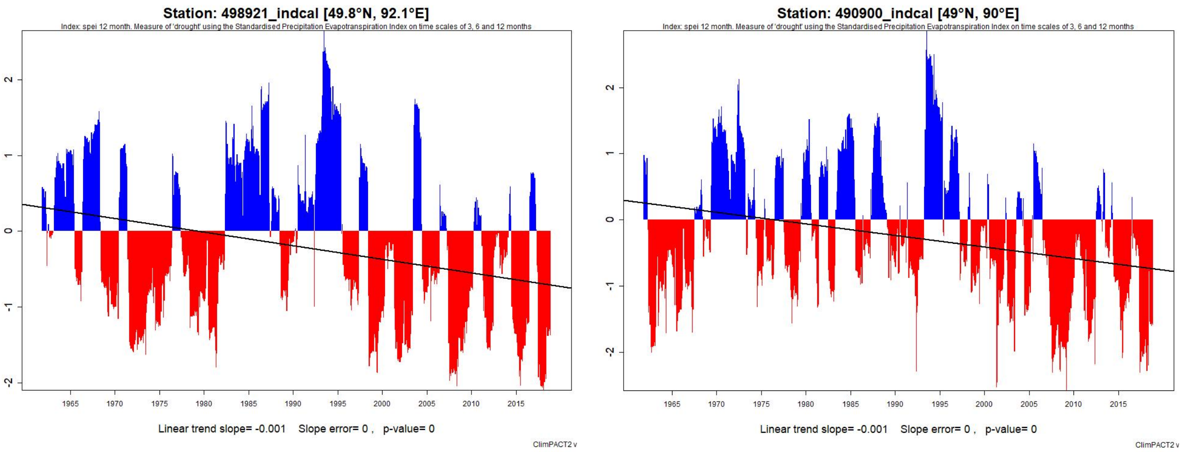

*Uvs (left) and Bayan-Ulgii (right). Declines show an increase in drought occurrences and severity.*

**Figure 43. Change in SPEI6, 1961-2018.**




*Uvs (left) and Bayan-Ulgii (right). Declines show an increase in drought occurrences and severity.*

**Figure 44. Change in SPEI12, 1961-2018.**




*Uvs (left) and Bayan-Ulgii (right). Declines show an increase in drought occurrences and severity.*

231. The summer season precipitation and potential evapotranspiration were estimated by Thornthwaite method. The summer season is defined by period from June to August (JJA). High evapotranspiration during the summer affects water supply for pastures to grow and hence drought conditions can develop causing limited biomass availability. There are clear and significant increases in evapotranspiration post 1961 in Bayan-Ulgii and Uvs. The trend of greater differences between precipitation and evapotranspiration is consistent with the trends in SPEI for increased drought, as previously shown (Figure 45-Figure 46).

232. Figure 47-Figure 50 show the changes in respectively winter and summer temperatures and winter and summer precipitation for Uvs. Both the increases in winter and summer temperatures are statistically significant. The increase in winter precipitation is statistically significant, while the decrease in summer precipitation is statistically insignificant.

233. Figure 51-Figure 54 show the changes in respectively winter and summer temperatures and winter and summer precipitation for Bayan-Ulgii. Both the increases in winter and summer temperatures are statistically significant. The increase in winter precipitation and the increase in summer precipitation are both not statistically significant.

**Figure 45. Summer season precipitation and evapotranspiration in Uvs, 1961-2017**

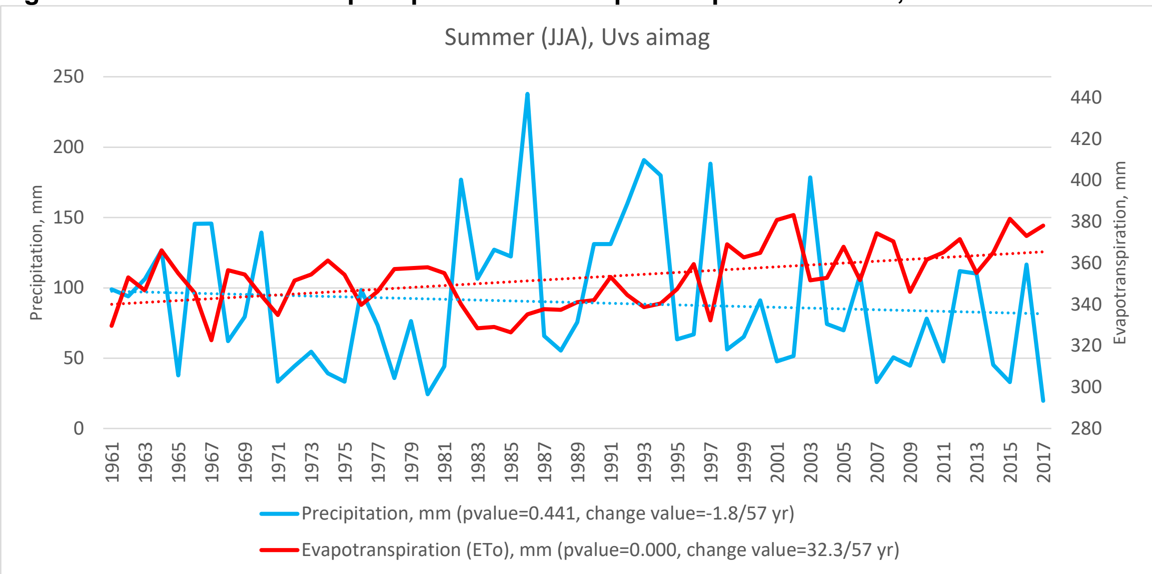



**Figure 46. Summer season precipitation and evapotranspiration in Bayan-Ulgii, 1961-2017**

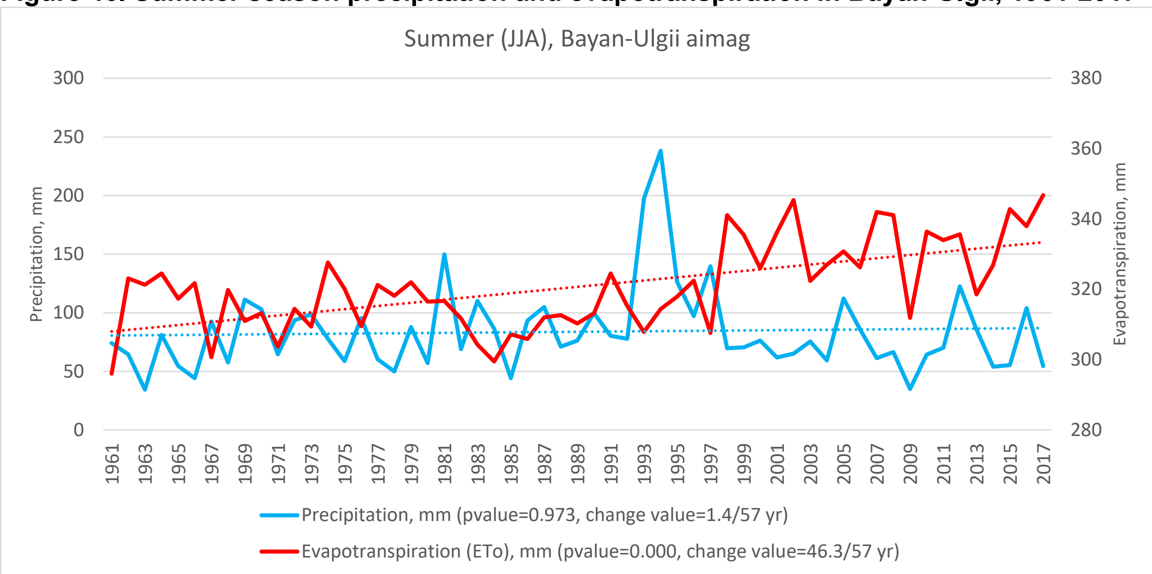



**Figure 47. Change in winter temperature, Uvs, relative to 1961-1990.**

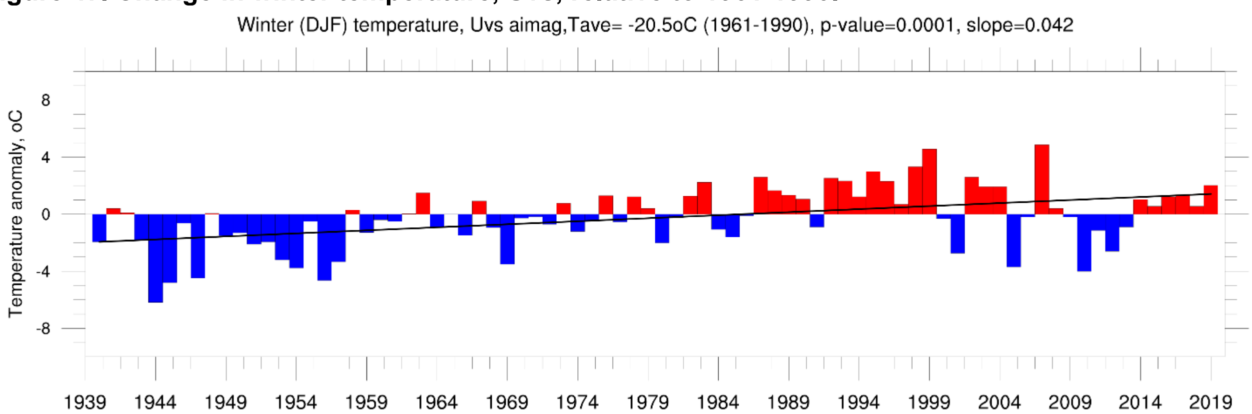


**Figure 48. Change in summer temperature, Uvs, relative to 1961-1990.**

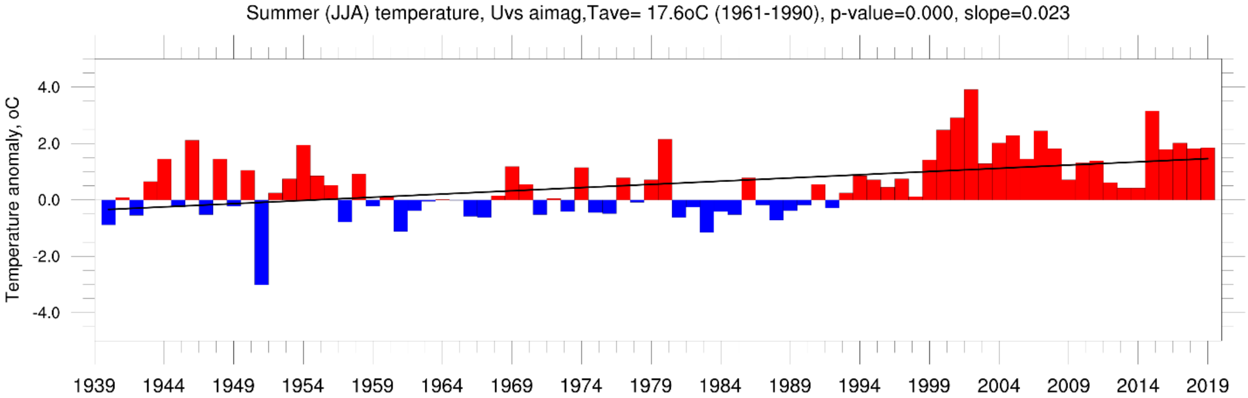



**Figure 49. Change in winter precipitation, Uvs, relative to 1961-1990.**

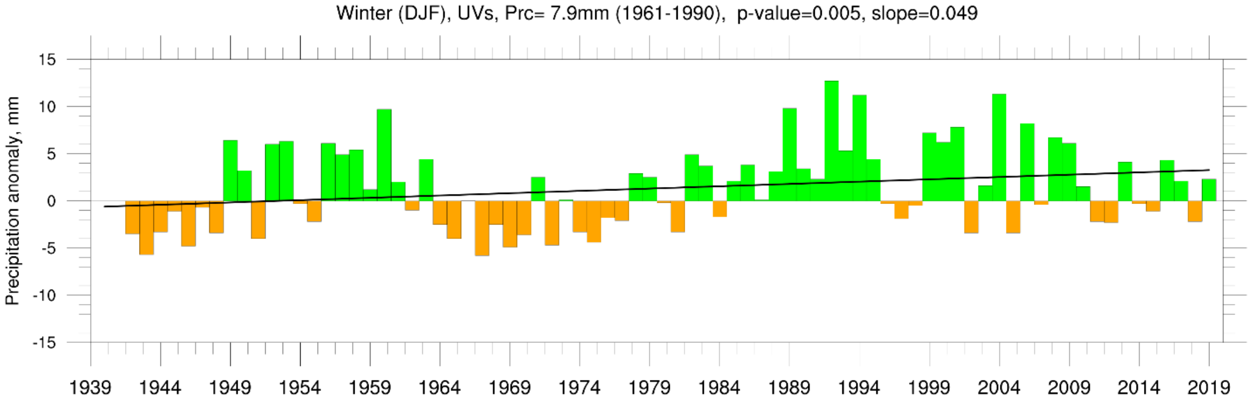



**Figure 50. Change in summer precipitation, Uvs, relative to 1961-1990.**

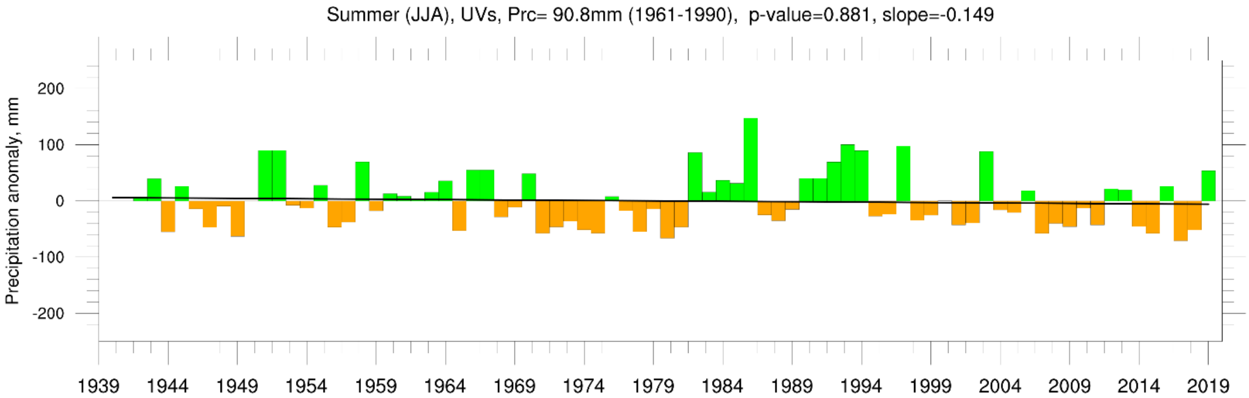



**Figure 51. Change in winter temperature, Bayan-Ulgii, relative to 1961-1990**

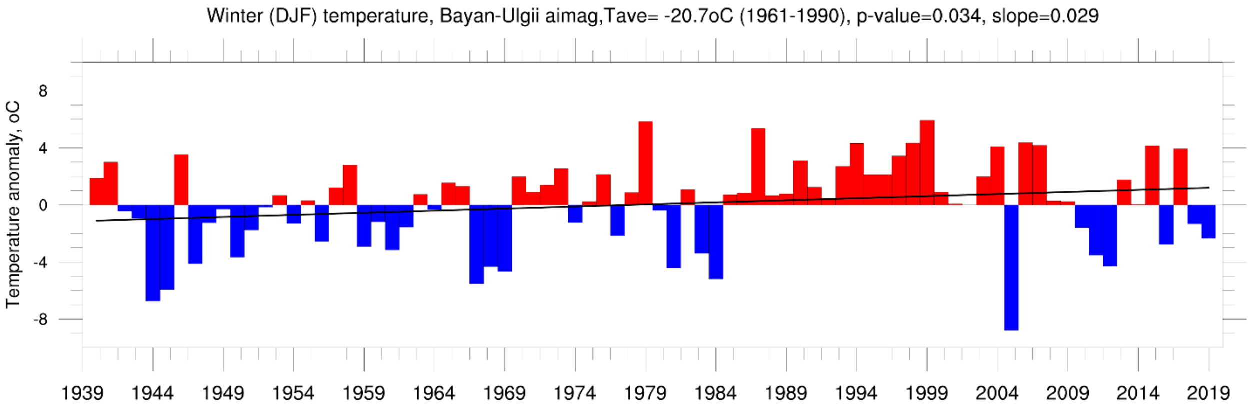


**Figure 52. Change in summer temperature, Bayan-Ulgii, relative to 1961-1990.**

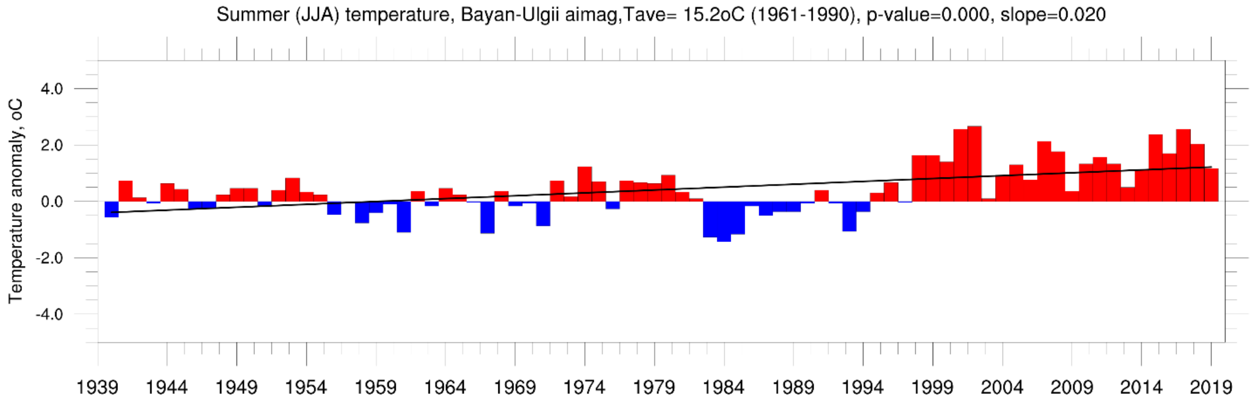



**Figure 53. Change in winter precipitation, Bayan-Ulgii, relative to 1961-1990.**

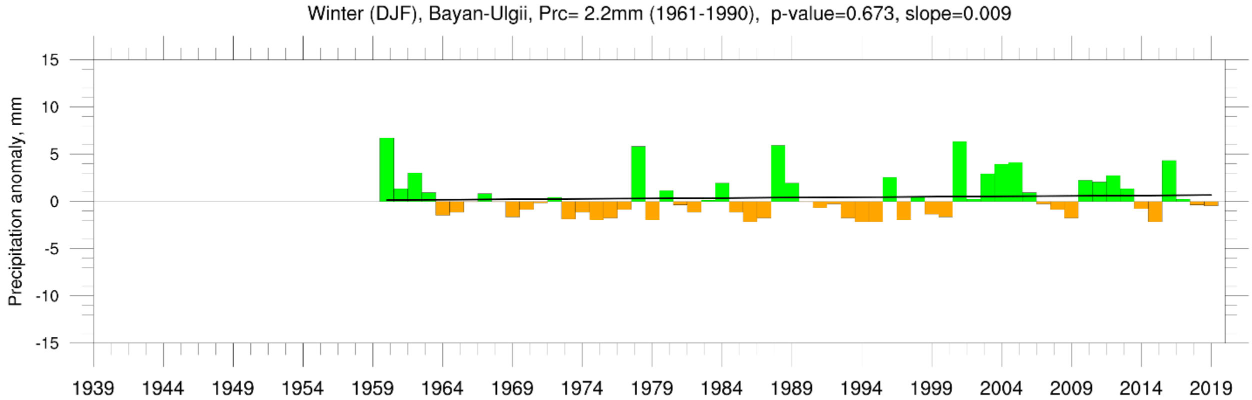
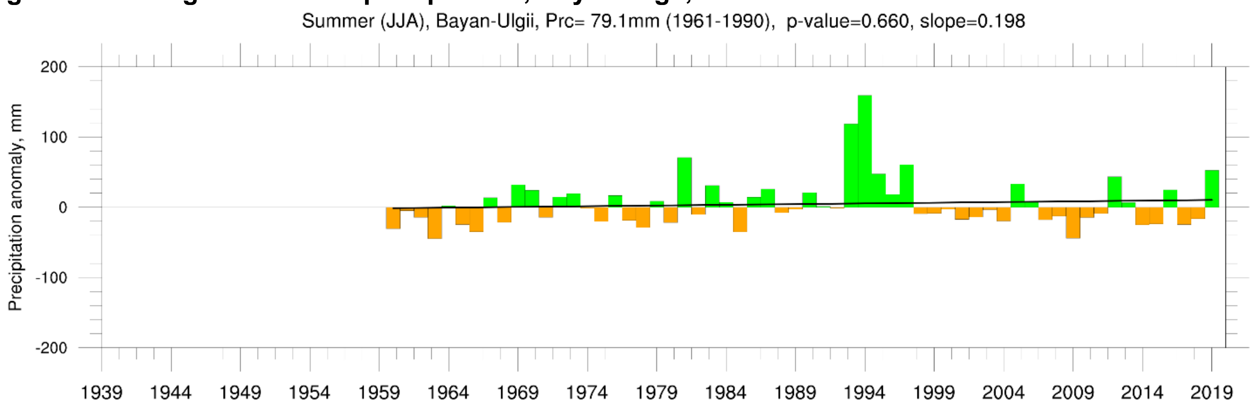



**Figure 54. Change in summer precipitation, Bayan-Ulgii, relative to 1961-1990.**

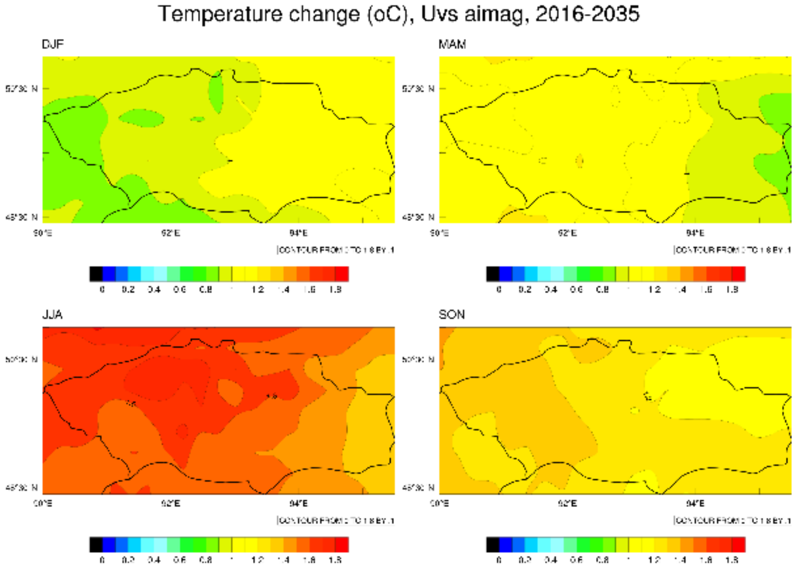



## F. Projected climate change in the ASDIP region

234. The spatial patterns already suggested that the key climate change impacts for Bayan-Ulgii and UVs would not differ markedly from those for Mongolia as a whole – increase in summer temperatures and a decrease in summer precipitation. This section describes the results of further downscaled climate change projections.

235. Figure 55 provides the spatial pattern of the projected temperature change for the four seasons in Uvs. All seasons show an increase, with the most significant increase in temperatures in summer.

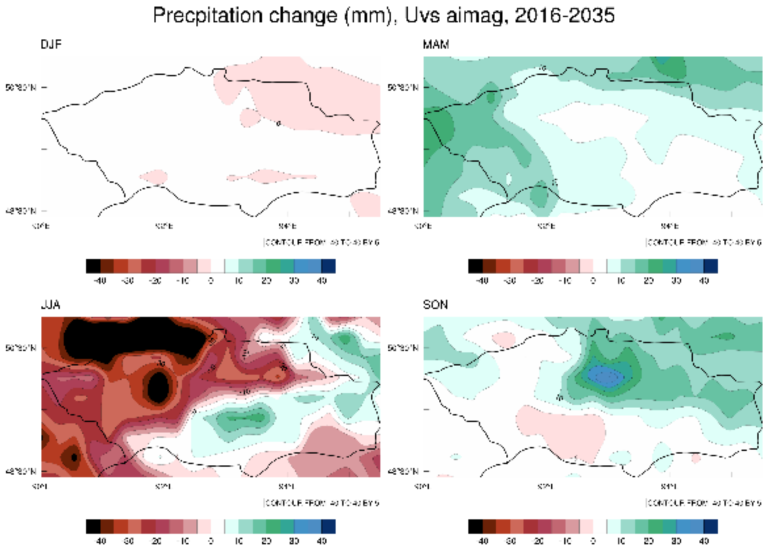
**Figure 55. Spatial pattern of projected temperature change, °C, Uvs, (2016-2035)**




*Top left: winter, top right: spring, bottom left: summer, bottom right: autumn*

236. Figure 56 provides the spatial pattern of the projected precipitation changes for the four seasons in Uvs. The most significant change is a decrease in precipitation in summer.

**Figure 56. Spatial pattern of projected precipitation change, mm, Uvs, (2016-2035)**

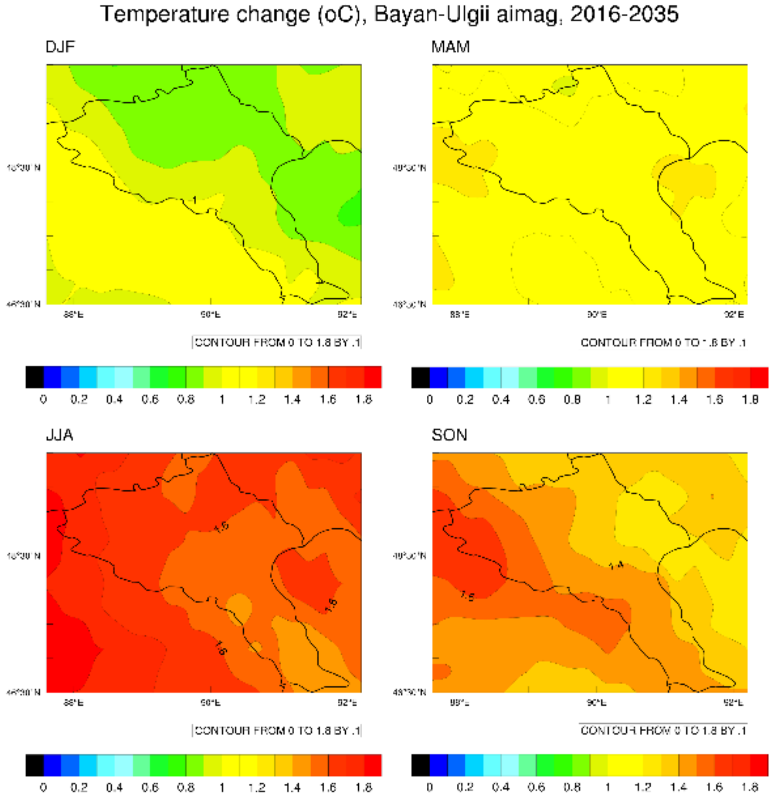



*Top left: winter, top right: spring, bottom left: summer, bottom right: autumn*

237. Figure 57 provides the spatial pattern of the projected temperature change for the four seasons in Bayan-Ulgii. All seasons show an increase, with the most significant increase in temperatures in summer.

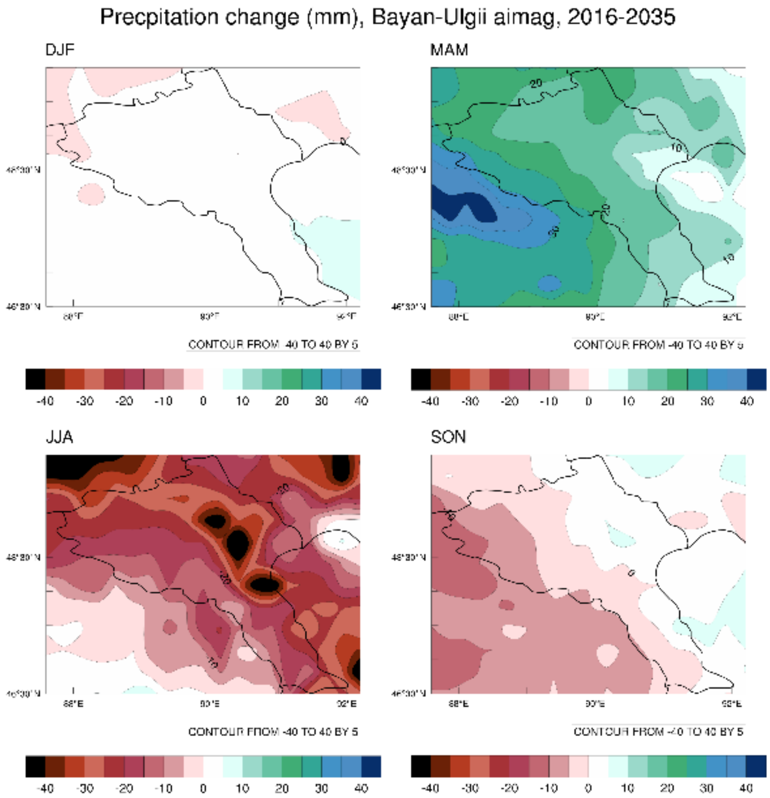
238. Figure 58 provides the spatial pattern of the projected precipitation changes for the four seasons in Bayan-Ulgii. The most significant change is a decrease in precipitation in summer. The results for Bayan-Ulgii and Uvs are similar to those described for Mongolia in section C, with clearly increasing temperatures and decreasing precipitation during the summer season.

**Figure 57. Spatial pattern of projected temperature change, °C, Bayan-Ulgii, (2016-2035)**




*Top left: winter, top right: spring, bottom left: summer, bottom right: autumn*

**Figure 58. Spatial pattern of projected precipitation change, mm, Bayan-Ulgii, (2016-2035)**

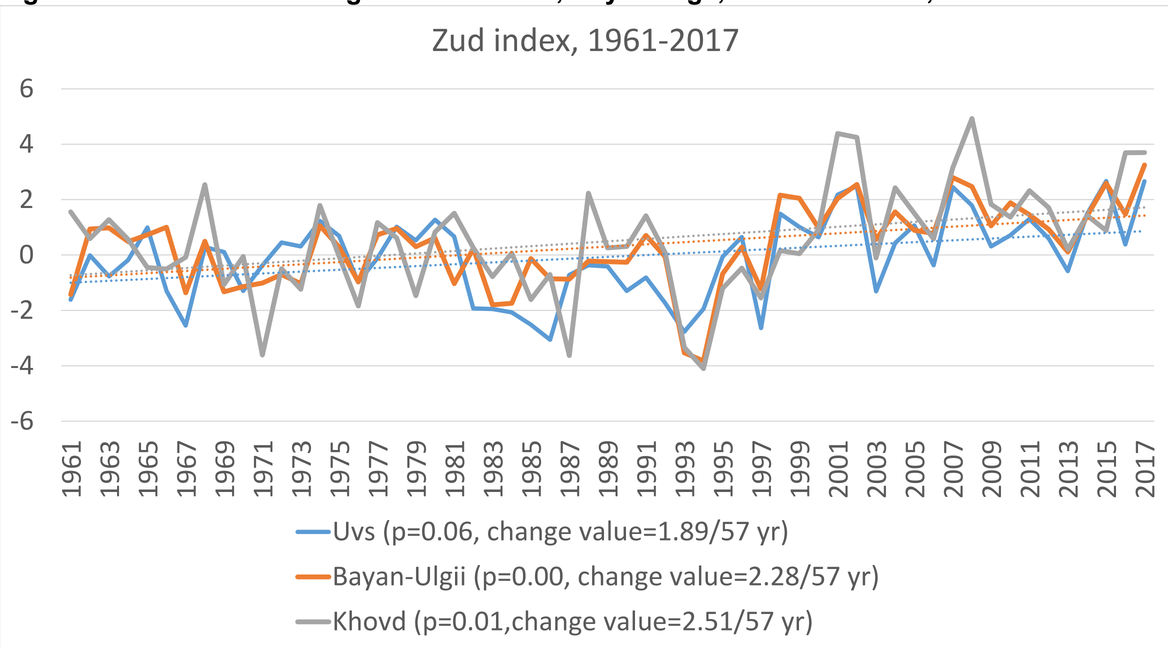



*Top left: winter, top right: spring, bottom left: summer, bottom right: autumn*

## G. Main climate change impacts on animal husbandry in the ASDIP region

239. Figure 59 provides the development of the dzud index in Bayan-Ulgii and Uvs (and Khovd). The increase in the dzud index is statistically significant, implying an increase in losses of animals in the targeted provinces due to dzuds.

**Figure 59. Interannual change of dzud index, Bayan-Ulgii, Khovd and Uvs, 1961-2017.**




*Positive values denote dzud conditions.*

240. Observed climate change (Section E) and the climate change projections (Section F) show an increase in summer drought in the project area, which means that the targeted provinces are susceptible to the same changes in rangeland productivity and animal husbandry productivity described in Section D.

**Insert 5. Climate change and animal husbandry in areas targeted by ASDIP**

Climate change will have a strong impact on animal husbandry, an important sector of the economy in the areas targeted by ASDIP in Tranche 1 and a source of employment for a large and vulnerable part of the population. Projections show that the impact of drought and heat may result in over 30% loss of output in the main rangeland types, and that the impact of drought and dzud on animal losses will dramatically increase in the Tranche 1 aimags of ASDIP. Reducing animal numbers will have a major impact on feed availability (with moderate grazing rather than high grazing, projections show an increase of above-ground biomass rather than a decline) and improve the use of scarce resources, resulting in stronger animal entering the winter, which in itself will provide protection against the impact of *dzud*. Increasing water availability and fodder will additionally help to cope with *dzud* conditions during winter.

241. Gomboluudev (2020) estimates climate vulnerability indices 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 indicator at provincial and regional levels are then converted using the normalization method that underpins UNDP's human development index (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 high vulnerability respectively high future risk (Table 22).

**Table 22. 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 |

242. According to the estimated climate change current vulnerability indices, Uvs and Khovd belong to the “highly vulnerable” and Bayan-Ulgii the “vulnerable” category as respectively. Considering future changes in temperature, precipitation and frequency of natural hazards show that the three aimags will be categorized in highly and extremely vulnerable during 2046-2065 (Table 23).

**Table 23. Multi-dimensional climate vulnerability index for the Tranche 1 aimags**

| Current vulnerability (1986-2005) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Aimag | Climate | Water resource | Permafrost | Forest resource | Pasture | Crop farming | Livestock | Biodiversity | Average |
| Uvs | 0.7 | 0.5 | 0.5 | 1.0 | 0.8 | 0.9 | 0.6 | 0.8 | 0.7 |
| Bayan-Ulgii | 0.5 | 0.3 | 0.5 | 1.0 | 0.7 | n.a | 0.4 | 0.9 | 0.6 |
| Khovd | 0.5 | 0.8 | 0.7 | 1.0 | 0.5 | n.a | 0.5 | 0.7 | 0.7 |
| **Future vulnerability (2046-2065)** | | | | | | | | | |
| Uvs | 0.8 | 0.5 | 0.9 | 1.0 | 1.0 | 0.9 | 1.0 | 0.8 | 0.9 |
| Bayan-Ulgii | 0.6 | 0.3 | 0.5 | 1.0 | 0.7 | n.a | 0.4 | 0.8 | 0.6 |
| Khovd | 0.7 | 0.8 | 0.9 | 1.0 | 0.8 | n.a | 0.6 | 0.8 | 0.8 |

## XI. REFERENCES

ADB (2013), *Making grasslands sustainable in Mongolia: Adapting to climate and environmental change*. Asian Development Bank.

Approved VCS Methodology VM0026, Version 1.0, dated 22 April 2014, Sectoral Scope 14: "Sustainable Grassland Management".

CDM EB (2007) AMS-II.E Indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories Energy efficiency and fuel switching measures for buildings Version 10.0. CDM EB of the UNFCCC. Bonn

CDM EB (2013), A/R Methodological tool: Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity. Version 02.0

Dagvadorj, D., T. Tennigkeit, A. Wilkes and C. Yeager (2013), Nationally Appropriate Mitigation Actions for Grassland and Livestock Management in Mongolia. *ADB Brief No. 13*, May 2013.

Densambuu, B., S. Sainnemekh, B. Bestelmeyer, U. Budbaatar (2018) National report on the rangeland health of Mongolia: Second Assessment. Green Gold-Animal health project, SDC; Mongolian National Federation of PUGs. Ulaanbaatar.

Freer, M., H. Dove and J.V. Nolan (2007), *Nutrient requirements of domesticated ruminants*. CSIRO Publishing, Collingwood, Australia.

GCF (2019), *Country Programme Mongolia*. Green Climate Fund.

Gomboluudev, P. (2020), Report on climate analysis over Uvs and Bayan-Ulgii aimags. Report commissioned by Nutawa sagl as background document for the ASDIP funding proposal.

Government of Mongolia (2010), Mongolia: *Nationally appropriate mitigation actions of developing country Parties*. Downloadable from: https://unfccc.int/files/meetings/cop_15/copenhagen_accord/application/pdf/mongoliacphaccord_app2.pdf

Government of Mongolia (2015), *Intended Nationally Determined Contribution (INDC) Submission by Mongolia to the Ad-Hoc Working Group on the Durban Platform for Enhanced Action (ADP)*.

Han, G., X. Hao, M. Zhao, M. Wan, B.H. Ellert, W. Willms, and M. Wang (2008). Effect of grazing intensity on carbon and nitrogen in soil and vegetation in a meadow steppe in Inner Mongolia. *Agriculture, Ecosystems and Environment* **125** (2008) 21–32.

He, N. P., Y. H. Zhang, Q. Yu, Q. S. Chen, Q. M. Pan, G. M. Zhang, and X. G. Han (2011). Grazing intensity impacts soil carbon and nitrogen storage of continental steppe. *Ecosphere* **2** (1)

Hydrological change. Section 4.1 in Chapter 4, Findings of Climate Change Impacts on Different Sectors, in Ecosystem Based Adaptation Approach to Maintaining Water Security in Critical Water Catchments in Mongolia MON/12/301 Project.

IFI Technical Working Group on GHG Accounting (2019), *The IFI Dataset of Default Grid Factors v.2.0.*

IMF (2019), Mongolia: Selected issues. *IMF Country Report No. 19/298*.

IPCC (2006a) IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 10: Emissions from Livestock and Manure Management, in Volume 4, Agriculture, Forestry and Other Land Use. Including amendments.

IPCC (2006b) IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 6 Grassland, in Volume 4, Agriculture, Forestry and Other Land Use. Including amendments.

IPCC (2006c) IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 2 Generic Methodologies Applicable to Multiple Land-Use Categories, in Volume 4, Agriculture, Forestry and Other Land Use. Including amendments.

IPCC (2014): Annex II: Glossary [Mach, K.J., S. Planton and C. von Stechow (eds.)]. In: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, pp. 117-130.

Kimble, J. M., Follett, R., and Lal, R. (2001). The characteristics and extent of US grazing lands. In 'The potential of US Grazing Lands to Sequester Carbon and Mitigate the Greenhouse Effect'. (Eds R. F. Follett, J. M. Kimble and R. Lal.) pp. 3–19. (CRC Press: Boca Raton, FL.)

Lal, R. (2004). Soil carbon sequestration impacts on global climate change and food security. *Science* **304**, 1623–1627.

Ministry of Environment and Tourism (2017), *Mongolia's Initial Biennial Update Report under the United Nations Framework Convention on Climate Change*. Ministry of Environment and Tourism.

Ministry of Environment and Tourism (2018), *Mongolia Third National Communication under the United Nations Framework Convention on Climate Change*. Ministry of Environment and Tourism.

Ministry of Food, Agriculture and Light Industry (2018), *Action Plan of Mongolian Agenda for Sustainable Livestock*. Ministry of Food, Agriculture and Light Industry.

Ministry of Environment and Green Development (2013). Technology Needs Assessment Volume 1. Climate Change Adaptation in Mongolia.

Ministry of Environment and Green Development of Mongolia (2014), Mongolia Second Assessment Report on Climate Change 2014.

Ministry of Nature and Environment (2001), Mongolia's Initial National Communication.

Ministry of Nature, Environment and Tourism (2010), *Second National Communication of Mongolia under the United Nations Framework Convention on Climate Change*. Ministry of Nature, Environment and Tourism, Mongolia

Mongolian Society for Range Management (2016). Pastures, Conservation and Climate Action, Mongolia. Annual report year 1 (1st April 2015 – 31st March 2016).

Mongolian Society for Range Management (2018). Pastures, Conservation and Climate Action, Mongolia. Annual report years 2 and 3 (01.04.2016-31.03.2017; 01.04.2017-31.03.2018).

NSO (2018), Statistical Yearbook 2018.

Ped, D.A. (1975). On indicators of droughts and wet conditions (in Russian). Proc. USSR Hydrometeor Centre Russian Meteorol. Hydrol. 156:19–39.

Tennigkeit, T. and A. Wilkes (2013), *Nationally Appropriate Mitigation Actions for Grassland and Livestock Management in Mongolia*.

UNDP (2018), Human Development Indices and Indicators. 2018 Statistical Update.

UNDP (2020), Feasibility Study: Improving Adaptive Capacity and Risk Management of Rural Communities in Mongolia.

UNEP (2002), Mongolia: State of the Environment 2002.

Upton, C., D. Dorligsuren, D. Dulmaa, G. Gantsogt (2015). Pastures, Conservation and Climate Action, Mongolia. Plan Vivo Project Design Document.

Van der Tak. C. (2019) *Mongolia Aimag and Soum Centers Regional Development Investment Program (ASDIP): Report on Climate Finance Sources*.

Vicente-Serrano, S.M., S. Beguería and J.I. López-Moreno (2010). A Multiscalar Drought Index Sensitive to Global Warming: The Standardized Precipitation Evapotranspiration Index, J. Climate, 23, 1696–718. doi: 10.1175/2009JCLI2909.1

Wilkes, A. and N. Batjargal (2015), *Mainstreaming Climate Technology in Mongolia: Report for the Agriculture sector*. Report prepared under TA-8109, Integration of Climate Technology Financing Needs into National Development Strategies, Plans, and Investment Priorities.

Wilkes, A., T. Tennigkeit and B. Baival (2013). Grassland Carbon Sequestration in Mongolia: Opportunities to improve herders' livelihoods through markets and policies. A product of the SDC-supported Linking Herders to Carbon Markets project.

Worden, R.L. and A.M. Savada (eds) (1991), *Mongolia: A Country Study*. Library of Congress. Federal Research Division

Websites

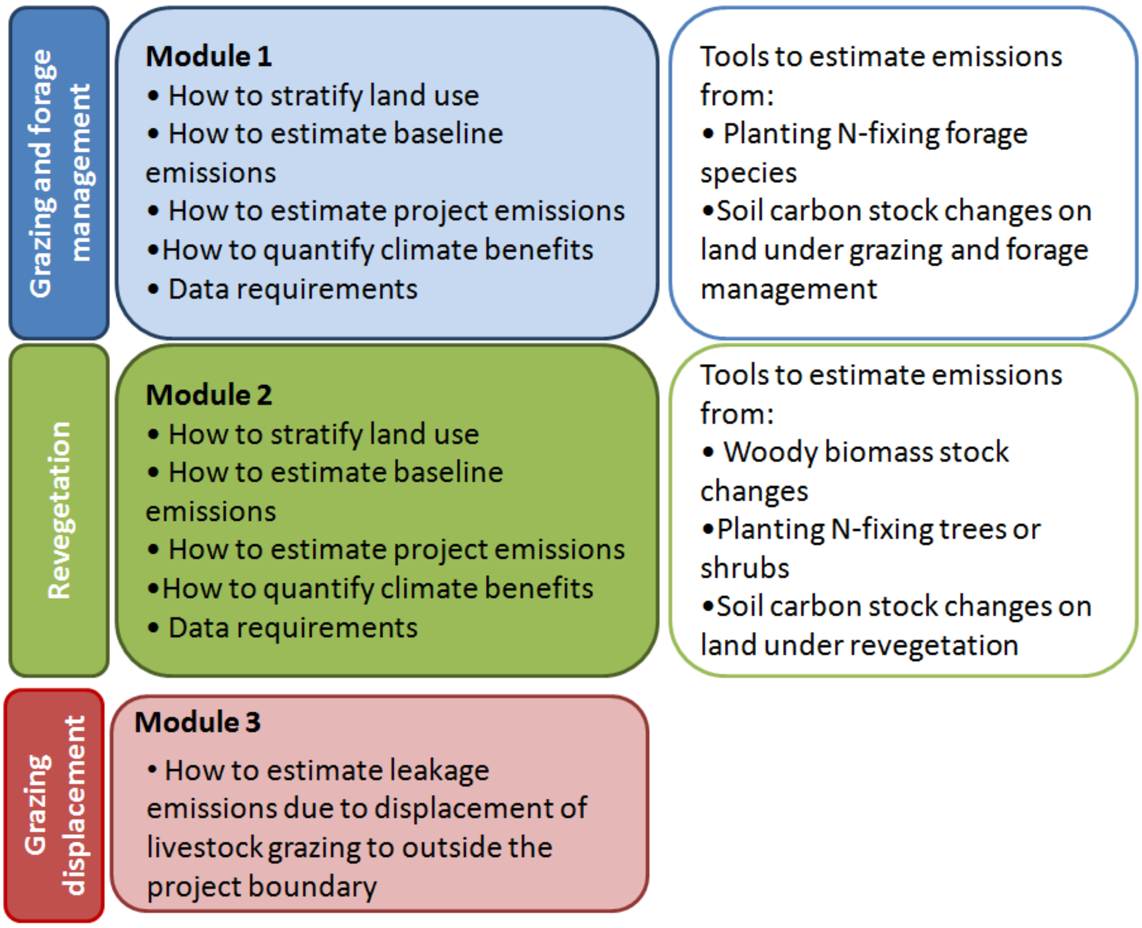
Mongolian Statistical Information Service, http://1212.mn/.
https://unfccc.int/files/meetings/cop_15/copenhagen_accord/application/pdf/mongoliacphaccord_app2.pdf

## ANNEX 1. SUMMARY OF THE PLAN VIVO MRV METHODOLOGY

1. The Plan Vivo methodology can be used to estimate the climate benefits of the following types of natural resources management activity in extensively managed grasslands: (1) Improved management of grasslands, including: improved grazing management and forage management (e.g. perennial forage cultivation, hay harvesting); (2) Revegetation of grassland, shrubland or forest, by (1) afforestation or reforestation and assisted natural regeneration of degraded shrub communities. Relevant improved grazing management activities may include changes in the timing of grazing and increased rotation of grazing between plots, changes in stocking rates and the intensity of grazing.

2. For grassland management activities, the sinks and sources accounted for include changes in soil carbon stocks, and emissions from cultivation of nitrogen-fixing forage species. The applicability conditions of the methodology limit its use to situations where project activities do not increase livestock numbers, so emissions from livestock enteric fermentation and manure management are not accounted for. For forest and shrub management, the methodology accounts for change in above and below ground woody biomass carbon stocks and soil carbon stocks, and emissions from re-vegetation with nitrogen-fixing tree or shrub species.

**Figure 60. Overview of the Plan Vivo methodology**




3. To make the methodology more accessible to natural resource management practitioners, the quantification requirements are set out separately for grazing and forage management (Module 1), and for re-vegetation activities (Module 2). Each of these modules presents guidance on stratification of the project area, quantification of baseline and project

emissions, and guidance on the data required for quantification of climate benefits. Project emissions can be quantified for each emission source by following the procedures set out in 6 appendixes to the methodology. A separate module provides guidance for quantifying leakage emissions due to displacement of grazing activities from the project boundary (Module 3).

4. A selection of the main data used in the MRV of the carbon sequestration has been included in Table 24 and Table 25. For a complete overview, see the Plan Vivo methodology and the Century operation manuals: https://www.nrel.colostate.edu/projects/century/.

**Table 24. Main data used for estimating climate benefits of grazing management**

| Parameter | Description | Source of data | Use of parameter |
|---|---|---|---|
| Area of each land use stratum under grazing management | Area (hectares) of each land use stratum | Field survey using GPS or calculated from existing maps | Quantification of area subject to different grazing management practices, and estimation of baseline and project scenario biomass removal rates |
| Above ground biomass | Above ground biomass (kg dry matter) of grassland vegetation in each land use stratum | Field survey or reliable values from monitoring plots in the project area, or peer reviewed literature that is representative of the project area | Quantification of biomass removal rates as input into Century model |
| Population of livestock of each type in each season | Type of livestock distinguished by sex and age class (young, mature) | Reliable statistics, or baseline activity survey | Quantification of biomass removal rates as input into Century model |
| Dates & number of grazing days in each season | Dates of grazing and number of days spent grazing during each season by each type / class of livestock | Baseline activity survey | Quantification of biomass removal rates as input into Century model |

**Table 25. Main data used for estimation of climate benefits of forage management**

| Parameter | Description | Source of data | Use of parameter |
|---|---|---|---|
| *For all forage* | | | |
| Area of each land use stratum planted with each type of forage | Area (hectares) of each land use stratum | Field survey using GPS or calculated from existing maps | Quantification of the area planted to each type of forage |
| Pre-project area under N-fixing forage species | Area (hectares) of land use stratum planted with N-fixing species in the baseline | Field survey | Assessment of the significance of the increase in N-fixing forage species area |
| Forage cultivation practices | Parameters describing management of cultivated forage plots (e.g. timing of sowing and harvest, tillage methods, proportion of biomass removed etc.) | Technical specifications for each land use stratum | As input into the Century model |
| *For nitrogen-fixing forage* | | | |

| Parameter | Description | Source of data | Use of parameter |
|---|---|---|---|
| $Crop_{g,t}$ | Annual dry matter returned to soils by N-fixing species *g* | Measurements from existing plots in project area, published estimates, expert judgment or IPCC default values | Estimation of $N_2O$ emissions from cultivation of N-fixing forage species |
| $EF_{NF}$ | Emission factor for N-fixing forage species | Published estimates or IPCC default values | Estimation of $N_2O$ emissions from cultivation of N-fixing forage species |
| $GWP_{N2O}$ | Global warming potential of $N_2O$ | IPCC default value | Estimation of $N_2O$ emissions from cultivation of N-fixing forage species |
| $N_g$ | Fraction of N in dry matter of N-fixing species | Published estimates or IPCC default values | Estimation of $N_2O$ emissions from cultivation of N-fixing forage species |

# ANNEX 2. CALCULATIONS OF EMISSIONS DURING CONSTRUCTION

## A. Introduction

1. During the early submission review by the independent technical advisory panel (iTAP) of the funding proposal and accompanying documentation of the Mongolia: Aimags and Soums Green Regional Development Investment Program (ASDIP), the Asian Development Bank (ADB) was among others requested to estimate the amount of greenhouse gas (GHG) emissions due to construction of infrastructure and housing. This annex has been prepared in answer to this request. It is based on a survey of a sample of the literature on the topic, includes an ex ante estimate of the greenhouse gas emissions due to the construction activities, and includes a methodology for the monitoring of the construction emissions during implementation of ASDIP.

## B. Review of literature

2. There are several academic papers providing examples of the calculation of greenhouse gas emissions due to construction activities. A list of reviewed papers has been included in the references below. Most of these studies use life-cycle analysis (LCA), either in the form of process LCA, input-output LCA, or hybrid LCA. See Box 2 for an overview of these methodologies.

**Box 2. Overview of LCA approaches employed in literature.**

There are three types of LCA that can be commonly found in literature: Process LCA, input-output LCA and hybrid LCA.

- Process LCA. Process LCA is the most traditional way of conducting a LCA. The method is based on local and current process data that is used to convert amounts of materials and energy into carbon emissions. The carbon emissions of each process in the product life cycle are analyzed separately. The emissions are then added together to reveal the total life cycle emissions.
- Input-output LCA. Input-output LCA or IO LCA is based on converting monetary costs into carbon emissions based on matrices that use industry average data. It uses the sectorial structure of the economy to capture how different sectors of the economy contribute to the final product and sectoral emission factors linking sectoral value added to greenhouse gas emissions. This approach links economic input-output analysis (see Leontief 1970) to environmental issues.
- Hybrid LCA. Hybrid LCA mixes process LCA and IO LCA. It uses process LCA for the most important sources of emissions, especially where different production methods exist next to each other, or where a sector is made up of widely different products. This method is then complemented with IO LCA to enhance the comprehensiveness of the method.

*Source*: Säynäjoki et al. (2012)

3. To maximize this annex's utility, it is important to assure that the method suggested for the *ex ante* estimate of emissions and their monitoring is practical and transparent, so that it can easily be replicated in other projects proposed by ADB and by other other AEs proposing projects to the GCF with significant construction activities.

4. It is assumed that the estimation methodology also needs to be accurate and conservative:

- Accurate: provide an estimate of actual emissions that is as close as possible; and
- Conservative: where calculated emissions deviate from actual emissions, overestimate them, so that the project's mitigation impact is not overestimated.

*Buildings and civil works*

5. The following is a summary of the sources of emissions in the construction of buildings: 1) emissions embodied in the building materials (the amount of GHG emissions emitted during the production of production materials); 2) emissions during transport of building materials; 3) emissions from fuel combusted in construction equipment; 4) emissions from electricity consumed in construction equipment; 5) electricity consumed in the transport of water and sewage; and 6) emissions from fuel consumed during the transport of construction waste.[50] It is important to understand these sources and their relative contributions.

6. The literature reviewed shows a considerable variation in amount of greenhouse gas emissions from construction of buildings. On a per $m^2$ basis, estimated emissions range from 0.072 $tCO_2e$ to 0.803 $tCO_2e$ (Jingke Hong et al. 2015). This means that while using a fixed coefficient between built area and greenhouse gas emissions would be simple, it will not be accurate. Noting that the built area is over 200,000 $m^2$, it also shows that the amount of emissions during construction of buildings will be considerable so that it is important to get the estimates right. Hence a simple fixed coefficient approach has been rejected.

7. On the other hand, the breakdown of emissions show that the most important source of emissions will be those embodied in the building materials (the amount of emissions emitted during the production of production materials) followed by those related to the transport of the building materials) and energy use on-site. According to literature estimates for a construction project with similar construction technology to ASDIP, embodied emissions account for about 87% of total emissions, emissions due to transport of building materials account for 6% and energy use on site for about 6%.[51] Emissions due to electricity consumption for water transport and due to fuel combustion for transport of construction waste are very small to negligible at around 1% (See Table 26).

**Table 26. Breakdown of emissions from a buildings construction project**

| **Item** | **GHG emissions (tCO2e)** | **Percentage breakdown** |
|---|---|---|
| 1) Emissions embodied in building materials | 19,660.22 | 86.73% |
| 2) Emissions from transport of building materials | 1,377.05 | 6.07% |
| 3) Emissions from fuel consumption by construction equipment | 643.74 | 2.84% |
| 4) Emissions from electricity use by construction equipment | 763.53 | 3.37% |
| ***Subtotal a): On-site energy use - 3) + 4)*** | ***1,407.27*** | ***6.21%*** |
| 5) Emissions from electricity use for transport of water and sewage | 9.70 | 0.04% |
| 6) Emissions from transport of construction waste | 214.92 | 0.95% |
| ***Subtotal b): others - 5) + 6)*** | ***224.62*** | ***0.99%*** |
| **Total** | **22,669.16** | **100.00%** |

*Source*: Hui Yan et al. (2010).

8. In this particular case, the bulk of the emissions from building materials and building materials transport are from steel and concrete or cement (embodied emissions in concrete are practically equal to the embodied emissions from cement – using 350 kg cement per $1m^3$ concrete as typical mix). These account for 94-95% of total emissions embodied in building materials and a similar percentage of building materials transport.[52]

[50] See Hui Yan et al. (2010) for details.
[51] See Hui Yan et al. (2010).
[52] Again, see Hui Yan et al. (2010). The caveat about the type of building is important: for instance, Jingke Hong et al. (2015) finds that the same building materials account for only 2/3 of total emissions embodied in building materials. This realization has led to the wide coverage of building materials in the monitoring described in Section F.

9. It should be noted that it is difficult to estimate and collect data on the fuel and electricity consumption due to the use of construction equipment on site. The reason is the multitude of equipment and processes, making it difficult to collect comprehensive data.

10. This suggests that a possible approach would be to (1) forecast the use of key building materials (steel and cement, including cement in concrete), (2) identify the emission coefficient of the production of these building materials and use a scaling factor (to go from 94-95% to 100%) to calculate the total embodied emissions, and (3) use a percentage of the total amount of embodied emissions of building materials to estimate emissions due to on-site energy use, and for water & sewage and construction waste transport. Finally, (4) based on the source of the key building materials, calculate the total number of ton-km traveled, and combine these with standard factor and scaling factor to arrive at emissions due to transport of building materials. Please refer to Section[53] C for details and to Section D for the application based on ASDIP data. Monitoring, however, would need to consider a wider scope of building materials and emission factors (see Section E), to ensure that all important sources of emissions are captured.

11. For civil works, the methodology proposes to use the same approach as for buildings, as described in the steps above. For roads, an exception is made which is described below, which allows for a coefficient approach to assess whether a more refined calculation as described here is warranted.

*Roads*

12. For roads, the methodology proposes to use coefficients (see Section E) and road lengths to make an initial estimate of the amount of GHG emission associated with the construction of the roads. Based on the initial estimate, a judgment can be made whether GHG emissions are likely to be substantial enough to warrant a more specific calculation based on the approach outlined for buildings and civil works (see paragraph 10).

13. For example, ASDIP involves the construction of 226.7 km of roads. World Bank (2010) gives a provincial road construction emissions coefficient of 207 $tCO_2$/km, resulting in an initial estimate of almost 47 thousand tCO2 for the construction of roads in ASDIP. This is substantial enough to warrant a more precise calculation based on the approach outlined above. To be conservative, the higher of the two values (based on the coefficient approach and the detailed calculation) can be applied in the estimates.

## C. Calculation method – ex ante estimate of construction emissions

14. For the *ex ante* calculation of the expected emissions from ASDIP and similar projects, this note proposes the following approach:

a) Road construction: Either according to a) or the highest number of a1) and a2).
   - a1) Disaggregate the road by road type and determine the length of each type of road constructed. Multiply the length of road constructed, by type, with the applicable coefficient from Table 31 in Section E, and sum.
   - a2) If the initial estimate is significant enough, compare this with the calculation based on steps b1-b4 below, adding bitumen as building material to be considered in the approach.

b) Building and civil works construction: sum of the emissions calculated in steps b1)-b4) below.

[53] Throughout this Annex, references to Sections are to references within this Annex.

b1) Embodied emissions in building materials: estimate the use of cement (including cement in concrete) and steel and multiply each with the emission factors from Table 32 in Section E, and sum. Multiply the result with 1.06. Note that this scaling factor is appropriate for ASDIP but may not be appropriate for other projects. In cases where this scaling factor is not appropriate, the best way forward is to broaden the coverage of building materials included in the analysis and sum the results, without employing a scaling factor – see Section E.

b2) Emissions from transport of building materials: Determine likely supply soures of cement and steel (plus others if applicable) and determine the distance of the source to the ASDIP construction site. From this and the amount of cement and steel used, determine the number of ton.km for each (assuming full weight roundtrips). Multiply each with the applicable emission factor from Table 33 in Section E, and sum. Multiply the result with 1.06. Note that this scaling factor is appropriate for ASDIP but may not be appropriate for other projects. In cases where this scaling factor is not appropriate, the best way forward is to broaden the coverage of building materials included in the analysis and sum the results, without employing a scaling factor – see Section E.

b3) Emissions from on-site energy use: Multiply the final result of step b1) with 0.0716. This factor is based on Hui Yan et al. (2010). The resulting number corresponds with subtotal a) in Table 26.

b4) Other emissions: Multiply the final result of step b1) with 0.0114. This factor is based on Hui Yan et al. (2010).

## D. Results for ASDIP

15. For the *ex ante* calculation of the expected emissions from ASDIP, we have used the raw data included in Table 27-Table 28. For eastern aimags, cement is expected to come from Khutul cement plant by way of UB. For western aimags, the same is true for cement used for Tranche 1. For Tranches 2 and 3, it is assumed that all cement will come from the Khovd Eco Cement plant in Buyant soum of Khovd aimag. Steel is in all cases assumed to come from Baotou in China by way of UB, and bitumen is expected to come from UB.

**Table 27. Input data for the estimate of emissions during ASDIP road construction.**

| Item | Unit | Value | Source / comment |
|---|---|---|---|
| Length of roads constructed | km | 226.7 | ASDIP estimates |
| Road construction emission coefficient | $tCO_2$/km | 207 | Table 31, Section E. “Provincial road” value |
| Amount of cement | Ton | 62,635 | ASDIP estimates |
| Amount of steel | Ton | 5,708 | ASDIP estimates |
| Amount of bitumen | Ton | 15,922 | ASDIP estimates |
| Estimated breakdown of roads constructed: | | | |
| - Western aimags, Tranche 1 | km | 50 | ASDIP estimates |
| - Western aimags, Tranches 2-3 | km | 101.7 | ASDIP estimates |
| - Eastern aimags, Tranches 2-3 | km | 75 | ASDIP estimates |
| Estimated distances over which building materials are transported | | | |
| Cement: Khutul-western aimags | km | 1886 | See paragraph 15 |
| Cement: Buyant soum-western aimags | km | 200 | See paragraph 15 |
| Cement: Khutul-eastern aimags | km | 870 | See paragraph 15 |
| Steel: Baotou-Western aimags | km | 2550 | See paragraph 15 |
| Steel: Baotou-Eastern aimags | km | 1532 | See paragraph 15 |
| Bitumen: UB-western aimags | km | 1686 | See paragraph 15 |
| Bitumen: UB-eastern aimags | km | 669 | See paragraph 15 |
| Emission factor cement | $tCO_2e$/t | 0.8349 | Table 32, Section E. Local value estimate used |
| Emission factor steel | $tCO_2e$/t | 1.45 | Table 32, Section E |
| Emission factor bitumen | tCO2e/t | 0.43 | Table 32, Section E. Local value estimate used |
| Transport emissions coefficient | $kgCO_2e$/t.km | 0.117 | Table 33, Section E. Transport in trucks > 32t |

16. It should be noted that the assumptions in Table 27 may overestimate the actual needs of the project, as significant tracts of the road construction involve road improvement rather than the construction of new paved roads. Therefore, the emissions estimate for road construction may exceed actual emissions.

**Table 28. Input data for the emissions estimate of buildings and civil works construction.**

| Item | Unit | Value | Source / comment |
|---|---|---|---|
| Amount of cement | Ton | 39,404 | TRTA teamleader estimate |
| Amount of steel | Ton | 2,403 | TRTA teamleader estimate |
| Western aimags, Tranche 1 (share) | % | 22.5% | ASDIP estimates |
| Western aimags, Tranches 2-3 (share) | % | 47.5% | ASDIP estimates |
| Eastern aimags, Tranches 2-3 (share) | % | 30.0% | ASDIP estimates |
| Estimated distances over which building materials are transported | | | |
| Cement: Khutul-western aimags | km | 1886 | See paragraph 15 |
| Cement: Buyant soum-western aimags | km | 200 | See paragraph 15 |
| Cement: Khutul-eastern aimags | km | 870 | See paragraph 15 |
| Steel: Baotou-Western aimags | km | 2550 | See paragraph 15 |
| Steel: Baotou-Eastern aimags | km | 1532 | See paragraph 15 |
| Emission factor cement | $tCO_2e/t$ | 0.8349 | Table 32, Section E. Local value estimate used |
| Emission factor steel | $tCO_2e/t$ | 1.45 | Table 32, Section E |
| Transport emissions coefficient | $kgCO_2e/t.km$ | 0.117 | Table 33, Section E. Transport in trucks > 32t |

17. The calculation of the expected emissions from ASDIP proceeds according to the steps outlined in Section C. The results are summarized in Table 29.

a) Road construction emissions: highest of a1) and a2)
   - a1) Road construction emissions, coefficient approach: 226.7 x 207 = 46,926.90 $tCO_2e$.
   - a2.1) Embodied emissions in building materials for road construction: (62635 x 0.8349 + 5708 x 1.45 + 15922 x 0.43) x 1.06 = 71,462.04 $tCO_2e$.
   - a2.2) Emissions for transport of road building materials: (62635 x (50/226.7 x 1886 + 101.7/226.7 x 200 + 75/226.7 x 870) + 5708 x (151.7/226.7 x 2550 + 75/226.7 x 1532) + 15822 x (151.7/226.7 x 1686 + 75/226.7 x 669)) x 2 x 0.117/1000 x 1.06 = 20,791.28
   - a2.3) Emissions from on-site energy use by construction equipment for road construction: 71462.04 x 0.0716 = 5,116.68 $tCO_2e$.
   - a2.4) Other emissions during road construction: 71462.04 x 0.014 = 1,000.47 $tCO_2e$.
   - a2) Total road construction emissions, a2): 71,462.04 + 20,791.28 + 5,116.68 + 1,000.47 = 98,370.47

a) Road construction emissions, final: max (46926.90, 98370.47) = 98,370.47

b) Building and civil works construction emissions: sum of b1-b4.
   - b1) Embodied emissions in building materials: (39404 x 0.8349 + 2403 x 1.45) x 1.06 = 38,565.71 $tCO_2e$.
   - b2) Emissions for transport of building materials: (39404 x (0.225 x 1886 + 0.475 x 200 + 0.3 x 870) + 2403 x (0.7 x 2550 + 0.3 x 1532)) x 2 x 0.117/1000 x 1.06 = 8,964.83 $tCO_2e$.
   - b3) Emissions from on-site energy use by construction equipment: 38565.71 x 0.0716 = 2,761.31 $tCO_2e$.
   - b4) Other emissions: 38565.71 x 0.014 = 539.92 $tCO_2e$.

b) Building and civil works construction emissions: 38565.71 + 8964.83 + 2761.31 + 539.92 = 50,831.77 $tCO_2e$.

c) Total ASDIP construction emissions: 98,370.47 + 50,831.77 = 149,202.24 $tCO_2e$.

**Table 29. Summary of ex ante construction emission results, ASDIP project**

| Item | Emissions | Share in emissions – ASDIP total and parts |
|---|---|---|

| | | ASDIP total | ASDIP, buildings and roads |
|---|---|---|---|
| ***Road construction*** | ***98,370.47*** | ***65.93%*** | ***100.00%*** |
| Building materials, embodied emissions | 71,462.04 | 47.90% | 72.65% |
| Building materials, transport | 20,791.28 | 13.93% | 21.14% |
| On-site energy use | 5,116.68 | 3.43% | 5.20% |
| Others | 1,000.47 | 0.67% | 1.02% |
| ***Building construction*** | ***50,831.77*** | ***34.07%*** | ***100.00%*** |
| Building materials, embodied emissions | 38,565.71 | 25.85% | 75.87% |
| Building materials, transport | 8,964.83 | 6.01% | 17.64% |
| On-site energy use | 2,761.31 | 1.85% | 5.43% |
| Others | 539.92 | 0.36% | 1.06% |
| **Total** | **149,202.24** | **100.00%** | **NA** |

*Source*: Consultant's calculations

18. The estimate of building construction emissions is 188 $kgCO_2e/m^2$, which is entirely plausible given the range of results in literature reported in Jingke Hong et al. (2015) of 0.072 $tCO_2e/m^2$ to 0.803 $tCO_2e/m^2$.

## E. Monitoring

19. To monitor the emissions ex post, we can make use of the more detailed information available at this stage. Our discussion here is slightly wider than above, so that the methodology becomes more general and can also cope with deviations from what is currently planned for ASDIP. This makes the methodology more flexible and applicable.

20. Table 30 provides an overview of the information that needs to be collected to monitor actual construction emissions of ASDIP. These data shall be combined with the emission coefficients and factors included in Tables 31-33.

**Table 30. Monitoring data to be collected**

| Parameter | Unit | Comments |
|---|---|---|
| Length of road constructed, by road type. | km | Road types to be covered include expressway, national road, provincial road, rural road – gravel, and rural road – DBST. |
| Building materials amounts | $m^3$, ton[54] | Building materials to be covered are: concrete, talcum powder, steel, UF foamed plastic, polyamides safety net, cement, aluminium, stainless steel products, glass, slag, clay haydite, welding rod, polyurethane, perlite, timber plates, wire entanglement, formwork, UPVC pipe, marble, gravel, ceramic, mosaic, alcohol and bitumen.[55] Other materials may be included if accounting for more than 0.1% of total building materials mass. If more than one producer is used for a given building materials, note the amounts supplied separately and number the sources (e.g. cement (1), cement (2), etc.). |
| Distance to building materials productions source, by building material and production site | km | Distance to be calculated based on the production source used. Coverage: all building materials and all building material producers from whom building materials for the project originate. |
| Source-specific emission factor | $tCO_2e/m^3$, $tCO_2e/kg$ | When the production plants of building materials have been determined, it may be assessed that the use of the default values in Table 27 is inappropriate. In such cases, source specific emission factors may be calculated and used. |

DBST = Double Bituminous Surface Treatment; UPVC = un-plasticized polyvinyl chloride

[54] The unit ton is used throughout except for concrete, timber plates and formwork.
[55] This list is based on Jingke Hong et al. (2015) with bitumen added.

**Table 31. Road construction emission coefficients**

| Road type | Greenhouse gas emission coefficient, tCO2e/km road |
|---|---|
| Expressway | 3,234 |
| National road | 794 |
| Provincial road | 207 |
| Rural road – gravel | 90 |
| Rural road – DBST | 103 |

DBST = Double Bituminous Surface Treatment. Highlighted numbers have been used in the calculations in Section D.
*Source*: World Bank (2016)

**Table 32. Building materials emission factors.**

| Building material | Unit | Suggested default | Preferred local value | Comments |
|---|---|---|---|---|
| Concrete | $tCO_2e/m^3$ | 0.261 | 0.2871 | Revised 10% upwards because of assessed technology lag. |
| Talcum powder | $tCO_2e$/ton | 1.250 | - | |
| Steel | $tCO_2e$/ton | 1.450 | - | |
| UF foamed plastic | $tCO_2e$/ton | 2.910 | - | |
| Polyamides safety net | $tCO_2e$/ton | 9.270 | - | |
| Cement | $tCO_2e$/ton | 0.759 | 0.8349 | Revised 10% upwards because of assessed technology lag. |
| Aluminium | $tCO_2e$/ton | 5.900 | - | |
| Stainless steel products | $tCO_2e$/ton | 1.450 | - | |
| Glass | $tCO_2e$/ton | 1.090 | - | |
| Slag | $tCO_2e$/ton | 0.443 | - | |
| Clay haydite | $tCO_2e$/ton | 0.327 | - | |
| Welding rod | $tCO_2e$/ton | 20.500 | - | |
| Polyurethane | $tCO_2e$/ton | 4.310 | - | |
| Perlite | $tCO_2e$/ton | 0.995 | - | |
| Timber plates | $tCO_2e/m^3$ | 0.583 | - | |
| Wire entanglement | $tCO_2e$/ton | 2.840 | - | |
| Formwork | $tCO_2e/ m^3$ | 0.644 | - | |
| UPVC pipe | $tCO_2e$/ton | 3.230 | - | |
| Marble | $tCO_2e$/ton | 0.436 | - | |
| Gravel | $tCO_2e$/ton | 0.00241 | - | |
| Ceramic | $tCO_2e$/ton | 0.780 | - | |
| Mosaic | $tCO_2e$/ton | 0.238 | - | |
| Alcohol | $tCO_2e$/ton | 0.828 | - | |
| Tubular pile | $tCO_2e$/ton | 1.450 | - | |
| Bitumen | $tCO_2e$/ton | 0.32 | 0.43 | |

UPVC = un-plasticized polyvinyl chloride. Highlighted numbers have been used in the calculations in Section D.
*Source*: Suggested default values are from Jingke Hong et al. (2015) with the exception of bitumen, for which Lancaster (2009) was used as a basis, with corrections for the electrical power grid emission factor by the consultant.

**Table 33. Transport emission factors**

| Means of transport | Unit | Suggested default value |
|---|---|---|
| Lorry 3.5-7.5 ton | $kgCO_2e$ / ton.km | 0.660 |
| Lorry 7.5-16 ton | $kgCO_2e$ / ton.km | 0.292 |
| Lorry 16-32 ton | $kgCO_2e$ / ton.km | 0.168 |
| Lorry >32 ton | $kgCO_2e$ / ton.km | 0.117 |

Highlighted numbers have been used in the calculations in Section D.
*Source*: Jingke Hong et al. (2015). For transport modes not covered in this table, please refer to the methodologies suggested in IPCC (2006).

21. The ex post calculations of the emissions then proceeds according to the following steps, mirroring the ones described in Section C:

a) Road construction emissions. Multiply the length of road of a given type constructed with the relevant emission coefficient from Table 31, and sum the products. In formula form:

$$E_{Road} = \sum_i (L_i . C_i) \quad \textbf{(1)}$$

With:

$E_{Road}$ Total emissions from road construction, in $tCO_2e$.
$L_i$ Length or road type *i* constructed, expressed in km.
$C_i$ The road construction emission coefficient or road type i, included in Table 31, expressed in $tCO_2e$/km road
*i* an index running over the road types included in Table 31.

Alternatively if the initial estimate shows a number high enough to warrant more in depth analysis, use the steps included in b) below.

b) Buildings construction emissions. Buildings construction emissions is equal to the sum of the emissions embodied in building materials, emissions from the transport of building materials, emissions from on-site energy use, and other emissions during construction of buildings. In formula form:

$$E_{Buildings} = E_{BM,embodied} + E_{BM,transport} + E_{energy,on\ site} + E_{others} \quad \textbf{(2)}$$

With:

$E_{buildings}$ Total emissions of greenhouse gas emissions due to construction of buildings, in $tCO_2e$.
$E_{BM,embodied}$ The emissions from production of building materials embodied in the building materials used. See b1) and formula (3).
$E_{BM,transport}$ The emissions due to the combustion of fuels during the transport of the building materials. See b2) and formula (4).
$E_{energy,on\ site}$ The emissions due to fuel combustion in and electricity consumption of construction equipment. See b3) and formula (5).
$E_{others}$ The other sources of emissions during building construction, primarily due to the use of electricity for the transport of water and sewage and the combustion of fuel in the transport of construction waste. See b4) and formula (6).

b1) Embodied emissions in building materials. The sum of the products of the amount of each building material used and the emission factor of the building material (see Table 32). During monitoring, usually the coverage of building materials is comprehensive, and hence the resulting outcome does not need to be scaled (see below). If the building materials coverage is less comprehensive, multiplication by a scaling factor is a possibility. The latter is reflected in formula 3 below.

$$E_{BM,embodied} = (\sum_j (A_j . F_j)) . S \quad \textbf{(3)}$$

With:

$A_j$ Amount of building material *j* used, expressed in tons or $m^3$ (see footnote 3).
$F_j$ Emission factor of building material *j*, expressed in $tCO_2e$/ton or $tCO_2e/m^3$ (see Table 32)
S A scaling factor. Normally 1 during monitoring (and this is planned for ASDIP); set at 1.06 during the *ex ante* calculations used in ASDIP with the abbreviated coverage of building materials.
*j* An index running over all building materials used (Table 32 is a typical, comprehensive list).

b2) Emissions from transport of building materials. The sum of the products of the amount of building materials sourced from a specific production plant, total distance from the source to the production site, and the means of transport specific emission factor per ton.km (see Table 33). See formula 4 below.

$$E_{BM,transport} = (\sum_{j,k,l}(W_{j,k,l}.D_{j,k,l}.T_l.2/1000)).S \qquad \textbf{(4)}$$

With:
$W_{j,k,l}$ The weight of building material *j* from production source *k* transported by means of transport *l*, measured in tons.
$D_{j,k,l}$ The distance over which building material *j* from source *k* is transported by means of transport *l*, measured in km. Indices *j* and *l* are included because the type of building material and the means of transport may influence distance. Note that the factor 2 in the formula is included to capture the roundtrip lag (in a conservative manner).
$T_l$ Transport emission coefficient of means of transport *l*, in kg$CO_2$e/ton.km, see Table 33. Note that the factor 1000 is the formula covers the conversion from kg to ton.
*k* An index running over all building material production plant locations.
*l* An index running over all means of transport.

b3) Emissions from on-site energy use. Obtained by multiplying the emissions embodied in building materials by a fixed factor. See formula 5 below.

$$E_{energy,on\,site} = E_{BM,embodied}.X \qquad \textbf{(5)}$$

With:
X A fixed factor. We recommend and have used a value of X of 0.0716. With proper justification, a different value may be used in cases different from ASDIP.

b4) Other emissions during construction of buildings. Obtained by multiplying the emissions embodied in building materials by a fixed factor. See formula 6 below.

$$E_{energy,on\,site} = E_{BM,embodied}.Q \qquad \textbf{(6)}$$

With:
Q A fixed factor. We recommend and have used a value of X of 0.0114. With proper justification, a different value may be used in cases different from ASDIP.

c) Total emissions. Total emissions are found by summing emissions due to road construction and emissions due to building construction. In formula form:

$$E_{Total} = E_{Road} + E_{Buildings} \qquad \textbf{(7)}$$

With
$E_{total}$ Total emissions due to construction of an urban renewal project, *in casu* ASDIP, in t$CO_2$e.

### F. Discussion

22. Above we have described a fairly comprehensive approach for the *ex ante* estimation and *ex post* monitoring of emissions due to an urban renewal project in a setting similar to ASDIP and have applied it *ex ante* to the ASDIP case. Our estimate for the total emissions due to the construction of ASDIP is 149,202.24 t$CO_2$e. In a worst case interpretation – no construction activities without ASDIP – this would mean that our estimate for net emission reductions (not including construction emissions) due to ASDIP need to be adjusted from 112.91 million to 112.76 million t$CO_2$e.

23. As also previously pointed out, the estimate of building construction emissions is 188 $kgCO_2e/m^2$, which is entirely plausible given the range of results in literature reported in Jingke Hong et al. (2015) of 0.072 $tCO_2e/m^2$ to 0.803 $tCO_2e/m^2$. This provides additional comfort that the estimates are realistic.

24. A notion that recently has been advanced in the discussions about building energy efficiency investments is the carbon payback time. The carbon payback time is the time required to earn back the investment in the form of additional emission during construction with the emission reductions during operation of the more energy efficient building solutions. In our case, the "investment" is 50,831.77 $tCO_2e$ and the return is 23,774 $tCO_2e/yr$ (only considering the emission reductions thanks to enhanced building energy efficiency, so ignoring emission reductions from solar panels and more efficient heat supply which are other benefits from ASDIP). This implies a carbon payback time of the building energy efficiency component of 2.1 years, which is very quick and compares favorably with those found in literature.

25. Säynäjoki et al. (2012), for example, studied an investment in Southern Finland. In the case of replacement of existing buildings with new, energy efficient buildings, the carbon payback time is several decades, with questionable climate benefits. By contrast, in the case of new construction (not analyzed in our case), energy efficient buildings may imply higher emission during construction, but is rapidly compensated by the lower emissions during use, resulting in a carbon payback time is only a few years. Pöyry et al. (2015) has a similar finding about the long time required for investment in energy efficient buildings replacing inefficient buildings to result in greenhouse gas emissions.

26. Several factors explain our markedly different findings for ASDIP. First, the existent housing stock in the case of ASDIP (the baseline before intervention) is very inefficient, increasing the scope for emission reductions through energy efficiency gains tremendously. Second, the long and extremely cold winters of Mongolia increase the gains from energy efficiency because of the extremely high heat demand. Third, Mongolia's energy supply systems are inefficient and based on the most carbon intensive fuels, further increasing the scope for greenhouse gas emissions through energy efficiency gains.

27. This favorable difference notwithstanding, it is worthwhile to identify options for reducing the emissions resulting from the construction phase of ASDIP. This may be done through procurement practices (using low carbon intensity of building materials as a selection criterion) and/or by promoting low carbon practices in building materials production through pilots. As the emissions embodied in cement *c.q.* cement included in concrete is the main source of greenhouse gas emissions (accounting for more than 70%), it is logical to focus on this complex.

28. Several options exist that will reduce carbon intensity of cement production and that may be promoted through procurement practices or pilots:
- Using low-carbon fuels (e.g., waste) in cement production;
- Using renewable power as source of power supply in cement production;
- Reuse waste heat, or recover waste heat for power generation;
- Reduce process emissions by replacing the feedstock for clinker production (e.g. change from calcium carbonate to calcium carbides or potassium carbonate)
- Reduce process emissions by reducing the use of clinker through the use c.q. increased use of other cementitious materials (such as fly ash and volcanic ash) in cement or the concrete mix. Using activation technologies will allow more significant replacement of clinker/cement by other cementitious materials.

## G. Conclusions

29. This annex described a comprehensive methodology for the calculation of emissions for the construction phase of urban renewal projects which can be applied to a multitude of projects but is especially well suited for construction projects in dry and arid climates.

30. The annex applies this methodology to the ASDIP case. We find that (1) the emissions during the construction of the buildings are approximately 51 thousand $tCO_2e$, (2) the emissions during the construction of the roads are approximately 98 thousand $tCO_2e$, and (3) total emissions during the construction of ASDIP are about 149 thousand $tCO_2e$. In the worst possible interpretation, this means that the emission reductions from ASDIP will be 112.91 million $tCO_2e$ instead of 112.76 million $tCO_2e$.

31. Looking into more detail, we find that the most important source of greenhouse gas emission during building construction are the emissions embodied in the building materials. This source of greenhouse gas emissions accounts for over 75% of the emission of buildings construction in ASDIP.

32. In contrast to many other studies focusing on the replacement of existing housing stock with new housing stock, the carbon payback time is short, slightly more than two years. Several factors explain this favorable difference. First, the existent housing stock in the case of ASDIP is very inefficient, increasing the scope for emission reductions through energy efficiency gains tremendously. Second, the long and extremely cold winters of Mongolia increase the gains from energy efficiency because of the extremely high heat demand. Third, Mongolia's energy supply systems are inefficient and based on the most carbon intensive fuels, further increasing the scope for greenhouse gas emissions through energy efficiency gains.

33. This note also considered opportunities to reduce the greenhouse gas emissions during construction and further improve the carbon payback time. Cement/concrete, accounting for more than 70% of total construction emissions, offer the best opportunities for lowering emissions embodied in building materials. Specific measures that could be promoted through preferential procurement and/or through pilots are:

- Using low-carbon fuels (e.g., waste) in cement production;
- Using renewable power as source of power supply in cement production;
- Reuse waste heat, or recover waste heat for power generation;
- Reduce process emissions by replacing the feedstock for clinker production (e.g. change from calcium carbonate to calcium carbides or potassium carbonate)
- Reduce process emissions by reducing the use of clinker through the use c.q. increased use of other cementitious materials (such as fly ash and volcanic ash) in cement or the concrete mix. Using activation technologies will allow more significant replacement of clinker/cement by other cementitious materials.

## H. References to Annex 2

Jingke Hong, Geoffrey Qiping Shen, Yong Feng, William Sin-tong Lau and Chao Mao. 2015. Greenhouse gas emissions during the construction phase of a building: a case study in China. *Journal of Cleaner Production* Volume 103, 15 September 2015, pp. 249-259.

IPCC. 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 2: Energy. Chapter 3: Mobile Combustion*.

Lancaster, I.M. (2009). *Taking Oil further: Bitumen Lifecycle & Footprint*.

Leontief, W., 1970. Environmental Repercussions and the Economic Structure: An Input-Output Approach. *The Review of Economics and Statistics* 52(3), pp 262–271.

Amalia Pöyry, Antti Säynäjoki, Jukka Heinonen, Juha-Matti Junnonen and Seppo Junnila. 2015. Embodied and construction phase greenhouse gas emissions of a low-energy residential building. *Procedia Economics and Finance* 21 (2015) 355 – 365

Antti Säynäjoki et al. 2012. A scenario analysis of the life cycle greenhouse gas emissions of a new residential area. *Environmental Research Letters* 7 (2012) 034037, pp.

World Bank. 2010. *Greenhouse Gas Emissions Mitigation in Road Construction and Rehabilitation A Toolkit for Developing Countries. Executive Summary*. Prepared by EGIS.

## ANNEX 3. ANALYSIS OF SELECTED MITIGATION OPTIONS

1. Wilkes and Batjargal (2015) made assessments of the financial viability, economic and environmental benefits of selected forage, livestock breeding and animal health activities (each contributing to GHG emission reductions and increased output/herd ratios that would fit the ASDIP approach to reducing overgrazing) over a 15-year period. Of the 6 activities assessed, all but one (i.e., small-scale hay making) have a positive pre-finance IRR, indicating that the return on the total investment is positive. The pre-finance IRR is higher than a benchmark of 18% for all but the sheep breeding activity.

2. The cash flow characteristics of each investment vary, on the basis of which different financing arrangements have been investigated. Some activities (e.g., large-scale hay making, beef cattle breeding and provision by vets of parasite control services can be financed using commercial loans at an 18% interest rate. However, individual vets, herder cooperatives, NGOs or other herder groups are likely to face constraints to accessing credit because of the collateral requirements of credit providers. Therefore, loan guarantee mechanisms may be required to expand access to credit by rural entities. Some activities (e.g., medium-scale hay making) would require interest rate subsidies in order to be financially viable. Other activities (e.g., sheep breeding using improved breeds) require grant co-financing of initial investments as well as interest rate subsidies.

**Table 34. Financial Characteristics of Each Activity and Corresponding Financing Measures**

| Activity | Pre-finance IRR[a] | Potential financial support measure | Post-finance IRR* |
|---|---|---|---|
| Small-scale hay making | negative | | Negative |
| Medium-scale hay making | 20% | 9% interest rate on 5-year loan to full value of initial investment | 34% |
| Large-scale hay making | 69% | 18% interest rate on 5-year loan to full value of initial investment | 158% |
| Sheep breeding using improved breeds | 5.6% | Grant subsidy for 67% of initial investment costs, 2.4% 5-year loan for remaining initial investment | 34% |
| Beef cattle breeding using improved breeds | 40% | 18% interest rate on 5-year loan to 70% of the initial investment with fee-for-service charge of MNT55,660 | 55% |
| Parasite control in sheep | 28% | 18% interest rate on 5-year loan to the full value of the initial investment with fee-for-service charge of MNT275 | 34% |

IRR = internal rate of return.

[a] Pre-finance IRR refers to the rate of return to the total investment without considering financing costs or subsidies or the source of finance. Post-finance IRR refers to the rate of return after including financing costs or subsidies at conditions indicated in the third column.

3. All the activities modeled have a positive EIRR. (Table 35) For all activities, the economic benefits valued included the increased value of livestock production and the value of GHG emission reductions or atmospheric removals. For all activities, the vast majority of gross economic benefits were due to the increased value of livestock production, indicating that the activities have strong economic benefits for herders. In comparison with many other GHG mitigation investments, the investment cost (i.e., initial investment per $tCO_2e$) is relatively low, and economic abatement costs (i.e., NPV of economic benefits over 15 years per $tCO_2e$) are strongly negative, indicating strong sustainable development benefits. In some cases, if valued at realistic market prices (e.g., $5 per $tCO_2e$), sale of emission reduction credits could make meaningful contributions to financing adoption of the activities.

4. In all cases, the economic abatement costs are negative, meaning that even with a price of carbon of zero, the proposed activities make economic sense (Table 35) as evidenced

by a combination of a positive economic NPV and positive GHG mitigation contributions (not including benefits from reductions to overgrazing and restoring carbon sinks, which would further increase the GHG emissions) and hence a negative economic cost per tCO2e mitigated.

**Table 35. Economic and Environmental Benefits of Agricultural Activities Assessed**

| Activity | EIRR | % of Gross Economic Benefits due to Livestock Production | Investment Cost ($/tCO₂e) | GHG Economic Abatement Cost (NPV of Economic Benefits) ($/tCO₂e) |
|---|---|---|---|---|
| Small-scale hay making | 51% | 99% | 43 | -58 |
| Medium-scale hay making | 100% | 98% | 14 | -49 |
| Large-scale hay making | 107% | 87% | 2 | -7 |
| Sheep breeding using improved breeds | 22% | 99% | 43 | -14 |
| Beef cattle breeding using improved breeds | 33% | 99% | 9 | -30 |
| Parasite control in sheep | 357% | 85% | 1 | -3 |

EIRR = economic internal rate of return, NPV = net present value, $tCO_2e$ = tonne of carbon dioxide equivalent.

5. There are also several other cost-effectives measures that can increase the output per animal in the herd, and hence reduce the herd size needed to produce a given amount of outputs. The following provides an overview that has been prepared as part of ADB TA-7534.

**Table 36. Potential mitigation activities in grassland management**

| Type of intervention | Potential activities |
|---|---|
| Improved grassland management | • For lightly or moderately degraded grassland (including shrub grassland types), reductions in grazing intensity and / or changes in the timing or duration of grazing, or application of organic or inorganic fertilizer, reseeding, and other conservation measures may increase soil carbon stocks |
| | • For heavily degraded grassland (including shrub grassland types), exclosure from grazing or seasonal exclusion from grazing, or reseeding or application of organic or inorganic fertilizer or other means, can increase soil carbon stocks |
| Pasture cultivation | • On degraded grasslands with limited potential for natural regeneration within a reasonable period of time, cultivation of perennial grasses (including perennial legumes where suitable), and /or fertilization with manure and / or irrigation and other means can increase soil carbon stocks |
| | • On degraded grasslands with limited potential for natural regeneration within a reasonable period of time, cultivation of biomass energy grass crops and / or application of organic or inorganic fertilizer and / or irrigation can increase soil carbon stocks as well as produce bioenergy sources |
| | • For existing low-productivity cultivated pastures, reseeding or application of organic or inorganic fertilizer or seeding with mixed grass species and other means can increase soil carbon stocks |
| | • For annual forage crops, changing to no-till methods or application of manure can increase soil carbon stocks |
| Avoided or reduced conversion or degradation of grassland | • By canceling or reducing approved plans to convert native vegetation (including native shrub grassland as well as marsh meadow) or drain marsh meadow etc can reduce losses of vegetation and soil carbon stocks |
| | • Through sustainable grassland management (e.g. suitable stocking management, reseeding with endemic species, biodiversity conservation etc), grassland ecosystem degradation can be prevented or reduced, and while maintaining supply of grassland ecosystem services, vegetation and soil carbon losses can be |

| Type of intervention | Potential activities |
|---|---|
| | reduced |
| Marsh meadow restoration and conservation | • Where marsh meadow has previously been drained and cultivated or degraded due to natural factors, abandoning crop cultivation and water management (e.g. raising groundwater levels) or other means to restore marsh meadow can lower soil organic matter decomposition, and increase soil carbon stocks |
| | • For degraded marsh meadow, reducing grazing intensity can promote restoration and increase soil carbon stocks |
| Land use conversions | • Conversion of degraded cropland to grass or perennial legumes and / or application of inorganic fertilizer can increase soil carbon stocks |
| | • Conversion of wasteland to perennial cultivated grass or legumes or shrubs can increase soil carbon stocks and / or woody biomass |
| | • Cultivating bioenergy grass crops on degraded cropland or wasteland and / or application of inorganic fertilizer and / or irrigation can increase soil carbon stocks and produce bioenergy feedstock |

*Note: Some management measures (e.g., application of organic or inorganic fertilizer, irrigation) would imply increased project emissions and would only have net emission reduction effects where increases in carbon pools offset increased project emissions.*

**Table 37. Potential mitigation activities in livestock management**

| Type of intervention | Potential activities |
|---|---|
| Increasing feed energy and protein use efficiency | • Adding leguminous grass to feed rations or adjusting the composition of feed to increase protein content can increase energy and protein utilization efficiency. Although total GHG emissions may increase, emissions per unit of livestock product (e.g. kg meat or milk) may be reduced. |
| | • Adding unsaturated fatty acids to feeds to control rumen $CH_4$ production can increase the energy efficiency of feed utilization and reduce total emissions of $CH_4$ per individual animal |
| | • In some situations, reducing the N content of feed ratios and / or reducing nutrients that may produce $CH_4$ or $N_2O$ and / or reducing total feed consumption to off-take may reduce emissions |
| | • Adding amino acids or other additives to pig or poultry feed can increase protein utilization efficiency and reduce the total amount of protein feed used and total N deposited in dung and urine, thus reducing energy use in feed production and $N_2O$ emissions from manure. |
| Shortening feeding periods | • Before off-take of grazing animals (e.g. lambs or calves), 2-3 months of fattening can improve product yields and reduce GHG emissions per unit of livestock product produced |
| | • Compared to conventional off-take practices, improved feeding and management can reduce durations to off-take, and reduce GHG emissions per unit of livestock product produced |
| | • Substitution of slow-growing breeds with faster growing breeds. |

**Table 38. Potential circular economy mitigation activities**

| | |
|---|---|
| Produce organic fertilizer | • Compared to traditional manure management, by separating solids and liquids, water and energy use in sheds can be reduced, and producing organic manure can reduce consumption of synthetic fertilizer |
| Biogas energy production | • Compared to traditional waste management methods, anaerobic fermentation techniques produce biogas which can be a source of energy, reduce $N_2O$ emissions in waste management and also save fuel wood or coal in energy use |

| | |
|---|---|
| | • Compared to electricity generation from coal, using biogas to generate electricity can reduce the GHG intensity of energy |
| Biogas energy production and organic fertilizer production | • Linking production of organic fertilizer to energy generation from biogas, can reduce energy emissions and waste management emissions |

## ANNEX 4. AFFORESTATION AND AGROFORESTRY

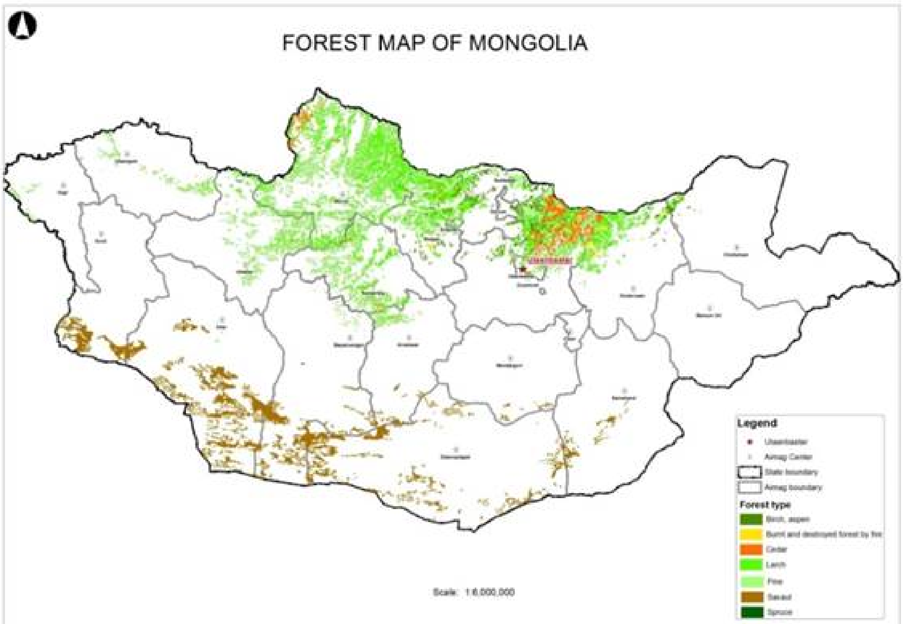
1. For several reasons, explained below, the opportunities for agroforestry and afforestation in the Mongolian context are limited, especially in the areas that have currently been targeted. Mitigation benefits from afforestation and agroforestry will be rather low in the targeted areas, because of the slow annual growth rate of trees (again, see below). However, where agroforestry and afforestation are viable options and included in investment plans, ASDIP will quantify the climate benefits:

- Mitigation thanks to sequestration
- Reduced water needs of animals, thanks to increased shadow (water use by animals is a function of the temperature to which they are exposed, and shadow reduces temperature by reducing direct sunlight)
- Creation of shelterbelts, which reduces heat loss in winter due to strong winds and hence reduces animal mortality.

2. Prospects for afforestation and agroforestry in Mongolia are in general not good. According to Worden and Savada (1991)*:* "*Mongolia's precipitation is not only low on the average; it varies widely and unpredictably from year to year and from place to place. The dates of first and last frosts, and hence the length of the growing season, also vary widely. Such general conditions favor grasses rather than trees, and they produce prairies rather than forests*."

3. Van Koppen and Galragchaa (2015) make a similar point: "*The forests of Mongolia have a long cycle of growth (at least 130 years) due to a dry and cold climate and a short potential growing season of forest free days of only 95 to 120 days on average.*" The latter publication also includes the following figure for the spread of forests in Mongolia:

**Figure 61. Forest Map of Mongolia**




4. The northern parts of Mongolia have boreal forests and some commercial forestry enterprises are in the northern aimags, for example in Mandel soum in Selenge aimag which borders the Republic of Buryatia in the Russian Federation. Poorer quality forests are in the south of Mongolia.

5. There is almost no natural forest growth in the aimags targeted in the first tranche, except for some *saxaul* forests in the southern parts of the aimags. Saxaul is a shrub or a tree,

mostly located in desert and semi-desert areas. It can be used as shelterbelts. Growing this type of three /shrub will be difficult at best and may not be part of a livestock production system and may therefore not the best use of funds.

6. Furthermore, it should be noted that under the current assumptions for Tranche 2 and 3 aimags (Zavkhan, Govi-Altai, Dornod, Sukhbaatar), the scope for agroforestry and afforestation would appear limited. However, the selection of these aimags for Tranches 2 and 3 is not final.

7. The above notwithstanding, afforestation and agroforestry investments are eligible for funding. Such investments are eligible for funding, provided that the quantitative criteria are met (e.g. a threshold CCB to investment ratio that needs to be achieved – where the climate change benefits will take into account both the mitigation and adaptation benefits of the planned investments). Whether afforestation and agroforestry will be part of ASDIP will therefore depend on bottom-up factors (whether proposals for afforestation and agroforestry investments are made), and on the merits of the proposal (meeting the selection criteria).

**References to Annex 4:**

Van Koppen, R-C and P. Galragchaa (2015), Integration of Climate Technology Financing Needs into National Development Strategies, Plans and Investment Priorities. *Mainstreaming Climate Technology in Mongolia: Report for Forestry Sector*. Report prepared for ADB

Worden, R.L and A.M. Savada (1991), *Mongolia: A country study*. Federal Research Division, Library of Congress. Area Handbook Series, DA Pam 550-76. Washington DC.