SFI Sustainable Forestry Implementation

With support from Federal Ministry of Food and Agriculture by decision of the German Bundestag

NFI Report **SFI/SNFI/2023**

Automated methodology of identifying forest/non forest for National Forest Inventory sample plots

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Kyiv, December 2023

unique land use

IAK AGRAR CONSULTING

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About the Project "Sustainable Forestry Implementation" (SFI)

The project "Technical Support to Forest Policy Development and National Forest Inventory Implementation" (SFI) is a project established in the framework of the Bilateral Cooperation Program (BCP) of the Federal Ministry of Food and Agriculture of Germany (BMEL) with the Ministry of Environment and Natural Resources of Ukraine (MENR). It is a continuation of activities started in the forest sector within the German-Ukrainian Agriculture Policy Dialogue (APD) forestry component.

The Project is implementing based on an agreement between GFA Group, the general authorized executor of BMEL, and the State Forest Resources Agency of Ukraine (SFRA) since October 2021. On behalf of GFA Group, the executing agencies - Unique land use GmbH and IAK Agrar Consulting GmbH - are in charge of the implementation jointly with SFRA.

The project aims to support sustainable forest management planning in Ukraine and has a working focus on the results in the Forest Policy and National Forest Inventory.

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Introduction

This final report describes the content of the tasks performed in accordance with the terms of reference for the automated methodology for identifying forest and non-forest land for the National Forest Inventory (NFI) plots.

The report includes summary information on the results of the work performed in the following areas:

- Regulations on stratification of inventory plots of the national forest inventory were prepared;
- Recommendations for automated classification of the national forest inventory plots based on the use of the Geographic Information System for Forest Resources Management of Ukraine by the State Enterprise "Ukrderzhlisproekt" (https://gis.lisproekt.gov.ua/portal/apps/sites/#/gis-lisproekt);
- Recommendations for the OpenForis software (https://openforis.org/) were developed, including setting up the structure of survey forms and data validation, while the Collect software (https://openforis.org/tools/collect/) in combination with Google Earth Pro (https://www.google.com/intl/ru_ALL/earth/versions/) provides ground-based observations and assessment of forest resources using high-quality satellite images with geographic information.
- Recommendations for analysing land cover classification data collected in Collect Earth Pro using the built-in OpenForis SAIKU Analysis application were developed.

1. EXPECTED RESULTS AND OBJECTIVES

The preliminary classification (the corresponding Ukrainian term is stratification) of inventory plots using remote sensing data into forest/non-forest areas is a mandatory part of the NFI survey. Today, this process is standard for all NFI, aimed at reducing the amount of field work and is usually ensured by manual expert interpretation of the location of each NFI sample area within or outside the forest area, when a point grid of the centres of NFI plots is overlaid on high-resolution satellite images.

The stratification is carried out in accordance with the Procedure for conducting NFI [1] and the requirements of the NFI technical documentation approved by the Production Enterprise "Ukrderzhlisproekt" [2] as the responsible organisation for conducting NFI of the State Forest Resources Agency of Ukraine (SFRA). It provides for preliminary and re-stratification with different types of remote sensing and software used. Both classifications have so far been carried out manually and are time-consuming.

SFRA plans to introduce a unified forest web platform to integrate different types of forest information and cover all forests in Ukraine, as envisaged by the Strategy of State Forestry Management until 2035 [3]. NFI data and results are seen as essential for this forest web platform. The integration of forest management data, state land cadastre data, forest masks developed by scientific organisations, remote sensing data and NFI also opens up opportunities for automated use of NFI information, in particular for preliminary classification of forest plots.

It is expected that the introduction of an automated procedure for stratification of NFI plots will, on the one hand, improve the quality of plot classification by using more types of remote sensing and GIS maps, and on the other hand, reduce the time spent by an expert to monitor indicative plots that need to be verified.

2. ORGANISATION OF THE PROCESS OF AUTOMATED STRATIFICATION OF NFI

2.1. Terms and definitions

The Geoinformation System of Forest Resources Management of Ukraine of the Production Enterprise "Ukrderzhlisproekt" is a comprehensive system designed to collect, store, analyse and use geographic data for the purpose of effective management of forest resources in Ukraine..

The OpenForis project is a set of free and open software tools that facilitate flexible and efficient data collection, analysis and reporting.

OpenForis Collect - is a software tool for collecting data in the field, designed for conducting area inventories, expeditions and scientific research. It allows you to create and manage questionnaires, collect data on mobile devices and export it for further analysis. Collect also has built-in capabilities for data validation and real-time data quality improvement.

Google Earth Pro - is an advanced version of Google Earth that provides additional features for visualising geographic data and performing geospatial analysis. It has a wider range of features than the free version of Google Earth, including the ability to upload more data, perform measurements, and use advanced tools to create visual effects. Google Earth Pro is widely used in geographic research, route planning, geodata visualisation, and other areas.

OpenForis SAIKU Analyses - is a data analysis tool that is part of the OpenForis platform. It allows users to perform a variety of analytical operations with data, including creating reports, visualisations and charts based on the collected data. SAIKU Analyses helps in understanding and interpreting the information obtained from the field inventories and expeditions carried out using the OpenForis platform.

2.2. Brief description of the organisation of the NFI stratification system

The stratification consists of preliminary automated and semi-automated main stratification, and related processes for preparing the classification scheme and draft main classification (Fig. 1).

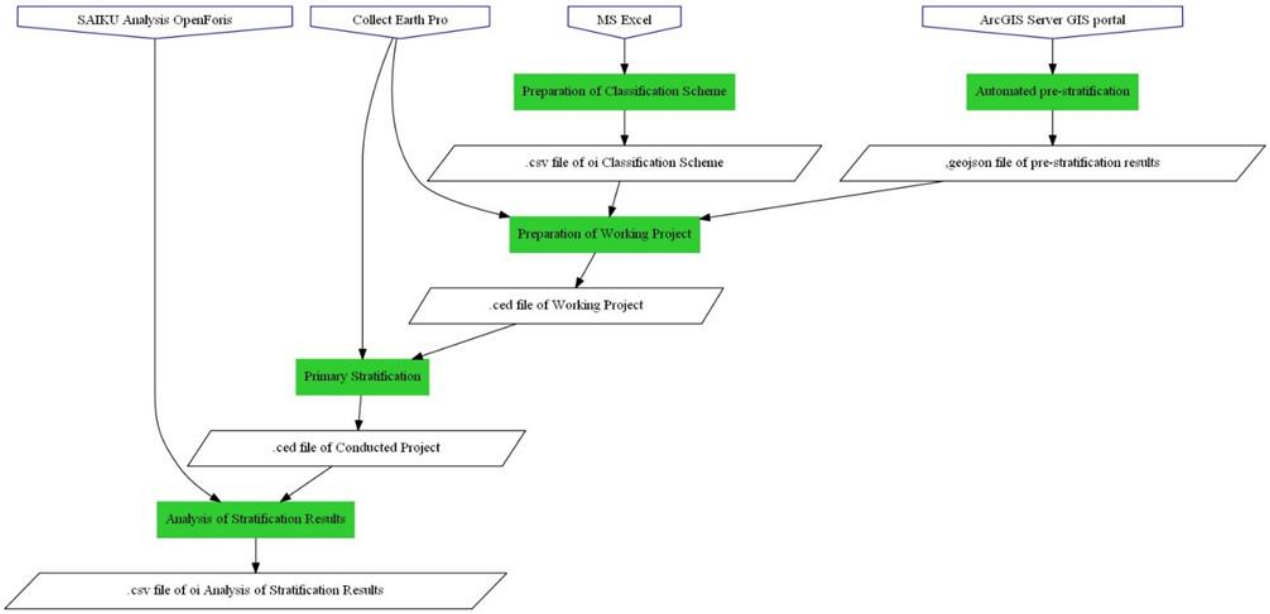


Figure 1. Scheme of conducting stratification

In order to train personnel to conduct stratification, a specialised module was developed in the system of the online training course on NFI (https://nfi-lms.pp.ua/login/index.php).

2.2.1. Preliminary automated stratification

The preliminary stratification is performed by special software tools (services) developed for the GIS portal of forest resources management. The relevant software tools have been tested and recommended for stratification of the 2024 NFI plots.

The portal contains information layers - forestry cartographic materials and information from the public map of the land cadastre, which allows to identify inventory plots lying within the boundaries of land forest plots in accordance with the current forestry and land management materials.

The GIS portal software tools pre-classify inventory plots (their centres) as forests if they are located within forestry lands according to the current forestry or land management materials.

Using the GIS portal services, inventory plots (their centres) can also be provided with the following additional attributes:

administrative territory (oblast, rayon, amalgamated territorial community); natural and climatic zone; land category; form of ownership; forest management information: forestry enterprise, quarter, taxation classification; classification as a nature reserve area; classification as a part of the Emerald network; classification of forests by naturalness categories (virgin forests, quasi-virgin forests, natural forests, semi-natural forests); soil type.

Based on the results of using the GIS portal software tools/services, an electronic file (.csv, .geojson) of the preliminary stratification results is automatically generated.

2.2.2. Main stratification

The main stratification is performed in the Collect Earth Pro software. Collect Earth Pro uses the Google Earth Pro interface in combination with HTML forms for data entry.

The classification scheme (survey design) used for the main stratification of inventory plots consists of three levels: two main levels of land cover classification and a third additional level of detail for a number of categories of the second level (Table 1).

Table 1 - Scheme of land cover classification for basic stratification

Land Cover Group (level 1)	Land Cover Type (level 2)	Land Cover Detail (level 3)
FOREST	COMMON FOREST (Area more 0.1 ha)	
	SHELTERBELTS (More than 3 tree lines side-by-side)	Width: More then 20 m/ Less then 20 m
	FOREST REGROWTH	Predominant Land Use: Forestry / Not Forestry
	FOREST OPEN AREA	Type: biofields, glades, firebreaks, clearings, upper storage areas / Type not identified
	DAMAGED FOREST	Type: Fires/ Wind/ Snow/ Dishes or Insects/ Type not identified
	FOREST EDGE	
	FOREST LOGGING (Clear Cutting Area)	
	INDICATIVE	
OTHER WOODY LAND	SHRUBLAND	
	ORCHARD	
	TREED URBAN AREA	Type: Gardens, Cemeteries, Urban tree stands (recreation area, parks etc/ Type not identified

Land Cover Group (level 1)	Land Cover Type (level 2)	Land Cover Detail (level 3)
	OTHER WOODY VEGETATION	Type: Forest Trees on Area less 0.1 ha/ Treed rocks / Weatland with low trees and srub vegetation outside forest/ Type not identified
GRASSLAND		
CROPLAND		
WATER	PERMANENT RIVER	
	PERMANENT LAKE	
	SEA	
WETLAND	PEATLAND	
	SWAMP (Herbaceous cover)	
SETTLEMENT	CITY (переважно багатоповерхова забудова)	
	VILLAGE (переважно одноповерхова забудова)	
OTHERS	ROAD	
	SAND	
	ROCKS	
	OTHER UNPRODUCTIVE	

3. DRAFT TECHNICAL DOCUMENTATION FOR STRATIFICATION

Order of the
UKRAINIAN STATE FOREST
MANAGEMENT PLANNING
ASSOCIATION
from _____№ _____

Regulations
on stratification of inventory plots of the national forest inventory
/DRAFT/

Basic concepts
Objectives

Conducting sampling and statistical surveys involves a combined approach that uses the stratification of inventory plots and field surveys of quantitative and qualitative characteristics of forests of the general population in forest inventory plots [11. Procedure].

Stratification of inventory plots is the process of classifying inventory plots based on remote sensing data (hereinafter referred to as remote sensing) for their location within forests and other forested areas with the formation of a list of forest, non-forest and indicative forest inventory plots [2. Procedure].

Inventory plots classified during stratification as forest inventory plots or indicative forest inventory plots shall be subject to a field survey to determine whether they are forest inventory plots [11. Procedure].

Performers

Engineers (taxation engineers) of I and II categories of the Center of National Forest Inventory of the State Enterprise "Ukrderzhlisproekt"

Regulatory and legal acts governing stratification

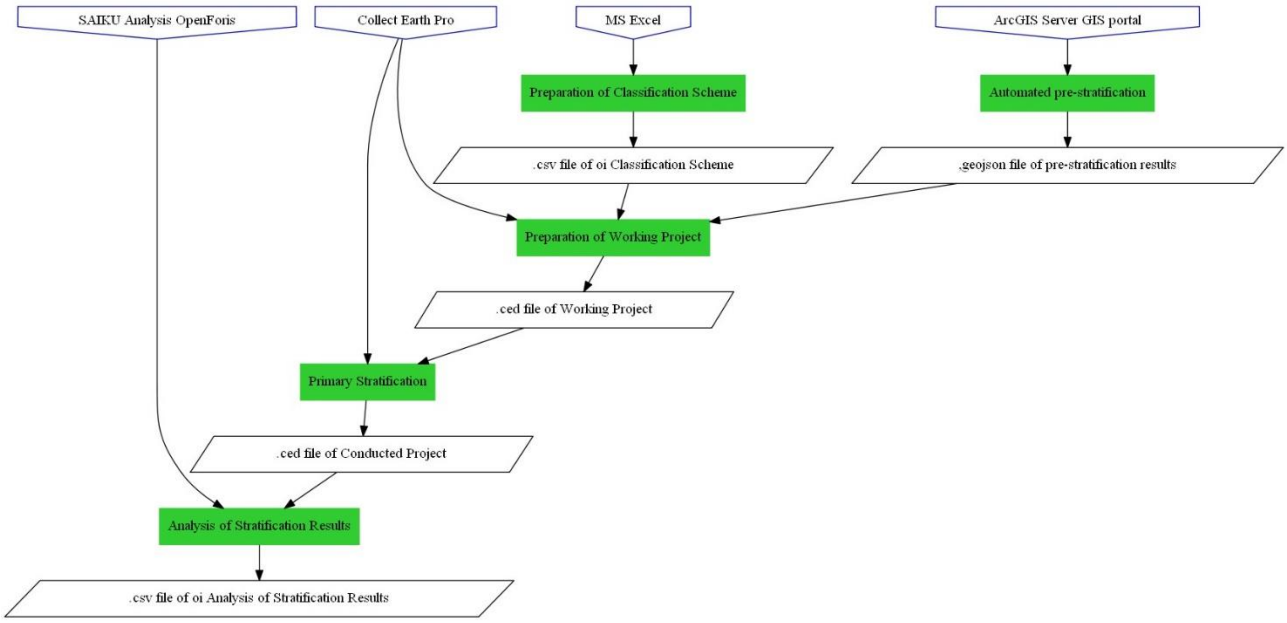
In accordance with the Procedure for conducting national inventory, preparatory work for the national forest inventory includes stratification of inventory plots.

Document flow

Document	**Regulatory, methodological and training materials**
An electronic file (.csv, .geojson) of the results of preliminary stratification	
Converted file (.shp)	
Electronic file (.csv, .geojson) of the results of the main stratification	

Application software

Software	Automated operations	Content of transactions
Services of the GIS portal of forest resources management (ArcGIS server)	Automated pre-stratification	The use of a geographic information system for forest resource management in Ukraine allows to automate the stratification process, ensuring the accuracy and speed of data processing, reducing the likelihood of errors, and providing users with the ability to select areas of the National Forest Inventory for the period from 2021 to 2025, as well as access to a wide range of information on the geographic information portal, including administrative division, land category, ownership, climate zones, nature reserve fund, and others.
Collect Earth Pro service of the openforis.org portal	Semi-automated basic stratification	The Collect Earth Pro service on the openforis. org portal provides a semi-automated basic stratification for forest inventory using the Collect Earth Pro geographic information system from the Open Foris Collect package, which integrates the Google Earth Pro interface and HTML forms for data entry; the classification scheme consists of three levels and includes various land cover categories such as forests, grasslands, water bodies, and others, giving users access to high-resolution satellite imagery such as the European Space Agency's Copernicus Sentinel 2 and Planet.
ArcGIS 10.3, QGIS 3.1	File conversion	Using ArcGIS 10.3 and QGIS 3.1 allows you to efficiently convert geospatial data files into a variety of formats, providing a wide range of tools for processing and analyzing geographic data, including the ability to use different projections and coordinate systems, as well as built-in algorithms for performing complex operations such as coordinate conversion, cropping and merging layers, analyzing spatial relationships, creating and customizing map visualizations.



Brief description of the process

Preliminary stratification

The preliminary stratification is performed by special software tools (services) developed for the GIS portal of forest resources management, which operates in the ArcGIS server 10.3 environment.

The portal contains the entire network of inventory plots of the NIF by years. The portal contains information layers - forestry cartographic materials and information from the public map of the land cadastre, which allows to identify inventory plots lying within the boundaries of land forest plots in accordance with the current forestry and land management materials.

The software tools of the GIS portal pre-classify inventory plots (their centers) as forests if they are located within the boundaries of forestry lands according to the current forestry or land management materials.

Using the services of the GIS portal, inventory plots (their centers) can also be provided with the following additional attributes

- administrative territory (oblast, rayon, united territorial community)
- natural and climatic zone;
- land category,
- form of ownership;
- forest management information: forestry enterprise, quarter, taxation allocation,
- classification as part of a nature reserve fund;
- assignment to the territories of the Smart Grid network
- classification of forests into naturalness categories (virgin forests, quasi-virgin forests, natural forests, semi-natural forests);

- soil type.

Based on the results of using the GIS portal software tools/services, an electronic file (.csv, .geojson) of the preliminary stratification results is automatically generated.

Main stratification

The main stratification is performed in the Collect Earth Pro program from the Open Foris Collect package (Google Chrome is recommended - download page http://www.openforis.org/tools/collect.html).

Collect Earth Pro uses the Google Earth Pro interface in combination with HTML forms for data entry. The forms are customized according to the classification scheme below. Collect Earth Pro provides access to the use of high-resolution satellite imagery, such as the European Space Agency's Copernicus Sentinel 2 and Planet.

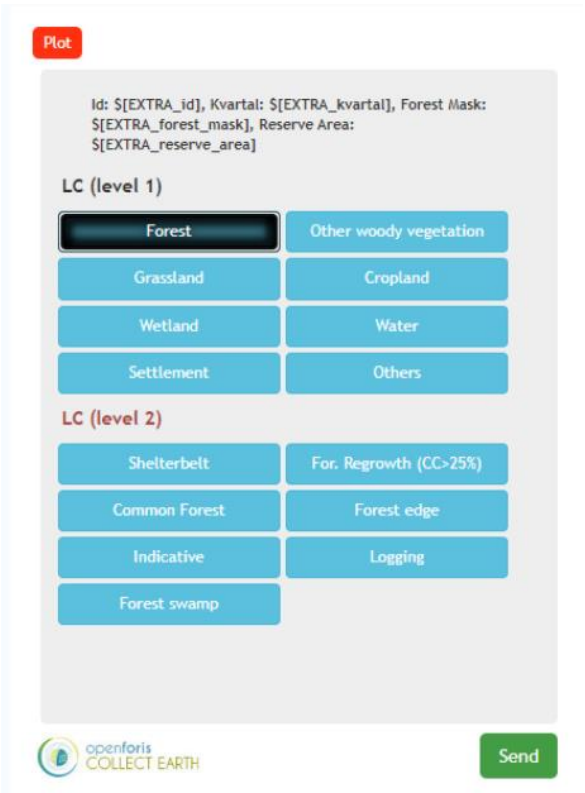
The classification scheme (survey design) used for the main stratification of inventory plots consists of three levels: two main levels of land cover classification and a third additional level of detail for a number of categories of the second level (Table 3).

Table 3 - Scheme of land cover classification in the main stratification

Land Cover Group (level 1)	Land Cover Type (level 2)	Land Cover Detail (level 3)
FOREST	COMMON FOREST (Area more 0.1 ha)	
	SHELTERBELTS (More than 3 tree lines side-by-side)	Width: More then 20 m/ Less then 20 m
	FOREST REGROWTH	Predominant Land Use: Forestry / Not Forestry
	FOREST OPEN AREA	Type: біополяни, галявини, протипожежні розриви, просіки, верхні склади/ Type not identified
	DAMAGED FOREST	Type: Fires/ Wind/ Snow/ Dishes or Insects/ Type not identified
	FOREST EDGE	
	FOREST LOGGING (Clear Cutting Area)	
	INDICATIVE	
OTHER WOODY LAND	SHRUBLAND	
	ORCHARD	
	TREED URBAN AREA	Type: Gardens, Cemeteries, Urban tree stands (recreation area, parks etc/ Type not identified
	OTHER WOODY VEGETATION	Type: Forest Trees on Area less 0.1 ha/ Treed rocks / Weatland with low trees and srub vegetation outside forest/ Type not identified
GRASSLAND		
CROPLAND		
WATER	PERMANENT RIVER	

Land Cover Group (level 1)	Land Cover Type (level 2)	Land Cover Detail (level 3)
	PERMANENT LAKE	
	SEA	
WETLAND	PEATLAND	
	SWAMP (Herbaceous cover)	
SETTLEMENT	CITY (mostly multi-storey buildings)	
	VILLAGE (predominantly one-story buildings)	
OTHERS	ROAD	
	SAND	
	ROCKS	
	OTHER UNPRODUCTIVE	

The view of the Collect Earth Pro program window for classifying a forest inventory plot is shown in Figure 1. The upper part of the program window displays the attributes obtained from the results of automated classification, which serve as reference data for making a decision on classifying the inventory plot as forest. In case of selecting the first level classification units, performers must define the second level classification unit, and for some attributes also the third level classification unit.



Technological map of inventory plots stratification

№ п/п	Operation			Responsible executors		Input document				Source document				Application software
	title	condition fulfillment	term fulfillment	Subdivisions	brief description of the work performed	name of the document	name participant of the process (position, qualifications)	format of the document		name of the document	name participant of the process	format of the document		
								papery	electronic			papery	electronic	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Pre-automated stratification	Access to the GIS portal	During the preparatory work, NFI	Personnel of the IEC, NFI	Creating spatial queries to obtain attributes (centers) of inventory plots	Vector layers of forestry, land management information, other geospatial layers on the GIS portal	Administrator of the GIS portal, GIS engineers of the NFI	-	(.shp, .lyr)	File of preliminary stratification results	Engineers of the I and II categories of the NFI	-	(.csv, .geojson)	Software applications/ .services of the GIS portal. ArcGIS Server 10
2	Preparation of a land cover classification scheme	Access to web services for viewing remote sensing data	Once per NFI cycle	Personnel of the NFI	Development of a land cover classification scheme	The procedure for conducting NFI	Taxation engineers, GIS engineers of the NFI	+		Classification scheme of land cover types	Head of the NFI, taxation engineers, GIS engineers	+	(.ced, (.csv)	Open Foris, Google Earth Pro

№ п/п	Operation			Responsible executors		Input document				Source document				Application software
	title	condition fulfillment	term fulfillment	Subdivisions	brief description of the work performed	name of the document	name participant of the process (position, qualifications)	format of the document		name of the document	name participant of the process	format of the document		
								papery	electronic			papery	electronic	
3	Preparing the Collect Earth project	Access to the Internet	Once per NFI cycle	The staff of the NFI Center	Preparation of the Collect Earth project for stratification based on the land cover classification scheme	Classification scheme of land cover types, file of preliminary stratification results, sample of the Collect Earth Pro project (available at openforis.org)	engineers, GIS engineers of the NFI	-	(.csv), Collect Earth project (.ced)	Collect Earth working project (.ced)	engineers, GIS engineers of the NFI	-	Collect Earth working project saved to local storage	Open Foris, Collect Earth
4	Carrying out the main classification	The Collect Earth project has been prepared	Every year during the NFI cycle	The staff of the NFI Center	Consistent revision of inventory plots and their classification in the Collect Earth project with the formation of a list of forest, non-forest and indicative forest inventory plots	Collect Earth work project	Engineers of the I and II categories of the NFI	-	Collect Earth working draft (.ced), tabular data of plots (.csv)	Completed project Collect Earth	Engineers of the I and II categories of the NFI	-	Completed project Collect Earth (.ced), tabular data of plots (.csv)	Collect Earth

№ п/п	Operation			Responsible executors		Input document				Source document				Application software
	title	condition fulfillment	term fulfillment	Subdivisions	brief description of the work performed	name of the document	name participant of the process (position, qualifications)	format of the document		name of the document	name participant of the process	format of the document		
								papery	electronic			papery	electronic	
5	Analysis of land cover classification data	Collect Earth stratification project completed	Every year during the NFI cycle	The staff of the NFI Center	Creating queries and filters for visualizing collected data in Collect Earth using the built-in SAIKU Analysis Open Foris application	Completed project Collect Earth (.ced), tabular data of plots (.csv)	Head of the NFI, taxation engineers, GIS engineers	-	Collect Earth working draft (.ced), tabular data of plots (.csv)	Table of errors in the analysis of land cover classification data	Head of the NFI, taxation engineers, GIS engineers	+	Tables (.xlsx, (.csv)	SAIKU Analysis Open Foris

List of accepted abbreviations

Remote sensing data - data on land surface sensing objects recorded by aerospace and ground-based means using the properties of electromagnetic waves emitted, reflected or scattered by the sensed objects

NFI - national forest inventory

CNIL - Center for National Forest Inventory of the State Enterprise "Ukrderzhlisproekt"

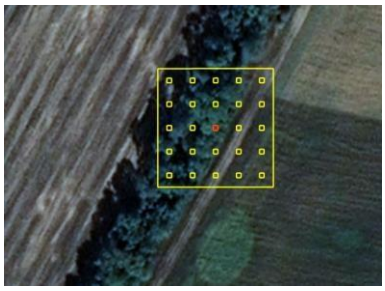
FIP Procedure - Procedure for conducting national forest inventory

ICC - Information and Computing Center of the State Enterprise "Ukrderzhlisproekt"

Annex 1. Land Cover Atlas used in stratification

Forest

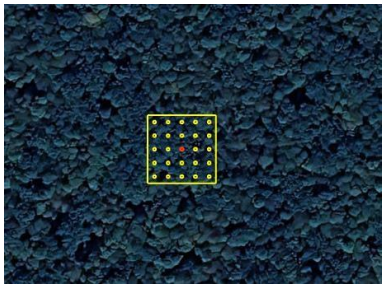
Shelterbelt



Forest Regrowth

Urban Forest

Common forest

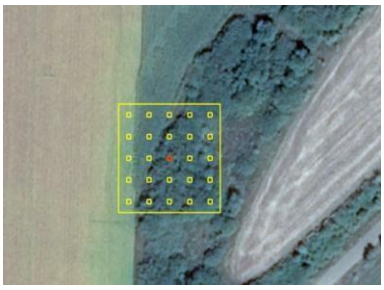


Forest edge

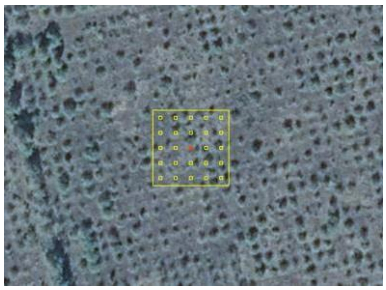
Damaged Forest

OTHER WOODY LAND

Shrubland



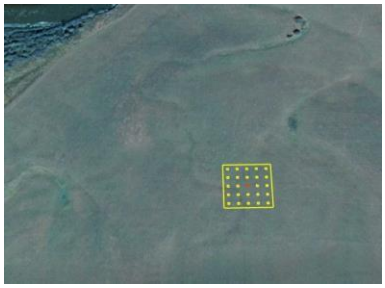
Orchard

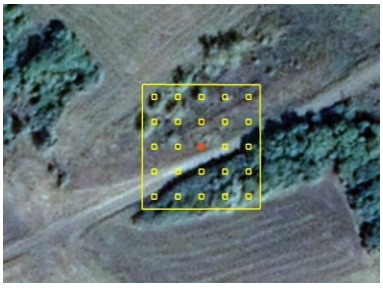


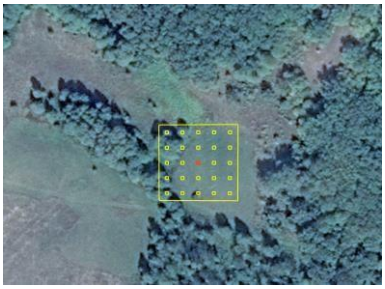
Garden Trees

OWV

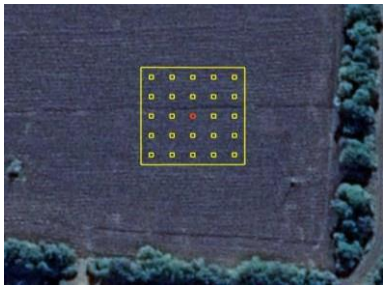
Grassland

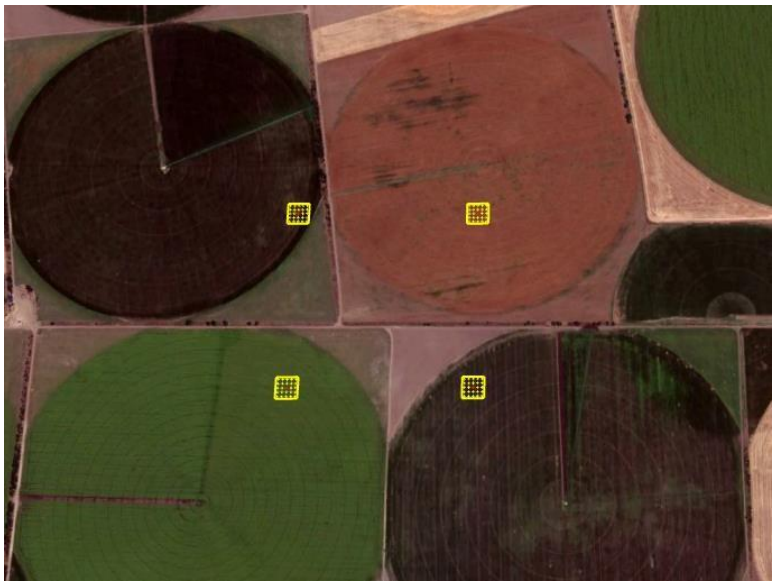






Cropland



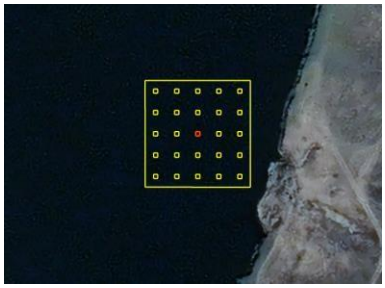




Wetland

Peatland

Water

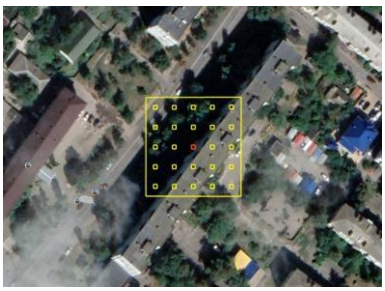
Permanent river



Permanent Lake

Sea

SETTLEMENT



Other unproductive