Mongolia - Multipurpose National Forest Inventory, 2017

REDD+ National Forest Inventory in Mongolia, UN-REDD Mongolia National Programme

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Identification

SURVEY ID NUMBER
MNG_2017_MNFI_v01_M_v01_A_ESS

TITLE
Multipurpose National Forest Inventory, 2017

COUNTRY

Name	Country code
Mongolia	MNG

STUDY TYPE
Forest Resource Survey

SERIES INFORMATION
Mongolia’s forest inventory efforts began in the 1950s with support from the Union of Soviet Socialist Republics [former]. The Forest Management Division, responsible for overseeing forest inventory, was established in 1958. The first National Forest Inventory (NFI) was conducted in 1956–1957, followed by the second NFI in 1974–1975, each with distinct objectives. However, no nationwide inventory took place between 1975 and 2013.
Following Mongolia’s transition to a market economy in 1990, subnational Forest Planning Inventories (FPI) have been conducted at the provincial level on a 10-year cycle, as mandated by the Law on Forest (2012, Art. 7.2). These FPIs, carried out by private forest inventory companies, cover approximately 800,000 hectares annually and serve as the basis for forest resource management and planning. The system establishes two levels of management polygons: (1) permanent forest compartments defined by natural geographic features such as rivers, shorelines, and ridges, as well as permanent infrastructure, and (2) sub-compartments, which are areas up to 50 hectares with uniform land use, species composition, age, and management requirements. Sub-compartment boundaries evolve due to harvesting, resurveying, and updates.
FPIs rely on stand-wise ocular assessments to estimate stand volume, species composition, and size distribution. Growing stock estimations utilize yield tables. Aerial photography, introduced in 1963 (scales: 1:60,000, 1:45,000, and 1:32,000), has been employed for delineating forest borders, estimating forest area, and monitoring land use changes. Topographic maps (scale 1:100,000) support compartment delineation and the identification of key geographical features. Since 2002, GIS and satellite imagery have been integrated into forest cover mapping, enhancing spatial analysis and data accuracy.

ABSTRACT
The Multipurpose National Forest Inventory (NFI) is the first comprehensive national-level forest assessment in Mongolia, designed to provide reliable and accurate data for informed policymaking, sustainable forest management, and international reporting, including REDD+. Conducted between 2014 and 2017 by the Forest Research and Development Centre in collaboration with national forestry institutions, universities, research organizations, and international experts, the NFI is built on standardized methods, systematic sampling, and permanent field plots to support long-term forest monitoring.
The inventory covers 4,367 sampling units to assess the multiple characteristics and functions of Mongolia’s boreal forests, which span 11.266 million hectares. Modern remote sensing techniques complement field measurements to ensure accurate assessment of forest area and changes over time. A comprehensive capacity development program, including training workshops and on-the-job learning, has strengthened institutional capacities in data collection, quality assurance, and data management.
The long-term objective of the NFI is to promote sustainable forest management by integrating environmental, social, and economic aspects into forestry policies. The findings support sectoral development, policy evaluation, and legislative coherence. To ensure continuity, the NFI is envisioned as a continuous monitoring system, with data collection conducted annually over a ten-year cycle. A combination of permanent and temporary plots is recommended to optimize data quality and cost-efficiency. The value of the NFI will increase with each cycle, providing crucial insights into forest trends, growth, and losses. Institutionalization of the NFI is necessary to sustain technical capacities, maintain the database, and adapt methodologies to evolving information needs

KIND OF DATA
Sample survey data [ssd]

UNIT OF ANALYSIS
Plots of lands

Scope

NOTES

The Mongolian National Forest Inventory (NFI) provides a comprehensive assessment of the country's boreal forests, offering critical data for sustainable forest management, policy development, and international reporting, including REDD+. The inventory is structured around key thematic areas to evaluate the status, distribution, and functions of forest ecosystems in Mongolia.

- Forest Extent and Distribution:

The NFI assesses the spatial extent and geographic distribution of Mongolia's boreal forests, covering approximately 9.49 million hectares of stocked forests and 1.77 million hectares of low-stocked forests. Remote sensing and field surveys are used to monitor forest cover changes over time.

- Forest Composition, Growing Stock, and Carbon:

The inventory evaluates growing stock volume, tree species composition, age distribution, and basal area. Siberian Larch dominates the boreal forests, contributing significantly to biomass and carbon storage. The NFI also estimates above- and below-ground biomass, providing essential data for carbon stock assessments and climate change mitigation strategies.

- Forest Management, Protection, and Utilization:

Mongolia's forests are classified into protected areas (34 percent), production forests (21 percent), and unmanaged forests (45 percent). The NFI assesses forest ownership, land use policies, and the extent of community-based and private forest management. It also estimates timber potential, wood harvesting rates, and the availability of fuelwood resources.

- Forest Health, Disturbances, and Environmental Challenges:

The NFI identifies key threats such as wildfires, snow and ice damage, insect infestations, grazing, and soil erosion. Wildfires impact nearly 28 percent of boreal forests, while climatic and human-induced disturbances affect forest health and regeneration. Deadwood assessments provide insights into biodiversity, carbon storage, and fire risk.

- Forest Regeneration and Structure:

The NFI evaluates natural regeneration, tree density, stand structure, and species diversity. It also classifies forests based on dominant species and stand age, informing sustainable forest management and restoration strategies.

- Soil, Landscape, and Ecosystem Characteristics:

The inventory assesses soil properties, landscape relief, altitude, slope, and litter layer thickness—key factors influencing forest distribution, water availability, and productivity.

- Carbon and Climate Change Implications:

The NFI provides detailed estimates of forest carbon pools, including biomass, deadwood, litter, and soil organic carbon. This data supports Mongolia's climate change reporting obligations and contributes to global efforts in forest-based carbon sequestration.

TOPICS

Topic
National Forest Inventory

KEYWORDS

Keyword
National Forest Inventory, Forest Resources, Forest Monitoring, Carbon Sequestration

Coverage

GEOGRAPHIC COVERAGE
National

UNIVERSE
To ensure comprehensive representation of Mongolia’s diverse forest landscapes, the country was divided into distinct inventory regions for systematic sampling and long-term monitoring. These regions were designed to reflect variations in forest structure, ecological conditions, and land use, ensuring accurate assessments of forest resources, including both stocked and low-stocked forests. The boundaries of these regions are stable, allowing for continuity in future assessments and monitoring efforts.
The Mongolian NFI is structured around six inventory regions, representing the country’s boreal forest ecosystems and associated landscapes: Altai, Khangai, Khuvsgul, Khentii, Boreal Forest Buffer Zone, and Low-Stocked/Degraded Forests. These regions capture variations in forest extent, composition, and land use, providing a robust framework for national forest monitoring.
The universe of the Mongolian NFI encompasses all tree populations within the boreal forest zone, including stocked forests, low-stocked forests, degraded and deforested areas, as well as trees outside formally designated forest lands. This approach enables a comprehensive evaluation of forest resources, their ecological functions, and their contribution to Mongolia’s socio-economic and environmental landscape.

Producers and sponsors

PRIMARY INVESTIGATORS

Name
REDD+ National Forest Inventory in Mongolia
UN-REDD Mongolia National Programme

PRODUCERS

Name
REDD+ National Forest Inventory in Mongolia
INTEND Geoinformatik GmbH
Proyecto Mirador
University of Tuebingen

FUNDING AGENCY/SPONSOR

Name	Abbreviation
Ministry of Environment and Tourism	MET
German Federal Enterprise for International Cooperation	GIZ
Food and Agriculture Organization of the United Nations	FAO

Sampling

SAMPLING PROCEDURE
The Multipurpose National Forest Inventory (NFI) of Mongolia follows a systematic sampling approach to estimate key forest attributes at both national and regional levels. The sampling framework integrates remote sensing assessments and field inventory measurements to ensure comprehensive forest monitoring.

- Sampling Grid:

National Grid: 9 km × 9 km spacing across the entire boreal forest

Regional Intensified Grids:

- Khangai, Khuvsgul, and Khentii regions: 4 km × 4 km grid
- Altai region: 1.5 km × 1.5 km grid to capture smaller forest patches

- Sampling Unit Allocation:

- Total Sampling Units: 4,367
- Stocked Forest Units: 4,211
- Low-stocked/Degraded Forest Units: 156
- The field samples were pre-stratified according to the five boreal forest inventory regions, ensuring proportional representation.
Allocation of sampling units per inventory regions:
A total of 1175 National Grid sample units are distributed following- Alti- 13, Khangai- 252, Khuvsgul- 438, Khentii- 285, Buffere zone boreal forest- 105 and Low stocked forest- 82 sampling units.
3192 additional intensified grid sampling units were distribute- Alti- 428, Khangai- 489, Khuvsgul- 1560, Khentii- 641, and Low stocked forest- 74 sampling units.
Allocation of sampling units per provinces:
Arkhangai- 311, Selenge- 514, Bayan-Ulgii- 180, Tuv 270, Bayankhongor- 4, Ulaanbaatar- 38, Bulgan- 443, Uvs- 272, Darkhan Uul- 12, Khentii- 274, Dornod- 21, Khuvsgul- 1602, Orkhon- 3, Zavxan- 240, Ovorkhangai- 27; which is the total sampling units for NFI- 4367

- Sample Plot Design:

Each sampling unit consists of three circular plots arranged in a triangular layout, with centers spaced approximately 100–112 meters apart. Data collection occurs at nested radius levels, capturing tree attributes, biomass, and environmental conditions:
- 20 m radius: Trees with DBH ? 30 cm, also canopy structure, slope, erosion, and fire occurrence.
- 12 m radius: Trees with DBH between 15 cm and 29.9 cm
- 6 m radius: Trees with DBH between 6 cm and 14.9 cm
Tree regeneration categories: 2 m radius
- Small: 10–50 cm height
- Medium: 50–150 cm height
- Tall: >150 cm height but DBH < 6 cm.
These measurements provide detailed insights into forest structure, regeneration, and ecosystem health, supporting long-term monitoring and sustainable forest management.

DEVIATIONS FROM THE SAMPLE DESIGN

Some deviations occurred due to inaccessibility of certain sampling units in remote or high-altitude areas. In these cases, alternative plots were selected using high-resolution satellite imagery to maintain sample representation. No significant changes in sample allocation methodology were reported. Around 90 sample units with count of 747 sub-sample units were shifted.

RESPONSE RATE

The response rate for field measurements was high, with data successfully collected from nearly all allocated plots. 34 units have not inventoried comment out of 64 not inventory status. Other 30 units have following comments "blank", "wrong indication of forest", "not forest-rock", "burnt forest with no living trees" and "All trees dead. Insects. Quality control checks were conducted on 10 percent of the field samples, and soil and litter samples were analyzed for carbon assessment. Approximately 6,300 tree core samples were collected for tree growth analysis.

WEIGHTING

The Ratio Estimation Method was applied to ensure representativeness of forest parameters such as growing stock volume, biomass, and forest degradation. The denominator in the ratio estimation was specified as the forest area within each plot, meaning that only portions classified as forest contributed to forest-related calculations. The total forest area was estimated based on a systematic remote sensing sampling survey using the Collect Earth Tool, applying a threshold of 10 percent canopy cover to classify plots as forest. Mongolia used forest mask to define the forest area and divided it by the regions. NFI plots were not used for land use assessment but to generated average values for the parameters for NFI.

Data Collection

DATES OF DATA COLLECTION

Start	End
2014	2016

DATA COLLECTION MODE
Field measurment [field]

Data Processing

DATA EDITING
Cleaning Operations/Data editing:

The National Forest Inventory (NFI) of Mongolia implemented a rigorous data cleaning and editing process to ensure high data quality and reliability. The process involved multiple layers of validation, encoding, revalidation, and statistical analysis. The key components of the cleaning operations are outlined below:

1. Field Data Validation and Encoding

• Field survey team leaders were responsible for submitting completed field forms to the Forest Research and Development Centre (FRDC) for validation.
• If inconsistencies were detected in the field data, forms were sent back to the responsible team leader for corrections before resubmission.
• Once cleared, the validated data were entered into the NFI database (MS Access) by trained data encoders.

2. Data Revalidation and Processing

• Before processing and statistical analysis, the encoded field data underwent additional validation through systematic filtering to detect inconsistencies and unrealistic values.
• Experts from FRDC and collaborating institutions were trained in data processing and analysis through workshops to establish a broad institutional understanding of how the NFI findings are generated.
• A strict quality control process ensured that errors in tree measurements, species identification, and environmental attributes were identified and addressed.

3. Control of Encoded Field Data

• Validation of encoded data showed that most inconsistencies from field forms had been corrected before entry.
• Any remaining inconsistencies were reviewed by forestry experts, and data that could not be corrected were excluded from the final analysis to avoid distortion of results.

4. Control Measurements

• Control measurements were performed on 10 percent of the total field sample to assess the accuracy of data collected by field teams.
• Discrepancies were identified in tree height, diameter, and soil-related measurements, with significant errors observed in plant species counts, ground slope, and soil horizon thickness.
• The validation process highlighted that measurement errors were more common in field-measured parameters than in visual observations.

5. Data Inspections and Peer Review

• Data audits were conducted at various stages to screen for errors, ensuring data plausibility and consistency.
• Encoded data were checked against predefined tolerance limits, and outliers were flagged for further review.
• The NFI findings underwent a peer-review process involving a technical committee and external experts to validate the results and ensure credibility.

6. Accuracy and Precision of Statistics

• Relative standard errors were calculated for all estimates, ensuring statistical reliability.
• The accuracy of estimates was supported by a well-defined sampling design, trained personnel, and multiple validation measures.
• For example, the estimated precision (sampling error at a 95 percent confidence level) for national-level growing stock was 1.0 percent, while regional estimates ranged between 2.6 percent and 10.6 percent.

Data Appraisal

ESTIMATES OF SAMPLING ERROR
Sampling desing was focused to capture stocked forest information. Only sampling error, following a ratio estimation approach, was considered. For the additional 157 NFI plots of low stocked forest areas, the sampling unit and sub-sampling plots' were not shifted. For more information, see Altrell, D. 2019. Multipurpose National Forest Inventory in Mongolia, 2014-2017 – A tool to support sustainable forest management. Geography, Environment, Sustainability, 12(3): 167-183. https://doi.org/10.24057/2071-9388-2019-36.

DATA APPRAISAL
Given the systematic sampling design, quality control measures, and validation processes, efforts were made to minimize potential biases.

Key steps taken to reduce bias include:

• Randomized selection of sample units within a structured grid.
• Verification of plots using high-resolution satellite imagery to correct errors.
• Control measurements on 10 percent of the field samples to detect inconsistencies.
• Training of field survey teams to reduce measurement errors.

Access policy

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CONFIDENTIALITY
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ACCESS CONDITIONS
Data is available on an external repository. The access conditions will follow the conditions set by the external repository (owned by the country).

CITATION REQUIREMENTS
Mongolian Ministry of Environment and Tourism 2019. Mongolian Multipurpose National Forest Inventory. 2014-2017. 2nd edn. Ulaanbaatar. Ministry of Environment and Tourism.

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DISCLAIMER
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Metadata production

DDI DOCUMENT ID

DDI_MNG_2017_MNFI_v01_M_v01_A_ESS_FAO

PRODUCERS

Name	Abbreviation	Affiliation	Role
Statistics Division	ESS	Food and Agriculture Organization of the United Nations	Metadata adapted for FAM

Data Dictionary

Data file	Cases	Variables