"THE INTEGRATED FOREST ECOSYSTEM MANAGEMENT PROJECT IN THE KYRGYZ REPUBLIC" (IFEMP)

CONSULTING SERVICES

NATIONAL FOREST INVENTORY EXECUTION AND CAPACITY BUILDING

Report on the results of NFI#2

Second National Forest Inventory in Kyrgyzstan

Report on the results of NFI#2

30.09.2022

Client (Publisher):

Forest Service under the Ministry of Agriculture of the Kyrgyz Republic

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List of Abbreviations

FAO	Food and Agricultural Organization, a sub-organization of the United Nations
FF	Forest fund of the Kyrgyz Republic
FMP	Forest Management Plan
FMIS	Forest Monitoring and Information System
FS	State Forest Service under the Ministry for Agriculture, Water, Management and Rural Development
GIS	Geographic Information System
GPS	Global Positioning System
IPCC	Intergovernmental Panel on Climate Change
LCC	Land Cover Classification
MOE95±[%]	Margin of Error for a confidence level of 95%
MRV	Measurement, Reporting and Verification
NFI	National Forest Inventory
NFI#1	1st National Forest Inventory
NFI#2	2nd National Forest Inventory
NFR	National Forest Reserve
OWL	Other wooded land
PIU	Project implementation unit
SAEPF	Former State Agency for Agriculture, Environmental Protection and Forestry
SFF	State Forest Fund
SKFHIP	Former name of the department "Forest and Hunting Inventory and Planning"
SPA	Special Protected Areas
TTFI	Technical Team for Inventory at the department "Forest and Hunting Inventory and Planning" at Forest Service
ULOU	Department "Forest and Hunting Inventory and Planning" at Forest Service
UNFCCC	United Nations Framework Convention on Climate Change

1. Introduction

1.1. Context

The development of the NFI serves as a baseline for the current forest status and for the future monitoring of forest situation as well as for the development of strategic planning and monitoring. The management planning at the leskhoz level will be complementary to the NFI.

The second National Forest Inventory (NFI#2) was carried out in the frame of the Integrated Forest Ecosystem Project (IFEMP). It was financed through a grant and loan of the World Bank and Global Environment Facility (GEF). The IFEMP consisted of four components.

The consortium of Unique -CAREC implemented the second national forest inventory (NFI#2) of Kyrgyzstan in close cooperation with Department "Forest and Hunting Inventory and Planning" (ULOU, formerly SKFHIP) under the Forest Service (FS; client, previously SAF, SAEPF).

NFI results are not only important at the national level, but also for many international environmental agreements on environment protection issues which the Kyrgyz Republic is party to.

1.2. Forests of Kyrgyzstan

1.2.1. Main statistical indicators of forests

The Kyrgyz Republic belongs to the forest-poor countries and forests are represented by diverse and valuable tree and shrub species. More than 90% of the forests of the Kyrgyz Republic are located at an altitude of 700 to 3,500 meters above sea level.

According to the Land Code of the Kyrgyz Republic, the "land fund" of the republic includes 7 categories and forests occur in almost all these categories.

Table 1 Overview of all seven land categories of Kyrgyzstan and information where forests can occur.

No	Categories	Comments about forests
1	Agricultural lands	Possibility of forests (protective strips, windproof plantings)
2	Lands of settlements	Possibility of forests (private forests and poplar plantations)
3	Lands of industry, transport, communications, energy, defense and other purposes	Possibility of forests (forest belts along the roads)
4	Lands of specially protected natural territories	The main forests of the republic
5	Lands of the state forest fund	The main forests of the republic
6	Lands of the water fund	Possibility of forests (riverside forests and water protected plantations)
7	Reserve lands	

The forests of the Republic constitute the Forest Fund (according to the Forest Code of the Kyrgyz Republic), consisting of forests of the "State forest fund", "forests on the territory of specially protected areas", "municipal forests" and "private forests".

Most of the forests grow on the lands of the State Forest Fund (forests of state forestry enterprises), specially protected areas (national parks and reserves) and on the territory of municipality (aiyl aimags).

In Kyrgyzstan, forest inventory is carried out by different means, depending on the purpose. Hence utilization of data differs for Forest Management Planning and National Forest Inventory:

Forest Management Planning (FMP)

- Inventory for management planning of forests at the level of national parks and reserves, forest enterprises and rural administrations. The results of this inventory are collected in the report "Forest fund of the Kyrgyz Republic", which is updated every 5 years.
- According to the last report "Forest fund of the Kyrgyz Republic" (2018), the total area of forests of the republic is 1,206,705.7 hectares, including:
  - State Forest Fund – 772,295.9 ha
  - Protected area lands – 119,371.0 ha
  - On other categories of land – 315,038.8 ha (municipal lands)

- The area of natural forests is 1,152,630 ha, artificial forests – 54,075.7 ha. The occupied area of trees is 538,905.5 hectares, shrubs – 352,761.9 hectares. According to forest legislative documents, also shrubby thickets belong to the forest area.

In contrast, the NFI#2, which has been carried out now, covers the whole country.

The first National Forest Inventory (NFI#1)

The first National Forest Inventory was conducted in Kyrgyzstan (2008-2010) and according to the results, the total forest area of the Kyrgyz Republic amounted to 1,298,050 6.49 or 6.49% of the total area of the country. In addition to forestry data, additional data on tree biomass and the amount of carbon absorbed by forests were calculated. The data of NFI#1, as a basis for policy decisions, were used in the development of the national program "The Concept of the development of the forest industry until 2040".

1.2.2. Management of forests

According to the Constitution of the Kyrgyz Republic, all forests are only in state ownership. However, the Forest Code allows for "private forests", but in reality, there are no registered private forests in Kyrgyzstan yet.

- **Forests of forest enterprises (SFF)** are managed by the **Forest Service** under the Ministry of Agriculture.
- **Forests of national parks and nature reserves** (forests of protected areas) are managed by the ***Department of Biodiversity Conservation and specially protected areas*** under the Ministry of Natural Resources and Ecology.
- Forests on the municipality territory are managed by the **local governments** (aiyl aimags).

The institutional structure of forest management is a vertical hierarchy, and the management system has country, regional and local levels.

State forest fund

Forest Service (country level): The functions are political decision-making, forest management (departmental control and monitoring of forestry). The Department manages territorial administrations and forestry enterprises.

Territorial forestry departments (regional level): The functions are forest management, control of forestry activities and reporting.

Forestry enterprises (local level): The functions are to carry out measures to protect forests from forest damage and fires, to protect forests from pests and diseases, to reproduce forests (reforestation, afforestation), to regulate forest use.

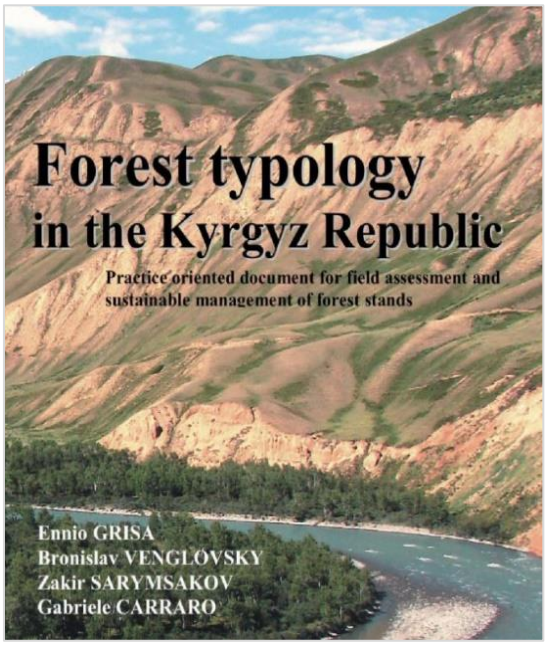
Protected areas

Department of biodiversity conservation and specially protected areas (national level): Functions are the introduction of policy decisions, forest management (departmental control and monitoring of protected areas). The Department manages territorial administrations and National parks and nature reserves.

Territorial administrations (regional level): The functions are forest management (activity control, management monitoring and reporting).

National parks and nature reserves (local level): The functions are the implementation of measures to protect forest ecosystems from forest damage and fires, to protect forests from pests and diseases, to reproduce forests (reforestation, afforestation), to regulate forest use.

1.3. Forest types in Kyrgyzstan



The latest research on forest typology and the development of a special manual was carried out in 2006-2008 with the support of the Kyrgyz-Swiss Forestry Support Program of Kyrgyzstan (Grisa et al. 2008).

The book on Forest Typology (Manual) is designed to describe the classification of forest conditions using simple, easily recognizable criteria (features) when identifying forest types.

Forest typology is used for forest management planning: forest planting, cutting, utilization of non-wood forest products (NWFPs), conducting scientific research, and rent of forest lands.

The forests of the republic have their own characteristics and grow in sharply different forest growth areas (see Table 2 and map). The forests of Kyrgyzstan have been zoned into forest growth areas in order to take into account a huge variety of natural conditions and similar silvicultural conditions. The forest growth areas are characterized by similar ecological conditions, silvicultural features and composition of forest forming species.

Table 2 Forest-growth areas of Kyrgyzstan

I	Turkestan-Alai	V	Talas
II	Ferghana-Alai	VI	Chuy-Kemin
III	Ferghana-Chatkal	VII	Issyk-Kul
IV	Chatkal	VIII	Naryn

Figure 1 Map of forest-growth areas of Kyrgyzstan

Following Grisa et al. (2008) forests are distributed among 11 main forest formations and each formation has subtypes. In total, for 11 forest formations 54 subtypes had been identified. See Table 3.

Table 3 Eleven forest formations

1	Walnut forests - 6 subtypes	7	Juniper forests - 7 subtypes
2	Pistachio forests - 3 subtypes	8	Spruce forests - 9 subtypes
3	Almond forests - 2 subtypes	9	Fir forests - 6 subtypes
4	Apple forests - 3 subtypes	10	Floodplain forests - 3 subtypes
5	Maple forests - 4 subtypes	11	Shrubs - 1 subtype
6	Hawthorn forests - 5 subtypes		

Derivation of six Main Forest Formations

Based on the 11 forest formations, 6 Main Forest Formations were identified, which represent the basis for the forest pre-stratification of the NFI#2: **Spruce-Fir forests, Juniper forests, Walnut forests, Pistachio & Almond forests, Other Broadleaved/mixed forests** and **Shrub forests**.

For the six Main Forest Formations, the first map of the forests of Kyrgyzstan was developed in 2008 under the supporting of the Kyrgyz-Swiss Forestry Support Program of Kyrgyzstan (Figure 2).

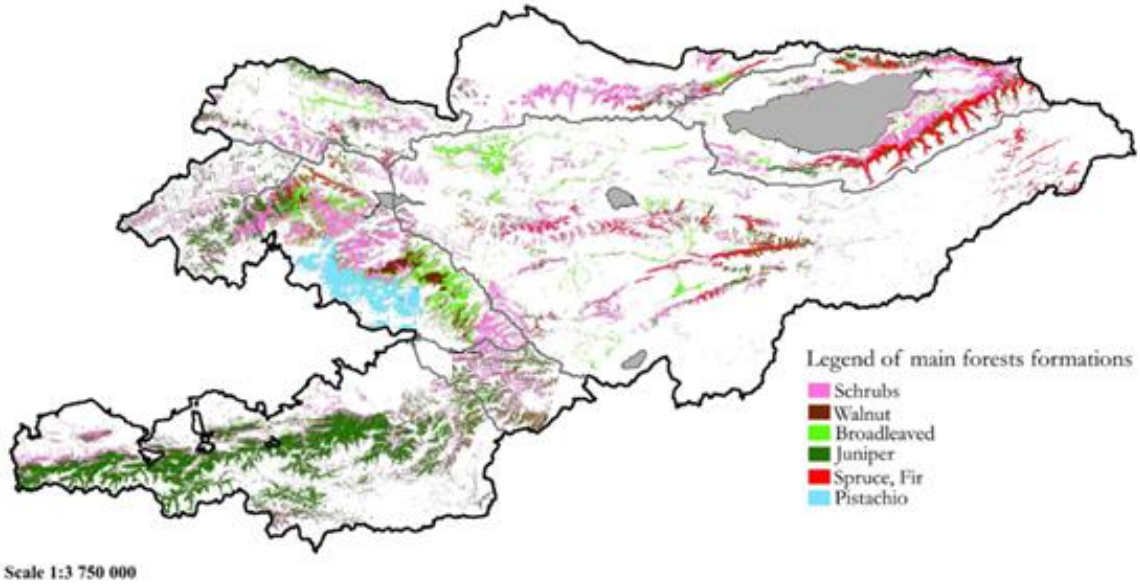


Figure 2 Map of the Main Forest Formations of Kyrgyzstan (developed by ECOGIS Public Foundation and by Ennio Grisa, 2003-2008)

Table 4 The six Main Forest Formations and general Forest Formations

Main Forest formations		Forest Formation of Forest typology		Forest type group by NFI #2	
No	**Name**	**Code**	**Name**	**Code**	**Name**
1	Spruce-Fir Forest	8	Spruce forests	7	Spruce forests
		9	Fir forests	8	Fir forests
2	Juniper forests	7	Juniper forests	6	Juniper forests
3	Walnut forests	1	Walnut forests	1	Walnut forests
4	Pistachio & Almond forests	2	Pistachio forests	2	Pistachio and almond sparse forests
		3	Almond forests		
5	Other mixed broadleaved forests	4	Apple forests	3	Apple forests
		5	Maple forests	4	Maple forests
		6	Hawthorn forests	5	Hawthorn forests
		10	Floodplain forests	9	Riverside and river-bed forests
		-	-	11	Other
6	Shrub forests	11	Shrub forests	10	Shrub forests

Spruce forests have mainly been detected in Issyk-Kul, Naryn and Chui regions. Fir forests grew mainly in Talas and Jalal-Abad regions. Walnut forests and Pistachio & Almond forests were present in Jalal-Abad and Osh regions. Shrub and Juniper forests grew in almost all regions of the republic.

The six derived Main Forest Formations have been used as pre-stratification for the NFI#2 (see 2.3 and Table 4). The table shows – from right to left - the re-grouping of 11 "Forest Type Groups" to 11 "Forest formations", which are then combined in a third step to 6 "Main Forest Formation" or forest strata.

2. The NFI#2 Design and Methodology

2.1. Introduction and short overview

2.1.1. Second National Forest Inventory (NFI#2) - Purpose and main elements

The 2nd National Forest Inventory (NFI#2) was prepared according to the Action Plan of the National Concept for the Development of the Forest sector of Kyrgyzstan until 2040 (SAEPF 2019). It was seen as element to provide high-quality and accessible information and to support reforms in the forest sector:

- at the national level for strategic planning and monitoring (taking into account external factors such as climate and demographic changes).
- at the local level for integrated forest ecosystem management planning.

The NFI#2 is crucial because it serves as basis for evaluating the current state of the forests, subsequent monitoring of the situation, as well as strategic planning and monitoring. NFI#2 results should also help to respond to local needs and local planning processes. Forest Management Planning (FMP) at the SFE level will complement the NFI and both should be information sources for the FMIS.

The second National Forest Inventory was initiated by the SAEPF (nowadays called Forest Service) and funded by the World Bank and the Global Environment Facility (GEF) within the framework of the project "Integrated Management of Forest Ecosystems of the Kyrgyz Republic" (IFEMP). The implementation of the 2nd National Forest Inventory was carried out by the consortium Unique-CAREC.

2.1.2. Second National Forest Inventory (NFI#2) - Implementation

The NFI#2 started in March 2019 and the field data collection was completed in autumn 2022. It consisted of three phases:

- During the **preparatory phase** stakeholder needs were assessed, the required number of samples based on preliminary stratification were determined, the methodology for field work and respective software for collecting field data were developed, quality assurance was set up and work maps prepared. The field teams were trained

in 2 stages: 2-days theoretical training and 5-days practical field training.

- During the **field phase** overall 1244 tracts and 2489 plots were assessed. The data were collected in a mobile application and directly sent to a central database located on a server. The fieldwork was carried out by 19 field teams, which were equipped with state-of-the-art measurement tools. The assessed area covered all the forest territories of Kyrgyzstan (see the map below), but some tracts were inaccessible due to administrative problems (inability to work on the border of the Batken region). Most field team leaders were specialists of the Forest and Hunting Department of the Forest Service with good work experience and skills in working with tools.

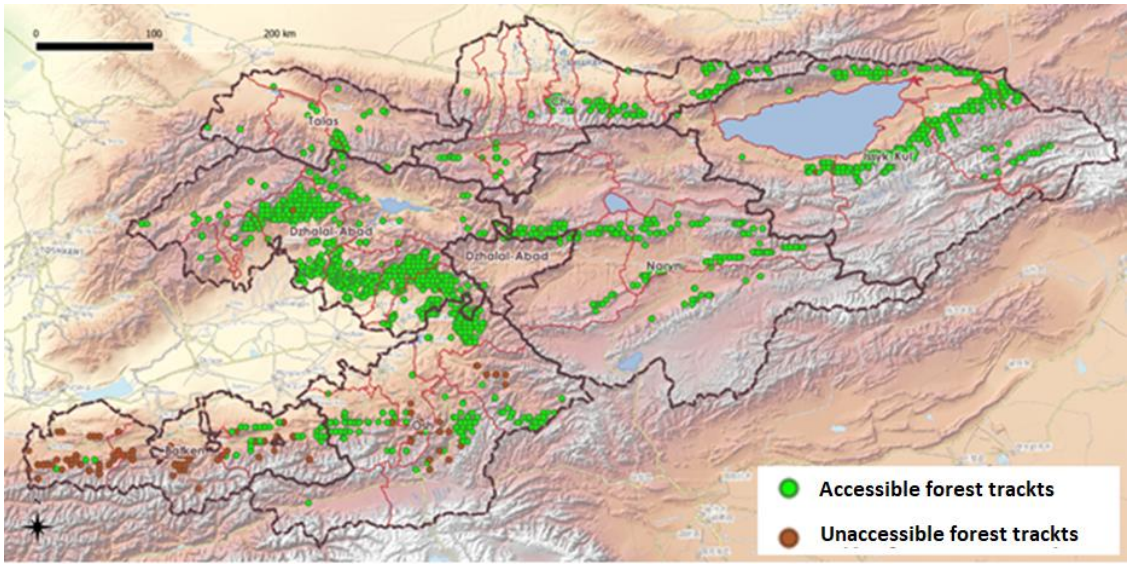


Figure 3 Distribution of the NFI #2 tracts covered with forest

- **Data processing, land cover mapping, trainings and presentation of results.** This stage is the most voluminous and important, taking into account the expected results. During this phase the following work has been carried out: plausibility control and final verification of data, development of software for data analysis and reporting, land cover and forest type mapping for the six main forest types, preparation of reports (technical and descriptive). Besides, trainings of SF staff were conducted.

2.2. National forest inventory design

2.2.1. Forest strata and grid size

For the NFI#2 a basic grid with distances in km was chosen fitting to the grid of 500 x 500 m of the forest management plan inventories. The grid size was adjusted according to features of the respective strata and sample size number for statistical accuracy. Table 5 provides an overview on the forest strata and final grid size for the tracts, used for the NFI#2.

Table 5 Forest strata and grid size of NFI#2

Level 1 (Basic Level)	Level 2 (LC Map)	Grid size (km x km)	Stratum area (ha)	Stratum area (in %*)
Forests (tree canopy Cover > 10 %)	Other broadleaves	4 x 4	2,398,345	12.0
	Juniper - 8x16	8 x 16	1,704,924	8.5
	Juniper - 8x8 densified to 4x4	4 x 4	1,668,345	8.3
	Juniper - 8x8 densified to 4x8	4 x 8	2,293,378	11.5
	Pistachio & Almond	2 x 2	409,134	2.0
	Spruce	2 x 4	3,467,104	17.3
	Walnuts	2 x 4	494,619	2.5
Other Wooded Land (tree canopy cover < 10%)	Shrubs	8 x 16	6,857,867	34.3
Total country			**19,995,089**	**100**

*) In % of the area of Kyrgyz Republic – see chapter 3.2.

2.2.2. General comparison between NFI#1 and NFI#2 design

The NFI in Kyrgyzstan has now been conducted for the second time as sample-based forest inventory. However, the number of samples and measurement accuracy is much higher in the NFI#2. The NFI#1 was conducted in the frame of the Integrated Inventory of Natural Resources, a widely applied methodology by FAO. This approach focuses assessments of all land use types among other forests, agricultural crops, pasture resources and the use of products with the identification of environmental, socio-economic problems. As part of this inventory, only 766 tracts (4 plots per tracts) were laid on a 10-minute X 10-minute coordinate grid (in geographical longitude and latitude).

The NFI#2 was conducted in 2019-2022 with an improved tract design and considering the Kyrgyz Forest Management Planning (FMP) approach, which is based on the methodology proposed in the framework of the "Kyrgyz–Swiss Forestry Support Program for the Kyrgyz Republic" (1995-2009). The final adapted methodology, developed and finalized by the Unique-CAREC consortium and approved by the TTFI in January 2020 builds on the pre-stratification of the country's forests using the dominant occurrence of the six Main Forest Formations. Depending on the forests area in each stratum and to ensure a sound statistical accuracy different tract grids of 1 km X 1 km, 2 km X 2 km, 4 km X 4 km, or 8 km X 16 km, respectively have been selected. The plot design was changed to a circular plot approach. Each tract contains 3 plots. Finally, 1,244 forested tracts and 2,489 circular plots were assessed by the inventory teams. The NFI#2 planned to re-visit plots of NFI#1 for estimating changes of relevant values and indicators.

Land cover classification

A new element of the NFI#2 in contrast to the NFI#1 is a land cover and Main Forest Formation classification (LCC) based on satellite images (ESA Sentinel-2). The project utilized combined reference data sets consisting of NFI#2 samples, reference data derived from stand data of forest management plans, but also from the assessments of the FAO/GEF project "Sustainable management of mountainous forest and land resources of Kyrgyzstan under climate change conditions (LULUCF study)" for the verification. The land cover classification via remote sensing data allowed to improve the pre-stratification. It improves the estimation of forest area and the area of the six Main Forest Formations. Finally, these area values are used for a post-stratification of the field data resulting in a reduction of the sampling error.

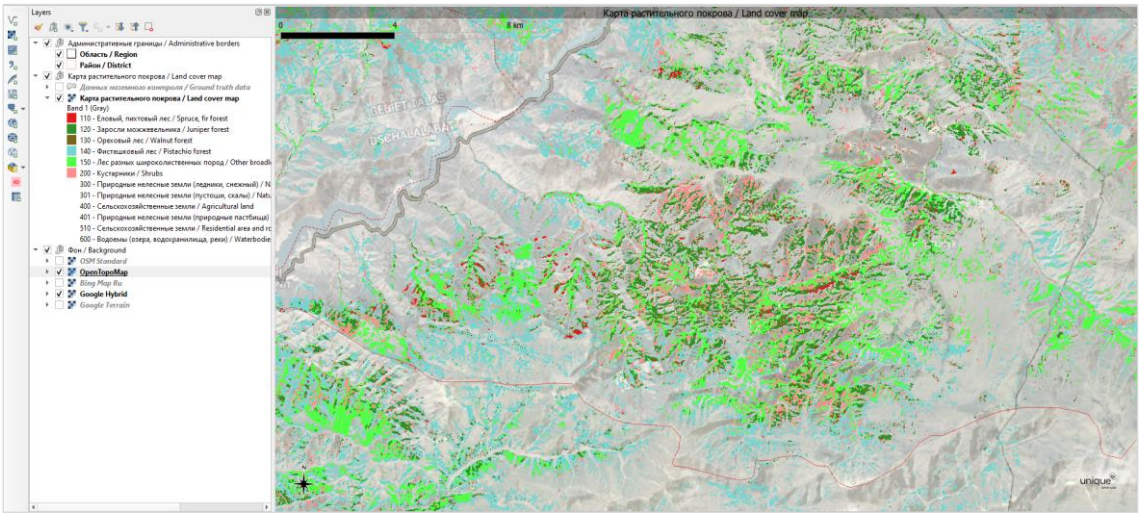


Figure 4 Zoom-in to illustrate the LCC map highlighting the six main forest types defined as the main strata of the NFI#2.

2.2.3. Integration of NFI#1 grid and FMP grid

2.2.3.1. Integration of NFI#1 tracts

In the frame of objective 1 of NFI#2 the design and methodology of NFI#1 was reviewed. The NFI#1 applied a systematic tract design with only 564 accessible tracts and four huge strip-shaped plots each. In total forest/shrub lands were assessed on 113 tracts only. Pistachio & Almond forests and Walnut forests occurred merely by one/respectively two tracts, the remaining four types occurred merely by less than 20 tracts. With this number of tracts, the NFI#1 merely could provide information with sufficient statistical error on the total forest/shrub land as a whole. This is also visible from the report on the NFI#1 that provided information on the statistical accuracy on the forest/shrub land area but not for the other information presented.

Since the grids of NFI#1 and NFI#2 exhibit not only different densities, but also different grid systems (NFI#1: grid in degree and minutes; NFI#2: metric grid in the Kyrg-06 coordinate system as for the FMP) the integration of the NFI#1 grid was only possible by significant adjustments. NFI#1 tracts were integrated by replacing the nearest neighboring tract of the basic NFI#2 grid with the respective NFI#1 tract. This lead in some cases to deviations in the spacing of the final NFI#2 grid. This approach, however, ensured full integration of all NFI#1 tracts that should be remeasured. The definition of the forest strata builds on the classification in NFI#1.

2.2.4. NFI#2 - tract and plot design

Tract and plot design have been intensively discussed with the Forest Service and are presented in detail in the NFI#2 Implementation plan (2020) and the NFI#2 report on required sample size (2019).

Tract design

NFI#2 standard tract: The NFI#2 standard tract consists of three sample plots with a distance of 200 m arranged in "L-tract design". The plot in the lower left corner is placed at FMP sample plot location (Figure 5).

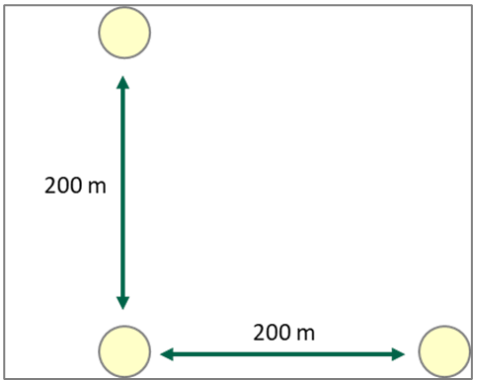


Figure 5 L-tract design of NFI #2

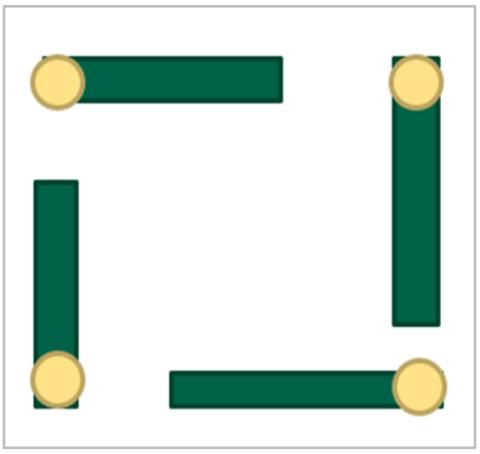


Figure 6 The circular NFI#2 plot allocation in case of a rectangular NFI#1 tracts

NFI#1 tracts: In case of an NFI#1 tract 4 plots are measured (to enable a higher remeasurement rate compared to a reduction to 3). The plot centers are established 12 m along the plot orientation of a NFI#1 plot that has a rectangular extend of 20m by 250m. The 4 plot centers will thus be situated in ca. 500m distance of each other (see Figure 6).

Plot design

The plot design is somewhat like the FMP plot design, as it is illustrated in Figure 7. Stand characteristics are assessed in a wide circle with r = 25 m around the plot center. Mature trees with a DBH >= 15 m are assessed in a circle with r = 12 m. Younger trees with a DBH >= 8 cm are assessed in a circle with r = 6 m. Finally, regeneration is assessed in small subplots with r = 2 m. The number of the subplots may differ depending on the forest type (see NFI#2 Field Manual 2019 and Figure 7).

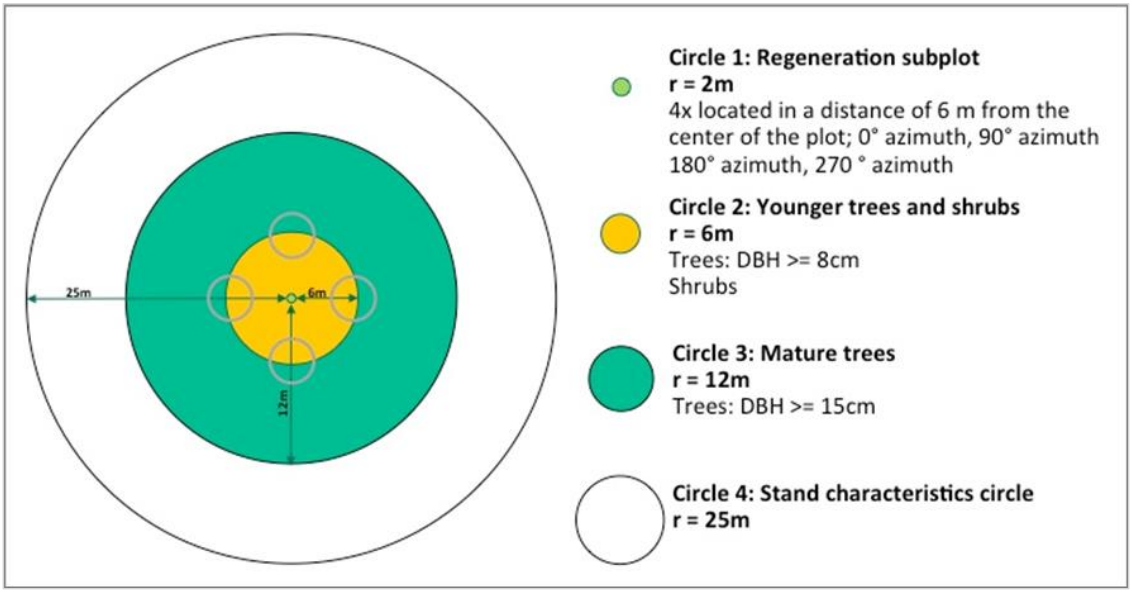


Figure 7 Plot design with the nested circles with different radius (r) for the assessment of respective attributes.

2.3. Pre-stratification

The six Main Forest Formations are not equally distributed. Further the six types do not cover areas of equivalent dimension, especially the Walnut forests and Pistachio & Almond forests cover substantially smaller areas compared to the other forest formations and shrub land (see Figure 8).

In order to achieve the envisaged balanced accuracy - +/- 5% for a 95% confidence interval for forest area and standing volume - for the six Main Forest Formations a stratified approach is necessary; this, since when using a pre-stratification and different densities of tracts per stratum the relative share of plots in different forest formations can be influenced.

To implement a stratification the delineation of the strata was done using mainly the forest type map from 2008 (see Figure 2) as it provides solid information on the spatial distribution of the six Main Forest Formations in the country. A schematic illustration of the stratification illustrating different densities is provided in Figure 8.

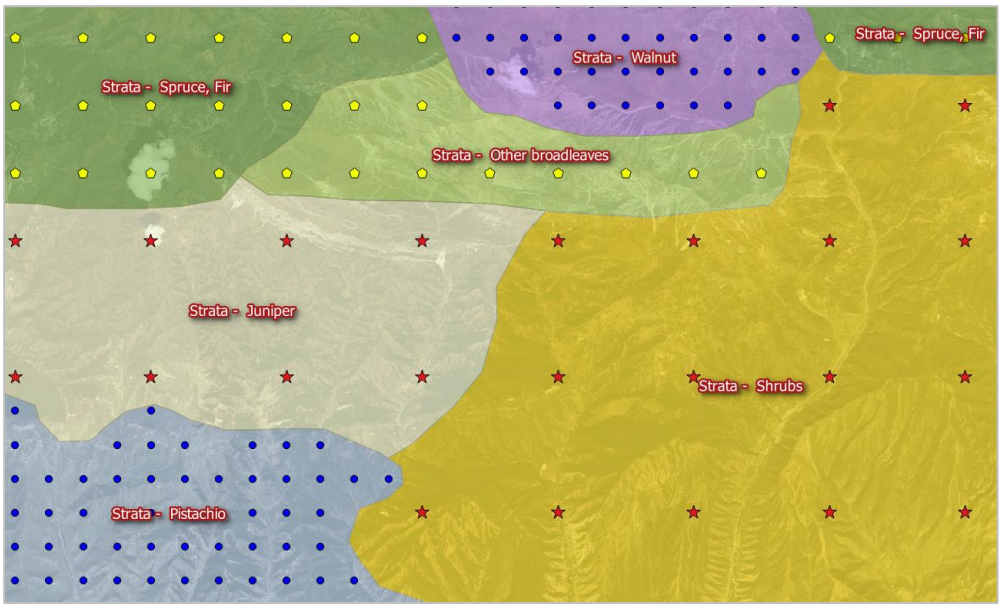


Figure 8 Schematic illustration of the pre-stratification with different tract densities in different strata

The pre-stratification established for the NFI#2 is shown in and the corresponding area statistics are presented in chapter 2.2.1 (see Table 5).

2.4. Pre-clarification

Field assessments have been conducted on forest and other wooded land only; this was achieved by a pre-clarification carried out before the field work using VHR remote sensing images at all sample plot locations. Plots that are clearly no forest/other wooded land were excluded from field work. The approach is illustrated by examples in Figure 9.

		
Plot classified as forest in the pre-clarification. This plot has been visited in the field.	Plot classified as non-forest in the pre-clarification. This plot was not visited in the field.	Plot classified in the pre-clarification as a plot to be checked in the field, since a clear decision based on the imagery was not possible. This plot has been visited in the field.

Figure 9 Illustration of the pre-clarification by examples

2.5. Field manual - Methodology for field works

The set of attributes of NFI#2 Manual is to a large extent in compliance with the already established FMP inventory. However, due to extended objectives of the NFI#2 (e.g., allowing biomass and carbon estimation), some new attributes were added to the assessment. The information needs assessment (NFI#2 INA Report 2019) provided a first orientation which of the attributes should finally be included and where limitations may exist. The final guidance on the attributes selected can be found in the field manual (NFI#2 Field Manual 2019):

- Tract attributes (Tract ID and Tract type)
- Stand characteristics attributes referring to general characteristics of the terrain and the surrounding forest stand.
- Sample plot data of 12 m radius referring mainly to attributes assessed within the 12 m radius circle. They refer to trees with dbh ≥ 15cm, stumps with diameters ≥ 20 cm, down dead wood ≥ 20cm at the thicker end, but also to assessment of shrub species and slope incline.
- Sample plot data of 6 m radius attributes are assessed within the 6 m radius, covering trees with dbh ≥ 8 cm, stumps with diameters ≥ 10 cm, down dead wood ≥ 10cm at the thicker end, ground cover and litter depth.
- Regeneration plot attributes provide information on tree regeneration per species, differentiated into four different height classes and were assessed within the 2 m radius regeneration circles.
- The full list of field attributes can be found in the NFI#2 Field Manual.

2.6. Field Data Quality Assurance

The QA procedure was based on a steady and smooth exchange of data and direct communication between all teams involved. Field control and continuously on-the-job support was conducted by the so-called Supervision & Control Teams. These teams consisted of the three forest experts, the International and National Coordinators and respective members of TTFI.

The Data Base team, consisting of TTFI and ULOU GIS and Database experts was responsible for overall data control. Finally, after all field work was finished the database was then subject to an additional final plausibility checkup lead by Unique head quarter and in close cooperation with the consortium team in Bishkek. This final checkup conducted a

data check of state-of-the-art plausibility checks across all data of all parameters in the database.

2.7. The field inventory 2020/2021

After an online Training of Trainers and Supervisors, followed by a theoretical training of Field Team Leaders in May 2020, a one-week practical training was conducted in Kegete, Chui Oblast for all field team leaders and the assistants. According to the Implementation Plan field teams worked according to the developed work packages (monthly or two-monthly work volumes).

Final data control, involving Unique headquarters, started end of 2021 and finished in September 2022.

2.8. Data analysis and reporting

2.8.1. NFI software

For the data collection process, mapping tasks, data storage, data processing, data analysis, retrieval and reporting software tools and related IT-infrastructure is essential. The NFI software tools themselves are seen as one modular part of the future Forest Monitoring and Information System (FMIS), allowing management, and monitoring the forests and their development over time.

Several NFI related software modules have been developed as addressed in the ToR. The full set of software modules to be used for the NFI#2 is depicted here. The full set of software modules to be used for the NFI#2 are presented in more detail in the report describing the "NFI#2 software concept".

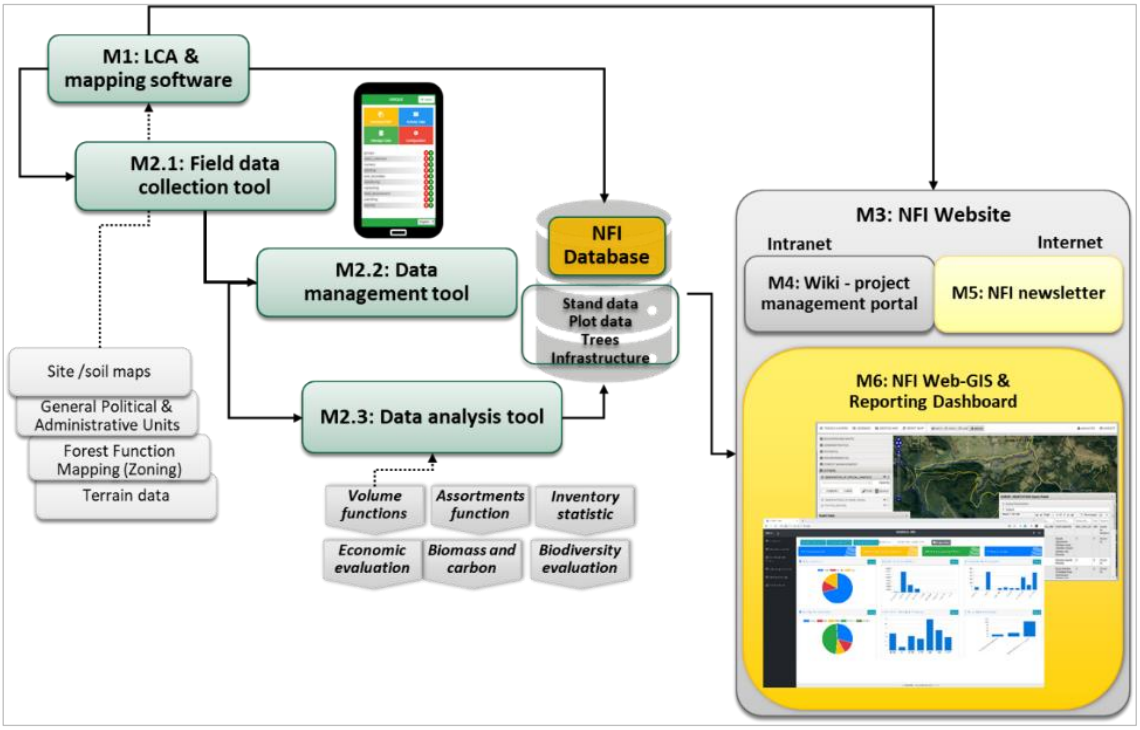


Figure 10 Full Set of Modules for NFI#2

2.8.2. Data Analysis workflow

Along with the field survey, data have been checked, compiled and could finally analyzed. After each field campaign (test in 2019, 2020 1st year) data have been analyzed test wise.

The data analysis workflow ending up with the NFI reports in the format of tables, graphs and maps is described in the following graph. For each step different modules of the NFI software had been applied.

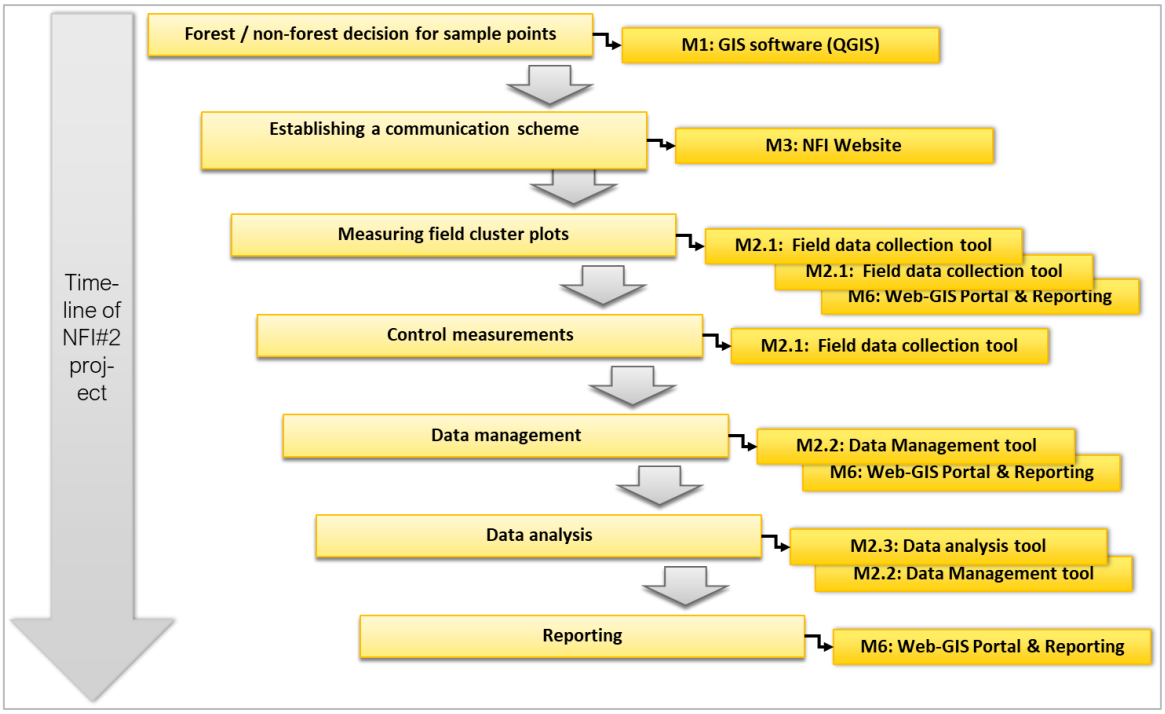


Figure 11 Data Analysis Workflow

2.8.3. Allometric functions

Tree species related allometric models are important as the volume estimations depend on a) reliable and accurate height and diameter measurements in the field and b) reliable and regionalized species-specific functions for volume estimation, biomass, and carbon. The word "regionalized" has been emphasized as there can be a significant difference between the volume estimated by using functions from different regions. Existing allometric models for volume, biomass, and carbon estimations per tree species in Kyrgyzstan had been systematically reviewed.

- The available models identified and suitable for the purposes of this study are presented in the "NFI#2 Report on tree species allometric models in Kyrgyzstan and the procedure for generating new ones".

2.9. Definitions of forest

The definition of "forest" according to national documents: Forest Code, Government documents: No.111 and No. 706 differs from that of the FAO definition. This is addressed by defining the following nomenclature that is used throughout this report:

Forest

The term "forest" is used in this report in line with what FAO defines as "Forest".

Shrub-forest

"Shrub forest" is defined at the national level as a forested area, but according to FAO, "shrub forests" do not refer to a forested area and are defined separately as "other forest land".

Forest and Shrub forest

This term is used when the national definition is applied. It refers to the union of the two landcover types "Forest" and "Shrub forest" as defined above. In Kyrgyzstan a tree covered area outside of settlements and crop land is defined as Forest if the area is > 0.2 ha. This explanation follows the Forest Code, Government documents: No.111 and No. 706.

2.10. Overview on and scopes of analysis

Main level and scopes of the NFI analysis are:

- A geographic scope – analysis by oblasts
- Ownership scope – analysis by different management groups
- Main Forest Formation or Forest Type Group – analysis by typical forest vegetation complexes as expression of forest development under climatic, soil and terrain conditions (see chapter 1.3).

These include area statistics by oblast, forest coverage by forest formations or forest type groups, volumes by oblast and forest formation groups and indicators related to density of forests (number of trees and basal area per hectare).

2.10.1. Geographic scope

The first level of administrative units in Kyrgyzstan, oblasts have been used to analyze data. To reflect the statistical data of the republic, the data of the Statistical Committee and Government document - "Land balance" of the Kyrgyz Republic was used – related digital map layer have been provided by the Forest Service in 2022.

Table 6 Total area per Oblast

	Oblast	Area, (ha) official map of regions	Area – official map of oblast , (in %)
1	Batken	1,703,816	8.5
2	Jalal-Abad	2,004,309	10.0
3	Issyk-Kul	3,365,135	16.8
4	Naryn	4,314,213	21.6
5	Osh	4,542,822	22.7
6	Talas	2,917,377	14.6
7	Chuy	1,147,417	5.7
	Total country	**19,995,089**	**100**

Finally, the area of KG has been adapted to the official 19,995,089 ha published in the Government document - "Land balance" #253-p, 16.05.2022 and adapted the areas of the region proportionally.

Not covered are districts and rayons, in other words: administrative subdivisions of the major oblasts, as their number of samples does not allow the use nor the publication of such results, as the sampling error is too large.

2.10.2. Ownership types

Forests of Kyrgyzstan (Tree forests and shrubby thickets) grow throughout the territory of the republic, on all categories of land (see page 3, Table 1). Basically, the forests of the republic are state-owned, and the right to manage forests belongs to the state. Ownership types refer to:

- **State forest fund (SFF):** Lands and forests of Forest enterprises
- **PA:** Land and forests of National natural parks and natural reserves
- **Outside SFF:** Forest under other authorities (mostly municipalities, but also on agriculture land, forests on military sites etc.).
- **Total Forest Fund:** Overall Forest Fund (all forests in the country).

Forests of forestry enterprises (SFF) are managed by the Forest Service under the Ministry of Agriculture, and forests of national parks, nature

reserves and reserves (forests of protected Areas) are managed by the Department of Biodiversity Conservation and Specially Protected Natural Territories under the Ministry of Natural Resources and Ecology. Municipal forests (mainly shrubby thickets) are managed by Aiyl aimags.

3. NFI#2 results

The results of the second National Forest Inventory are presented hereafter. It starts with an overview on the assessed sampling elements.

The following forest area statistic provides an overview of the LCC based tree and forest cover in the country. In the following the forest area is presented by oblast, ownership type or forest type groups.

The second group of analyses presents standing volume of forests and basal area and number of trees - indicators of density of forests. Finally, the carbon content of the aboveground biomass is shown. Where applicable results of the NFI#1 are existing, a direct comparison is presented.

3.1. Overview on assessed sampling elements

Table 7 Overview on assessed sampling elements

Item	Amount (NFI#1)	Amount (NFI#2)
Number of tracts established in the grid	776	9,990
Number of plots established	3,081	30,694
Number of tracts pre-clarified as forest		1,309
Number of plots pre-clarified as forest (NFI#1 no pre-clarification: plots found with forest cover)	113	2,653
Number of plots pre-clarified as forest and accessible (NFI#1 no pre-clarification: plots found with forest cover)	210	2,489
Number of tracts assessed in the field	113	1,244
Number of plots assessed in the field	210	2,489
Number of plots accessible & measured in the field		2,235
Number of trees measured		13,757
Number of unique tree species		36

Item	Amount (NFI#1)	Amount (NFI#2)
Number of stumps measured		1,346
Number of standing deadwoods measured		493
Number of lying deadwoods measured		686
Number of unique shrub species measured		26
Number of unique species found in the re-generation		34

3.2. Results of the land cover classification on forest area

The land cover and Main Forest Formation classification (LCC) based on satellite images (ESA Sentinel-2) allowed to improve the pre-stratification and improved the estimation of forest area and the area of the six Main Forest Formations. Finally, these area values are used for a post-stratification of the field data resulting in a reduction of the sampling error.

The area of regions of the country has been taken over from the official country boundary and oblast boundary of the "Statistical Committee" received from FS in August 2019 and finally adapted to the official country area of 19,995,089 ha published in the Government document #253-p, 16.05.2022 "On the land balance of Kyrgyzstan". All pixel-based classification results have been corrected to this country area.

In result 9,41% of the total area of Kyrgyzstan is now be classified as covered with forests and trees, which sums up to 1,881,949 hectares.

Table 8 Land cover and tree cover classification of the six Main Forest Formations by remote sensing (Sentinel-2)

Value	Pixel count	% Class	Area (ha)
Spruce-Fir Forest	31,159,733	1.56	311,407.1
Juniper forests	44,018,670	2.20	439,897.9
Walnut and mixed fruit forests	5,765,546	0.29	57,658.6
Pistachio & Almond forests	11,323,644	0.57	113,195.8
Other mixed broadleaved forests	27,136,908	1.36	271,204.6
Other wooded land / Shrub forests	68,906,653	3.44	688,585.3
Forest and other (woodlands, shelter belts…) and trees outside forest	**188,311,154**	**9.41**	**1,881,949.2**
Glaciers and Snow	59,658,126	3.0	596,550.4
Rocks and Bare Soil	852,722,516	42.6	8,526,853.8
Arable Land	203,764,202	10.2	2,037,582.1
Pasture/Grassland	609,046,177	30.5	6,090,361.8
Settlement	8,969,261	0.4	89,732.3
Waterbodies	77,203,027	3.9	772,059.3
Non-Forested area	**1,811,363,309**	**90.59**	**18,113,139.8**
Total	**1,999,674,463**	**100.0**	**19,995,089,0**

3.2.1. Final forest area statistic based on multiple sources

The findings from the NFI#2 on the forest area derived from the LCC process have been compared and combined with different forest area statistics available in the FS, mainly from the Forest Management Planning in SFF land and in protected areas, but meanwhile also implemented for the land outside SFF land, at the same time, data on the country's land is compared, including from the Land Balance of the Kyrgyz Republic, approved on May 16, 2022, # 253-p.

Like the comparison with previous studies on land cover or forest area, the comparison with FMP based statistics on forest area does not fully match with the NFI#2 results. This is because the different inventory and data collection processes using different methods. In the FMP stands are delineated in detail and described in the field, in the NFI we worked with remote sensing data and sample plots. Secondly the FMP data are

from different years and partly older than 10-15 years. The following Table 9 combines the best sources to give the forest area by Main Forest Formation.

Table 9 Area of Forests (FAO + national definition) for the six Main Forest Formations derived from combined data sources with different forest area statistics available in the Forest Service*

Main Forest Formations	Forests (FAO + national) (>= 0.2 ha)		
	ha	in %	% of country area
Spruce & Fir Forests	284,453.1	16.6	1.51
Juniper Forests	420,299.6	24.5	2.02
Walnut Forests	69,438.9	4.0	0.28
Pistachio & Almond Forests	62,763.5	3.7	0.50
Other broadleaved and mixed Forests	235,458.5	13.7	1.29
Shrub Forests	645,153.3	37.6	3.00
Total forest area (LCC + FMP)	**1,717,566.9**	**100.0**	**8.59**
Orchards + other plantations (national land balance)	- 76,680.0	4.5	0.38
Total forest area excluding orchards and other plantations (from national land balance)	**1,640,886.9**	**95.5**	**8.2**
"Other wood-shrub areas" (from national land balance)	- 462,921,0	26.6	2.3
Total forest area excluding shrub forests & orchards and other plantations (from national land balance)	**1,177,965.9**	**68.6**	**5.9**

*) It needs to be stated clearly, that the combined area values are a result of several forest area statistics and therefore cannot be matching 100% to the findings of the LCC (see Table 8) and the results of the NFI#2 field survey (see Table 10). Deviations are caused by different methods and assessment intensities.

In a final step, to match with the national land use statistic (Government document #253-p "On the land balance of Kyrgyzstan" (2022) certain perennial crops like orchards and other plantations have been considered. These tree-covered areas - mainly around settlements – might be bigger than 0.2 ha and cannot be automatically separated from forests when using satellite image classification as in the LCC. Following the land balance ca. 76,680 ha need to be subtracted, resulting in a forest area of 1.64 Mio ha or 8.2% of the country area.

As there is an unsolvable overlap between the category "Orchards and other plantations" in the national land balance and the forest area from the NFI#2, which cannot be identified and separated, for any further analysis of NFI#2 data the land cover analysis data have been

used as the best source – even if patches of orchards and other plantations might be included.

In accordance with the data of the country's land balance (Government Document No. 253 "On the Land Balance of Kyrgyzstan" (2022), some perennial crops were considered, such as gardens and other plantings, shrub land and plantations outside the SFF and protected areas, which do not count to the forested area of the country.

It follows from this that during the classification of vegetation cover during the LCC of NFI#2, according to the national land balance, the areas of the categories "Tree and shrub plantations" and "Gardens and other plantations" outside the SFF land and protected areas it was impossible to identify and show on the map, since there was no access to such maps. According to the land balance, 539,601 ha of those "tree covered areas" can be deducted from the forest and tree covered area of ***1,717,566.9 ha, and as a result, the forest area in the inner sense amounted to 1,177,965.9 ha or 5.9% of the country's area without shrubs.***

As a result, key forest indicators are calculated based on data from sample plots of NFI#2, and the LCC based forest area ***of 1.72 Mio ha of forests or 8.6% of the country's area including all forests***, but also shelter belts, parks, gardens and plantations in a settlement context if these cover an area of more than 0.2 ha.

3.3. Basic area statistics for Kyrgyzstan and the oblasts

The following results are derived from the analysis of the 2,235 forest covered sample plots assessed in the field.

3.3.1. Absolute and relative [%] area of forest and shrub-forest by oblast and ownership type

Table 10 presents the forest area (FAO definition) and the shrub forest area by oblast and ownership type. As before the forest area is calculated including the inaccessible forest plots.

Table 10 Absolute and relative [%] area of forest and shrub-forest by oblast and ownership type

Oblast	Result type and unit	State Forest Fund area			Area outside State Forest Fund			Total Forest Area	Total area of oblast + country
		Forest	Shrub-forest	Total	Forest	Shrub-forest	Total		
Batken	[1000 ha]	117.79	13.14	130.93	31.91	5.63	37.54	168.47	1,702.67
	MOE95±[%]*	11.03	52.34	9.54	34.85	78.60	33.27	0.00	
	[%] of forest & shrub forest area of the oblast	6.92	0.77	7.69	1.87	0.33	2.20	9.89	100.00
Chu	[1000 ha]	18.12	22.12	40.24	31.05	44.14	75.19	115.43	2,002.96
	MOE95±[%]*	32.75	68.56	45.48	20.38	32.19	20.58	19.82	
	[%] of forest & shrub forest area of the oblast	0.90	1.10	2.01	1.55	2.20	3.75	5.76	100.00
Dzhalal-Abad	[1000 ha]	354.54	131.52	486.05	177.78	58.16	235.95	722.00	3,362.87
	MOE95±[%]*	11.19	19.71	9.74	20.38	31.42	18.56	5.99	
	[%] of forest & shrub forest area of the oblast	10.54	3.91	14.45	5.29	1.73	7.02	21.47	100.00
Issyk-Kul	[1000 ha]	117.03	61.12	178.15	12.71	23.07	35.78	213.94	4,311.31
	MOE95±[%]*	1.44	21.77	7.52	5.33	45.54	29.42	7.95	
	[%] of forest & shrub forest area of the oblast	2.71	1.42	4.13	0.29	0.54	0.83	4.96	100.00
Naryn	[1000 ha]	71.57	63.31	134.88	0.00	2.38	2.38	137.26	4,539.76
	MOE95±[%]*	6.59	33.72	16.29	0.00	68.42	68.42	16.12	
	[%] of forest & shrub forest area of the oblast	1.58	1.39	2.97	0.00	0.05	0.05	3.02	100.00
Osh	[1000 ha]	154.75	25.07	179.83	46.52	40.69	87.21	267.04	2,915.41
	MOE95±[%]*	11.40	41.57	9.43	27.49	33.64	20.63	2.49	
	[%] of forest & shrub forest area of the oblast	5.31	0.86	6.17	1.60	1.40	2.99	9.16	100.00
Talas	[1000 ha]	22.25	41.62	63.87	6.40	23.16	29.56	93.43	1,146.64
	MOE95±[%]*	57.73	50.43	38.47	92.30	70.85	64.78	33.11	
	[%] of forest & shrub forest area of the oblast	1.94	3.63	5.57	0.56	2.02	2.58	8.15	100.00

Oblast	Result type and unit	State Forest Fund area			Area outside State Forest Fund			Total Forest Area	Total area of oblast + country
		Forest	Shrub-forest	Total	Forest	Shrub-forest	Total		
Total country	**[1000 ha]**	**856.05**	**357.91**	**1,213.96**	**306.37**	**197.24**	**503.61**	**1,717.57**	**19,981.63**
	MOE95±[%]*	**5.37**	**11.70**	**4.32**	**13.14**	**16.04**	**10.41**	**0.00**	
	[%] of forest & shrub forest area of the country	**4.28**	**1.79**	**6.08**	**1.53**	**0.99**	**2.52**	**8.60**	**100.00**

Most of the forest and shrub-forest is inside the State Forest Fund land (SFF), 1,214,000 ha compared to 503,610 ha. The share of forests and shrub forests on State Forest Fund is 6.08%, forests and shrub forests outside of State Forest Fund land cover 2,52% of the countries area. Of the total forest area, the Main Forest Formation Shrub Forest sums up to 555,500 ha, respective 32% of the forest area. The largest forest area was found in Dzhalal-Abad (720,000 ha), the smallest in Talas (93,430 ha). State Forest Fund forests has the biggest share in Naryn, the smallest in Chu, where forest outside State Forest Fund land is dominating.

3.3.2. Total area and relative area [%] by oblast and Main Forest Formation

Table 11 shows the areas and proportions of the six main Forest Formations for each oblast and the total country.

Shrub Forests cover 32%, Juniper Forests 28%, Spruce-Fir Forest 15%, Other Mixed Broadleaved Forests 17%, Walnut Forests 5% and Pistachio Forests the remaining 2% of the Kyrgyz forests.

Significant differences between oblasts can be observed. Batken forests are almost totally composed by Juniper forests (87.7%) and Shrub forests (11.14%). Issyk-Kul and Naryn are dominated by Spruce Forests. Dzhalal-Abad and Osh have the most diverse forest structures with all or most of the Main Forest Formations present. Most of the country´s Walnut Forests are in Dzhalal-Abad (76,110 ha out of country total of 91,280 ha) as well as Pistachio & Almond Forests (39,670 ha), which was found in small areas as well in Batken (1,880 ha).

It needs to be stated clearly again, that the forest area values presented in Table 9 are a result of several forest area statistics and therefore cannot be matching 100% to the findings of the LCC (see Table 8) and the results of the NFI#2 field survey presented here (see Table 10). Deviations are caused by different methods and assessment intensities.

Table 11 Total area of accessible forest and relative area [%] by Main Forest Formation and oblast*

Oblast	Result type and unit	Spruce-Fir Forests	Juniper Forests	Walnut Forests	Pistachio Forests	Other mixed broadleaved Forests	Shrub Forests	Total forest area
Batken	[1000 ha]		147.82		1.88		18.77	168.47
	MOE95±[%]		5.42		108.92		41.67	0.00
	[%] of forest & shrub forest area of the oblast		87.74		1.11		11.14	100.00
Chu	[1000 ha]	24.55	12.71			11.91	66.26	115.43
	MOE95±[%]	3.47	4.56			72.28	29.57	19.82
	[%] of forest & shrub forest area of the oblast	21.26	11.01			10.32	57.40	100.00
Dzhalal-Abad	[1000 ha]	34.15	177.02	76.11	39.67	205.37	189.68	722.00
	MOE95±[%]	16.90	19.14	12.45	4.81	15.62	15.18	5.99
	[%] of forest & shrub forest area of the oblast	4.73	24.52	10.54	5.49	28.45	26.27	100.00
Issyk-Kul	[1000 ha]	124.05	4.82			0.88	84.19	213.94
	MOE95±[%]	1.37	7.44			18.87	20.11	7.95
	[%] of forest & shrub forest area of the oblast	57.98	2.25			0.41	39.35	100.00
Naryn	[1000 ha]	68.82	2.12			0.63	65.70	137.26
	MOE95±[%]	1.90	201.66			256.74	32.77	16.12
	[%] of forest & shrub forest area of the oblast	50.14	1.54			0.46	47.86	100.00
Osh	[1000 ha]	3.84	133.87	15.17		48.40	65.77	267.04
	MOE95±[%]	7.62	11.83	8.24		15.97	23.79	2.49
	[%] of forest & shrub forest area of the oblast	1.44	50.13	5.68		18.12	24.63	100.00
Talas	[1000 ha]	1.64	5.96			21.04	64.78	93.43
	MOE95±[%]	9.46	99.09			61.03	41.13	33.11
	[%] of forest & shrub forest area of the oblast	1.76	6.38			22.52	69.34	100.00
Total country	**[1000 ha]**	**257.04**	**484.32**	**91.28**	**41.55**	**288.23**	**555.15**	**1,717.57**
	MOE95±[%]	**2.32**	**8.00**	**10.40**	**6.73**	**11.86**	**7.80**	**0.00**
	[%] of forest & shrub forest area of the country	**14.97**	**28.20**	**5.31**	**2.42**	**16.78**	**32.32**	**100.00**

3.4. Basic properties of forests in Kyrgyzstan

3.4.1. Tree and shrub volume by ownership type and oblast

In Table 12 the standing volume of trees and shrubs by ownership type (State Forest Fund and outside State Forest Fund) for each oblast is presented, first separately for trees and shrubs and then as a total of trees and shrubs.

Table 12 Tree and shrub volume by ownership type and oblast

Oblast	Result type and unit	State Forest Fund	Outside State Forest Fund	Total forests
Batken	Tree volume [1000 m³]	3,775.2	502.0	4,277.2
	MOE95±[%]	20.97	50.20	17.33
	Shrub volume [1000 m³]	267.1	80.8	347.9
	MOE95±[%]	17.98	39.66	12.40
	Tree & Shrub volume [1000 m³]	4,042.4	582.8	4,625.2
	% of oblast volume	87.4	12.6	100.0
	Tree volume [m³/ha]	28.8	13.4	25.4
	Shrub volume [m³/ha]	2.0	2.2	2.1
	Trees and shrub volume [m³/ha]	30,9	15,5	27,5
Chu	Tree volume [1000 m³]	1,498.4	4,603.1	6,101.5
	MOE95±[%]	22.10	6.32	7.21
	Shrub volume [1000 m³]	221.0	272.5	493.5
	MOE95±[%]	73.04	25.07	34.83
	Tree & Shrub volume [1000 m³]	1,719.3	4,875.6	6,594.9
	% of oblast volume	26.1	73.9	100.0
	Tree volume [m³/ha]	37.2	61.2	52.9
	Shrub volume [m³/ha]	5.5	3.6	4.3
	Trees and shrub volume [m³/ha]	42,7	64,8	57,1
Dzhalal-Abad	Tree volume [1000 m³]	16,069.9	7,927.3	23,997.1
	MOE95±[%]	10.01	28.36	10.62
	Shrub volume [1000 m³]	1,509.7	1,056.6	2,566.4
	MOE95±[%]	26.94	24.06	11.70
	Tree & Shrub volume [1000 m³]	17,579.6	8,983.9	26,563.5
	% of oblast Tree & Shrub volume	66.2	33.8	100.0
	Tree volume [m³/ha]	33.1	33.6	33.2
	Shrub volume [m³/ha]	3.1	4.5	3.6
	Trees and shrub volume [m³/ha]	36,2	38,1	36,8
Issyk-Kul	Tree volume [1000 m³]	23,644.8	1,730.3	25,375.1
	MOE95±[%]	1.74	6.51	1.65
	Shrub volume [1000 m³]	787.9	112.7	900.6
	MOE95±[%]	24.06	19.78	21.17
	Tree & Shrub volume [1000 m³]	24,432.7	1,842.9	26,275.6
	% of oblast Tree & Shrub volume	93.0	7.0	100.0
	Tree volume [m³/ha]	132.7	48.4	118.6
	Shrub volume [m³/ha]	4.4	3.2	4.2

Oblast	Result type and unit	State Forest Fund	Outside State Forest Fund	Total forests
	Trees and shrub volume [m³/ha]	137,1	51,5	122,8
Naryn	Tree volume [1000 m³]	9,639.7	0.0	9,639.7
	MOE95±[%]	3.64	0.0	3.64
	Shrub volume [1000 m³]	331.1	8.6	339.7
	MOE95±[%]	26.11	21.82	25.47
	Tree & Shrub volume [1000 m³]	9,970.9	8.6	9,979.5
	% of oblast Tree & Shrub volume	99.9	0.1	100.0
	Tree volume [m³/ha]	71.5	0.0	70.2
	Shrub volume [m³/ha]	2.5	3.6	2.5
	Trees and shrub volume [m³/ha]	73,9	3,6	72,7
Osh	Tree volume [1000 m³]	4,129.0	803.1	4,932.2
	MOE95±[%]	15.08	38.71	13.58
	Shrub volume [1000 m³]	536.8	337.6	874.5
	MOE95±[%]	12.02	26.68	8.49
	Tree & Shrub volume [1000 m³]	4,665.9	1,140.8	5,806.6
	% of oblast Tree & Shrub volume	80.4	19.6	100.0
	Tree volume [m³/ha]	23.0	9.2	18.5
	Shrub volume [m³/ha]	3.0	3.9	3.3
	Trees and shrub volume [m³/ha]	26,0	13,1	21,7
Talas	Tree volume [1000 m³]	1,866.4	100.4	1,966.8
	MOE95±[%]	3.88	14.61	74.07
	Shrub volume [1000 m³]	141.0	98.5	239.5
	MOE95±[%]	38.13	62.12	33.88
	Tree & Shrub volume [1000 m³]	2,007.3	198.9	2,206.3
	% of oblast Tree & Shrub volume	91.0	9.0	100.0
	Tree volume [m³/ha]	29.2	3.4	21.1
	Shrub volume [m³/ha]	2.2	3.3	2.6
	Trees and shrub volume [m³/ha]	31,4	6,7	31,4
Total country	**Tree volume [1000 m³]**	**60,623.4**	**15,666.2**	**76,289.6**
	MOE95±[%]	**3.88**	**14.61**	**3.97**
	Shrub volume [1000 m³]	**3,794.6**	**1,967.4**	**5,762.0**
	MOE95±[%]	**8.45**	**15.60**	**5.58**
	Tree & Shrub volume [1000 m³]	**64,418.0**	**17,633.6**	**82,051.6**
	% of total Tree & Shrub volume	**78.5**	**21.5**	**100.0**
	Tree volume [m³/ha]	**49.9**	**31.1**	**44.4**
	Shrub volume [m³/ha]	**3.1**	**3.9**	**3.4**
	Trees and shrub volume [m³/ha]	**53,1**	**35,0**	**47,8**

The total volume of trees is 76,289.6 thousand m³ in Kyrgyzstan. This information was determined with an accuracy of ± 3.97 % (95% confidence interval). Tree volume in the State Forest Fund comprises 60,623.4 thousand m³ and outside of the State Forest Fund the volume of trees is 15,666.2 thousand m³.

The total volume of shrubs is 5,762.0 thousand m³ in Kyrgyzstan. The volume of shrubs in the State Forest Fund with comprises 3,794.6 thousand m³ and outside of the State Forest Fund the volume of shrubs is 1,967.4 thousand m³.

Trees and shrubs have a joint volume of 82,051.6 thousand m³ in Kyrgyzstan.

Expressed in values relative to the area, tree volume in forest is 44.4 m³ per ha; in State Forest Fund it is 49.9 m³ per ha and in forests outside of the State Forest Fund it is lower, namely 31.1 m³ per ha.

By oblast the findings vary substantially.

The oblasts with the highest volume of trees occur in Issyk-Kul with 25,375.1 thousand m³ and in Dzhalal-Abad with 23,997.1 thousand m³. The oblasts with the lowest values of the total volume of trees are Batken with 4,277.2 thousand m³ and Talas with 1,966.8 thousand m³.

The oblast with the highest value of volume of trees per area is Issyk-Kul with 118.6 m³/ha and the lowest value occurs in oblast Talas with 18.5 m³/ha.

3.4.2. Tree and shrub volume by Main Forest Formations and oblast

In Table 13 the standing volume of trees and shrubs by Main Forest Formation and oblast is presented, first separately for trees and shrubs and then as a total of trees and shrubs.

In Kyrgyzstan the total volume of trees is 76,289.6 thousand m³. Most of the tree volume occurs in the Main Forest Formation Spruce-Fir Forests with 46,547.6 thousand m³ followed by Juniper Forests with 10,199.8 thousand m³, Walnut Forests with 9,712.5 and Other mixed and broadleaved Forests with 9,548.4. The lowest values of tree volume occur in Shrub Forests with 186,6 thousand m³ and Pistachio & Almond Forests with 94,7 thousand m³.

In Kyrgyzstan the total volume of shrubs is 5,762.0 thousand m³. Most of the shrub volume occurs in the Main Forest Formation Shrub Forests with 3,012.4 thousand m³ followed by Juniper Forests with 1,472.1 thousand m³ and Other mixed and broadleaved Forests with 730.2 thousand m³. The lowest values of shrub volume occur in Walnut Forests with 88.9 thousand m³ and in Pistachio & Almond Forests with 27.7 thousand m³.

Table 13 Tree and shrub standing volume per area and by oblast

Oblast	Result type and unit	Spruce-Fir Forests	Juniper Forests	Walnut Forests	Pista-chio&Al-mond Forests	Other mixed broadleaved Forests	Shrub Forests	Total forests
Batken	Tree volume [1000 m³]	0.0	4,266.4	0.0	0.0	0.0	10.8	4,277.2
	MOE95±[%]		17.4				85.5	17.3
	Shrub volume [1000 m³]	0.0	264.0	0.0	0.8	0.0	83.2	347.9
	MOE95±[%]		12.8		108.9		47.2	12.4
	Tree & Shrub volume [1000 m³]	0.0	4,530.4	0.0	0.8	0.0	94.0	4,625.2
	% of oblast Tree & Shrub volume	0.0	98.0	0.0	0.0	0.0	2.0	100.0
	Tree volume [m³/ha]		28.9				0.6	25.4
	Shrub volume [m³/ha]		1.8		0.4		4.4	2.1
	Trees and shrub volume [m³/ha]		30.6		0.4		5.0	27.5
Chu	Tree volume [1000 m³]	5,333.5	201.0	0.0	0.0	526.8	40.2	6,101.5
	MOE95±[%]	3.9	5.5			73.1	105.0	7.2
	Shrub volume [1000 m³]	43.9	33.4	0.0	0.0	108.2	308.0	493.5
	MOE95±[%]	6.9	5.0			87.0	37.2	34.8
	Tree & Shrub volume [1000 m³]	5,377.4	234.4	0.0	0.0	634.9	348.2	6,594.9
	% of oblast Tree & Shrub volume	81.5	3.6	0.0	0.0	9.6	5.3	100.0
	Tree volume [m³/ha]	217.3	15.8			44.2	0.6	52.9
	Shrub volume [m³/ha]	1.8	2.6			9.1	4.6	4.3
	Tree and shrub volume [m³/ha]	219.1	18.4			53.3	5.3	57.1
Dzhalal-Abad	Tree volume [1000 m³]	5,903.4	3,498.5	8,409.2	94.7	5,977.7	113.7	23,997.1
	MOE95±[%]	33.1	17.8	9.5	13.0	18.4	36.3	10.6
	Shrub volume [1000 m³]	77.5	729.3	74.2	26.9	530.1	1,128.3	2,566.4
	MOE95±[%]	4.7	24.8	6.2	11.6	28.3	20.1	11.7
	Tree & Shrub volume [1000 m³]	5,980.9	4,227.8	8,483.3	121.6	6,507.8	1,242.0	26,563.5
	% of oblast Tree & Shrub volume	22.5	15.9	31.9	0.5	24.5	4.7	100.0
	Tree volume [m³/ha]	172.9	19.8	110.5	2.4	29.1	0.6	33.2
	Shrub volume [m³/ha]	2.3	4.1	1.0	0.7	2.6	5.9	3.6
	Tree and shrub volume [m³/ha]	175.1	23.9	111.5	3.1	31.7	6.5	36.8
Issyk-Kul	Tree volume [1000 m³]	25,181.0	0.0	0.0	0.0	194.0	0.0	25,375.1
	MOE95±[%]	1.7				18.9		1.7

Oblast	Result type and unit	Spruce-Fir Forests	Juniper Forests	Walnut Forests	Pista-chio&Al-mond Forests	Other mixed broadleaved Forests	Shrub Forests	Total forests
	Shrub volume [1000 m³]	219.9	36.4	0.0	0.0	0.5	643.7	900.6
	MOE95±[%]	1.9	7.8			18.9	29.6	21.2
	Tree & Shrub volume [1000 m³]	25,400.9	36.4	0.0	0.0	194.6	643.7	26,275.6
	% of oblast Tree & Shrub volume	96.7	0.1	0.0	0.0	0.7	2.4	100.0
	Tree volume [m³/ha]	203.0				221.4		118.6
	Shrub volume [m³/ha]	1.8	7.6			0.6	7.6	4.2
	Trees and shrub volume [m³/ha]	204.8	7.6			222.0	7.6	122.8
Naryn	Tree volume [1000 m³]	9,529.4	9.0	0.0	0.0	94.1	7.3	9,639.7
	MOE95±[%]	2.5	122.5			256.7	256.7	3.6
	Shrub volume [1000 m³]	77.8	4.5	0.0	0.0	0.3	257.1	339.7
	MOE95±[%]	3.1	99.1			256.7	33.6	25.5
	Tree & Shrub volume [1000 m³]	9,607.2	13.5	0.0	0.0	94.3	264.4	9,979.5
	% of oblast Tree & Shrub volume	96.3	0.1	0.0	0.0	0.9	2.6	100.0
	Tree volume [m³/ha]	138.5	4.3	0.0		149.3	0.1	25.5
	Shrub volume [m³/ha]	1.1	2.1			0.4	3.9	2.5
	Tree and shrub volume [m³/ha]	139.6	6.4			149.7	4.0	27.9
Osh	Tree volume [1000 m³]	521.0	2,130.0	1,303.3	0.0	966.7	11.2	4,932.2
	MOE95±[%]	8.0	27.4	10.9		32.3	108.7	13.6
	Shrub volume [1000 m³]	5.5	397.4	14.7	0.0	65.9	391.0	874.5
	MOE95±[%]	9.2	14.2	9.6		16.0	23.8	8.5
	Tree & Shrub volume [1000 m³]	526.5	2,527.4	1,318.0	0.0	1,032.6	402.2	5,806.6
	% of oblast Tree & Shrub volume	9.1	43.5	22.7	0.0	17.8	6.9	100.0
	Tree volume [m³/ha]	135.8	15.9	85.9		20.0	0.2	18.5
	Shrub volume [m³/ha]	5.9	3.0	1.0		1.4	5.9	3.3
	Tree and shrub volume [m³/ha]	141.8	18.9	86.9		21.3	6.1	21.7
Talas	Tree volume [1000 m³]	79.4	94.9	0.0	0.0	1,789.1	3.4	0.0
	MOE95±[%]	12.5	99.1			81.3	256.7	74.1
	Shrub volume [1000 m³]	6.0	7.1	0.0	0.0	25.2	201.1	239.5
	MOE95±[%]	10.6	76.1			76.1	37.7	33.9
	Tree & Shrub volume [1000 m³]	85.5	102.0	0.0	0.0	1,814.3	204.4	2,206.3

Oblast	Result type and unit	Spruce-Fir Forests	Juniper Forests	Walnut Forests	Pista-chio&Al-mond Forests	Other mixed broadleaved Forests	Shrub Forests	Total forests
	% of oblast Tree & Shrub volume	3.9	4.6	0.0	0.0	82.2	9.3	100.0
	Tree volume [m³/ha]	48.3	15.9			85.0	0.1	21.1
	Shrub volume [m³/ha]	3.7	1.2			1.2	3.1	2.6
	Tree and shrub volume [m³/ha]	52.0	17.1			86.2	3.2	23.6
Total country	**Tree volume [1000 m³]**	**46,547.6**	**10,199.8**	**9,712.5**	**94.7**	**9,548.4**	**186.6**	**76,289.6**
	MOE95±[%]	**4.3**	**11.1**	**8.3**	**13.0**	**18.7**	**34.0**	**4.0**
	Shrub volume [1000 m³]	**430.7**	**1,472.1**	**88.9**	**27.7**	**730.2**	**3,012.4**	**5,762.0**
	MOE95±[%]	**1.4**	**13.1**	**5.3**	**11.6**	**23.8**	**10.3**	**5.6**
	Tree & Shrub volume [1000 m³]	**46,978.4**	**11,671.9**	**9,801.4**	**122.4**	**10,278.6**	**3,198.9**	**82,051.6**
	% of total Tree & Shrub volume	**57.3**	**14.2**	**11.9**	**0.1**	**12.5**	**3.9**	**100.0**
	Tree volume [m³/ha]	**181.1**	**21.1**	**106.4**	**2.3**	**33.1**	**0.3**	**44.4**
	Shrub volume [m³/ha]	**1.7**	**3.0**	**1.0**	**0.7**	**2.5**	**5.4**	**3.4**
	Trees and shrub volume [m³/ha]	**182.8**	**24.1**	**107.4**	**3.0**	**35.7**	**5.8**	**47.8**

By oblast and Main Forest Formation the findings vary substantially.

The Main Forest Formation within an oblast with the highest volume of trees is Spruce-Fir Forests in Issyk-Kul with 25,375.1 thousand m³. The Main Forest Formations in an oblast with the highest value of volume of trees per area is 222.0 m³/ha in Other mixed broadleaved Forests in Issyk-Kul followed by Spruce-Fir Forests in Chu with 219.1 m³/ha and Spruce-Fir Forests in Issyk-Kul with 204.8 ha/ha.

3.4.3. Area and number of trees by Main Forest Formation

In Table 14 the area, the total number of trees and the number of trees per hectare by Main Forest Formation is presented.

Table 14 Area and number of trees by Main Forest Formation

Main Forest Formation	Area [ha]	N trees/ha	N trees	N trees - MOE95±[%]
Spruce-Fir Forests	257,036	422	108,400,640	3.2
Juniper Forests	484,324	174	84,301,845	13.6
Walnut Forests	91,275	331	30,233,440	11.3
Pistachio & Almond Forests	41,549	94	3,897,484	13.0
Other mixed broadleaved Forests	288,233	332	95,621,678	18.4
Shrub Forests	555,149	6	3,300,387	52.1
Total Country	**1,717,567**	**190**	**325,755,474**	**6.3**

In total the estimated number of trees in Kyrgyzstan is 325.7 million of trees. Most trees with 106.4 million of trees occur In Spruce-Fir Forests, followed by Other mixed broadleaved Forests with 331.8 million of trees and Juniper Forests with 84.3 million of trees. In Walnut Forests with 30.3, in Pistachio & Almond Forests with 3.8 and in Shrub Forests with 3.3 million substantially less trees occur.

Under the six Main Forest Formations Spruce-Fir Forests with 421.7 trees/ha, Walnut Forests with 331.2 trees/ha and Other mixed broad-leaved Forests with 331.8 trees/ha are those with the highest number of trees per ha. Juniper Forests with 174.1 trees/ha, Pistachio & Almond Forests with 93.8 trees/ha and Shrub Forests with 6.0 trees/ha show substantially lower values.

3.4.4. Area and number of trees by Tree Species Groups

Table 15 Area and number of trees by Tree Species Groups

Tree Species Groups	Area [ha]	N trees/ha	N trees	N trees - MOE95±[%]
Picea schrenkiana Gr.	1,717,567	58	100,269,417	3.4
Pinus sylvestris Gr.	1,717,567	1	1,230,481	7.4
Juniperus Gr.	1,717,567	49	84,680,665	13.5
Juglans regia Gr.	1,717,567	7	12,699,345	13.1
Acer turkestanica Gr.	1,717,567	16	27,496,389	17.7
Malus & fruit trees Gr.	1,717,567	15	25,088,528	23.9
Pistacia Gr.	1,717,567	2	3,656,670	13.6
Crataegus-Sorbus-Morus Gr.	1,717,567	32	55,444,761	28.1
Betula & other BL Gr.	1,717,567	5	8,503,473	53.7
Populus-salix Gr.	1,717,567	4	6,685,745	61.4
Total	**1,717,567**	**190**	**325,755,474**	**6.3**

In Table 15 the area, the total number of trees and the number of trees per hectare by Main Forest Formation is presented.

In total the estimated number of trees in Kyrgyzstan is 325.7 million of trees. The most frequent tree species group is Picea schrenkiana group with 100 million trees, followed by the Juniperus group (84 million trees) and the Crataegus-Sorbus-Morus group with 55 million trees.

As individual trees have no area, the area for the tree species groups is always the total forest area, the density information N/ha in result is proportional to the total N and respective highest in the Picea schrenkiana group (58 N/ha) and lowest in the rare Pinus sylvestris group (1 N/ha).

3.4.5. Carbon stock from above- and below-ground biomass of trees and shrubs

3.4.5.1. Carbon by "ownership type" and oblast

In Table 16 Carbon by "ownership type" and oblast the aboveground carbon stored in trees and shrubs is presented per ownership type and oblast. It is shown in CO2-equivalents.

Table 16 Carbon by "ownership type" and oblast

Oblast	Result type and unit	SFF	Outside SFF	Total
Batken	CO2-equiv. trees [t/ha]	35.00	16.18	30.81
	CO2-equiv. trees [1000 t]	4,582.4	607.5	5,189.9
	MOE95±[%] trees	21.0	50.2	17.4
	CO2-equiv. shrubs [t/ha]	3.07	3.27	3.11
	CO2-equiv. shrubs [1000 t]	401.4	122.7	524.1
	MOE95±[%] shrubs	18.2	39.7	12. 6
	CO2-equiv. trees & shrubs [t/ha]	38.10	19.45	33.92
	CO2-equiv. trees & shrubs [1000 t]	4,983.7	730.3	5,714.0
Chu	CO2-equiv. trees [t/ha]	40.47	65.51	56.78
	CO2-equiv. trees [1000 t]	1,628.6	4,925.3	6,553.9
	MOE95±[%] trees	20.1	7.1	7.3
	CO2-equiv. shrubs [t/ha]	8.28	5.28	6.32
	CO2-equiv. shrubs [1000 t]	333.3	396.6	729.9
	MOE95±[%] shrubs	73.5	24.6	35.4
	CO2-equiv. trees & shrubs [t/ha]	48.75	70.79	63.10
	CO2-equiv. trees & shrubs [1000 t]	1,961.9	5,322.0	7,283.9
Dzhalal-Abad	CO2-equiv. trees [t/ha]	46.46	42.13	45.05
	CO2-equiv. trees [1000 t]	22,583.5	9,941.50	32,525.0
	MOE95±[%] trees	10.6	25.1	9.7
	CO2-equiv. shrubs [t/ha]	4.61	6.85	5.34
	CO2-equiv. shrubs [1000 t]	2,240.0	1,615.8	3,855.8
	MOE95±[%] shrubs	14.4	27.3	11.8
	CO2-equiv. trees & shrubs [t/ha]	51.07	48.98	50.39
	CO2-equiv. trees & shrubs [1000 t]	24,823.5	11,557.3	36,380.8
Issyk-Kul	CO2-equiv. trees [t/ha]	140.22	50.57	125.23
	CO2-equiv. trees [1000 t]	24,980.6	1,809.6	26,790.2
	MOE95±[%] trees	1.7	6.5	1.7
	CO2-equiv. shrubs [t/ha]	5.80	4.56	5.59
	CO2-equiv. shrubs [1000 t]	1,033.6	163.3	1,196.9
	MOE95±[%] shrubs	21.3	19.4	18.6
	CO2-equiv. trees & shrubs [t/ha]	146.02	55.13	130.82
	CO2-equiv. trees & shrubs [1000 t]	26,014.2	1,973.0	27,987.2
Naryn	CO2-equiv. trees [t/ha]	74.91	0.0	73.61
	CO2-equiv. trees [1000 t]	10,104.0	0.0	10,104.0
	MOE95±[%] trees	3.48		3.48
	CO2-equiv. shrubs [t/ha]	3.41	5.18	3.44
	CO2-equiv. shrubs [1000 t]	460.5	12.3	472.8
	MOE95±[%] shrubs	25.2	22.9	24.6

Oblast	Result type and unit	SFF	Outside SFF	Total
Osh	CO2-equiv. trees & shrubs [t/ha]	78.32	5.18	77.05
	CO2-equiv. trees & shrubs [1000 t]	10,564.5	12.3	10,576.8
	CO2-equiv. trees [t/ha]	29.99	12.62	24.32
	CO2-equiv. trees [1000 t]	5,392.9	1,100.9	6,493.8
	MOE95±[%] trees	14.5	38.9	13.2
	CO2-equiv. shrubs [t/ha]	4.36	5.89	4.86
	CO2-equiv. shrubs [1000 t]	784.6	514.1	1,298.7
	MOE95±[%] shrubs	12.1	26.7	8.7
	CO2-equiv. trees & shrubs [t/ha]	34.35	18.51	29.18
	CO2-equiv. trees & shrubs [1000 t]	6,177.5	1,615.0	7,792.5
Talas	CO2-equiv. trees [t/ha]	33.5	3.99	24.16
	CO2-equiv. trees [1000 t]	2,139.5	117.8	2,257.3
	MOE95±[%] trees	73.8	94.2	70.1
	CO2-equiv. shrubs [t/ha]	3.00	4.96	3.62
	CO2-equiv. shrubs [1000 t]	191.8	146.5	338.3
	MOE95±[%] shrubs	34.0	63.4	35.4
	CO2-equiv. trees & shrubs [t/ha]	36.50	8.95	27.78
	CO2-equiv. trees & shrubs [1000 t]	2,331.3	264.3	2,595.6
Total country	**CO2-equiv. trees [t/ha]**	**58.83**	**36.74**	**52.35**
	CO2-equiv. trees [1000 t]	**71,411.5**	**18,502.8**	**89,914.3**
	MOE95±[%] trees	**4.3**	**13.8**	**4.0**
	CO2-equiv. shrubs [t/ha]	**4.49**	**5.90**	**4.90**
	CO2-equiv. shrubs [1000 t]	**5,445.2**	**2,971.4**	**8,416.6**
	MOE95±[%] shrubs	**8.1**	**15.9**	**5.6**
	CO2-equiv. trees & shrubs [t/ha]	**63.31**	**42.64**	**57.25**
	CO2-equiv. trees & shrubs [1000 t]	**76,856.7**	**21,474.3**	**98,331.0**

In Kyrgyzstan the total aboveground carbon in trees and shrubs is 98,331.0 thousand tons CO2-equivalents, or, expressed per area, 57.25 t/ha CO2-equivalents. The majority of 76,856.7 thousand tons occurs in State Forest Fund, in forests outside State Forest Fund 21,474.3 thousand tons are stored. The oblast with the highest storage is Dzhalal-Abad with 36,380.8 thousand tons, followed by Issyk-Kul with 27,987.2 thousand tons.

3.4.5.2. Carbon by Main Forest Formation and oblast

In Table 17 the aboveground carbon stored in trees and shrubs per Main Forest Formation and oblast is presented in CO2-equivalents.

Table 17 Carbon by Main Forest Formation and oblast

Oblast	Result type and unit	Spruce-Fir Forests	Juniper Forests	Walnut Forests	Pistachio & Almond Forests	Other mixed broadleaved Forests	Shrub Forests	Total
Batken	CO2-equiv. trees [t/ha]		35.02				0.68	3.11
	CO2-equiv. trees [1000 t]	0.0	5,177.1	0.0	0.0	0.0	12.8	5,189.9
	MOE95[%] trees		17.5				85.5	17.3
	CO2-equiv. shrubs [t/ha]		2.68		0.61		6.73	3.11
	CO2-equiv. shrubs [1000 t]	0.0	396.6	0.0	1.1	0.0	126.4	524.2
	MOE95[%] shrubs		13.0		108.9		47.2	12.6
	CO2-equiv. trees & shrubs [t/ha]		37.70		0.61		7.41	6.22
	CO2-equiv. trees & shrubs [1000 t]	0.0	5,573.8	0.0	1.14	0.0	139.1	5,714.0
Chu	CO2-equiv. trees [t/ha]	133.71	19.43			48.60	1.09	6.32
	CO2-equiv. trees [1000 t]	5,656.0	246.9	0.0	0.0	579.0	72.0	6,553.9
	MOE95[%] trees	3.9	5.5			72.7	105.0	7.3
	CO2-equiv. shrubs [t/ha]	2.72	3.90			13.79	6.78	6.32
	CO2-equiv. shrubs [1000 t]	66.8	49.6	0.0	0.0	164.3	449.3	729.9
	MOE95[%] shrubs	7.0	5.0			87.0	37.9	35.4
	CO2-equiv. trees & shrubs [t/ha]	136.43	23.33			62.39	7.87	12.65
	CO2-equiv. trees & shrubs [1000 t]	5,722.8	296.5	0.0	0.0	743.2	521.3	7,283.9
Dzhalal-Abad	CO2-equiv. trees [t/ha]	182.41	23.9	164.99	4.78	44.62	0.82	5.34
	CO2-equiv. trees [1000 t]	6229.0	4231.1	12557.0	189.8	9163.5	154.7	32,525.0
	MOE95[%] trees	32.8	17.8	9.4	13.0	18.7	39.9	9.7
	CO2-equiv. shrubs [t/ha]	3.45	5.85	1.48	1.04	3.97	9.13	5.34
	CO2-equiv. shrubs [1000 t]	117.7	1,036.0	112.7	41.1	815.9	1,732.4	3,855.8

Oblast	Result type and unit	Spruce-Fir Forests	Juniper Forests	Walnut Forests	Pistachio & Almond Forests	Other mixed broadleaved Forests	Shrub Forests	Total
Issyk-Kul	MOE95[%] shrubs	4.7	23.8	6.2	11.5	28.5	20.2	11.8
	CO2-equiv. trees & shrubs [t/ha]	185.86	29.75	166.47	5.82	48.59	9.95	10.68
	CO2-equiv. trees & shrubs [1000 t]	6,346.7	5,267.0	12,669.7	230.9	9,979.4	1,887.1	36,380.8
	CO2-equiv. trees [t/ha]	213.85				299.86		5.59
	CO2-equiv. trees [1000 t]	26.527.3	0.0	0.0	0.0	262.9	0.0	26,790.2
	MOE95[%] trees	1.7				18.9		1.7
	CO2-equiv. shrubs [t/ha]	2.57	8.96			0.91	9.91	5.59
	CO2-equiv. shrubs [1000 t]	318.2	43.2	0.0	0.0	0.8	834.7	1,196.9
	MOE95[%] shrubs	1.9	7.8			18.9	26.7	18.6
	CO2-equiv. trees & shrubs [t/ha]	216.42	8.96			300.77	9.91	11.19
	CO2-equiv. trees & shrubs [1000 t]	26845.6	43.2	0.0	0.0	263.7	834.7	27,987.2
Naryn	CO2-equiv. trees [t/ha]	145.24	5.23			143.98	0.11	3.44
	CO2-equiv. trees [1000 t]	9,995.2	11.1	0.0	0.0	90.7	7.021	10,104.0
	MOE95[%] trees	2.5	122.5			256.7	256.7	3.5
	CO2-equiv. shrubs [t/ha]	1.65	3.23			0.61	5.36	3.44
	CO2-equiv. shrubs [1000 t]	113.3	6.8	0.0	0.0	0.4	352.3	472.8
	MOE95[%] shrubs	3.1	99.1			256.7	32.9	24.6
	CO2-equiv. trees & shrubs [t/ha]	146.89	8.46			144.59	5.47	6.89
	CO2-equiv. trees & shrubs [1000 t]	10,108.5	17.9	0.0	0.0	91.1	359.3	10,576.9
Osh	CO2-equiv. trees [t/ha]	142.15	19.68	126.45		28.57	0.21	4.86
	CO2-equiv. trees [1000 t]	545.2	2,634.1	1918.2		1,382.6	13.81	6,493.8
	MOE95[%] trees	8.0	27.3	10.9	0.0	31.7	108.7	13.2
	CO2-equiv. shrubs [t/ha]	2.17	4.34	1.48		2.06	8.93	4.86
	CO2-equiv. shrubs [1000 t]	8.3	580.9	22.4	0.0	99.7	587.4	1,298.7
	MOE95[%] shrubs	9.2	14.2	9.6		16.1	24.1	8.7
	CO2-equiv. trees & shrubs [t/ha]	144.32	24.02	127.92		30.63	9.14	9.73
	CO2-equiv. trees & shrubs [1000 t]	553.5	3,215.1	1,940.5	0.0	1,482.3	601.2	7,792.5
Talas	CO2-equiv. trees [t/ha]	50.51	18.8			97.84	0.05	3.62
	CO2-equiv. trees [1000 t]	83.0	112.0	0.0	0.0	2,059.1	3.2	2,257.3
	MOE95[%] trees	12.5	99.1			76.7	256.7	70.1

Oblast	Result type and unit	Spruce-Fir Forests	Juniper Forests	Walnut Forests	Pistachio & Almond Forests	Other mixed broadleaved Forests	Shrub Forests	Total
Total country	CO2-equiv. shrubs [t/ha]	4.26	1.82			1.81	4.36	3.62
	CO2-equiv. shrubs [1000 t]	7.0	10.9	0.0	0.0	38.2	282.2	338.3
	MOE95[%] shrubs	10.5	99.1			76.1	39.6	35.5
	CO2-equiv. trees & shrubs [t/ha]	54.76	20.62			99.66	4.41	7.24
	CO2-equiv. trees & shrubs [1000 t]	90.0	122.9	0.0	0.0	2097.3	285.4	2595.7
	CO2-equiv. trees [t/ha]	**190.77**	**25.63**	**158.59**	**4.57**	**46.97**	**0.47**	**52.35**
	CO2-equiv. trees [1000 t]	**49,035.8**	**12,412.4**	**14,475.1**	**189.8**	**13,537.7**	**263.5**	**89,914.3**
	MOE95[%] trees	**4.3**	**11.1**	**8.2**	**13.0**	**16.6**	**38.1**	**4.0**
	CO2-equiv. shrubs [t/ha]	**2.46**	**4.39**	**1.48**	**1.02**	**3.88**	**7.86**	**4.90**
	CO2-equiv. shrubs [1000 t]	**631.3**	**2,124.0**	**135.1**	**42.3**	**1,119.3**	**4,364.7**	**8,416.7**
	MOE95[%] shrubs	**1.4**	**12.5**	**5.3**	**11.6**	**23.9**	**10.0**	**5.6**
	CO2-equiv. trees & shrubs [t/ha]	**193.23**	**30.02**	**160.07**	**5.59**	**50.85**	**8.33**	**57.25**
	CO2-equiv. trees & shrubs [1000 t]	**49,667.1**	**14,536.4**	**14,610.2**	**232.1**	**14,657.0**	**4,628.2**	**98,331.0**

In Kyrgyzstan the total aboveground carbon in trees and shrubs is 98,331.0 thousand tons CO2-equivalents. Most carbon in trees and shrubs occurs in the Main Forest Formation Spruce-Fir Forests with 49,667.1 thousand tons CO2-equivalents.

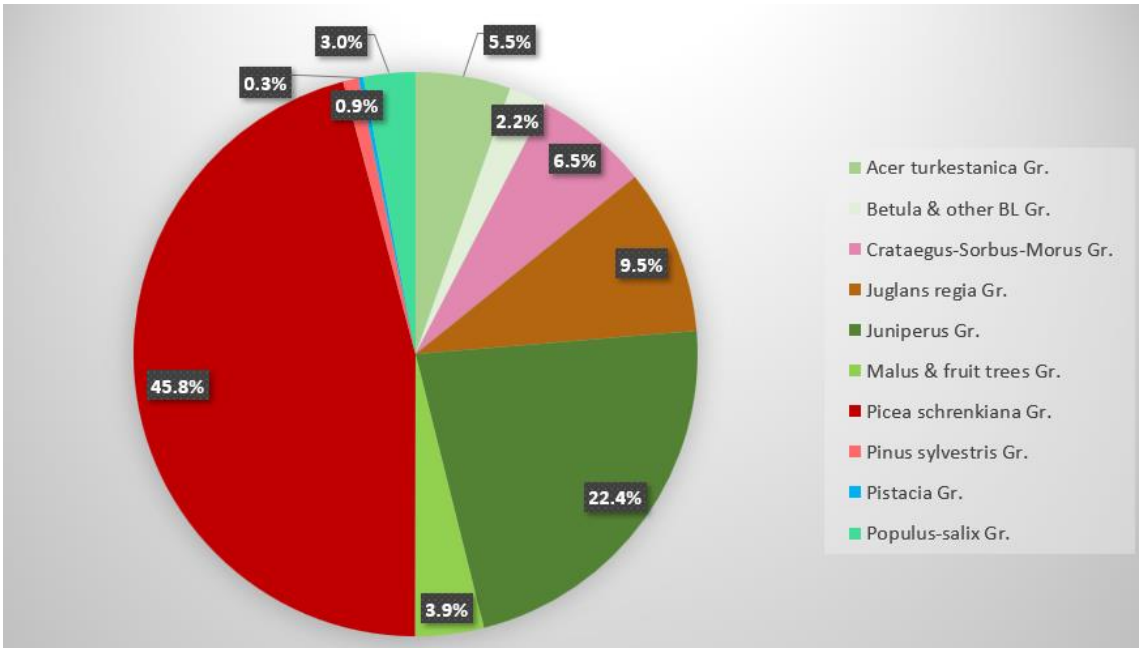
The oblast with the highest total aboveground carbon in trees and shrubs is Dzhalal-Abad with 36,380.8 thousand tons.

The Main Forest Formation in an oblast with the highest aboveground carbon in trees and shrubs is Spruce-Fir Forests in Issyk-Kul with 10,313.4 thousand tons.

3.4.6. Share of tree species groups

36 different tree species have been identified in the field; they are grouped in 10 tree species groups. Figure 12 shows the share of the 10 forest tree species groups in the country.

Figure 12 Share of tree species groups from basal area

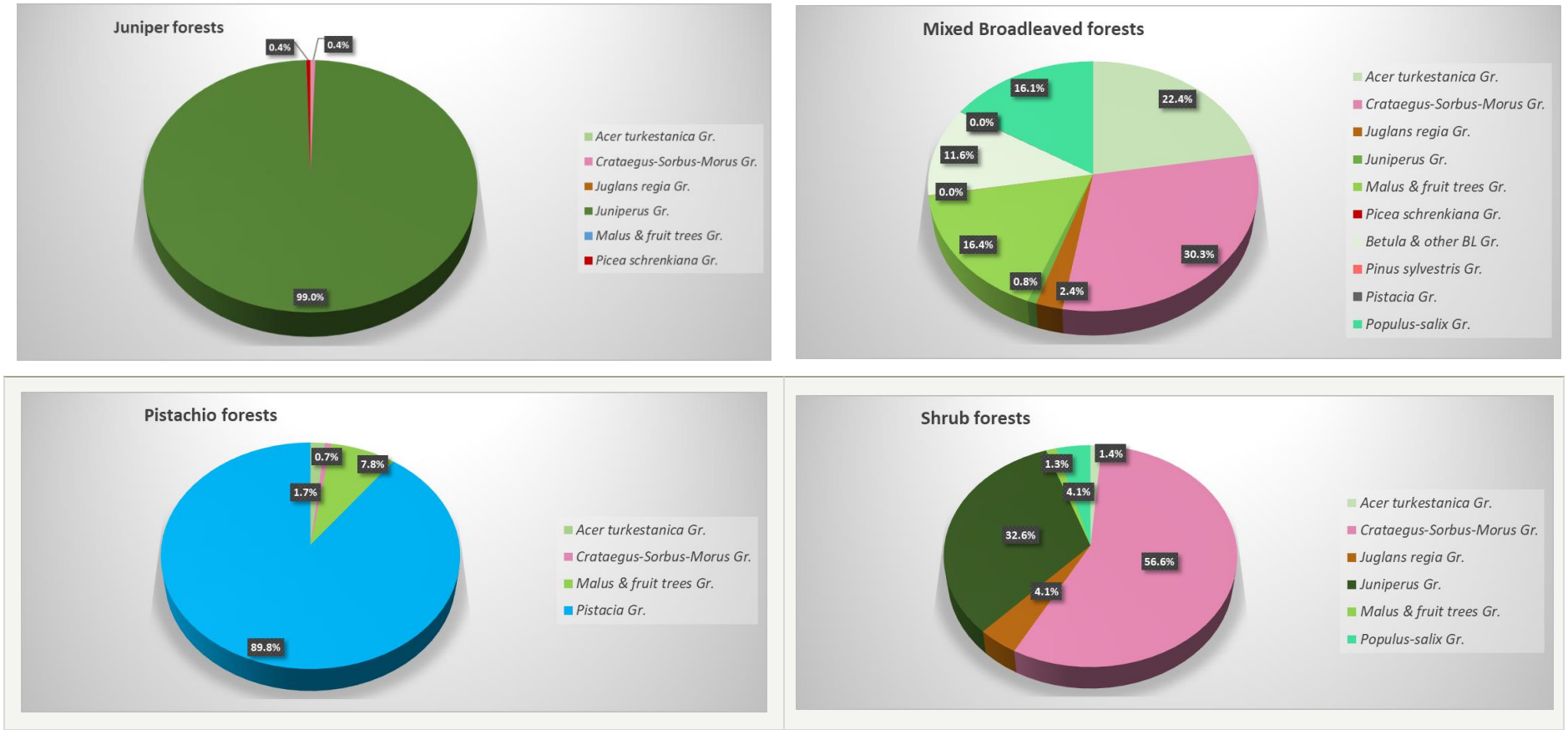


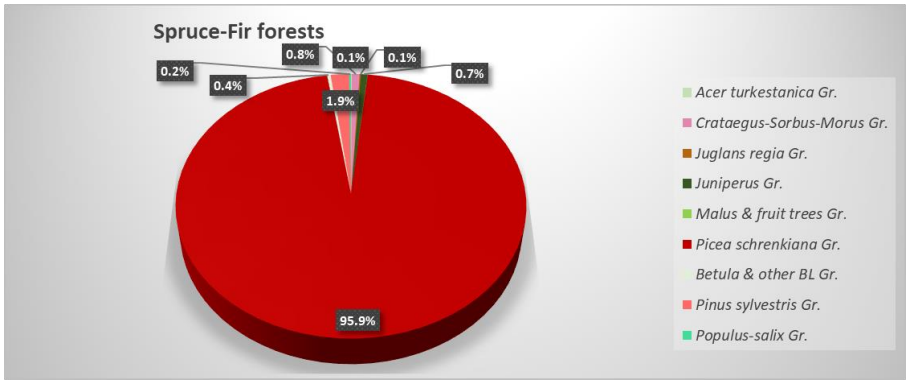
The Picea schrenkiana group dominates in the forests of Kyrgyzstan with a share of 45.8% (share of the basal area). Species group Juniperus has a share of 22.4%, followed by the Juglans regia group with 9.5%. The other species groups have smaller shares: Crataegus-Sorbus-Morus group with 6.5%, Acer turkestanica group 5.5 %, the Malus & fruit trees group 3.9%, Populus-salix group with 3.0%, Betula and other broad-leaved group 2.2%, Pinus sylvestris group 0.9% and Pistacia group with 0.3%.

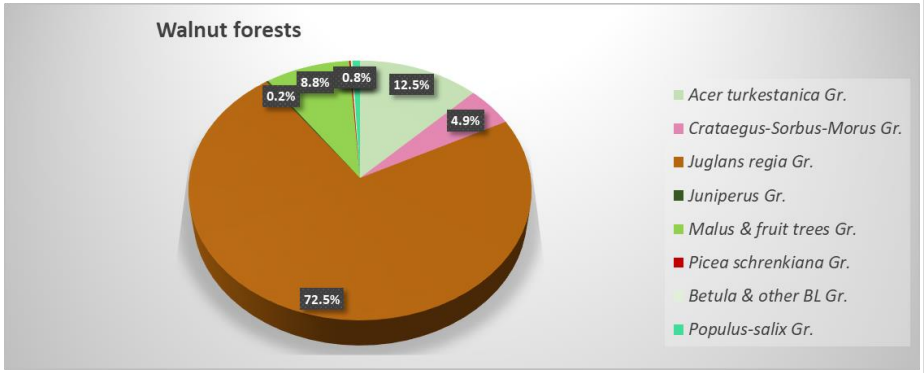
3.4.7. Share of tree species groups inside of the Main Forest Formations

The tree species groups typically forming the six Main Forest Formations are shown in Figure 13.

Figure 13 Share of tree species groups from basal area by Main Forest Formation







The Main Forest Formations are each characterized by a typical tree species distribution: In Juniper Forests the dominating tree species group is the Juniperus group that's basal area cover a share of 99.0%. In Pistachio & Almond forests the species group Pistachio dominates with 89.8%. In Spruce-Fir Forests Picea schrenkiana dominates with 95.9%. In Walnut Forests Juglans regia dominates with 72.5%. Merely in the Main Forest Formations Mixed Broadleaved Forests and in Shrub Forests several species from the forests: in Mixed broadleaved Forests the Crataegus-Sorbus-Morus group contributes 30.3%, the Acer turkestanica group 22.4% and Malus and fruit trees group 16.4% and Populus salix group as well with 16.1%. In Shrub Forests the Crataegus-Sorbus-Morus group dominates with 56.6% followed by the Juniperus group with 32.6%.

3.4.8. Tree volume, increment of tree volume and increment given in CO2-equivalents

The volume increment of all measured trees in the entire forest and in the six Main Forest Formations is shown in Table 18.

Table 18 Tree volume, increment of tree volume and increment given in CO2-equivalents

Result type and unit	Spruce-Fir Forests	Juniper Forests	Walnut Forests	Pistachio Forests	Other mixed broad-leaved For-ests	Shrub Forests	Total forests
Tree volume [1000 m³]	46,547.6	10,199.8	97,12.5	94.7	9,548.4	186.6	76,289.6
Tree volume [m³/ha]	181.1	21.1	106.4	2.3	33.1	0.3	57.4
Volume increment [1000 m³/a]	897.8	263.8	255.5	4.2	325.3	10.1	1,756.9
Volume increment [m³/ha/a]	3.5	0.5	2.8	0.1	1.1	0.02	1.0
CO2-equivalent increment [1000 t/a]	952.0	320.7	375.5	8.2	475.2	14.5	2,146.1
CO2-equivalent increment [t/ ha/a]	3.7	0.7	4.1	0.2	1.6	0.03	1.3

The volume increment in the forests of Kyrgyzstan is 1,756.9 thousand m³ and the Co2-equivalent increment is 2,146.1 thousand tons and expressed relative to the forest area the volume increment is 1.0 m³/ha.

The volume increment is highest in Spruce-Fir Forests with 897.8 thousand m³ in total or 3.5 m³/ha. The volume increment is also relatively high in Walnut Forests with 255.5 thousand m³ in total or 2.8 m³/ha followed by Other mixed broadleaved Forests there the volume increment is 325.3 thousand m³ in total or 1.1 m³/ha and in Juniper Forests with 263.8 thousand m³ in total or 0.5 m³/ha. In the Pistachio & Almond Forests and in Shrub Forests the volume increment is low.

3.5. Protection status

For each plot the protection status was assessed. The status "nature protected area" was assessed if the forest was in a protected area, a nature reserve or national park.

In Table 19 the protected areas are presented by oblast and for the entire country.

Table 19 Area by oblast and protection status

Oblast	Forest in nature protected areas			Forest outside nature protected areas		
	Area (ha)	Area (%)	MoE (95%)	Area (ha)	Area (%)	MoE (95%)
Batken	3,754.2	2.2	107.7	164,717.2	97.8	2.5
Chu	31,295.1	27.1	19.6	84,135.2	72.9	26.2
Dzhalal-Abad	57,555.2	8.0	39.6	664,444.9	92.0	6.8
Issyk-Kul	13,478.4	6.3	5.0	200,458.0	93.7	8.5
Naryn	23,295.8	17.0	26.2	113,966.6	83.0	18.8
Osh	5,121.3	1.9	110.2	261,917.1	98.1	3.3
Talas	20,576.0	22.0	62.9	72,852.0	78.0	35.4
Total country	**155,076.1**	**9.0**	**17.2**	**1,562,490.9**	**91.0**	**1.7**

In the forests of Kyrgyzstan 9.0% are under a legal protection status. In several oblasts the protection status exceeds 15%: in Issyk-Kul with 17.0%, Talas with 22.0% and in Chu with 27.1%. In other oblasts the share of forests under a nature protection status is below 9%: Dzhalal-Abad with 8.0%, Issyk-Kul with 6.3%, Batken with 2.2% and Osh with 1.9%

3.6. Tree regeneration

The regeneration of forest trees has been measured on up to 4 circular sub-plots per sample plot, each subplot with a radius of 2 m. The young trees were counted grouped by height-diameter classes, type of origin and vitality.

The results are presented in the following three tables, Table 20 shows the regeneration by Main Forest Formation and Table 21 by age class.

Table 20 Regeneration by Main Forest Formation

Main Forest Formations	Forest area [ha]	N trees	N trees/ha	Area with regeneration [%]	N trees/ha in regeneration areas
Spruce-Fir Forests	257,036.2	256,755,253	998.9	31.0	3,221.1
Juniper Forests	484,323.9	59,091,365	122.0	16.4	746.1
Walnut Forests	91,275.0	48,126,486	527.3	42.6	1,238.1
Pistachio & Almond Forests	41,549.3	6,321,024	152.1	17.7	857.8
Other mixed broad-leaved Forests	288,233.1	86,570,821	300.4	31.8	944.0
Shrub Forests	555,149.3	68,859,957	124.0	3.9	3,160.1
Total	**1,717,567.0**	**525,724,906**	**306.1**	**18.6**	**1,649.8**

By Main Forest Formation (Table 20) substantial differences occur as well. The highest number of regeneration occurs in Spruce-Fir Forests with 998.9 trees per ha, the smallest number in Juniper Forests with 122.0 trees per ha.

Table 21 Regeneration by age class

Age Class	Forest area [ha]	N trees	N trees/ha	Area with regener-ation [%]	N trees/ha in regeneration areas
1.0 - 19.9	11,400.0	2,743,634	240.7	15.5	1,549.7
20.0 - 39.9	185,963.7	65,374,714	351.5	33.9	1,038.3
40.0 - 59.9	296,278.4	121,969,047	411.7	26.7	1,543.9
60.0 - 79.9	287,629.8	95,854,245	333.3	21.9	1,520.4
80.0 - 99.9	152,067.8	71,229,246	468.4	24.0	1,947.7
100.0 - 119.9	72,387.9	35,449,769	489.7	29.4	1,667.2
120.0 - 139.9	43,454.2	22,676,315	521.8	24.0	2,170.5
140.0 - 159.9	35,965.6	29,147,435	810.4	27.1	2,995.6
160.0 - 179.9	11,420.7	2,258,114	197.7	26.4	749.8
180.0 - 199.9	5,908.3	2,550,644	431.7	11.1	3,879.4
200.0 - 219.9	4,507.1	2,490,912	552.7	39.6	1,396.1
220.0 - 239.9	643.9	348,806	541.7	68.1	795.8
>= 240	9,771.6	174,111	17.8	2.0	895.2
Temporarily no trees	45,018.7	4,597,956			
Shrub Forests	555,149.3	68,859,957	124.0	3.9	3,160.1
Total country	**1,717,567.0**	**525,724,906**	**306.1**	**18.6**	**1,649.8**

The number of regeneration trees per area is very evenly occurring through all age classes, only in forests exceeding an age of 240 years it was low with only 17.8 per ha.

In all other age-classes the number of regeneration trees per ha is between 197.7 in age class 160.0 - 179.9 and 810.4 in age class 140.0 - 159.9.

3.7. Additional forest indicators

This chapter compiles information on additional aspects of forests. This comprises standing and lying dead wood, the information about the vertical structure of forest stands and the layer structure. Finally, the origin of the forest is presented showing the share of artificial and natural regenerated stands.

3.7.1. Total deadwood

Standing and lying deadwood had been assessed on all sample plots. The number of trees, the volume, biomass and CO2-equivalents of standing and lying dead trees by oblast and for entire Kyrgyzstan are available. As the decay of the deadwood has been assessed, the biomass and the CO2-equivalents are calculated considering the observed changes in the decay process.

Total deadwood (standing deadwood plus lying deadwood) by oblast is shown in Table 22.

Table 22 Sum of standing and lying deadwood by oblast

Oblast	Area of for-est [ha]	N dead wood pieces /ha	Vol (m³/ha)	Biom. (t/ha)	CO2-eqiv. (t/ha)	N dead wood pieces	Vol (m³)	Biom. (t)	CO2-equiv. (t)
Batken	168,471.4	8.8	1.5	0.9	1.3	1,479,060	249,492	145,927	211,698
Chu	115,430.3	25.5	4.6	2.7	3.1	2,944,998	536,011	308,179	353,558
Dzhalal-Abad	722,000.1	16.4	4.0	2.4	3.1	11,862,451	2,853,201	1,697,161	2,236,633
Issyk-Kul	213,936.4	14.4	10.3	5.4	6.5	3,070,680	2,196,133	1,153,244	1,394,665
Naryn	137,262.4	15.8	8.0	4.3	5.3	2,166,451	1,104,805	591,437	722,516
Osh	267,038.4	9.3	1.1	0.7	1.1	2,484,606	282,324	175,848	289,206
Talas	93,428.0	0.9	0.3	0.1	0.2	83,590	26,305	13,416	23,083
Total country	**1,717,567.0**	**14.0**	**4.2**	**2.4**	**3.0**	**24,091,836**	**7,248,272**	**4,085,211**	**5,231,358**

In Kyrgyzstan the total dead wood sums up to 4.2 m³ per ha. There are substantial differences between oblasts, Issyk-Kul has the highest values of total dead wood volume per ha with 10.3m³/ha, Talas the lowest with 0.3m³/ha.

The volume per ha of the living trees is 44.4 m³ per ha (see Table 13). Thus, the volume of living and dead wood sums up to a total of 48.6 m³ per ha. Thus, total dead wood contributes substantially to volume, biomass and CO2-equivalents. In total, dead wood comprises 5.2 Mio tons of CO2-equivalents and adds 5% to the total from living trees and deadwood, which sums up to 103 Mio tons of CO2-equivalents (see Table 17 for carbon stock of living trees and shrubs).

3.7.2. Forest area by layer structure

Table 23 provides information on the layer structure by Main Forest Formation.

Table 23 Layer structure by Main Forest Formation

Main Forest Formation	Layer Structure	Area of forest [ha]	Share in %
Spruce-Fir Forest	none*	438.3	0.2
	one layer	29,537.4	11.5
	two layers	58,806.3	22.9
	multi-layer	168,254.2	65.5
Juniper Forests	none*	33,852.1	7.0
	one layer	272,463.1	56.3
	two layers	152,528.8	31.5
	multi-layer	25,480.0	5.3
Walnut Forests	none*	0.0	0.0
	one layer	8,509.4	9.3
	two layers	33,870.5	37.1
	multi-layer	48,895.2	53.6
Pistachio & Almond Forests	none*	0.0	0.0
	one layer	38,414.6	92.5
	two layers	2,929.2	7.0
	multi-layer	205.6	0.5
Other mixed broad-leaved Forests	none*	19,937.6	6.9
	one layer	113,884.4	39.5
	two layers	58,051.6	20.1
	multi-layer	96,359.6	33.4
Shrub Forests	none*	526,512.3	94.8
	one layer	23,312.4	4.2
	two layers	5,324.5	1.0
	multi-layer	0.0	0.0
Total country	**none***	**580,740.3**	**33.8**
	one layer	**486,121.3**	**28.3**
	two layers	**311,510.9**	**18.1**
	multi-layer	**339,194.5**	**19.7**
Total forest area		**1,717,567.0**	**100**

*) none means that there is no tree cover at the moment and layer could not be assessed.

The layer structure in the forest in Kyrgyzstan shows multi-layered stands on 19.7% of the forest area, two layered stands on 18.1%, one layered forest stands on 28.3% and forests with "none" structure have a share of 33.8%. "None" means that there is no tree cover at the moment and layer could not be assessed.

There are significant differences among the Main Forest Formations: Spruce-Fir Forests is dominated by multi-layer structure (65.5%); in Walnut forests multi-layer structure is dominating as well with 53.6%, in other mixed broadleaved forests multi-layer structure has still a high share of 33.4%. In Juniper Forests one layered stands (53.3%) and two layered stands(31.5%) dominate. In Pistachio & Almond Forests one layered stands are dominating (92.5%), in Shrub Forests mainly forests with no layer structure occur (94.8%).

3.7.3. Forests area by origin

The findings on the origin of the stands are presented in Table 24.

Table 24 Origin stands by oblast

Oblast	Origin*	Area of forest [ha]	Area Share [%]
Batken	natural	162,840.1	96.7
	mixed	5,631.4	3.3
	artificial	0.0	0.0
Chu	natural	105,527.6	91.4
	mixed	438.3	0.4
	artificial	9,464.4	8.2
Dzhalal-Abad	natural	684,686.2	94.8
	mixed	25,448.9	3.5
	artificial	11,864.9	1.6
Issyk-Kul	natural	199,910.1	93.4
	mixed	6,136.5	2.9
	artificial	7,889.8	3.7
Naryn	natural	136,385.7	99.4
	mixed	438.3	0.3
	artificial	438.3	0.3
Osh	natural	263,699.8	98.7
	mixed	2,560.7	1.0
	artificial	777.9	0.3
Talas	natural	85,999.5	92.0
	mixed	0.0	0.0
	artificial	7,428.4	8.0
Total	**natural**	**1,639,049.1**	**95.4**
	mixed	**40,654.1**	**2.4**
	artificial	**37,863.8**	**2.2**
Total forest area		**1,717,567.0**	**100.0**

*) Origin natural: > 80 % of trees origin from natural regeneration; Origin mixed: 20 – 80 % of trees origin from natural regeneration; Origin artificial: < 20 % of trees from natural regeneration

Natural forests dominate in Kyrgyzstan (95.4%) and in all oblasts from 91.4% in Chu to 99.4% in Naryn.

Table 25 Origin of the stands by Main Forest Formation

Main Forest Formation	Origin of stands*	Area of forest [ha]	Area Share [%]
Spruce-Fir Forests	mixed	6,574.8	2.6
	natural	239,503.4	93.2
	artificial	10,958.1	4.3
Juniper Forests	mixed	3,754.2	0.8
	natural	480,569.7	99.2
	artificial	0.0	0.0
Walnut Forests	mixed	16,890.0	18.5
	natural	72,341.5	79.3
	artificial	2,043.5	2.2
Pistachio & Almond Forests	mixed	4,625.0	11.1
	natural	30,192.4	72.7
	artificial	6,731.9	16.2
Other mixed broad-leaved Forests	mixed	6,494.6	2.3
	natural	264,448.6	91.7
	artificial	17,289.9	6.0
Shrub Forests	mixed	2,315.4	0.4
	natural	551,993.5	99.4
	artificial	840.4	0.2
Total country	**mixed**	**40,654.1**	**2.4**
	natural	**1,639,049.1**	**95.4**
	artificial	**37,863.8**	**2.2**
Total forest area		**1,717,567.0**	**100.0**

*) Origin natural: > 80 % of trees origin from natural regeneration; Origin mixed: 20 – 80 % of trees origin from natural regeneration; Origin artificial: < 20 % of trees from natural regeneration

Natural forests dominate in all Main Forest Formations as well, from 72.7% in Pistachio & Almond Forests up to 99.4% in Shrub Forests.

3.8. Damages of forests and on trees

The inventory covered several aspects of damages to forests. This chapter presents damages in form of erosion, damages from grazing activities and finally presents damages detected on the measured trees.

3.8.1. Forest area with signs of erosion

The site of the plot was analyzed and classified if visible signs of erosion exist. Table 26 shows the area with visible signs of erosion damages.

Table 26 Forest area with signs of erosion

Oblast	Visible signs of erosion Area [ha]	Visible signs of erosion Area in %
Batken	14,547.7	8.6
Chu	7,236.5	6.3
Dzhalal-Abad	326,823.7	45.3
Issyk-Kul	16,915.9	7.9
Naryn	20,682.1	15.1
Osh	100,091.5	37.5
Talas	13,629.6	14.6
Total country	**499,926.9**	**29.1**

The area of visible signs of erosion differs substantially between the oblasts. Dzhalal-Abad (45.3%) and Osh (37.5%) have a large share of visible signs of erosion. In the other oblast this share varies from 6.3% in Chu to 15.1% in Naryn.

3.8.2. Forest area with grazing damages

Grazing damages have been assessed as any kind of damage caused to plants by animals.

Table 27 Forest area with grazing damages by Oblast

Oblast	No visible signs of grazing damage		Signs of grazing damage	
	area [ha]	area in %	area [ha]	area in %
Batken	42,235.2	25.1	126,236.2	74.9
Chu	49,848.0	43.2	65,582.4	56.8
Dzhalal-Abad	159,030.0	22.0	562,970.1	78.0
Issyk-Kul	60,991.5	28.5	152,944.9	71.5
Naryn	69,743.2	50.8	67,519.2	49.2
Osh	41,086.3	15.4	225,952.1	84.6
Talas	56,597.7	60.6	36,830.2	39.4
Total country	**479,531.9**	**27.9**	**1,238,035.1**	**72.1**

It comprises signs of grazing like paths, traces, excrements, damaged trees, grazed grass. Table 27 shows the area with visible signs of grazing damages. Grazing damages occur on 72.1% of the forests in the country. These damages are highest in Osh (84.6%) and lowest in Talas (39.4%).

3.8.3. Damages on trees – type of damages and number of damaged trees

Damages on trees have been assessed on each single measured tree.

Based on this single tree assessment, the frequency of damaged trees is shown in Table 28.

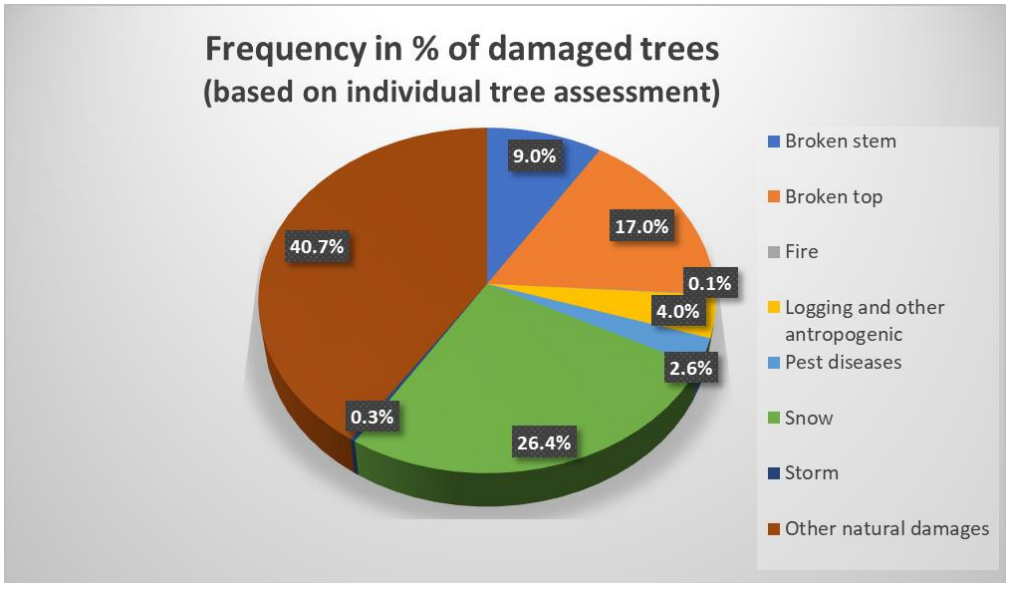
Table 28 Number of trees with damages or undamaged

Oblast	Forest area [ha]	Damage on tree level: % of trees
Batken	168,471.4	24.9
Chu	115,430.3	8.0
Dzhalal-Abad	722,000.1	23.9
Issyk-Kul	213,936.4	3.3
Naryn	137,262.4	5.7
Osh	267,038.4	11.8
Talas	93,428.0	7.9
Total country	**1,717,567.0**	**16.3**

The highest share of damages occurs in Batken (24.9%), the lowest in Issyk-Kul (3.3%), the average share of damages on tree level in the country is 16.3%.

The following Figure 14 gives an overview on the share of dominant groups of damages on tree level in the country.

Figure 14 Relative frequency of damages on tree level



Based on single tree assessment, not based on weighted plots and strata, the statistics on damages on tree level have been analyzed.

The damage type "Other natural damages" shows with 40.7% the highest relative frequency, followed by "Snow" with 26.4%, "Broken top" with 17.0%, "Broken stem" with 9% and other damages with lower share.

3.9. Forest Biomass

Table 29 Tree related biomass per age class

Age Class	area (ha)	mean Age	mean DBH (cm)	mean H (m)	Volume (m^3/ha)	Biom. (t/ha)	Vol (m^3)	Biom. (t)
1.0 - 19.9	11,400	12	10	5	6	6	73,384	67,310
20.0 - 39.9	185,964	32	15	8	26	21	4,909,685	3,837,078
40.0 - 59.9	296,278	49	20	10	52	37	15,530,521	11,091,124
60.0 - 79.9	287,630	69	23	11	71	48	20,531,435	13,849,487
80.0 - 99.9	152,068	88	27	13	100	67	15,165,856	10,116,902
100.0 - 119.9	72,388	106	27	13	111	74	8,014,059	5,321,980
120.0 - 139.9	43,454	128	28	14	125	81	5,433,606	3,523,455
140.0 - 159.9	35,966	153	26	11	84	56	3,028,220	2,027,402
160.0 - 179.9	11,421	168	34	15	179	115	2,044,066	1,312,445
180.0 - 199.9	5,908	189	28	14	90	57	534,467	334,334
200.0 - 219.9	4,507	211	22	15	152	94	685,197	423,970
220.0 - 239.9	644	233	22	10	40	25	25,669	15,792
>= 240	9,772	337	33	11	14	11	133,626	105,297
temporarily no trees	600,168		15	6	0	0	186,555	152,910
TOTAL	**1,717,567**	**68**	**22**	**11**	**44**	**30**	**76,296,345**	**52,179,485**

Table 29 shows the total values of tree related biomass per age class. Shrub layers are not considered in this table, only trees. The lowest values of biomass (t/ha) can be found in the lower ranges of age, being the tons/ha peak in the range of 160.0-179-9 years. The age classes with the highest biomass (T) can be found between ages 40 to 100, due to the highest areas (between 150.000 and 300.000 ha).

Table 30 Tree related biomass per Main Forest Formation

Main forest formations	area (ha)	mean age	mean DBH (cm)	mean H (m)	Volume (m^3/ha)	Biom. (t/ha)	Vol (m^3)	Biom. (t)
Juniper forests	484,324.0	84.6	20.2	6.7	21.1	14.9	10,206,361.0	7,207,227.0
Other mixed broad-leaved forests	288,233.1	47.4	16.8	8.3	33.1	27.3	9,548,540.0	7,855,649.0
Pistachio forests	41,549.3	46.7	11.2	3.9	2.3	2.7	94,764.0	110,204.0
Shrub forests	555,149.3		14.7	6.1	0.3	0.3	186,555.0	152,910.0
Spruce-Fir forests	257,036.3	79.2	26.2	17.4	181.1	110.7	46,547,634.0	28,454,011.0
Walnut forests	91,275.1	68.1	25.4	13.2	106.4	92.0	9,712,492.0	8,399,486.0
Total	**1,717,567.0**	**67.8**	**21.9**	**10.6**	**44.4**	**30.4**	**76,296,345.0**	**52,179,485.0**

Table 30 presents the values for tree related biomass per Main Forest Formation. Shrub forests contain the lowest t/ha value (0.3) and biomass (110.204 t) as tree species are rare in areas where shrub species are dominating. As for pistachio forests, low biomass are the results of the open characteristics of these forests. The calculated Biomass total ranges around 52,179,485.0 t, showing an average of 30.4 tons per hectare.

4. References

- Chyngojoev A., B. Surappaeva and D. Altrell. "Integrated Assessment of Natural Resources of Kyrgyzstan 2008–2010." *FAO: Bishkek. Kyrgyzstan* (2010). Available online: https://www.fao.org/forestry/30655-067a616376e5bf5ebac056446ec010d1f.pdf (accessed on 16 October 2023).
- Grisa E., Wenglowski, B., Sarymsakov, Z., Carraro, G. (2008) Forest typology in the Kyrgyz Republic. Practice oriented document for field assessment and sustainable management of forest stands. Swiss Foundation for development and international cooperation "INTER-COOPERATION". 264 p. (in english)
- KYRFOR (2008) Kyrgyz-Swiss Forestry Support Program 2008. Swiss Foundation for development and international cooperation "INTER-COOPERATION".
- Martín-Ortega P. (2020) LULUCF assessment with Collect Earth. Kyrgyzstan Mapathon 2019. 143 p.
- SAEPF (2019) Concept of Forest development until 2040 of the Kyrgyz Republic. State Agency of Environmental Protection and Forestry, 27th May 2019, Bishkek, 29 p. Available online: https://www.fao.org/faolex/results/details/en/c/LEX-FAOC196023/ (accessed on 16 October 2023).

NFI#2 technical reports used as references

- Unique-Carec (2019): NFI Information needs assessment report, 42 p.
- Unique-Carec (2019): NFI#2 Report on required sample sizes - Design of the NFI & related anticipated variances. NFI#2- Objective 1.4, IFEMP, Bishkek, 26 p.
- Unique-Carec (2020): NFI#2 Field Manual, 59 p.
- Unique-Carec (2020): NFI#2 Implementation Plan, 34 p.
- Unique-Carec (2020): NFI#2 Technical guideline for data quality assurance, 22 p.
- Unique-Carec (2020 / 2021): NFI#2 Reports on Field Work: Field work report I 2020,14 p.; Field work report II 2020, 20 p.; Field work report III 2021, 24 p.; Field work report IV 2021, 19 p.