GOVERNMENT OF MONGOLIA
MINISTRY OF ENVIRONMENT AND TOURISM

REDD+ MONGOLIA

Preliminary Assessment of the Drivers of Forest Change in Mongolia:

A Discussion Paper for Supporting Development of Mongolia's National REDD+ Strategy

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Preface

Mongolia has made international commitments to climate change as a signatory of the UN Framework Convention on Climate Change (UNFCC, in 1992) and the Paris Agreement in 2016. In June 2011, Mongolia became a partner country of the United Nations initiative in Reducing Emissions from Deforestation and Forest Degradation in countries (UN-REDD Programme). Since then Mongolia has taken significant steps towards implementing REDD+, Mongolia approved its National REDD+ Road Map in 2014, and the UN-REDD National Program started officially in 2016. The main goal of the programme is to support the Mongolian government to design and implement its National REDD+ strategy.

As part of the activities needed to develop the REDD+ strategy, UN-REDD Mongolia national program carried out a preliminary assessment of the drivers of forest change under the UNDP funded Technical Support Program. This document aims to present an overview of the current of the drivers of deforestation and forest degradation in Mongolia. The report should be treated as a discussion document aimed to provide a preliminary starting point from which to discuss issues relating to the countries forests and provide information towards development of Mongolia's National REDD+ Strategy.

The study has been constrained by the quality of data sets on drivers of deforestation and degradation that was available for analysis, with some of the data being compiled from unpublished government data sets. Whereas every effort has been made to ensure that data collected and presented herewith is current and accurate, we acknowledge that data is not exhaustive and there may be some inconsistencies between data sets. Any reference to data within this report should not be undertaken without suitable acknowledgement of the limitations and constraints of the datasets used herewith. As additional data sets and information become available, such as the data from the GIZ Multi-Purpose National Forest Inventory, there will be additional updates or supplementary reports made to supplement our understanding of drivers of deforestation and degradation in Mongolia.

However, the document herewith presents a useful and comprehensive starting point for development of Mongolia's National REDD+ Strategy. The UN-REDD Mongolia National Program welcome additional data, comments and reports which can be utilised in subsequent iterations of this report.

Table of Contents

Abbreviations

AAC	Annual allowable cut
ALAGaC	Administration of Land Affairs, Geodesy and Cartography of Mongolia
BCEF	Biomass conversion and expansion factor
BEF	Biomass expansion factor
C	Carbon stock in forest biomass
CF	Carbon fraction of dry matter
D	Basic wood density
EIC	Environmental Information Centre
FAO	Food and Agriculture Organization of the United Nations
FRDC	Forest Research and Development Centre
FUG	Forest user group
GASI	General Agency for Specialized Inspection
GDP	Gross domestic product
GHG	Greenhouse gas
GIZ	Technical cooperation agency of the German Government
IPCC	Intergovernmental Panel on Climate Change
MET	Ministry of Environment, Green Development and Tourism
MNET	Ministry of Nature, Environment and Tourism
NFI	National forest inventory
NSO	National Statistical Office of Mongolia
PFE	Private forest entity
R	Below-ground biomass to above-ground biomass ratio
REDD+	Reducing Emissions from Deforestation and Forest Degradation
tCO2e	Tonnes of carbon dioxide equivalent
UNDP	United Nations Development Programme
V	Merchantable volume
WWF	World Wide Fund for Nature

List of Figures

List of Tables

1.0 Introduction

1.1 Forests and Climate Change

Forests are critical to global climate change system due to their ability to absorb and store carbon, and because their continued deforestation or forest degradation leads to further greenhouse gas emissions. Current estimates state that forests account for around 10% of global greenhouse gas emissions (IPCC, 2013). The concept of mitigation of climate change through avoiding deforestation was raised through the United Nations Framework Convention on Climate Change (UNFCC). Parties to the UNFCCC agreed to consider mechanisms to address climate change through reducing emissions from deforestation and forest degradation through; a mechanism known as Reducing Emissions from Deforestation and Forest Degradation (REDD+). REDD+ has been ratified in international climate change agreements, most recently as part of the Paris Agreement (2016) as of the UNFCC's Conference of Parties in 2015.

The rationale for REDD+ is for countries to implement policies and strategies for retaining forest carbon stocks instead of clearing for other land uses or to prevent reducing carbon stocks through degrading activities such as illegal logging or forests fire. REDD+ highlights the benefits for establishing global and national commitments to tackling climate change through working reducing greenhouse gas emissions in the forest sector. However, it also should be viewed in a wider context as successful REDD+ strategies will contribute towards more effective management and monitoring of forest resources, improved forest governance and greater discourse with communities and civil society, improved maintenance and provision of ecosystem services, and as a part of wider green development efforts for climate change mitigation and adaptation. Mongolia officially adopted its National REDD+ Readiness Roadmap in 2014, following this the UN-REDD National Programme was launched in 2016 in order to intensify its support to Mongolia in particular to support the preparation of the National REDD+ Strategy.

1.2 The Context of Deforestation and Degradation for REDD+ Strategies

Mongolia supports over 17,911,123 ha of forest land which accounts for approximately 11.8% of the countries land area (FRDC, 2015). The forest consists of two main types, namely the northern boreal forests and the southern saxual forests, with approximately 4,699,500 ha comprised of saxual forest (Annex 1.0). The boreal forest is comprised of deciduous and coniferous forest growing in the forest steppe, boreal forest and montane areas, these areas are dominated by conifers including Siberian larch, Scots and Siberian pines, and broadleaf species, particularly birch, with aspen and poplar also occurring. The southern saxual forests are located in the southern desert and desert steppe regions, they consist of scattered trees and are rarely over 4m in height, the biomass is reported as being very low, approximately $1m^3$ per hectare. Though the saxual forests are important for stabilising arid zone land and reducing desertification, they are not deemed as likely to be important from a REDD context (in terms of contribution to substantial greenhouse gas emission abatement or increased removals) and are therefore not included in this study.

The boreal forests are vulnerable to disturbance in environmental conditions and potentially impacted by climate change. Boreal forests exhibit slow growth which makes them highly different in nature to tropical forests, with interventions such as tree planting or sustainable harvesting regimes more difficult to design. It is therefore important to gain an understanding of the drivers and underlying causes of forest change before designing policies and measures to address forest change. Under the context of devising a National REDD Strategy the definitions of terms deforestation and forest degradation should be reviewed as these are looked at from the context of climate change mitigation and reduced emissions following UNFCC guidelines.

Forest definition needs to be specific to a countries' needs. Currently in Mongolia there are two definitions, depending on the specific survey and user group. The FRDC taxation definition relates to relative stocking density (RSD). Relative Stocking Density depends on a combination of factors comprised of timber stocking density, species and perceived maximum timber potential of a stand and is mainly defined for the purposes of production forestry. This definition will need refining in the future to meets the requirements of REDD+ (specifically for national forests monitoring system and development of forest emission levels) and for comparison to other international programs which tend to base definition on canopy cover and tree heights. Forest, in the context of REDD+, also describes lands that are temporarily un-stocked or unplanted. Mongolia's definition of forest will be revised in the future to take into account to ensure that it meets needs of Mongolia's REDD+ measurement, reporting and verification.

Deforestation is defined under the UNFCC as 'the direct human-induced conversion of forest land to non-forest land'. Deforestation normally includes areas that are converted to agriculture, grazing land, mining, urban areas or areas whereby the impact of an activity will not lead to the natural regeneration of an area, or whereby the impact of the disturbance or changing in environmental conditions affects the forest that it cannot sustain a tree cover above the 10% canopy cover threshold. Areas that are harvested through logging where the forests will be naturally regenerated or through silviculture means in the next ten years would not be considered as deforestation. Additionally, bare areas which occur through anthropogenic fire would normally be expected to regrow and regenerate naturally, thus would not be classified as deforestation [1]. However, it should also be noted that in some areas of Mongolia once removal of canopy cover occurs it may set off an ecological reaction

[1] Note: It is conceivable that large and highly intense forest fire would lead to conditions whereby natural regeneration would be prohibited as locations for seedlings may be considerable distances from source of fire and the heat intensity may have destroyed all standing trees and the existing soil seed bank. However, if these areas are actively managed, or under official status as 'managed' forest areas, this would only be considered deforestation in certain circumstances.

which results in loss of soil moisture and creation of microclimate which may be unsuited to additional tree growth.

Degradation refers to change within the forest as the direct, human-induced long-term loss persisting for a certain number of years. Degradation in most cases does not show as a change in the area of forest but in a decline of the forests stocks and biomass. There are many specific definitions regards degradation and a definition needs to be determined for specific purposes of Mongolia's greenhouse gas accounting and for the national REDD+ strategy. It can be broadly defined for the purpose of this report, as an impact or activity which reduces the carbon stocks for at least short term period, perhaps in boreal forests this may be considered as a longer period than tropics where growth rates are considerably faster.

Other definitions for degradation exist related to other ecological or other factors, such as a decline in biodiversity, ecological services or cultural and landscape values. However, in the context of REDD+ we are primarily focussed on the measurement and reporting of a decline in carbon stocks (and greenhouse gasses) rather than in a forests ecological functions per se. Other aspects of 'forest degradation' such as production, biodiversity or regeneration capacity, will be examined during the design, implementation and monitoring of specific policies and measures as these are fundamental aspects that need to be considered during design of forest management strategies.

Timber extraction, such as undertaken through sustainable timber harvesting and thinning, leads to a temporary reduction in forest carbon stocks and the consequent emissions. However, the aim of a sustainable system is that the biomass that has been extracted would be recovered or increased after a period of time (or logging cycle) as a result of forest growth or improved growth[2]. This form of management is often considered a better long-term strategy for forests than unsustainable management or no management intervention since it also results in additional benefits, and may reduce the risk of fire or pest infection. It is therefore extremely important to ensure that the allowable extracted timber volume and logging damage is carefully calculated to enable the forests to recover and to help with improved forest growth. Overharvesting will result in long-term forest degradation. Harvest volume and rotation length need to be calculated carefully in boreal forests.

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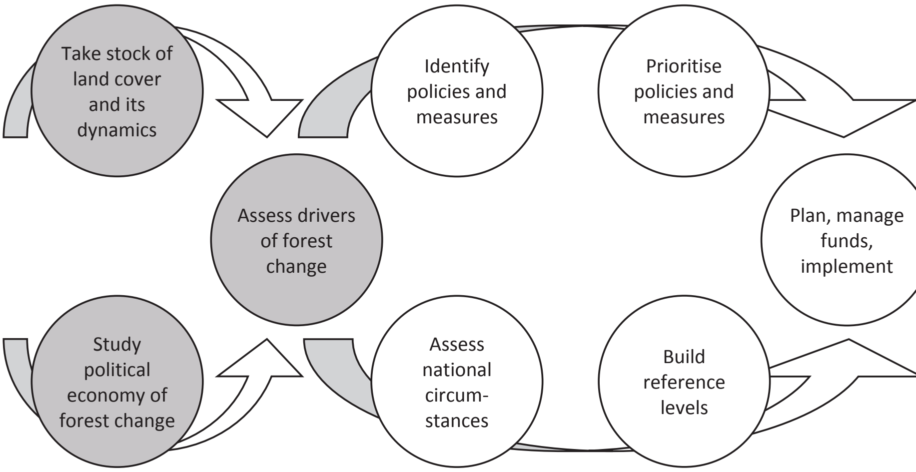


Figure 1. Steps in the Development of a National REDD+ Strategy

1.3 Aims and Objectives

This document summarizes a preliminary assessment of drivers and underlying causes of deforestation, forest degradation and enhancement of carbon stocks. **This understanding is the required basis for designing the policies and measures at national and local level to address strategies for improved forest management. The report provides a preliminary assessment of the drivers and an understanding of the underlying barriers and constraints. It aims to provide a starting point for further analyses and study, and is not meant to be a definitive analysis, rather it aims to highlight the main issues and to suggest areas for further analysis and study.** This information is instrumental in the identification of REDD+ policies and measures and for devising a national *REDD+ strategy.* Specifically, the aims and objectives of the study were to:

- To undertake an overview of historical forest cover change.
- To undertake an assessment and prioritisation of drivers of forest change according to their magnitude, GHG emissions and trends.
- To conduct an analysis of the political economy of forest change including the identification of drivers of forest change and their underlying causes.
- To make initial recommendations for development of national REDD+ strategy and development of reference level.

2.0 Methodology

2.1 Analytical Framework

The study builds upon previous list of drivers identified in the National REDD+ Roadmap (MEDGT, 2014) and proceeds along the lines of four sequential analytical steps (Figure 2).

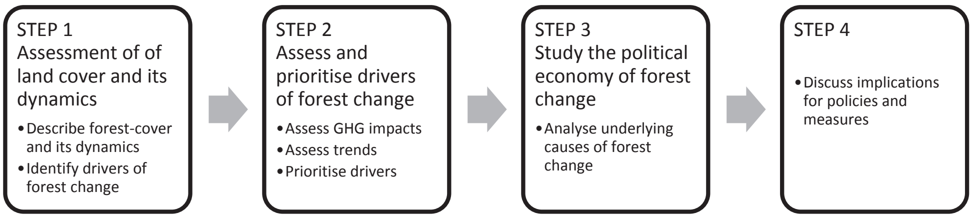


Figure 2. Overview of Steps in Analysis of Drivers of Forest Change

2.2 Drivers and Underlying Causes of Forests Change

In the context of REDD+, it is important to identify the direct drivers and their underlying causes of forest change. Forest change, as defined herewith, includes deforestation, forest degradation and the enhancement of carbon stocks. Deforestation and forest degradation are associated with GHG emissions, activities enhancing carbon stocks can either directly lead to removals and improved forest growth, such as tree planting. The approach to the analysis of drivers of forest change (Geist and Lambin 2002) has been applied in many countries and has become a standard in the context of REDD+. Although this study refers to 'drivers', in other studies, these have also been referred to as 'direct drivers', 'proximate drivers', 'proximate causes', and 'direct causes'. In this particular context, drivers of forest change are anthropogenic activities that directly affect forest cover. Mostly these drivers are measurable as they often correspond to the fate of land in the land-use change processes. Examples may include commercial agriculture, subsistence agriculture, infrastructure and urban expansion, and fuel wood extraction. Activities enhancing carbon stocks are treated together with the drivers, and may include such activities as afforestation.

The underlying causes of forest change are often complex interactions of demographic, economic, technological, policy, institutional, cultural, socio-political, and environmental processes. Examples of underlying causes which may affect direct drivers, may include governance regimes, agricultural policies, infrastructure development, domestic and international commodity price changes, and emergence of new markets for crops, timber or bio-fuels. Here we identify six underlying causes, namely demographic, economic, technological, political, cultural and socio-political and environmental. The latter also includes aspects related to climate change which may be of particular importance to Mongolia's situation in the boreal region. Some underlying causes cannot easily and readily be measured due to their complexity, in other cases underlying causes can be directly measured (e.g. population growth, commodity prices, etc.). But in both cases their impact on the drivers and thus on forest change is indirect and thus hard to quantify. Underlying causes encompass both catalytic and inhibiting factors (e.g., a policy for timber import and tightening up domestic protection might inhibit logging, but it might also catalyse illegal activities). Although this study refers to “underlying causes”, other studies have referred to these as ‘underlying drivers ‘, ‘indirect causes ‘or ‘indirect drivers ‘. The underlying cause of climate change also needs to be considered as anthropogenic, the effects can only be estimated through modelling and research, and may differ between the southern and northern boreal forests of Mongolia. The effects may result in ecological impacts such as increased incidence of fire, melting of permafrost and reduced soil moisture, soil carbon oxidation, change in pest and pathogen populations; such as observed in North American boreal forests ecosystems.

For identifying drivers and their underlying causes, the separation of human-induced and natural forest changes is of particular importance, under IPCC Guidelines countries only need to report on anthropogenic causes of emissions. Some drivers may be attributable to both natural and anthropogenic causes. For example, although forest fires can be caused by nature, human-induced fires are also common, it is important to define the causes. This distinction of anthropogenic activities is useful because it underlies intervention planning to reduce carbon loss and enhance carbon stocks. Many of the drivers are complex, for example, though insect and pathogens are a natural occurrence, infestations are exacerbated through anthropogenic factors such as fire and logging, which weakens the trees and making them more vulnerable to infection, or through provision of more deadwood habitat for insect pests, though quantitative estimations regards the degree to which anthropogenic factors can be applied needs further analysis. In addition, climate change may result in the geographical distribution of insects expanding as shown in other boreal countries.

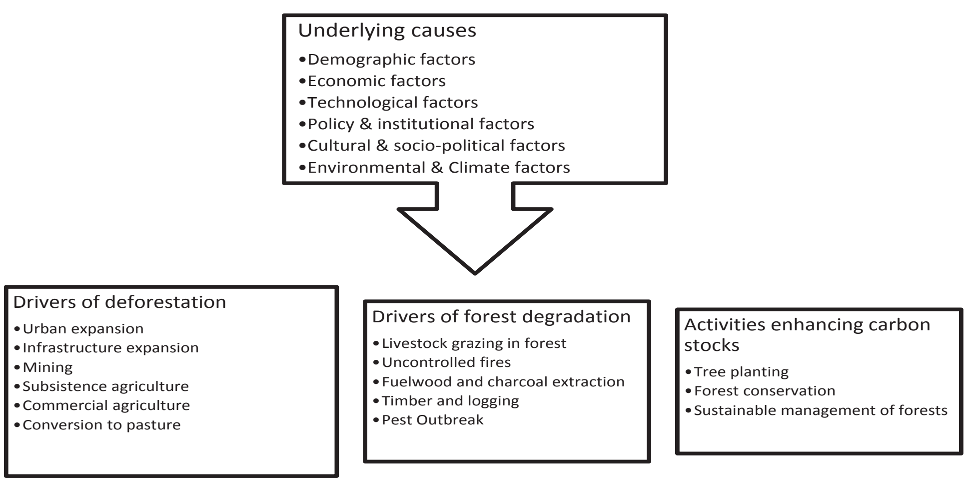


Figure 3. Generic Set of Drivers and Underlying Causes of Forest Change

2.3 Data Collection

The drivers study draws on assessment of forest land cover and forest land use data; data is obtained through three main sources namely GIZ's forest mask from the National Forest Inventory (NFI); the land database at the Environmental Information Centre; and the Forest Taxation Inventories (Forest Research and Data Collection; FRDC); see Table 1. In addition, an analysis by UN-REDD National Program using Collect Earth (UN-REDD, 2014) was used as a comparison. This latter study is being updated to improve our understanding of forest change and for the development of the national Forest Reference Level.

Table 1. Main Sources of Forest Data for Drivers Analysis

Data source	Years of coverage	Classification	Forest definition	Use for the driver's study
GIZ's forest mask	2000, 2009 and 2013	Binary forest – non-forest	>1.5 ha area, > 2m vegetation height, > 10% crown cover	Cross-checking of results
UN-REDD collect earth dataset	2000 and 2013	IPCC's 6 land cover classes and information about disturbances	10% crown cover, includes also open forests below the threshold	Cross-checking of results
FRDC's forest taxation inventories	Various for provinces, approximately once in 10-15 years	Forests with details on structure and intervention	Several kinds of forests above and below 0.3 stock density	Main dataset for quantifying drivers
FRDC / GIZ national forest inventory	2014	Forests with details on structure and intervention	>1.5 ha area, >2m vegetation height, >10% crown cover	For future updating of results
Land database at the EIC	Annual time series	6 main classes with 4-9 subclasses each	Consistent with FRDCs data	Ancillary dataset on non-forest land cover

Forest Taxation Inventories - The principal dataset for quantifying drivers used in this report was the national forest taxation inventories which have been implemented by the Forest Research and Development Centre (FRDC) since 1959. Inventories are aimed at information collection on forest resources for forest management planning. Taxation experts visit forest stands in regular intervals to assess parameters such as forest area, volume, quality, condition, average tree height, diameter and age, next to disturbance, regeneration and logging. The specific time points of taxation inventories vary between the provinces. Forest taxation covered the whole country during campaigns that took place in 1959-1974, 1974-1990, and 1990-2015.

Land Database at Environment Information Centre (EIC) - The land database at the EIC provides ancillary data concerning non-forest land uses. The land database includes a complete dataset on land mapping in Mongolia; with data collected by several technical ministries. For forest land, they use the FRDC's datasets, mainly comprising the forest taxation inventory, and for cropland and grassland, they draw on agricultural census data from the Ministry of Agriculture. These data are consistent with the IPCC's six land cover classes, and area estimates cover annual time series and are broken down to the provincial level.

National Forest Inventory - The Forest Research and Development Centre (FRDC) currently with support from GIZ have complete a national forest inventory (NFI). The NFI was designed to be a multipurpose forest resources inventory across approximately 4311 sampling units in the whole northern boreal forest area; saxual forest was not sampled. The data collected covers a wide range of ecological information, forest use and resource base. It created a forest mask for the Northern forests in 2013 and assessed forest changes between 2000 and 2009; the results are expected to be published by the end of 2016. Data from the GIZ national forest inventory were not yet available at the time this study; though a provisional analysis of some data has been analysed in a UN-REDD study on multiple-benefits (UNREDD, 2016a).

Collect Earth - The UN-REDD Programme's assessment of land use and its changes was useful for crosschecking of results. A group of approximately 20 Mongolian forest and remote sensing experts applied the FAO Open Foris application 'Collect Earth Mongolia', conducting sample-based visual interpretation of satellite images (UNREDD, 2014). The results reflect land-use changes in 1989-2001 and 2013. They cover both the northern boreal forests and the southern saxual forests. The assessment constructed land-use change matrices using the IPCC's main six land-use classes: forest land, grassland, cropland, wetland, settlements and other land. It also includes information on forest disturbances.

2.4 Assessment of the Extent of Drivers and Forests Change

The combination of the available datasets was used to provide area estimates for the drivers of forest change as best as possible (Table 3). Forest fire, 'unsustainable logging and subsequent degradation', tree planting and 'deforestation by continued degradation' are quantified based on the forest taxation inventory (FRDC, 2014). Burnt-over forest and logged area are split because they mostly represented degraded forest and to a lesser extent also deforestation. Data on area affected by pest outbreaks was collected from FRDC (2014). In addition, pest control measures are quantified based upon an unpublished dataset available related to pest control, here there is an annual time series available of such data, broken down by province.

Table 2. Forest Taxation Data Categories and Extraction of Information on Drivers of Forest Change

Forest taxation inventory (FRDC data)		Description	Relevance for the study
Closed forest area (>0.3 stock density)	Natural forest	Natural forest, including naturally regenerated forest	Not relevant because no driver (but relevant for pest control)
	Shrubs	Woody perennial vegetation with height below forest thresholds	Not relevant because no driver
	Forest plantation	Planted or sown forest with crown closure	Tree planting
Open forest area (<0.3 stock density)	Open stand	Moderately degraded forest through unsustainable logging, wind and snow and pests that typically took place decades ago. These areas are typically followed by grazing and fire).	Unsustainable logging and subsequent degradation
	Burnt-over forest area	Strongly degraded forest through fire (typically followed by unsustainable logging and grazing)	Forest fire (98%) Deforestation by continued degradation (2%)
	Logged area	Strongly degraded forest through unsustainable logging; typically followed by grazing and pests	Unsustainable logging and subsequent degradation (90%) Deforestation by continued degradation (10%)
	Natural regeneration with scattered trees	Naturally regenerated forest with scattered larger trees	Not relevant
	Reforested area	Recently planted or sown forest before crown closure	Not relevant
	Area affected by pests	Strongly degraded forest through pests -typically followed by fire, unsustainable logging and grazing	Unsustainable logging and subsequent degradation
	Area damaged by wind or snow	Strongly degraded forest through wind and snow (typically followed by unsustainable logging, pests and grazing)	Unsustainable logging and subsequent degradation
Non-forest area		All non-forest area within forest land which does not support natural forests and open forests, such as hayfield, pasture land, grassland of mountain, lake, river, marshland, alpine grassland, sand, nursery, etc.	Not relevant because not forest

Mining is quantified based on the EIC's land database. It is clear that only a fraction of mining takes place in forests as mining also takes place in grassland areas. Although the specific fraction of mining areas falling in forests is unknown, it is approximated here by assuming that it is equally distributed across land types, Mongolia's forest cover accounts for 11.70%[3] of the countries area. A more comprehensive analysis of current mining concessions and overlaid with forest areas would provide a more accurate measure of areas current and future potential threat from mining.

Table 3. Environmental Information Centres Data Categories and Extraction of Information on Mining

Land database		Relevance for the study
Agriculture land	Pasture, Grassland, Cropland, Fallow land, Agriculture buildings land, Unsuitable area for agriculture	Not relevant
Settlement and other settled area	Buildings and construction land	Not relevant
	Common land tenure	Not relevant
	Manufacture land	Not relevant
	Mining area	Mining in forest area (11.70%)
	Ger area	Not relevant
Road and network land	Road, Railway area, Airway area, Power network	Not relevant
Forest land	Forest cover land	Consistent with forest taxation inventory
	Logged area	
	Nursery area	
	To be forest area	
	Other forest land	
Water land	Rivers, Lake, pool, Stream, spring, Glacier, perpetual snows	Not relevant
Special utility land	State protected area, State border land, State defence intent area, Foreign diplomatic, consul, representations land, Science, research and meteorology station land, Pasture for fattening livestock of joint aimags, State reserve of grassland, Contracted land of black gold, Land of free zone	Not relevant

2.5 Estimation of Emissions and Removals

Simple calculations were undertaken to generate estimates of emissions and removals for each driver, these estimates should be used only for discussion basis as they will be improved considerably as more data becomes available. Calculations are based on estimated area affected by the driver, and the estimated emissions (or removals) per area unit; as far as possible standard IPCC methodologies were applied (IPCC 2003, 2006). While area statistics are derived from a range of existing area data, as

[3] Figure used in this calculation, it can be revised following more accurate analysis. However, it is deemed a good proxy to estimate mining's impact on forests emissions in the absence of detailed spatial information where active and future mines are located.

described above, emissions per area unit depend on biomass density estimates for Mongolia's forests; estimates from expert consultation filled data gaps were existed. Emissions and removals are reported as tonnes of carbon-dioxide equivalent (tCO2e). They refer to living tree biomass only and do not account for deadwood, litter or soil-organic carbon, herbaceous plants and shrubs.

2.6 Consultations

Consultations with representatives of important agencies provide confidence in the robustness of the results. The following key agencies were consulted through interviews and workshops. A corresponding, detailed list of individual interview partners is included in Annex 2.0. Consultations took place on occasion of several events next to individual interviews. Consultative work included the following events:

- A kick-off workshop took place in May 2015. It served to agree with partners on the approach to the analysis. This includes agreeing on the principal data sources for quantitative analysis, on the set of basic definitions and on the forest regions and time periods to cover. The approach to engaging partners was also discussed.
- A field trip was carried out to Teshig, Mandal soum, Selenge province, in June. The field trip served to field test the methodology for driver's analysis.
- A consultative discussion took place in October to collect feedback from programme partners on the analysis, particularly regarding the assessment of forest area changes and associated GHG emissions.
- A validation workshop took place in November 2015. It focused on the drivers' underlying causes. It also laid out general results to the programme partners to collect feedback and discuss its implications.

2.7 Limitations

- **Data Availability**

This study undertook an effort to quantify drivers in area and in their emissions and removals and relied upon existing data from several sources, data can indicate orders of magnitude for drivers, but cannot provide accurate estimates. The data used were of much better quality than that available in most REDD+ countries. Nonetheless, there are inconsistencies observed in quantitative data between different sources, and quality of data collection between different agencies, years and approaches may not be consistent. This study's most important data source is the results of the forest taxation inventories conducted by the FRDC. Much better data is forthcoming, notably through GIZ's work on the national forest inventory and possibly also in the context of that collected through the UN-REDD National Programme. As such, this study will be updated once more recent or improved information is available.

- **Spatial Analysis and Threat Assessment**

A spatial analysis of risk and threats should be undertaken once improved forest cover data is available, this will help us to design a more spatially targeted REDD Strategy so that most vulnerable areas could be highlighted for interventions.

- **Forest Definitions**

Mongolia's unusual forest definition may not suit the needs of a REDD+ reporting. Mongolia currently defines forests by the stock density; although internationally, forests are usually defined by morphological parameters of crown cover, area size and tree height. Aligning with such international best practices would make work with Mongolia's forest cover data easier, moreover, choosing a forest definition for the purpose of REDD+, namely for the development of a national reference level and for national result-based reporting is being undertaken.

- **In-depth Studies**

In future iterations of the report, the studies could be extended to cover further drivers and activities enhancing carbon stocks. Most notably, this study did not in detail assess Forest User Groups (FUGs), or activities for forest thinning. These activities result in short-term emissions but ultimately through enhancing carbon stocks or reducing the underlying causes of forest degradation are seen as a more productive and effective long-term management regime. Also, it did not look into detail with regards the government's efforts for fire management. Grazing was not treated with the same attention as other drivers of forest change, nor was any investigation on land pressures or effects of communities being displaced by mines investigated. In particular, detailed studies on existing government programmes for carbon stock enhancement, detailed evaluations might provide important clues for defining REDD+ policies and measures.

- **Future Drivers**

No assessment of the degree of future threat or importance from drivers has been undertaken, this may help to prioritise which ones would be the focus in the REDD+ Strategy.

- **Policies and Measures**

The suggestions in latter part of the report, go a long way towards looking into the underlying causes of drivers and towards identifying entry points for possible interventions. But more work is required to identify interactions between underlying causes and for proposing policies and measures that are likely to be feasible.

3.0 Overview of Mongolia's Forest Status and Change

3.1. Forest Status

Mongolia's forests cover two distinct forest regions: the northern boreal forests, and the southern saxaul forests in the arid desert regions (Figure 5). Forest cover in Mongolia covers 17,911,1 thousand ha of forest area consisting of 13211.7 thousand ha boreal and 4699.5 thosand ha saxual forests accounting for 11.6% of the countries area (FRDC, 2016). There are other continued efforts to undertake forest cover assessments and these will be utilised for the development of the National REDD Strategy. According to the FRDC's taxation inventories, 47,000 ha (0.4%) of closed boreal forest have been lost annually since 2004. Open forests, in turn, have increased by approximately 150,000 ha /year (11.3%) annually during the same period. Figure 4 shows the recorded area of forests from the FAO Forest Resource Assessment which is largely based on data provided by Mongolia using the FRDC taxation survey.

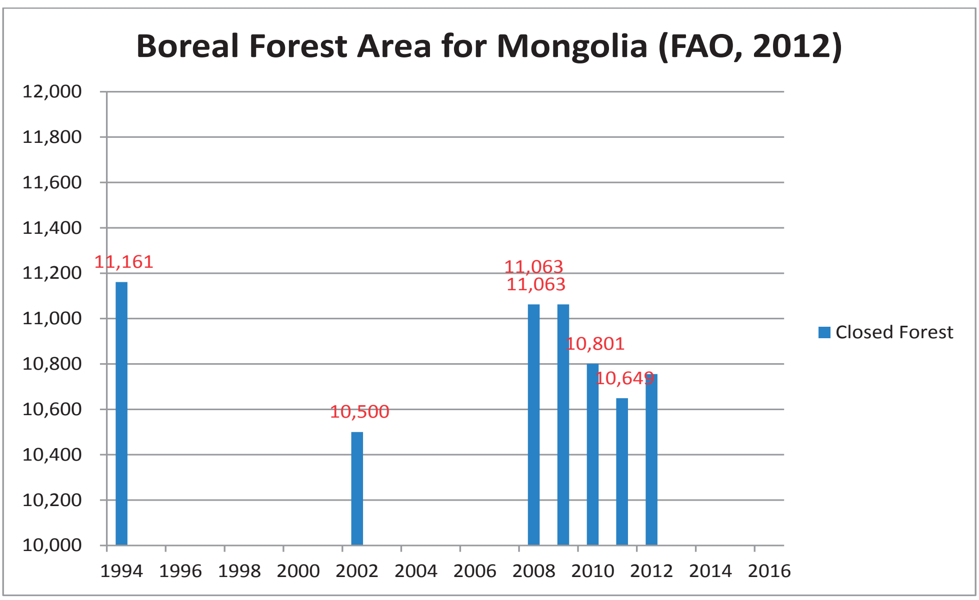


Figure 4. Boreal Forest Area by Year Reported by FAO Forest Resource Assessment (FAO, 2012)

Northern boreal forests are part of the transitional zone between the Siberian taiga forest to the north and the grasslands to the south. They typically grow on mountain slopes between 800-2500 m above sea level. These forests are mainly coniferous, mixed with some broadleaf trees. According to the FRDC's forest taxation inventories, larch, birch and saxaul trees account for more than 60%, 10% and 15% of forest areas, respectively. In terms of growing stock, larch contributes close to 80%, while all other trees are below 10% (compare Annex), the average growing stock amounts to 131 m3 /ha (FAO 2014). Mongolian forests have low productivity and growth, and they are vulnerable to disturbance from drought, fire and pests. Forests can easily lose their ecological balance following disturbance, and, they have a relatively low ability for expansion to currently non-forested areas, all of which are due the boreal forests location in the southern boundary of the northern hemisphere's cold forested region with a harsh continental climate.

Southern saxual forests grow in the southern desert and on the desert steppe. The trees are less than 4 m in height, predominant species include saxual trees and poplar. The average growing stock of such land in Mongolia amounts to less than 1 m^3 /ha (FAO 2014). Saxual forest also has low growth rates as is evident in arid desert regions, with forests adapted for long periods of low moisture, and roots are reported to be very deep. In the past these forests were exploited heavily for commercial charcoal and fuelwood, pressures still exist for mining and household fuelwood.

Though we acknowledge the ecosystem service function provided by saxual forests, this study focuses on the northern boreal forests. The National REDD+ Readiness Roadmap underlines that these provide most opportunities for forest-based emission reduction (MEGD 2014d). Part of the reason is the rather low growing stock in southern saxual forests. Furthermore, most of the analysis here focuses on provinces with large forest areas; with ten provinces accounting for 96% of northern boreal forest cover (Table 4).

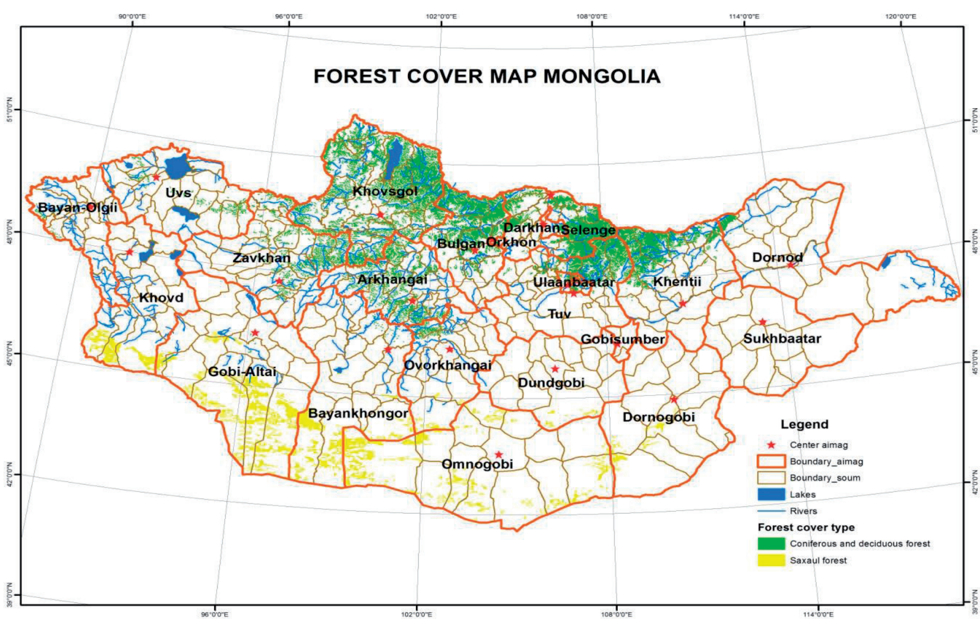


Figure 5 . Forest Cover of Mongolia (Environmenta Information Centre; (unpublished))

Table 4 . Mongolia's Provinces and Northern Boreal Forest Area (FRDC 2015b)

Provinces	Forest area (ha)	Provinces	Forest area (ha)
Arkhangai	991,429	Selenge	1,847,033
Bayan-Olgii	67,863	Tuv	1,315,178
Bayankhongor	23,557	Uvs	232,275
Bulgan	1,789,592	Khovd	15,972
Gobi-Altai	9,437	Khovsgol	3,867,726
Dornod	239,017	Khentii	1,705,071
Zavkhan	706,089	Darkhan-Uul	77,474
Ovorkhangai	169,262	Ulaanbaatar	112,132
Umnugobi	142	Orkhon	16,900
		Sukhbaatar	15,664

There are several forest definitions being applied in parallel in Mongolia. Firstly, the Law on Forest provides an ecological definition, referring to a complex environment specific to ecological and geographical conditions (in-situ), where trees, bushes, shrubs, and other plants, lichen, moss, wildlife and microorganisms naturally co-exist. Secondly, for forest inventory and forest management practice of Mongolia, the most commonly used forest definition draws on a relative stock density threshold of 0.3 (corresponding to approximately 25-35% crown cover, depending on stand age), with closed forests above, and open forests below. Thirdly, much of the available remote sensing information, however, draws on the FAO forest definition, using a 10% crown cover threshold. The choice of forest definitions has impact on quantitative analysis and more work is required to choose the 'right' definition for the context of REDD+. The extent of Mongolia's forest area varies greatly according to crown cover and height thresholds applied. Using a different forest definition might change some of the quantitative results, particularly, because there are abundant areas of relatively low stocked forest and large areas of forests with relatively low height. There is not at the moment clarity as to the forest definition for measurement of GHG emissions from the forest sector under REDD+. The drivers analysis applies the FRDC dataset forest definition which is defined through the use of 'stocking density' with a stocking threshold of 30% defined to determine open and closed forests (closed >30%; open <30%). In using these datasets, this forest definition has been applied to the results of this study, as mentioned previously application of a different definition would show different results.

Table 5. Data Source and Forest Classification Data.

Data Source	Years of Coverage	Classification
GIZ's forest mask	2000, 2009 and 2013	Binary forest – non-forest
UN-REDD collect earth dataset	2000 and 2013	IPCC's 6 land cover classes and information about disturbances
FRDC's forest taxation inventories	Various for provinces, approximately once in 15 years (Annex 1.2)	Forests with details on structure and intervention

3.2 Other Studies on Drivers of Forest Change in Mongolia

About 10-15 years ago, a series of reports painted a gloomy picture of Mongolia's forest sector. In 2002, (World Bank, 2004) an imminent crisis in the forest sector was identified and identified much need for reform exhibited by over-harvesting, rampant illegal logging, ill-conceived government priorities and an inability to enforce laws and regulation (World Bank 2004). The World Bank also collected lessons learned on the government's tree planting programmes, highlighting irregularities in use of public funding, low success rates and technical capacity gaps (World Bank 2006a). The World Bank also diagnosed incoherent policies in setting harvesting rates and portrayed the forest sector as being dominated by illegal activities (World Bank 2006b). The WWF similarly reported on the abundance of illegal logging (WWF 2002). Two academic studies have looked at pressures from livestock, demand for fuel and industrial wood, the impact of forest fires, next to the impacts of climate change (Tsogtbaatar 2004, 2013). Mongolia's National REDD+ Readiness Roadmap identified forest fires, illegal logging, pests, pathogens and diseases, grazing and damage from mining as principal drivers of forest change. It also points to a set of underlying causes that include an overemphasis on forest conservation, a demand for wood products outstripping the official supply, inadequate forest law enforcement, impacts of climate change and desertification on forests, and unclear land tenure (MEGD 2014d).

3.3 Mongolia's Macro-Economic Trends

In Mongolia, the collapse of the socialist system and the subsequent transition and eventual recovery are important context for the drivers assessment, such macro-economic trends provide a backdrop for the assessment of drivers of forest change (Figure 6).

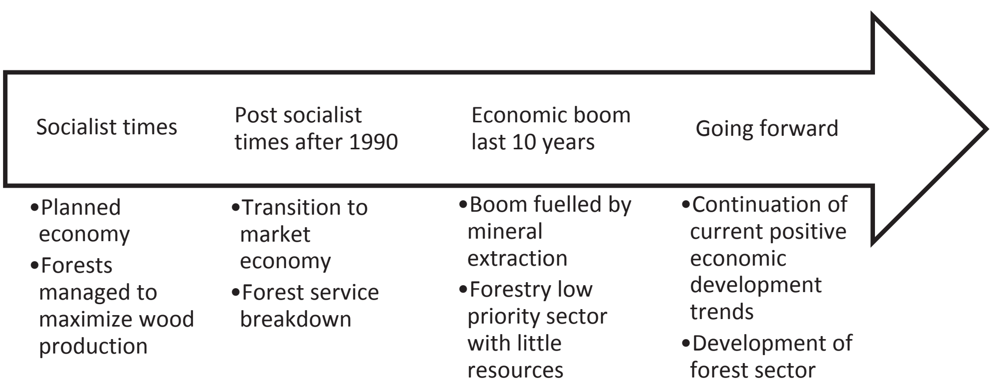


Figure 6. Timeline for Changes in Mongolia's Forest Sector

Mongolia's forest sector has declined since the collapse of the socialist regime. During the socialist era, Mongolia's economy was centrally planned, growth was sluggish and social development slow. The socialist economy also included a solid system for the management of forests that mainly aimed to maximize timber production. The country received technical support on forest management from the Soviet Union. In 1990, the Soviet Union collapsed and since then Mongolia has taken many steps to reform the economy and its political systems. The initial transition period was painful for the country, the country's forest management collapsed and unregulated forest exploitation was rife. The last 10 years have witnessed an economic boom, based partly on the discovery of vast, exploitable mineral resources. The economy has shown double-digit growth rates and is now considered an upper-middle income country (World Bank 2015b). In this new context, the forest sector is marginalized and attracts little government resources for management (UNDP 2013b). Recently, the boom has slowed down and the current macro-economic trends point to continued moderate growth World Bank 2015a). Concerning the forest sector, no major developments are apparent, and the marginalization of the sector could continue. With this, the last 10 years are a good reference period for studying the drivers of forest change. It is expected that the coming years will see similar trends. The analysis of data and literature therefore considers the years 2004-2014 as this study's reference period.

4.0 Overview of Drivers of Forests Change

Whilst drivers for deforestation are often usually clear to understand and measure, often a set of drivers typically compound each other resulting in forest degradation which complicates their measurement on an individual basis. In Mongolia this complex interaction of degradation drivers can lead to deforestation. Once disturbed, the resilience of a forest ecosystem decreases, and a combination of pressures from unsustainable logging, livestock grazing, fires and pests occur together. Any of these drivers can provide an entry point to a process of increasing forest degradation. Independent to the specific driver that triggered degradation, forests increasingly degrade and ultimately turn into steppe with few trees or shrubs. Despite the similarity of resulting vegetation, it is for this study nonetheless important to distinguish between the drivers that first trigger the degradation process. A set of drivers and underlying causes resulting in enhancing carbon stocks are also elaborated in this report, which discusses and provides reasons for focusing on some drivers and activities enhancing carbon stocks. The following drivers and activities enhancing carbon stocks are focus of the analysis:

Deforestation Drivers

- Mining
- Deforestation through continued degradation

Degradation Drivers

- Forest Fire
- Unsustainable logging and subsequent degradation
- Damage from pest outbreaks
- Grazing
- Fuelwood collection

Enhancing Forests Stocks

- Tree Planting
- Sustainable Forest Management
- Community Forestry

4.1 Forest Fires

Forest fires affect large areas in Mongolia (Figure 7a), generally about 95% of these are regarded as caused by human activities, only 5% are due to natural factors, mainly lightning (Chuluunbaatar 2001, 2012). Fires most likely occur during the spring and autumn period, the highest fire risk season, when activities such as timber harvesting, use of non-timber forest products, hunting may cause forest fires (Nyamjav, Goldammer, and Uibrig 2007). Forest fires burn large amounts of herbaceous plants, peat, humus layer, moss, tree crowns, shrubs, and trees on the surface of the forest soil. There can be surface, ground and crown fires depending on environmental conditions and the amount of fuel in the forest ecosystem, with crown fires resulting in affects that are more deleterious and may lead to a large number of tree deaths. Once burnt, forests are more susceptible to damage from pests, and makes forests more accessible for logging, specifically for dead wood collection and grazing, as the resulting opening of crown cover will benefit grass and therefore attract grazing animals. The effects of fire also result in increased oxidisation of organic matter in soils leading to emissions several years after the forest fire incident. Recurrent burning often compounded with grazing suppresses natural regeneration that would occur in natural forests. It is reported that on average one million hectares of land is affected by fire each year, with 70% occurring in grassland areas (Ouyanna, pers. com). The incidence of fires should also look at steppe / grassland fires as these are often the most common cause of forests fire (Chukka, pers. com).

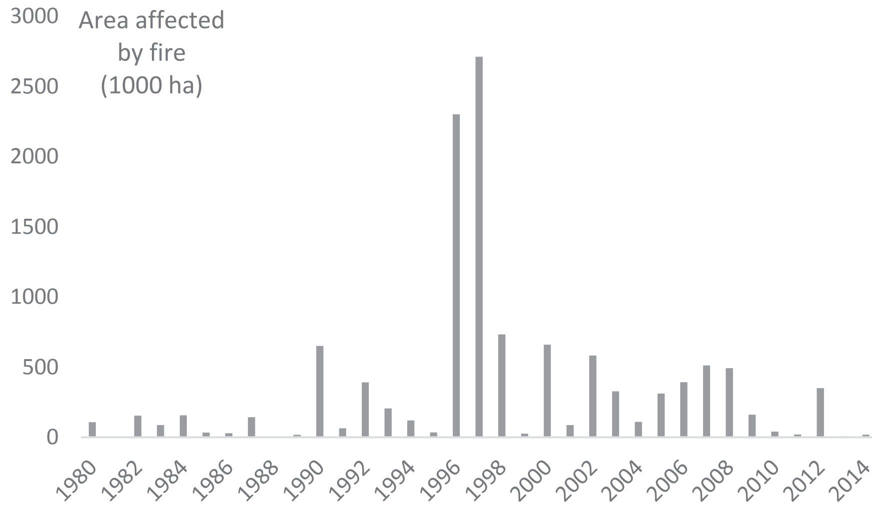


Figure 7a. Overall Forest Area Affected by Forest Fire in Mongolia 1980-2014 (Dorjsuren 2014; NSO of Mongolia 2015)

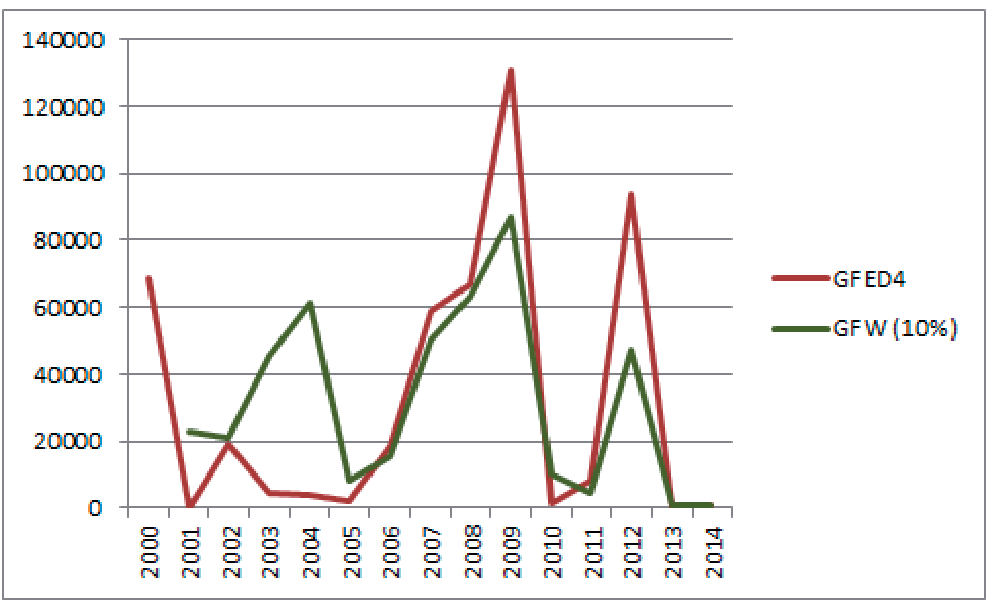


Figure 7b. Overall Area Affected by Fire in Mongolia (FAO, Fire stat).

Red line indicates forests fires and green line represents forest cover derived from global data set (Hansen et al.); extracted from Lee (pers. Com).

4.2 Unsustainable Logging and Subsequent Degradation

Most logging practices in Mongolia are unsustainable and consequently lead to long-term forest degradation. Logging companies do not follow best practices for sustainable forest management and reduced impact logging is not practiced. Though Codes of Practice are available in Mongolia, logging safeguards are usually not implemented to reduce the subsequent effects of increased fire, pest damage, and grazing following timber extraction. Unsustainable logging compromises the forests capacity for regeneration, with soil compaction, forest fire, grazing and logging damage impacting forest regeneration. This report treated clear felling and other forms of unsustainable logging together, because they are carried out by the same actors, have similar effects on forests, and are both reflected as logged areas in the forest taxation inventory, so no separation of data was possible. Logging is not per se unsustainable and damaging to forests and as part of a sustainable management regime has inordinate benefits, however, sustainable logging and thinning occur only small pilot initiatives[4].

The Mongolian forest industry has been steadily declining since the economic crisis of the early 1990s; in the 1980s the forest industry made up around 10% of Mongolia's gross domestic product (Chimed, Enkhsaikhan, and Banzragch 2014). The harvest volume amounted to around 2 million m^3 /year (Figure 8). In the 1990s, Mongolia underwent an economic crisis and large wood harvesting and processing centralized industries and factories collapsed. The majority of the wood harvesting and processing PFEs ceased manufacturing wood products and took to exporting roundwood and sawn timber to China. In 1999, environmental concerns led to the parliament passing legislation that all but halted export of round wood and sawn material. During recent years, official timber harvesting rates have oscillated around approximately 1 million m^3 /year (Figure 8). Much of this harvest has been met through sanitation cutting or forest cleaning whereby timber is removed from forests affected by fire, pests and diseases. From the total, 9.1% were harvested through harvest cutting, 4.6% from thinning, 86.3% from forest cleaning and sanitation cutting. There is an average 18.8% of total harvest for commercial wood and 81.2% for fuelwood; the latter is used for householder consumption, charcoal making and sale to urban areas.

[4] GIZ, Multiple-purpose National Forest Inventory Program implement Sustainable Forest Management practices and are developing guidelines and codes of practice. The FAO GEF Biodiversity, REDD+ and Forest User Group project are working with Forest User Groups to apply thinning regimes as a way of reducing pest damage, extraction of poles and firewood and improve forest growth for eventual harvesting of timber.

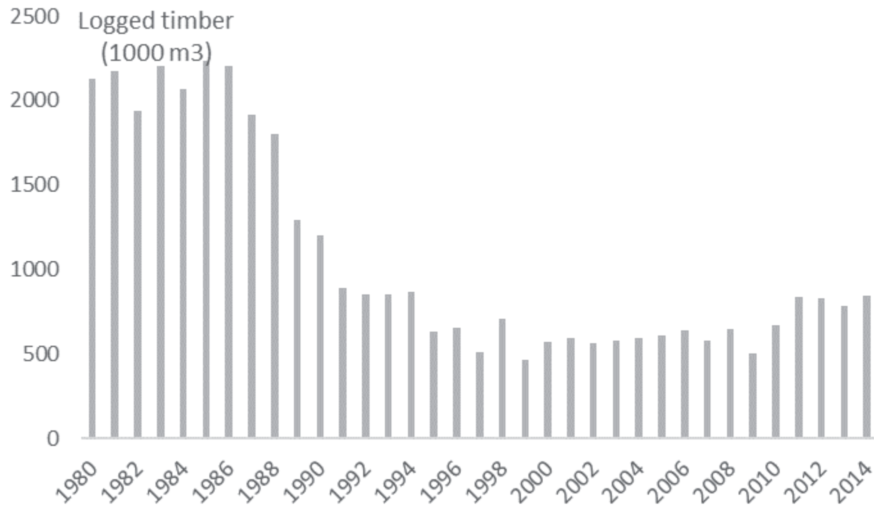


Figure 8. Total Volume of Official Timber Harvested in Mongolia, 1980-2014 (Dorjsuren 2014; NSO of Mongolia 2015).

In Mongolia, regulation limits logging to so-called 'forest cleaning', akin to salvage and sanitation cutting following forest fire or severe pest outbreak. According to the provision 3.1.15 of the Mongolian Law on Forest such 'forest cleaning' consists of removal of dead trees, fallen twigs and trees that have died due to forest fire, defoliating insects, disease, strong wind and snowfall. In an international context salvage cutting is usually understood to remove dead or severely damaged trees to recover economic value that would otherwise be lost. Sanitation cutting is usually understood to remove trees to improve stand health by stopping or reducing the spread of disease (Helms 1998). There is also evidence that removing of fallen trees reduces fire risk (Chuluunbaatar 2012), but this evidence is not uncontested and other studies have highlighted possible negative impacts on ecosystems (Lindenmayer and Noss 2005; Nappi et al. 2011). Currently, most legal logging activities in Mongolia are conducted as 'forest cleaning' and fall short of national targets for timber production. Official data indicate that annually 729,000 m3 of timber were harvested during 2011-2014 (Figure 8). This volume falls short of official planned requirements to support Mongolia's wood industry and its emerging needs. An ongoing governmental programme for forest cleaning targets covering 315,000 ha and 1.4m m3 of timber and fuelwood every year until 2020, primarily in the forest-rich provinces.

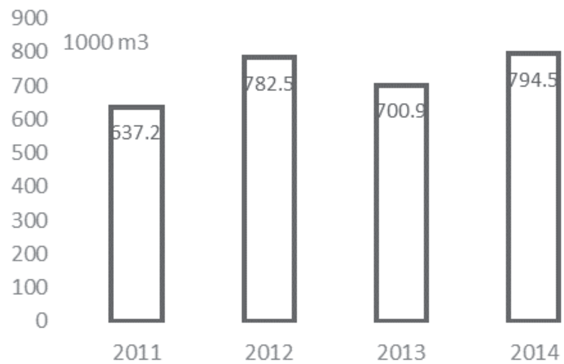


Figure 9. Volume of Timber Harvested through 'Forest Cleaning' in 2011-2014 (MEGD 2014a)

Government policy promotes timber import through tax exemptions and reducing import tariffs. Wood and wooden materials were exempt from customs tax and value added tax in 2013. Import volumes sharply increased and around 140,000 m3 of sawn wood was imported in 2013 and 2014 (Table 6). Import volumes, mainly from Russia, remain relatively low for several reasons. Firstly, on the Russian side, there is a minimum order size for exports, prices are high, and export taxes amount to 80% on round wood and timber. Secondly, taxes, as well as payments for transport and storage, are due in advance which means that only a few, large PFEs can comply with these requirements.

Table 6. Imported Wood and Materials between 2010-2014
("Mongolian Customs General Administration" n.d.).

	Amount in 2010 (m3)	Amount in 2011 (m3)	Amount in 2012 (m3)	Amount in 2013 (m3)	Amount in 2014 (m3)
Firewood	459	986	72,731	3854	74,557
Roundwood	24	1255	1962	870	4850
Wood for specific use	16,924	1094	3	41	4
Railway sleeper	2806	26,000	1816	324	141
Sawn wood	1947	11,707	6321	18,768	33,529
Total	22,161	41,041	82,834	23,858	113,080

Unsustainable logging and subsequent degradation mainly takes place as an illegal activity. Although there are no official statistics available, there is a gap between official supply and demand statistics that can be explained through unofficial activities. Since 2011, official harvest rates have been lower than 1 million m3 /year (Figure 8). The FRDC estimated that there is demand of approximately 1million m3 /year for commercial wood, and of approximately 2 million m3 /year for fuelwood (FRDC 2013). Similarly, a World Bank survey reported that around 1.2 million m3 of wood consumed annually in Ulaanbaatar is supplied through illegal logging and thus exceeds official harvesting by a factor of two (World Bank 2006b).

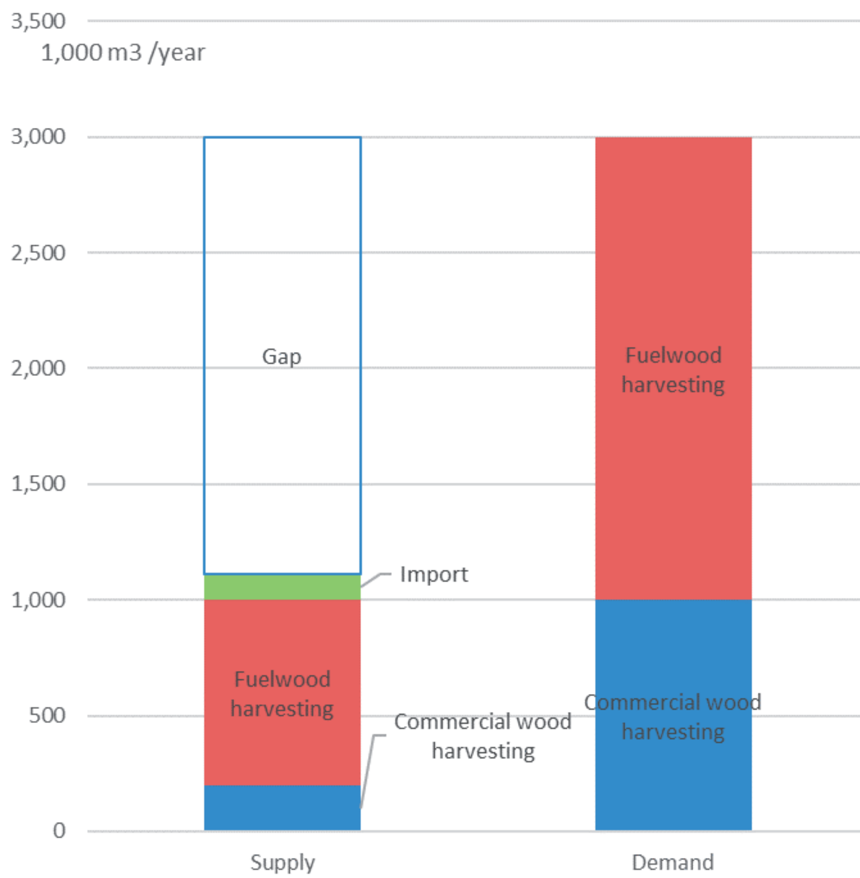


Figure 10. Data for Fuelwood and Commercial Wood Harvesting showing Difference between Supply and Demand Statistics

Community forestry takes place through a system of 'forest user groups' (FUGs). The licenses granted to FUGs allow fuelwood collection through 'forest cleaning'. Typically, FUG licenses do not allow for sustainable selective logging, although in pilot cases, more comprehensive licenses have been granted. The MET licenses PFEs for certain kinds of activities, according to six types of licenses; namely for thinning, forest cleaning, forest restoration, reforestation and nursery operations. Special equipment and skills are needed for conducting forest inventory and taxation, for pest control and there are fewer PFEs in these fields. Commercial forest utilization licenses are provided to only few, bigger wood harvesting PFE, which have staff, equipment and skills for harvesting, wood transportation, and saw milling. FUGs and PFEs ultimately implement much of the forest management activities. Both of these organizations work through licenses. At present, there are as many as 1,179 FUGs, together covering 3,119,635 ha. There are almost 83 PFEs active, together covering 681,378 ha (Table 7).

Table 7. Forest Licences held by Forest User Groups and Private Forest Enterprises (MEGD 2014a).

Provinces	Number of FUGs	Area of FUGs (ha)	Number of PFEs	Area of PFEs (ha)
Arkhangai	71	180, 819	1	4510
Bulgan	173	540, 385	2	19,379
Dornod	30	142, 911	3	139,619
Zavkhan	56	156,783	Unknown	Unknown
Ovorkhangai	47	54,265	1	250
Selenge	153	472,441	55	443,641
Tuv	104	168,644	18	58,700
Uvs	30	32,693	Unknown	Unknown
Khovsgol	246	952,973	Unknown	Unknown
Khentii	136	335,943	3	11,879
	1,046	**3,037,857**	**83**	**677,978**

Fuelwood collection is an activity conducted by FUGs or by dedicated PFEs; it is reported through stakeholder meetings to currently have little impact on Mongolia's boreal forests. Firewood collection does not actually contribute to forest degradation, if anything, it could have a positive impact as helps to reduce the impacts of pest attack and forest fire risk. Fuelwood collection is not treated as a driver of forest degradation because it seems to be no more than a secondary activity under community forest management efforts. Also, the forest taxation inventory does not include data on fuelwood collection. However, it has been reported in the past that large scale commercial logging was done for fuelwood which did cause a major impact on forest degradation and deforestation. In addition, the impact on saxual forests may be different as these have low above ground biomass and may be more sensitive to commercial or household firewood collection.

4.3 Tree Planting and Enhancing Carbon Stocks

*T*ree planting covers large areas in Mongolia. This government activity is implemented by specialized PFEs. It includes both the direct planting of saplings, sowing seeds of trees and techniques for assisted natural regeneration of severely disturbed forests. (The programme for building a green wall is not relevant for this work because it focuses on steppe in the Gobi region where the saxual forests occur). Tree planting in Mongolia is mainly carried out for forest rehabilitation. The objectives are to regenerate various kinds of degraded forests after disturbance if there is insufficient natural regeneration. Forest rehabilitation measures include direct planting, assisted natural regeneration and protection of saplings. The need for forest regeneration by far outstrips the capacity to actually plant or assist natural regeneration. During the last 10 years' forest rehabilitation work was undertaken in small modest areas between several thousands of hectares annually (Figure 11).

Figure 11 shows planting areas, however, it is interesting to observe that analysis of field observations as per forest taxation inventory the success rates of these plantings is very low with only 200 hectares per year being classified as new forests. It was reported that of every 6000 hectares planted, only approximately 2000 hectares is regarded as successful after the first year. The State Forest policy proposes that naturally regenerated and planted forests will be increased to 310,000 ha in 2020 and 1.5m ha in 2030 (Government of Mongolia 2015b). Assuming that about 70% of rehabilitation would be through natural regeneration, there would be a theoretical need for tree plantings of 90,000 ha in 2015-2020 and more in 2020-2030; this would assume also that plantings have high success rates, which is currently an incorrect assumption.

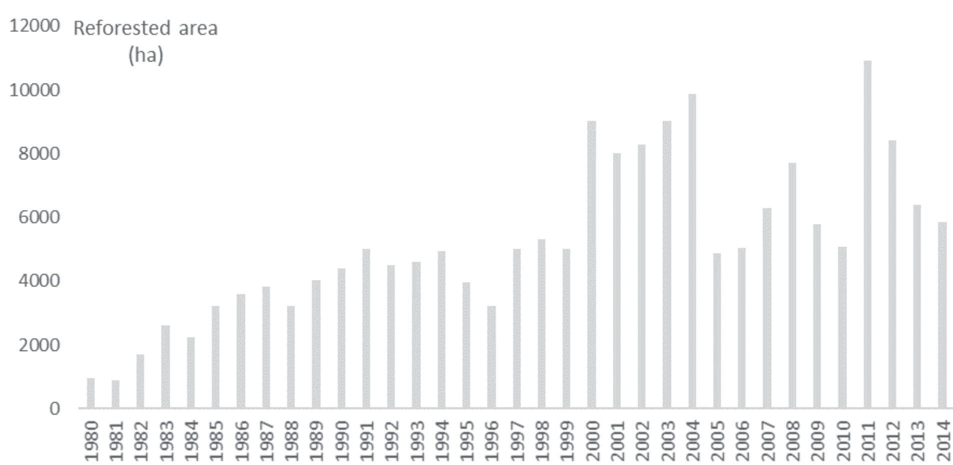


Figure 11. Overall annual reforestation area in Mongolia 1980-2014 (Dorjsuren 2014; NSO of Mongolia 2015).

PFEs implement most tree planting activities. Most activities are carried out through a tendering process that considers incorporation as PFE or other organizations with access to nursery, capability of staff and cost profiles. Beyond the actual planting, the PFEs or other organizations need to provide for irrigation and protection of the reforested areas for 3 years and achieve high survival rate. Typical conditions release full budget for survival rates >75%, but dictate replanting at rates >50%, and full reimbursement of advances at rates <25% (MEGD, 2013). However, field observations indicate that planting stock is poor, often sites are poorly planned, grazing can impact success rates, and the provenance of tree seedlings is not known. Future efforts should consider improved maintenance and after care, consideration of weeding regimes, better strategies to remove the impacts of grazing, and strategies to improve planting stick. In addition, most reforestation schemes focus on panting pines, however, in some vases broadleaved species may grow better.

4.4 Minor and Major Pest Damage

Insect damage is caused by a complex interaction of factors that are only partly human induced. Beneficial and detrimental insects in any forests live in harmony with the ecosystem, with outbreaks often being part of the natural ecological cycles. However, the ecological balance can be lost and the provides suitable conditions for pest outbreak due to weakened forests health as a result of forest fire, logging, competition for water. In particular, after fire, there is high risk of pest infestation and also logged-over forests tend to attract pests. Especially in 2000-2002, there were favourable conditions for reproduction of harmful insect species which resulted in large pest outbreaks, this mass reproduction of Siberian and gypsy moths covered most of Mongolia's forests (Tuzov et al. 2005). Damage can be severe, after a gypsy moth outbreak in 2002, larch forests in eastern Khentii have been replaced by birch (Undraa, et.al, 2009). The effects of widespread pesticide use may also affect the ecological balance between predators and prey. Increasing aridity as a result of climate change has also been said to favour mass proliferation of harmful insects (Dorjsuren 2014); climate change has also been reported to lower the abundance of insect parasites which may ultimately effect cause increased abundance of insect pests.

- Pest outbreaks and damage over subsequent years can lead to deforestation, herewith classified as Severe Pest Damage.
- Minor pest outbreaks will only slow growth for one season and these tend to lead to forests degradation., herewith classified as Minor Pest Damage. If there is no further pest outbreak, or other cause of degradation, it is expected that in following growing years the forests will recover.
- Pest damage is also one of the contributing factors of degradation (combined with fire, environmental change, logging) which can lead to 'deforestation through continued degradation'.
- Further analysis of historical data and reports from FRDC and Ministry of Environment are required to gain a further understanding of the extent of pest damage.

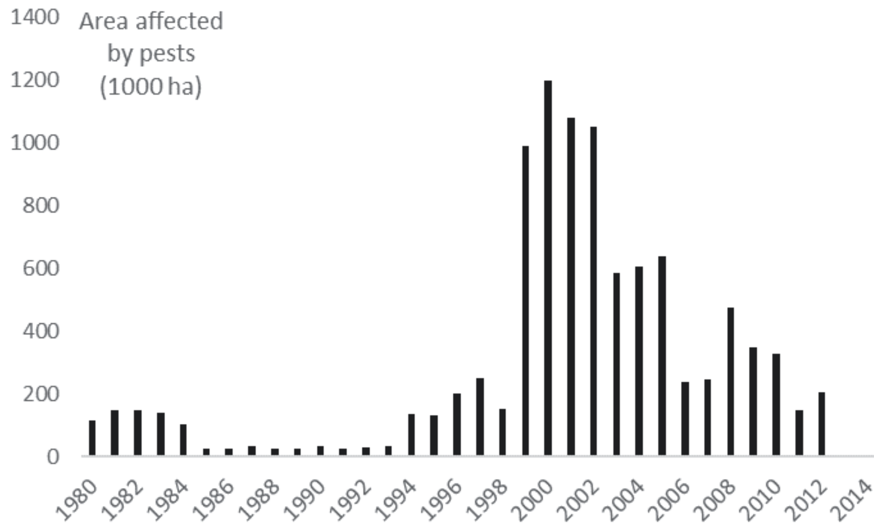


Figure 12. Overall Forests Area affected by Pests in Mongolia 1980-2014 (Dorjsuren 2014; NSO of Mongolia 2015).

Pest control measures begin with ongoing monitoring of pests and diseases and also include actively controlling pest outbreaks; this work is carried out by specialized contractors who collect data to monitor pest populations through routine surveys in the spring and autumn. The purpose of the survey is to determine the distribution of the pest and disease, to assess damage conditions, reveal hotspot of pest infestation and disease. Ultimately, the surveys serve to define the condition of the forest affected by pest and disease and to select the area to carry out measures to check the outbreaks. The main methods to control pest outbreaks are through use of chemical, physical, mechanical, biological, quarantine methods. It is clearly effective to use a combination of these methods. Measures to combat with forest pest and disease control are carried out using aircraft and shoulder spray equipment and other tools by chemical, microbiological and mechanical methods. The use of aerial spraying of pesticides was stopped in 2012. A previous iteration of this report considered pests only in terms of forest enhancement through pest control, however, we now consider them as a driver of deforestation and degradation, pest control will be considered as a policy and measure in future development of the REDD+ Action Plan.

4.5 Deforestation through Continued Degradation

Continued degradation is the most common reason for deforestation. The long-term compounded effect of the several above drivers of forest degradation leads to deforestation. Once disturbed, forests increasingly degrade and ultimately, they turn into steppe with few trees or shrubs. Since several factors are compounded in deforestation, it is difficult to identify a single factor of the major cause, therefore they have to be treated as a group of factors. The taxation data does not include area data that would enable disaggregating deforestation by the individual forest degradation drivers. Continued degradation is common across Mongolia's forest areas. Although clearly human pressure concentrates on the forest edges, the areas affected are vast, an FRDC dataset shows how forest density reduced from 0.55 to 0.51 in only 8 years between 2007 to 2015 (Figure 13). This degradation leads eventually and in places to deforestation. It is due to the long-term compounded effect of forest fires, pest damage, often triggered by improper unsustainable logging, and exacerbated by uncontrolled grazing and recurrent burning inhibiting regeneration (Tsogtbaatar 2013).

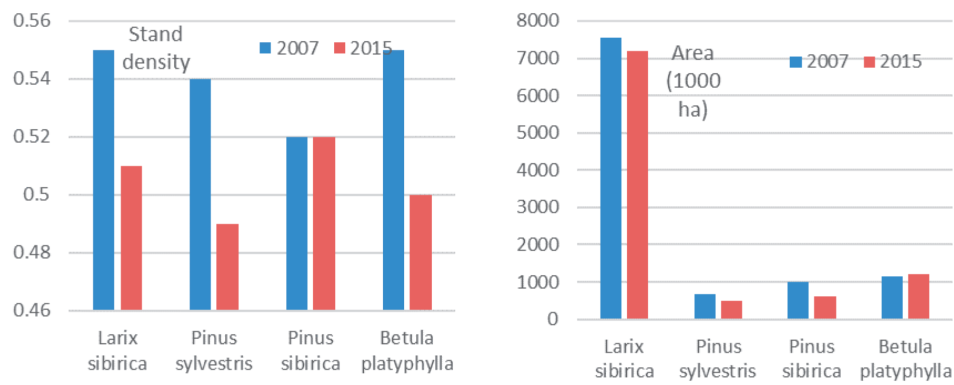


Figure 13. Forest Area and Density Change by Tree Species (Forest Agency 2011; MEGD 2014a)

4.6 Mining Causing Deforestation

Mining can also cause deforestation when mining companies remove the top soil and open pits. Such activities happen independently of the other drivers of forest degradation and deforestation. To date, 2,736 mining licenses have been issued covering 11m ha (7.0% of the total national territory). These include 1.1m ha of exploitation licenses and 9.9m ha of exploration licenses (MEGD, 2015). In 2009, in the forest provinces the total area under exploration and mining licenses is estimated to be between 2-14% of forest areas (Table 8). Further collection of detailed datasets from the Ministry of Mining needs.

Table 8. Exploration and Mining Licences Granted in 2009 (Forest Agency 2011).

Province (aimag)	Total forest area (ha)	Exploration licenses	Area under exploration licenses (ha)	Mining licenses	Area under mining licenses (ha)	Total area under licenses (ha)	Total area under licenses (%)
Khuvsgul	4,209,000	82	236,904	1	5	236,909	2.0
Selenge	1,931,200	171	252,267	99	16,289	268,556	14.0
Bulgan	1,917,600	57	413,665	7	2,709	416,374	3.3
Khentii	1,783,900	78	285,094	12	1,440	286,534	5.0
Tuv	1,445,300	39	19,817	10	1,211	21,028	3.4
Arkhangai	1,008,700	51	112,371	12	1,916	114,287	6.2
Zavkhan	778,000	20	35,630	-	-	35,630	2.6
Dornod	188,800	16	5,310	2	43	5,353	9.5
Uvs	185,600	25	19,142	1	63	19,205	14.0
Uvurkhangai	171,200	13	28,019	13	3,310	31,329	10.5

Mine-site restoration is insufficient on much of the mining areas. By the end of 2013, 24,636 ha for mining were disturbed. On 41.65% and 27.5% of the areas, respectively, technical reclamation and biological restoration were carried out (MEGD, 2015). Technical reclamation refers to closing the mining pit; whereas biological restoration refers to re-establishing vegetation cover by sowing of perennial plants and planting trees. The absence of grown soil makes biological reclamation difficult and often establishment of vegetation cover is unsatisfactory.

A mining moratorium on new areas, declared in 2010, has drastically reduced the land areas affected by mining activities. In 2009, the State Great Khural passed the "Law of the Prohibition of Mining Operations in the Headwaters of Rivers, Protected Zones of Water Reservoirs and Forested Areas" this makes sense to ensure vital ecosystem services are protected. In the framework of its implementation, the government released the Resolution 174 of 2010 and revoked licenses of 238 companies. Also in 2011, the Ministry of Nature and Environment and Tourism (today's Ministry of Environment and Tourism) appointed a working group to assess the damage of mining activities to the environment and the cost of restoration. The working group concluded that about 53 entities carried out gold exploitation activities in 10,000 ha of forest area, of which 1043.3 ha of forest areas were completely destroyed. It concluded that damage to the environment and ecology had been causes that amounted to 12.8 billion MNT (MNET 2011).

4.7 Grazing

Mongolia has a long tradition of raising livestock. Pastoral nomadism is the prevailing form of land use (Lkhagvadorj et al. 2013a). Currently around one third of Mongolia's population lives as nomads from livestock husbandry (Dagvadorj et al. 2009). Currently, there are about 52m heads of livestock, with about 23.3m sheep and 22.0m goats next to several other kinds of livestock (NSO of Mongolia 2015). Grazing is not, in itself, a driver forest change, but works together with several other factors contributing to deforestation through continued degradation. The complexity of factors is described in the section on deforestation through continued degradation. In addition, this sub-section provides information on the damaging impacts of grazing on forests. Grazing within forests is widespread and an important factor inhibiting regeneration, animals eat young trees and it suppresses regeneration. Grazing is therefore a contributing factor to the degradation of already distributed forest; this contributes towards the Deforestation through Continued Degradation. Grazing is not typically an entry point to forest degradation, however, grazing is problematic because of its abundance, and in particular may be one of the reasons why forests planting has such low success. In areas along the forest edges with human pressures such as unsustainable logging and fires, grazing will typically also prevail and is absent only in remote areas. Grazing exacerbates the effects of other drivers of forest degradation, mainly because it suppresses regeneration after disturbance.

Herders do not typically own or manage pastureland. During the country‘s transition from a centralized socialist system to a market economy in the 1990s, state herding collectives that allocated pastures and campsites and coordinated grazing land were dismantled and livestock were privatized. Pastureland itself, however, remained under state ownership (Fernández-Giménez and Fern 2002; Upton 2005).

Today, larger herds are managed without a clear pasture allocation system and forest grazing is common; especially in the winter time when pasture is limited, in addition, animals may transit through forest on way to other pasture lands which also results in grazing damage of saplings and seedlings. Mongolia’s forests are widely used for livestock grazing; bout 35-40% of the livestock population graze in and near forest areas, trampling young trees and saplings, and inflicting heavy environmental toll on the land (Tsogtbaatar 2013). The multi-purpose national forest inventory estimated for Altai and Khangai that 14.7% and 32% of forests suffered from moderate grazing pressure, and 20.4% and 2.3% of forests from intensive grazing pressure. Pressure was less intense in Khentii and Khovsgol (3.0). Grazing is not restricted to the forest edges only. In Altai, livestock dung was regularly found also in the forest interior (Lkhagvadorj et al. 2013a, 2013b).

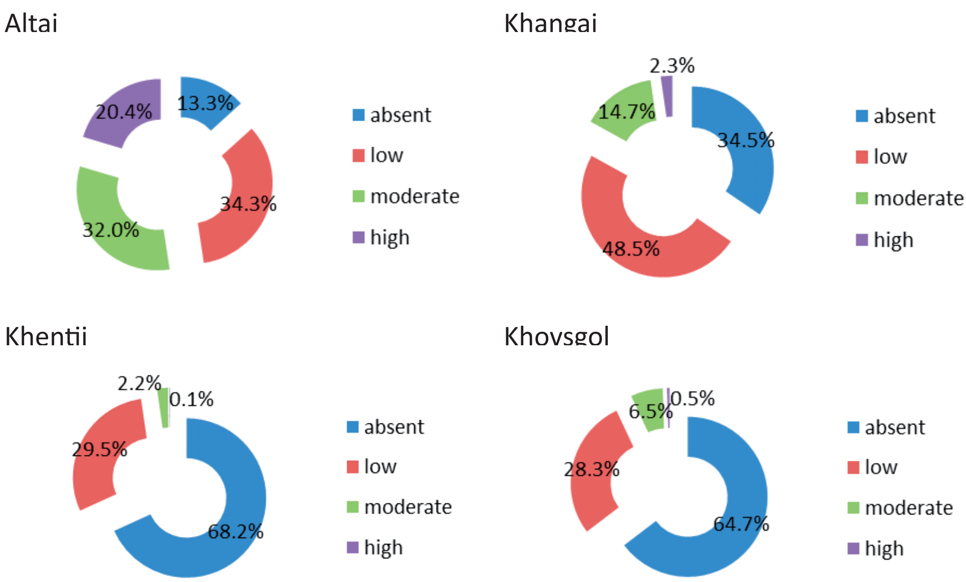


Figure 14. Grazing Intensity in Forests recorded by the Multi-purpose National Forest Inventory (GIZ 2015).

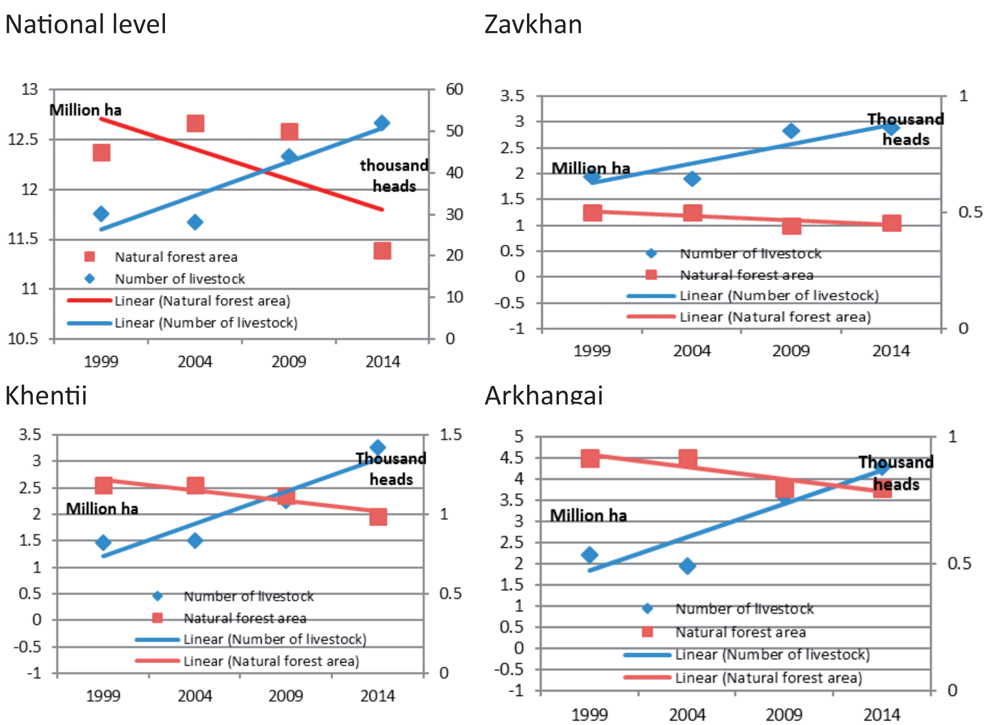


Figure 15. Relationship between number of livestock and natural forest area (Source: NSO. 2003, 2005, 2010,2015).

Figure 15 shows an inverse trend between number of livestock (blue lines) compared to area of forest red line). Though this trend is not linked to direct degradation or deforestation but it is an increasing factor. Livestock pressure may be increasing and placing more pressure on young forests and regenerative capacity. Grazing also changes the ground flora of a forest, towards a grassier flora, and may have impacts on soil moisture levels. Particularly damaging to forests are goats. Whilst sheep consume large amounts of forbs and grasses and lesser amount of woody species, goats prefer leaves and tender twigs of woody species and consume young growth of many woody species that are less palatable to other species (Sankey et al. 2006; Vallentine 2001). They can consume needle leaves of conifer trees up to 220 cm tall by bending down the trees to reach the leaves on higher branches. Goat grazing is often restricted in tree plantations where tree seedlings are short or thin enough to be bent over by goats (Child, Byington, and Hansen 1992).

While tall trees are out of reach, grazing is most damaging for forest regeneration. Browsing goats have found to reduce forest regeneration of larch forests at the forest edges in Mongol Altai (Khishigjargal 2013). According to a recent FAO study of 16 leading FUGs, one of the main factors causing degradation was due to livestock grazing, covering 31% of total forest area in those 16 FUGs (MEGD 2014b). A larch forest in Central Khangai was found to have much fewer large saplings in burned area with grazing than in areas without grazing (Undraa et al. 2015). It has also been found that grazing intensity and distance from forest edge strongly affects the survival rate of planted seedlings (Tsogtbaatar 2013). In western Khangai, goats have been found to consume larch needles even if plenty of fresh herbage was available on the ground, and most of the tree saplings were heavily damaged by the goats (Lkhagvadorj et al. 2013a, 2013b). For north-western Khentey, livestock grazing has been identified as the principal cause of lacking larch regeneration (Dulamsuren et al. 2011). According to the field survey of areas affected by livestock in Central Khangai, 12 years old seedlings had heights of only 7-10 cm (Dorjsuren 2015).

4.8 Sustainable Logging and Thinning

Sustainable logging and thinning are not treated as an activity enhancing carbon stocks in this report because it is only restricted to a few pilot projects and thinning activities have been negligible during the timeframe covered in this report. Notwithstanding, thinning activities may become an important activity for enhancing carbon stocks in Mongolia's forests.

The objectives of thinning according to Mongolia's Forest Law (2007) are:

1.1 The purpose of the forest thinning isto provide normal forest growth, development, productivity, to prevent forest from insect pests, disease, fire, and to protect its ecological balance.

1.2 Forest thinning is an important part of forestry. Forest thinning shall be conducted from the period of tree crown closure until commercial cutting in order to create favorable conditions for the growth and development of quality trees.

1.3 The main objectives of forest thinning are to regulate forest water, protect soil and improve other economic qualities, establish forest that is tolerant of unfavourable climatic conditions, decrease fire damage, improve forest health conditions, improve wood quality, increase tree productivity, increase tree resources per hectare, decrease lifetime of forest technical ripeness; produce forest dominated by high value and economic trees.

Thinning is a common silvicultural practice, being widely used to improve growth, enhance forest health and produce higher quality timber (Dong 2001; Helms 1998; Juodvalkis, Kairiukstis, and Vasiliauskas 2005). Reducing stand density means that more resources become available to the remaining trees, this may be of particular importance in areas of water stress, which, after adapting to the new situation, will generally respond by growing faster (Kerr and Haufe 2011). Forest thinning also creates gaps in the canopy allowing more sunlight and more rain to reach the soil, which in turn leads to accelerated litter decomposition and more favourable conditions for the development of natural regeneration (Kerr and Haufe 2011); though this may also increase decomposition of soil organic matter.

Recently, an increasing number of studies have shown thinning to enhance biomass productivity and carbon accumulation. In particular moderate thinning treatment has been reported to be effective means to conserve vegetation carbon storage (Horner et al. 2010; Lee et al. 2010). In forests in northern China, low and moderate intensities of thinning have been found to stimulate volume production in younger stands. The opposite is observed in older stands and at high thinning intensities (Wang et al. 2013). In Lithuania, significant increase in volume increment is achievable with thinning 10-20 year-old pine, birch and ash, or 10-30 year-old oak, aspen and spruce (Juodvalkis, Kairiukstis, and Vasiliauskas 2005). A study of thinning in 40-50 years old larch in central Khangai showed that cumulative volume production increased by 67-81% in comparison with unthinned stands (Tsogt 2014). It has been estimated that biomass increase may generally be expected at thinning intensity around 30-40% of the growing stock in stands with densities above 0.7 (Tsogt 2014).

Currently, thinning activities in Mongolia are almost negligible. Official data indicate that annually approximately 54,000 m3 of timber were harvested through thinning during 2011-2014 (Figure 16). There seems to be significant potential to increase thinning volumes and improve forest health, this may not have immediate impacts on carbon sequestration but it may reduce stress on densely packed forests, which may lead to tree death (due to competition for light and water) and make them more vulnerable to pest attack.

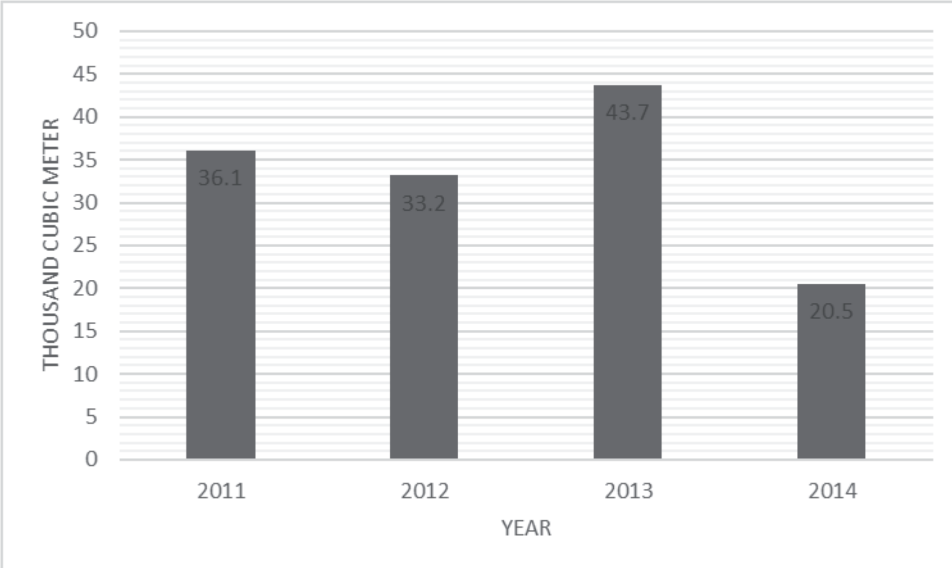


Figure 16. Volume of Thinning Extraction in Mongolia's Forests between 2011-2014 (Source: (MEGD 2014a)).

5.0 Analysis of Forest Change and Drivers

5.1 Drivers of Forest Change

On average, during the last decade, every year forest fires affected 139,000 ha, unsustainable logging and subsequent degradation occurred on 34,000 ha. Deforestation due to pest damage is not recorded in the taxation data, forest degradation due to pests is combined with other factors and not reported here. Pest control measures covered 110,000 ha. There was also 200 ha of forests annually become classified as new forests through planting, 'deforestation through continued degradation' affected 3,200 ha, and mining destroyed about 1500 ha.

A combination between the forest taxation inventory, unpublished data at the FRDC and the integrated land classes report provided these area estimates (Table 9).

Table 9. Estimated Annual Area Affected by Drivers in Mongolia (FRDC, 2015).

Driver	Type of driver	Average annual area (ha)	Source	Time frame
Forest fires	Forest degradation driver	138,605	Forest taxation inventory, with degradation / deforestation fractions according to Table 8	2004-2014
Unsustainable logging and subsequent degradation	Forest degradation driver	34,305	Forest taxation inventory, with degradation / deforestation fractions according to Table 8	2004-2014

Driver	Type of driver	Average annual area (ha)	Source	Time frame
Pest Damage	Forest degradation driver and Deforestation Driver	9,000 [1]	Forest taxation data	2004-2014
Pest control	Activity enhancing carbon stocks	109,980	Unpublished FRDC dataset	2006-2014 (province data: 2012 only)
Tree planting	Activity enhancing carbon stocks	208	Forest taxation inventory, with degradation / deforestation fractions according to Table 8	2004-2014 (province data: 1999-2014)
Deforestation by continued degradation	Deforestation driver	3,229	Forest taxation inventory, with degradation / deforestation fractions (Table 8)	2004-2014
Mining	Deforestation driver	1,544	Integrated Land Classes Report, with fraction in forest area according to Table 8	2004-2014

The forest taxation inventory shows that burnt-over forest area, logged area, area affected by pests and area damaged by wind or snow increased in aggregate by about 1.5m ha between 1999 and 2014. These processes all represent different types of forest degradation that strongly affected Mongolia's forests. Another indication of ongoing degradation is that closed forest areas decrease while open forest areas increase (Table 10).

Table 10. Area of Forest Change in Boreal Forests in in Mongolia between 1999 to 2014 (Forest Agency 2011; FRDC 2015b).

Forest types	Area in 1999 (1000 ha)	Area in 2004 (1000 ha)	Area in 2009 (1000 ha)	Area in 2014 (1000 ha)
Forest land	12,522	12,172	12,977	13,202
Closed forest area (>0.3 stock density)	11,045	10,847	11,063	10,379
Natural forest	10,629	10,465	10,355	9,729
Shrubs	416	381	707	647
Forest plantation	0.05	0	0.34	2
Open forest area (<0.3 stock density)	1,477	1,325	1,915	2,823
Open stand	559	589	676	759
Burnt-over forest area	418	289	818	1,703
Logged area	69	65	102	105
Natural regeneration with scattered trees	431	383	257	109

Reforested area	1	3	11
Area affected by pests	0	60	136
Area damaged by wind and snow	0		1

About 2% of burnt-over forest area and about 10% of logged area are deforested, about 11.7% of mining areas fall into forests. Expert estimation is used to separate out deforestation and degradation areas for the categories of the forest taxation inventory (Table 11). The average national forest cover was used as a proxy to estimate deforestation due to mining in forest areas i.e as 11.7 % of Mongolia is forest land it is assumed that 11.7% of mines occur in forests area; obviously this is a large assumption but can serve as a quick estimate till accurate mining data is overlaid with forest data (Table 13).

Table 11. Estimated Percentage of Areas Leading to Deforestation and Forest Degradation.

	Deforestation	Degradation	Outside forest	Source
Burnt-over forest area	2.00%	98.00%	0.00%	Expert estimation, including both effects of soil erosion and of cutting and grazing
Logged area	10.00%	90.00%	0.00%	Expert estimation, including both effects of soil erosion and of cutting and grazing
Area affected by pests	0.00%	100.00%	0.00%	Expert estimation[2]
Area damaged by wind or snow	0.00%	100.00%	0.00%	Expert estimation
Mining areas	11.70%	0.00%	88.30%	Average national forest cover

The forest taxation inventories provide data to quantify four drivers: forest fires, unsustainable logging and subsequent degradation, tree planting, and deforestation by continued degradation (Table 9-11). In 2004-2014, the area affected by forest fires (corresponding to burnt-over forest area) grew by 1.4m ha. The area affected by unsustainable logging and subsequent degradation (corresponding to logged area, area affected by pests and area damaged by wind or snow) grew by 340,000 ha. The area with tree plantations (corresponding to forest plantation) grew by about 2000 ha only. The area suffering from deforestation by continued degradation grew by 30,000 ha.

An unpublished FRDC dataset shows that pest control measures cover about 110,000 ha every year since 2006. The areas monitored and hot spot areas are clearly larger.

The FRDC keeps these records of their pest control activities, they are not formally published but they were basis for quantifying pest control for the drivers study (Table 9 and Table 12).

Table 12. Area of Pest Control Measures (from an unpublished dataset at the FRDC).

	Study area of pest distribution (1000 ha)	Hot spot area affected by pest (1000 ha)	Area of pest control measures (1000 ha)
2006	240	96	17
2007	850	209	27
2008	1,200	474	72
2009	1,200	350	82
2010	1,523	327	299
2011	2,042	150	123
2012	2,121	204	150
2013	2,237	211	122
2014	2,259	444	98

The integrated land classes report shows how mining areas increased by approximately 180,000 ha between 2004 and 2014. Some of the increase in mining area is on the expense of forest areas. In absence of detailed information, the average forest cover may indicate which fraction of mining areas falls into forests. Deforestation due to mining is therefore estimated to occur on 11.7% of mining areas, which was about 15,000 ha between 2004-2014 (Table 9 and Table 13).

Table 13. Mining Area between 1999 to 2014 (ALAGaC n.d.).

	Land classes	Area in 1999 (1000 ha)	Area in 2004 (1000 ha)	Area in 2009 (1000 ha)	Area in 2014 (1000 ha)
Class 2	Settlement and other settled area	403	441	542	711
7	Buildings and construction land	35	38	55	75
8	Common land tenure	303	300	294	330
9	Manufacture land	11	4	9	41
10	Mining area	33	74	146	206
11	Ger area	21	25	38	59

5.2 Analysis of Drivers by Provinces

The drivers affect forests all across Mongolia, but there are differences between the provinces.

The breakdown by the provinces may provide important input to tailoring policies and measures to local circumstances and in designing an effective National REDD+

Strategy. Provinces with highest levels of drivers are Arkhangai, Zavkhan, and Khentii. In these provinces, there was at least one driver that had severe impacts in both absolute and relative terms during the last ten years (Table 14).

Table 14. Estimated Area of Forest Affected by Drivers 2004 to 2014

Provinces	Forest fires	Unsustainable logging and subsequent degradation	'Pest control'	Tree planting[3]	Deforestation by continued degradation	Mining
Total area (ha /year)						
Arkhangai	5,519	993	22,007	0	223	57
Bulgan	13,027	5,618	16,710	4	353	52
Dornod	10,452	2,620	0	6	221	227
Zavkhan	12,869	-1,958	21,900	0	196	0
Ovorkhangai	94	1,471	0	0	30	109
Selenge	22,771	5,516	8,100	153	600	112
Tuv	10,961	-949	2,500	14	244	202
Uvs	185	1,169	11,054	3	-48	23
Khovsgol	32,853	2,656	40,650	2	772	10
Khentii	30,142	10,770	10,300	16	637	15

Key: Cells with boxes indicate top-three provinces for a given driver. Shaded cells indicate drivers that are relevant in both absolute and relevant terms. Analysis only considers forest fires, unsustainable logging and subsequent degradation, and pest control.

The same data sources as for the country-wide assessment provide basis for quantification of drivers at the province level. The forest taxation inventory had information on forest fires, unsustainable logging and subsequent degradation, tree planting and deforestation by continued degradation (Table 16), the unpublished dataset from the FRDC for pest control has detail also on provinces, pest damage is shown in Table 15.

Table 15.Estimated Area of Pest Control Measures and Mining, 2004-2014

(Provincial breakdown of data on pest control measures from unpublished source at the FRDC and of data on mining area from the Integrated Land Classes Report.

Provinces	Area of pest control measures in 2012 (ha /year)	Mining area in 2004 (ha)	Mining area in 2014 (ha)
Arkhangai	22,007	4,913	9,788
Bulgan	16,710	1,038	5,487
Dornod	0	11,296	30,694
Zavkhan	21,900	10	10
Ovorkhangai	0	2,812	12,156
Selenge	8,100	10,554	20,112
Tuv	2,500	7,307	24,584
Uvs	11,054	1,417	3,409
Khovsgol	40,650	213	1,098
Khentii	10,300	1,478	2,741

[1] NB It is reported in 2015 (FRDC, 2016) that 135,783 ha of pest infected / damaged forest area exists in Mongolia.

[2] This estimate appears to be under estimating the impact of pests as a driver of deforestation, during recent field visits large areas of boreal forest were observed to have died through successive pest attacks. This data needs to be further investigated.

[3] Tree planting between 2004 and 2012

Table 16. Estimated Area of Forest Area by Province, 2004-2014

Provinces	Natural forest	Shrubs	Forest plantation	Open stand	Burnt-over forest area	Logged area	Natural regeneration with scattered trees	Reforested area	Area affected by pests	Area damaged by wind or snow	Total forested area
Areas 2014 (1000 ha)											
Arkhangai	799	9	0	45	65	14	12	0	48	0	991
Bulgan	1,315	67	0	111	234	16	10	1	36	0	1,790
Dornod	75	16	0	29	115	1	3	0	0	0	239
Zavkhan	457	43	0	43	133	11	18	0	1	0	706
Ovorkhangai	135	0	0	14	3	6	5	0	6	0	169
Selenge	1,397	42	2	94	257	28	20	5	0	1	1,847
Tuv	957	138	0	50	149	7	7	2	6	0	1,315
Uvs	197	4	0	27	2	2	1	0	0	0	232
Khovsgol	3,152	123	0	181	353	11	16	0	31	0	3,868
Khentii	990	186	0	120	391	3	11	0	3	0	1,705
Areas 2004 (1000 ha)											
Arkhangai	919	11	0	69	8	3	75	0	0	0	1,085
Bulgan	1,431	76	0	99	101	7	37	0	0	0	1,751
Dornod	103	10	0	3	8	1	16	0	0	0	141
Zavkhan	501	50	0	58	2	17	41	0	0	0	669
Ovorkhangai	150	0	0	7	3	3	16	0	0	0	180
Selenge	1,711	56	0	52	25	15	85	0	0	0	1,944
Tuv	1,014	52	0	67	37	5	76	0	0	0	1,252
Uvs	136	3	0	10	0	7	3	0	0	0	160
Khovsgol	3,093	85	0	194	17	1	0	0	0	0	3,391
Khentii	1,187	7	0	17	84	1	26	0	0	0	1,321

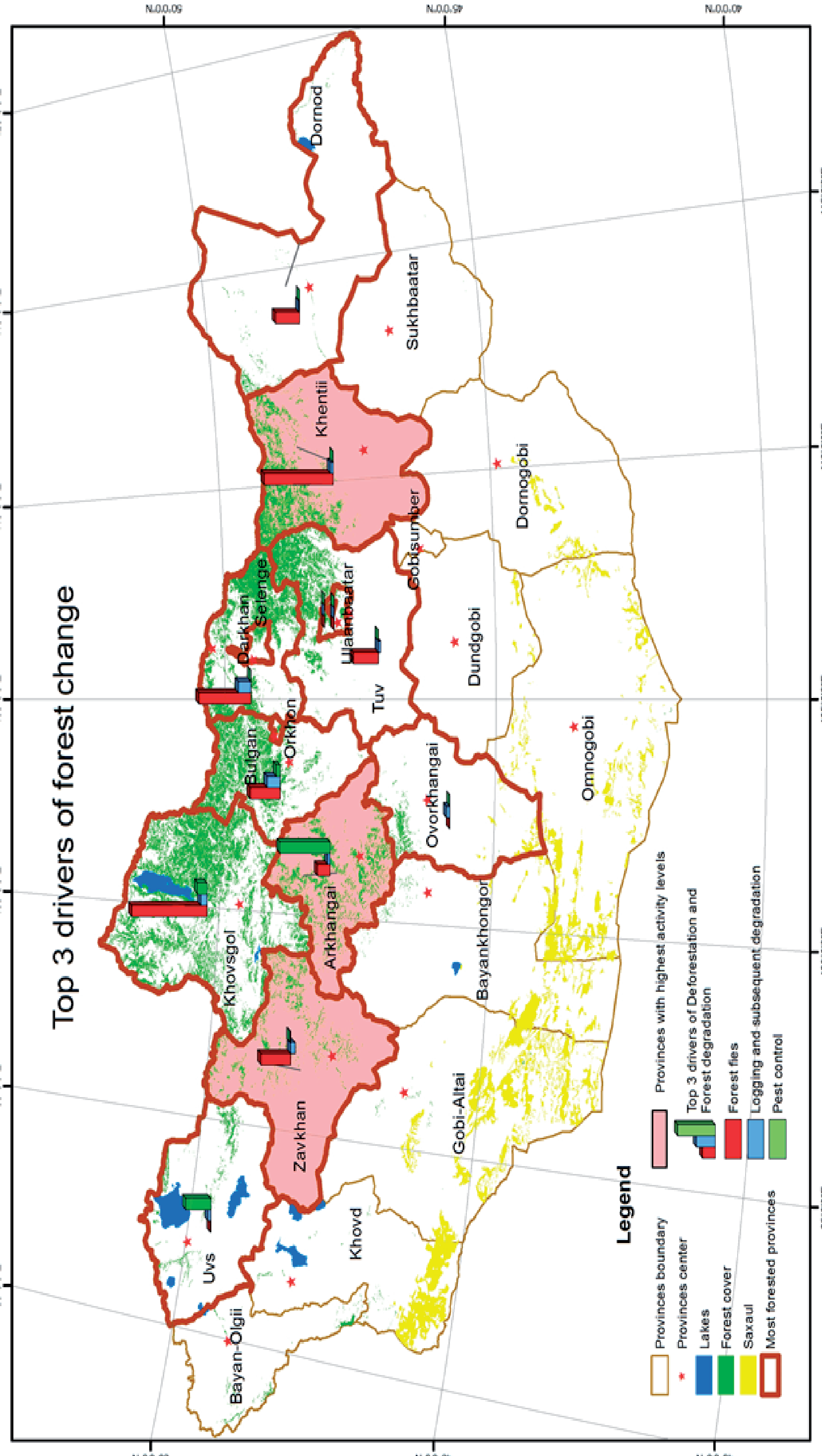


Figure 17. Map showing Top Three Drivers of Forests Change in Mongolia.

5.3 Assessment and Prioritisation of Drivers

The prioritisation of drivers drew on the areas affected, the greenhouse gas emissions and anticipated future trends. The area affected is based on combination of different data sources as previously mentioned. Greenhouse-gas emissions were calculated using standard methodologies and conservative estimates for emission factors. The trend analysis focused on trends in area changes which serves as a simple means of identifying patterns in the absence of detailed data sets.

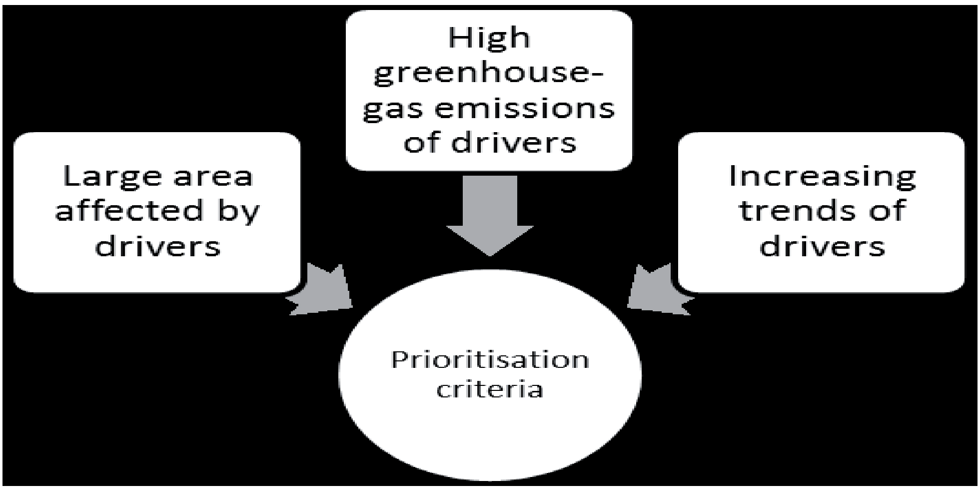


Figure 18. Criteria for Prioritising Drivers of Forest Change.

5.4 Quantitative Assessment of Greenhouse Gas Emissions

It is estimated that living biomass in Mongolia's natural forests averages 191.7 tCO2e /ha. This estimate relies on data from the taxation inventories where commercial volumes are assessed by tree species. The data mostly reflect closed, natural forests and the calculated averages therefore also reflect closed forest conditions. Averaging techniques and standard IPCC methodologies were used to derive the country-wide average carbon stock in total living tree biomass (see Annex 3.0). Disturbed forest is estimated to have around 15-20% lower biomass stocks than natural forests, depending on the types of disturbance. This estimate relies on an assessment of average volume reduction that the drivers study team jointly developed (Table 17). It refers to conditions of disturbed forest compared against conditions in natural forest. Of course, in any given forest, disturbance may be more or less severe and recovery may be more or less successful. The approach is in line with standard IPCC methodology (IPCC 2006). For example, for forest fires, the average volume reduction corresponds to the combustion factor (fBF) in the equation for calculation emissions from forest fires: CFIRE = AFIRE* BABOVE * fBF * CF * [44/12] (Annex 3.0).

Table 17. Estimation of Total Live Tree Biomass for Forests Types

Reduction estimates refer to average natural forest volume estimated at 191.7 tCO2e /ha.

Forest types in taxation inventory	Description	Drivers	Volume reduction vs. natural forest (%)	Volume reduction vs. natural forest (tCO2e /ha)
Natural forest	Natural forest, including naturally regenerated forest	No driver	0%	0.00
Open stand	Moderately degraded forest through unsustainable logging, wind and snow and pests	Unsustainable logging and subsequent degradation	20%	38.34
Burnt-over forest area	Strongly degraded forest through fire	Forest fire	16%	30.67
Logged area	Strongly degraded forest through unsustainable logging	Unsustainable logging and subsequent degradation	15%	28.76
Area affected by pests	Strongly degraded forest through pests	Unsustainable logging and subsequent degradation	15%	28.76
Area damaged by wind or snow	Strongly degraded forest through wind and snow	Unsustainable logging and subsequent degradation	20%	38.34

Forest fires reduce volume by about 16% or 29 tCO2e /ha. The IPCC's default combustion factors for surface fires and crown fires are 15% and 43%, respectively (IPCC 2003). Literature shows that low, moderate and high-severity surface fires covered 76%, 14% and 8% of the burnt areas, while crown fires occurred in 2% of the burnt areas (Dorjsuren 2009). The weighted average amounts to a 16% volume reduction.

Applying similar reasoning, for open forest, logged area, area affected by pests and area damaged by wind or snow, volume reduction was estimated at 16%, 15%, 15%, and 20%, respectively. For logged area, the estimate relates to the amount of wood left in forests (IPCC 2003).

The carbon stock of in living tree biomass in forest plantation may average 22.8 tCO2e /ha. This estimate refers to tree planting area as per the taxation inventory. It is based on data for an average Scots pine plantation of age 16 years (Annex 3).

In summary, emissions and removals are estimated to amount to about 150-190 tCO2e /ha for deforestation drivers, to about 30 tCO2e /ha for forest degradation drivers and to 20-30 tCO2e /ha for activities enhancing carbon stocks (Table 18). The estimates reflect typical types of conversion next to information about volume for the several forest types. The carbon stock estimates for natural forest and for degraded forests are based on above analysis. Barren land is treated as having no biomass at all. Although grasslands store biomass in the non-tree biomass pools particularly in soil biomass which is significant, woody biomass is zero. The per-hectare values will be used together with area estimates to calculate emissions and removals for individual drivers.

Table 18. Emissions (+) and Removals (-) of Drivers per Hectare.

Driver	Type of conversion	Land cover before conversion	Land cover after conversion	Carbon stock before conversion (tCO2e / ha)	Carbon stock after conversion (tCO2e / ha)	GHG emissions (+) or removals (-) (tCO2e /ha)
Forest fires	Forest degradation	Natural forest	Burnt-over forest area	191.70	161.03	30.67
Unsustainable logging and subsequent degradation	Forest degradation	Natural forest	Open stand, logged area, area affected by pests, area damaged by wind or snow	191.70	158.16	33.55
Tree planting	Activity enhancing carbon stocks	Grassland	Forest plantation	0	22.79	-22.79
Deforestation by continued degradation	Deforestation	Burnt-over forest area, logged area	Grassland	158.16	0	158.16
Mining	Deforestation	Natural forest	Barren land	191.70	0	191.70

In total, forest degradation drivers emitted about 5.4m tCO2e /year, deforestation drivers emitted about 0.5m tCO2e /year. These numbers (Table 19) were calculated using area estimates for the individual drivers together with estimates of emissions and removals per area unit (Table 18).

Table 19. Total Estimated Annual GHG Emissions and Removals by Drivers of Forest Change.

Driver	Type of conversion	Area affected by drivers (ha /year)	GHG emissions or removals (tCO2e /ha / year)	Total GHG emissions (+) or removals (-) (tCO2e /year)
Forest fires	Forest degradation	138,605	30.67	4,251,349
Unsustainable logging and subsequent degradation	Forest degradation	34,305	33.55	1,150,858
Pest damage	Forest degradation & Deforestation	Not calculated		

Tree planting	Activity enhancing carbon stocks	208	-22.79	-4,741
Deforestation by continued degradation	Deforestation	3,229	158.16	510,649
Mining	Deforestation	1,544	191.70	296,066

5.5 Future Trends

Trends of the drivers are assessed based on changes in areas affected across the last 15 years; for forest fires, unsustainable logging and subsequent degradation, tree planting and deforestation by continued degradation, the trend could be identified based on three timepoints only based on the cycles of the taxation survey.

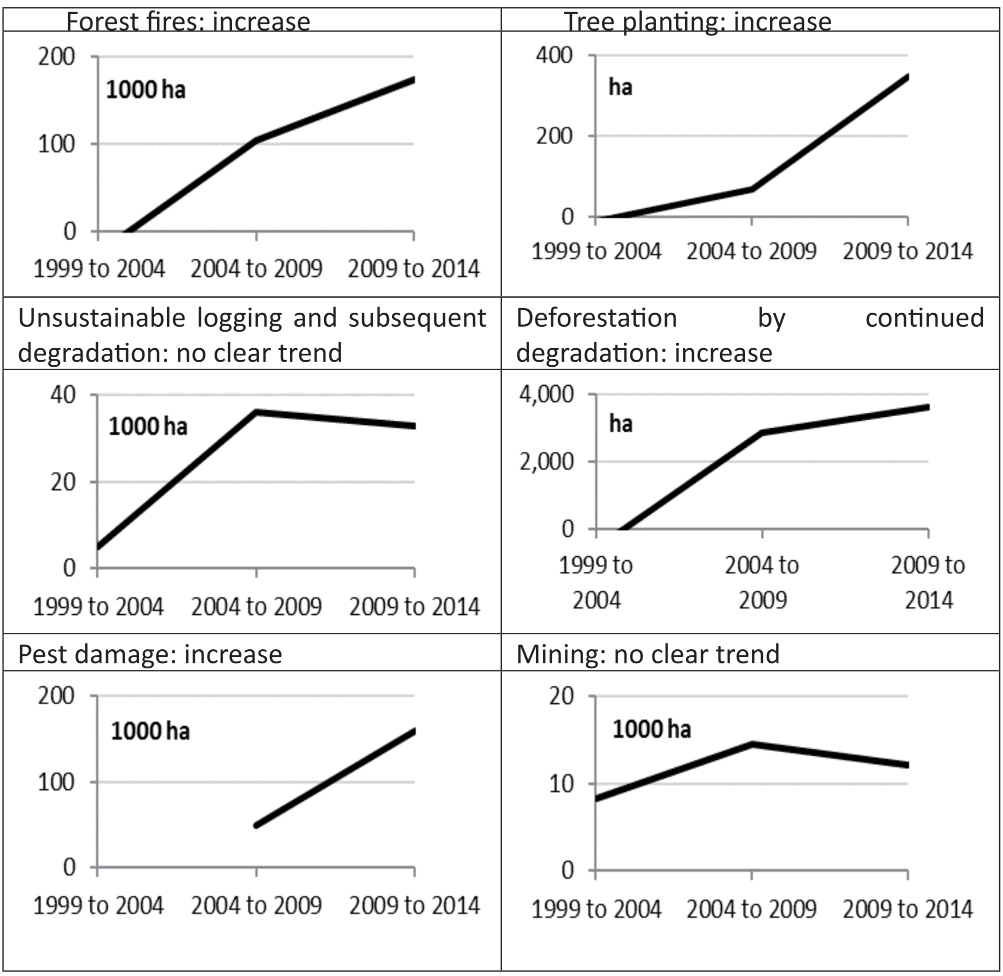


Figure 19. Trends of for Drivers of Forests Change

Forest fires, deforestation by continued degradation and tree planting have increased though data is scant, trend line indicates a positive increase. Unsustainable logging and subsequent degradation, and mining do not show a clear trend. A strong decrease is followed by a decrease across only 15 years. It is unclear whether these changes indicate fluctuations or whether the data are simply not accurate enough to actually isolate trends. Data for pests needs to be checked against the detailed information provided but not yet analysed.

5.6 Prioritisation of Drivers

Drivers prioritisation relied on the drivers' area extent, carbon implications and the area trends of the drivers. Those drivers with large areas, high GHG emissions and increasing trends were deemed priority (Table 20).

Table 20. Summary Table for Drivers Prioritisation.

Driver	Area affected (ha /year)	GHG emissions (+) or removals (-) (tCO2e /year)	Trend	Prioritization
Forest fires	138,605	4,251,349	Increase	Priority
Unsustainable logging and subsequent degradation	34,305	1,150,858	No clear trend	Priority
Minor and Major Pest Damage	Not Known	Not Known		Priority
Tree Planting	208	-4,741	Increase	Not a priority
Deforestation by continued degradation	3,229	510,649	Increase	Not a priority
Mining	1,544	296,066	No clear trend	Not a priority

It is a priority for Mongolia's REDD+ programme to support policies and measures that address forest fires. Forest fires affect large areas and generate emissions of approximately 4.3m tCO2e /year. Forest fire occurrence has strongly increased during the last years. A range of underlying causes could be addressed through well-designed interventions. It is a priority for Mongolia's REDD+ programme to support policies and measures that address unsustainable logging and subsequent degradation. Unsustainable logging and subsequent degradation affect large areas and create approximately 1.2m tCO2e /year. There is a complex set of causes that underlie the driver and that could be addressed through technical and functional capacity development, regulatory strengthening and law enforcement, awareness raising and a public discourse on the need for forest use and conservation. Beyond the amount of emissions that could be reduced, unsustainable logging and subsequent degradation are also prioritized because they are closely linked to forest management practices and therefore key to designing interventions in the forest sector.

It is a priority for Mongolia's REDD+ programme to support pest control measures. During the last years, large areas were already covered by pest control measures. These activities have reduced emissions by approximately 3.7m tCO2e /year. There has been a strongly increasing trend. Possible interventions would include technical and functional capacity development next to directly funding pest control.

It is only of low priority for Mongolia's REDD+ programme to support tree planting. It only affects rather small areas and generates negligible carbon removals.

Policies and measures addressing forest fires, unsustainable logging and subsequent degradation, and pest control will also reduce deforestation by continued degradation that results from these same drivers. Most of this report treats deforestation by continued degradation separately because of the different data sources needed and the large emissions that occur upon deforestation, but there is no need to discuss policy and measures separately.

It is only of low priority for Mongolia's REDD+ programme to support policies and measures to address mining. Mining only affects smaller areas than other drivers and leads to approximately 0.3m tCO2e per year, which is less than other drivers. The significance of mining has decreased during the last years. Most importantly, the economic forces involved in expansion of the mining sector can hardly be tackled by REDD+ policies and measures and consequently the kinds of addressable underlying causes it somewhat limited.

6.0 Underlying Causes of Forest Change

Underlying causes of forest change include demographic, economic, technological, policy & institutional, cultural & socio-political, and environmental factors. The review perused available literature for an overview. Complementary interviews provided a cross-reference (Table 21).

Growing population has increased general activity levels in forests; small-scale rural activities result in fires and pervasive pressure. Indirectly it also boosts demand for wood products, increases labour force and may contribute to rural poverty. Population growth is compounded with urbanization and urban expansion creates a need for wood products and construction areas.

Fast economic growth has made more government funds available for activities enhancing carbon stocks, such as tree planting and pest control. It has created more demand for wood products and thus led to increasing unsustainable logging and subsequent degradation. Being the engine of economic growth, the mining sector has required large areas for its operations.

Lingering rural poverty continues to drive pervasive small-scale rural activities leading to forest fires, illegal logging and ultimately deforestation by continued degradation. Such lingering poverty contrasts with the economic successes from the mining boom.

Low technical capacity for forest management exacerbates forest fires and unsustainable logging and subsequent degradation; it compromises the effectiveness of pest control and tree planting. The lack of equipment is widespread, but more importantly, forest management techniques are outdated. Institutions generally have a low management capacity for pest control and firefighting.

Weak institutions introduce a lack of transparency around the allocation of mining permits and public procurement for tree planting activities. Less than full compliance with applicable regulations in mining can increase deforestation and reduce related restoration. The selection of suboptimal service provider's compromises success rates for tree planting.

The regulatory environment and law enforcement capabilities are insufficient on fire prevention, illegal logging, grazing and mining. Some regulations are inadequate and, in other cases, applicable fines are too low or missing. The insufficient regulatory environment is compounded by a low capacity for law enforcement and compromises fire management, promotes unsustainable logging, fails to curtail grazing activities and leads to inadequate mining practices in forest areas.

There is much political interest in forest protection, which leads to restrictive and in places counter-productive policies for logging and mining. There is contention around a recent mining moratorium. The low harvest rates prevent an effective forest sector from developing. Most funding is allocated to tree plantings and to pest control rather than being directed to investment into a more effective forest administration.

Large parts of the population perceive forests as a public good of little economic value and have little sense of misconduct when grazing in forests or when logging or mining illegally. Pervasive small-scale rural activities are not well regulated, often illegal and lead to forest degradation and deforestation. The forest administration, in turn, focuses on traditional production and forest protection and is unable to capture the value forests create in other sectors (e.g., livestock, tourism).

Climate change has led to increasing occurrence of pests and compromised forests' regenerative capacity. Reduced rainfall and increased the occurrence of droughts have created unfavourable conditions for tree plantings, led to more forest fires and increase pest occurrence.

Table 21. Summary on Underlying Causes for Drivers of Forest Change

	Forest fires	Unsustainable logging and subsequent degradation	Pest Outbreak	Tree planting	Deforestation by continued degradation	Mining
Demographic factors						
Population growth	• Pervasive small-scale rural activities spreading fires (hunting, gathering, tourism, herding)	• Increasing demand for wood products	• Secondary pest outbreak in increased logging debris		• Pervasive small-scale rural activities hindering regeneration	
Urban expansion and urbanization		• Increasing demand for wood products to expand settlements • Illegal logging around new settlements			• Land allocation for expansion around existing settlements • Ineffective planning of settlement expansion	
Economic factors						
Economic growth, fuelled by recent mining boom	• Funding availability for fire management (although still insufficient)	• Increasing demand for wood products	• Funding availability for pest control (although still insufficient)	• Funding availability for reforestation (although still insufficient)		• Mining sector difficult to curtail • Growth of large-scale mining
Rural unemployment and poverty	• Pervasive small-scale rural activities spreading fires (hunting, gathering, tourism, herding)	• Illegal logging as source of rural livelihood		• Publicly funded tree planting to create rural employment opportunities • Livestock damage from migrants	• Pervasive small-scale rural activities compromising forest regeneration • Lack of livelihood alternatives to small-scale rural activities	• Migration to rural mining areas • Pervasive illegal small-scale mining operations
Technological factors						
Low technical capacity for use of forest resources, restoration, and protection	• Insufficient practices for salvage cutting and slash disposal • Low management capacity for fire control • Insufficient funding for forestry research	• Often unsustainable selective cutting practices (taking the best trees or too many trees) • Insufficient funding for forestry research	• Unsustainable logging techniques promoting pest outbreak • Often ineffectual pest control techniques • Low management capacity for pest control • Insufficient funding for forestry research	• Inappropriate planting techniques • Weak reforestation plans • Insufficient funding for forestry research	• Unsustainable logging practices • Recurring pest outbreaks and forest fires • Ineffectual fire management and pest control • Insufficient forest hygiene promoting pests and fires • Insufficient funding for forestry research	• Careless treatment of soil and vegetation in mining • Insufficient funding for forestry research

	Forest fires	Unsustainable logging and subsequent degradation	Pest Outbreak	Tree planting	Deforestation by continued degradation	Mining
Lack of equipment for forest management	• Lack of firefighting equipment • Lack of firebreaks	• In places used unsustainable clearcutting practices using skidding crawler tractors	• Information on pest outbreaks not timely available			
Policy & institutional factors						
Low capacity for law enforcement with lack of awareness, resources and incentives	• Law for fire prevention inadequately enforced • Ineffective design of reward scheme for information on illegal activities	• Inadequate surveying by state inspectors and rangers • Low cutting volumes, incentivizing illegal logging • Ineffective design of reward scheme for information on illegal activities		• Little prosecution of grazing in plantations • Ineffective design of reward scheme for information on illegal activities	• Little prosecution of illegal small-scale rural activities • Ineffective design of reward scheme for information on illegal activities	• Inadequate law enforcement on mining in forest areas • Ineffective design of reward scheme for information on illegal activities
Insufficient regulatory environment for forest protection	• Regulations for fire prevention inadequate • No effective regulation of non-timber forest products • No clarity on designated tourism zones according to fire risk	• Inadequately low penalties and fines for illegal logging		• Little prosecution of grazing in plantations	• Little prosecution of illegal small-scale rural activities	

	Forest fires	Unsustainable logging and subsequent degradation	Pest Outbreak	Tree planting	Deforestation by continued degradation	Mining
Weak institutions in forest management, particularly at local forest units	• Lack of staff and low management capacity for pest and fire control • Often incomplete implementation of forest management plans	• Lack of staff and low management capacity for logging • Often incomplete implementation of forest management plans	• Lack of staff and low management capacity for pest and fire control • Often incomplete implementation of forest management plans • Low transparency and slow public procurement and inferior service providers	• In transparent and slow public procurement and inferior service providers • Often incomplete implementation of forest management plans		• Corruption around allocation of mining permits
Forest administration focused on traditional production and protection	• Financing portfolio limited to central budget allocations, funding gaps • Insufficient mainstreaming of climate change aspects into provincial planning	• Financing portfolio limited to central budget allocations, funding gaps • Insufficient mainstreaming of climate change aspects into provincial planning	• Financing portfolio limited to central budget allocations, funding gaps • Insufficient mainstreaming of climate change aspects into provincial planning	• Financing portfolio limited to central budget allocations, funding gaps • Insufficient mainstreaming of climate change aspects into provincial planning	• Financing portfolio limited to central budget allocations, funding gaps • Insufficient mainstreaming of climate change aspects into provincial planning	• Insufficient mainstreaming of climate change aspects into provincial planning
Ineffectual licensing with low incentives for PFEs and FUGs	• Low financial incentives for FUGs to prevent fires	• Limitations to sustainable logging under FUG and PFE licenses	• Low financial incentives for FUGs to prevent pests			
Cultural & socio-political factors						
Socio-political transition and unstable government agencies	• Aerial firefighting in some areas discontinued	• Wood processing industry privatized, leading to lost capacity • Increased illegal logging due to lost jobs in formal forestry industry	• Lost research on bacterial preparation • Outdated technology in private sector • Lack of production capacity • lack of international competitiveness	• Insufficient long-term forest restoration planning		

	Forest fires	Unsustainable logging and subsequent degradation	Pest Outbreak	Tree planting	Deforestation by continued degradation	Mining
General lack of awareness and experiences for use of forest resources	• Low capacity at FUGs and PFEs for fire management, pest control, tree planting and general use of forest resources	• Low capacity at FUGs and PFEs for fire management, pest control, tree planting and general use of forest resources	• Low capacity at FUGs and PFEs for fire management, pest control, tree planting and general use of forest resources	• Low capacity at FUGs and PFEs for fire management, pest control, tree planting and general use of forest resources	• Low capacity at FUGs and PFEs for fire management, pest control, tree planting and general use of forest resources	
Political environment favouring conservation with low awareness of value added in forest sector	• Low funding availability for forest management	• Low funding availability for forest management • Low cutting volumes, incentivizing illegal logging	• Low funding availability for forest management	• Low funding availability for forest management	• Low funding availability for forest management	
Perception of forests as a public good of low value (especially for herding) and lack of awareness of legal regulations	• Pervasive small-scale rural activities spreading fires (hunting, gathering, tourism, herding)	• Prevalence of illegal logging • Low awareness of misconduct in illegal logging		• Low sense of misconduct from grazing in plantations • Frequent livestock damage to reforested areas	• Pervasive small-scale rural activities compromising regeneration • Low sense of misconduct in illegal small-scale activities	
Environmental factors						
Reduced rainfall and increased air temperature, drought	• Increased fire frequency • Drier vegetation more prone to fires		• Increased occurrence of pests through aridity	• Low survival rate due to low precipitation	• Regenerative capacity compromised • Increased occurrence of pests • Lower seed quality	

6.1 Demographic Factors

Mongolia had a population of close to 3 million people in 2014, population has grown steadily during the last decade with growth rates amounting to 1.74-2.21% during 2011-2014 (Figure 20) which places increased pressure on remaining natural resources (Figure 27).

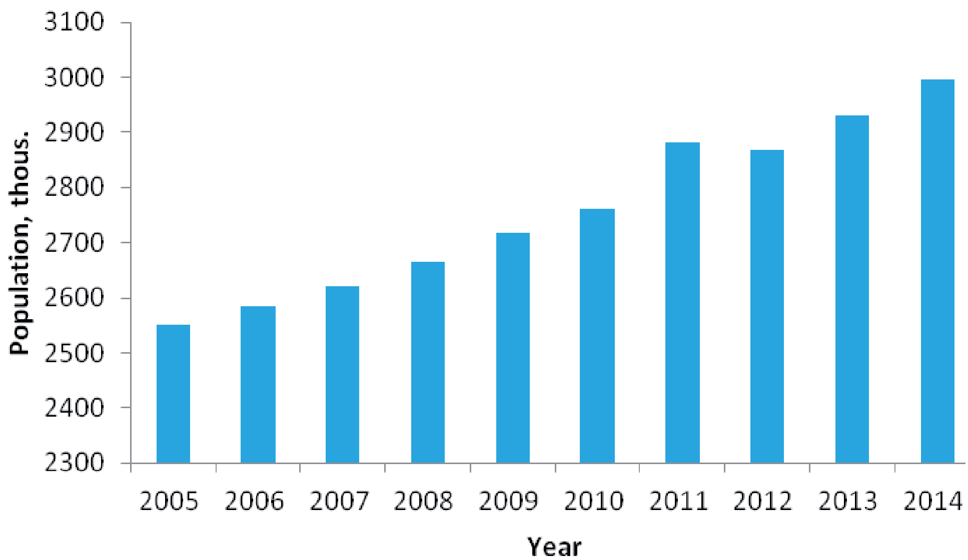
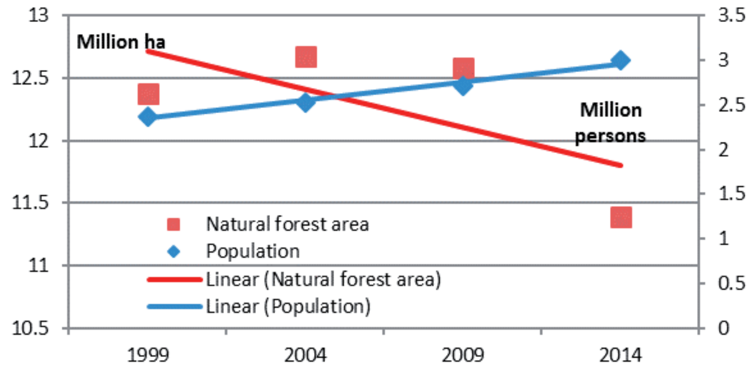


Figure 20. Mongolia's Population Growth 2005 to 2014 (NSO of Mongolia 2015)**.**

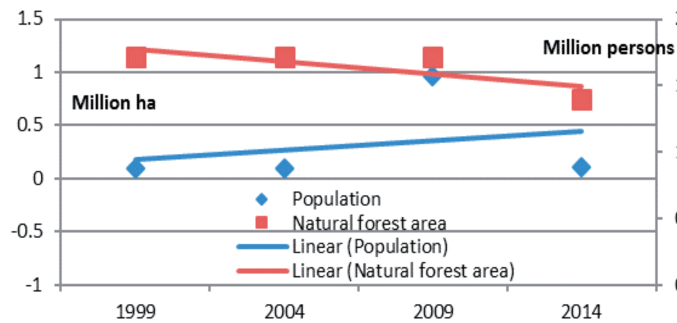
Mongolia's population is rapidly urbanizing and there is ongoing need for construction materials. There is a relatively high rate of urbanization at a 2.78% annual rate of change in 2010-2015 (CIA n.d.). In 2014, about two thirds of the population lived in cities and only one third in the countryside (65.3% and 34.7%, respectively); almost 1.4 million people live in Ulaanbaatar city alone.

Population growth and urbanization create demand for wood products, demand for lands to grow settlements and pressure on forests. While population has increased during the last decades, forest areas have continued to decline at various scales and locations. Forest areas declined most around Ulaanbaatar city. But also in the countryside, population growth creates economic growth and increasingly pervasive rural activities: herding, hunting, gathering and others (Figure 21).

National level



Selenge province



Ulaanbaatar city

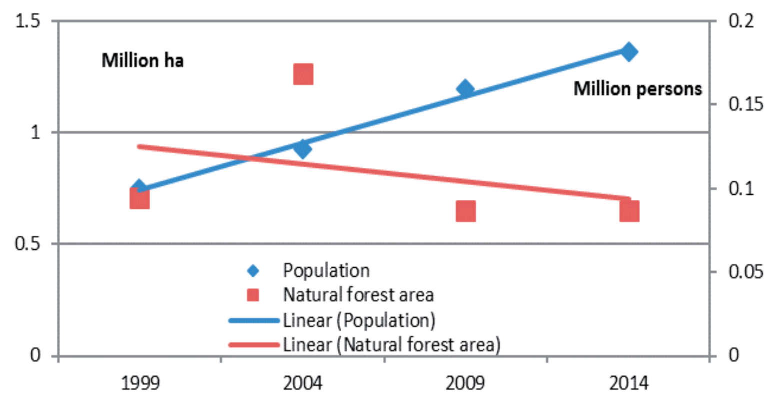


Figure 21. Relationship between Forest Area and Population (NSO of Mongolia 2015).

Demographic factors as underlying causes of forest change:

- Population growth
  - Pervasive small-scale rural activities spreading forest fires (hunting, gathering, tourism, herding)
  - Increasing demand for wood products
  - Secondary pest outbreak in increased logging debris
  - Pervasive small-scale rural activities hindering forest regeneration
- Urban expansion and urbanization
  - Increasing demand for wood products to expand settlements
  - Illegal logging around new settlements
  - Land allocation for expansion around existing settlements
  - Ineffective planning of settlement expansion

6.2 Economic Factors

The Mongolian economy has grown rapidly during recent years, fuelled by a mining boom; this growth is the backdrop for much of the dynamics in the forest sector too. The country has developed from a low income country to an upper-middle income country (The World Bank 2015b). The country's gross domestic product increased by 2.4 times in 2005-2009 and by 7.9 times in 2010-2014 (9.0). Much of this growth was fuelled by the mining sector, which increased 2.2 times and 7.4 times over the same period. During the last 10 years, the growth rates have been continuous and fluctuated around 10% (Figure 22).

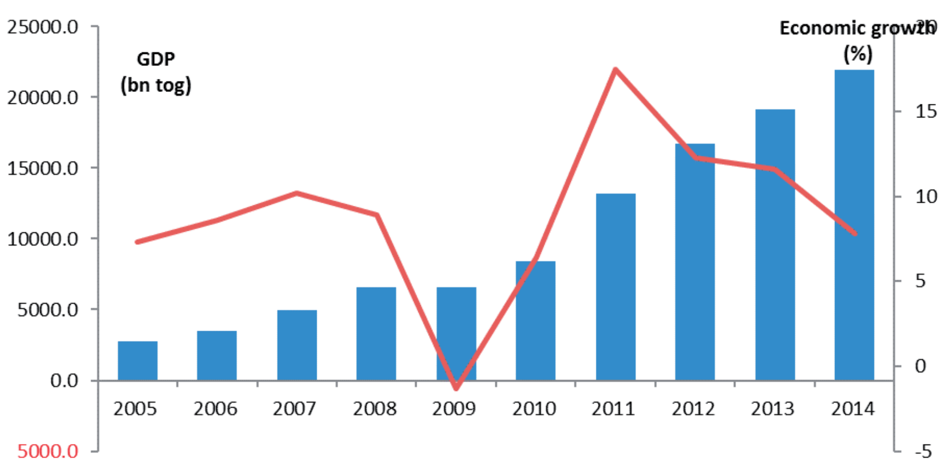


Figure 22. Mongolia's Gross Domestic Product and Economic Growth Rate 2005-2014 (NSO of Mongolia 2015).

Grazing is one key sector of Mongolia's economy. Livestock numbers have continued to grow during the last years (Figure 23), in part related to the growing rural population and also due to perverse government policy which encourages large herds and an increased demand for cashmere wool, leading to large herds which excessively graze steppe areas and may lead to increased grazing in forest areas. Community-based agreements on grazing and pasture management may help to improve productivity of grassland, reduce land degradation, reduce pressure on forests and may lead to higher quality livestock. Incentives should be investigated to ensure farmers maintain herds at optimal size for the carrying capacity of the grassland area.

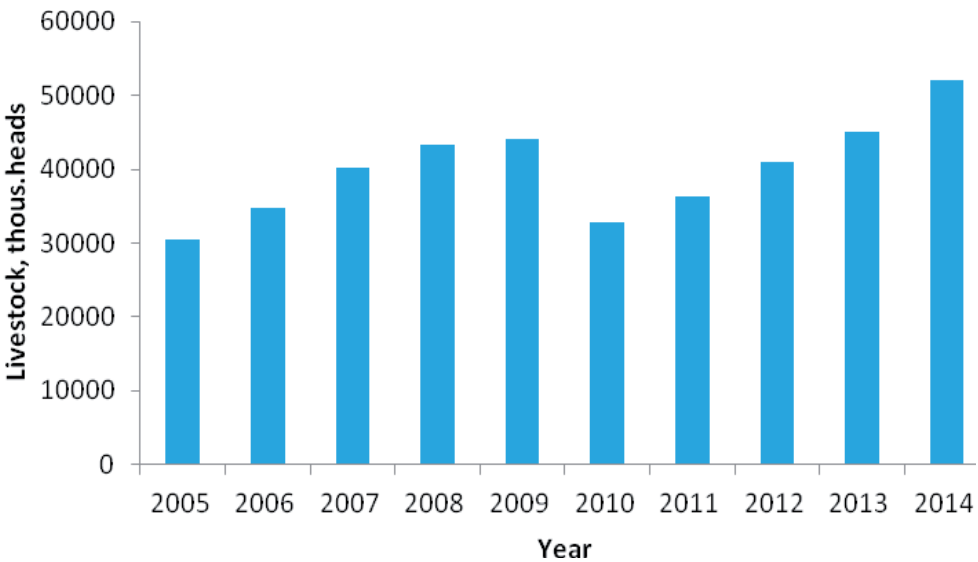


Figure 23. Number of Livestock in Mongolia 2005-2014 (NSO of Mongolia 2015).

During the last 10 years, government spending on the protection and rehabilitation of natural resources has multiplied; albeit at a slower rate, forestry-related spending also increased greatly (Figure 24). Economic growth has led to growth in public expenditure by 740% across the last 10 years. Driven by a political environment favouring conservation, spending on the environmental sector outgrew overall national budget growth, but spending on the forest sector increased slower than overall environmental spending (Figure 24). Increasing amounts of funding have been allocated to the traditional and protective forestry activities, such as implementing pest control. By the same token, the more recent economic downturns have resulted in a restrictive public financing environment in which the forest sector is often one of the first sectors to be affected (UNDP 2016). Moreover, such one-sided budget allocation may relate to the political environment favouring conservation, and there still remains a perception that such traditional activities would need to receive more resources (e.g., because only a fraction of areas with hotspot of forest pest were treated, and only a fraction of required areas were reforested (MEGD 2013, 2014a).

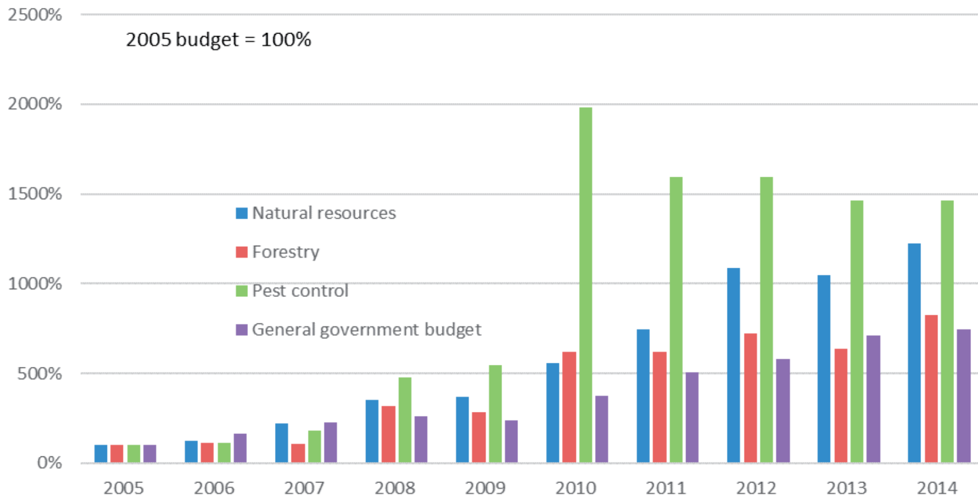


Figure 24. Public Expenditure on Forest Protection and Management 2005 - 2014 (MET 2015b; NSO of Mongolia 2015).

Despite the economic progress, development challenges remain, and particularly the rural population relies on small-scale activities exerting pressure on forests. The poverty rate remains rather high, particularly among the rural population and population living in the countryside; in 2010, 39.2% of the population were poor and despite the rapid economic growth, poverty levels did not reduce (Figure 25). Much of the rural population continues to rely on small-scale rural activities for their livelihoods: hunting, gathering, herding and others (Lkhagvadorj et al. 2013a). These activities exert pressure on the forest resource, can spread forest fires, inhibit forest regeneration and ultimately lead to forest degradation.

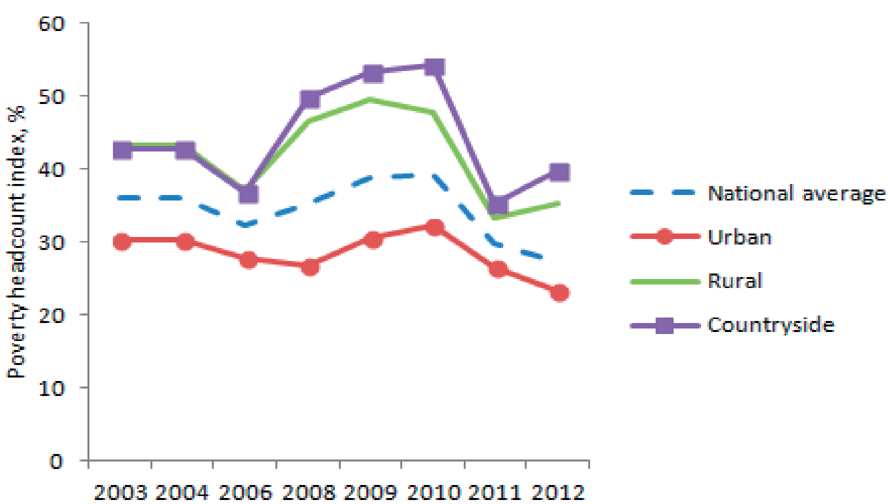


Figure 25. The Percentage of Population Living Below the ‘Poverty Line, 2003-2012 (NSO of Mongolia 2015).

Rural poverty is an underlying cause of deforestation. Across the provinces, poverty reduction (weakly) correlates with forest area change (Figure 26). In those provinces where efforts to reduce poverty were most successful, forest area tended to increase. In those provinces where efforts to reduce poverty were less successful, forest area tended to decrease (Figure 26).

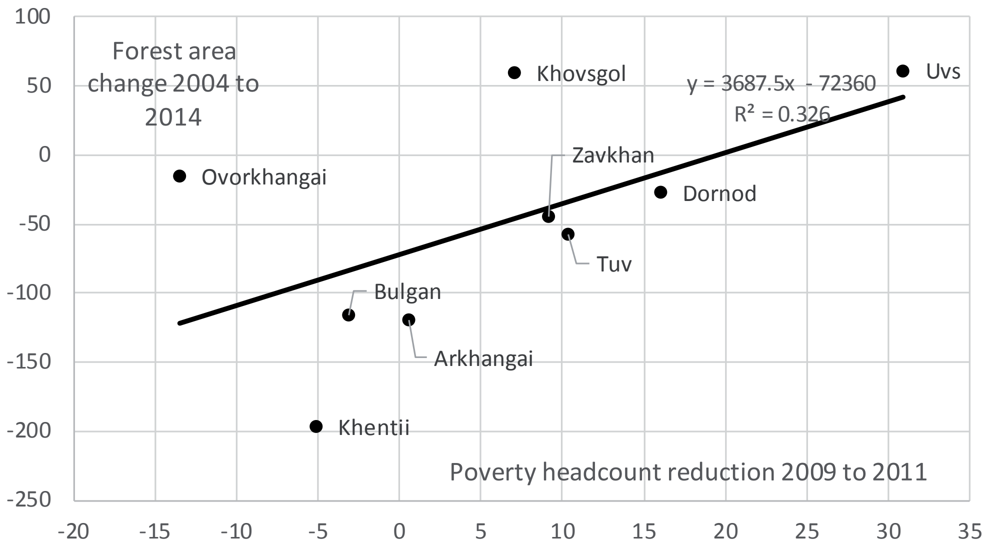


Figure 26. Link between Forest Area Change and Poverty Reduction (NSO of Mongolia 2009, 2012)).

Economic factors as underlying causes of forest change:

- Economic growth, fuelled by recent mining boom
    - Funding availability for fire management (although still insufficient)
    - Increasing demand for wood products
    - Funding availability for pest control (although still insufficient)
    - Funding availability for reforestation (although still insufficient)
    - Mining sector difficult to curtail
    - Growth of large-scale mining
- Rural unemployment and poverty
    - Pervasive small-scale rural activities spreading fires (hunting, gathering, tourism, herding)
    - Illegal logging as source of rural livelihood
    - Publicly funded tree planting to create rural employment opportunities
    - Livestock damage from migrants
    - Pervasive small-scale rural activities compromising forest regeneration
    - Lack of livelihood alternatives to small-scale rural activities
    - Migration to rural mining areas
    - Pervasive illegal small-scale mining operations

6.3 Technological Factors

*F*orest management relies on often outdated techniques from the 1980s or 1990s. Mongolian forestry was a key sector of the economy then. But after the economic breakdown of the early 1990s, the forestry sector also collapsed and has never nearly reached its economic thrust since . Harvesting rates amounted to about 2m m^3 /year in the 1980s and have fallen to levels well below 1m m^3 /year since . There has been little new impetus during the last years and there is much need for new technology and capacity development.

Techniques for tree planting rely on Russian technology, introduced in the 1970s and are not always well adjusted to Mongolia's conditions. Seeds are usually of unknown origin and may not be suited to the area where they are planted. By establishing seedbeds and sowing seeds in greenhouses and tree nurseries, planting takes place using bare-root seedlings often with poor root stock and sometimes overaged or poor quality. In the extreme climate conditions of Mongolia, such bare-root seedlings can have a poor ability to adapt, translating into short planting time.

Unsustainable logging techniques often have unnecessarily degrading effects on soil and vegetation. Since the 1960s and 1970s skidding technology was widely used. Tractor skidding at butt end of the tree causes 15-30% mineralization of soil and destroys 70-90% of the natural seedlings and saplings (Dorjsuren and Sainbayar 1989; Korotkov and Dorjsuren 1983). In the mountain conditions of Mongolia, clear cutting of forest stand causes sharp changes of the microclimate, deterioration of hydro-physical properties of soil which increases surface run-off, development of erosion process and forms unfavourable condition for the following regeneration of forest (Krasnoschekov and Gombosuren 1988; Krasnoschekov and Sorokin 1988; Krasnoschekov 2005; Ogorodnikov et al. 1983). This may also lead to deforestation through the extensive change in micro-climate.

For firefighting, low-cost techniques are being applied, with firebreaks established through ploughing, though some success has been made. Techniques for extinguishing fires include: whipping fire edges by fire beater and branches of trees, blowing using fire's apparatus, covering with soil, spraying water, back-fire. Modern technologies would include spraying with liquid fire suppressant, retardant using aircraft and helicopter, fire extinguisher to establish non-combustible foam line. Much technical capacity for aerial firefighting has been lost in the early 1990s.

Pest control relies largely on mechanical and chemical methods; biological methods are not widely used. Mechanical work to combat harmful insects includes collecting moth eggs, installing light and pheromone traps. Chemical pest control relies on pesticides. Most advanced biological methods include spraying with bacterial preparations, but much technical capacity for such measures has been lost in the wake of the collapse of the socialist economy. The vast area of Mongolia combined with low numbers of staff and poor infrastructure make reacting to pest outbreaks problematic.

The forest sector offers few attractive job prospects at either FUGs or PFEs. Despite existing educational programmes (6 universities and 10 vocational training centres alone), the forest sector offers little attractive job prospects that would allow professional development. The forest sector is economically marginalized. Much work is seasonal, salaries are low, and work placements are often far from settlements (MEGD 2013, 2014a). Underqualified personnel carry out much of the work and results are suboptimal.

An assessment of technical capacity at PFEs has delivered discouraging results. Proficiency examinations of PFEs' capacity to deliver work according to their licensed scope were carried out in 2013. About one in five PFEs were not considered fit and lost licenses. In 2012, 626 organizations held licenses, and after proficiency examinations in 2013, there were 136 fewer licenses. In 2014, the number increased again to 648 licensed PFEs in 2014 (Table 22). It is questionable whether PFEs were able to address capacity gaps in a short time or whether in fact the diagnosed gaps remained.

Table 22. Number of Private Forest Entities (PFE) (MEGD 2013, 2014a).

PFE license activities	2012	2013	2014
Forest inventory, taxation	19	15	20
Protection from pest and disease, pest control measures	22	18	22
Commercial forest utilization	20	18	33
Thinning, forest cleaning	291	227	306
Use of non-timber forest products	7	3	11
Forest restoration, reforestation, nursery operation	266	209	292
TOTAL	626	490	684

Forest User Groups (FUGs) have a have made significant efforts at maintaining and enhancing forests areas through implementing fire management, logging, pest control, and tree planting. The restricted licensing scheme for FUGs creates little scope for financial profitability and many FUGs are inactive as no economic incentives. Training and capacity building would be a required key input for developing FUGs capabilities (MEGD 2013, 2014a).

Several capacity assessments revealed that local level forest units have mostly very limited technical capacity and equipment. An assessment by FAO of 24 inter-soum forest units in 2013 relied on a scorecard with criteria such as number of staff, number of trained staff, equipment, attitudes to and knowledge of biodiversity issues, and knowledge of participatory forest management. According to this assessment, the units scored less than 40% of maximum capacity scores and not one unit scored more than 55% (Tserendeleg n.d.). An assessment by GIZ of 41 inter-soum and soum forest units in 2012 looked at staffing and equipment; concluded that 40% of units in the largest forest provinces were under staffed and that only 65% of positions were actually occupied (GIZ 2012). According to the same survey, less than half of these were qualified in the environmental field and 32% did have no relevant qualification at all. Moreover, there are also severe constraints in access to equipment. Most inter-soum forest units had no more than one single vehicle at their disposal (GIZ 2012). Despite such capacity gaps, little resources are being directed to training of forest units or to providing adequate equipment, while most forest sector spending is directed to other activities (see section 0).

Technological factors as underlying causes of forest change:

- Low technical capacity for use of forest resources, restoration and protection
  - Insufficient practices for salvage cutting and slash disposal
  - Low management capacity for fire control
  - Insufficient funding for forestry research
  - Often unsustainable selective logging practices (taking the best trees or too many trees when harvesting)
  - Unsustainable logging techniques promoting pest outbreaks
  - Often ineffectual pest control techniques
  - Low management capacity for pest control
  - Inappropriate planting techniques
  - Weak reforestation plans
  - Unsustainable logging practices
  - Recurring pest outbreaks and forest fires
  - Ineffectual fire management and pest control
  - Insufficient forest hygiene promoting pests and fires
  - Careless treatment of soil and vegetation in mining
- Lack of equipment for forest management
  - Lack of firefighting equipment
  - Lack of firebreaks
  - In places unsustainable clear felling techniques using skidding crawler tractors
  - Information on pest outbreaks not timely available

6.4 Policy & institutional Factors

Mongolia possesses a well-developed framework of policies and corresponding laws for the forest sector. These provide all the necessary guidance for the sustainable management of Mongolia's forest resources. Over the last 10 years, Mongolia's government adopted a long list of policy documents and laws that improve the environment for forest protection, and its use and restoration (Table 23). Most recently, there is the new Forest Sector Policy (Government of Mongolia 2015b) that aligns with the Green Development Policy (MEGD 2014c) which also sets the basis for the country's Intended Nationally Determined Contribution to the UNFCCC process (Government of Mongolia 2015a).

Table 23. Newly Adopted Policy and Legal Documents concerning Environment and Forest Protection.

• The State Ecological Policy from 1997 lays out a goal of stabilizing forest resources at an appropriate level to meet domestic timber needs. It considers reforestation measures, export limitations, support to timber import, and the protection of forests from pests, diseases, fire. • In line with this, the 1998 Sustainable development program for the 21st century of Mongolia set the specific objectives for forest conservation, sustainable use and restoration and identified implementing activities. • In 1999, the parliament adopted law on export customs duty on some products that became an important instrument to restrict export of wooden raw materials. • The Green Wall national program was approved in 2005. A Green Belt will be built, crossing the Gobi Desert and steppe regions with a total length of up to 3700 km and a total area of 200,000 ha. The programme has three phases and will be implemented over a 30-year period. In Phase 2005-2015 40,000 ha of forest plantations shall be established. • Forests also are included as the fourth strategic objective of the Comprehensive National Development Strategy of Mongolia from 2008. Conditions for sustainable use and protection of forest reserves, reforestation and maintaining ecological balance shall be created: through developing forest mapping and sustainable forest management programmes, through woodlands and creating green zones in Gobi and steppe regions, and through introducing modern management methods for forest protection • In 2009, by initiative of non-governmental organizations, the government passed the Law of the Prohibition of Mining Operations in the Headwaters of Rivers, Protected Zones of Water Reservoirs and Forested Areas. It plays a significant role for prohibiting mining in forest areas.

• The National Security Concept of Mongolia from 2010 included provisions related to research on natural resources, the export of forest products, an increase of the forest reserve, wood fuel and the development of a roadmap to protect nature and forests.

• In 1998, the Mongolian Government passed its National Forest Programme, renewed in 2001 and amended in 2011. It aimed to improve the capacity for protecting, using sustainable and restoring forest in accordance with the requirements of sustainable development and ecological balance.

• In 2012, parliament amended the law on environmental protection, revised the forest law, released the law on soil and combating desertification and amended the laws on disaster protection and on fire safety. This was part of a larger reform package that also lapsed the law on forest and steppe fire prevention and the law on fees for harvest of timber and firewood. With these reforms the forest law takes a central role for natural resource management, covering issues such as forest leasing, the forest management plan, protection, forest fires, insect, disease prevention.

• The Green Development Policy includes strategic objectives and measures relevant to forestry.

3.2.7. Enhance forest absorption of greenhouse gasses by intensifying reforestation efforts and expanding forest areas to 9% of the country's territory by 2030.

3.2.8. Create sustainable financing systems through the introduction of community-based natural resource management in the protection and sustainable use of forests, non-timber resources, flora and fauna.

• On 14th May 2015, the State Forest policy and the state policy on forest conservation, sustainable use and restoration during 2015-2030 were adopted. These documents identify forest policy objectives, guiding principles and targets, to guide future decision-making on issues related to forest conservation and use, rehabilitation for the well-being by complex of Mongolian political, economic, social and environmental issues in accordance with a comprehensive policy on green development.

Table 24. Text in the State Forest policy implementation plan of Mongolia Relevant to Drivers (MET 2015a).

1.To improve capacity for forest fire prevention and firefighting work 1.2. To strengthen the material base for forest fire prevention and firefighting work and to establish section for firefighting of forest and steppe fires under the provincial emergency office and soum's units in charge of forest issues, to finance for supplying of forest fire extinguishing chemicals, machinery, equipment and tools; 1.6. To take measures to detect immediate and fight forest fires by providing satellite remote sensing, aerial and ground patrols; 2. To improve efficiency of works for protection from forest pest and diseases control 2.1. To take measures to combat with pest at the start of the increase in the number of pests on the basis of permanent monitoring for pest outbreak and to improve results of pest control by introducing the achievements of modern biological science; 2.3. To reduce dramatically the use of toxic chemicals for measures of combat with pest and disease, and to use mainly bacterial preparations, to organize works to produce domestically the necessary preparations and introduce biological and biotechnical, physical and mechanical and silvicultural methods for pest control; 3. To restrict forest illegal utilization 3.2. To create a legal framework for implementation of measures to combat with the illegal exploitation of forest resources and improve the machine hardware in aimag and inter-soum's forest units; 4. To improve the result of forest rehabilitation work 4.3. In the nurseries, to introduce advanced technology breeding of seedling that is adapted in the climate change and unfavourable conditions, resistant to drought and aridity, high adaptability and good growth and breed seedlings with hidden root systems; 5. To utilize forest rationally 5.3. To provide economic incentives and all aspects of the support and assistance in the logging for introducing advanced techniques and technologies that are adapted in the area and environmentally friendly, maintained the ecological balance. 6. To improve the science, information and professional education, awareness in forest sector 6.2. To improve forest census and inventory and to expand experimental studies on the development of methods and technology for conducting harvest cutting in mountain forests and wood processing industry; 6.3. To develop advanced technology for specific forest vegetation province, regions and to conduct study for natural and artificial forest rehabilitation; 6.7. To improve cooperation between Forestry professional organizations and citizens and train specifically forest owners who possess and lease under the contract, and raise awareness to local citizens through these people;

Although the policy and legal framework is well developed, implementation is not fully undertaken. In many cases, institutions are overwhelmed with the tasks for managing the forest resources, particularly at the local level. Earlier work highlighted that in 2013, only 36 soum-level forestry units had been established, of which only 22 were operational. With a total forest area around 13 million ha, forest units are responsible for large forest areas well above 300,000 ha. According to the government resolution No. 255 of 2012 on "Approval of Norms, Normative, and Locations of Forested Areas", the areas should be even larger. Average staffing levels are 3-5 only (GIZ 2012; MEGD 2014b), with very limited technical capacities, and with severe constraints in equipment . This situation is exacerbated by only incomplete coordination between different sectors within the government, where earlier work has identified competing demands and responsibilities between sectors (UNDP 2013a).

Chronically low harvest rates indirectly promote illegal logging and undermine forest sector policy and regulation targeted at forest protection. Harvest rates are set much lower than domestic demand and imports do not compensate for the gap . The FRDC estimated in 2013 that there is demand of approximately 3m m^3 /year of commercial wood and fuelwood (FRDC 2013). Official harvesting rates, however, amount to well below 1m m^3 /year. The supply gap has led to illegal logging. The low harvesting rates undermine much of the policy framework oriented towards conservation and protecting the forest resource.

Forest law enforcement is inadequate. Such rampant illegal logging by far exceeds legal wood supply; it points to an inability or a lack of willingness to police against illegal logging or otherwise implement regulations around cutting volumes. The forest administration relies on rangers to police forest areas. But in 2011, only 403 rangers had to police the country's vast forest areas (MEGD 2014d). With about 35,000 ha each, effective policing is difficult. A second reason for the forest administration's low enforcement power is the policy of separating regulatory and enforcement responsibilities. Its forest rangers can neither order illegal activities to stop nor impose penalties, but need to work with the General Agency for Specialized Inspection (GASI) and its inspectors at province or district levels.

There are frequent environmental offences in the forest sector, in particular by illegal loggers. In 2007-2009, forest-related offences were the largest set of environmental offences and these were mostly related to illegal logging. According to data from the GASI, on average about 22% of all environmental offences were under the forest law, more than for any other category. About 50% of these related to illegal logging (Figure 27).

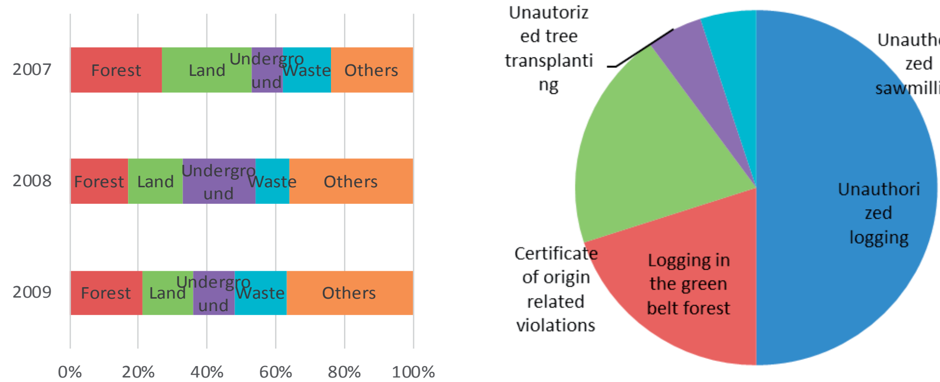


Figure 27. Breakdown of Environmental and Forest Related Violations (Source: (GASI 2014)).

The Law on Forests defines the institutional structure for law enforcement, after its adoption in 2007, recorded violations and confiscations of illegally harvested timber as well as equipment increased markedly, albeit temporarily (Figure 28). Since then, some violations have been passed on to the police for prosecution. Among other things, this law established the Forest Agency and FRDC at national level, provincial forest offices, and forest units in soums. Moreover, it redefined fines and penalties, including for confiscation.

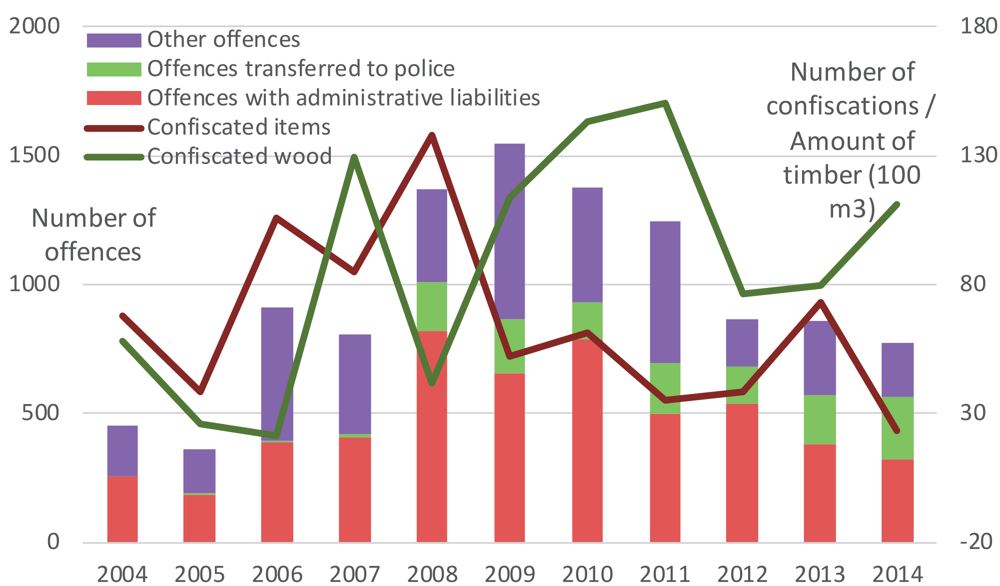


Figure 28. Forest-related violations 2004-2014 (GASI 2014).

The rural population may be unaware or otherwise not abide by legal restrictions, in particular regarding small-scale rural activities; for example, Article 29 of the Mongolian Law on Forests contains several restrictions that clash with the common nomadic lifestyle in rural areas. Article 29.1.4 to 29.1.8 concern hay making in the forest land without explicit permission; logging or grazing in forested areas, plantations with grown seedlings or areas designed for such activity; logging and extracting non-timber forest products in forest tenure without a consultation with the relevant authorities...; and activities by citizens, forest user groups and organizations on logging, extracting non-timber forest products, hunting and travelling to forest during fire danger period without respective permission; and transplanting seedlings from a natural forest without a permission from the relevant authority. Several of these activities are commonplace nonetheless, often without a sense of wrong-doing. Clearly, prevailing rural poverty often renders herding, hunting, collection of non-wood forest products an important part of rural livelihoods that is not easily foregone.

Grazing activities are particularly difficult to regulate. These activities form part of Mongolia's nomadic tradition and a key sector of the economy. They also damage forests and contribute to reducing its regenerative capacity. Forests, however, are mostly considered of low value without much recognition to the socio-economic value it generates. The legal framework for grazing is given with the Article 52 of the Law on Land from 2002, it has been called into question whether it still provides an adequate framework to address the problem of overgrazing and to guide sustainable pasture use (MEGD 2014d). In 2008, efforts were undertaken to create a dedicated Law on Pastureland to address this situation. However, due to the social and political sensitivity of regulating grazing , the State Great Khural could not debate or approve law (MEGD 2014d).

There are overlaps between mandates of institutions and the responsibility for fire prevention is separated from the responsibility for fire control. The law on forests clarifies that the Central State administration through soums and inter-soum forest units shall provide information about forest fire risk and forest fire occurrence, plan, manage and oversee fire prevention. It is the Central State administrative body for emergency issues, however, that is in charge of fire control (MEGD 2013). The separate of fire prevention from fire control introduces a lack of efficiency and effectiveness in fire control and ultimately contributes to their spread.

No government agency is directly in charge of forest management; illegal activities often remain unchecked. Since 1996, provincial forestry land is privately owned and government agencies only indirectly manage forests. Forest management activities are coordinated at four hierarchical levels of the administration and ultimately implemented by FUGs and PFEs (Figure 29). The lack of a government agency directly mandated to manage forests is an important reason for widespread illegal activities in and around forests.

Ministry of Environment, Green Development and Tourism

- To coordinate the formulation and implementation of the state policy and legislation, and making and enforcing rules and regulations for forest protection, rational use, rehabilitation, breeding, providing an environmental fight;
- To ensure the formulation and implementation of forest legislation, making and enforcing rules and regulations for forest protection at national, provincial and soum levels.
- To ensure inter-sectoral and interregional coordination for forest protection, sustainable use and rehabilitation, breeding, obtain approvals on standards from relevant authorities, and approve with other relevant administrative bodies and ensure implementation;
- To set the maximum limits of Annual Allowable Cut (AAC) in accordance with in the law and legislation
- To limit and prohibit the utilization of timer and non-timber forest products in certain regions for a specified period of time upon consideration of ecological requirements and existing forest reserves;

Forest Research and Development Centre

- To reserve and store selective forest seed resources, examine seed of trees, shrubs for sowing at forest seed laboratories;
- To conduct an activities in the garden collections of woody plants that grow in Mongolia, to care and maintain the garden, to enrich the wood collection;
- To create and enlarge the forest database;
- To select areas of reforestation and design, and to ensure handed over the planted forest to the state forest;
- To determine the damage in forestland caused by forest fires and illegal logging;
- To test and introduce new technologies for reforestation and silvicultural measures;
- To be taken silvicultural measures oriented to improve the forest state;

Environmental department at province and city / forest bureaus

- To organize works to ensure the implementation of forest legislation within the territory, report to aimag and capital city governors, the public administration;
- To create aimag and capital city forest databanks, provide information to the central state administrative body and public administration;
- To provide by specialized supervision for their dependent soum, district forest units, oversee their activities;
- To be conducted and ordered research of forest resources by professional organization;
- To impose and concentrate fees on forest resources utilization in accordance with applicable laws and regulations;
- To organize activities for forest protection and sustainable use, rehabilitation, breeding within the territory;

Forest units at soum, inter-soum and district level

- To separate a timber harvest area from a forest; Issue certificates of origin to timber harvests and wooden materials
- To implement program on forest protection, sustainable use and breeding program and the management plan at soum and district level;
- To provide professional and methodological recommendations to the FUGs, PFEs and organizations possessing the parcel of forests;
- To impose fees on forest resources utilization and ensure compliance thereof;
- To implement and appraise results on forest protection, sustainable use, restoration, breeding at the aimag and soum level;
- To operate the national forest database;
- To organize public trainings and education activities on forest protection, sustainable use, restoration, breeding.

Figure 29. Forest Administration Functions (MEGD 2014a).

There have been frequent reforms of the administrative setup for the forest sector, weakening the institutions. Currently, the Ministry of Environment and Tourism (MET) is responsible for forestry issues and forest protection and counts on the Forestry Research and Development Centre (FRDC) for implementation of forest policies in rural areas. During the last 30 years, the organization in charge has changed no fewer than ten times and there were even times when no agency at all was directly in charge of forest issues (Table 25).

Table 25. Agencies in Charge of Forest Issues since 1987.

Time period	Name of Organization
1987-1990	Forestry and Hunting Enterprise Board
1991-1994	Forest and Plants Office
1994-2000	Bureau of Forestry
2000-2002	Department of Natural Resources
2002-2004	Agency for Nature, Forest and Water Resources
2004-2008	GAP – no specific agency in charge of forest issues
2008-2012	Forest Agency
2012-2014	Division of Forest Conservation and Reforestation
2014-2015	Division of Forest Policy Coordination
2012-2015	Forest Research and Development Centre

The forest administration focuses on traditional forest production and protection activities and its financing portfolio is almost exclusively limited to central government allocations, unable to capture value added to other sectors. Forests generate a significant amount of value to several sectors of the economy, according to a recent estimate up to 12.5% of the gross national product (UNDP 2013b). Most of this value, however, occurs through informal activities and to other sectors than forestry, such as agriculture, tourism, and use of non-wood forest products (UNDP 2013b), and there is generally low awareness (see section 0). The forest administration has not yet managed to tap into the value added into other sectors. It focuses on traditional forest management (UNDP 2013a). For example, pest control activities accounted for between a third and a half of all forest management expenditures in 2011-2014 (Figure 24), while investment spending was negligible (UNDP 2013b).

Staff costs consume the lion share of forest sector expenditure and there is little investment into technology and equipment. The most recent breakdown of the FRDC's budget shows an increase of expenditure on staff and salaries from about two thirds to about three quarters in 2013-2014. Only less than 10% are allocated to equipment and a small fraction to training and communications (Figure 30). Much scope to increase investment into technology and developing technical capacities has also been diagnosed previously (UNDP 2013a).

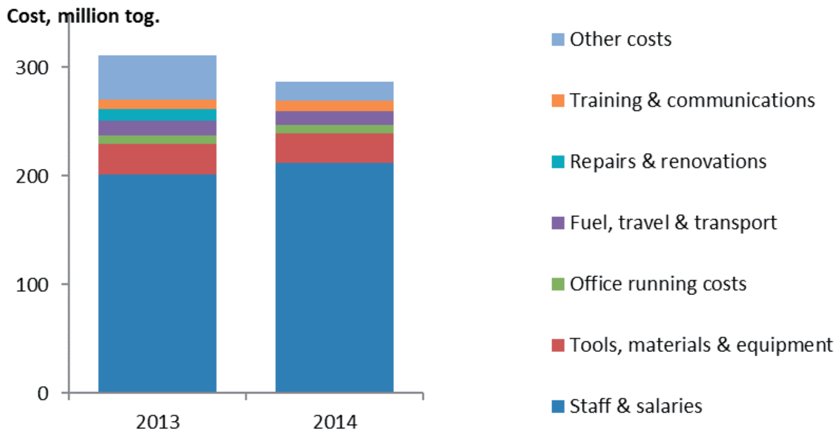


Figure 30. Breakdown of the FRDC budget in 2013 and 2014 by Expenditure Type (FRDC 2014, 2015a).

The restricted licensing scheme for FUGs creates little scope for financial profitability and many FUGs are inactive. The licenses granted to FUGs typically include fuelwood collection but do not allow for sustainable logging. The limited scope for generating profits has led to a situation where FUGs are largely inactive (MEGD 2014b) or where main activities focus on forest grazing, particularly during the winter, and not on forest management (MEGD 2014b). The technical capacity is usually rather low. Although some FUGs are operational and may have better capacity, their intervention areas are tiny, measured against Mongolia's vast forest areas (MEGD 2014b). The private sector plays only a marginal role in managing Mongolia's forests. Only for a small part of Mongolia's forests, PFEs have been issued licenses. Also in terms of financial flows and investments, the private sector has been found not to play an important role in Mongolia (UNDP 2013a). It is therefore unsurprising that technical capacity at the private sector is mixed at best.

Policy & institutional factors as underlying causes of forest change:

- Low capacity for law enforcement with lack of awareness, resources and incentives
    - Law for fire prevention Inadequately enforced
    - Ineffective design of reward scheme for information on illegal activities
    - Inadequate surveying by state inspectors and rangers
    - Low cutting volumes incentivizing illegal logging
    - Little prosecution of grazing in plantations
    - Little prosecution of illegal small-scale rural activities
    - Inadequate law enforcement on mining in forest areas

- Insufficient regulatory environment for forest protection
    - Regulations for fire prevention inadequate
    - No effective regulation of non-timber forest products
    - No clarity on designated tourism zones according to fire risk
    - Inadequately low penalties and fines for illegal logging
    - Little prosecution of grazing in plantations
    - Little prosecution of illegal small-scale rural activities

- Weak institutions in forest management, particularly at local forest units
    - Lack of staff and low management capacity for pest and fire control
    - Lack of staff and low management capacity for logging
    - Often incomplete implementation of forest management plans
    - Lack of transparent and slow public procurement and inferior service providers
    - Corruption around allocation of mining permits

- Forest administration focused on traditional production and protection
    - Financing portfolio limited to central budget allocations, funding gaps
    - Insufficient mainstreaming of climate change aspects into provincial planning

- Ineffectual licensing with low incentives for PFEs and FUGs
    - Low financial incentives for FUGs to prevent fires
    - Limitations to sustainable logging under FUG and PFE licenses
    - Low financial incentives for FUGs to prevent pests

6.5 Cultural & Socio-political Factors

Mongolians have an ancient nomadic culture with strong historical traditions that still influence the common rural lifestyle and constitute part of a political environment overemphasizing conservation. The common rural lifestyle attributes great importance to animal husbandry, as well as to a range of other small-scale rural activities, such as hunting and collection of non-wood forest products. This cultural context renders adequate regulation sensitive and forest law enforcement difficult where regulations clash with common rural lifestyles. The cultural background also constitutes part of a political environment that overemphasizes conservation. For example, it is striking that close to 85% of Mongolia's forest resource are under protection (Figure 31), restricting access to local communities and stoking forest-use conflicts.

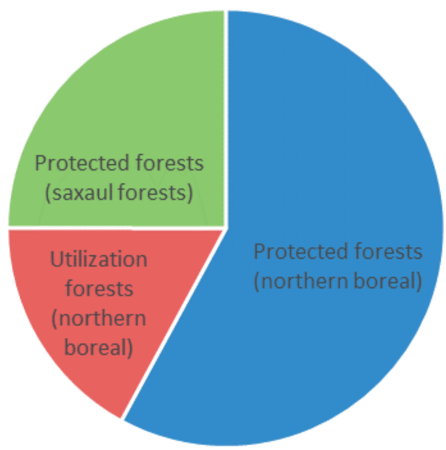


Figure 31. Protected and Utilization Forests (MEGD 2014d).

The political environment favouring conservation has helped elevate public spending on forests and conservation; it has also hindered introducing modern forest management practices. Forest sector spending has had growth rates exceeding a factor of 10 during the last 10 years. The economic boom during the same time frame has helped, but forest sector spending has grown even faster than the overall budget (UNDP 2013a, 2013b). The political environment favouring nature protection pairs with a low appreciation of how modern approaches to forest management are conducive to nature protection. The chronically low logging volumes and one-sided allocation of public forest sector funding are in part motivated by such an ill-conceived interest in forest conservation.

The Forest Service in Mongolia was first established in 1924, wood harvesting industry was established in 1926. With the forest sector development, knowledge and skills have been acquired for forest protection and rational forest use. There is less traditional knowledge and experiences for tree planting because forest restoration began only much later in the 1970s. Until the mid-1990s, during the planned economy, forest utilization was the key objective of forest management. During the socio-political transition in the early 1990s, the forest sector lost much of its technical capacity. Firefighting air patrols in some provinces with high forest resources were abolished, losing the capacity to organize fire patrol flights and to suppress rapidly fuel hotspot using paratrooper force. Consequently, areas affected by forest fires increased. After an ill-conceived privatization, the country's largest timber processing enterprises found themselves technologically obsolescent and short of funding. Resulting bankruptcies, led to many forest sector jobs getting lost. Many of the former employees turned to illegal logging to sustain a livelihood with all its negative environmental consequences (Chimed, Enkhsaikhan, and Banzragch 2014). During a gap in pest control activities in the 1990s, research results were lost. Nowadays, national champions such as Shim & Co. Ltd. still produces bacterial preparations but the technology is outdated, there is insufficient capacity to produce large amounts of bacterial preparations and the cost for nationally producing bacterial preparation is not internationally competitive. Such national champions have not been able to participate in national tenders or lost out against international competitors (FRDC 2014, 2015a). Across the whole forest sector there is a general lack of technical capacity (see section 0).

There is a widespread perception that forests are a low-value public good. According to Provisions 1 and 2 of the Constitution of Mongolia, forest resources are state property and under the sole authority of the Mongolian people. During the socio-political transition after the collapse of the planned economy, perception of forests as a public good prevailed, and an attitude of unabated exploitation emerged. Illegal logging and uncontrolled grazing come with little awareness of wrongdoing among large parts of the rural population.

There is little awareness of the socio-economic importance of forest ecosystems. Recent studies have substantiated how the forest sector generates huge value to the economy, amount to as much as 12.5% of the gross national product (UNDP 2013b). Most other sectors are utterly unaware (UNDP 2013a), probably in part because it mostly occurs through informal activities in animal husbandry, agriculture, tourism, and use of non-wood forest products (UNDP 2013b).

Cultural & socio-political factors as underlying causes of forest change:

- Socio-political transition and unstable government agencies
    - Aerial firefighting in some areas discontinued
    - Wood processing industry privatized, leading to lost capacity
    - Increased illegal logging due to lost jobs in formal forestry industry
    - Lost research on bacterial preparation
    - Outdated technology in private sector
    - Lack of production capacity
    - Lack of international competitiveness
    - Insufficient long-term forest restoration planning

- General lack of awareness and experiences for use of forest resources
    - Low capacity at FUGs and PFEs for fire management, pest control, tree planting and general use of forest resources

- Political environment favouring conservation with low awareness of value added in forest sector
    - Low funding availability for forest management
    - Low cutting volumes, incentivizing illegal logging

- Perception of forests as a public good of law value (especially for herding) and lack of awareness of legal regulations
    - Pervasive small-scale rural activities spreading fires (hunting, gathering, tourism, herding)
    - Prevalence of illegal logging
    - Low awareness of misconduct in illegal logging
    - Low sense of misconduct from grazing in plantations
    - Frequent livestock damage to reforested areas
    - Low sense of misconduct in illegal small-scale rural activities

6.6 Environmental Factors

Aridity has significantly increased during the last decades. Both average temperatures (and thus evapotranspiration) have increased and average rainfall has decreased during the past 75 years. Annual average surface air temperature warmed by 2.1°C and precipitation has decreased by about 7%. The aridity index declined accordingly (Figure 32) (MEGD, 2015).

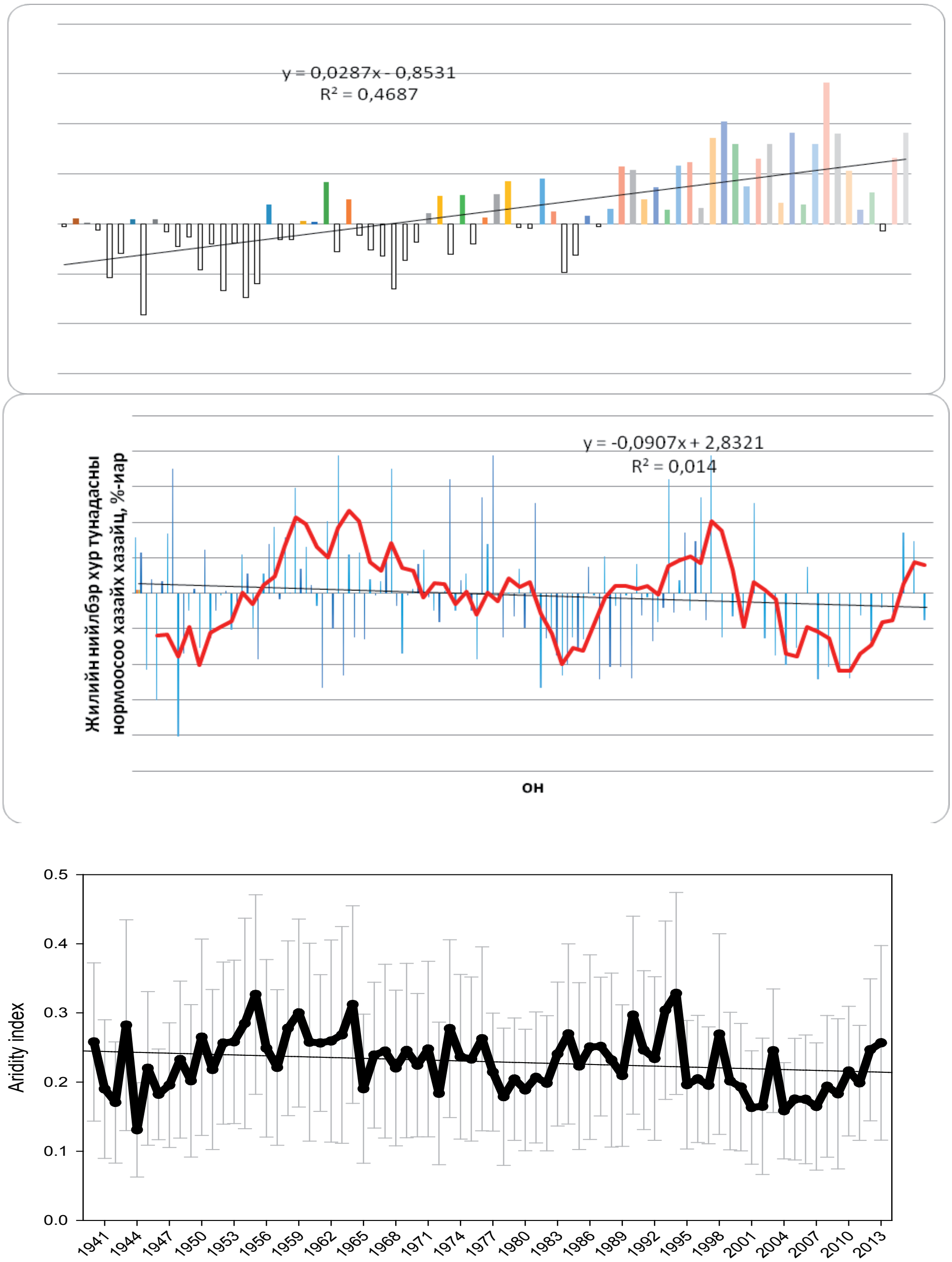


Figure 32. Annual Average Air Temperature, Precipitation, and Aridity Index and Changes in Mongolia 1940-2014 (MET 2015b).

During the years to come, climate change may be extreme. By the end of this century, the relatively rapid warming is expected to be 5.5-7.5°C in winter in the western and eastern regions of Mongolia and 5.0-5.5°C in the summer season in the western region. Winter precipitation is expected to rise to 55 - 75% in central, western and eastern regions, but summer precipitation is expected to reduce by 5-10% in the western region.

Climate changes are not uniform across the large and diverse Mongolian territory, changes in temperature fluctuated by 1-3°C, with relatively rapid warming in the central and western regions. The warming was more intensive through mountainous regions and desert and steppe regions have warmed somewhat. Annual sum of precipitation in Altai and Gobi areas increased slightly, whereas it is expected to decline in all other regions.

Increased aridity and increased occurrence of severe winters increase disturbances and reduce forests regenerative capacity. Areas affected by pests and by fires have grown strongly among other things due to increased aridity and changing weather patterns. The drier climate and less precipitation favour pest proliferation. Drier vegetation is also more fire prone. At the same time, aridity has contributed to decreasing seed quality. All of these factors together indirectly contribute to forest degradation. Although elevated temperature should be favourable, droughts have severely compromised growth rates (Dorjsuren 2014).

Environmental factors as underlying causes of forest change:

- Reduced rainfall and increased drought
    - Increased fire frequency
    - Drier vegetation more prone to fires
    - Increased occurrence of pests through aridity
    - Low survival rate due to low precipitation
    - Regenerative capacity compromised
    - Increased occurrence of pests
    - Lower seed quality

7.0 Implications for Development of a REDD+ strategy

7.1 Towards Identifying Policies and Measures

The presented description of drivers and their underlying causes will become useful to structure work for identifying policies and measures. Pending more detailed analysis, the drivers study provides basis for suggesting a set of entry points. Using these as a point of departure, the upcoming UN-REDD National Programme will conduct more work to design policies and measures. Such upcoming work will include a careful review of GHG reduction opportunities and much consultation to identify policy interventions as well as specific measures with potential to reduce GHG emissions or to enhance carbon stocks.

Effective policies and measures may address the most important drivers of forest change: forest fires, and unsustainable logging and subsequent degradation. These drivers were identified as most significant by impacts on areas and GHG emissions. The study also comprehensively covers several other drivers with smaller impacts, e.g., mining, to not exclude them from subsequent work as these may be important on other grounds than prioritisation criteria used here. A later identification of REDD+ policies and measures may also look in more detail at drivers of forest change that this study did not specifically address. For example, grazing has degrading effects on forests and policies and measures could also be designed to address it.

Effective policies and measures may also include carbon stock enhancing activities such as pest control and others that are not yet ongoing. The study was limited in scope to carbon stock enhancing activities that are already ongoing at a larger scale. A future REDD+ programme may include carbon stock enhancing policies and measures that go beyond this scope. For example, sustainable logging and thinning is not currently occurring at large scale and may nonetheless have much potential for upscaling under REDD+. Policies and measures need to be tailored to the context within the provinces. The drivers of deforestation vary greatly between the regions. Looking into absolute and relative intensities, Arkhangai, Zavkhan, and Khentii emerge as provinces with highest activity levels.

To be most effective, interventions to address drivers should both target underlying causes and directly aim at the drivers themselves. For example, interventions to address illegal logging should not only be limited to more law enforcement. A public perception of forests as public good is an underlying cause of illegal logging. Interventions to raise awareness about forest destruction should combine with law enforcement measures that directly target illegal loggers, balancing a focus on underlying cause and the drivers themselves.

Broad societal trends in countries' economy, demography, and socio-cultural make-up can be beyond the scope of most policies and measures. For example, population growth counts among the underlying causes of deforestation in Mongolia. Population control measures would nonetheless not count among forest protection policies. This is in one reason why REDD+ strategies and their policies and measures need to be linked to the larger national development framework that can, conversely, tackle broader socio-economic trends.

In Mongolia, technical and functional capacity development, regulatory strengthening and law enforcement, awareness raising and public discourse, next to direct funding of activities enhancing carbon-stocks may have promise for addressing the drivers of forest change (Table 26). These broad types of policies and measures emerge from examining drivers' underlying causes. A detailed analysis of policies and measures, however, is beyond the scope of the drivers study and should be undertaken next.

Table 26. Drivers, Underlying Causes, and Possible Interventions

	Individuals	Organizations	Context
Forest fires: underlying causes	• Technical gaps in fire management	• Insufficient regulatory environment	• Environmental changes (hard to address) • Pervasive small-scale activities
Forest fires: possible interventions	• Technical capacity development	• Regulatory strengthening	• Awareness raising
Unsustainable logging and subsequent degradation: underlying causes	• Unsustainable logging practices	• Prevalence of illegal logging	• Increasing demand for wood products (hard to address) • Overemphasis on protection
Unsustainable logging and subsequent degradation: possible interventions	• Technical capacity development	• Regulatory strengthening	• Awareness raising • Public discourse on conservation needs
Pest control: underlying causes	• Ineffectual pest control techniques • Outdated logging techniques		• Environmental changes (hard to address)
Pest control: possible interventions	• Technical capacity development	• Direct funding for pest control	
Tree planting: underlying causes	• Technical capacity gaps		• Unfavourable climatic conditions (hard to address) • Strong public interest in forest protection • Grazing pressure
Tree planting possible interventions	• Technical capacity development	• Direct funding for tree planting	• Awareness raising • Regulatory strengthening regarding grazing
Deforestation by continued degradation: underlying causes	• Unsustainable logging practices	• Insufficient regulatory environment • Prevalence of illegal logging	• Environmental changes (hard to address) • Increasing demand for wood products (hard to address) • Grazing pressure • Recurrent burning and pest outbreaks
Deforestation by continued degradation: possible interventions	• Technical capacity development	• Regulatory strengthening	• Awareness raising • Public discourse on conservation needs
Mining: underlying causes	• Low technical capacity in adequate management of vegetation cover in mining		• Economic importance of mining (hard to address) • Rural poverty (hard to address) • Prevalent illegal activities (hard to address) • Poor transparency in public decision making (hard to address)
Mining: possible interventions	• Technical capacity development on treatment of vegetation cover in mining		

Imminently obvious causes of forest fires include that vegetation is increasingly dry and fire prone, that pervasive small-scale rural activities spread fires and that the forest administration has a low capacity to manage fires. Regarding underlying causes, forest fires are caused by demographic and economic factors, but also have their causes in the weak institutions and the low technical capacity for forest management. There is also an insufficient regulatory environment and a low capacity for law enforcement (Table 26).

To curb the damaging impacts of forest fires, technical and functional capacities for forest and fire management need development. There are several entry points for possible interventions to curb the damaging impacts of forest fires. As with other drivers, there is a role for developing technical and functional capacities for forest management. Such improved capacities would translate into better capability to enforce fire prevention regulations and also to better fight fires. Underpinning such capacity development, an awareness raising campaigns with the general public may also be useful to enhance understanding of how to avoid fire outbreaks and increase precaution despite pervasive small-scale activities in and close to forests (Table 26).

Unsustainable logging and subsequent degradation lead to forest deөforestation because of frequently unsustainable logging practices in both legal and illegal logging, while increasing demand for wood products creates the backdrop in an environment that overemphasizes forest conservation. A whole suite of factors determines this situation, including larger economic and demographic trends, budget allocation focusing on traditional forest activities, and the low functional and technical capacity of the forest sector and its institutions. There is also a seemingly contradictory misguided public perception of forests as a public good with little economic contribution towards Mongolia's economic, yet forests resources are important for provision of timber and environmental services (Table 26).

Developing the sustainable forest management, improving law enforcement capabilities and raising awareness about illegal activities would help protect forests from unsustainable logging and subsequent degradation. Clearly, there is little scope to intervene with demographic and economic trends. But there may be entry points with possible campaigns to raise awareness among the general public about misconduct in illegal logging. Increasing allowable cutting volumes will require a discourse with the general public and decision makers alike about the only seemingly conflicting needs for forest use and the protection of its resource base. Most importantly, however, the forest sector budget would need to have more focus on law enforcement measures, possibly at the expense of more traditional forest activities such as tree planting and pest control. The forest sector also needs capacity development both to improve its management and law enforcement capability and also simply its technical capacity (Table 26).

There is a strong ongoing programme for pest control but pest control techniques are often ineffectual, while environmental changes create an environment more conducive to pests. The ongoing pest control programme receives significant (although still insufficient) funding, and arguably, this funding can be sustained because of the favourable macro-economic development. It is also clear that the occurrence of pest outbreaks has reasons in the changing environmental conditions. Underlying causes of problems with pests include environmental changes and increased aridity, strong population growth, as well as technical capacity gaps in the forest sector (Table 26).

Developing technical and functional capacities would make pest control more effective. Such a programme would upgrade the management capacity, provide training on pest control techniques, improve the early-warning capabilities and also aim to introduce improved logging practices. While population growth and environmental changes are beyond the scope of most policy interventions, the low technical capacity for forest management provides a good entry point for designing reform programmes (Table 26).

There is abundant public funding for tree plantings, but success rates are low due to technical capacity gaps, intense grazing pressure, and often unfavourable climatic conditions. Next to political interest in forest protection, publicly funded tree planting programmes also provide rural employment opportunities and may alleviate rural poverty. The low success rates are due to intense pressure from grazing and other rural activities, also linked to rural poverty. Adversary environmental conditions have a part to play in compromising survival rates too. Clearly, technical capacity limitations also count among the causes that underlie low success rates in tree plantings (Table 26).

Developing technical capacities would make tree planting programmes more successful, but legal reforms and raising awareness are also needed to keep grazing and other pressures at bay. The rural population would need to be taught that tree plantings are worth protection. Legal reforms include both stepping up law enforcement against illegal grazing, and also a review of procurement process where currently not always technically best service providers are chosen (Table 26).

Continuing degradation leads to deforestation because of a combination between environmental factors, unsustainable management practices, grazing pressure and recurrent burning and pest outbreaks. The same causes underlie continued degradation that underlie forest fires, pest control and unsustainable logging and subsequent degradation (Table 26).

Addressing the drivers of such ongoing degradation and deforestation is part of the menu of options for addressing forest fires, for enhancing pest control and addressing unsustainable logging and subsequent degradation. There is no need to discuss interventions separately, but the same interventions will also reduce deforestation by continued degradation.

Mining leads to deforestation due to continuing growth of large-scale mining operations, which often treat soil and vegetation carelessly, especially if operations are illegal. The expansion of mining areas is product of a mining boom that fuels the country's economic growth. Persistently high levels of rural unemployment, continued migration to mining areas, and inadequate law enforcement create an environment with pervasive illegal mining operations. Whether large-scale or illegal operations, soil and vegetation are often treated carelessly. There is low technical capacity on adequate management of vegetation cover in mining operations (Table 26).

There are strong economic and demographic factors behind mining expansion and addressing its damaging impacts could include improved treatment of soil and vegetation. It would focus on improving management practices in operations rather than attempting to reduce the amounts of mining areas (Table 26).

7.2 Towards Analysing National Circumstances for the National Forest Monitoring System

The drivers define the context for building Mongolia's approach to REDD+ forest monitoring. The approach to the development of forest reference levels depends on the continuity of expected future trends in drivers. Moreover, the prioritisation of certain drivers for policies and measures, as well as highlighting which REDD+ activities have greatest potential will inform the design of the approaches to REDD+ monitoring.

National forest monitoring for REDD+ needs to track forest degradation and activities enhancing carbon stocks in addition to deforestation. Different from many other countries, the majority of Mongolia's GHG emission come from forest degradation. To be relevant, monitoring for REDD+ needs to track forest degradation in addition to deforestation. Moreover, there are important ongoing government programmes for carbon stock enhancement and REDD+ monitoring needs to be relevant to these too.

There is no obvious caveat against basing a REDD+ reference level on a linear extrapolation of land cover trends from the recent past. Underlying causes of forest change have been largely continuous during the last 15 years. After the economic collapse in the wake of transitioning to a market economy, Mongolia has had a strong economic recovery. Although at late growth has slowed, it largely continues. Here, the analysis of trends relied on rather limited data and a more thorough examination of national circumstances for REDD+ should be undertaken before reaching conclusion on this issue.

The reference period for setting reference levels needs to begin after the onset of Mongolia's economic recovery. Only relatively recently, Mongolia's economy has taken its current shape. The country's economy suffered with the collapse of the Soviet Union and went through painful economic restructuring. Today, Mongolia's economy has recovered and is fuelled by a strong mining sector. This trend has been ongoing for about 15 years and is expected to continue.

Beyond forest cover and structure, monitoring drivers of forest change might be both feasible and useful for a REDD+ programme. In most REDD+ countries, forest monitoring limits to forest structure and cover. But data availability and quality in Mongolia is far better and allowed for quantification of drivers based on existing datasets. Collecting data relevant to drivers and activities enhancing carbon stocks should be targeted also going forward and would allow tracking drivers and conceivably success of REDD+ policies and measures.

7.3 Preliminary Conclusions on Entry Points for Policies and Measures

The analysis of drivers of forest change provides a set of entry points for identifying REDD+ policies and measures. Using these, the forthcoming UN-REDD National Programme will work towards identifying and designing policy interventions as well as specific measures with potential to reduce GHG emissions or to enhance carbon stocks.

Mongolia's forests need more and better forestry. Policymaking overemphasises an ill-understood approach to forest protection. For years, cutting volumes have been too low, trade policies restrictive and licensing policies obstructive. The upshot has been anaemic forest industries, declining technical forestry expertise and a proliferation of illegal and unsustainable logging. More and better forestry would raise logging rates, step up thinning activities, review licensing policies and amply develop technical capacity. Mongolia's forestry sector needs a broad development programme to promote the sustainable management of its forests.

Introducing sustainable logging and thinning could effectively address currently prevailing unsustainable and often illegal logging practices. Much of the current logging is unsustainable and often illegal. In an effort to protect forests, the last years have seen chronically low harvesting rates and restrictive licensing. These protective efforts have had a perverse effect and further promoted rampant illegal and unsustainable logging. Relaxing licensing restrictions and increasing harvesting rates, under due supervision and with due technical support, is necessary to introduce sustainable logging and thinning. Slowly, sustainable forest use will render illegal and unsustainable logging obsolete.

Capacities for forest management need urgent upgrading. Technical capacity gaps underlie most of the drivers, and modern best practices need to be introduced for firefighting, pest control, tree planting, and forest management alike. Mongolia's forest sector has declined over decades, much of its foundation is outdated or was lost in the years after the economic collapse in the 1990s. Government spending in the forest sector neglects investment and regulation does not provide incentives for the private sector. Outdated approaches and technology could probably be addressed through training and investment. Such capacity development at the forest administration, but also in the private sector and communities, would need to go hand-in-hand with a push for more and better forestry in the country to be successful.

More and better forestry will include regulatory reform to engage the private sector and communities. The current licensing schemes for FUGs create little economic incentive to sustainable forest management. Private forest entities (PFEs) hold logging licenses, but forest-user groups (FUGs) have only limited logging rights. To be effective, FUGs need to receive long-term logging licenses, with technical government support and under due government supervision. Communities will begin perceiving forests as a source of livelihood rather than as a low-value common good.

Public education could curb forest degradation. Many people in Mongolia perceive forests as a common good of little value and have little sense of wrongdoing in illegal logging, destructive grazing or careless behaviour that too often produces fires. Education is needed about the benefits of forest management and about the value that forests create across the economy, for tourism, livestock grazing and from use of non-timber forest products. A campaign is also needed about the correct behaviour in fire prone areas, and the damaging effects of illegal logging and grazing. The general public needs this information, and so do senior decision makers that design and implement policies and measures for management of forest areas.

Public forest spending needs to modernize the sector, moving beyond traditional forestry operations and reorienting towards investment in capacity development, regulatory reform and law enforcement. To develop Mongolia's forest sector change could begin with the forest administration itself. Current foci are traditional forest operations; fire management and pest control consume most resources. Funding needs to be redirected and invested into building technical and functional capacities. There needs to be regulatory reform and law enforcement needs strengthening. Much political will is required even within the forest administration to bring about such changes.

Redirecting spending may also lead to diversifying the forest sector's financing portfolio. Currently, the forest sector almost exclusively relies on allocations from the central government budget. This does not correspond to the broad range of values that the forests generate to sectors as diverse as energy, water, tourism and agriculture. The forest administration should attempt to tap into this value generation through a range of innovative financing instruments. Earlier work has identified these to include: integrating forests into the spending of other sectors; incorporating sectoral values into forest management budgets; establishing payments for forest ecosystem services and biodiversity offset arrangements; enhancing forest product markets; mobilising credit and investment capital and other enabling incentives; rationalising fees and cost norms; improving earmarking and retention of forest funds; and harmonizing financial and management planning. Beyond mobilizing financial resources, pursuing forest management based on the enormous value that forests generate to the Mongolian economy also provides a new vision to the forest sector.

A bid to introduce modern, more and better forestry may face considerable inertia even if underpinned by a REDD+ programme. There is a long decline in the forest sector and momentum for change is not obvious. The forest administration would need to work on several fronts at the same time: regulatory reform, reorienting expenditure, capacity development programmes, partner engagement and public education. It is a tall order to turn such a trend around in the context of a REDD+ programme, which would be looking at the short to medium term, at least for its results-based financing aspects.

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Annex 1.0 : Forest Cover Data (Dec 2015), Taxation Surveys (FRDC, 2016)[5]

Province name	Forested				Not-forested								Total forest area	Total non-forest area	Total area
	Natural forest	Shrubs and retina	Planted forest	Total	Sparse forest	Burned area	Logged forest	Reforestation area	Forested area	* PDAA	* WSAA	Total			
Arkhangai	799,4	8,8	-	808,2	45,2	64,5	13,8	11,9	-	47,8	-	183,2	991,4	17,2	1008,6
Bayan-Ulgii	42,3	9,8	-	52,1	15,1	-	0,5	0,1	-	-	-	15,7	67,9	0,2	68,1
Bayankhongor	29,8	0,1	-	29,8	2,4	0,3	-	0,8	-	-	-	3,6	33,4	0,1	33,5
Bulgan	1315,0	67,1	0,04	1382,1	110,9	233,7	15,6	9,9	1,3	35,9	-	407,4	1789,6	128,1	1917,7
Govi-Altai	9,1	-	-	9,1	0,2	-	0,2	-	-	-	-	0,3	9,4	-	9,4
Dornod	75,4	15,5	0,06	91,0	28,5	114,7	1,5	3,1	0,3	-	-	148,1	239,0	4,9	243,9
Zavkhan	456,8	43,5	-	500,2	43,1	133,1	10,5	18,0	-	1,1	-	205,9	706,1	25,9	732,0
Uvurkhangai	134,6	0,4	-	135,0	13,6	3,5	6,0	5,2	-	6,0	-	34,2	169,3	2,5	171,7
Umnugovi	0,1	-	-	0,1	-	-	-	-	-	-	-		0,1	-	0,1
Sukhbaatar	0,6	1,6	-	2,2	13,4	-	-	-	-	-	-	13,4	15,7	-	15,7
Selenge	1397,4	42,1	1,53	1441,0	93,9	256,9	28,2	20,4	5,4	0,3	0,9	406,0	1847,0	84,1	1931,2
Tuv	957,2	137,9	0,14	1095,2	50,0	148,5	7,0	7,1	1,7	5,6	0,00	220,0	1315,2	73,0	1388,2
Uvs	197,3	3,6	0,03	200,9	26,7	2,0	2,0	0,6	0,0	0,0	-	31,3	232,3	4,4	236,6
Khovd	12,4	-	-	12,4	3,6	-	-	-	-	-	-	3,6	16,0	-	16,0
Khuvsgul	3152,5	123,4	0,02	3275,9	180,9	352,7	11,3	15,9	0,5	30,7	-	591,9	3867,7	144,1	4011,8
Khentii	989,7	186,2	0,16	1176,1	120,2	391,2	3,4	11,4	0,2	2,6	-	529,0	1705,1	49,7	1754,7
Darkhan	64,8	1,3	0,08	66,2	7,2	0,7	0,3	3,1	-	-	-	11,3	77,5	4,5	82,0
Ulaanbaatar	87,1	6,5	0,02	93,6	5,4	1,6	3,9	0,9	1,3	5,4	-	18,5	112,1	3,9	116,0
Orkhon	15,6	-	-	15,6	0,5	0,2	0,3	-	-	0,2	-	1,3	16,9	0,9	17,8
Dornogovi	0,012	-	-	0,012	-	-	-	-	-	-	-	-	0,012	-	0,012
Total forest	**9737,3**	**647,5**	**2,1**	**10386,9**	**760,7**	**1703,7**	**104,5**	**108,4**	**10,7**	**135,8**	**0,9**	**2824,7**	**13211,7**	**543,5**	**13755.1**
Nature likely to forest (coniferous, broad-leave forest)				**6.64 %**	Forest fund area compared to the Mongolia total land area in percentage										**8.79 %**

*Explanation: *PDAA - Pest and disease-affected area, *WSAA – Wind and snow affected area*

[5] *Explanation*

- *Forested areas include planted forest area, fully-covered with shrubs area and area which has a forest.*
- *Non-forest areas include areas that had a forest and became non-forested area due to some reasons (logged, cut, burned or affected by the pest and disease), area which has no forest currently, but has a possible condition for growing forest (reforesting area, sparse forest area, forested area)*
- *Non-forest area include mountain slopes dry grassland area and high mountain with no forest, grove, nursery in forest fund.*

Province name	Forested /thousand.hectare area/				Not-forested /thousand.hectare area/								Total forest area	Total non-forest area	Total area
	Natural forest	Shrubs and retina	Planted forest	Total	Sparse forest	Dried saxuals	Saxauls collected area	Area on which will paInt saxuals	Forested area	* PDAA	* WSAA	Total			
Bayankhongor	509,5	3,1	-	512,6	274,4	-	-	0,1	-	-	-	274,5	787,2	-	787,2
Govi-Altai	461,7	91,3	-	553,0	1078,6	-	1,0	31,7	-	-	-	1111,3	1664,3	-	1664,3
Dornogovi	54,7	1,1	-	55,8	51,5	-	-	9,6	-	-	-	61,1	116,9	-	116,9
Dundgovi	16,8	-	0,043	16,9	15,0	-	-	1,0	-	-	-	15,9	32,8	-	32,8
Uvurkhangai	68,5	9,7	-	78,2	24,3	3,7	-	19,3	-	-	-	47,3	125,5	-	125,5
umnugovi	604,6	13,5	-	618,1	565,7	0,8	0,6	3,9	-	-	-	571,0	1189,1	-	1189,1
Khovd	47,3	11,3	-	58,6	725,2	-	-	-	-	-	-	725,2	783,8	-	783,8
Total Saxual forest	1763,1	130,0	0,043	1893,1	2734,7	4,6	1,6	65,5	-	-	-	2806,3	4699,5	-	4699,5
Nature likely to forest (Saxuals)				1.22 %	Saxual forest fund area compared to the Mongolia total land area in percentage										3.03 %
Total	**11500.4**	**777.5**	**2.1**	**12 280. 0**	**3495. 3**	**1708.3**	**106.1**	**173.9**	**10.7**	**135.8**	**0.9**	**5631.1**	**17911.1**	**543.5**	**18454.6**
Nature likely to forest in National level				**7.85 %**	Forest fund area compared to the Mongolia total land area in percentage										**11.8 %**

Annex 1.2 Chronology on the conducted taxation inventory management plan on the Forest fund

№	Province name	Taxation inventory management plan conducted year	Re-arrangement conducted year	Forest fund area / thousand.hectae/
1	Arkhangai	1995, 1996	2008	1008,6
2	Bayan-Ulgii	1985	2008	68,1
3	Bayankhongor	1991, 2006	2015	33,5
4	Bulgan	1997-1999	2010	1917,7
5	Govi-Altai	-	2005	9,4
6	Dornod	2003	2012	243,9
7	Zavkhan	2006	2013	732,0
8	Uvurkhangai	1997	2008	171,7
9	Umnugovi	-	2011	0,14
10	Sukhbaatar	-	2011	15,7
11	Selenge	1992-1994	2008, 2009	1931,2
12	Tuv	2007	2013	1388,2
13	Uvs	1990	2011	236,6
14	Khovd	-	2011	16,0
15	Khuvsgul	2000-2003	2012	4011,8
16	Khentii	2004, 2005	2013	1754,7
17	Darkhan	2006	2013	82,0
18	Ulaanbaatar	1998	2008	116,0
19	Orkhon	2001	2010	17,8
20	Dornogovi	2007	2016	0,01
Forest area				**13755.1**
1	Bayankhongor	1990, 2006	2015	787,2
2	Govi-Altai	1990	2011	1664,3
3	Dornogovi	1990, 2007	2015	116,9
4	Dundgovi	1990, 2007	2015	32,8
5	Uvurkhangai	1990	2011	125,5
6	Umnugovi	1990	2011	1189,1
7	Khovd.	1990	2011	783,8
Saxual forest /desert popular/ area				**4699.5**
Nation-wide				**18454.6**

Annex 2.0 : List of Interviews Conducted and Workshop Participants

#	When	Where	Name of interviewees	Position and affiliation	Topics discussed
1	13-05-2015	UNDP office	Bunchingiv Bazartseren	UNDP	Workplan of the drivers study
2	15-05-2015	Selenge province Mandal soum	O.Munkhsukh	Deputy governor of Mandal soum	Challenges facing forest management and environmental protection in Mandal soum
3	15-05-2015	Selenge province Mandal soum	R.Naran	Head of inter soum forest unit	Forest situation, Forest inventory, drivers of forest degradation and deforestation
4	15-05-2015	Selenge province Mandal soum	B.Onon	Inspector	Illegal logging, enforcement of law on forest
5	15-05-2015	Selenge province Mandal soum	Ts.Erdenechuluun	Director of vocational training center	Training for forest professional workers, GIZ assistance for vocational training
6	15-05-2015	Selenge province Mandal soum	M.Sergelen	Specialist of GIZ	Training forest in Tunkhel village, experimental thinning and clearing site in the forest
7	15-05-2015	Selenge province Mandal soum	Badar-Uugan	Specialist of GIZ	Training works, Nursery operations
8	15-05-2015	Selenge province Tunkhel village	M.Tileuberd	Director of wood processing company "Khangai's eagle "	Wood processing factory and wooden products (bricket fuel, chaga mushroom syrup, furniture)
9	15-05-2015	Selenge province Tunkhel village	N.Togtokhbayar	Woodman of wood processing company "Khangai's eagle "	Wood processing process
10	29-05-2015	Bulgan province, Teshig soum	D.Bayardalai	Deputy governor of Teshig soum	Introduction of our survey's objective
11	29-05-2015	Bulgan province, Teshig soum	D.Nyamsuren	inspector	Forest degradation and deforestation, activities related with nature
12	29-05-2015	Bulgan province, Teshig soum	J.Tungalag	Ranger	Forest degradation and deforestation
13	29-05-2015	Bulgan province, Teshig soum	B.Munkhtur	Ranger	Forest degradation and deforestation
14	30-05-2015	Bulgan province, Teshig soum	B.Tsetsegee	Ranger	Forest degradation and deforestation
15	30-05-2015	Bulgan province, Teshig soum	S.Altankhuyag	Director of "Teshig trees"Co.LTD	Wood processing factory
16	30-05-2015	Bulgan province, Teshig soum	worker	Khyalganat Co.LTD	Wood processing factory

17	31-05-2015	Bulgan province, Teshig soum	B.Munkhtsetseg	Leader of FUG "Munkhiin bulag"	FUG activity
18	30-05-2015	Bulgan province, Teshig soum	R.Ochirsuren	Chairman of Citizens' Representatives khural	Introduction of our survey's objective
19	30-05-2015	Bulgan province, Teshig soum	Sh.Ganga	Head of Citizens Public Khural	Introduction of our survey's objective
20	02-09-2015	FRDC	Kh.Michid	Head, division of research and utilization of forest resources	Forest resource, study on harvested timber
21	04-09-2015	MET	N.Enkhtaivan	Senior specialist of Division of Forest Policy Coordination	Forest professional organizations, FUGs related study and materials
22	01-07-2015	FRDC	B.Ganzorig	Head of unit on forest protection and breeding, rehabilitation	Report on works combating with pest
23	03-07-2015	FRDC	S.Gantulga	Director of FRDC	State of forest units equipment supply
24	05-10-2015	MET	Ts.Chuluunbaatar	Senior specialist of Division of Forest Policy Coordination	Study on forest fire distribution and cause
25	16-10-2015	MET	Ts.Banzragch	Director of Division of Forest policy and coordination	Feedback on results of drivers study
26	29-10-2015	MET	B.Otgonsuren	Senior specialist of Division of Forest Policy Coordination	Study on forest resource and timber harvesting /logging/
27	29-10-2015	MET	D.Enkhjargal	Specialist of Division of Forest Policy Coordination	Forest rehabilitation measures, its achievement, weakness
28	30-10-2015	MET	Ts.Banzragch	Director of Division of Forest policy and coordination	To get proceeding on the State forest policy, to exchange opinions
29	30-10-2015	FRDC	D.Myagmarsuren	Accountant of FRDC	Budget spending of FRDC
30	01-11-2015	MET	E.Erdenekhuu	Forest specialist of Cadastre Division, MET	To take report of environmental state in Mongolia, to exchange opinions
31	03-11-2015	MET	P.Tsogtsaikhan	Head of division of Environmental assessment and audit	Mining license, repot for restoration after mining
32	07-11-2015	National Statistical office	A.Demberel	Head of center	Request documents that related with macroeconomic indicators
33	20-11-2015	UNDP	B.Bunchingiv	Environment team leader	Feedback and comment for final report
34	23-11-2015	State specialized Inspection agency of Mongolia	S.Nyamdavaa	inspector	Report on forest violations study
35	24-11-2015	National Statistical office	M.Mendsaihkan	Head of NSO	Request information and material that related with poverty
36	24-11-2015	National Statistical office	Kh.Baajiikhuu	Staff of NSO	Study on poverty index

#	Name of participant	Position and affiliation	Inception	Consultation	Validation
1	S.Gantulga	Director of Forest research and Development Center	√	√	√
2	Ts.Banzragch	Director of Forest policy coordination department	√	√	√
3	E.Erdendebat	GIZ	√	√	√
4	B.Chuluunkhuu	Climate change policy and climate financing officer, GIZ	√		
5	Klaus Schmidt Corsitto	GIZ	√		√
6	J.Tsogtbaatar	National expert	√		√
7	L.Dorjtseden	National expert	√	√	√
8	Ch.Dorjsuren	National expert	√	√	√
9	B.Enkhtsetseg	National expert	√	√	√
10	Charlotte Hicks	Programme officer, Climate Change and Biodiversity UNEF WCMC	√		
11	Ben Vickers	Regional programme officer, UN-REDD, FAO	√		
12	Till Neeff	International expert	√		√
13	Philip Cowling	International expert	√		√
14	B.Bunchingiv	Environment team leader, UNDP	√	√	√
15	Z.Narangerel	National expert	√	√	√
16	M.Undraa	National expert	√	√	√
17	Ts.Enkhbaatar	University of Science and Technology	√		√
18	Ts. Chuluunbaatar	Senior specialist of Forest policy coordination department (fire)	√		√
19	Dan Altrell	GIZ	√	√	√
20	E.Sanaa	GHG Inventory expert, Climate change project implementing unit, Nature conservation fund of the MET	√		√
21	N.Enkhtaivan	Senior specialist of Forest policy coordination department (forest user groups)	√	√	√
22	B.Tsogtbaatar	Senior specialist of Forest policy coordination department	√		√
23	D.Enkhjargal	Specialist of Forest policy coordination department (reforestation)	√	√	√
24	Turtogtokh	Citizen, Tudevtei soum, Zavkhan province	√		
25	D.Enkhtaivan	Head of Environmental agency, Zavkhan province	√		
26	I.Dorj	Specialist of Department of Forest Policy and Coordination, MET		√	√
27	M.Chuluunchimeg	Contract worker of Department of Forest Policy and Coordination, MET		√	√
28	A. Byambaa	Specialist of Department of Forest Policy and Coordination, MET		√	

29	E.Erdenekhuu	Forest specialist of Cadastre Division, MET	√	
30	L.Nyam (Erdene)	Director of Division of Land Resources Coordination, MET	√	√
31	M.Otgontugs	Cadastre department, MET	√	
32	G.Bayarsaikhan	Senior specialist of Department of Light Industry, MoI	√	
33	B.Bat-Ochir	Forest Research and Development Centre (FRDC)	√	
34	G.Enkhbold	Forest Research and Development Centre (FRDC)	√	
35	B.Bayartsetseg	Director of Training and Research Institute of Forestry and Wood Industry	√	√
36	B.Tsengel	Teacher. of Department of Forestry Study of Mongolian National University (NUM)	√	
37	Z.Tsogt	Senior researcher of Laboratory of Forest Phytocenology of Institute of General and Experimental Biology, (MAS)	√	
38	J.Bat-Erdene	Teacher, University of Life Science	√	
39	Andrew Inglis	FAO/GEF Project Chief Technical Advisor	√	√
40	H.Ykhanbai	FAO/GEF National Project Coordinator	√	√
41	L.Natsagdorj	Consultant of Information and Research Institute of Meteorology, Hydrology and Environment	√	√
42	D.Tsendsuren	Forest researcher, Institute of Geography and Geoecology	√	√
43	Ts.Khongor	Forest Research Association	√	
44	G.Luvsantseren	Head, United association of foresters	√	
45	G.Tsengelzaya	Head of Forest unit, Selenge aimag, Environment and tourism administration	√	√
46	R.Naran	Head of Inter-soum forest unit in Mandal soum, Selenge aimag	√	
47	S.Radnaabazar	Head of 5th bag in Mandal soum, governor of Tunhel village	√	
48	L.Gandush	Head of Bugant group, Eruu soum Selenge aimag	√	
49	I.Davaanyambuu	Head of Forest unit, Environment and tourism administration, Tuv aimag	√	√
50	S.Narantsetseg	Head of “Altan orts” forest user group, Batsumber soum, Tuv aimag	√	
51	A.Gantumur	Head of Environment and tourism administration of Selenge aimag	√	
52	G.Gantumur	“ Oichin “ forest user group, Khishig-Undur soum, Bulgan aimag	√	
53	Kh.Khishigjargal	Programme analyst, UNDP Mongolia	√	√

54	B.Khishigjargal	UN-REDD Mongolia Programme Manager	√	√
55	O.Bilguun	UN-REDD Mongolia Programme Coordinator	√	√
56	Ts.Tsengel	State-Secretary, MET and UN-REDD Programme Political Focal Point		√
57	T.Bulgan	Director of Department of Green Development Policy and Strategic Planning, MET		√
58	B.Otgonsuren	Senior specialist of Department of Forest Policy and Coordination, MET		√
59	R.Ganbat	Specialist of Department of Forest Policy and Coordination, MET		√
60	E.Erdenekhuu	Forest specialist of Cadastre Division, MET		√
61	N.Ganibal	Director of Department of Livestock Husbandry Policy Implementation and Coordination, MoFA		√
62	I.Battsetseg	Head of Investigation and Monitoring Department, ALAGAC		√
63	J.Altangadas	Head of Unit, Forest Research and Development Centre (FRDC)		√
64	B.Ganzorig	Head of Unit, Forest Research and Development Centre (FRDC)		√
65	A.Ganbaatar	Specialist of Forest Research and Development Centre (FRDC)		√
66	N.Batkhuu	Prof. of Department of Forestry Study of Mongolian National University (NUM)		√
67	D.Tsendsuren	Forest Researcher, Institute of Geography and Geoecology		√
68	L.Uuganbayar	Head of Inter-soum forest unit in Selenge river bight, Tsagaannuur soum, Selenge aimag		√
69	S.Bat-Amgalan	Head of Inter-soum forest unit in Yuruu zone, Selenge aimag		√
70	U.Bayan-Erdene	Head of Inter-soum forest unit of Orkhon zone, Baruunburen soum, Selenge aimag		√
71	A.Amarbayasgalan	Head of Forest Bureau , Arkhangai aimag's Environment and tourism administration		√
72	D.Munkhnaran	Head of Inter-soum forest unit in Erdenemandal soum, Arkhangai aimag		√
73	T.Munkh-Erdene	Head of Inter-soum forest unit in Ikh Tamir soum, Arkhangai aimag		√
74	L.Galkhuu	Head of Inter-soum forest unit in Tsenkher soum, Arkhangai aimag		√
75	S.Munkhsaikhan	Head of Forest Bureau, Dornod aimag's Environment and tourism administration		√

76	J.Lkhagvadorj	Head of Inter-soum forest unit in Bayan-Uul Soum, Dornod aimag		√
77	B.Ariunaa	Head of Forest Bureau, Zavkhan aimag's Environment and tourism administration		√
78	Tsendsetgel	Head of Inter-soum forest unit in Tosontsengel soum, Zavkhan aimag		√
79	D.Tsengeldalai	Head of Inter-soum forest unit in Batsumber soum, Tuv aimag		√
80	Ts.Azjargal	Head of Inter-soum forest unit in Mungunmorit soum, Tuv aimag		√
81	H.Khadbaatar	Officer of forest bureau, Khuvsgul aimag		√
82	Nyamkhishig	Head of Inter-soum forest unit in Ulaan-Uul soum, Khuvsgul aimag		√
83	I.Naimanjin	Head of Inter-soum forest unit in Murun soum, Khuvsgul aimag		√
84	Munguntsetseg	Head of Forest Bureau, Khentii aimag's Environment and Tourism agency		√
85	D.Ganbaatar	Head of Tsenkhermandal soum forest unit, Khentii aimag		√
86	E.Munkh-Ochir	Head of Inter-soum forest unit in Binder soum, Khentii aimag		√
87	B.Otgonjargal	Officer of Bulgan aimag's Environment and Tourism agency		√
88	D.Mandakhsaikhan	Head of Inter-soum forest unit in hh soum, Bulgan aimag		√
89	E.Munkhzul	Officer of Darkhan-uul aimag's Environment and Tourism agency		√
90	Ulzii	Engineer of Inter-soum forest unit in Khongor soum, Darkhan-Uul aimag		√
91	Ch.Boldbaatar	Head of Division for forest and Greening Department of Environment and Tourism, UB mayor office		√
92	Bernd Steinhauer	KfW BACCProject Chief Technical Advisor_IC team		√
93	P.Galragchaa	KfW BACCProject Deputy Chief Technical Advisor, IC Team		√
94	Hans Hoffmann	Team leader of the ADB project on SFM to Improve Livelihood of Local communities		√
95	Kevin Gallagher	FAO Mongolia DRR		√
96	G.Nyamjargal	FAO Mongolia RR Assistant		√
97	Thomas Eriksson	UNDP Mongolia DRR		√
98	Akihito Kono	UNDP/UN-REDD Asia-Pacific Regional Office		√
99	D. Munkhzorig	Sustainable Forest Management Council of Mongolia, NGO		√
100		Translator	√	√

Annex 3.0 : Details on estimation of biomass in regeneration and closed forest

Living tree biomass in regeneration may average 22.8 tCO2e /ha. This estimate refers to reforested area as per the taxation inventory. It is based on data for an average Scots pine plantation of age 16 years. Available growth data indicate that vegetation stores about 14.7 m^3 /ha in such plantations, corresponding to total above-ground biomass of approximately 6.2 t d.m. /ha (Figure 33).

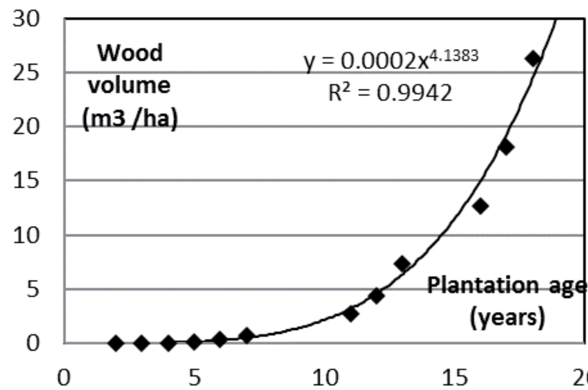

Figure 33. Growth of Scots pine plantations (Dorjsuren, Enkhbat 2011).

Biomass in natural forest was estimated to amount to 179.73 tCO2e /ha (Annex 4.0). This stock was calculated using IPCC standard approaches (IPCC 2006):

C = V * BCEF * (1+R) * CF

With BCEF = D * BEF

Where:
C = Carbon stock in biomass of a forest, tC /ha
V = merchantable volume, m^3 /ha
BCEF = biomass conversion and expansion factor, tC /m3 merchantable volume
D = basic wood density, t d.m. /m3 merchantable volume
BEF = biomass expansion factor that expands the dry-weigth of growing (or stem) stock of tree to none-merchantable biomass components(stump, branches, foliage etc.) , dimensionless
R = root-to-shoot ratio, dimensionless
CF = carbon fraction of dry matter, tC /t d.m.

Carbon losses due to disturbances (forest fires, pest damage, etc.) are calculated using another IPCC standard approach (IPCC 2006).

L disturbance = A disturbance * BW * (1+R) * CF * fd

Where:

L disturbance = annual losses of carbon, t C /year

A disturbance = area effected by disturbances, ha /year

BW = average above-ground biomass of land areas affected by disturbance, t d.m. /ha

fd = fraction of biomass lost in disturbance. The parameter fd defines the proportion of biomass that is lost from the biomass pool: a stand replacing disturbance will kill all (fd = 1) biomass while an insect disturbance may only remove a portion (e.g. fd = 0.3) of the average biomass C density.

Annex 4.0 Estimation of Biomass Stock in Mongolia's Boreal (FRDC, 2015 a, b) .

Tree species		Siberian larch (Larix sibirica)	Scotch pine (Pinus sylvestris)	Siberian pine (Pinus sibirica)	Siberian spruce (Picea obovata)	Siberian fir (Abies sibirica)	Birch (Betula plathyphylla)	Poplar (Populus spp.)	Aspen (Populus tremula)	Siberian elm (Ulmus pumila)	Willow (Salix spp.)	Total / mean	Source
Total area	1000 ha	7,179	487	626	21	1	1,198	36	11	3	165	9,729	from FRDC
Total growing stock	1000 m3 commercial volume	977,086	61,841	116,132	2,862	239	76,811	2,176	677	81	3,431	1,241,335	from FRDC
Average age	years	138.61	119.14	153.75	127.39	127.95	53.42	64.24	45.96	43.34	23.98	125.73	from FRDC
Growing stock	m3 commercial volume /ha	136.1	126.9	185.4	134.1	174.3	64.1	60.7	60.5	24.7	20.8	127.6	Calculated from above
Mean annual increment in commercial volume	m3 commercial volume /ha /year	0.98	1.07	1.21	1.05	1.36	1.20	0.95	1.32	0.57	0.87	1.03	Calculated from above
Wood density	t d.m. /m3	0.49	0.42	0.38	0.4	0.4	0.51	0.35	0.35	0.51	0.45	0.48	Table 3A.1.9-1. IPCC. 2003
Aboveground biomass	t d.m. /ha	90.03	71.95	95.09	72.39	94.13	42.50	27.63	27.52	16.39	12.14	82.29	Equation 3.2.3. IPCC, 2003
Root-shoot ratio	dimensionless	0.24	0.39	0.24	0.39	0.24	0.39	0.39	0.39	0.39	0.39	0.27	Table 4.4. IPCC, 2006
Biomass expansion factor	dimensionless	1.35	1.35	1.35	1.35	1.35	1.30	1.30	1.30	1.30	1.30	1.34	Table 3A.1.10. IPPC, 2003
Carbon fraction	tC /t d.m.	0.51	0.51	0.51	0.51	0.51	0.48	0.48	0.48	0.48	0.48	0.51	Table 4.3. IPCC, 2006
Total carbon stock	t C /ha	56.94	51.01	60.14	51.32	59.52	28.36	18.43	18.36	10.93	8.10	52.28	Equation 3.2.3. IPCC, 2003
Ratio of molecular weights CO2-C	tCO2 /tC	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	Global default
Total GHG stock	tCO2e /ha	208.77	187.03	220.51	188.16	218.26	103.98	67.58	67.32	40.08	29.70	191.70	Calculated from above

Annex 5.0: Consultation Workshops

5.1. Kick-off Workshop

The Kick off workshop: "Workshop on REDD+ Institutional Arrangements and Drivers of Deforestation and Forest Degradation" was held in KHAAN Meeting hall of the Ministry of Environment, Green Development and Tourism. It took place 09:00 A.M. – 12:30 A.M Tuesday, 19 May 2015.

The workshop was organized by the Ministry of Environment, Green Development and Tourism, UNDP and UN-REDD Programme.

Workshop objectives:

- To update participants on the National REDD+ process in Mongolia
- To introduce studies on Institutional Arrangements and Drivers of Deforestation and Forest Degradation
- To provide opportunities for participants to provide feedback on the studies

Mr Till Neeff and Mr.Ch.Dorjsuren presented a presentation titled "Study of the drivers of forest-cover change in Mongolia". Participants discussed the inception report.

Regarding the study on the drivers of forest change, the workshop concluded the following:

- To include pest to drivers of forest degradation and deforestation
- To use existing default of IPCC for identify reference level
- To cooperate with other similar projects
- To consider climate change impacts

5.2 Consultation Workshop

The meeting "Discussion of results of the assessment on drivers of Deforestation and forest degradation in Mongolia" was held in Khaan Meeting Hall of the Ministry of Environment, Green Development and Tourism (MET) on Friday, October 16, 2015.

The meeting objectives were

- To introduce results of studies on Drivers of Deforestation and Forest Degradation
- To provide opportunities for participants to provide feedback on the studies

The meeting was chaired by Mr Banzragch, Director of Department of Forest Policy and Coordination, MET.

There were 42 participants from state and local governments, non-governmental organizations, companies, universities, research institutes and forest user groups.

In summary, the participants concluded that the study team has successfully fulfilled the objective of the study. The proposed set of drivers and underlying causes of deforestation and forest degradation is applicable and relevant to Mongolia. All participants actively took part in discussion and offered valuable feedback.

Key recommendations from discussions are:

- Check the calculation of emissions,
- Prioritize the drivers and their underlying causes,
- Propose policies and measures to be included in a REDD+ strategy.

5.3. Validation workshop

The Validation Workshop on Institutional Assessment Study & Analysis of Drivers of Forest Change was held in Khar-khorin hall, Ulaanbaatar hotel, on Thursday, 19 November 2015.

The workshop objectives were:

- To review the findings of an Institutional Assessment Study
- To review the findings of Analysis of Drivers of Forest Change
- To provide opportunities for participants to provide feedback on the studies

The workshop was chaired by Mr Ts.Banzragch, Director, Department of Forest Policy and Coordination, National Director of Mongolia's UN-REDD National Programme.

There were 103 participants from state and local governments, non-government and business organizations, universities, research institutes and staffs of forest units, forest user groups.

Regarding the study on the drivers of forest change, the participants concluded that the consulting team has successfully fulfilled the objective of the study. Drivers and underlying causes of deforestation and forest degradation suggested by consulting is applicable to Mongolia. All participants actively took part in discussion and offered valuable feedbacks.

The workshop also concluded group work by participants on

- Forest fires
- Logging and subsequent degradation
- Pest control

Regarding the study on the drivers of forest change, key conclusions from the workshop were the following:

- To add the results of group work to the report
- To include grazing impact in the report
- To highlight in the report, the importance of awareness raising on fire prevention

Regarding results of group work, the following table summarizes additional text included in the main report in response to selected input received.

Selected input received during group work on forest fire
• Unsustainable use of non-timber forest products
• Firebreak are insufficient
• There is no specific policy that relevant to their environmental and climatic feature in rural areas
• Forest fire fighting capacity is low; personnel are not available
• Informants are not afforded privacy; the informant system needs to be improved for reporting on illegal logging, forests fire and other activities
Selected input received during group work on logging and subsequent degradation
• Policy and the legal environment for population migration arrangement is weak
• There is lack of technical equipment in scientific organizations and university and funding is insufficient
• Lack of research funding for forests vulnerability that affecting by climate change and its adaptation
• Government structures often change and unclear roles and responsibilities
Selected input received during group work on pest control
• Due to economic situation, it cannot cover completely areas necessary to be carried out pest control
• To improve legal environment of budget allocation
• To improve research methodology
• Lack of professional personnel (specialized by pest control, its technicians)in inter-soums forest unit
• Retention personnel in rural areas needs to be improved
• To prepare training courses for personnel
• To implement work stated in forest management plan
• Lose time for the selection after announcing tender which means that often tenders are approved after the pest season, but work often still needs to go ahead which results in wasted money and ineffective pest control

Annex 6. Update: Summary of Mongolian National Forests Inventory Results (MET, 2017)

This Annex is a summary of the main findings of the Mongolian National Forest Inventory, based on field data, collected in year 2014 and on remote sensing surveys in 2014 and 2016. The findings are presented for the boreal forest area and by each inventory region: Altai, Khangai, Khuvsgul, Khentii and a Boreal Forest Buffer zone. For further details the following resources should be consulted:

- Mongolian Ministry of Environment and Tourism, 2016. Mongolian Multipurpose National Forest Inventory 2014-2016. 1st edn. Ulaanbaatar. Ministry of Environment and Tourism.

- The main findings and data from the multipurpose national forest inventory are published and disseminated both through report hard copies (current report) and through the on-line Web portal www.forest-atlas.mn, where all findings, data and related documentation can be found together with interactive maps to illustrate the new information.

Summary

The Multipurpose National Forest Inventory (NFI) is the first of its kind in Mongolia. The inventory originated in the need of reliable and accurate information on Mongolia's forestry resources for fact-based development of national forest policies addressing the multiple functions and benefits of forest, and also for international reporting, including on REDD+. The multipurpose NFI was implemented during 2014-2016, by the Forest Research and Development Centre, in collaboration with all of Mongolia's main forestry institutions, universities and research organisations, as well as with international expertise. Current NFI is Mongolia's first national-level forest inventory built on standardised methods for field measurements on systematic and permanent field plots, and is established as a tool for generating data in a long-term forest monitoring system.

The multipurpose national forest inventory has been designed to cover the multiple functions of forest, as well as being compatible with the international reporting requirements for REDD+. The findings from the inventory are based on measurements of 251 890 trees and 166 830 tree regeneration, and on other field inventory data from the 4211 sampling units, to describe the multiple characteristics and functions of forest. The two main NFI findings are the Stocked Boreal Forest Area, 9.1 million hectares, and the Average Growing Stock Volume, 114 m3 per hectare, or totally 1036 million m3.

1. Forest Area, Stocking Volume and Species Composition

This Annex provides an overview of area statistics and distribution of Mongolian boreal forest as produced by the Mongolian NFI (MET, 2017). The extent of forest and its corresponding area statistics vary depending on how forest is defined[6]. The NFI data represents data for the Stocked Boreal Forest, ie those with higher timber volumes. The area presented within the NFI data (MET, 2017) for forest area is different to official statistics (FRDC, 2016) and that derived from Collect Earth by the UNREDD program (UNREDD, in prep) which determined 13.1 and 13.2 million hectares respectively. The difference is because the classification of forest cover for the NFI had higher demands for qualification of forest, whereas the UNREDD assessment was based on 10% forest cover. This needs to be considered during the interpretation of the annex since the less well stocked forests, which account for approximately 4 million hectares, are not described within this Annex. The threats and pressures (and subsequent interventions) is likely to be greater, especially for issues such as grazing (as they may be more likely to be livestock on the more degraded areas on the forest edge) and pests / fire since their degraded states may make them more vulnerable. This needs further investigation in the future.

The forest area statistics in Table 1.0 present the geographic distribution of Mongolia's boreal forest in 2014, by Aimag. Khuvsgul aimag is the most forested, with more than 3 million hectares, followed by Bulgan and Selenge aimags, with 1.4 million hectare each. Arkhangai, Tuv and Khentii aimags have between 0.7 and 0.8 million hectare of boreal forest, and Zavkhan aimag has 0.5 hectares of boreal forest. In total boreal forest have been registered in 17 of the countries Aimags.

Table 27. Forests Area Statistics in Mongolia by Aimag

Boreal Forest Area by Aimag (Province), ***ha , %***							
Aimag		**Forest area****		**Aimag**		**Forest area****	
		(ha)	**Proportion**			**(ha)**	**Proportion**
1	Arkhangai	792 340	8.7%	10	Khuvsgul	3 041 668	33.4%
2	Bayan-Ulgii	39 145	0.4%	11	Orkhon	13 578	0.1%
3	Bayankhongor	33 508	0.4%	12	Ovorkhangai	118 900	1.3%
4	Bulgan	1 448 018	15.9%	13	Selenge	1 353 368	14.9%
5	Darhan-Uul	57 496	0.6%	14	Tuv	764 752	8.4%
6	Dornod	28 725	0.3%	15	Ulaanbaatar	75 869	0.8%
7	Gobi-Altai	2 347	0.03%	16	Uvs	129 321	1.4%
8	Khentii Khovd	704 777	7.7%	17	Zavkhan	490 960	5.4%
9		1 153	0.01%				
				Mongolia		**9 095 925***	**100%**

Table 2.0 shows the growing stock volume as presented by tree size (dbh) and forest inventory region. The average growing stock volume is 114 m3 per hectare (±1.0 % at a confidence level of 95 percent). The forest regions with the highest average growing stock are Khangai and Khuvsgul with 130 m3/ha and 121 m3/ha respectively. Altai region stands out with the lowest growing stock, 74 m3/ha, mostly due to relatively small volumes in the higher diameter classes.

6

Table 28. Volume for Forests in Mongolia

Growing Stock Volume, by Tree Dbh class and Forest Inventory Region, m^3/ha								
Regions	Boreal Average Forest				Boreal Production Forest			
	Tree Dbh class			Total •6 cm	Tree Dbh class			Total •6 cm
	>30 cm	15-30 cm	6-15 cm		>30 cm	15-30 cm	6-15 cm	
Mongolia	**59.1**	**41.9**	**12.9**	**113.9**	**62.6**	**40.1**	**12.6**	**115.3**
Altai	36.7	26.0	11.4	74.1	29.2	20.4	8.2	57.8
Khangai	62.8	50.7	16.3	129.8	62.8	49.7	15.5	127.9
Khuvsgul	64.8	42.7	13.8	121.3	75.8	42.1	14.0	131.9
Khentii	50.2	36.0	9.2	95.5	43.9	28.7	7.5	80.2
Boreal buffer zone	48.8	39.4	10.9	99.2	48.2	36.9	11.8	96.9

Siberian Larch (Larix sibirica) is very dominant in the boreal forest of Mongolia, and it represent 92 m3/ha, or 81 percent of the average growing stock volume. Siberian Pine (Pinus sibirica) comes on second place with 7.6 m3/ha (6.7%), then the White Birch (Betula platyphylla) with 7.3 m3/ha (6.4%) and Scotch Pine (Pinus sylvestris) with 5.6 m3/ha (4.9%). The other tree species, all together, represent less than 1.5 percent of the growing stock volume. The dominance of Siberian Larch is even more underlined in the Regions of Altai and Khangai, while Khentii region is the most diverse regarding tree species distribution where Siberian Larch represent 48 m3/ha and Siberian Pine, Scotch Pine and White Birch together represent 45 m3/ha. Notable is that the presence of Siberian spruce (Picea obovata) is strongest in Altai region with 2.8 m3/ha. Among the Poplars (Populus spp.) Aspen (Populus tremula) is the most common in all regions, with a national average of 0.4 m3/ha, except for in the Altai region, where Aspen is almost absent, and instead Populus suaveolens tops the list of Poplars with 0.4 m3/ha.

Table 29.Total Growing Stock Volume (Million m3) by Tree Species and Forest Inventory Region

Growing Stock (Living Tree Stems) Volume, by tree species and Forest Inventory Region, *Million* m^3						
Species name (Latin)	Forest Inventory Region					Total
	Altai	Khangai	Khuvsgul	Khentii	Boreal buffer zone	
All tree species*	**12.9**	**221.3**	**522.8**	**229.4**	**49.7**	**1036.2**
Larix sibirica	12.3	214.2	453.1	114.2	41.8	**835.7**
Pinus sylvestris	0.001	0.01	10.9	36.9	2.9	**50.7**
Pinus sibirica	0.03	5.9	21.9	38.8	2.6	**69.2**
Picea obovata	0.5	0.2	4.8	2.6	0.3	**8.4**
Abies sibirica	0.03	-	0.2	1.8	0.03	**2.1**
Betula platyphylla	0.01	0.9	31.1	32.2	2.0	**66.2**
Populus laurifolia	-	0.01	0.1	0.02	-	**0.1**
Populus suaveolens	0.1	0.02	0.1	-	-	**0.2**

Populus tremula	0.0001	0.03	0.5	2.8	0.1	**3.5**
Ulmus pumila	-	0.01	0.04	0.008	-	**0.1**
Populus diversifolia	-	0.002	-	0.005	-	**0.01**

1.2 Harvesting Wood Products

In Mongolia tree harvesting can potentially be implemented outside protected areas, in the so-called production forests. The "harvestable" tree species are Siberian Larch (Larix sibirica), Scots Pine (Pinus sylvestris) and White Birch (Betula platyphylla), the estimation of potential timber and fuel wood supply is limited to these three tree species, and to the production forest area. Table 4.0 shows that currently the average potential timber volume is 61 m3/ha in the boreal forests (totally 386 million m3), and most of the timber volume, 35 m3/ha is found in the greater Dbh classes, >30 cm. The Khangai and Khuvsgul regions have the greatest timber potential with 74 m3/ha and 71 m3/ha respectively. The Altai and Khentii regions have the lowest timber potential, with only 33 m3/ha and 35 m3/ha respectively. Siberian Larch (Larix sibirica) is the most dominant timber species with potentially 56 m3 timber volume per hectare. The Khentii region is the only where Larch is not so dominant, as Scots Pine (Pinus sylvestris) counts for almost half of the potential timber volume, with 15 m3/ha. The potentially harvestable tree species Siberian Larch (Larix sibirica), Scots Pine (Pinus sylvestris) and White Birch (Betula platyphylla) the growing stock corresponding to over- aged/over-mature volume was estimated, based on the concept that Siberian Larch and Scots Pine are over-aged when older than 200 years, or with a Dbh bigger than 45 cm, and that White Birch is over-aged when more than 100 years old, or with a Dbh of more than 40 cm.

Table 30. Harvestable Timber Volume by Forests Inventory Region (MET, 2017)

Timber volume by tree Dbh class and Forest Inventory Region, m^3/ha				
Forest Region	**Dbh class**			**Total**
	>30 cm	**15-30 cm**	**6-15 cm**	
Mongolia	**35.8**	**20.3**	**5.2**	**61.3**
Altai	17.3	11.4	4.0	**32.8**
Khangai	37.8	28.3	7.5	**73.6**
Khuvsgul	43.1	21.6	5.8	**70.5**
Khentii	23.2	10.3	1.7	**35.2**
Boreal buffer zone	29.5	20.6	5.4	**55.6**

Table 31. Timber Volume by Tree Species in Forest Inventory Regions

Tree species	Timber volume by tree species and Forest Inventory Region, m3/ha					
	Forest Inventory Region					Mongolia
	Altai	Khangai	Khuvsgul	Khentii	Boreal buffer zone	
All tree species	32.8	73.6	70.5	35.2	55.6	**61.3**
Larix sibirica	32.8	73.5	68.3	18.6	52.7	**56.2**
Pinus sylvestris	-	0.01	1.6	15.5	2.8	**4.6**
Betula platyphylla	-	0.01	0.6	1.1	0.1	**0.5**

Past Historical Logging

Historical wood harvesting is estimated through the stumps assessed in the field inventory, and no consideration was given whether the stumps were found in protected forest or in the productive forest area. The tree species was not assessed, so no species specificity for harvested wood volume can be estimated. The degree of decay was assessed for each stump, and this will be a proxy for the age of the stump, i.e. the time since the tree was harvested. Full decomposition of an average stump in the boreal forest of Mongolia is estimated at more than 50 years (Shorohova, E. & Kapitsa, 2012; Shorohova, E. & Kapitsa, 2014), and that the rate of decomposition is constant throughout the stump's lifecycle, then the degree of decay (%) divided by two, could be equivalent to years since the tree was harvested.

With this assumption totally 14 m3 stem volumes have been logged per hectare in the boreal forest during the last 50 years period (1964-2014), which corresponds to an average annual logging rate of less than 0.28 m3 per hectare, or totally 2.5 million m3/year. Most wood volume harvested per hectare in the last 50 years has been in Altai, Khangai and the Boreal Buffer Zone, with 30, 27 and 25 m3 per hectare, respectively. Least harvested wood volume per hectare was in Khentii and Khuvsgul regions, with 8 and 10 m3 per hectare, respectively. It should be noted that this applies to the Stocked Boreal Forests. Applying the same assumption of decay rates, 2.3 m3 has been logged per hectare during the ten-years period 2004-2014, which corresponds to an average annual logging rate of less than 0.23 m3 per hectare (Table 7.0), or totally 2.1 million m3/year

Table 32. Volume and Number of Tree Stumps by Decay in Forests Inventory Region Table 32.1 Logged Stem Volume

Forest Region	*Logged Stem Volume*, by degree of stump decay and Forest Inventory Region, m^3/ha*										
	Degree of stump decay (%)										All
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	
Mongolia	**1.0**	**1.3**	**1.3**	**1.1**	**1.6**	**0.9**	**1.0**	**1.5**	**1.8**	**2.5**	**14.0**
Altai	3.6	2.3	2.4	2.2	2.3	1.6	1.5	2.6	3.5	7.5	**29.7**
Khangai	2.6	2.9	1.9	2.0	2.9	1.6	2.0	3.2	3.3	4.9	**27.2**
Khuvsgul	0.7	0.4	1.1	0.9	1.3	0.8	0.8	1.1	1.4	1.5	**10.0**
Khentii	0.1	1.1	0.9	0.4	1.0	0.5	0.4	0.9	1.1	2.1	**8.4**
Boreal buffer zone	1.3	4.0	1.4	2.3	1.9	1.7	2.0	2.3	3.7	3.9	**24.8**

Table 33. Logged Tree Number

Forest Region	Logged Stem Volume*, by degree of stump decay and Forest Inventory Region, m3/ha										
	Degree of stump decay (%)										All
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	
Mongolia	2.6	5.0	5.2	3.8	5.3	4.0	5.3	6.3	7.2	10.4	**55.2**
Altai	14.4	16.8	17.7	14.7	12.2	9.7	11.8	15.2	20.0	42.5	**175.0**
Khangai	4.7	11.2	8.8	6.6	9.5	7.1	8.1	14.8	13.2	18.0	**102.1**
Khuvsgul	1.9	1.6	3.1	2.6	3.6	2.6	3.2	3.4	4.0	5.1	**31.2**
Khentii	1.1	3.7	4.0	3.0	4.1	3.4	5.1	4.0	6.3	10.2	**45.0**
Boreal buffer zone	4.7	14.7	12.0	5.7	9.0	5.7	12.6	11.1	14.7	19.5	**109.8**

Regeneration

The average tree regeneration in the stocked boreal forests is 3025 stems per hectare (Table 7.0). Tree regeneration in Khentii and Khuvsgul regions is over the national average with 3617 stems/ha and 3260 stems/ ha respectively. Altai has the lowest tree regeneration with 1763 stems/ha. The average tree regeneration, with a height more than 150 cm, is 959 stems/ha, which is a better indicator for regeneration with higher potential of surviving. Tree regeneration in Khuvsgul and Khentii regions is over the national average with 3544 stems/ha and 3215 stems/ha respectively. Altai has the lowest tree regeneration with 1339 stems/ha. The average tree regeneration with a height more than 150 cm is 934 stems/ha, which is a better indicator for regeneration with higher surviving potential. Siberian Larch (Larix sibirica) is the most common tree regeneration in boreal forest, with an average of 1282 stems per hectare (Table 8.0). The only region, in which Larch is not dominant, is the Khentii region, where White Birch (Betula platyphylla) is the most common with 1386 stems per hectare.

Table 34. Forest Regeneration by Number of Trees in Forests Inventory Region

Tree Regeneration in Boreal Average Forest and in Boreal Production Forest by Height Class and Forest Inventory Region, *stems/ha*								
Region	**Boreal Average Forest**				**Boreal Production Forest**			
	Height Class			**Total**	**Height Class**			**Total**
	>150 cm	**50-150 cm**	**<50 cm**		**>150 cm**	**50-150 cm**	**<50 cm**	
Mongolia	**959**	**749**	**1317**	**3025**	**934**	**707**	**1261**	**2902**
Altai	585	368	810	**1763**	345	186	809	**1339**
Khangai	686	491	824	**2001**	537	409	722	**1668**
Khuvsgul	913	767	1581	**3260**	955	824	1765	**3544**
Khentii	1345	992	1280	**3617**	1443	887	884	**3215**
Boreal buffer zone	563	440	1077	**2081**	533	477	1330	**2340**

Deadwood

Deadwood was defined in the multipurpose NFI as all non-living woody biomass including standing dead trees, dead wood on the ground (fallen parts of, or whole, trees lying on the ground and stumps) larger than or equal to 5 cm in diameter. The amount and quality of dead and decaying wood is considered an important indicator of biodiversity in boreal forest. Lying and standing dead wood are important components of the natural life cycle of forest ecosystems. Dead wood contributes to soil nutrient content and influences global carbon storage and affects forest fire behaviour. The degree of deadwood can influence and affect the intensity and scale of forest fires. It is a habitat for fauna and flora, as many species are specialized in using this habitat, in addition, the abundance of deadwood following fires can result in pest infection as many insects live off or in deadwood. Dead wood is an important factor for biological diversity, and the ecological benefits of fallen dead wood are recognized along with its contribution to fire risk. Establishing a balance between dead wood and growing stock is necessary to sustain a healthy and productive forest. The measurement of decaying and decayed trees was introduced in the NFI to describe biodiversity and dead wood carbon pool in the forest, of particular importance is to distinguish between standing and fallen deadwood. In the Mongolian boreal forest exist on average 46.5 m3 of dead wood per ha, of which 18.7 m3/ha (40%) is standing dead wood (Table 9.0), 25.8 m3/ha (56%) is fallen dead wood, and 2.0 m3/ha (4%) are stumps. The total dead wood contributes an additional 40% of wood volume to the forest, in addition to the growing stock. Table 9.0 shows that the amount of dead wood on the ground is almost the same in all regions, between 26.6 m3/ha and 33.1 m3/ha, with the exception of the Altai region, which only has 16.3 m3/ha. Khentii and Khuvsgul regions have less stump volume than the other regions, 1.1 m3/ha and 1.4 m3/ha respectively. The total amount of standing dead wood is rather similar in the forest regions, between 18.0 m3/ha and 21.7 m3/ha. The only exception is the Altai region, which only has 4.1 m3 standing dead wood per hectare.

Table 35. Standing and Fallen Deadwood in Mongolian Boreal Forests

Table 35.1 Fallen Dead Wood and Stumps

Volume of Fallen Dead wood and Stumps by Forest Inventory Region, *m^3/ha*			
Region	Dead Wood Type		Total
	Fallen Dead Wood	Stumps	
Mongolia	25.8	2.0	**27.8**
Altai	12.4	4.0	**16.3**
Khangai	28.9	4.2	**33.1**
Khuvsgul	25.3	1.4	**26.6**
Khentii	26.0	1.1	**27.0**
Boreal buffer zone	24.6	3.5	**28.0**

Table 35.2 Volume of Standing Dead Trees

Stem Volume of Standing Dead Trees, by Dbh class and Forest Inventory Region, *m^3/ha*				
Region	Tree Dbh class			Total
	>30 cm	15-30 cm	6-15 cm	
Mongolia	10.0	6.2	2.5	**18.7**
Altai	1.7	1.3	1.1	**4.1**
Khangai	11.4	7.4	2.9	**21.7**
Khuvsgul	10.4	5.7	2.2	**18.3**
Khentii	9.3	6.3	2.3	**18.0**
Boreal buffer zone	7.8	8.1	4.9	**20.7**

Forest Health

The findings of the multipurpose NFI reflect the stocked forest areas, and the most evident environmental challenges that have a significant drivers of forest damage in the boreal forests are snow or ice breakage, forest fires, forest pests (insects) and grazing. Soil erosion and lightning have only a minor impact on the forest health. The local impact of the health damage is defined through the proportion of the basal area affected. More than 70.9 percent of the stocked boreal forest is classified as very healthy, with more than 70% of the basal area without any sign of damage, and only 6.8 percent of the forest is damaged on more than 90% of the total basal area (Table 10.0). Only 0.1 percent of the stocked boreal forest shows very serious damage, where more than 70% of the total basal area shows effects of severe damage, or dead trees, and only 0.3 percent of the forest shows serious damage, where 30-70% of the total basal area shows effects of severe damage, or dead trees.

Table 36. Proportion (%) of forest area by health category and severity, as proportion of Basal Area Affected

Proportion of forest area by health category and severity, as proportion of Basal Area Affected, *% area*				
Health class	Proportion of Basal Area Affected			
	(<10%)	(10-30%)	(30-70%)	(>70%)
Healthy	6.8	4.1	18.2	70.9
Moderate damage	75.7	15.7	6.4	2.1
Severe damage	97.6	1.9	0.3	0.1
Dead	59.2	25.0	9.7	6.1

Independent of the total growing stock volume per hectare, the amount of damaged growing stock volume per hectare is quite similar in all of the five forest inventory regions, between 11 m^3/ha and 15 m^3/ha. The Altai region has the lowest growing stock volume per hectare, so in relative terms the proportion of damaged growing stock volume in Altai is much higher than in the other four regions, 20 percent, compared with the average 11 % damaged growing stock volume in all boreal forests.

The distribution of moderately and extensively damaged growing stock volume is also rather similar in all five forest inventory regions, between 10 m^3 and 13 m^3 moderately damaged GS volume per hectare, and between 0.6 m^3 and 1.8 m^3 extensively damaged GS volume per hectare (Table 11.0).

Table 37. Stem Volume per hectare (m3/ha) by Health Class and Forest Inventory Region

Stem Volume per hectare by Health Class and Forest Inventory Region, *m^3/ha*				
Forest Region	Tree Health Class			
	Healthy	Moderate damage	Extensive damage	Dead
Mongolia	**101.5**	**11.4**	**1.0**	**18.7**
Altai	59.4	12.8	1.8	4.1
Khangai	115.7	12.7	1.4	21.7
Khuvsgul	110.4	9.9	1.0	18.2
Khentii	82.0	12.9	0.6	17.9
Boreal buffer zone	85.6	12.2	1.4	20.6

Of the causative agents affecting the health of forest/trees, Forest fire and the climatic agent Snow or Ice are the ones most affecting the health of the growing stock, 5.7 m3/ha and 5.3 m3/ ha respectively (Table 12.0). Damage on growing stock, caused by Snow or Ice is relatively high in the Altai and Khangai regions, with 11 m3/ha and 9 m3/ha respectively, while damage on growing stock caused by forest fire is relatively high in the Khentii region, 11 m3 per hectare. Among the assessed causative agents was also direct human-induced damage (e.g. mechanical damage on tree stems). However, no such damage was recorded during the field survey. Other direct or indirect human-induced damage, like starting forest fires or managing livestock in forest have not been assessed.

Table 38. Damaged Growing Stock Volume (m3/ha), by Causative Agent and Forest Inventory Region

Damaged Growing Stock Volume, by Causative Agent and Forest Inventory Region, m^3/ha					
Forest Region	Causative Agent				
	Snow or Ice	Insects	Fungi	Lightning	Forest fire
Mongolia	**5.3**	**1.0**	**0.2**	**0.1**	**5.7**
Altai	11.0	2.2	1.0	0.3	0.1
Khangai	8.7	0.9	0.4	0.02	4.0
Khuvsgul	5.6	0.8	0.2	0.2	4.2
Khentii	1.9	0.9	0.0	0.1	10.6
Boreal buffer zone	7.4	2.7	0.6	0.01	2.8

Different health causative agents show different spatial patterns in how they affect the trees. Table 13.0 shows that Snow or Ice is the cause with the highest local impact, severely affecting 22 % of the damaged forest area (more than 70 percent of the growing stock affected).

Table 39. Proportion (%) of damaged forest area by Causative Agent and Severity (proportion of Damaged Basal Area

Proportion of damaged forest area by Causative Agent and proportion of Basal Area Affected, %				
Health causative agents	Proportion of Basal Area Affected by Causative Agent			
	(<10%)	(10-30%)	(30-70%)	(>70%)
Snow or Ice	9.7	0.5	1.7	21.9
Fire	25.7	0.4	0.9	6.9
Insects	30.2	0.7	0.8	2.0
Fungi	32.4	0.3	0.4	0.8
Lightning	33.4	0.2	0.1	0.2

Forest Fire

18.6 percent of Mongolia's boreal forest shows evidence (burnt stems) that they have been affected by forest fire during recent decades. The Khentii region shows the largest impact of forest fire, where 34.7 percent of the forest has been affected. In the Altai region forest fire has had a minor impact, only 1.4 percent of the forest shows signs of fire (Table 14.0).

Table 40. Proportion of Forest Area Affected by Forests Fire

Proportion of forest area affected by forest fire, by forest Inventory Region %		
Region	Recent Forest fire	No evidence of Fire
Mongolia	**18.6**	**81.4**
Altai	1.4	98.6
Khangai	8.3	91.7
Khuvsgul	13.2	86.8
Khentii	34.7	65.3
Boreal buffer zone	13.0	87.0

Snow or Ice Damage

Snow or Ice is the climatic agent that damage most boreal forest area, especially in the Khuvsgul and Khangai regions.

Insect Pests

Insects are present in all forests. Most of them are harmless and only a few species can become harmful if the trees are stressed, due to biotic or abiotic factors (drought, flooding, snow, ice, wind, or due to old age, but in healthy forests insects are generally not a major threat. Insects most often “attack” a tree when its health condition already has been reduced and its defenses are weakened, such as experienced after forest fire. Pests are rarely the initial cause for a tree’s reduced health, or death. The NFI registered insects present on/in damaged trees, which does not necessarily mean that they were the main cause of the tree’s reduced health.

Lightning

Damage caused by lightning in Mongolia’s boreal forests is negligible. Only 0.1 m3/ha of the growing stock is affected on average

Fungal Damage

Similar to Insects, Fungus is present in all forests, and in most cases harmless. If trees are stressed and their defenses are weakened, fungus often enters and can cause damage. Fungus is not considered to cause major damage on the Mongolia’s boreal forests, where only 0.2 m3/ha of the growing stock is affected on average.

Grazing

An average of 8.5 percent of the forest area has been grazed with moderate impact and only 13 percent has been grazed with a high impact. The only region that falls out of this description is the Altai region, where 32 percent of the forest area has been grazed with moderate impact and 20.4 percent has been grazed with high impact.

Table 41. Proportion (%) of forest area by grazing intensity and Forest Inventory Region

Proportion of forest area by Grazing Intensity and Forest Inventory Region, %				
Region	Grazing Intensity			
	Non	Low	Moderate	High
Mongolia	**57.5%**	**32.7%**	**8.5%**	**1.3%**
Altai	13.3%	34.3%	32.0%	20.4%
Khangai	34.5%	48.5%	14.7%	2.3%
Khuvsgul	64.1%	29.0%	6.5%	0.5%
Khentii	68.2%	29.5%	2.2%	0.1%
Boreal buffer zone	41.8%	30.8%	25.3%	2.2%

Summary

The Mongolian NFI data provides some interesting factors about the state of the stocked boreal forest in Mongolia and an assessment of drivers of deforestation and degradation. The data set is immense and undoubtedly more detailed analysis could be undertaken in the future to look at trends. However, the data only represents a one off survey and no historical data, though the degree of current damage, stump decay as a proxy and other factors can be used to infer about historical change in Mongolia's forests. Key points are:

- The NFI identifies 9.1 million hectares of stocked forest, ie those with higher tree volumes. This means that the most degraded forests have not been sampled. UN-REDD will sample this habitat in 2017.
- The average forests volume is 113m3 per hectare for the stocked forests, this would be lower if it included the poorer forests which were not classified as forests.
- Historical logging was identified through the assessment of stumps and stem decay. The data shows that older stumps were more common than recent ones, indicating that historically logging was much higher, as verified by other data on logging, especially under the communist time period.
- Grazing is not a serious problem in the stocked forests, apart from localized hotspots. However, in the poorly stocked forest it is likely to be a problem.
- Forests regeneration is high in the stocked forests, also verifying that grazing pressure is not high. However, in the poorly stocked forests (which are likely to be in fragments or forest edges, natural regeneration may be lower due to grazing or environmental condition)

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Утас: +976-7711-7750
И-мэйл: info@unredd.mn
Вэб хуудас: www.reddplus.mn