National Forest Inventory (NFI) in Slovenia - purpose, role and use of results

dr. Mitja Skudnik[1,2], doc. dr. Primož Simončič[1]

1: Slovenian Forestry Institute SFI, Večna pot 2, Slovenia

2: University of Ljubljana, Biotechnical faculty, Department of Forestry and Renewable Forest Resources, Večna pot 83, Slovenia

corresponding author: mitja.skudnik@gozdis.si

NFI – National Forest Inventory

The NFI is 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;

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.

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

NACIONALNA GOZDNA INVENTURA

GOZDARSKI INŠTITUT SLOVENIJE
SLOVENIAN FORESTRY INSTITUTE

ZAVOD za GOZDOVE SLOVENIJE

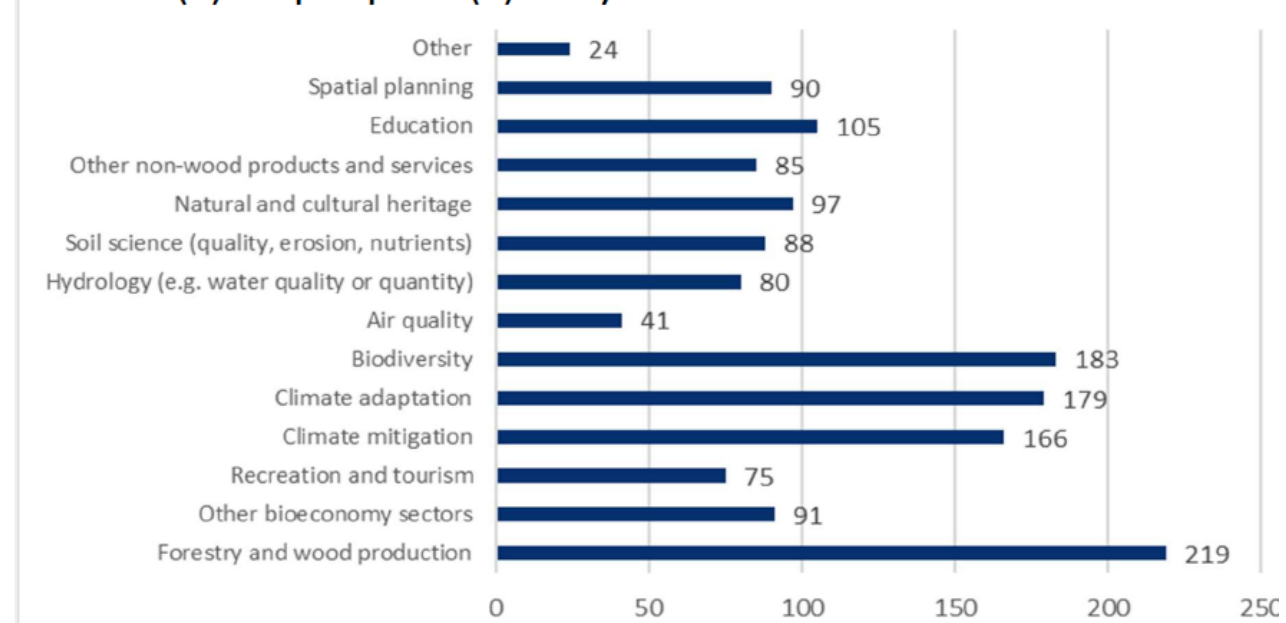REPUBLIKA SLOVENIJA
MINISTRSTVO ZA KMETIJSTVO, GOZDARSTVO IN PREHRANO

Ministrstvo za okolje, podnebje in energijo

New EU Forest Strategy for 2030

STANDING FORESTRY COMMITTEE'S SUB-GROUP ON FOREST MONITORING AND STRATEGIC PLANS

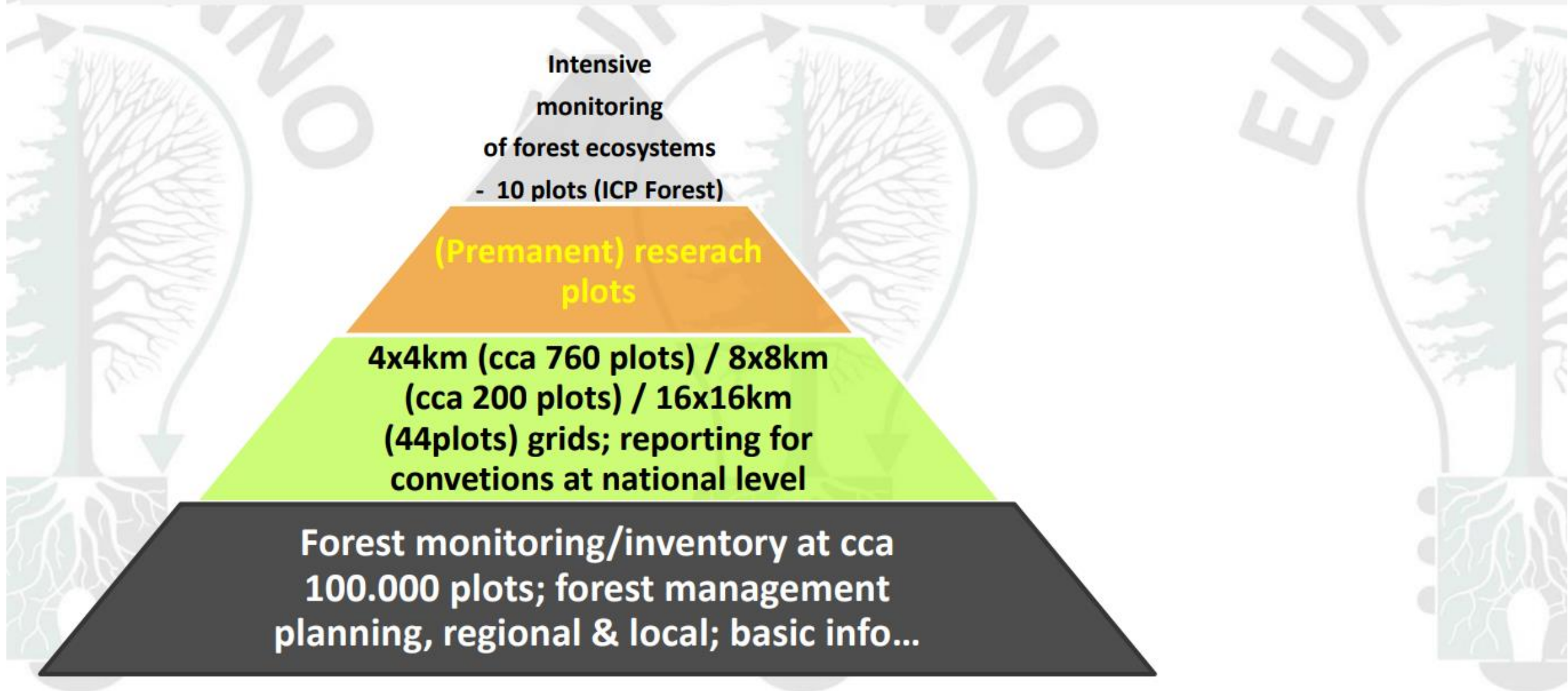which sector(s) or purpose(s) do you consult forest information?

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

Main benefits from creating an EU-wide forest monitoring system timely, comparable and open accessible information:

- main benefits: 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…

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

Pyramids of different levels of monitoring of the condition of Slovenian forests, at different levels, intensity and purposes as part of Slovenian forestry information system
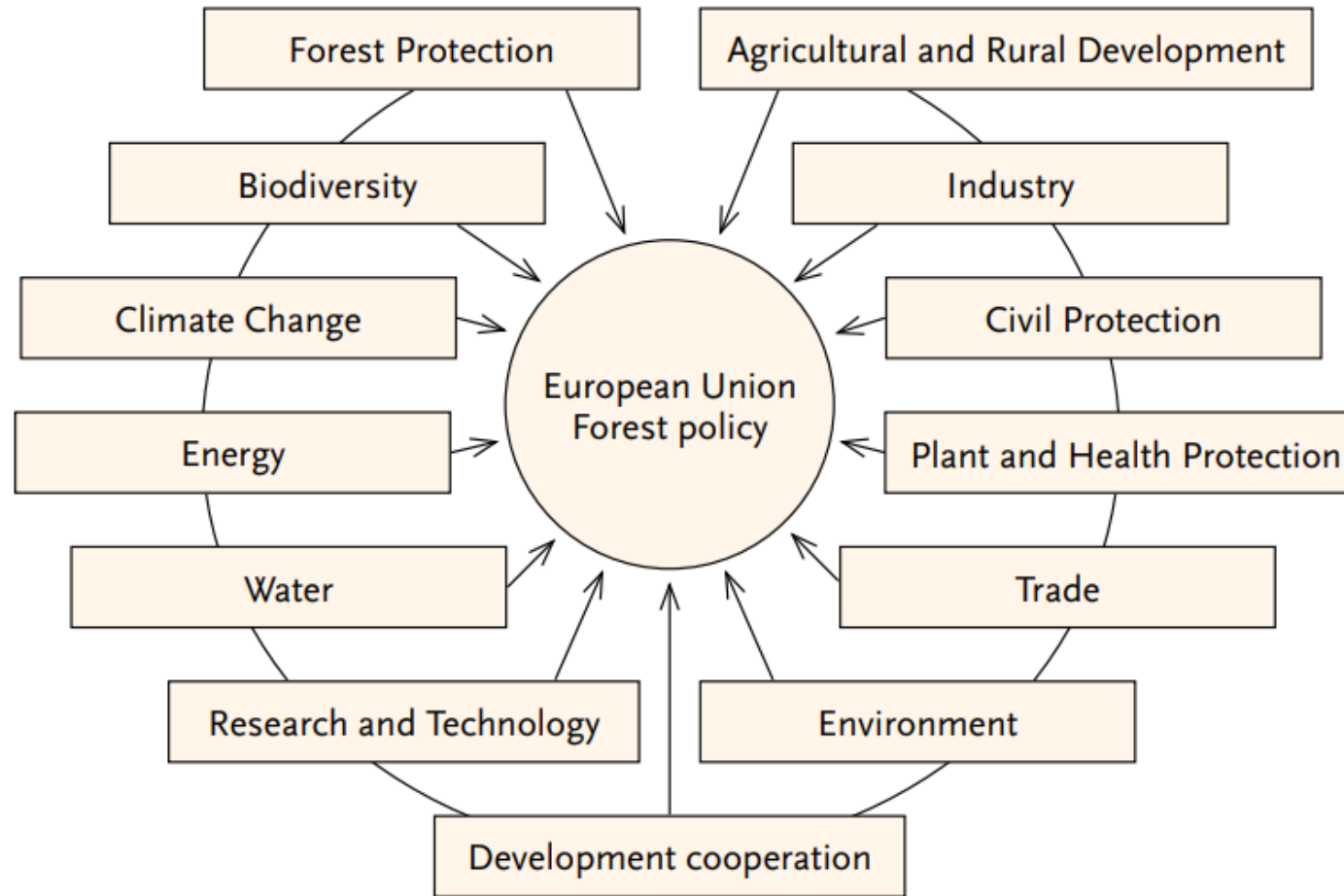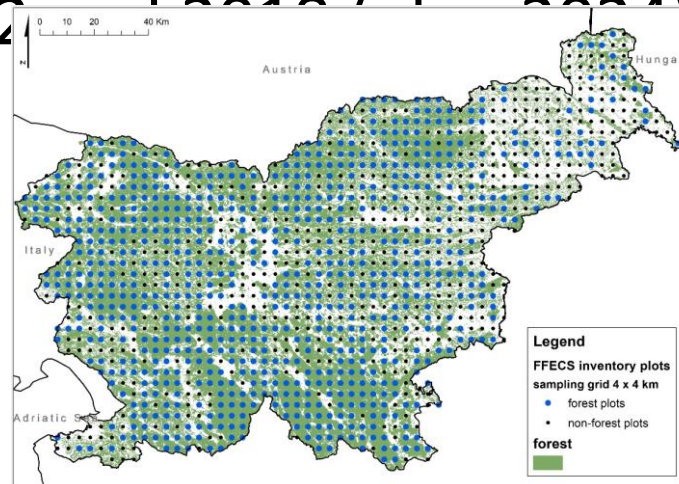

Intensive

monitoring

of forest ecosystems

- 10 plots (ICP Forest)

(Premanent) reserach plots

4x4km (cca 760 plots) / 8x8km (cca 200 plots) / 16x16km (44plots) grids; reporting for convetions at national level

Forest monitoring/inventory at cca 100.000 plots; forest management planning, regional & local; basic info...

Figure 1. Policy areas relevant for forest policy in the EU (Modified from Pülzl 2005).

EU Forest-focused and forest related policies - assessment

Policies	Main problem / concept of forest	Main objectives / problem solution path	Governance approach	Implementation
Forest-focused	• Forests for society • Need to be managed sustainably and provide multiple services	Sustainable Forest Management framed as multi-functional forest management but only vaguely defined	• "Soft" approach (strategies and action plan), focusing on communication and coordination • Subsidiarity central	• Flexible and fragmented implementation • Often implemented through forest-related policy instruments
Agriculture and rural development	• Forests are not prioritised • Focus across Europe is on rural development and agriculture	• Economic competitiveness and rural development as main concerns • Social and environmental objectives are included to a certain degree	• Policy is based on provision of financial means (subsidies and payments) for sustainable land use and rural development • Payments linked to social and ecological standards	• Member states choose activities they wish to finance within the common framework • Implementation is regulated and monitored • Evaluations show that Member states' spending is biased towards production measures
Environment (including biodiversity)	• Forest as place of biodiversity and source of ecosystem services • Needs to be conserved through appropriate (sustainable) management practices	Provision of a conservation status of forest ecosystems and the provision of ecosystem services, through protection and sustainable management, are central	• Regulatory framework approach with environmental directives • Financial means and provision of information less central	• A certain conservation status or ecosystem services have to be provided by applying conservation and management concepts, such as protected areas • Flexible implementation, but often delayed due to conflicts.

Policies	Main problem / concept of forest	Main objectives / problem solution path	Governance approach	Implementation
Energy and climate change	Forests primarily defined as the provider of a renewable energy source and/or carbon sink	• Increase of the share of renewable energy production and increase biomass production • Use of forests for carbon sequestration	"Soft" approach (strategy) combined with framework regulatory policy (including binding targets)	EU binding targets for renewable energy and emission reduction have to be met via Member states' policies
Industry and trade	• Forests defined as a resource • Focus is on the competitiveness of the European forest sector	Creation of an innovative and competitive forest sector, supported by research and industrial development	"Soft" approach (communications and research plan) combined with regulatory policy	Implementation interlinked with other forest-related policies, such as CAP and energy policy, Forestry Strategy and EU Forest Action Plan

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

- Start in year 2000 (Forest and Forest Ecosystem Condition Survey – FFECS; IPC Forest, national legislation)

- 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, 2012, and 2018 (plus 2024)

- 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 - <u>methodology</u>
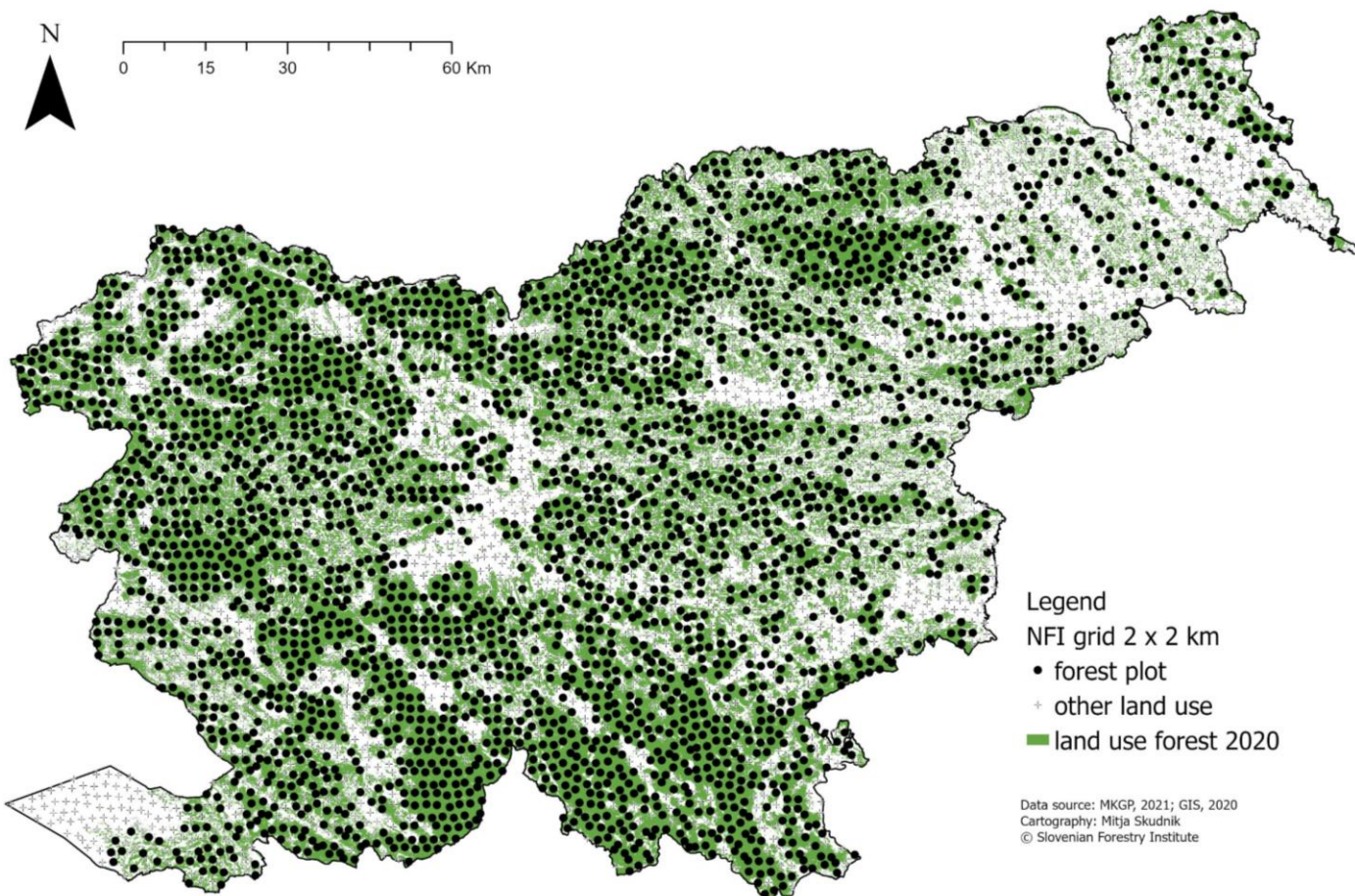
- Unaligned systematic sampling (USS)

- Sampling density 2 km x 2km

- 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
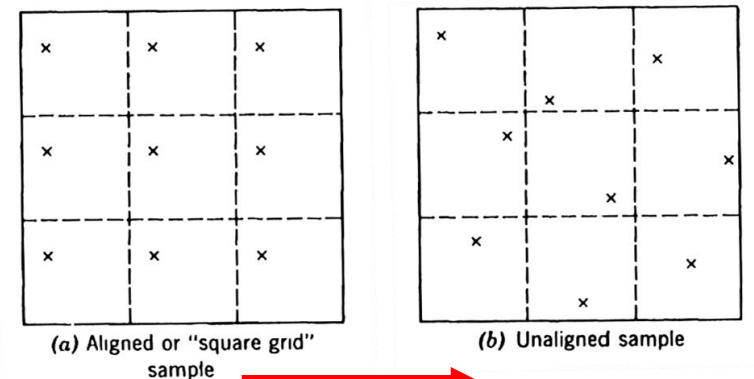
Cochran W. G., 1977

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)
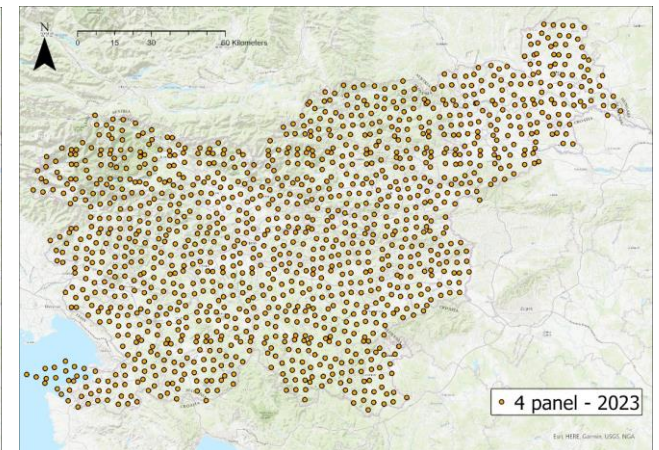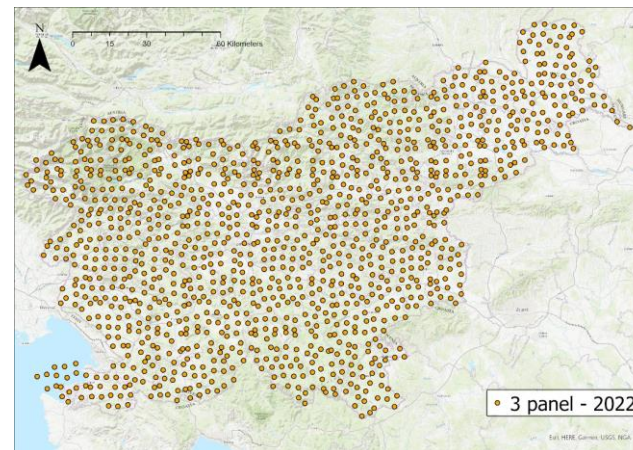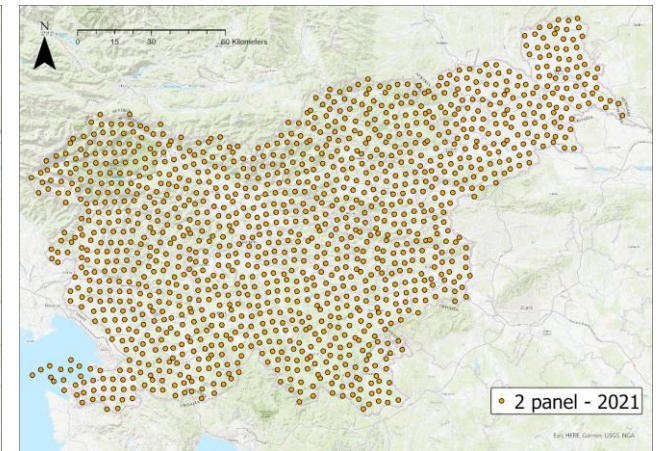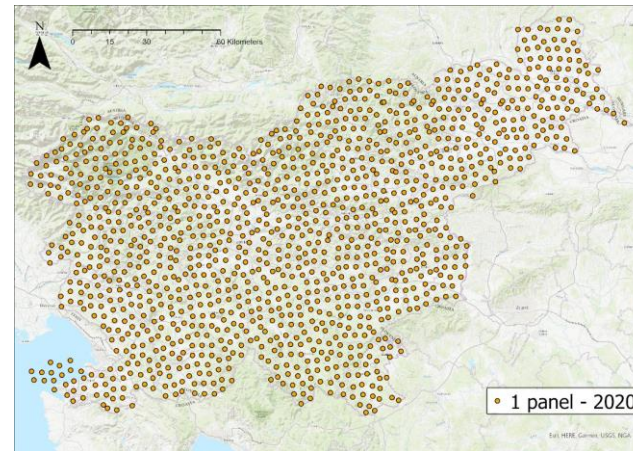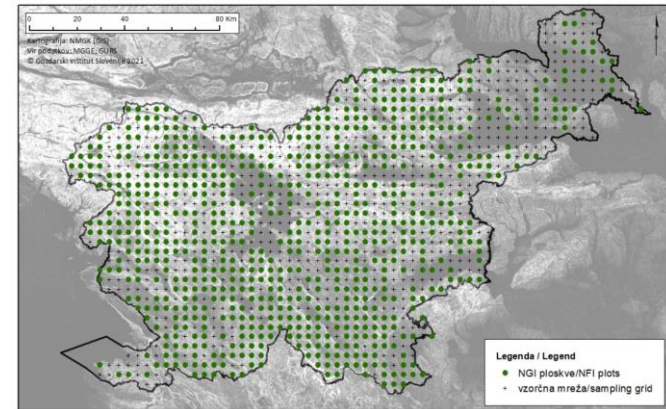
PLOT CONFIGURATION -

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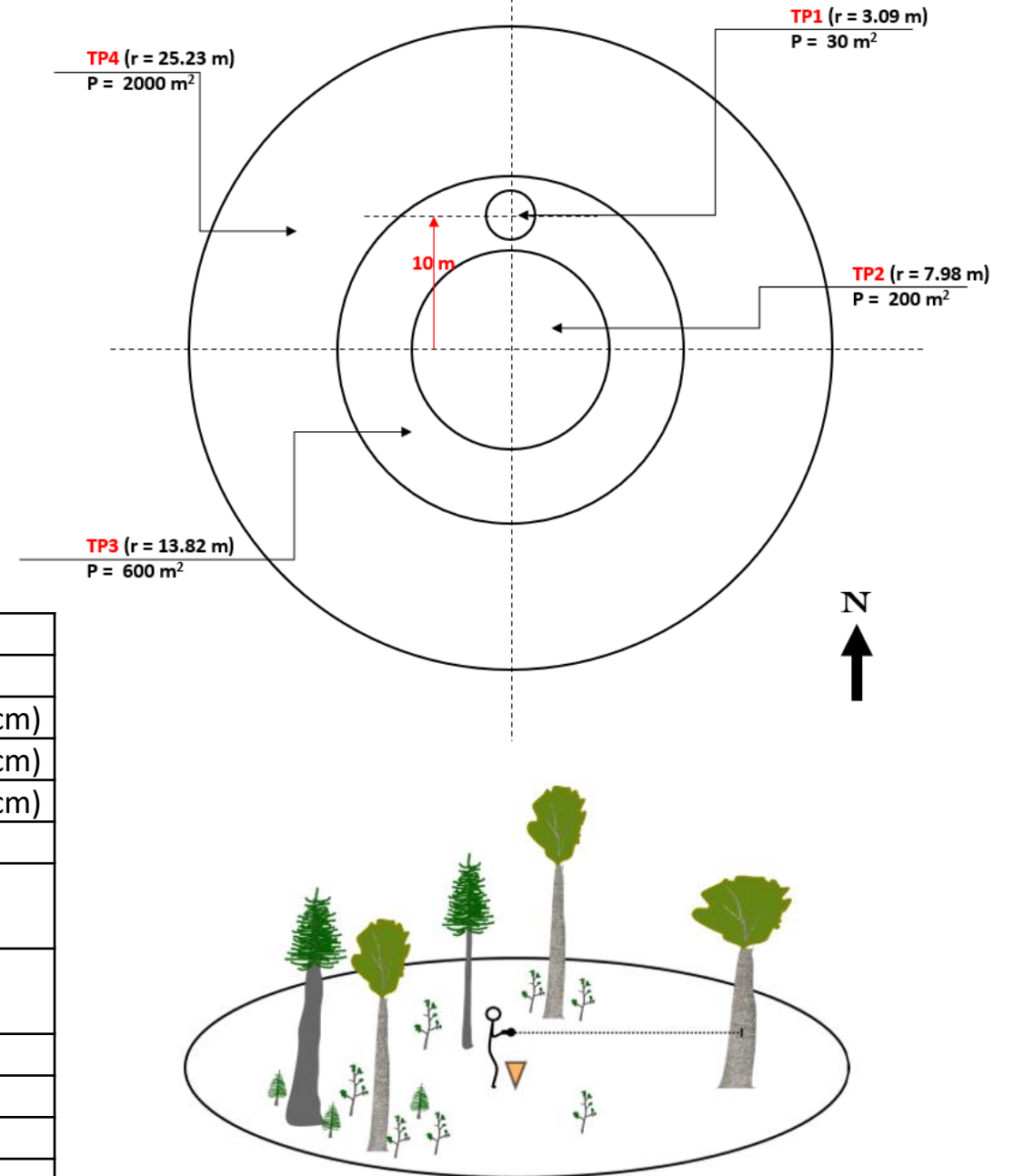
Indicator	Subplot and thresholds
Live trees $d_{1,3} < 10$ cm in $h \geq 1,3$ m	TP1
Live trees $d_{1,3} \geq 10$ cm	TP2 ($d_{1,3} \geq 10$ cm), TP3 ($d_{1,3} \geq 30$ cm)
Standing dead tree	TP2 ($d_{1,3} \geq 10$ cm), TP4 ($d_{1,3} \geq 30$ cm)
Lying dead tree	TP2 ($d_{1,3} \geq 10$ cm), TP4 ($d_{1,3}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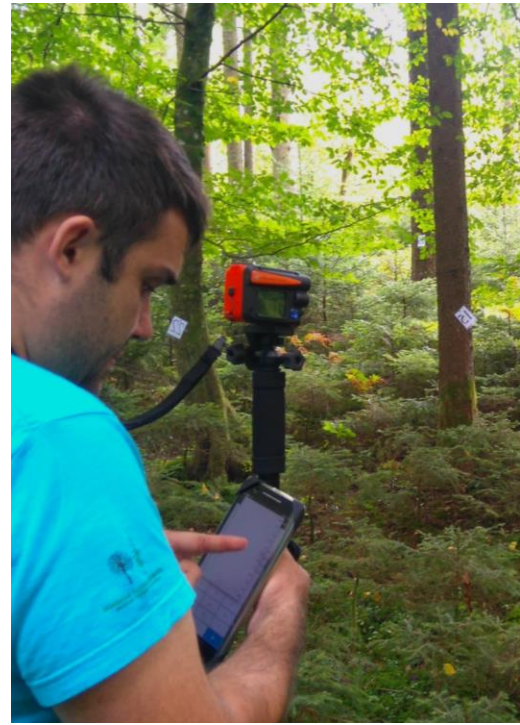
FIELD WORK

- 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
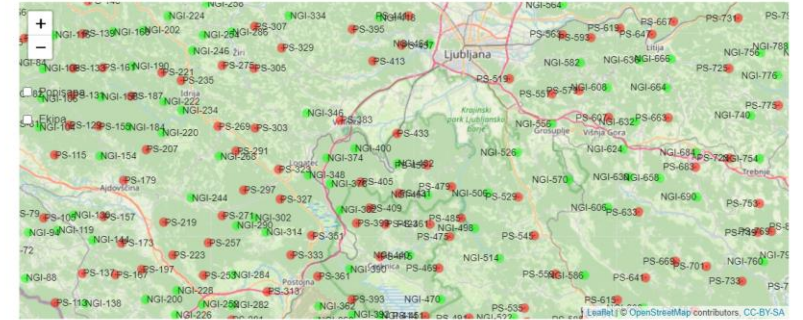
DATABASE STRUCTURE

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 …
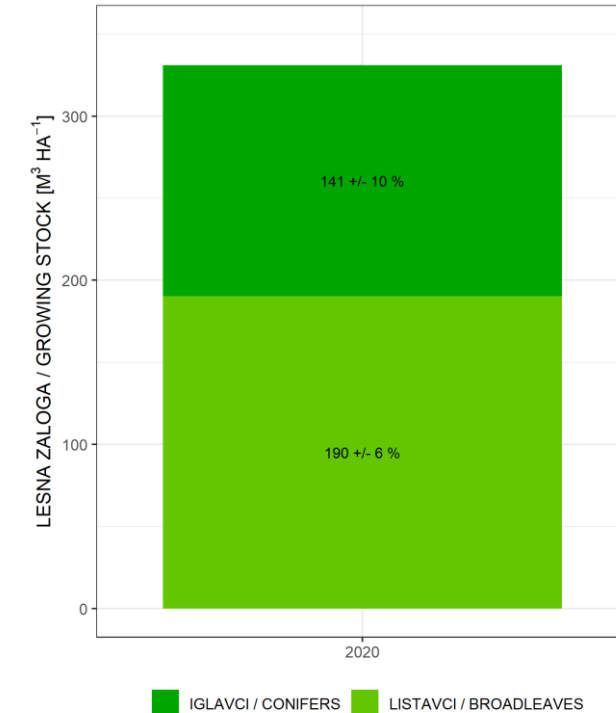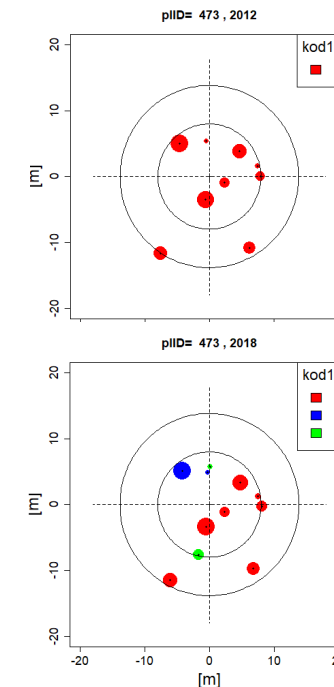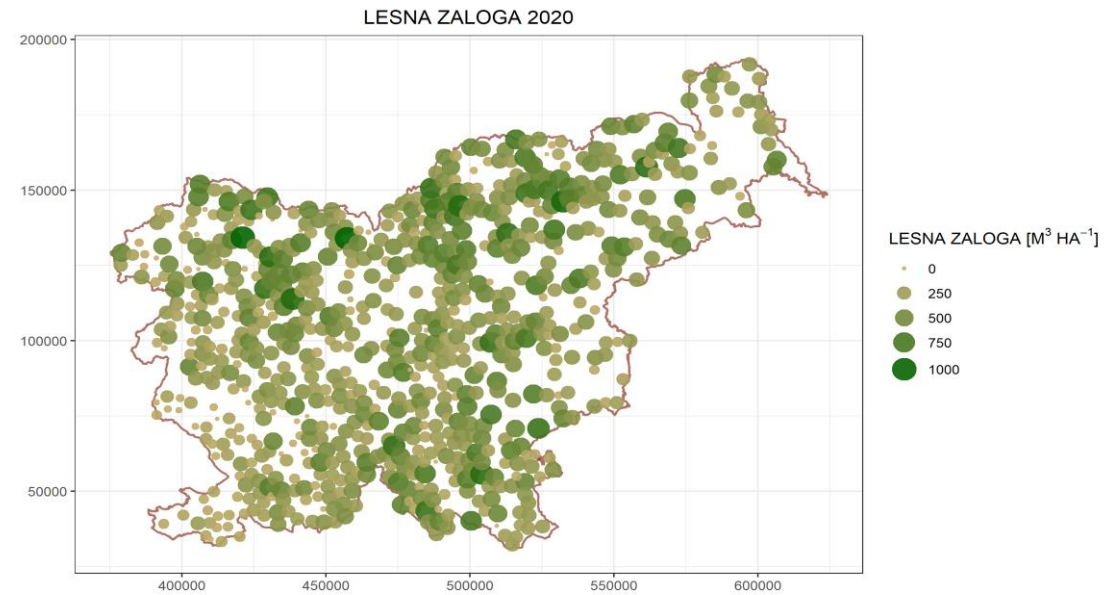
NFI and Reports: the state of Slovenian Forest and Forestry

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!

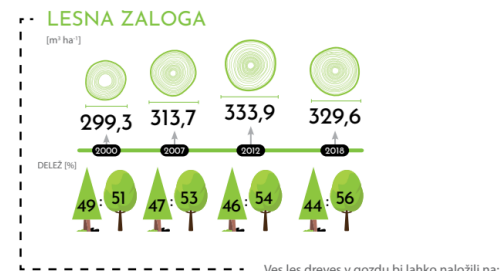# Presentation of the results to the professional and general public, inventory promotion
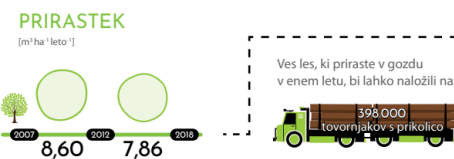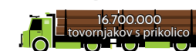
VIDEO about Slo NFI: https://www.youtube.com/watch?v=l60ef3ZfEPw&t=146s

PUBLICATIONS AND REPORTS

- State and changes of Slovenian forests in period (2000-2018) -> http://dx.doi.org/10.20315/SFS.181
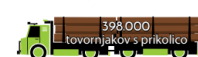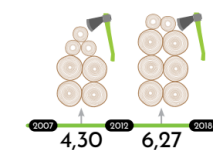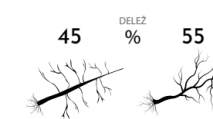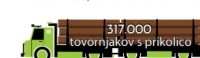
Collection of additional information on NFI areas: forest floor and litter, forest functions, timber quality, biodiversity, age structure,...;

New challenges ?

Legenda

- distrična rjava tla
- evtrična rjava tla
- hipoglej
- izprana tla
- karbonatna rjava tla
- ranker
- rendzina
- psevdoglej
- rjava pokarbonatna tla
- litosol
- obrečna tla

0   30   60 km

Kartografija: Enka Kozamernik
Viri podatkov: GURS, 2019; GURS, 2015; GIS, 2022
© Gozdarski inštitut Slovenije, 2022

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
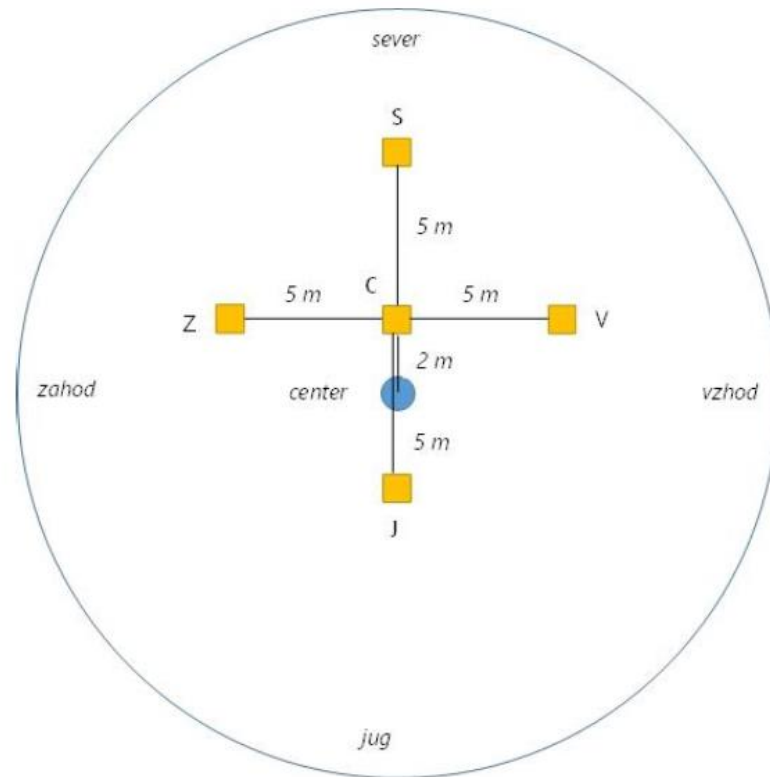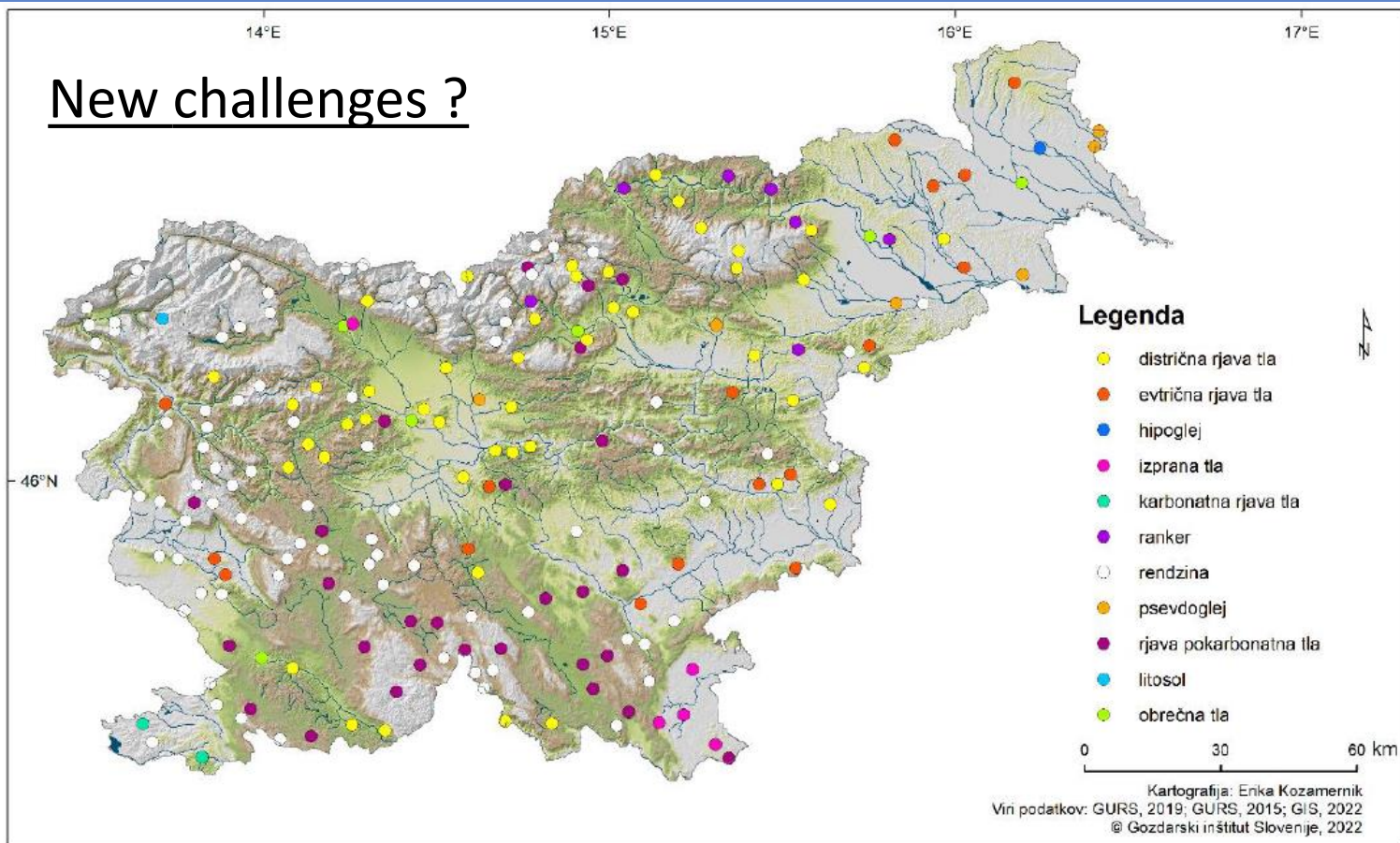
Forest soil and litter sampling Sub-plots at NFI plots

LULUCF: Fit for 55

- REGULATION (EU) 2023/839, 19.04.2023 amending Regulation (EU) 2018/841 as regards the scope, simplifying the reporting and compliance rules, and setting out the targets of the Member States for 2030, and Regulation (EU) 2018/1999 as regards improvement in monitoring, reporting, tracking of progress and review
- Contribution of the LULUCF sector to reach the goal (i.e. -55% by 2030)
- Target 2021-2025: "no-debit rule"
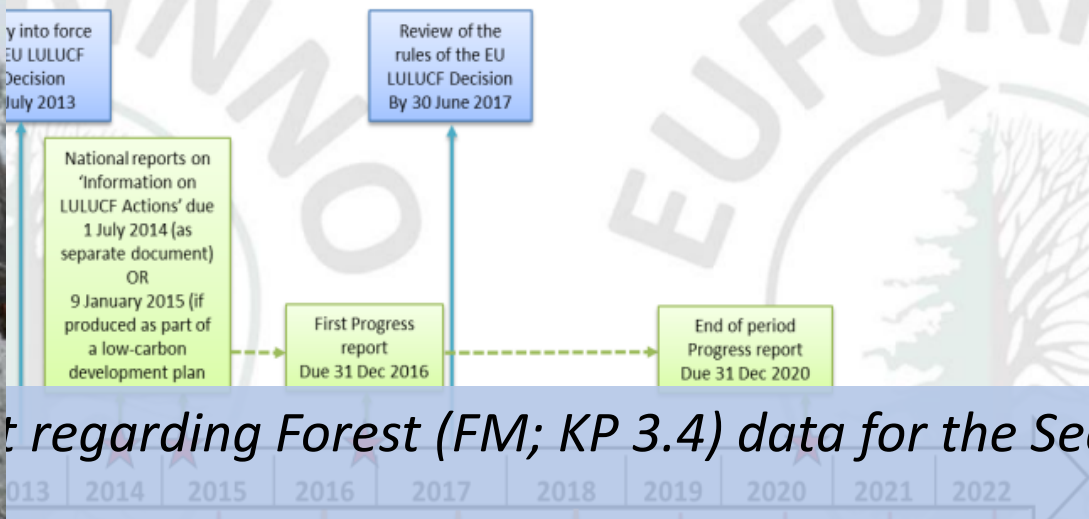- Target 2030: -310 Mt CO_2 eq and negotiation for the LULUCF Regulation
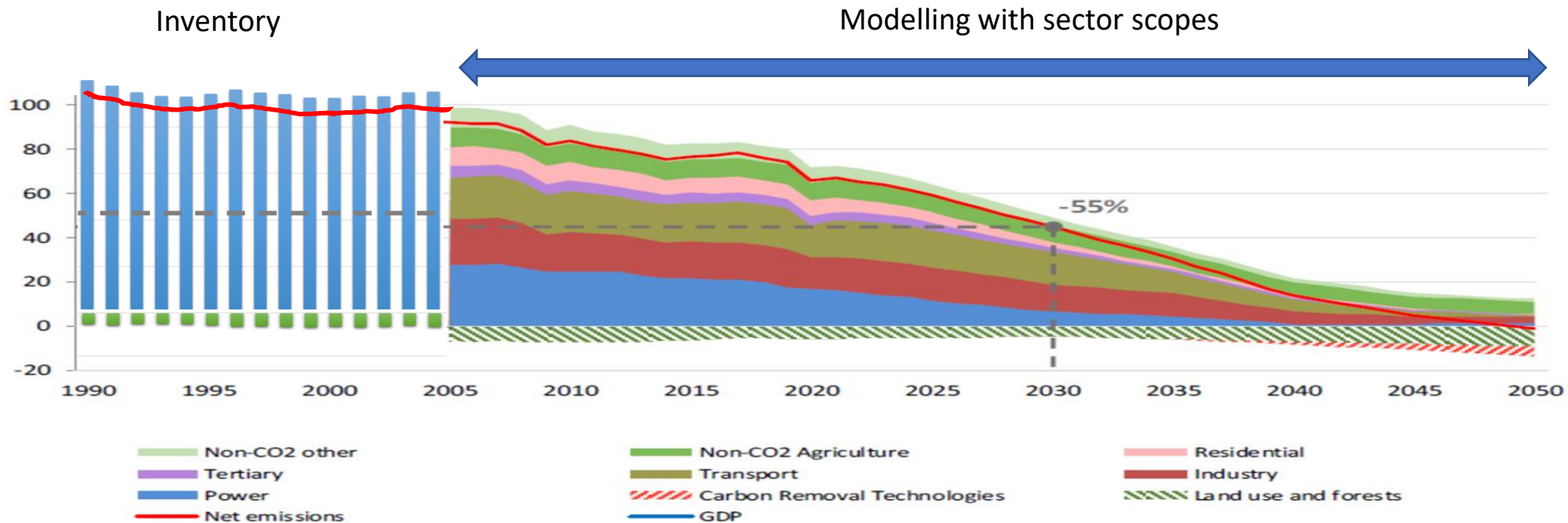
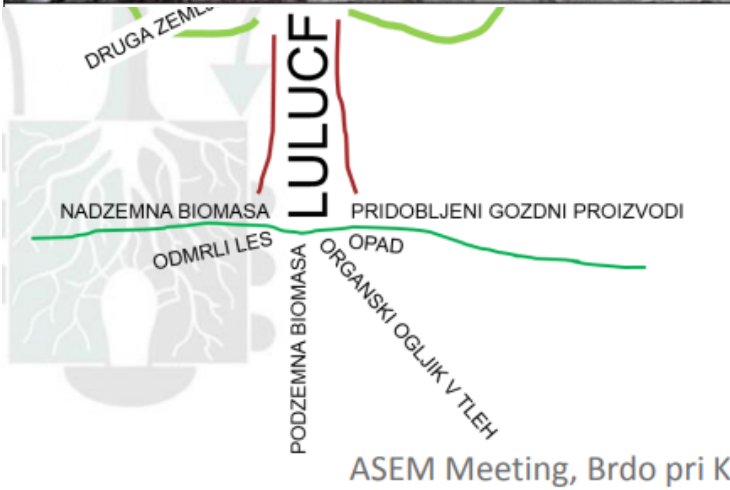LULUCF: EU pathway to climate neutrality

Reporting and planning associated with Art. 10 and Art. 3(2) ... ing period 2013-2020

... regarding Forest (FM; KP 3.4) data for the Second

With use new NFI data and other data – is it possible to explain large extreme events in Slovenian Forest 2014-2018 and GHG emissions "IF" (!) – KP units (cca 7,8-10 M!!!)