

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

## **NFI#2 for Kyrgyzstan**

**presentation for the Ukrainian NFI  
team**

**Part 4: NFI#2 results**

Unique-CAREC:  
Axel Weinreich

21.05.2024





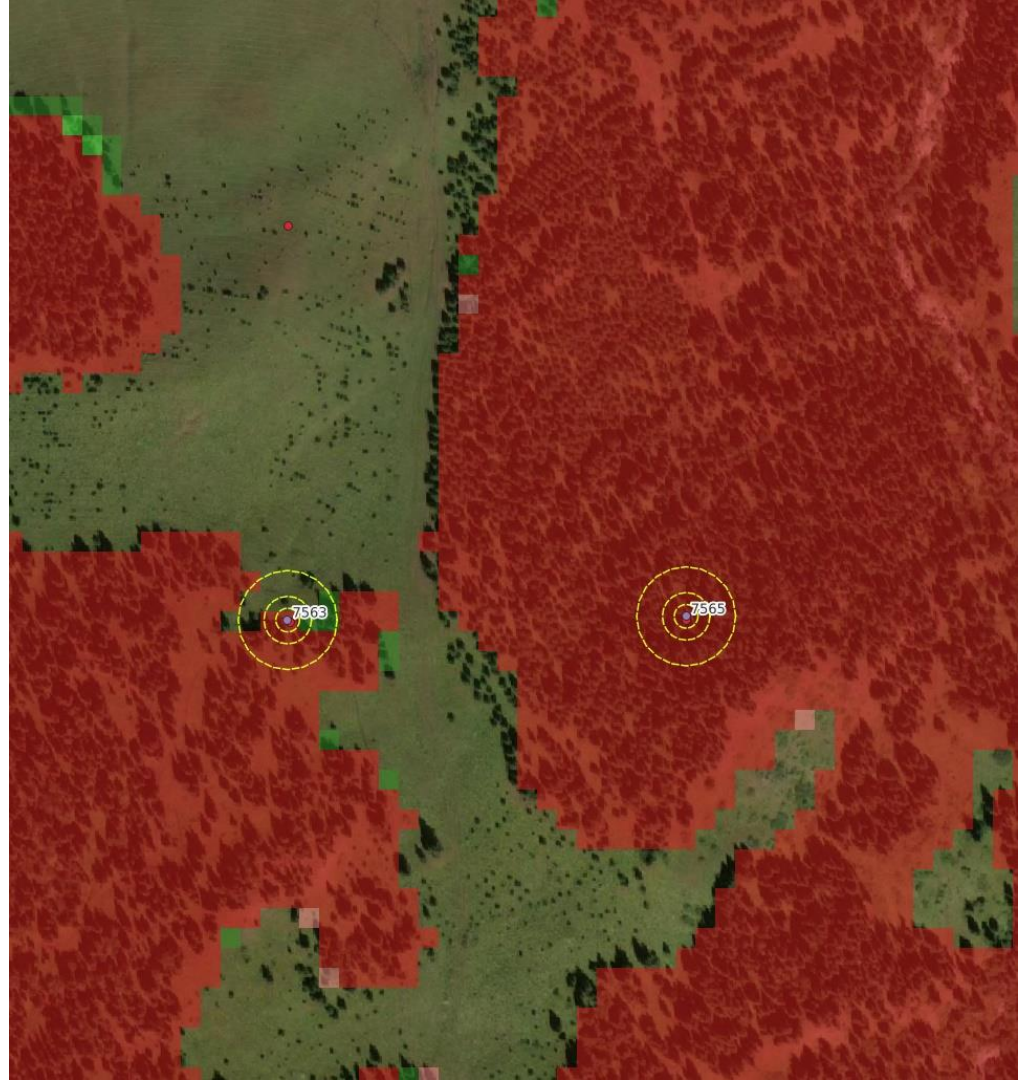
## Content

- Part 4.1: LCC method and results - map and verification
- Part 4.2: Results of the terrestrial NFI#2
  - Area
  - Volume, Basal area, N-trees, Biomass, CO<sub>2</sub>
  - Regeneration
  - Increment
  - Biodiversity

# Part 4.1

Land cover classification  
(LCC) results

- map and verification



## NFI#2 - Land Cover Classification – report on methodology and verification

- This report presents the development and results of the Land Cover and classification of the six Main Forest Formations via an analysis of Sentinel -2 satellite images for the territory of Kyrgyzstan.



Вторая национальная  
инвентаризация лесов в  
Кыргызстане

НИЛ №2 - Классификация  
землепользования - Отчет  
о методологии и проверке

Версия 1 – 30.09.2022






# LCC results - map and verification



## Reference data collection

- Reference information could be obtained from FMP data (stand level data), VVHR imagery like Google or Bing, the NFI#2 Plots and plots from a FAO supported LULUCF project. Thousands of reference datasets have been checked and training polygons have been created covering all tiles and all LC classes in each region.

Class code	Class color	Name (short)	Sample
110	Red	Spruce/Fir Forest	
120	Green	Juniper Forest	
130	Brown	Walnut Forest	

# LCC results - map and verification



## Reference data collection

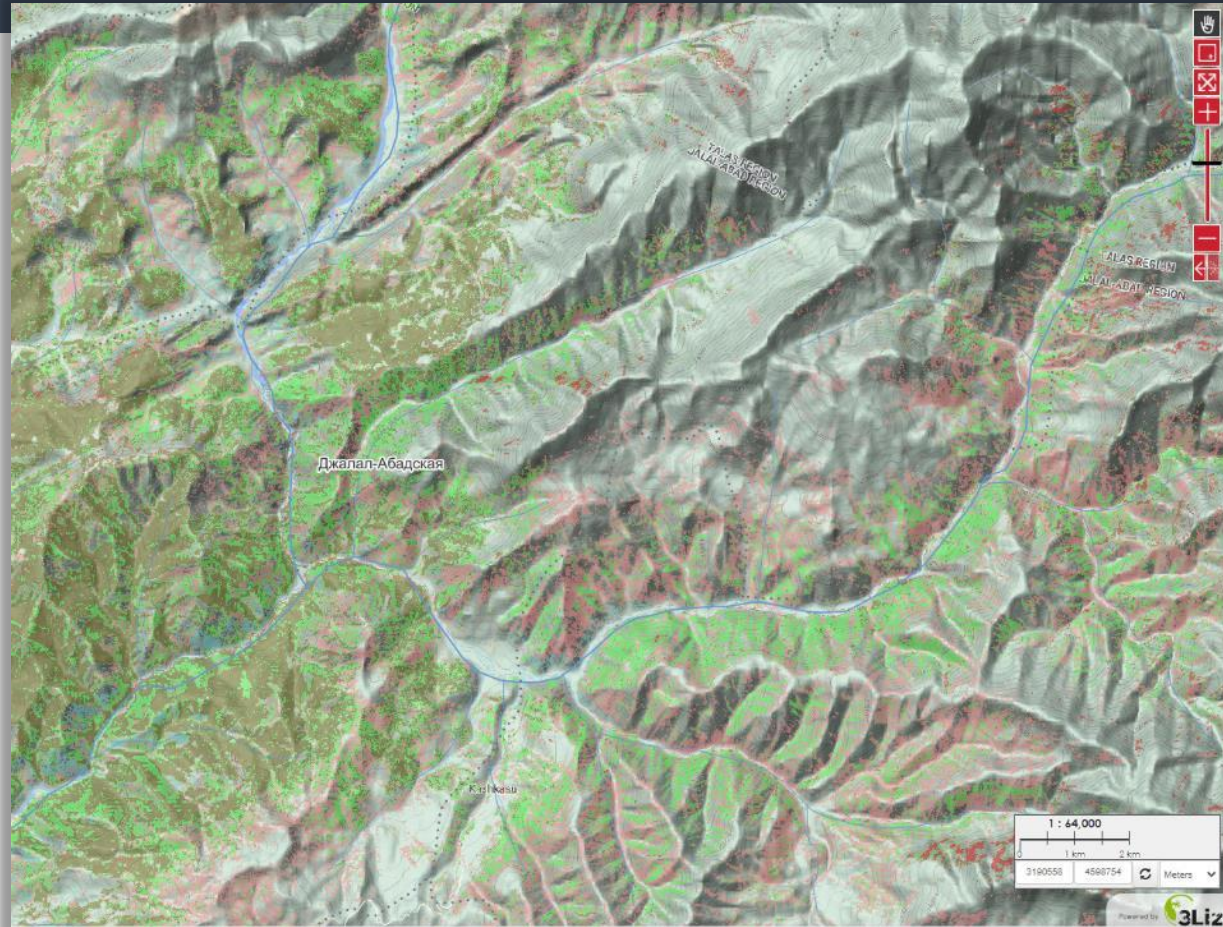
- The delineated reference data corresponds to a total of **1,539,463** pixels of 10x10m resolution, which represents an area of ca. **153,946** ha.

Class	(no. of pixels)	Area (ha)
110 - Spruce-Fir Forest	137,623	1,376
120 - Juniper forests	21,926	219
130 - Walnut forests	54,591	546
140 - Pistachio Forest	13,977	140
150 - Other mixed broadleaved forests	30,354	304
200 - Shrub forests	12,265	123
300 - Glaciers and Snow	296,715	2,967
301 - Rocks and Bare Soil	217,816	2,178
400 - Arable Land	252,705	2,527
401 - Pasture/Grassland	207,040	2,070
510 - Settlement	33,016	330
600 - Waterbodies	261,435	2,614
<b>Total</b>	<b>1,539,463</b>	<b>153,946</b>

# LCC results - map and verification



- Classification results:
  - Land Cover Classification - Raster file
  - Land Cover Classification - Vector File



# LCC results - map and verification



## Verification of the LCC classification

- **Producer's Accuracy (%)** = N of correctly classified pixels / all reference pixels x 100 = **Recall or hit-rate**
- Values: 0% = No match; 100% = Total match
- **User's accuracy (%)** = N correctly classified pixels / all classified pixels x 100 = **Precision**
- Values: 0% = No match; 100% = Total match
- **Kappa coefficient** – an index which assesses the level of agreement between reference data and LCC classification results. The Kappa Coefficient evaluates the accuracy of a classification. Kappa essentially evaluates how well the classification performed as compared to just randomly assigning values, i.e. did the classification do better than random. The Kappa Coefficient can range from -1 to 1.

Class	Class name	Producer's accuracy	User's accuracy
		(%)	(%)
110	Spruce/Fir Forest	96.5	97
120	Juniper Forest	83.6	78.7
130	Walnut Forest	87.6	88.9
140	Pistachio Forest	97.1	86.4
150	Other BL/Mixed Forest	72.7	70.2
200	Other wooded land / Shrub Forest	76.0	66.0
300	Glaciers and Snow	99.9	83.7
301	Rocks and Bare Soil	96.5	99.4
400	Arable Land	99.6	99.2
401	Pasture/Grassland	97.5	99.5
510	Settlement	100	85.7
600	Waterbodies	99.9	99.4
<b>Total accuracy</b>		<b>94.7</b>	
<b>Kappa value</b>		<b>0.939</b>	



# LCC results - map and verification



- Classification results

- 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.

Value	Pixel count	% Class	Area (ha)
<b>Spruce-Fir Forest</b>	31,159,733	<b>1.56</b>	<b>311,407</b>
<b>Juniper forests</b>	44,018,670	2.20	439,898
<b>Walnut forests</b>	5,765,546	0.29	57,659
<b>Pistachio forests</b>	11,323,644	0.57	113,196
<b>Other mixed broadleaved forests</b>	27,136,908	1.36	271,205
<b>Other wooded land / Shrub forests</b>	68,906,653	3.44	688,585
<b>Tree cover and Forest</b>	<b>188,311,154</b>	<b>9.41</b>	<b>1,881,949</b>
<b>Total country</b>	<b>1,999,674,463</b>	<b>100.00</b>	<b>19,995,089</b>

# Results - Forest Area by Main Forest Formations



- Following the FAO and national forest definition forests and shrub forests cover 1.72 Mio ha or 8.60% of the countries area on NFI #2.
- Considering ca. 76,680 ha\* orchards + fruit plantations the resulting forest area can be estimated to 1.64 Mio ha or 8.2%.

Main Forest Formations	Forest area (FAO + national) (>= 0.2 ha)		
	ha	in %	% of country
Spruce & Fir Forest	284,453.1	16.6	1.4
Juniper Forest	420,299.6	24.5	2.1
Walnut Forest	69,438.9	4.0	0.3
Pistachio Forest	62,763.5	3.7	0.3
Other broadleaved and mixed Forest	235,458.5	13.7	1.2
Shrub Forest	645,153.3	37.6	3.2
<b>Total forest area (FAO+national)</b>	<b>1,717,566.9</b>	<b>100.0</b>	<b>8.6</b>
- orchards, fruit plantations*	76,680.0	4.5	0.4
<b>Forest area (national statistic)</b>	<b>1,640,886.9</b>	<b>95.5</b>	<b>8.2</b>

\* ) document # 253-p dated 2021 "On the land balance of Kyrgyzstan"

## Part 4.2

### Results of the NFI#2

- Area
- Volume, Basal area, N-trees, Biomass, CO2
- Regeneration
- Biodiversity

18:43 Мелодия звонка

18:44

Обратно

Данные ПП

старт

увеличить

10 km 5 mi

100 m 500 ft

Leaflet | © OpenStreetMap contributors

Дистанция до ПП  
Азимут до ПП  
Текущий азимут (курс)

ID Тракта (ПП)

7457-1

Время начала навигации  
10:06:10

Время окончания навигации  
14:36:12

Следующий

19090  
210  
50

Дистанция до ПП  
Азимут до ПП  
Текущий азимут (курс)

ID Тракта (ПП)

7457-3

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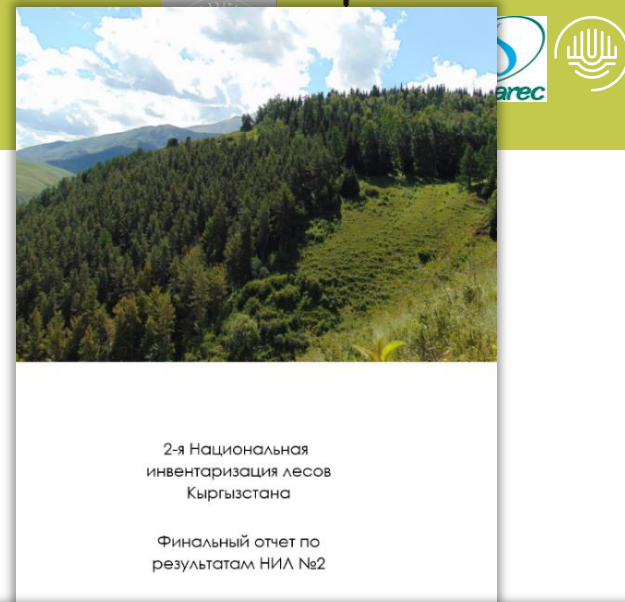
Время окончания навигации  
15:23:20

Следующий

GPS Камера

GPS Камера

# Results of the NFI#2 – two sources



## A) NFI#2 report

- main results in tables for each key attribute with explanations
- comparison with the NFI#1 results, wherever possible

## B) NFI#2 reporting dashboard

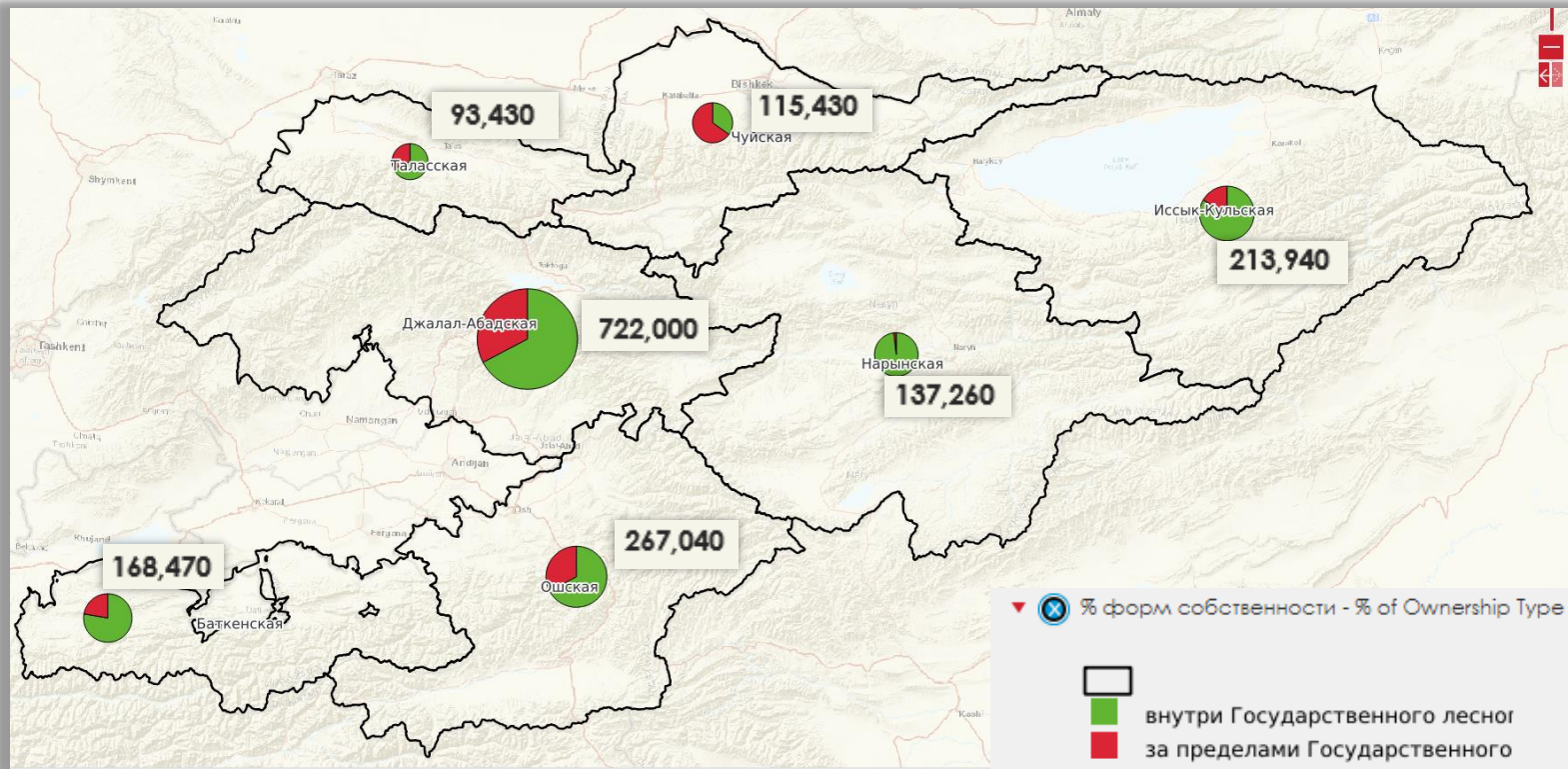
- results mainly for all key attributes (N, BA, Volume, Increment) together in one overview
- tables can be filtered and exported to Excel
- more details can be explored

Основные лесо-формации	Классы диаметра деревьев	area (га)	Средний возраст	Средний ДВР (см)	Средний диаметр (см)	Количество деревьев / га	Площадь (га)	Объем (м³/га)	Биомасса (Т/га)	CO2 эквивалент(Т/га)	Объем прирост (м³/га/г)	CO2 эквивалент прирост (Т/га/г)	Количество деревьев	Площадь (га)
..._TOTAL	0.0 - 9.9	1717567	67.6	8.9	5.5	20.77	0.19	0.90	0.49	0.04	0.0472	0.0572	52048770	
..._TOTAL	10.0 - 19.9	1717567	67.6	14.0	7.9	101.19	1.56	6.16	4.64	0.00	0.2854	0.3712	172607232	2
..._TOTAL	20.0 - 29.9	1717567	67.6	24.3	10.9	31.07	1.44	7.91	5.44	0.07	0.2217	0.2636	53370672	3
..._TOTAL	30.0 - 39.9	1717567	67.6	34.1	14.1	14.74	1.35	8.97	6.21	10.35	0.1912	0.3227	25222287	2
..._TOTAL	40.0 - 49.9	1717567	67.6	44.5	17.3	6.62	1.03	7.37	5.05	8.72	0.1211	0.1414	11362183	1
..._TOTAL	50.0 - 59.9	1717567	67.6	54.1	19.2	3.22	0.74	5.98	3.93	6.60	0.0735	0.0839	5537961	1
..._TOTAL	60.0 - 69.9	1717567	67.6	64.1	21.5	1.28	0.41	5.41	3.85	-4.02	0.0814	0.0580	2190582	
..._TOTAL	70.0 - 79.9	1717567	67.6	74.2	24.1	0.49	0.19	3.77	1.34	1.97	0.0753	0.0114	767332	
..._TOTAL	80.0 - 89.9	1717567	67.6	83.6	25.1	0.19	0.11	1.02	0.05	1.12	0.0075	0.0084	330141	
..._TOTAL	>= 90	1717567	67.6	112.4	29.9	0.15	0.13	1.31	0.90	1.37	0.0247	0.0467	218024	

# Results of the NFI#2 – Forest Area



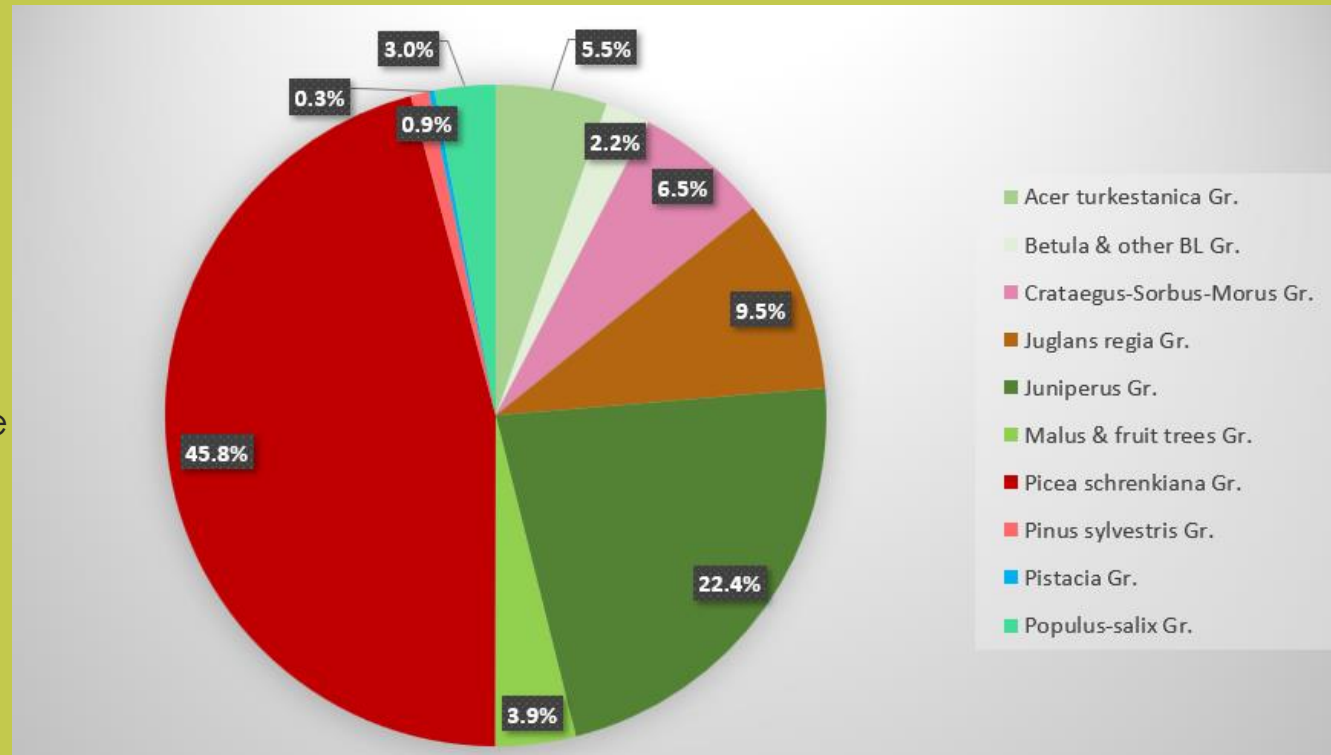
- Absolute [1000 ha] area of forest and shrub-forest per ownership type by oblast



# Results of the NFI#2 – Tree species composition



- 36 different tree species have been identified in the field
- they are grouped in 10 tree species groups.
- The figure shows the share of the 10 forest tree species groups in the country.



# Results of the NFI#2 – tree volume + volume increment



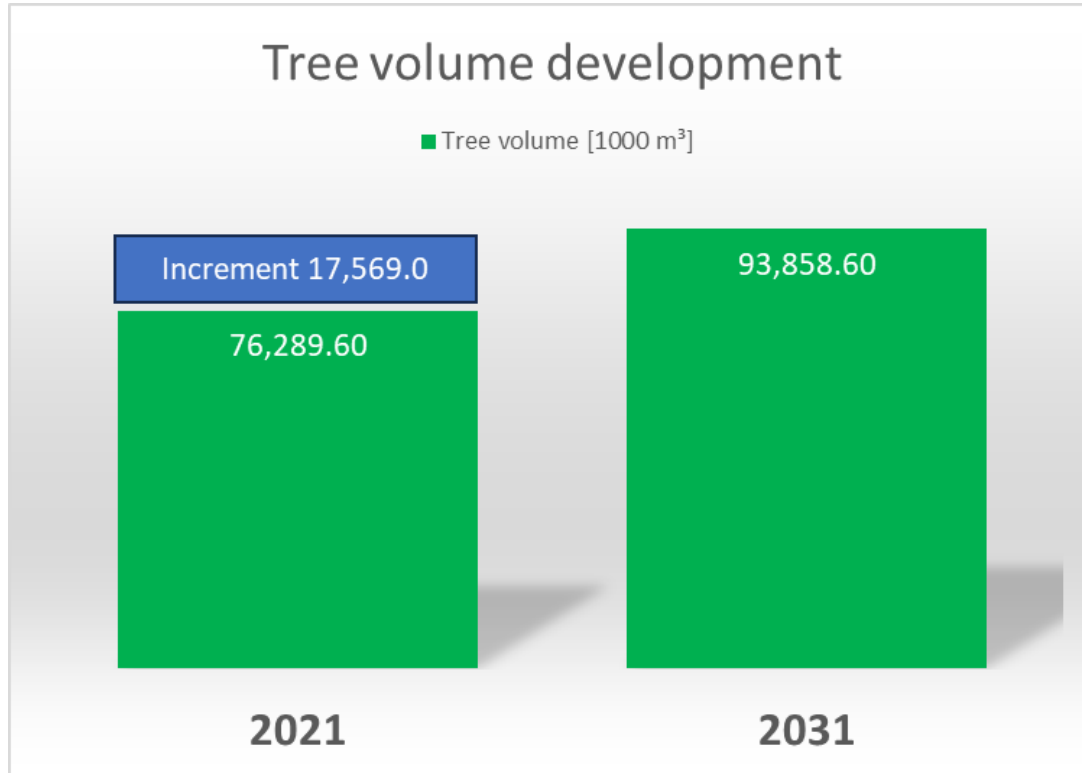
## • Volume + volume increment by Main Forest Formation

Result type and unit	Spruce-Fir forests	Juniper forests	Walnut forests	Pistachio forests	Other mixed broadleaved forests	Shrub forests	Total forests
<b>Tree volume [1000 m³]</b>	46,547.6	10,199.8	9,712.5	94.7	9,548.4	186.6	76,289.6
<i>in % of total forest</i>	61.0	13.4	12.7	0.1	12.5	0.2	100
Margin of error 95±[%]	4.3	11.1	8.3	13.0	18.7	34.0	4.0
<b>Tree volume [m³/ha]</b>	181.1	21.1	106.4	2.3	33.1	0.3	57.4
<i>in % of total forest</i>	316	37	185	4	58	1	100
<b>Volume increment [1000 m³/a]</b>	897.8	263.8	255.5	4.2	325.3	10.1	1,756.90
<i>in % of total forest</i>	51.1	15.0	14.5	0.2	18.5	0.6	100
<b>Volume increment [m³/ha/a]</b>	3.5	0.5	2.8	0.1	1.1	0.0	1.0
<i>in % of total forest</i>	350	50	280	10	110	2	100
<b>CO2-equivalent increment [1000 t/a]</b>	952.0	320.7	375.5	8.2	475.2	14.5	2146.1
<i>in % of total forest</i>	44	15	17	0.1	22	1	100
<b>CO2-equivalent increment [t/ ha/a]</b>	3.7	0.7	4.1	0.2	1.6	0.03	1.3
<i>in % of total forest</i>	285	54	315	15	123	2	100

- Standing tree volume is 76,289,000 m³, 61% are in Spruce-Fir forests.
- Volume increment is 1,756.900 m³ and the Co2-equivalent increment is 2,146.100 t dry; Volume increment is 1.0 m³/ha.
- Highest in Spruce-Fir forests (3.5 m³/ha) and high in Walnut forests (2.8 m³/ha)
- In the Pistachio forests and in Shrub forests the volume increment is extremely low.



- Expected tree volume development in the next 10 years





# Results of the NFI#2



- Comparison with NFI# 1

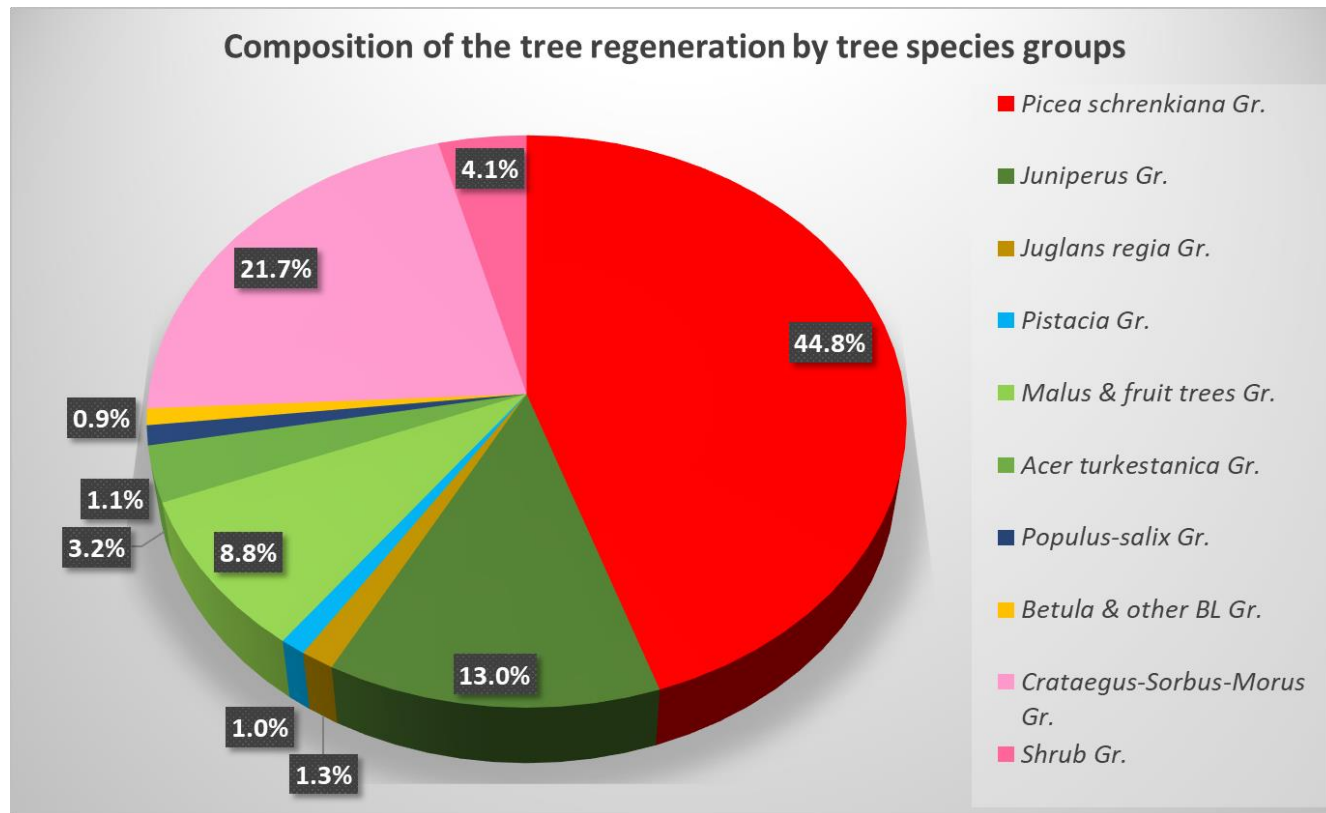
	NFI#1 2009	NFI#2 2021
Forest Area [1000 ha]	1,298.1	1,717.57
Forest Area [in % of country]	6.5	8.6
Standing tree volume [1000 m <sup>3</sup> ]	49,000.0	76,289.6
Standing tree volume MOE95%	----	3.97
Standing tree volume /ha	37.7	44.4
Shrub biomass [1000 t]	1,736.7	4,883.9
N trees	225,976,364	325,755,474
N trees / ha	168	190
Regeneration [N trees]	488,117,000	525,724,906
Regeneration [N trees / ha]	376	306

# Results of the NFI#2 – Regeneration



## Composition of tree regeneration by tree species groups

- Regeneration occurs on 18.6 % of the forest area.
- The number of re-generation trees in total is 525.724.906.
- There are 306 regeneration trees per ha of forest.



# Results of the NFI#2 – Biodiversity indicators



## Deadwood as biodiversity indicator

- In all Kyrgyzstan the total dead wood is 4.22 m<sup>3</sup> per ha:
- 3.12 m<sup>3</sup> occur in lying deadwood and 1.10 m<sup>3</sup> in standing deadwood.

Main_forest_formation	Deadwood compartiment	vol_m3_ha	vol_m3
Juniper forests	Lying deadwood	1.40	679,792
	Standing deadwood	1.00	484,430
Other mixed broadleaved forests	Lying deadwood	1.69	486,497
	Standing deadwood	0.96	276,807
Pistachio forests	Lying deadwood	0.00	0
	Standing deadwood	0.00	0
Shrub forests	Lying deadwood	0.12	68,705
	Standing deadwood	0.05	27,309
Spruce-Fir forests	Lying deadwood	14.43	3,708,649
	Standing deadwood	3.18	816,549
Walnut forests	Lying deadwood	4.54	414,220
	Standing deadwood	3.13	285,315
<b>TOTAL</b>	<b>Lying deadwood</b>	<b>3.12</b>	<b>5,357,863</b>
	<b>Standing deadwood</b>	<b>1.10</b>	<b>1,890,409</b>

End of part 4

Thanks for your  
attention!

**unique land use GmbH**

Schnewlinstr. 10

79098 Freiburg, Germany

Tel +49 761 208534 – 0

[unique@unique-landuse.de](mailto:unique@unique-landuse.de)

[www.unique-landuse.de](http://www.unique-landuse.de)

