GOVERNMENT OF MONGOLIA

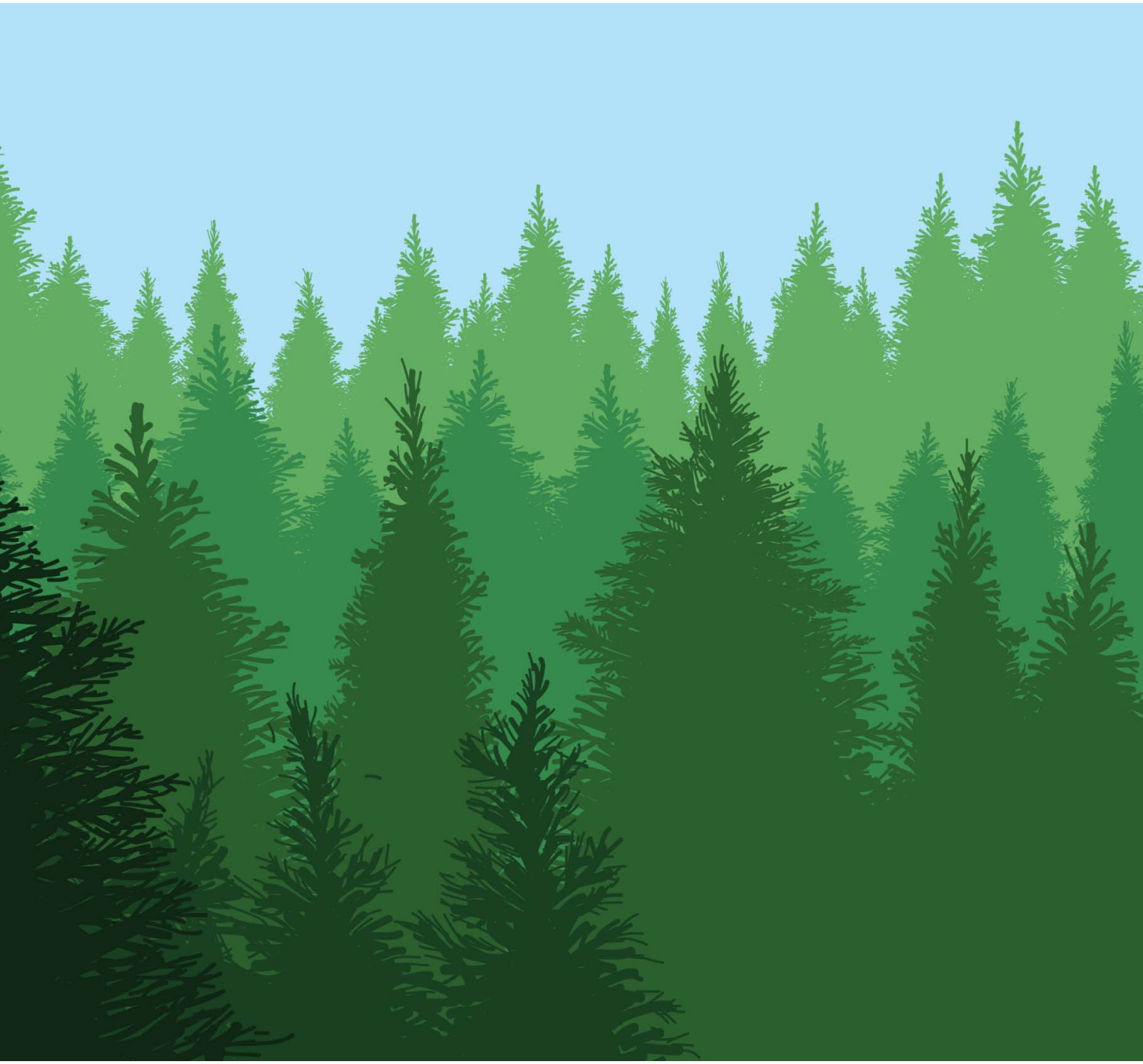
MINISTRY OF ENVIRONMENT, GREEN DEVELOPMENT AND TOURISM

UN-REDD PROGRAMME

Food and Agriculture Organization of the United Nations | UNDP | UNEP

Spatial analysis to support REDD+ planning in Mongolia: Joint working sessions report

Working sessions convened as part of Mongolia's National UN-REDD Programme, October 2015 and March 2016



The working sessions covered in this report were organized by the Environmental Information Centre Division of the Information and Research Institute of Meteorology, Hydrology and Environment (IRIMHE) and the UN-REDD Mongolia Programme as part of Mongolia's National UN-REDD Programme.

The UN-REDD Programme is the United Nations Collaborative Initiative on Reducing Emissions from Deforestation and forest Degradation (REDD) in developing countries. The Programme was launched in 2008 and builds on the convening role and technical expertise of the Food and Agriculture Organisation of the United Nations (FAO), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP). The UN-REDD Programme supports nationally-led REDD+ processes and promotes the informed and meaningful involvement of all stakeholders, including Indigenous Peoples and other forest-dependent communities, in national and international REDD+ implementation.

The UN-REDD Programme provided technical support for this workshop from the United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC). UNEP-WCMC is the specialist biodiversity assessment centre of the United Nations Environment Programme (UNEP), the world's foremost intergovernmental environmental organization. The Centre has been in operation for over 30 years, combining scientific research with practical policy advice.

Should readers wish to comment on this document, they are encouraged to get in touch via:
Zagdaa Narangerel, IRIMHE: znarangerel@yahoo.com
Xavier de Lamo, UNEP-WCMC: xavier.delamo@unep-wcmc.org

Suggested citation:
Z. Narangarel, de Lamo, X., Hicks, C. and Guth, M. (2016) Spatial analysis to support REDD+ planning in Mongolia: Joint working sessions report. Working sessions convened as part of Mongolia's National UN-REDD Programme, October 2015 and March 2016, Information and Research Institute of Meteorology, Hydrology and Environment (IRIMHE), Ulaanbaatar. Prepared on behalf of the UN-REDD Programme. UNEP World Conservation Monitoring Centre, Cambridge, UK.

Acknowledgements:
With thanks for input and comments from the participants: M. Bayasgalan, N. Lkhamsuren, G. Batkhishig, N. Gandoljin, B. Nyamsuren, G. Nandin-Erdene, Z. Narangerel, B. Khishigsuren, R. Otgonchimeg, Byambatseren, Kh. Khadbaatar, T. Altantsetseg, E. Munkhjargal, G. Oyunkhuu, M. Undraa, Baljinniyam, Elbegjargal, Undrakh, Amanjol and Batchimeg. Thanks also to Will Simonson and Lera Miles (both UNEP-WCMC) for their review of this report.

Report

Spatial analysis to support REDD+ planning in Mongolia: Joint working session report

Working sessions convened as a part of Mongolia's UN-REDD National Programme, October 2015 and March 2016

Information and Research Institute of Meteorology, Hydrology and Environment (IRIMHE), Ulaanbaatar

Report compiled by: Zagdaa Narangerel (IRIMHE), Charlotte Hicks (UNEP-WCMC), Xavier de Lamo (UNEP-WCMC) and Miriam Guth (UNEP-WCMC)

UNEP WCMC

Contents

Acronyms and abbreviations

AFOLU	Agriculture, Forestry and Land Use sector
ALAGAC	Administration of Land Affairs, Geodesy, and Cartography
DBH	Diameter at breast height
DEM	Digital Elevation Model
EIC	Environment Information Center
ES	Ecosystem services
FRDC	Forest Resources Development Center
GHG	Greenhouse gas
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
IPCC	International Panel on Climate Change
IRIMHE	Information and Research Institute of Meteorology, Hyrology and Environment
IUCN	International Union for Conservation of Nature
KBA	Key Biodiversity Area
MEGDT	Ministry of Environment, Green Development and Tourism
MNET	Ministry of Nature, Environment and Tourism
NFI	National Forest Inventory
NGO	Non-government organization
NTFPs	Non-timber forest products
REDD+	Reducing Emissions from Deforestation and Forest Degradation; 'plus' Conservation of forest carbon stocks, sustainable management of forests; and enhancement of forest carbon stocks
UNEP-WCMC	United Nations Environment Programme World Conservation Monitoring Centre

Executive Summary

This report presents the outcomes of two joint technical working sessions on spatial analysis using QGIS to support REDD+ planning in Mongolia. The purpose of the sessions was to build the capacity of the Information and Research Institute of Meteorology, Hydrology and Environment (IRIMHE) and staff from other key national organisations in the use of spatial information to support REDD+ planning, with a focus on the multiple benefits of REDD+. The sessions introduced the use of QGIS, a free, open-source GIS software package, as well as other tools, and enabled the participants to contribute to the spatial analyses that will become the final products of this collaboration.

The sessions were held as part of a wider collaboration between the Mongolian Ministry of Nature, Environment and Tourism (MNET), the Institute for Research and Information on Meteorology, Hydrology and Environment (IRIMHE), and the UNEP World Conservation Monitoring Centre (UNEP-WCMC), which aims to develop capacity to use spatial decision-support tools for REDD+ planning in Mongolia. This work was initiated in response to a 'targeted support' request from Mongolia to the UN-REDD Programme. Both working sessions included more than 20 participants from IRIMHE and other national-level organizations, and a representative from each focal aimag (province) for the project, Tov and Khovsgol.

In addition to building capacity in QGIS and the use of spatial analysis to support REDD+ planning, the sessions saw the participants produce a series of draft maps related to REDD+ planning and multiple benefits at the national and aimag scales, which are intended to feed into Mongolia's REDD+ planning process. These maps explore forest cover and forest cover change, pressures on forests such as wildfire and mining concessions, and biodiversity, as well as the priority benefits identified by the two aimags, including the role of forests in water regulation and supplying timber and fuelwood.

Another a key outcome of the sessions and consultations was an improved understanding of the availability and applicability of spatial datasets in Mongolia relevant to REDD+ planning and an initial list of potential multiple benefits of REDD+ relevant to the country, based on consultations held with stakeholders in each of the focal aimags.

1. Introduction

1.1 Overview

This report presents the outcomes of two joint working sessions held in Ulaanbaatar in October 2015 and March 2016. The working sessions were among a number of connected events organized under Mongolia's UN-REDD National Programme, consisting of the two working sessions and two consultation workshops held in Murun (capital of Khovsgol aimag) and Zuunmod (capital of Tov aimag) in November 2015. The outcomes of these consultation workshops at the aimag (provincial) level are documented in a separate report. A report back meeting in November 2015 shared the progress made with representatives of the Department of Forest Policy and Coordination.

Mongolia became a partner country of the UN-REDD Programme in June 2011, and is the first country with significant boreal forest cover to join the Programme. Mongolia's large land area includes approximately 18 million hectares of forest[1], which can be broadly categorized as boreal forests in the north and Saxaul forests in the south. In 2014, Mongolia released a National REDD+ Readiness Roadmap, which it is now implementing.

The working sessions and consultations are part of a wider collaboration between the Mongolian Ministry of Nature, Environment and Tourism (MNET), the Institute for Research and Information on Meteorology, Hydrology and Environment (IRIMHE), and the UNEP World Conservation Monitoring Centre (UNEP-WCMC). This collaboration aims to support the implementation of Mongolia's REDD+ Readiness Roadmap by developing capacity to use spatial decision-support tools for REDD+ planning. This work was initiated in response to a 'targeted support' request from Mongolia to the UN-REDD Programme

The purpose of the joint working sessions was to develop capacity of both national-level and provincial-level participants in the use of decision support tools for REDD+ planning, with the aim of enhancing potential benefits from REDD+ and reducing potential risks. The working sessions also introduced QGIS, a free, open-source software package, as well as approaches for using QGIS and other tools, in order to create maps relevant to REDD+ planning, with a focus on exploring the multiple benefits from retaining, restoring and better managing forests (see Box 2 below).

Held over 26-30 October at IRIMHE in Ulaanbaatar, the first working session involved 20 participants (17 women, 3 men), many with a technical background and experience in spatial planning, including staff from IRIMHE's various divisions, as well as other national organisations involved in forest, environmental and land-use planning, such as GIZ, Administration of Land Affairs, Geodesy, and Cartography (ALAGAC) and the Botany Institute. A representative from each focal aimag, Khovsgol and Tov, also attended the session (lists of participants are provided in Annex 2).

[1] Global Forest Resources Assessment 2015: Mongolia (http://www.fao.org/3/a-az278e.pdf)

Box 2: What are multiple benefits of REDD+?

While the main objective of REDD+ is to protect and enhance the carbon stored in our forests, REDD+ also has the potential to deliver multiple benefits beyond carbon. These benefits may be environmental, social and political.

For example, it can promote biodiversity conservation and secure ecosystem services from forests such as water regulation, erosion control and non-timber forest products. It can also lead to improved livelihoods for forest-dependent communities and clarified tenure over forest lands.

The second working session was also held at IRIMHE, over 7-16 March 2016. It had two parts: first a formal session involving 13 participants (8 women, 5 men) from a range of organizations[2], and from each focal aimag; followed by a smaller and more informal working group that focused on finalizing some of the analyses. Many of the participants had already attended the first working session in 2015.

1.2 Objectives

The main objectives of the working sessions were: a) to build capacity of IRIMHE and staff from other key national organisations in the use of spatial information to support REDD+ planning, with a focus on multiple benefits and other planning elements; and b) to introduce QGIS and other free software tools to create maps relevant for REDD+ planning.

An associated objective was to understand and set priorities for analysis on the priority benefits from forests at the aimag level, in Tov and Khovsgol. This was achieved through the consultations held in the two focal aimags (outcomes presented in a separate report).

2. Topics covered

The agendas for the sessions are provided in Annex 3; the main topics and issues covered during the working session are summarized below. Presentations, tutorials and other workshop materials are available online.

2.1 Introductory session

The first working session began with welcoming remarks, introductions and a presentation of background information on REDD+ in Mongolia, including the REDD+ Readiness Roadmap and National Programme (by Dr Enkhstetseg Bato-Chir, UN-REDD Targeted Support Coordinator).

This was followed by an overview of the project and the role of spatial analysis in supporting REDD+ planning, particularly for planning to enhance the benefits and reduce the risks of

[2] Including IRIMHE, GIZ, the Green House Gas Inventory Unit, ALAGAC, the Botany Institute the Forest Research and Development Centre, MEGDT (now MNET), the Mongolia UN-REDD Programme Management Unit (PMU).

REDD+ actions. After brainstorming types of benefits and risks associated with a particular REDD+ action (increased enforcement to address illegal logging), the participants did a group exercise, using transparent map layers (from Tanzania) to identify priority areas for REDD+ site actions. Divided in three groups, they selected the most relevant spatial data to identify priority areas for three different REDD+ actions: 1) restoration of degraded forests; 2) improve management of existing protected areas; and 3) improve control and management of wildfires. The results of the activity are shown in Table 1 below.

Table 1: Results of group exercise

	Group 1	Group 2	Group 3
REDD+ action being considered	Restoration of degraded forest	Improve management of existing protected areas	Improve control and management of fire
Basemap selected & why	Restoration potential	Land cover and land use map Because land use category is important for management	Forest cover map Because it covers most of the map/area of the country (biomass stock of natural forest)
Layers selected & why	**Fire occurrence** → To identify areas for reforestation **Soil erosion** → If there is fire, soil erosion will occur **Non-timber forest products** → It improves forest-related livelihoods **Participatory forest management** → Potential to facilitate reforestation (preservation, protection) **Wildlife corridors** → To improve biodiversity	**Land use, land cover** → as base map **Protected areas** **Wildlife corridors** **Population density** **Carbon stocks** **Soil erosion** **Road map** **Gas, oil exploration** → Because these data are relevant for protected area management.	**Population map** **Fire occurrence** **Protected areas** **Non-timber forest products** **Forest user group/ participatory management**
Data unavailable that would have been useful	- Tree species distribution map - Climate data (precipitation) - Livestock density	- Control/enforcement points - Surface water and waterbodies - Electricity resources/network - Cultural areas, tourism map	- Wildlife corridor and habitat - Groundwater data

Photos: Group exercise using transparent maps




2.2 Introducing QGIS

After a short introductory presentation on QGIS, the participants worked in pairs through a first tutorial, an introduction to QGIS. This involved exploring the data, projection settings, adding and removing layers, and changing the symbology of a map, as well as installing plugins, querying data, joining tables, using the processing toolbox, and creating map layouts.

Given the general high level of existing skill among the participants in other GIS packages (e.g. ArcGIS), the activities included a focus on highlighting the differences and similarities between both platforms in carrying out some of the tasks explained in the tutorial. This tutorial and the rest of learning materials were provided in Mongolian and English, and there is an interest in distributing these further, as there is demand for the use of QGIS at various levels in Mongolia.

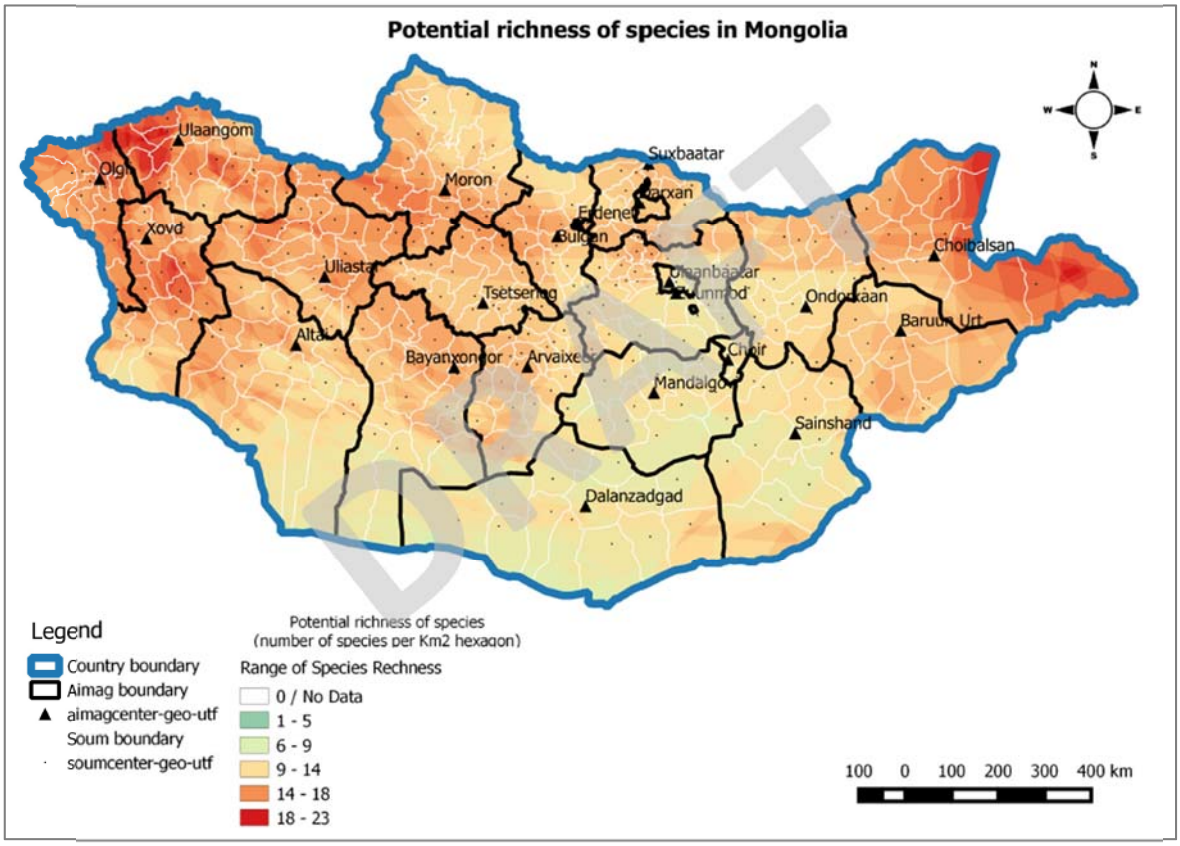
Photos: Working on introductory tutorial

2.3 Mapping areas important for biodiversity

Both the first and second working sessions included exercises to identify and map areas important for biodiversity conservation. Together, we identified a number of datasets, spatial and otherwise, that could be used to present information about Mongolia's biodiversity, including data on species distribution and population, habitats, non-timber forest products (NTFPs), international datasets such as Important Bird Areas, and hunting data (see summary in Box 3 below).

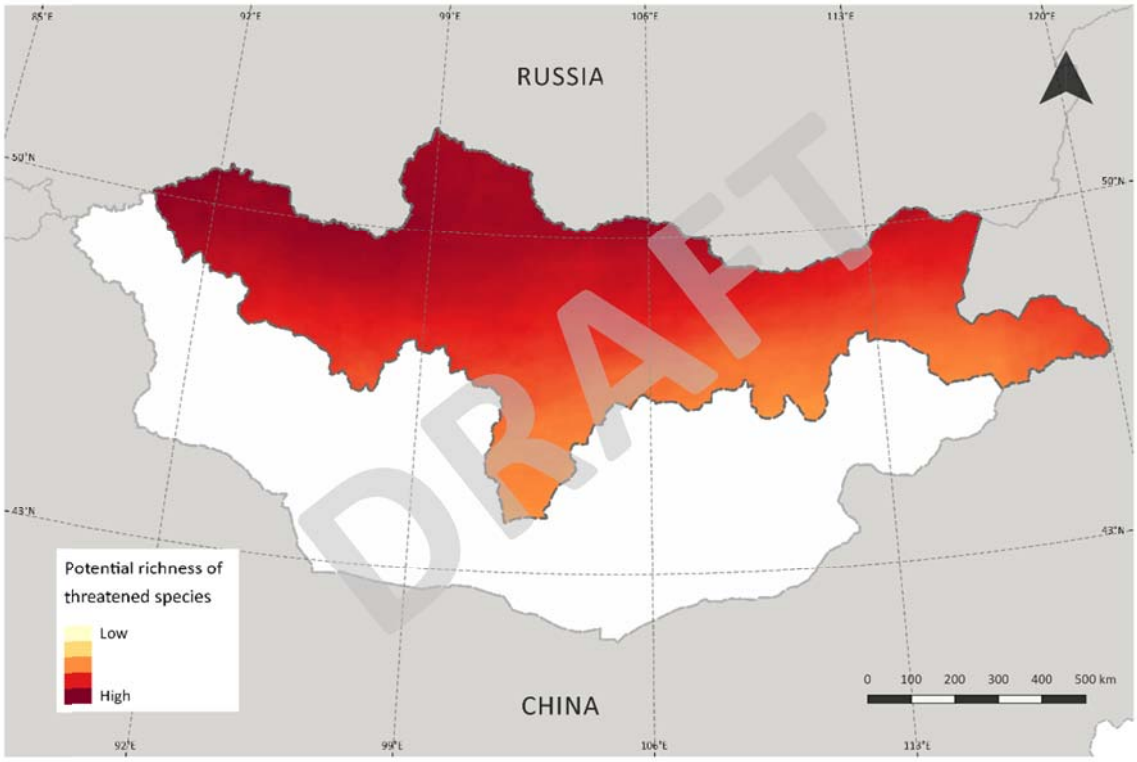
Global species' range of occurrence data was introduced, along with where it is sourced (the IUCN Red List of Threatened Species http://www.iucnredlist.org/) and the permissions required to use this data. In the first session, the participants worked through a tutorial on processing species range data in order to produce a threatened species richness map for Mongolia. The species data requested included: Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) and Least Concern (LC) species of terrestrial mammals, birds, amphibians and reptiles. Map 1 below is a sample of the output of this activity, showing threatened species richness across the country, ranging from low values in green/yellow to high values in red.

Map 1: Sample threatened species richness map output prepared in the working session, Oct. 2015



In the second session, participants worked through a similar process to refine the analysis for the forested aimags of Mongolia. The species selected this time were terrestrial mammals, birds, reptiles and amphibians, found in forest habitats in Mongolia, in the categories of Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) and Least Concern (LC). 181 species met these criteria. An example of the draft map output for all forest aimags is shown below (Map 2).

Map 2: Sample threatened species richness map output prepared in the working session, March 2016



Box 3: Biodiversity data in Mongolia

Biodiversity includes diversity at different levels, such as habitats, species, and genes. According to discussions during the working sessions, in Mongolia, there is currently data available on the following aspects of biodiversity:

Species:

- Species distribution: a database of around 1600 flora and 600 fauna species. Available in spatial form showing species ranges for around 160 species (from the IUCN Red List)
- Species populations: population database for key endangered species. The national database has aimag level data, which in principle is compiled from soum level data. Every soum has a land inspector and > 200 soums have an environmental inspector (if no environmental inspector, land inspector is responsible). However, to date we have not been able to identify or obtain access to this dataset.
- Red List data: two lists are used, the IUCN Red List, and the Mongolia Red Book.
- Forest species: a map of forest species distribution (wildlife).
- Species/population specific data, e.g. recent inventory of ungulates.

Habitats:

- Forest map: 2010 map with six forest classes
- Vegetation cover map
- Water and wetlands: landcover map includes lakes, rivers, riparian areas. A map is available showing Mongolia's six Ramsar Sites.
- Climate data is available, but no habitat suitability analysis has been done at this stage; plus digital elevation model (DEM) (i.e. elevation as an aspect of suitability)
- Protected areas: National level (99); Aimag level (300); Soum level (600)

Box 3: Biodiversity data in Mongolia, cont.

Habitats, cont:

- World Heritage sites: four sites, natural and cultural
- International data: can be used to complement, e.g. Key Biodiversity Areas and Important Bird Areas (from Birdlife International)

NTFPs:

Key NTFPs include: pine nuts; berries; mushrooms; medicinal plants (e.g. processed into tea in Khovsgol). NTFPs are important for local people, but there are limited studies on distribution/use. However, other data may be available, e.g. production data or harvesting permits. These are issued for private and commercial harvesting and are linked to forest area.

Utilization/threats:

- Hunting statistics: each aimag collects data on hunting, by species and volume/number killed. These come from inspectors at soum level. Includes legal and illegal hunting.
- Hunting zone map: shows areas for occurrence of certain species, and where it is legal to hunt. Hunting areas include private and public lands.

Migration/corridors:

Mongolia has some migratory species, mainly birds and fish. Fences often prevent movement of other species, e.g. large mammals. Some corridor areas have been set up (e.g. wildlife crossings, road crossings), but these are rarely demarcated or mapped. In Khovsgol and Tov, there are large areas of continuous forest, so corridors have not been needed.

Biodiversity offsets:
No information on this; land compensation usually paid to people but not aware of biodiversity offsets.

Inventory data:
National Forest Inventory (NFI) is currently being finalized and should include presence of Red-listed tree species. Also indicated will be presence of erosion impacts, soil type, etc. The 'forest taxation inventory' identifies forest type through remote sensing, then uses field work in some representative areas to check volume/density.

Mongolian takhi (Przewalskis horses, E. ferus, classified as endangered) in Khustai National Park. Photo: Charlotte Hicks, UNEP-WCMC.

2.4 Mapping carbon stocks

The first working session included a short introductory presentation about the different techniques used for mapping vegetation carbon density, and a discussion of the initial results of the Mongolia study on drivers of forest change, as well as on the types of data available in Mongolia related to land cover, land cover change and carbon stocks (see Box 4 below for more details).

In pairs, the participants then worked on some exercises related to carbon mapping, starting with a comparison of two international datasets. They made a map estimating carbon stocks in land cover classes, using some sample carbon values (based on International Panel on Climate Change (IPCC) default values) and Mongolia's 2010 and 2000 land cover maps.

The use of the Zonal Statistics plugin was demonstrated to explore the relationship between carbon density and different land class types, such as forest types, permafrost types, protected areas, soil types and mining areas. Participants noted that the forests with the highest potential carbon stocks were located in the north of the country (Map 3) and that mining concessions with the highest potential soil carbon density were also in the north (Map 4), highlighting this part of the country for further future analysis.

Box 4: Land cover and carbon stocks data in Mongolia

What data related to carbon stocks are available?

- NFI: will provide information on biomass, so will calculate average carbon values. Used 4,322 points to collect data on: forest areas; species; DBH; soil; slope; litter; impacts (e.g. grazing).
- Forest Taxation Inventory: held by FRDC. Information on: forest type (ca. seven classes); area; volume (density); DBH; age; management category; fire/pest impacts; timber quality.
- National GHG Inventory: under the Climate Change Office; next inventory due to be finished in 2017, including agriculture, forestry and land use (AFOLU) sector.
- Agro-meteorological stations: across country, measure grass biomass every month, dry and wet. Have not yet calculated carbon values.
- Biomass map: uses satellite images (NOA/MODIS) to create biomass map every 10 days, classified by biomass value.
- IPCC/global estimates of carbon values: default values only, not always a good match with Mongolian land cover classes.
- Soil type map: could be used for soil carbon map.
- Permafrost map: shows permafrost areas/types. Lack carbon values but Geoecology Institute working on this.
- Forest phytomass research: being conducted by Institute of Botany.

What are key drivers of land cover change?

Other than those identified in the Mongolian draft drivers study, participants noted:

- Urban expansion: may increase in future.
- Grazing.
- Agriculture: but limited by land suitability.
- Livelihoods dependent on forest exploitation: may increase in future.
- Mining identified, but disagreement about whether it will increase or decrease. Recognition that impacts can differ depending on type (e.g. small-scale vs large-scale; formal vs informal).

What spatial data is available on land/forest cover change?

- Current and past land cover and forest cover maps.
- Forest taxation inventory.
- Reforestation map: shows coordinates of tree planting sites.
- Desertification, fire maps: shows areas of change due to these drivers.

How is land/forest cover change analysis usually conducted in Mongolia?

- Using satellite images (MODIS, NOA, LANDSAT), processing software e.g. IDRISI, ENVI, ERDAS.
- Usually for creating statistical data and monitoring data, rather than maps.

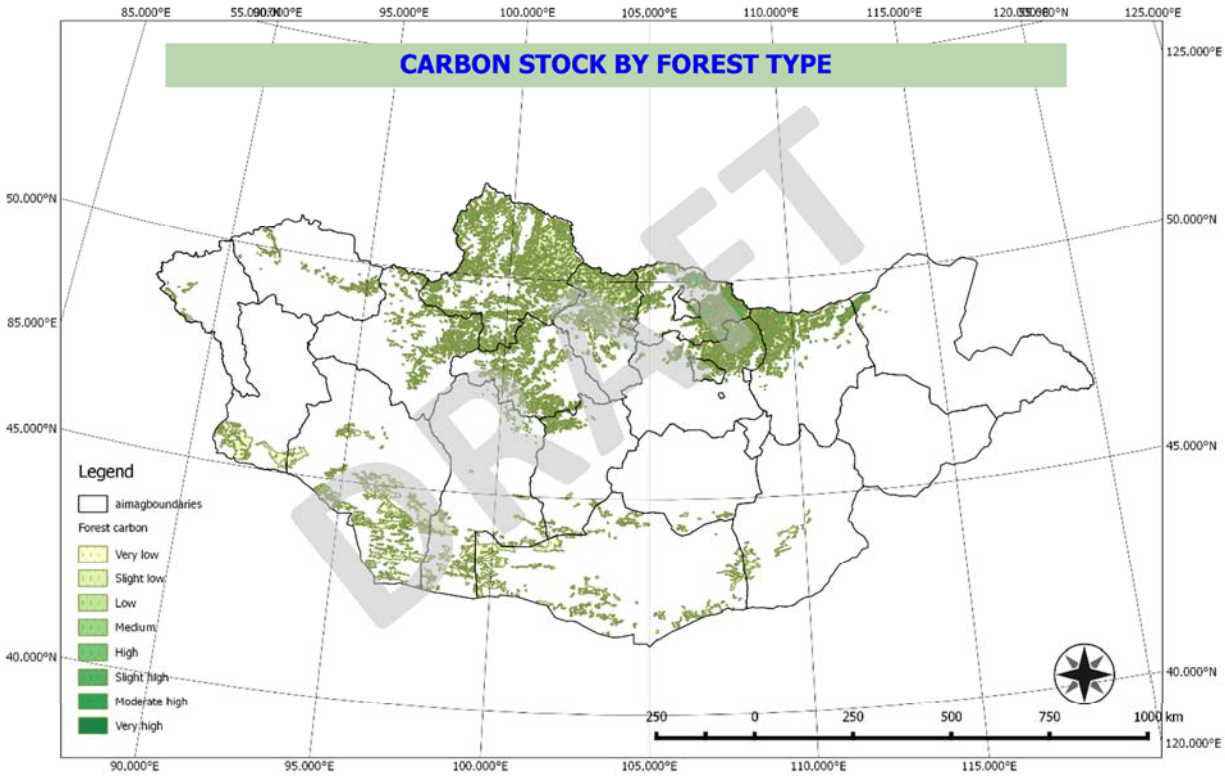
What about spatial data on drivers of change?

- Impacts: desertification map; fire map; insect distribution map.
- Reforestation map: areas that may become forest in future.
- Land cadastre map: shows land ownership.
- Spatial land use plans: done every year at soum level; every five years at aimag and national level; shows land suitability for agriculture, development and other uses.
- Mining areas map: official mine sites. (Illegal mining often around legal sites).
- Data on degraded land: includes land degraded by mining (legal & illegal).
- Grazing: carrying capacity map, based on real-time data.
- Pasture and hayland map: based on survey data. (Not clear whether this is for designated/legal pastureland or actual pastureland). ALAGAC also has fine scale pasture and grazing maps, including soil maps, pasture degradation and overgrazing maps.

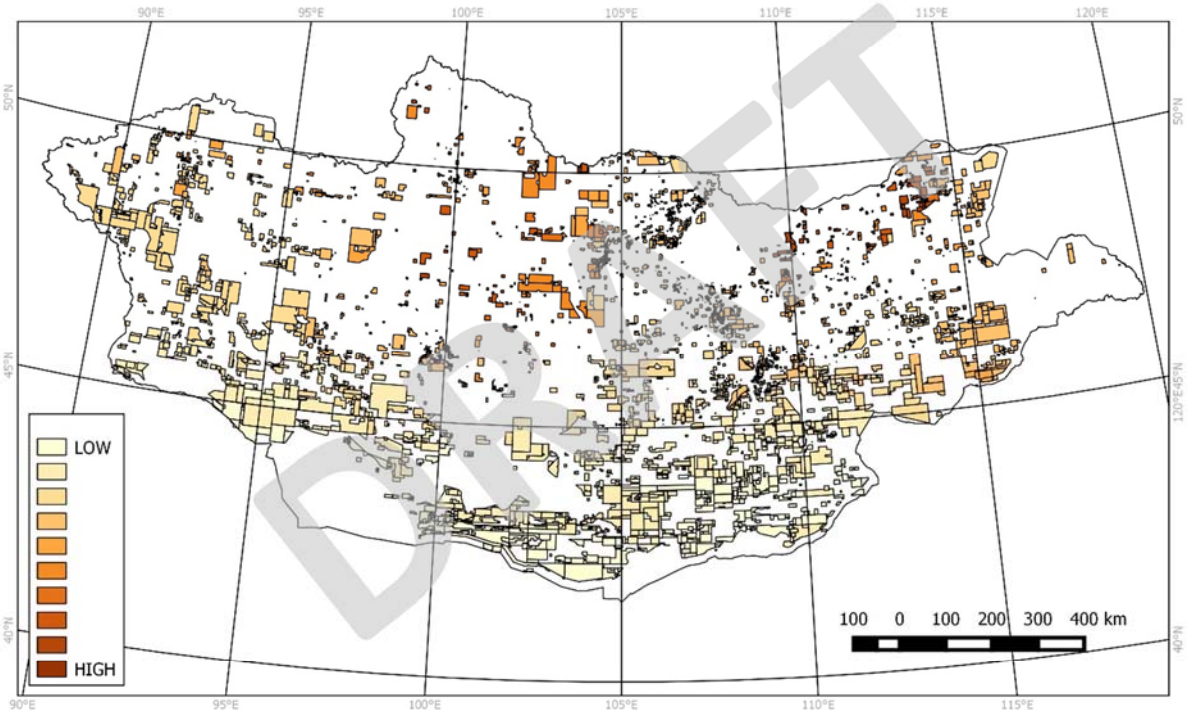
Are there additional types of information available in the aimags (Tov as example)?

- Key drivers in Tov: fire (more natural than human caused); illegal logging (people from outside local area involved). Note that key underlying forces can be outside the aimag, e.g. demand for forest products in the city drives illegal logging in Tov.
- Forest crime data is collected but without coordinates; may however record which soum.

Map 3: Sample map showing estimated carbon stocks in different forest types prepared during working session, Oct. 2015

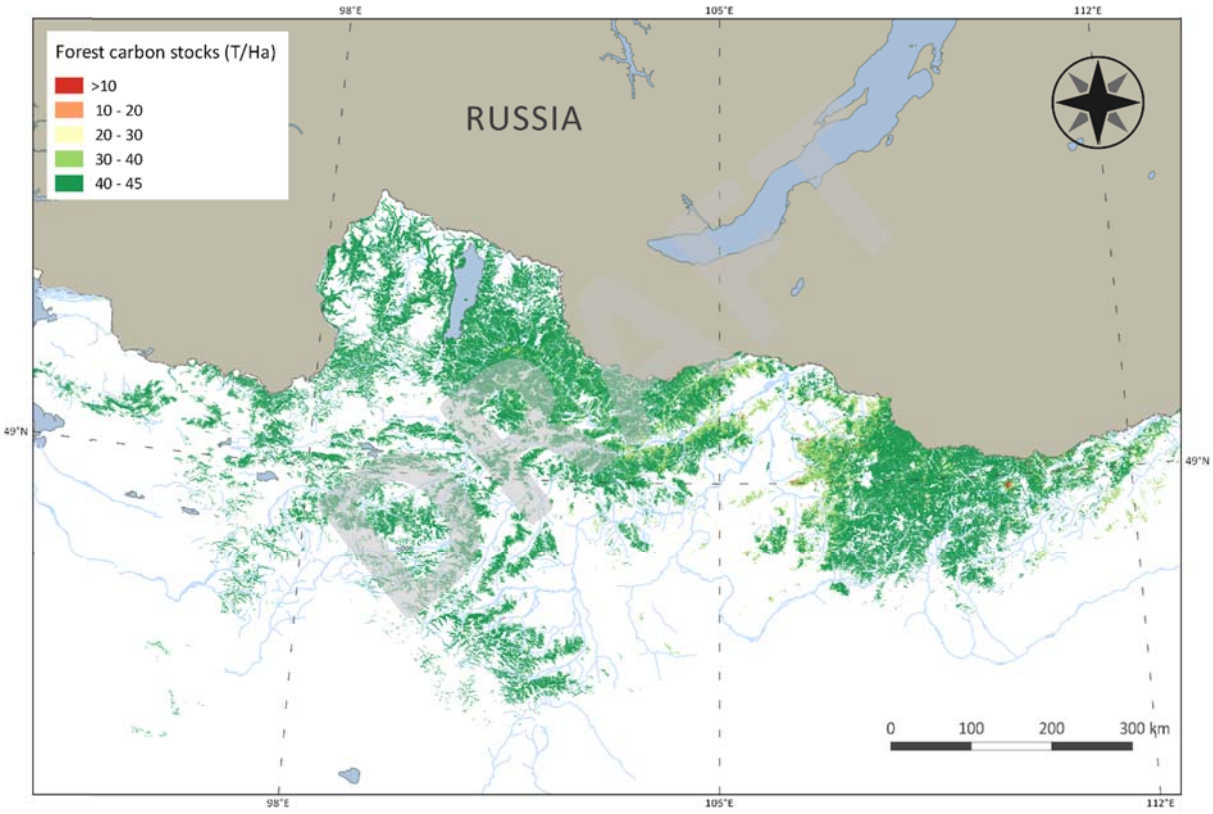


Map 4: Sample map showing relative concentration of soil carbon in the different mining areas of Mongolia, prepared during working session, Oct. 2015



During the second working session, workshop participants used field data on aboveground and belowground carbon from the 2015 Multipurpose National Forest Inventory of Mongolia to estimate averages carbon densities per forest type, using the forest type distribution map from the national taxation inventory (e.g. Map 5). Participants first explored how the QGIS plugin "Group Stats" can be used to compute statistical operations in vector files. A forest carbon shapefile was created by joining the results of the Group stats operation to the national taxation inventory.

Map 5. Sample map showing distribution of above and belowground living biomass of the boreal forests of Mongolia, prepared during Mar. 2016 working session



2.5 Analyzing change

During the first working session, we focused on looking at changes in land cover and carbon stock estimates, as we still did not have access to forest inventory data. The participants prepared an analysis of the change in carbon stocks over two periods, using the carbon density maps previously produced. Later on, a demonstration of the usefulness of the MOLUSCE was conducted.

MOLUSCE is a plugin for QGIS designed to analyze, model and simulate land-use changes useful for land-cover change analysis. Together we produced tables showing the areas of the land-cover classes, with increases and decreases in different categories. We produced a map of these changes, using a simplified categorization to show changes between seven broad classes.

During the second working session in March 2016, we began to use several different datasets to looks at change in Mongolia's forested aimags, especially in the focal aimags of Tov and Khovsgol:

- Landsat derived forest cover for 2000 and 2009;
- The Hansen dataset for tree cover loss, 2000-2014.
- The forest inventory data, including combined inventory data for forested aimags (2014) and the most recent taxation inventory data for the two aimags.

After working with the first two datasets to map forest cover change at the national level, we noted some differences between them, especially the extent of forest gain. We discussed the different forest definitions being used in Mongolia (e.g. remote sensing and taxation inventory) and the impact this can have on mapping forest extent. It was suggested to use the 2014 NFI data and the taxation inventories, as these are considered 'approved' by the Ministry.

The participants then began working with the forest taxation inventory data to map forest extent and quality in the two focal aimags. After fixing some problems in the data, in pairs, the participants reclassified the forests in each soum to try and build up a map of degraded and healthy forests. This work, as well as the analysis of potential for forest restoration, involved further discussion of the fields are included in the taxation inventory dataset, and in other forest datasets in Mongolia, and how these could help to classify forest as degraded vs healthy (see Annex 4).


2.6 Estimating the contribution of forest to water supply

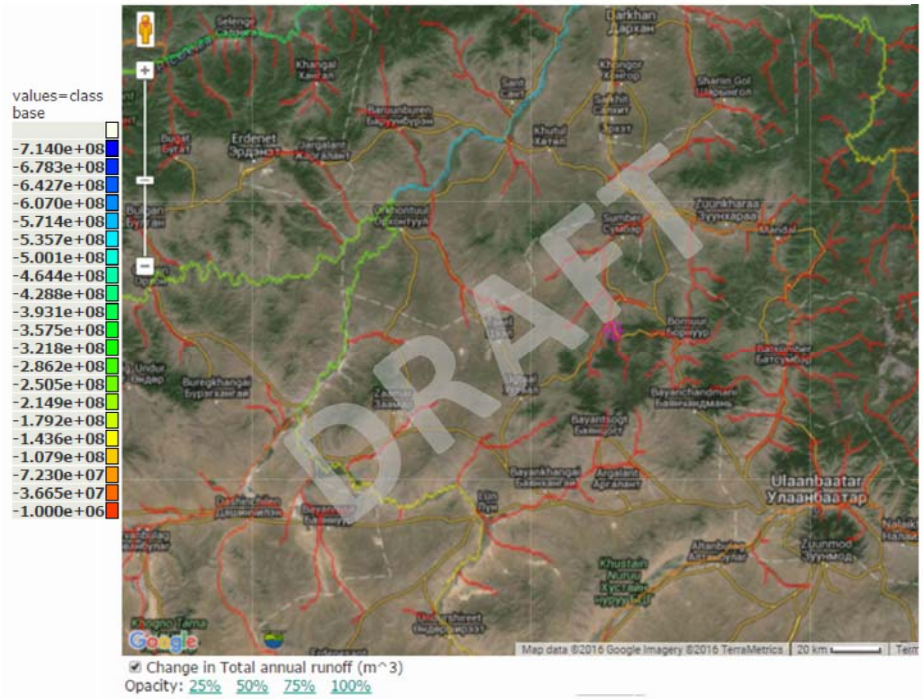
Results from the aimag consultation workshops held in November 2015 indicated that freshwater provision is one of the most valued services provided by forests. In order to analyze this service further, the March 2016 session included an introduction to WaterWorld (www.policysupport.org/waterworld), an open-access, online tool for spatial modelling of hydrological ecosystem services.

Following an introductory presentation and some discussion of concepts like water budgets and water balance, the participants used WaterWorld to assess the role of forests in local landscape water balance and runoff in Khovsgol and Tov aimags.

Photos: Left) Discussion of the key variables taken into account in the WaterWorld's water balance model. Right) Participant importing the WaterWorld outputs into QGIS.

They ran a 1-km resolution hydrological baseline analysis for both aimags and compared it to a scenario of "no tree cover". Preliminary analysis of results suggest that a reduction of forest cover would reduce water availability and total annual runoff as a result of a decrease in fog capture by the trees. In addition, we ran an alternative land use scenario, in which all non-forest areas were afforested, in order to show where afforestation or reforestation actions could have the largest positive impact on soil erosion reduction and water provision. This data is expected to feed into a more general analysis of potential opportunity areas for reforestation in Tov (please see section 2.7.3 below), noting that only a subset of areas would likely to be considered suitable for conversion to forest.

Map 6. Sample showing change in total annual runoff in Tov aimag in a scenario of total deforestation

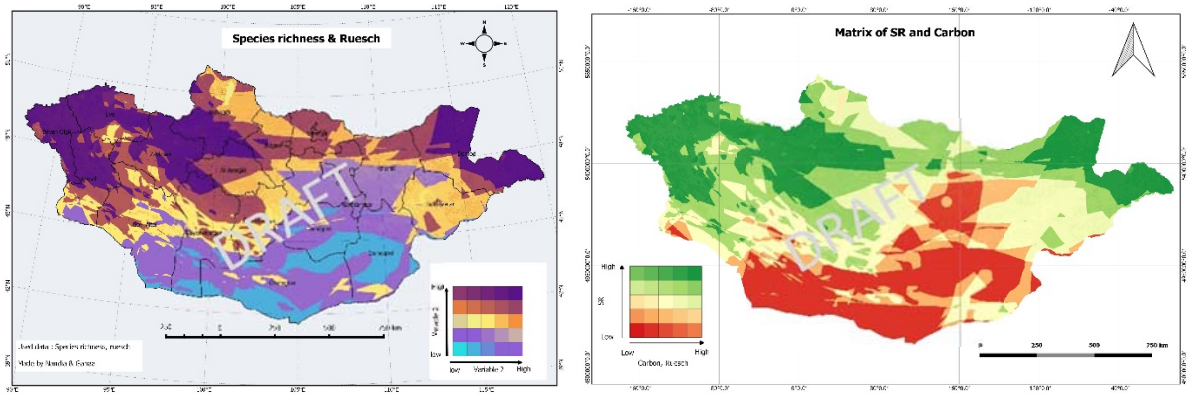


2.7 Developing workflows for spatial multi-criteria analysis

2.7.1 Matrix style map

The final exercise of the first working session aimed to show how different layers related to REDD+ multiple benefits can be combined through a matrix style map. Participants produced a map showing the level of potential species richness combined with the level of estimated carbon density. Deciding the best combination of colours was a challenge identified, which was followed up in the next working session (see examples of two matrix maps below).

Map 7: Examples of draft matrix style maps for estimated carbon stocks and species richness prepared during working session, Oct. 2015

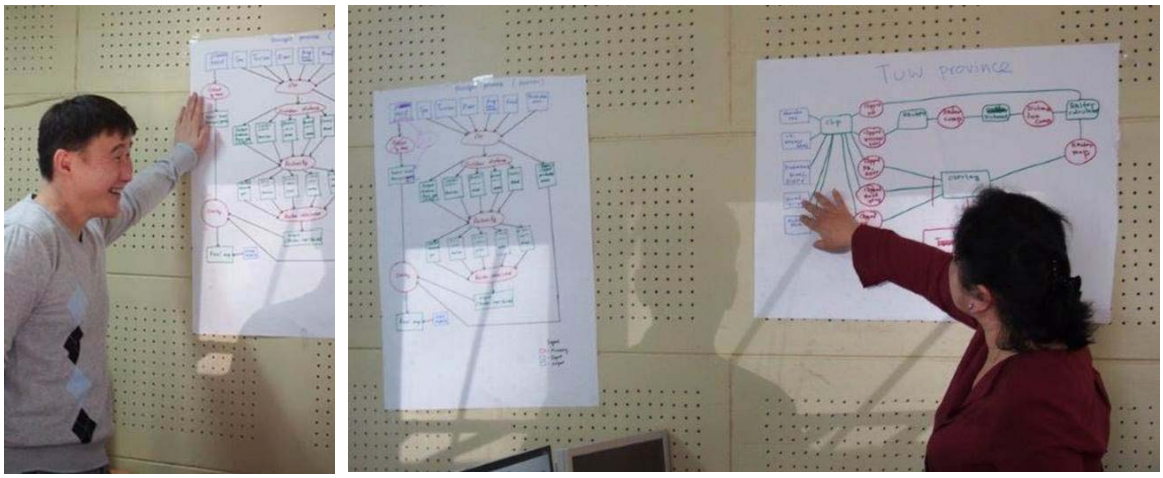


2.7.2 Areas important for timber, fuelwood and NTFPs

After an introductory presentation on developing spatial workflows in GIS mapping, workshop participants then put this into practice to begin to map forest areas important for tourism and recreation in Tov and Khovsgol. Working in groups, one for each aimag, participants began by defining the concepts in the map and identifying input layers. Each group then created workflow diagrams that could be used to develop the maps. During presentation of the workflows, some of the key issues raised were: which forest layer to use for forest cover? What distances count as close/far from forest for tourism sites? Are there sites that attract tourists regardless of distance (e.g. IBAs)? These discussions helped to clarify and refine the workflows to produce the final maps.

Photos: Creating spatial workflows to identify important forest areas for nature-based tourism and recreation

Photos: Presentation of the workflows



The participants then started to carry out the first workflow steps in QGIS, exploring at the same time the tools that QGIS has available to implement such steps.

2.7.3 Potential for restoration

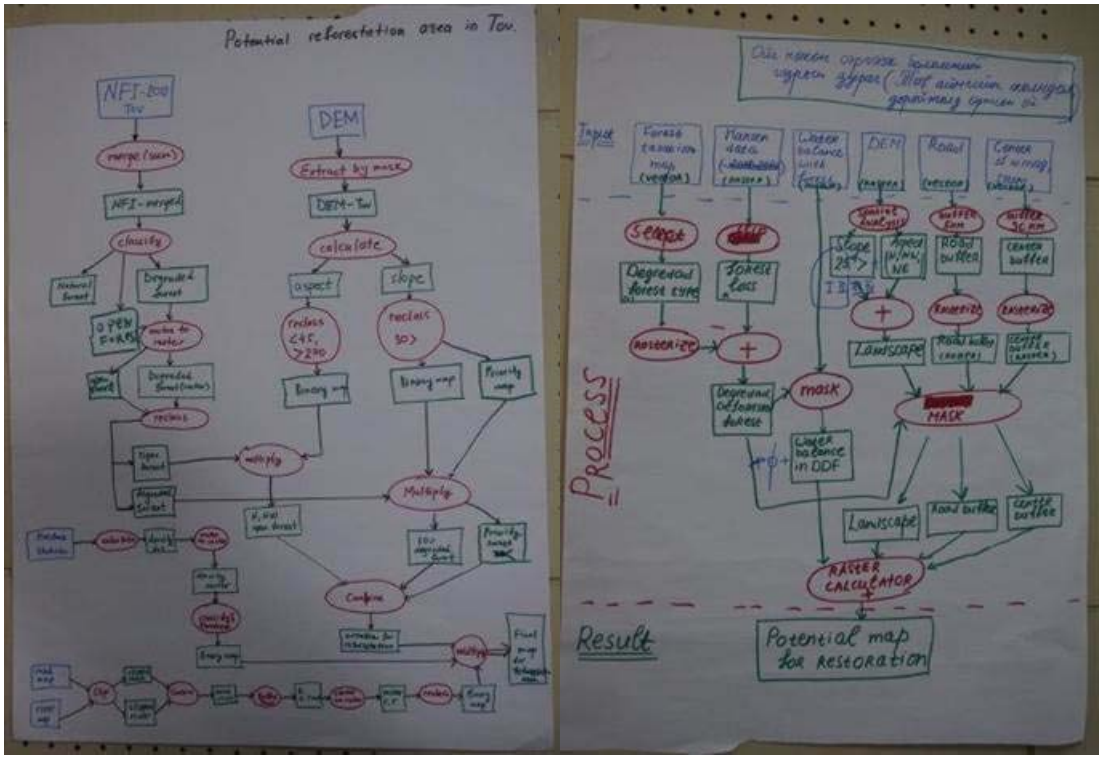
The session started with an introductory presentation on definitions, methods and criteria related to forest restoration and analysis to prioritize areas for restoration. This included discussion of some definitions used in Mongolia (e.g. for open and closed forest), as well as forest restoration activities as a part of REDD+, including the potential for multiple benefits and consistency with the Cancun safeguards.

The participants then split into two groups to develop workflows for a map showing areas with potential for forest restoration in Tov aimag. Each group discussed definitions, criteria to prioritize areas for restoration and input layers, and then created a diagram for their spatial workflow.

Some key elements included identifying degraded and deforested areas, using biophysical criteria such as slope and aspect, and social/economic/political criteria, such as proximity to population centers, roads and livestock density. One group also suggested using the WaterWorld output on water balance to identify areas where reforestation may have benefits for water supply, as it was highlighted as a particularly key benefit of forests in the aimag.

Photos: Developing and presenting spatial workflows on potential opportunity areas for forest restoration.

Fig. 1: Draft spatial workflows produced by the groups.



Closing the sessions

Both working sessions closed with a recap of the layers produced and a discussion of proposed next steps. The participants also completed feedback forms about the working session, the results of which are provided in Annex 5.

Photo: Working session participants, Oct. 2015

3. Report-back meeting, November 2015

4.1 Overview

Held directly after the completion of the consultation workshops, the report-back meeting took place on 9 November 2015 at the Department of Forest Policy and Coordination, MEGDT (now MNET), in Ulaanbaatar. The meeting included Mr Tsesed Banzaragch (Director of the Department), Mr Khishigjargal Batjantsan, Mr Bilguun Oyuntsetseg, Mr D. Jagdag and Mr B. Otgonsuren (specialists from the Department), along with staff from IRIMHE and UNEP-WCMC.

4.2 Objectives

i. Report-back to the Director and other representatives of the Department of Forest Policv and Coordination on the outcomes and outputs of both the technical working session on spatial planning for REDD+ multiple benefits and the consultation workshop on the priorities for multiple benefits at the aimag level.

ii. Discuss the timeline and next steps for spatial analysis work to support REDD+ planning in Mongolia.

4.3 Presentations

Charlotte Hicks (UNEP-WCMC) provided a brief background of the 'targeted support' project and outlined the objectives of the technical working session and the participatory workshops.

Xavier de Lamo (UNEP-WCMC) then explained the structure of the working session and the topics covered during the week, while also presenting some sample draft outputs of the session to give the meeting participants an idea of the type of analyses that were carried out. Charlotte then gave an overview of the topics covered in the two participatory workshops in Khovsgol and Tov, and briefly explained the list of priority multiple benefits identified by the participants. She then introduced the proposed next steps for the collaboration, such as finalization of spatial layers and preparation of a report on the working session. Charlotte and Xavier also shared the draft list of the analyses to be produced through the remainder of the targeted support.

4.4 Discussion

The meeting including discussion on the outcomes of the working session, next steps, similar studies that could contribute to the project's future work, and more general issues related to REDD+ and multiple benefits. Some comments from the attendees included:

- Recommendation to make full use of the NFI data, produced together with support from GIZ.
- Recommendation to incorporate relevant information from the forest sector valuation and financial flows study, conducted by the UN-REDD Programme and partners in 2013.
- Noting that the project's outputs are expected to be very useful for REDD+ decision-making, especially in the context of the upcoming establishment of a multi-sector REDD+ Taskforce (likely early next year).

Charlotte and Xavier noted plans to make use of the NFI data as far as possible and undertook to explore further the economics study. They also responded that we would like to make the outputs as useful and as relevant as possible for future REDD+ planning, and would welcome any suggestions and feedback to facilitate this. As part of this process, the final draft list of analyses will be shared with key staff in MNET, UN-REDD PMU and IRIMHE for their comments.

ANNEX 1: Proposed list of analyses for project, Nov. 2015

NATIONAL/FORESTED AIMAG SCALE ANALYSES

	MAP	DATA REQUIREMENTS	POTENTIALLY USEFUL DATASETS	AVAILABILITY
1	Forest cover change	Forest cover maps from two periods of time, using same imagery and methodology	Landsat-derived forest cover maps for the years 2000-2010 Hansen dataset National forest inventory (2014)	Yes. Available at EIC Yes? Check with GIZ.
2	Vegetation carbon density	Average aboveground carbon density values for different vegetation types of Mongolia	Possibly GIZ, otherwise GHGI values if available	Not yet available. Check again in early 2016.
3	Relationship between forest cover change and protected areas	Forest cover maps from two periods of time, using same imagery and methodology; protected area boundaries	Protected area boundaries Forest cover datasets (see 1)	Yes. Available from EIC. See above.
4	Relationship between forest cover and mining areas	Forest cover maps from two periods of time, using same imagery and methodology; Mining areas for the same periods of time.	Mining areas for the years 2000 and 2010 from the Mining Cadastre database. Forest cover datasets (see 1)	Mining areas for 2000; 2010 may be available at EIC as well. See above.
5	Threatened species richness	Species range data for all forested aimags	IUCN species range data	Yes. Free international dataset.

AIMAG SCALE ANALYSES

AIMAG	MAP	DATA REQUIREMENTS	IDENTIFIED DATASETS	AVAILABILITY
Both	Forest extent and state	The most recent forest inventory data	The most recent forest taxation inventories for all soums of Khovsgol and Tov aimags	Need to request from FRDC.
Both	Carbon density	Average carbon density values for different vegetation types in Khovsgol and Tov	Forest cover data; Average aboveground biomass/carbon values	Yes. Not yet available. See 2.

Both	Importance of forest for tourism and recreation	Spatial location of all points of tourist interest Forest status	Aimag scale tourism maps. Tourism map of Mongolia at 1000000 Statistics of number of tourist per year at soum level.	Check whether use aimag scale or national scale tourist data
Both	Importance of forest for water supply	None, the model that will be used (WaterWorld) can use already available data 1km scale resolution (Good internet connection is required)	See previous box.	Yes.
Khovsgol	Importance of forest for timber and firewood provision	Data or proxies relating to extraction of timber and firewood Map of main cities, towns and villages. Map of roads and main pathways. Forest status	Most up-to-date statistics of firewood and timber production/demand at soum level Most up-to-date data on number of timber and firewood extraction permits at soum level. Forest taxation inventory data Results of participatory mapping	Maps or urban centers and roads and pathways available at EIC website. Statistics on timber/firewood production and permits seems to be available at the soum level.
Khovsgol	Importance of forest for recreation in springs/rest areas	Locations of springs/rest areas Forest status	Tourism map showing springs Forest taxation inventory data Results of participatory mapping	Yes. Checking whether national or aimag level data most suitable
Khovsgol	Importance of forest for NTFPs provision	Data or proxies relating to extraction of NTFP Map of main cities, towns and villages. Map of roads and main pathways. Forest status	Statistics of production/demand of the most important NTFPs at soum level Data on number of NTFP extraction permits at soum level. Forest taxation inventory data	Maps or urban centers and roads and pathways available at EIC website. Statistics on NTFP production and permits seems to be available at the soum level.
Tov	Potential opportunity areas for forest restoration (including natural regeneration)	Forest inventory data at soum level for at least 2 years to identify deforested/degraded areas.	Forest taxation data for at least two years: the most up-to-date one and the oldest digital version	

		Areas affected by forest fires/pests/illegal logging in the last years. Areas prioritised for restoration	Results of participatory mapping Biodiversity/wildlife areas (?)	IUCN Red List data already available, but should explore if other, finer scale data can be available at the aimag/soum level.
Tov	Importance of forest for firewood provision	Data or proxies relating to extraction of timber and firewood Map of main cities, towns and villages Map of roads and main pathways. Forest status	Most up-to-date statistics of firewood and production/demand at soum level Most up-to-date data on firewood extraction permits at soum level Forest taxation inventory data Results of participatory mapping	Maps or urban centers and roads and pathways available at EIC website. Statistics on firewood production and permits seems to be available at the soum level.
Tov	Importance of forest for biodiversity and wildlife habitat	Species distribution data at the finest scale possible.	Species census data at the soum level (at least available for mammals) Species distribution (?) from Mongolia's Red Book of endangered species.	IUCN RED List data already available, but should explore if other, finer scale data can be available at the aimag/soum level.

ANNEX 2: Participants lists

2.1 Participants, October 2015 working session

No.	Name	Organization/position
1	M. Bayasgalan (f)	Head of EIC
2	N. Lkhamsuren (f)	GIS specialist, EIC
3	G. Batkhishig (f)	Administrator of environmental database, EIC
4	N. Gandoljin (f)	GIS specialist, EIC
5	B. Nyamsuren (m)	Programmer, EIC
6	G. Nandin-Erdene (f)	RS/GIS specialist, Remote Sensing Division, IRIMHE
7	Z. Narangerel (f)	Forest database specialist, EIC
8	B. Khishigsuren (f)	GIS specialist, GIZ
9	R. Otgonchimeg (f)	ALAGAC
10	Byambatseren (m)	Forest engineer, Mungunmorit Forest unit, Tov aimag
11	Kh. Khadbaatar (m)	Senior specialist, Forest Department of the Nature Environment and Tourism Office, Khovsgol aimag
12	T. Altantsetseg (f)	Engineer Meteorology sector, IRIMHE
13	E. Munkhjargal (f)	Environmental research sector, IRIMHE
14	G. Oyunkhuu (f)	Water sector, IRIMHE
15	M. Undraa (f)	Botany Institute
16	Baljinniyam (f)	Climate sector, IRIMHE
17	Elbegjargal (m)	RS/GIS specialist, Remote Sensing Division
18	Undrakh (f)	Programmer, EIC
19	Amanjol (f)	RS/GIS specialist, Remote Sensing Division
20	Batchimeg (f)	Programmer, EIC
Organizers		
1	Charlotte Hicks (f)	UNEP-WCMC
2	Xavier de Lamo (m)	UNEP-WCMC
3	Z. Narangerel (f)	Forest Specialist, EIC
4	B. Khongorzul (f)	Programmer/Translator, EIC
5	O. Urangoo (f)	Assistant, EIC
6	U. Erdenebold (m)	Assistant, EIC

2.2 Participants, March 2016 working session

N	Name	Organization/position	M/F	Attended Oct. '15 session?
1	Z. Narangerel	Forest database specialist, EIC	F	y
2	G. Batkhishig	Administrator of Environmental database, EIC	F	y
3	N. Gandoljin	GIS specialist, EIC	F	y
4	G. Nandin-Erdene	RS/GIS specialist, Remote Sensing Division, IRIMHE	F	y
5	B. Khishigsuren	GIS specialist, GIZ	F	y
6	R. Otgonchimeg	ALAGAC	F	y
7	Byambatseren	Forest engineer, Mungunmorit Forest unit, Tov aimag	M	y
8	Kh. Khadbaatar	Senior specialist, Forest Department of the NET Office, Khovsgol aimag	M	Y
9	M. Undraa	Forest researcher Botany institute, MAS	F	Y
10	B. Khosbayar	Forest mapping specialist, FRDC	M	N
11	E. Erdenekhuu	Forest mapping specialist, MNEGDT	M	N
12	Ts. Khongor	UN-REDD	M	N
13	Sanaa Enkhtaivan	GHG Inventory team, CCPIU	F	N
Facilitators/organizers				
14	Charlotte Hicks	UNEP-WCMC	F	Y
15	Xavier De Lamo	UNEP-WCMC	M	Y
16	Richard Metcalfe	International Consultant NFMS and RELs, UN-REDD	M	N
17	B. Khishigjargal	Program manager, UN-REDD	M	N
18	B. Khongorzul	Translator, from EIC	F	Y
19	Munhchimeg	IT engineer from EIC	F	Y

ANNEX 3: Working session agendas

3.1 October 2015 session

Time	Activity	Presenter/facilitator
	DAY 1 – 26 October	
09:00 – 09:20	Welcoming remarks	Ms Bayasgalan (EIC)
09:20 – 09:40	Introductions & ice-breaker	Charlotte (UNEP-WCMC)
09:40 – 10:00	Overview of objectives and agenda	Xavier (UNEP-WCMC)
10:00 – 10:30	Presentation: Introduction to REDD+ in Mongolia	Enkhtsetseg Bato-chir
10:30 – 11:00	*Coffee/tea break*	
11:00 – 11:30	Presentation: Role of spatial information in supporting REDD+ planning	Charlotte (UNEP-WCMC)
11:30 – 12:30	Group exercise: REDD+ benefits & risks, and prioritising areas for REDD+ actions	Charlotte & Xavier (UNEP-WCMC)
12:30 – 13:30	*Lunch*	
13:30 – 14:30	Group exercise, cont, and report back	
14:30 – 15:00	Presentation: Introduction to QGIS	Xavier (UNEP-WCMC)
15:00 – 15:30	Distribution of USB sticks	
15:30 – 16:00	*Coffee/tea break*	
16:00 – 17:30	Checking installation Start introductory tutorial	Xavier & Charlotte (UNEP-WCMC)
	DAY 2 – 27 October	
09:00 – 10:30	• Tutorial: Introduction to QGIS *This tutorial will introduce QGIS and will show how open-source software can be used to undertake spatial analysis of datasets of relevance to planning, multiple benefits and environmental safeguards for REDD+. It includes a series of exercises/steps to practice using key QGIS functions.*	Xavier & Charlotte (UNEP-WCMC)
10:30 – 11:00	*Coffee/tea break*	
11:00 – 12:30	Continue work on introductory tutorial	
12:30 – 13:30	*Lunch*	
13:30 – 15:30	Continue work on introductory tutorial	
15:30 – 16:00	*Coffee/tea break*	
16:00 – 17:30	What are the important areas for biodiversity? • Discussion: what spatial data on biodiversity in Mongolia is available?	Charlotte (UNEP-WCMC)
	Day 3 – 28 October	
09:00 – 10:30	Biodiversity, cont. • Species richness tutorial: *This tutorial will show how IUCN Red List data and related datasets can be extracted and processed to represent the potential species richness of forest and other habitats in QGIS.*	Xavier & Charlotte (UNEP-WCMC)
10:30 – 11:00	*Coffee/tea break*	
11:00 – 12:30	Continue mapping species richness	
12:30 – 13:30	*Lunch*	
13:30 – 15:30	Continue mapping species richness	
15:30 – 16:00	*Coffee/tea break*	

16:00 – 17:30	Species richness mapping cont.	
	DAY 4 – 29 October	
09:00 – 10:30	Where is carbon located? • Discussion of approach and methods (e.g. density values, global datasets) • Carbon mapping tutorial *This tutorial will show how spatial analysis can be used to represent the relative distribution of carbon stocks among forest types and different land categories (i.e. protected areas, mining concessions, etc.)*	Xavier & Charlotte (UNEP-WCMC)
10:30 – 11:00	*Coffee/tea break*	
11:00 – 12:30	Continue mapping carbon stocks.	Xavier & Charlotte (UNEP-WCMC)
12:30 – 13:30	*Lunch*	
13:30 – 15:30	Continue mapping carbon stocks	
15:30 – 16:00	*Coffee/tea break*	
16:00 – 16:30	Presentation: Where are forests and their benefits are under pressure? Interim results of the drivers study.	
16:30 – 17:30	Discussion: what does the available data tell us about land cover change and drivers of change?	
18:00 ----	*Group dinner*	
	DAY 5 – 30 October	
09:00 – 10:30	Where are there changes in forest condition/cover? *Methods for analysing change in forest/landcover*	Xavier & Charlotte (UNEP-WCMC)
10:30 – 11:00	*Coffee/tea break*	
11:00 – 12:30	• Showing areas with potential multiple benefits: overlays *This tutorial will show how the previously created individual maps can be combined to highlight areas where actions to reduce deforestation and degradation can potentially enhance more benefits.*	Xavier (UNEP-WCMC)
12:30 – 13:30	*Lunch*	
13:30 – 15:30	Multiple benefits, cont.	
15:30 – 16:00	*Coffee/tea break*	
16:00 – 17:00	• Overlays, cont. • Wrap-up session: - Discussion of next steps - Evaluation forms - Closing remarks	

3.2 March 2016 session

Part 1: Joint working session on spatial analysis for multiple benefits of forests and potential for REDD+ action using QGIS

Time	Activity	Presenter
	DAY 1 – 7 March	
9:00 – 9:10	Welcoming remarks	Mr Khishigjargal, Programme Manager, UN-REDD Programme Mongolia
9:10 – 9:30	Introductions & ice-breaker	Charlotte (UNEP-WCMC)

9:30 – 10:00	Overview of objectives and agenda of session	Xavier (UNEP-WCMC)
10:00 – 10:30	Re-cap: objectives and activities of the project	Charlotte (UNEP-WCMC)
10:30 – 11:00	*Coffee/tea break*	
11:00 – 11:30	Overview of the maps to be produced and the data to be used this week	Xavier (UNEP-WCMC)
11:30 – 12:00	Designing map templates – Making simple, informative maps that communicate	Xavier (UNEP-WCMC)
12:00 – 12:30	Distribution of USB sticks	
12:30 – 13:30	*Lunch*	
13:30 – 15:30	Mapping forest cover change	Xavier (UNEP-WCMC)
15:30 – 16:00	*Coffee/tea break*	
16:00 – 17:30	Continue work on mapping forest cover change	Xavier (UNEP-WCMC)
	8 March – PUBLIC HOLIDAY	
	DAY 2 – 9 March	
9:00 – 9:15	Recap of previous day	Charlotte (UNEP-WCMC)
9:15 – 10:30	*IF prior day's activities not finished:* Finalization of mapping forest cover change analysis	Xavier (UNEP-WCMC)
10:30 – 11:00	*Coffee/tea break*	
11:00 – 12:30	• Mapping threatened species richness in all forested aimags in Mongolia in relation to biomass carbon	Xavier (UNEP-WCMC)
12:30 – 13:30	*Lunch*	
13:30 – 15:30	Continue work in the threatened species richness and carbon mapping	Xavier (UNEP-WCMC)
15:30 – 16:00	*Coffee/tea break*	
16:00 – 17:30	Continue work on the threatened species richness and carbon mapping *IF times allows:* Defining spatial logic and creating workflows: Mapping importance of forest for tourism and recreation in the aimags of Khovsgol and Tov	Charlotte/Xavier (UNEP-WCMC)
	Day 3 – 10 March	
9:00 – 9:15	Recap of previous day	
9:15 – 10:30	*IF prior day's activities not finished:* Finalization of mapping importance of forest for tourism and recreation in the aimags of Khovsgol and Tov	
10:30 – 11:00	*Coffee/tea break*	
11:00 – 12:30	Mapping forest extent and state in the aimags of Khovsgol and Tov	
12:30 – 13:30	*Lunch*	
13:30 – 15:30	Mapping biomass carbon density in the aimags of Khovsgol and Tov	
15:30 – 16:00	*Coffee/tea break*	
16:00 – 17:30	Mapping the importance of forest for timber and firewood provision.	
	DAY 4 – 11 March	
9:00 – 9:15	Recap of previous day	
9:15 – 10:30	Mapping importance of forest for water supply	
10:30 – 11:00	*Coffee/tea break*	
11:00 – 12:30	Continue mapping forest hydrological services	
12:30 – 13:30	*Lunch*	
13:30 – 15:30	Continue mapping forest hydrological services	
15:30 – 16:00	*Coffee/tea break*	
16:00 – 17:30	Continue mapping forest hydrological services	

DAY 5 – 12 March		
9:00 – 9:15	Recap of previous day	
9:15 – 10:30	Mapping potential opportunity areas for forest restoration in Tov	
10:30 – 11:00	*Coffee/tea break*	
11:00 – 12:30	Continue mapping opportunity areas for forest restoration	
12:30 – 13:30	*Lunch*	
13:30 – 15:30	Mapping the importance of forests for the provision of non-forest timber products in Khovsgol	
15:30 – 16:00	*Coffee/tea break*	
16:00 – 17:00	Wrap-up session	

Part 2: Follow-up session

The working session outputs will be further refined by a smaller group of participants between 14 to 16 March. A draft agenda of this second part of the working session will be drafted based on the results of the first part of the session.

ANNEX 4: Table of forest datasets and definitions

As discussed at working session, March 2016

4.1 Forest datasets and definitions

Name/year	Status	Forest definition used	Owner/ reference
Landsat data, 2000/2009 (forest, non-forest) (generated from landcover map by RS)	Used in EIC databases; not all users can access taxation inventories, so this data more accessible. No more permission needed to publish.	Not clear; check with someone in Institute. Also not clear the methodology used to produce, accuracy assessment, etc., please check with someone in Institute	EIC
Taxation inventory data, aimag scale (Khovsgol & Tov), multiple years	Official/approved by Ministry Requested by IRIMHE from FRDC; should not need further approval to publish. Share final maps with FRDC for comment/for info?	Closed forest/planted forest: >0.3 RSD Open forest/non-forested forest <0.3 Shrubs, by spp, L-M-H density 1 ha minimum size 2m height (<2m is OF, to be forest?) **See below for more detail on classifications**	FRDC
National taxation inventory, 2014 (forest cover, forest type, forest land type) Uses soum/aimag data from 2010-2014; national level spatial data is updated every 10 yrs; forest report of statistical data is submitted to Ministry every year.	Official/approved by Ministry Requested by IRIMHE from FRDC; should not need further approval to publish. Share final maps with FRDC for comment/for info?	As above	FRDC

Forest/land categories

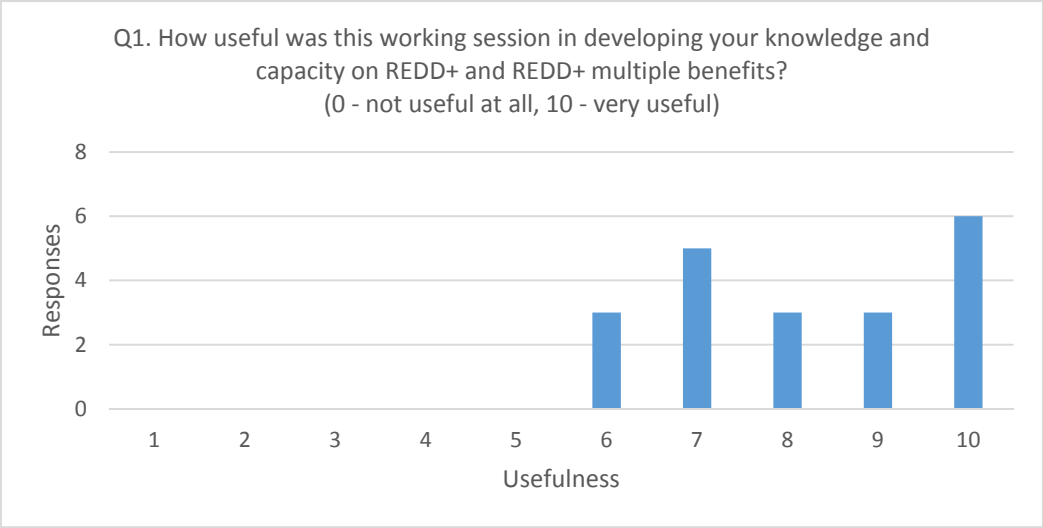
Six categories under Land Law	Sub-categories				
Settlement area					
Roads					
Communications infrastructure (?)					
Water Fund area					
Agricultural Fund area	**Grasslands**				
	Cropland				
	Desert, etc				
Forest Fund area	**Non-forest land**	(in taxation inventories,			

		only record non-forest land areas close to forest areas)			
	Forest land	**Forested forest land**	Closed forest (>0.3 RSD)	Natural forest (>0.3 RSD)	Larch, pine, birch, etc
				Planted forest (>0.3 rsd?)	Pine, etc
			Shrubs	L-M-H density	Hawthorn, etc
		Non-forested forest land	Open forest (<0.3 RSD)	Sparse forest	Can include degraded as well as naturally sparse forest, so use aspect to determine if NF/DF.
				Burnt	Burnt areas where most of forest has been degraded
				Pest-affected	Pest affected areas where most of the forest has been degraded
				Logged	Logged areas where most of the forest has been degraded
				To be forest	Areas that are regenerating
		Some additional classifications	*Age class*	*Can determine whether forest can be cleaned/selectively logged/clear-felled*	
			RSD ≥ 1	*Allowed for cleaning/FW production (?)*	
			RSD ≥ 0.5	*Allowed for selective logging for timber (?)*	
			Slope (>30)	*Forest classified as protected; no timber or FW harvesting (?)*	
			Shrub type	*Rarely recorded, or not consistently recorded across compartments*	

Annex 5: Participants' feedback on sessions

4.1 October 2015 session

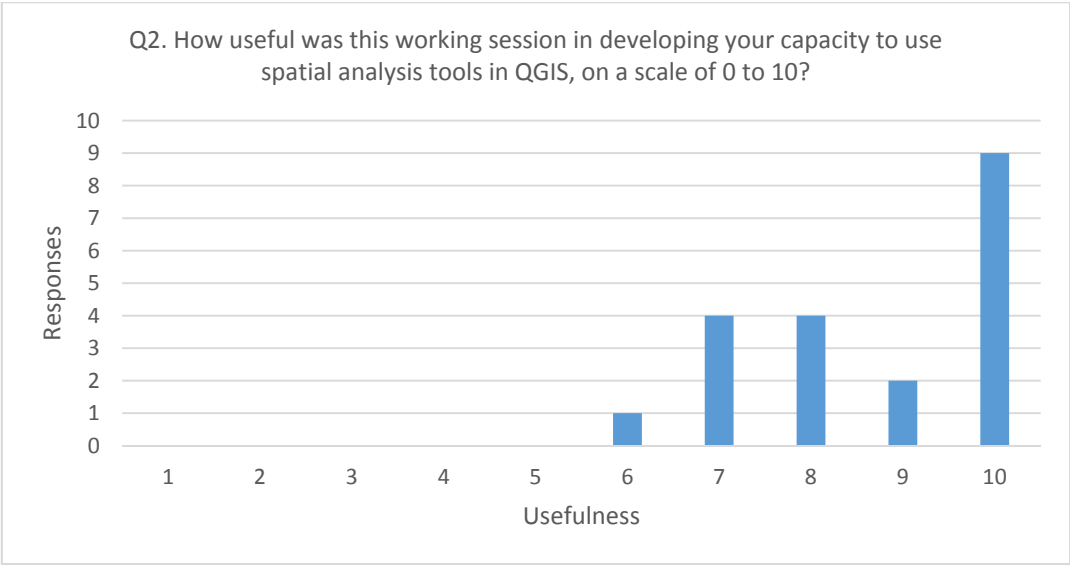
To gather feedback from the participants about the utility of the working session and suggestions for the future, a feedback questionnaire was distributed on the last day. The results are summarized below.



Comments on the usefulness of the working session in developing knowledge and capacity on REDD+ and REDD+ multiple benefits were for example:

"I obtained knowledge to achieve the results and learned multiple data processing on QGIS software."

"Before I don't have knowledge about REDD+. This workshop session under some of the significant information and can connect to my work."



Comments on the usefulness of the working session in developing capacity to use spatial analysis tools in QGIS included:

"I learned a lot of things and studied things that are very significant for our work."

"Tutorials were very good. I'll use those methods in the future a lot."

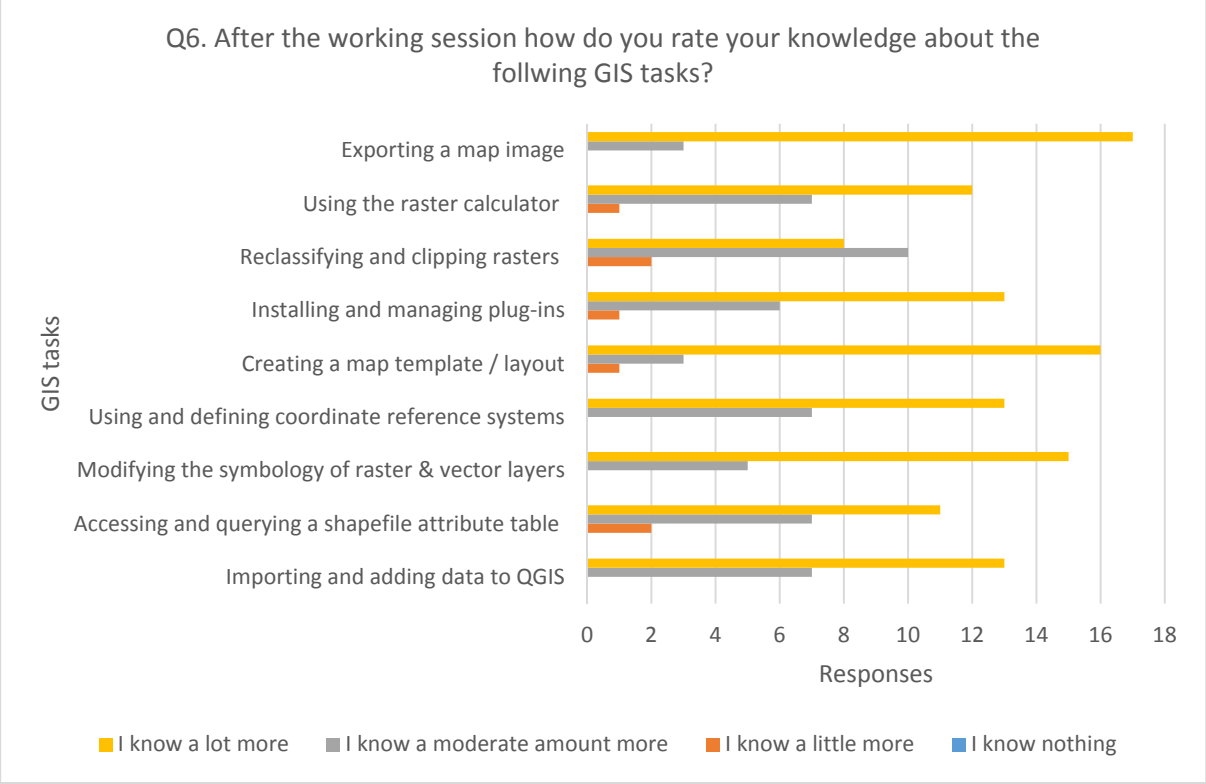
"My GIS skills improved. I learned how to work with raster and vector layers."

Regarding the **most useful topics or tools** shown in the working session, most participants stated that everything covered in the session was useful (6 responses). Others found raster data and the raster calculator (4 responses), the land cover change analysis (4 responses), overlaying maps (3 responses) and using the carbon map (3 responses) to be very useful. Other answers included species richness, forest change calculation tools and new understanding about the UN-REDD Programme and REDD+.

As **least useful topic or tool,** the land cover map was mentioned (2 responses). One participant stated that he did not use a lot of tools in his work. All other participants regarded everything covered in the working session as useful.

Almost all participants were satisfied with the working session **organization and logistics.** Two participants mentioned, however, that some of the tools did not work (2 responses), and that the material provided was very good but there were not enough handouts for everybody (1 response).

After the working session, the participants rated their knowledge about the following GIS tasks, as shown in the graph below:



When questioned what **additional technical (GIS) knowledge** would be helpful for the participants in order to undertake work on spatial planning for REDD+, some suggestions were:

"How to use the results of the analysis."

"Carbon estimation. Land cover change analyze."

"To add 3D tools."

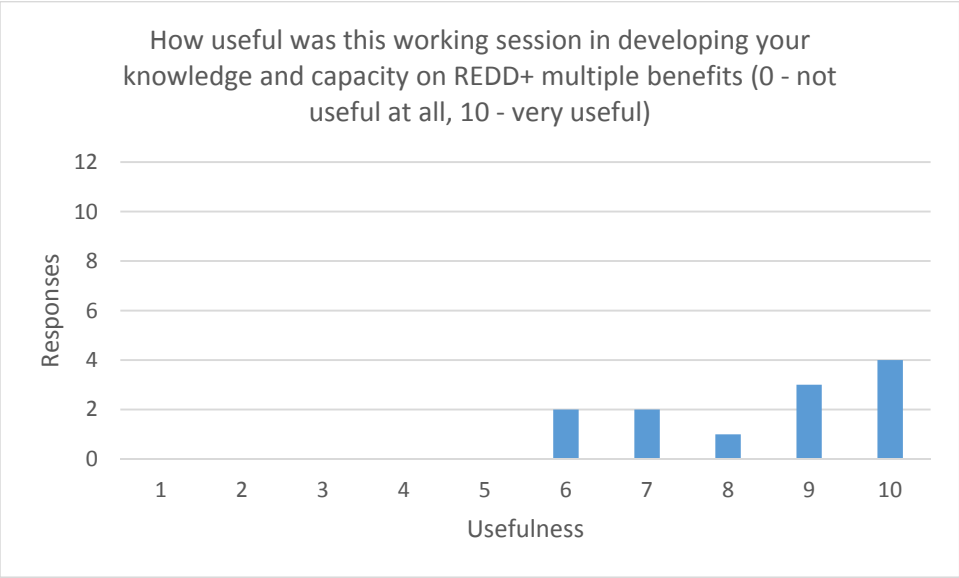
"Combine multilayer in QGIS."

"ArcGIS, field inventory data (how to collect) quality of data, requirements."

Other Comments and suggestions included the need for advanced training in the future (6 responses). Other participants would have liked the session to have been done more slowly (2 responses).

4.2 March 2016 session

A feedback questionnaire was also distributed on the last day of the second working session. There was a total of 12 respondents and the results of the questionnaire are summarized below.



Some comments on the usefulness of the working session in developing knowledge and capacity on REDD+ and REDD+ multiple benefits were:

"Developing maps was very interesting. I learned a lot especially using satellite image data, DEM etc."

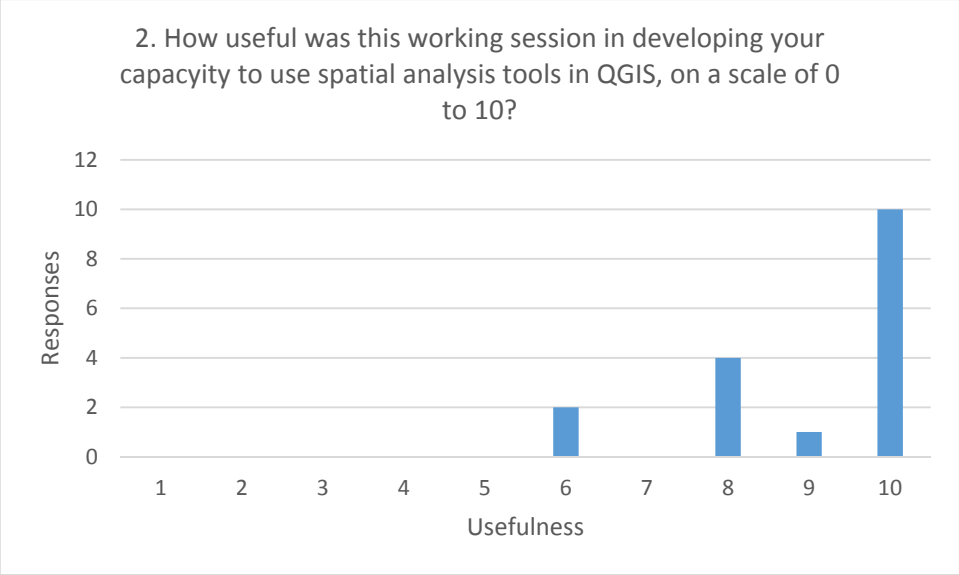
"Because of slow processing of computer, we couldn't get all maps completely. But we learned many valuable lessons how to do map for REDD."

"Spatial planning is very useful for REDD+ planning in Mongolia"

"Using open source software is very useful for people and organizations."

"It was very useful working session. I will use what I have learned from this session further."

"I have more understanding about REDD+."



Comments on the usefulness of the working session in developing the participants' capacity to use spatial analysis tools in QGIS included:

"I loved using raster analysis."

"Attending this working session was very helpful to improve my QGIS skills. And I also learned many new tools from creating map."

"I learned a lot about using QGIS tools"

"I'm learning spatial analyzing tools of QGIS and I have to learn more by myself"

"Previous experience of mine was in ArcMap. There are some tools seems better in QGIS."

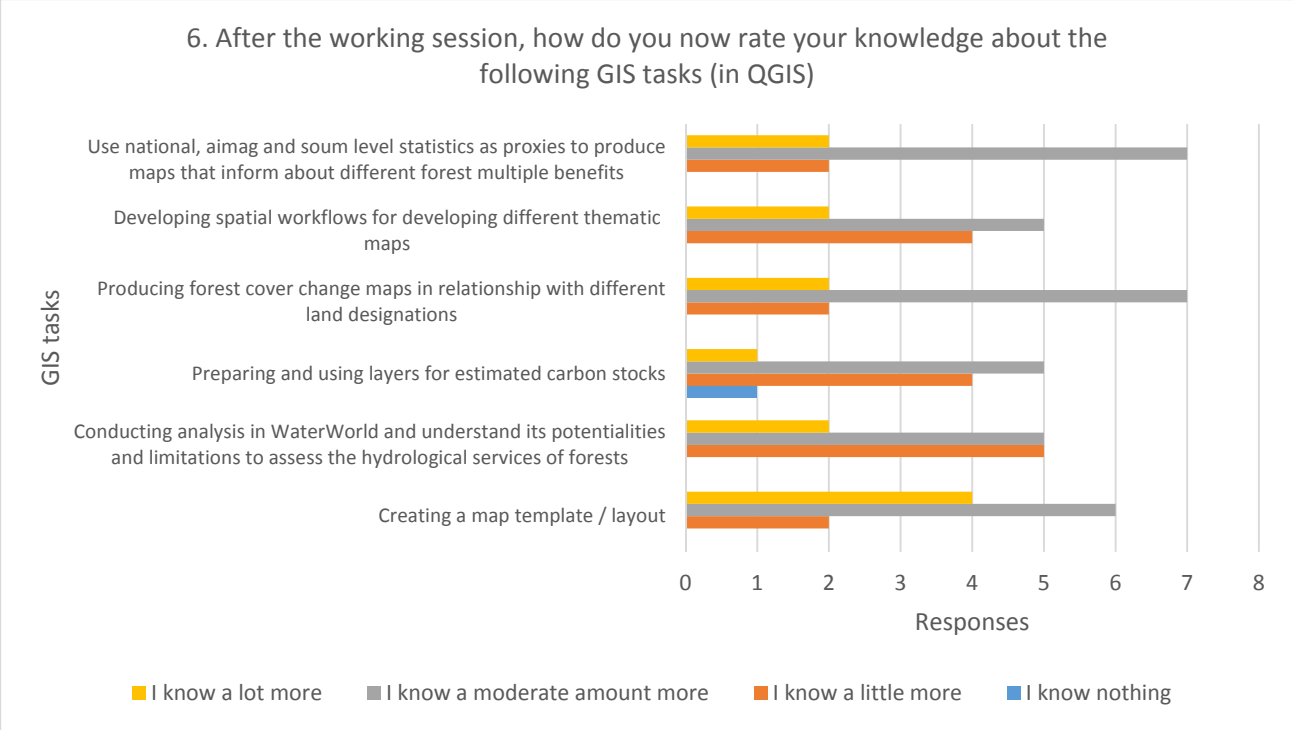
"Learned many types of spatial analysis."

Regarding the **most useful topics or tools** that participants learnt about in the working session, most participants stated that learning about the WaterWorld tool was very useful (7 responses). Other topics considered especially useful by participants were forest cover change, forest restoration maps and forest degradation and deforestation (Hansen dataset) (7 responses). Two participants also nominated creating a species richness map with IUCN Red List data and processing raster data (reclassify, slope, aspect) respectively as very useful. Two respondents found everything covered useful.

One respondent considered raster operations as **least useful topic or tool** because vector analysis was faster. Most other respondents regarded everything covered in the working session useful (6 responses).

The participants were satisfied with the working session **organization and the logistics** (7 responses). However, the computer quality and speed were criticized (6 responses).

After the working session, the participants rated their knowledge about the following GIS tasks (in QGIS) as shown in the graph below:



Suggestions for **additional technical (GIS) knowledge** that would be helpful for the participants in order to undertake work on spatial planning for REDD+ were:

"We didn't have time to do some maps. So need to extend date (download data, processing etc.)"

"Using NTFP. Suitability map for forest utilization"

"Participatory (local people and specialist in different fields), field survey and observation"

"Safeguard topics and REDD+ planning using spatial data"

"I want to learn more about tools that are only for REDD+"

Other comments and suggestions by the participants were the need for advanced training (1 response), the creation of a map for suitable forest utilization (1 response) and to increase the PC quality (1 response).