Experiences with the National Forest Inventory (NFI) in Slovenia

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3rd Meeting of the Regional Expert Advisory WG on Forest from the Western Balkans
31 January–1 February in Durrës, Albania

I.   Why NFI

II.   Methodology (harmonization, upgrading, ensuring robustness, covering space, time …)

III. Funding

IV.   Field work and field team … specific work of the inventory field team, cooperation between SFI and SFS teams, use of appropriate field equipment, …

V.   Quality assurance

VI. Ensuring the continuity of NFI implementation …

VII. Databases management - data ownership (MAFF/SFS/SFI …), open science

VIII. Data usage

   VI. National – basis for professional decisions - of a professional, political and economic reasons

   VII. International – reporting, supporting international and EU policies

   VIII. Public data – experts, forest owners, interested public / NGO's …

IX. Presentation of the results to the professional and general public, inventory promotion (influence on support /political/, public opinion, education, …)

<u>Why NFI</u> ?

- The NFI is an important and internationally recognized source of data on forests at the national level (statistics, exact nomenclature, measurement protocols, modeling …)
- Permanent, long-term activity must be part of the stable foundation;

What/content: Collection of data on the condition of forests, habitats and dendrometric indicators of living and dead trees according to an internationally comparable and harmonized methodology of statistical sampling.

Why/purpose: Monitoring the state and development of forests at the national level for the needs of domestic and international reporting and guidance of forestry policy.

2nd Meeting of the subWG of SFC

STANDING FORESTRY COMMITTEE'S SUB-GROUP ON FOREST MONITORING AND STRATEGIC PLANS
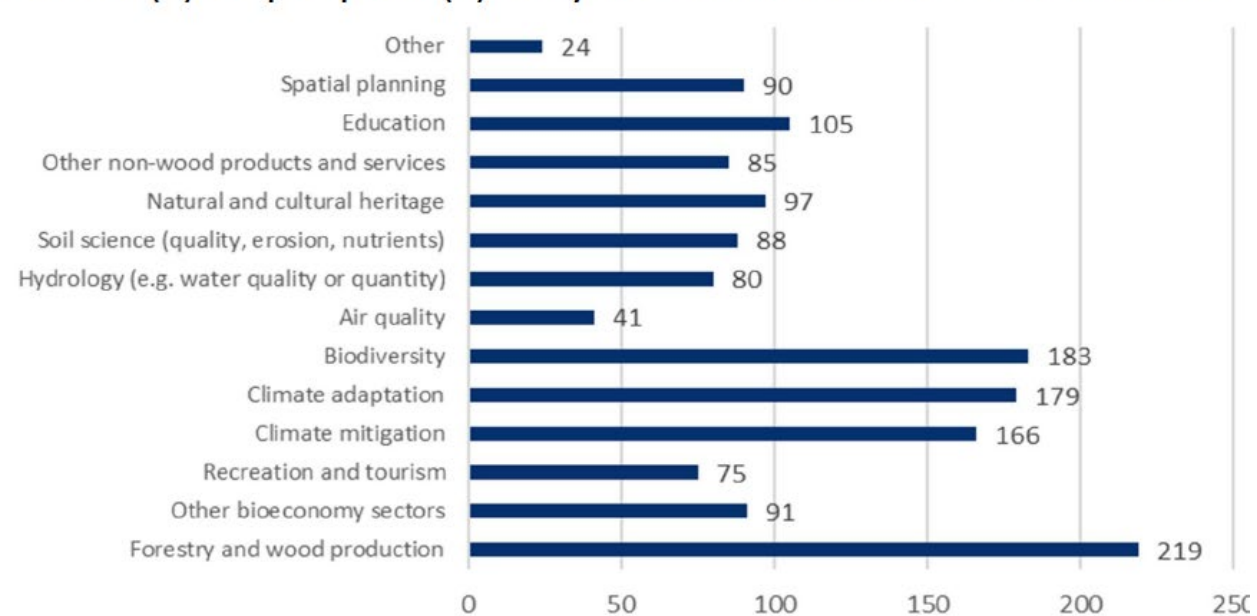
New EU Forest Strategy for 2030

2. Use of forest information

which sector(s) or purpose(s) do you consult forest information?

Sector/Purpose	Value
Other	24
Spatial planning	90
Education	105
Other non-wood products and services	85
Natural and cultural heritage	97
Soil science (quality, erosion, nutrients)	88
Hydrology (e.g. water quality or quantity)	80
Air quality	41
Biodiversity	183
Climate adaptation	179
Climate mitigation	166
Recreation and tourism	75
Other bioeconomy sectors	91
Forestry and wood production	219

3. Need for forest information (IV)

Q: What are the main benefits from creating an EU-wide forest monitoring system with detailed, accurate, regular timely, comparable and openly accessible information?

- Main benefits are:
  - Better **scientific knowledge**
  - Better preparedness to prevent and respond to **natural disturbances**
  - Better **forest management and planning**

- Less popular benefits are:
  - Better control of illegal logging
  - Diversification of forest ecosystem services
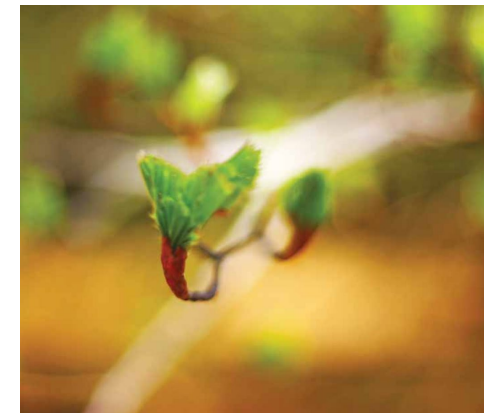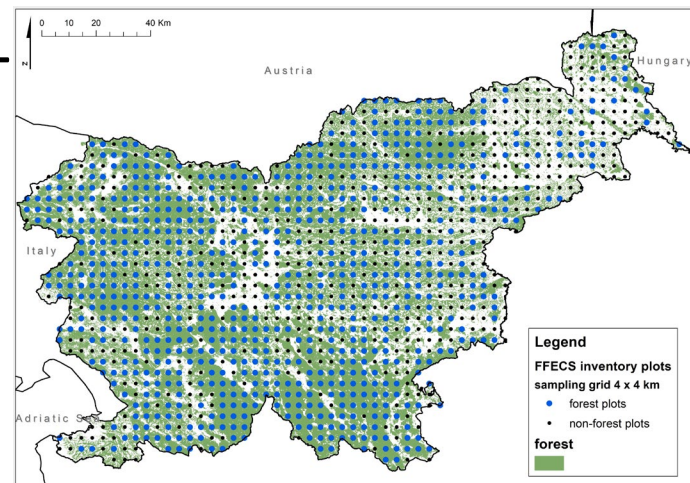 - Savings from the use of remote sensing technologies

NFI and EO methods

Table 1. Current forest monitoring and reporting practice in Germany (References [26,28,31,32]).

Title	Repetition Interval	Grid	Purpose	Recorded Properties	Executing Institution
national forest inventory, NFI (*Bundeswaldinventur*)	decadal the next NFI is scheduled for 2021/2022	base: 4 × 4 km^2 grid; double density: 2.83 × 2.83 km^2; quadruple density: 2 × 2 km^2	large-scale inventory and wood production potential, i.e. an economically motivated initiative	approx. 150 parameters (e.g. tree species, tree height, diameter, age, amount of deadwood)	data collection by individual forest specialists, reporting and analyses by Federal Research Institute for Rural Areas, Forestry and Fisheries (*Thünen Institut*)
national forest soil inventory, NFSI (*Bodenzustandserhebung*)	approx. 15 years the last survey was conducted 2006–2008	16 × 16 km^2 grid corresponding to 420 plots intersecting with forests in Germany during the first inventory; 8 × 8 km^2 corresponding to 1859 plots	generatation of reliable data on the current state and changes in forest soils and selected features of the forests	soil hemistry, soil reaction, aqua regia, C, N, S, P, 1:2 extraction nitrogen, cation exchange capacity, soil water, tree growth, ground vegetation, tree nutrition (leave/needle chemistry)	individual data collection of the 16 federal states—reporting and analyses by the Federal Research Institute for Rural Areas, Forestry and Fisheries (*Thünen Institut*)
crown condition survey, CCS (*Waldzustandserhebung*)	annual	16 × 16 km^2 grid corresponding to 420 plots at national level; some federal states perform the assessment on denser grids and assess additional points for the monitoring at federal state level (e.g. 4 × 4 km^2 or 2 × 2 km^2)	assessment of spatial and temporal variation of tree vitality; detection of drivers and effects of plant stress	crown condition, impact factors (e.g. insects)	
intensive monitoring	continuous some parameters are assessed periodically (e.g. soil assessment on decadal basis)	case studies at 68 sites	understanding cause-effect relationships in forest ecosystems	crown condition, impacts factors, soil chemistry, soil reaction, aqua regia, C, N, S, P, cation exchange capacity, soil solution, tree growth, ground vegetation, tree nutrition, litterfall, deposition, meteorology, air quality	

Stefanie Holzwarth et al. 2020

HISTORY OF LARGE-SCALE FOREST INVENOTY IN SLOVENIA – **development of NFI in Slo**

- Start in year 2000 (Forest and Forest Ecosystem Condition Survey - FFECS)
- Cooperation between SFI (design, methods, calculations, fieldwork, control) and SFS (fieldwork).
- Sampling: centric systematic sampling on grid 4 km x 4 km
- Plots remeasured in years 2007, 201)
- 2020 new sampling

  design -> NFI

Legend
FFECS inventory plots
sampling grid 4 x 4 km
- forest plots
- non-forest plots
forest

Monitoring gozdov
in gozdnih ekosistemov
Priročnik za terensko snemanje podatkov

Pdf available on:
http://eprints.gozdis.si/566/

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Large-scale FI																										

NEW SAMPLING DESIGN in 2020 - methodology
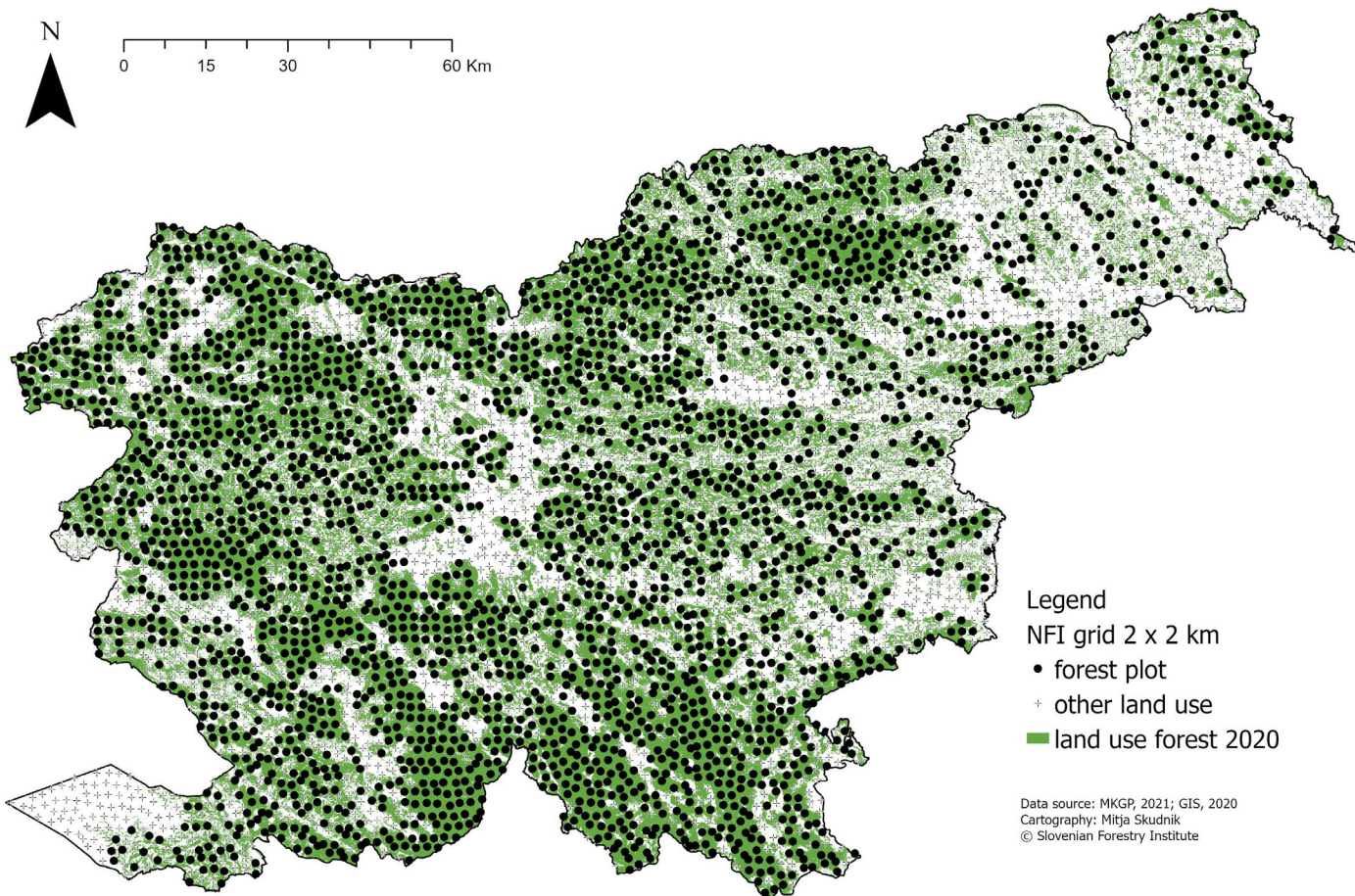
- Unaligned systematic sampling (USS)

- Sampling density 2 km x 2km

WHY USS?

- USS identified as the most precise sampling design under the assumption of common types of spatial correlation

- increased precision in case of periodicities

Legend
NFI grid 2 x 2 km
• forest plot
+ other land use
land use forest 2020

Data source: MKGP, 2021; GIS, 2020
Cartography: Mitja Skudnik
© Slovenian Forestry Institute

(a) Aligned or "square grid" sample

(b) Unaligned sample
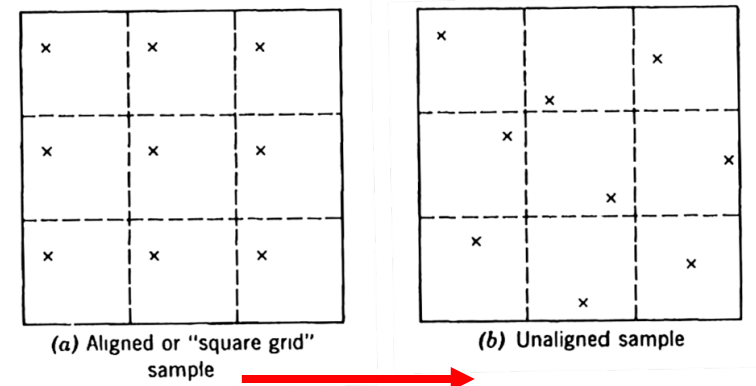
Cochran W. G., 1977

NFI SINCE 2020 - <u>method development</u>

- Interpenetrating panel system

- Yearly panel on grid 4 km x 4 km (1/4 of plots on grid 2 km x 2 km)

- 5-year inventory cycle

2020 – NFI panel 1 (cycle 1)

2021 – NFI panel 2

2022 – NFI panel 3

2023 – NFI panel 4

2024 – FFECS (old grid)

2025 – NFI panel 1 (cycle 2)
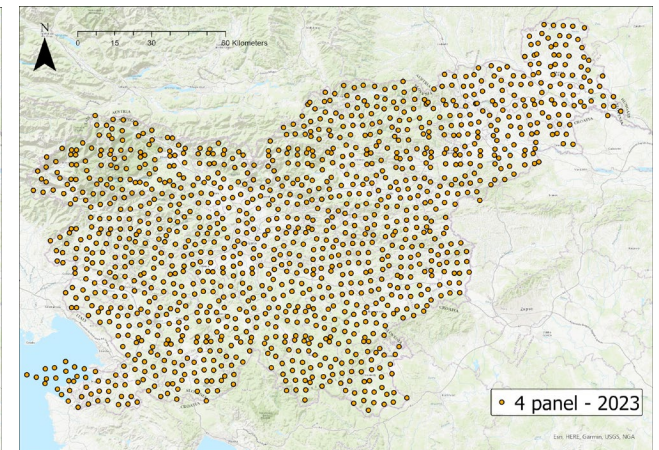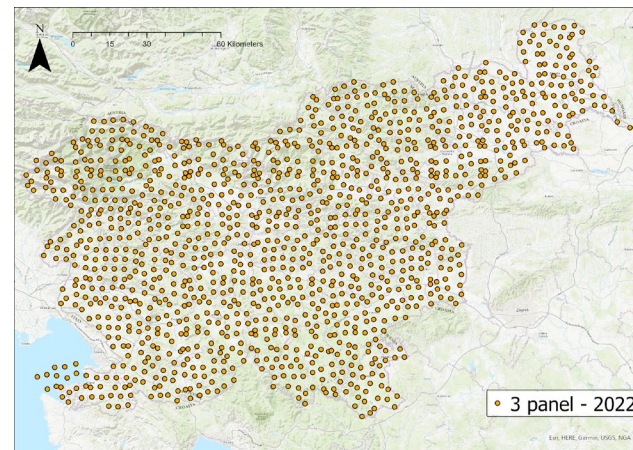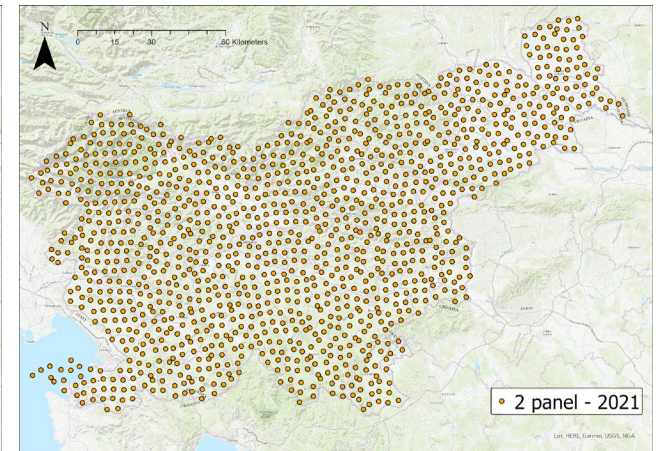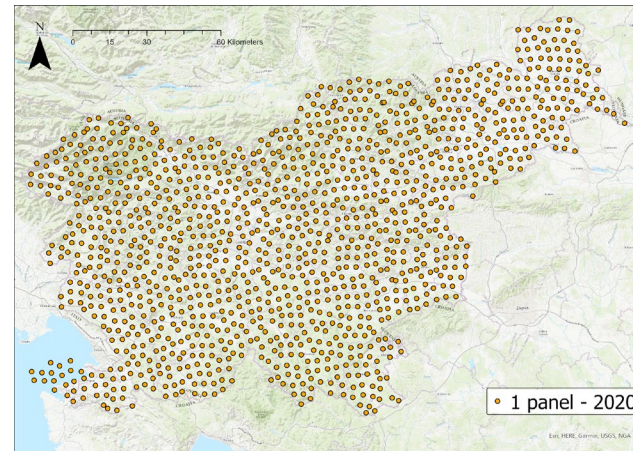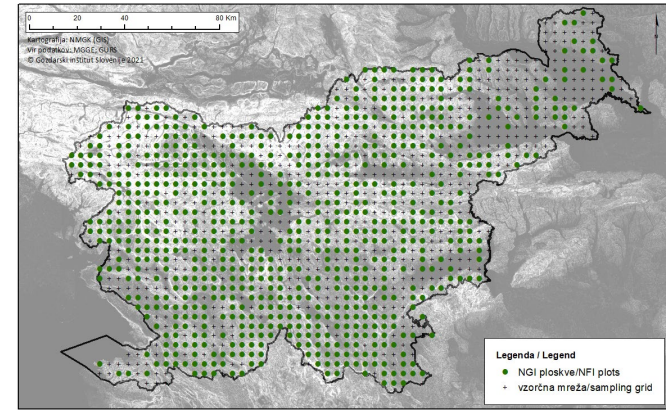
PLOT CONFIGURATION -

- Internationally harmonized indicators
- Detailed field manual
- Permanent circular plots with fixed radii
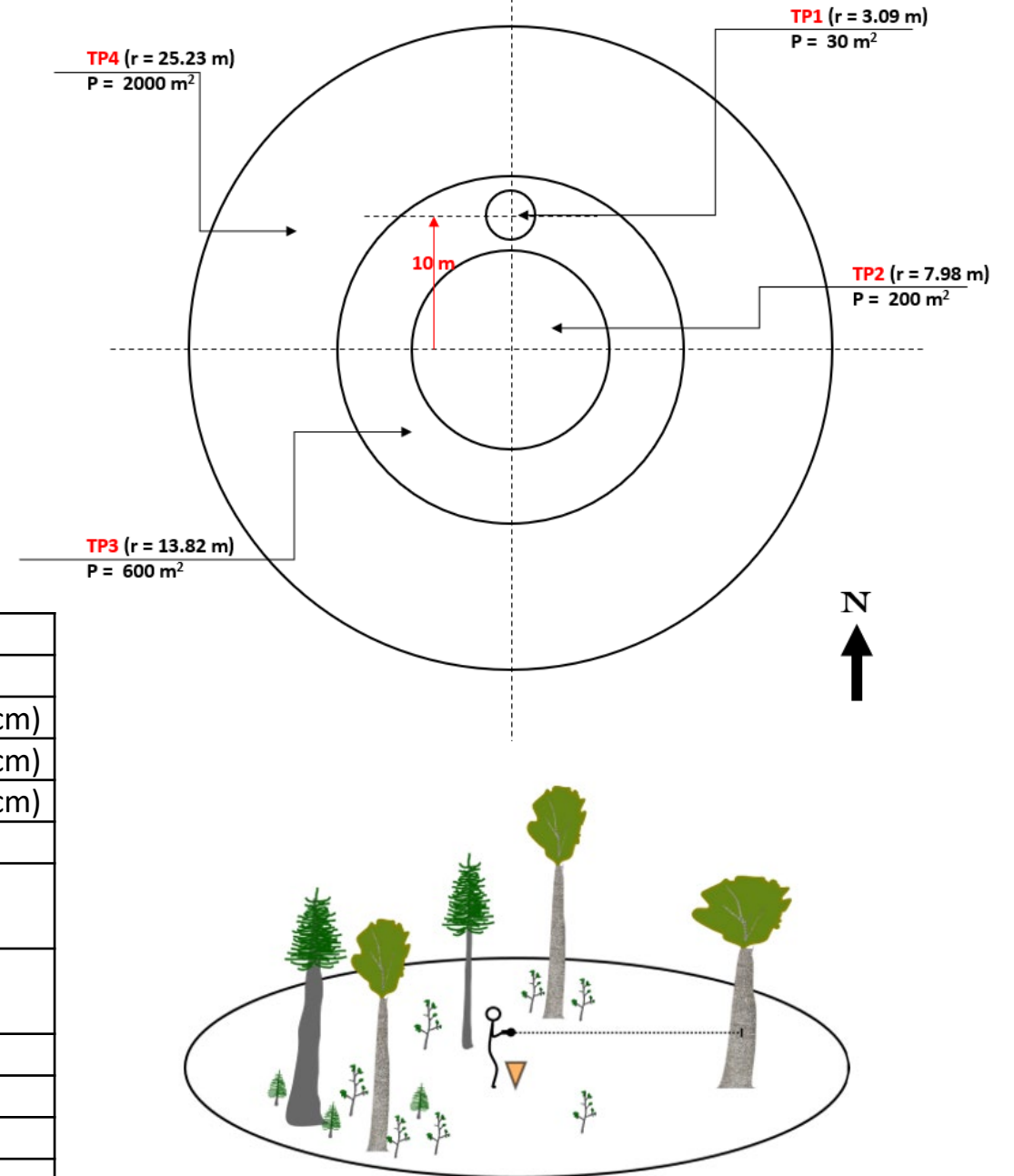
Indicator	Subplot and thresholds
Live trees $d_{1,3}$ < 10 cm in h ≥ 1,3 m	TP1
Live trees $d_{1,3}$ ≥ 10 cm	TP2 ($d_{1,3}$ ≥ 10 cm), TP3 ($d_{1,3}$ ≥ 30 cm)
Standing dead tree	TP2 ($d_{1,3}$ ≥ 10 cm), TP4 ($d_{1,3}$ ≥ 30 cm)
Lying dead tree	TP2 ($d_{1,3}$ ≥ 10 cm), TP4 ($d_{1,3}$ ≥ 30 cm)
Stump	TP2 ($d_{1,3}$ ≥ 10 cm, h ≥ 20 cm)
Snag	TP2 ($d_{1,3}$ ≥ 10 cm, h ≥ 50 cm), TP4 ($d_{1,3}$ ≥ 30 cm, h ≥ 50 cm)
Coarse woody debris (deadwood biomass)	TP2 ($d_{1,3}$ ≥ 10 cm, h ≥ 50 cm), TP4 ($d_{1,3}$ ≥ 30 cm, h ≥ 50 cm)
Plot characteristics	TP4
Stand characteristics	TP4 and sourounding
Horizontal forest structure	TP4
Vertical forest structure	TP4

NFI Funding

REPUBLIKA SLOVENIJA
MINISTRSTVO ZA KMETIJSTVO, GOZDARSTVO IN PREHRANO → Public Forest Service

REPUBLIKA SLOVENIJA
MINISTRSTVO ZA OKOLJE IN PROSTOR → Climate Change Fund

A. Ensuring stable financing – not project financing
B. Predictable funding - amount of funding, timing, yearly plans, …
C. Investments in equipment (terrain, software, …) and in education
D. Control of the use of funds …

FIELD WORK – organizational challenges

- Well-trained permanent field teams (6 – X)…

- How to organize different

- "Modern" field equipment

- Independent quality control

FIELD WORK

- Internally developed tablet application for navigation and data collection

FIELD WORK - DATA SYNCHRONIZATION

- Regular daily synchronization of data from field computers to SFI data server

- Daily updated work overview in webapp – access to teams and others involved in NFI

DATABASE STRUCTURE

Data base -> MySQL

Internal GIS MySQL server

Calculations -> MySQL functions

Graphical interface -> C#

Data usage: Results & Reporting

- Transparent calculation methods

- Estimation+known estimation errors (sampling)

- Quality control (QC)

- Used for international and national reporting

- **The most important available results:**

1. **State of the forest**: growing stock, basal area, number of trees, dominant height, volume of deadwood biomass, diversity indices …

2. **Changes in forest in time, area**: increment, harvest, mortality …

3. **Forest characteristics and data stratification**: Information on stand structure, vertical and horizontal forest structure …
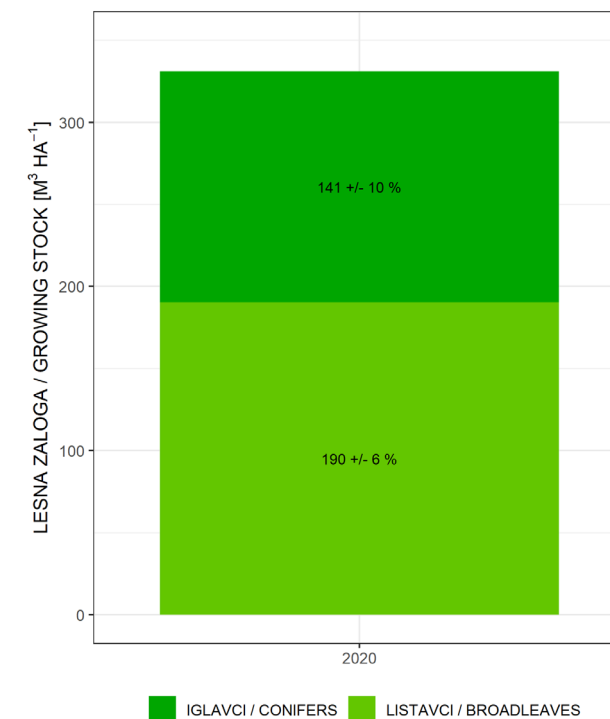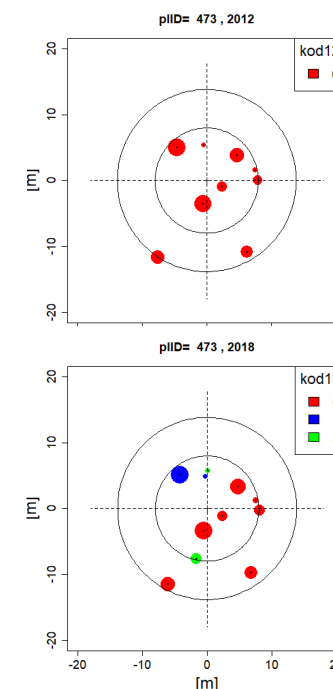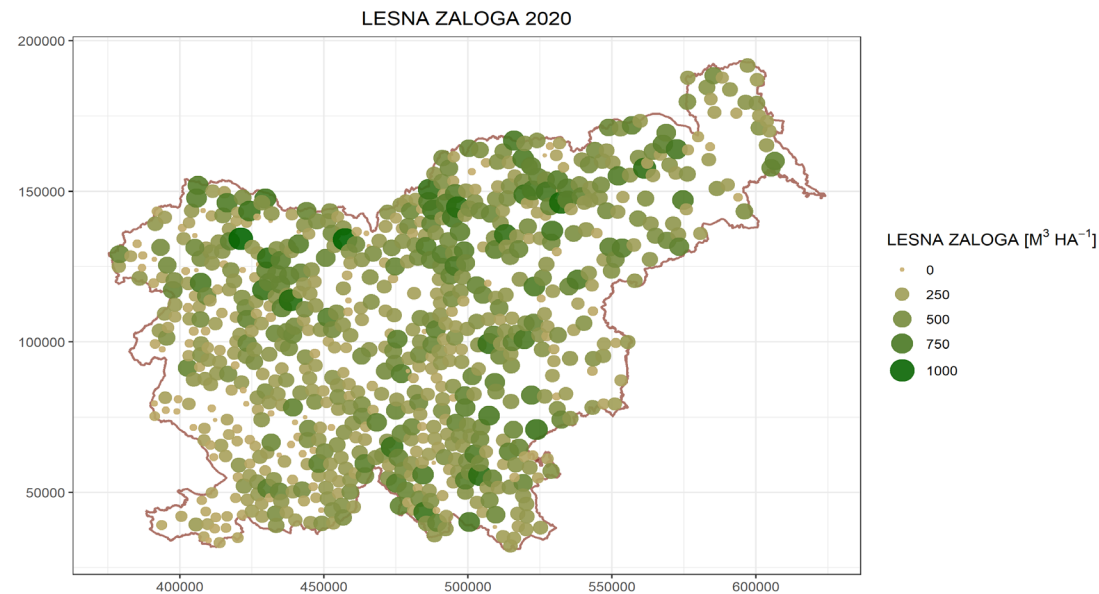
NFI and Reports: the state of Slovenian Forest and Forestry

Report on the implementation of the National Forest Programme - The report is based on Pan-European criteria and indicators for sustainable forest management.

State of Europe's Forests (Forest Europe, every 5 years, latest report - 2020)

Global Forest Resources Assessment (FAO, every 5 years, latest report - 2020)

Joint Forest Sector Questionnaire (JFSQ) (UN Economic Commission for Europe -UNECE, the Food and Agriculture Organization -FAO, Eurostat...)

Forest condition in Europe: ICP Forests Technical Report under the UNECE Convention on Long-Range Transboundary Air Pollution (ICP Forests, Annual)

Slovenia's National Inventory Report (UNFCCC and EC, annual) - Data for the **Land use, land use changes and forestry** sector; NFI is important data source!
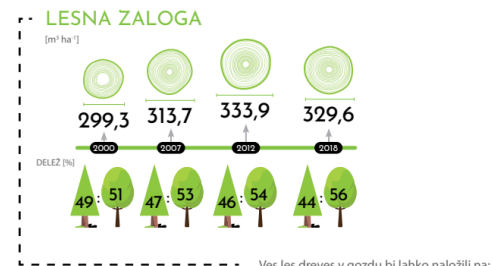
Presentation of the results to the professional and general public, inventory promotion

PUBLICATIONS AND REPORTS

- State and changes of Slovenian forests in period (2000-2018) ->
http://dx.doi.org/10.20315/SFS.181

https://www.youtube.com/watch?v=l60ef3ZfEPw&t=146s
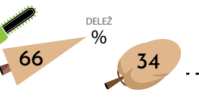
New EU forest strategy for 2030

The measures proposed in the strategy, to be reviewed in 2025, include:

> - promoting **sustainable forest management** (SFM), including by encouraging the sustainable use of wood-based resources;
> - providing **financial incentives** for forest owners and managers to adopt environmentally friendly practices, such as those linked to **carbon storage and sequestration**;
> - improving the size and biodiversity of forests, including by planting 3 billion **new trees by 2030**;
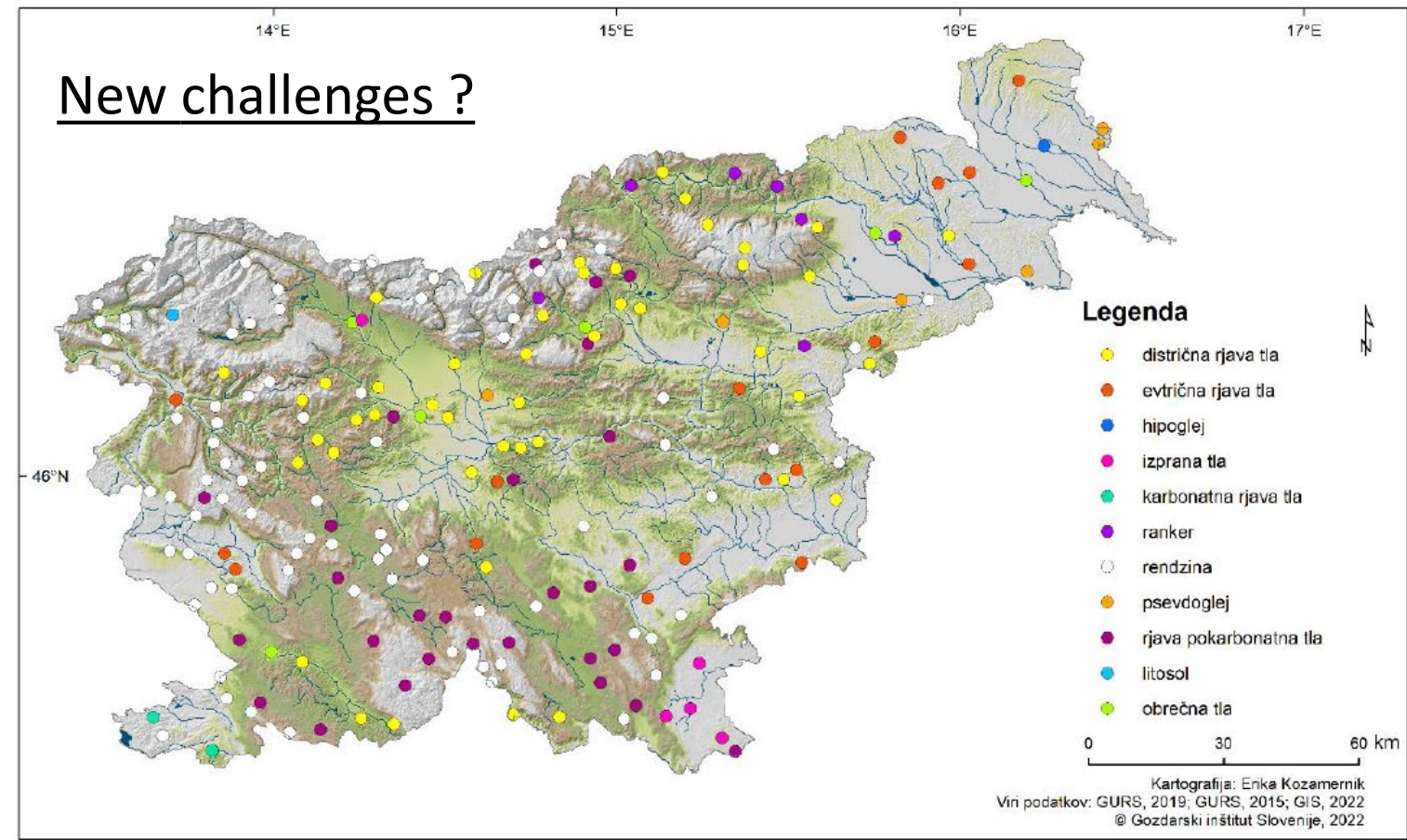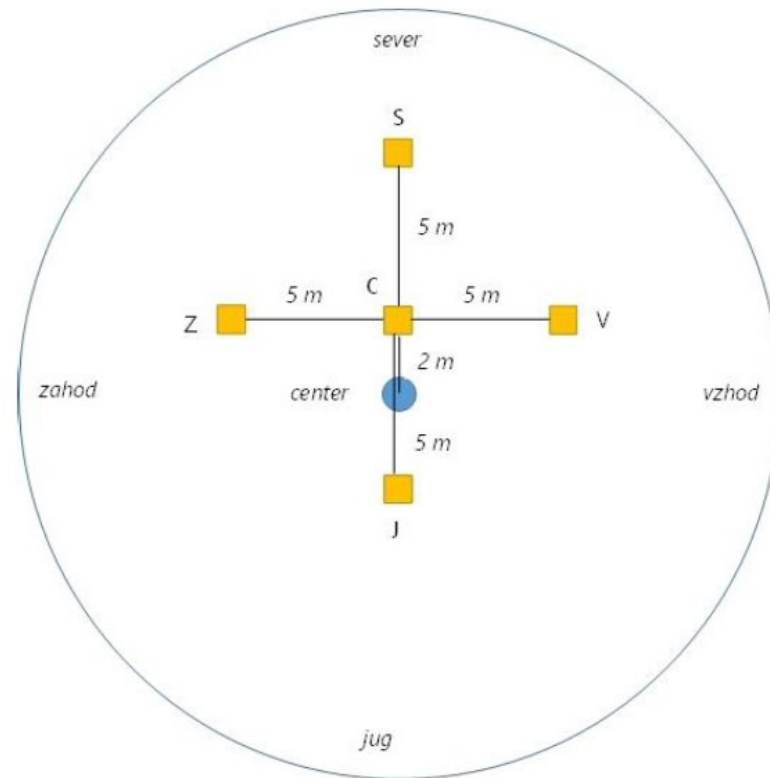> - promoting **alternative forest industries**, such as ecotourism, as well as non-wood products, such as cork, honey and medicinal plants;
> - encouraging the take-up of financial support under the **common agricultural policy (CAP)**, which can help forests and forest-based industries mitigate against climate change;
> - providing **education and training** for people working in forest-based industries and making these industries more attractive to young people;
> - establishing a **legally binding instrument** for ecosystem restoration, and a new legislative proposal on **EU forest observation, reporting and collection**;
> - protecting the EU's remaining **primary and old-growth forests**.

Collection of additional information on NFI areas: forest floor and litter, forest functions, timber quality, biodiversity, age structure,...;

Monitoring ogljika v gozdnih tleh, mokriščih in urbanih tleh

New challenges ?

Forest soil and litter sampling Sub-plots at NFI plots

Map of soil types and sampling locations in forests (200 plots / part of NFI grid) in 2022 and 2023

Carbon storage in forest soils, wetlands and urban soils 2002_2023; Climate Fund
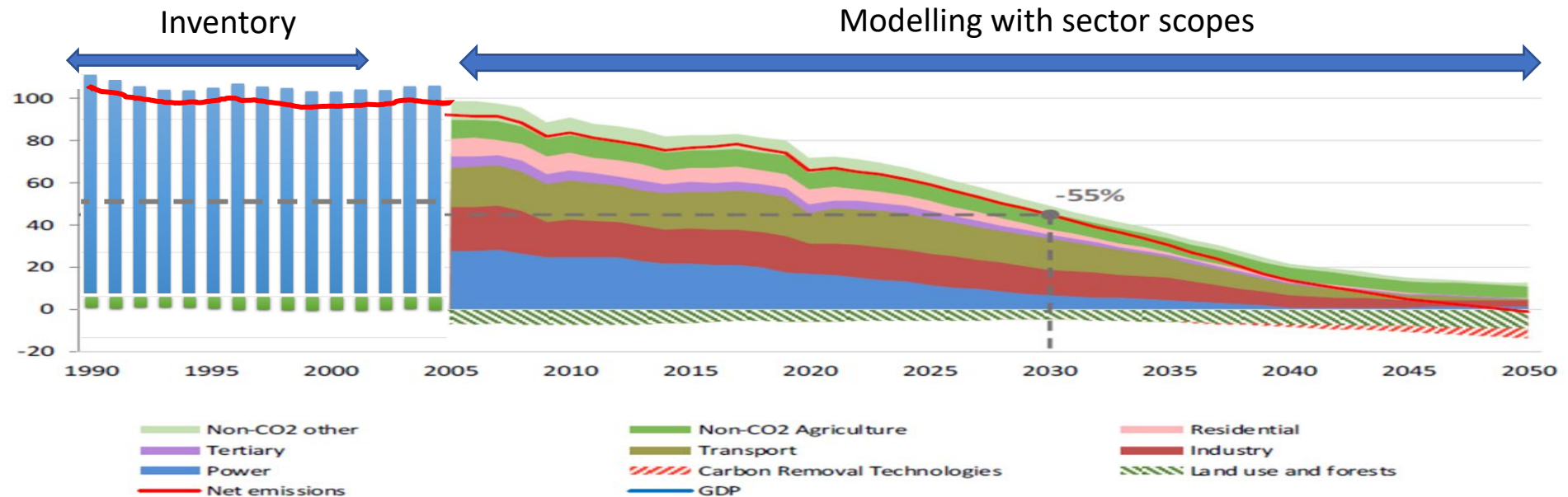
LULUCF: Fit for 55

- Revision of the LULUCF Regulation
- Contribution of the LULUCF sector to reach the goal (i.e. -55% by 2030)
- Target 2021-2025: "no-debit rule"
- Target 2030: -310 Mt CO_2 eq and negotiation for the LULUCF Regulation

LULUCF: EU pathway to climate neutrality

Inventory

Modelling with sector scopes

-55%

Legend: Non-CO2 other, Tertiary, Power, Net emissions, Non-CO2 Agriculture, Transport, Carbon Removal Technologies, GDP, Residential, Industry, Land use and forests

- The NFI is internationally recognized source of data on forests at the national level - enables internationally comparable insight into natural resources for forests

- the methodology must be harmonized (Europe, EC, worldwide..), comparable, it must be repeatable, robustness to ensure long-term implementation, ...

- Permanent, long-term activity must be part of the stable foundation

- Data use: data dissemination - > web application (digitization of information), data management and publica data

- Reporting - proper use of data, citation, verification, AC /QC system (publication of data - such as scientific articles...)

- Collection of additional information on NFI

- NFI data - annually available information on forest condition at country level, data time series;

- Important role of NFI in forest sector - contribution to common EU/EC target - reduction of emissions from GHG EU (i. e. -55% 2030) .

- Future / today: different techniques, f. e. Earth Observation methods and NFI…