

Innovative Approaches to Monitoring Forest Changes in the Ukrainian Carpathians Using Satellite Data and AI

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Joint Workshop of the GOCF-GOLD SCERIN and MedRIN Networks

CIHEAM conference center, Chania, Greece, July 16 – July 19, 2024

Land Cover Change (LCC) and Extreme Events in the Context of Climate Change

Mediterranean Agronomic Institute of Chania

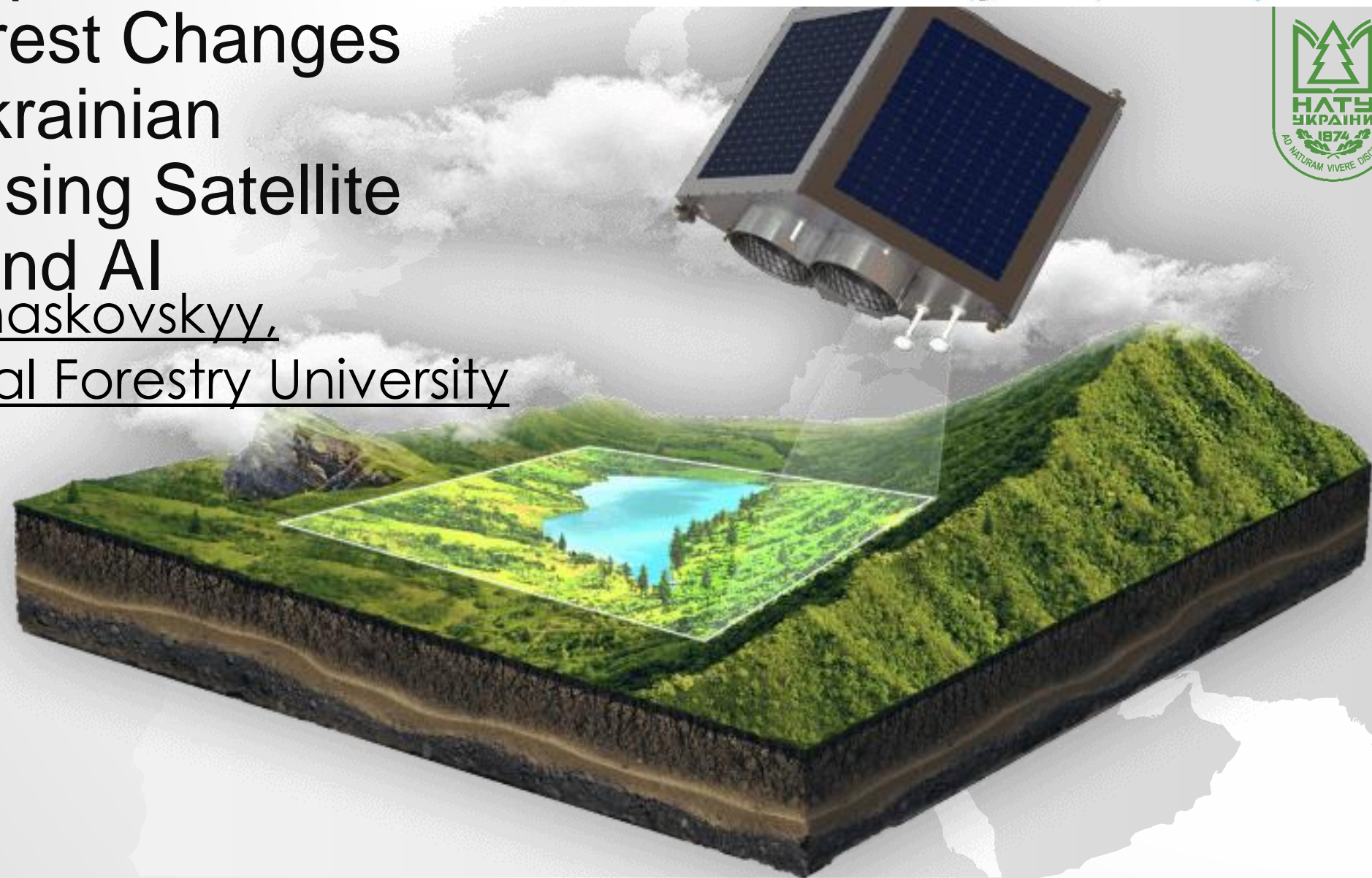
Region of Crete

Eratosthenes Center of Excellence, Cyprus University of Technology

Aristotle University of Thessaloniki

NASA LCLUC Program

GOCF-GOLD and START, USA



18 July 2024

AIMS

- **Continuous Monitoring:**
 - Regularly monitor forest health and detect changes using high-resolution satellite imagery and UAV surveys.
- **Damage Assessment:**
 - Evaluate the extent and severity of forest damage from pests, climate change, and human activities.
- **War Impact Analysis:**
 - Assess the impact of military actions on forest ecosystems by comparing pre- and post-conflict satellite images.
- **Reforestation Monitoring:**
 - Track the progress and effectiveness of reforestation efforts and forest recovery.



1. Background / Objectives

2. Methods

3. Materials

3.1. Satellite images (free periodic vs commercial daily)

3.2. GIS based Forest Management Maps

4. Results

4.1. Optical vs Radar

4.2. Annual vs Near to Real Time

4.3. Visual vs Automatic

4.4. Algorithms evolution (NDVI vs Computer Vision)

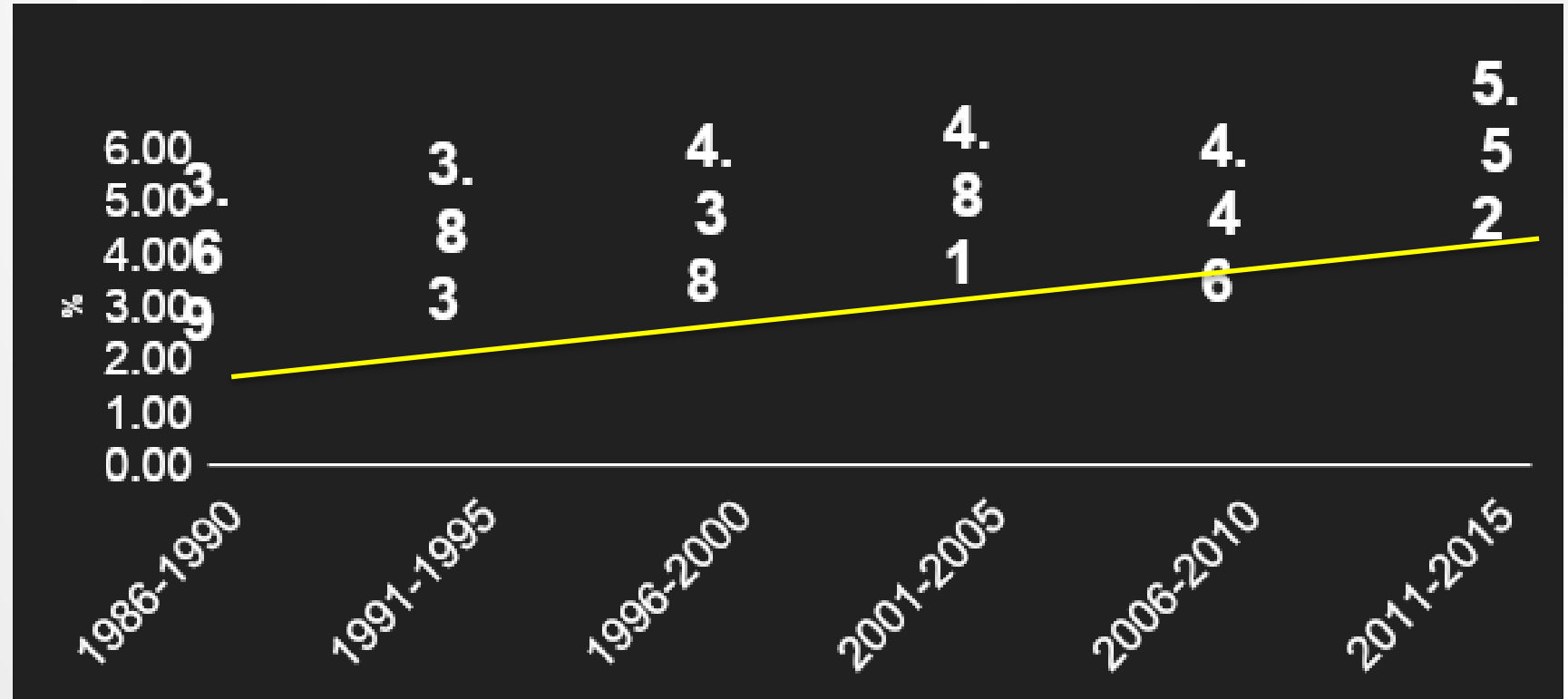
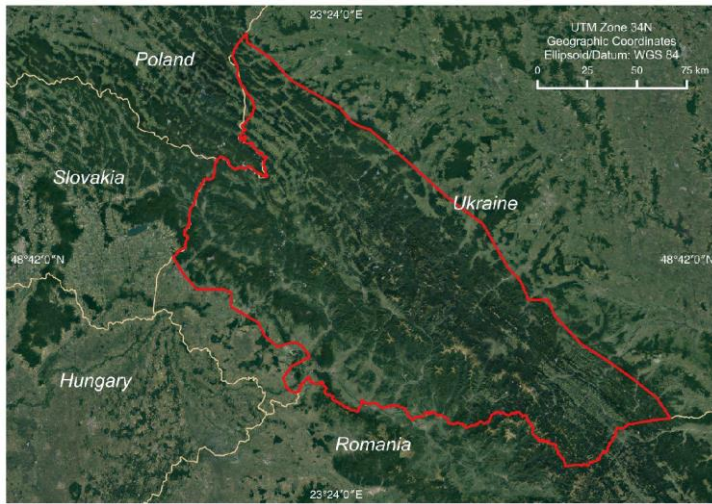
1. Background / Objectives

Study area: Ukrainian Carpathian



Ukrainian Carpathians - young mountains with cone-shaped peaks, low ridges and a flat slopes, among which valleys are situated. The highest peak of this part of Carpathians is Goverla. It's height is 2061 m. There is no glaciers, but snow is staying very long time. Often it avalanches down the slopes and damages the nature sights and people's livelihoods. Although the Carpathian Mountains occupy a small area in Ukraine, it house more than half of all animals of the country. Only in the Carpathians live such endemic species as: carpathian squirrel carpathian newt, and a snow vole. The bisons are brought from the Bialowieza Forest.

Analysis of the canopy cover changes in the Carpathians based on space images

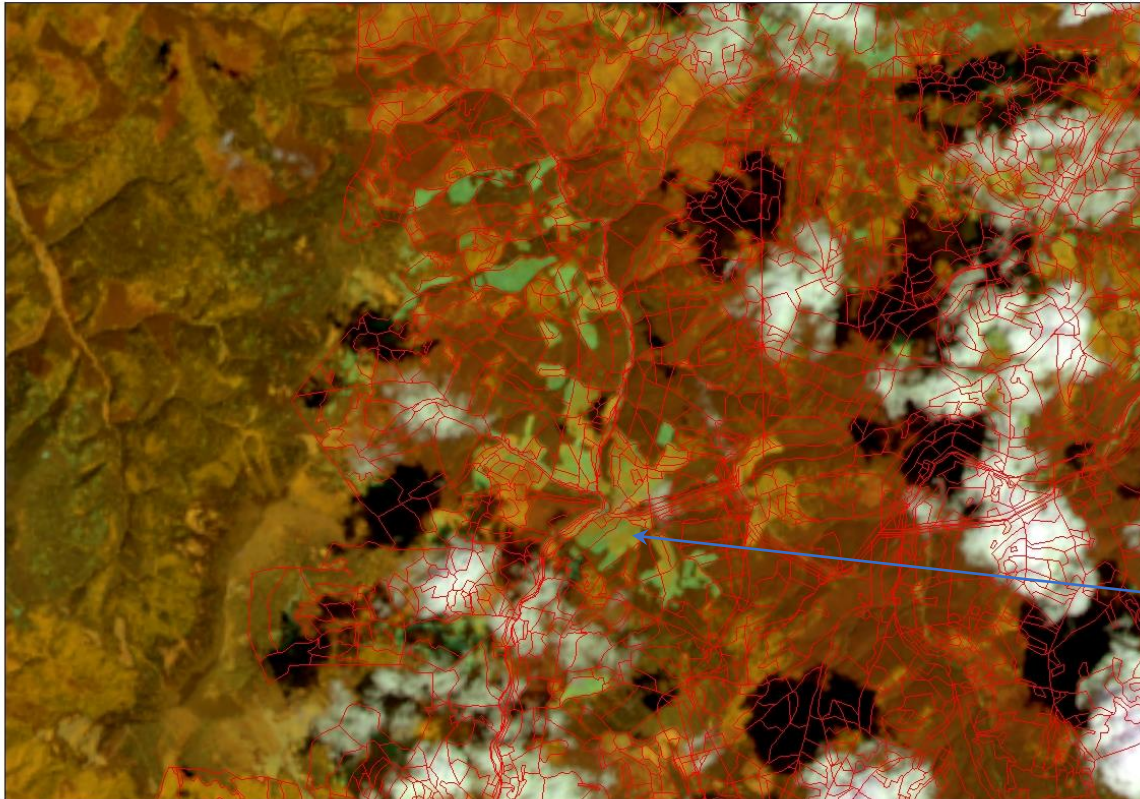


- Logging rate in the Carpathians is increasing;
- About 1% of the territory of the Carpathian Forest area is being deforested every year (an average of 0.87% for the period from 1984 to 2016);
- 10 years out of 33 forest cover loss exceeded 1% of the territory of Ukrainian Carpathians

1. Background / Objectives

However, more than 90 % of Ukraine's forests are plantations or regulated even-aged stands. Wood is harvested within final felling, thinnings, sanitary and other cuttings. Final felling in Ukraine is mainly clear cutting. This kind of harvesting is good to identify on the Satellite images like Landsat and Sentinel-2.

We will utilize the Sentinel-2 and Planet Scope scenes from 2015 to 2022 years image archive.



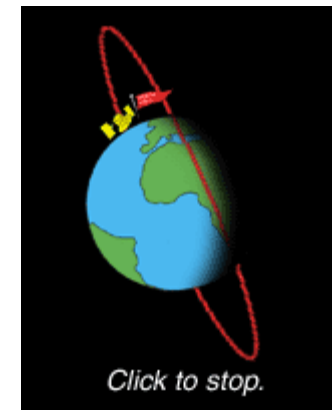
Clear cutting in Ukrainian Carpathians on Landsat-8

3. Materials

3.1. Satellite images (free periodic vs commercial daily)

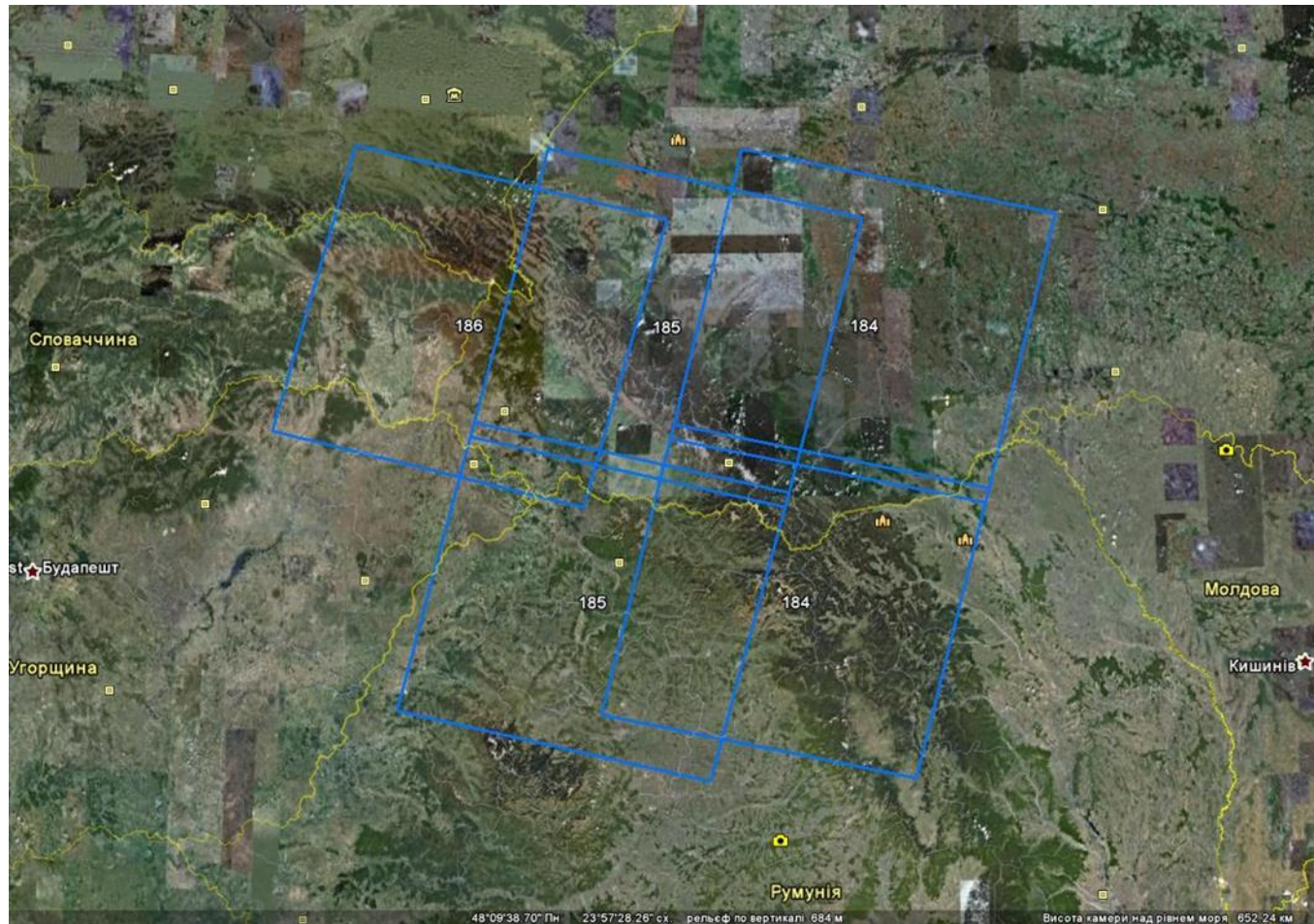
Free Satellite Imagery Sources

Data Hub System - Ukraine



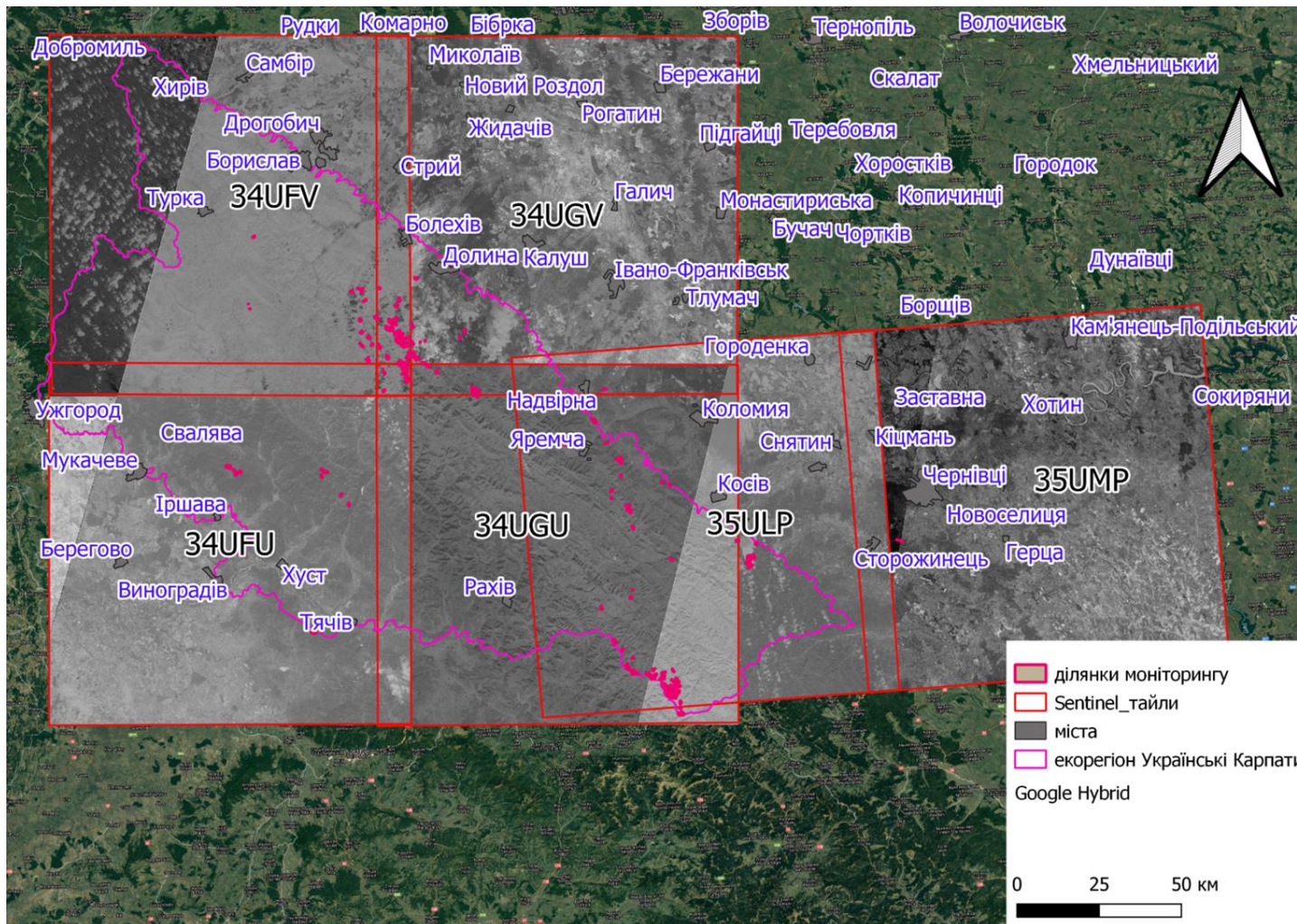
3. Materials

Satellite images Landsat for Ukrainian Carpathian



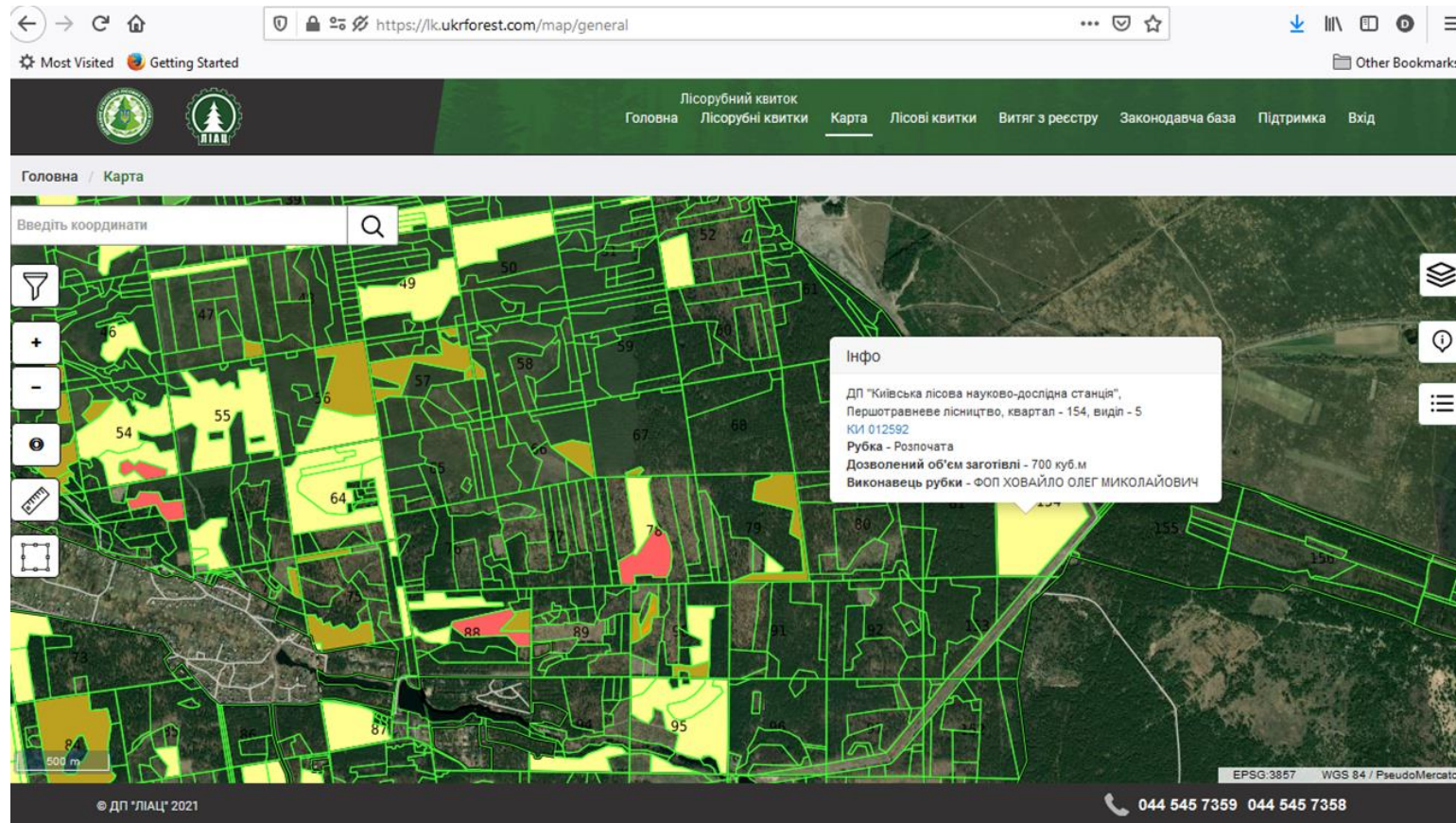
3. Materials

Satellite images Sentinel-2 for Ukrainian Carpathian



3. Materials

3.2. GIS digital Forest Management Maps



The screenshot displays a web-based GIS application for forest management. The browser address bar shows the URL <https://lkukforest.com/map/general>. The page features a dark green header with navigation links: "Лісорубний квиток", "Головна", "Лісорубні квитки", "Карта", "Лісові квитки", "Витяг з реєстру", "Законодавча база", "Підтримка", and "Вхід". Below the header, the main content area shows a satellite map with overlaid forest management data. A search bar at the top left contains the text "Введіть координати". A pop-up information window titled "Інфо" is open over a specific plot, displaying the following details: "ДП 'Київська лісова науково-дослідна станція', Першотравневе лісництво, квартал - 154, виділ - 5", "КИ 012592", "Рубка - Розпочата", "Дозволений об'єм заготівлі - 700 куб.м", and "Виконавець рубки - ФОП ХОВАЙЛО ОЛЕГ МИКОЛАЙОВИЧ". The map includes various interactive tools such as a search icon, a filter icon, zoom in (+) and zoom out (-) buttons, a full-screen button, and a scale bar. The footer contains the copyright notice "© ДП 'ЛІАЦ' 2021" and contact information "044 545 7359 044 545 7358".

4. Results

4.1. Commercial vs Free



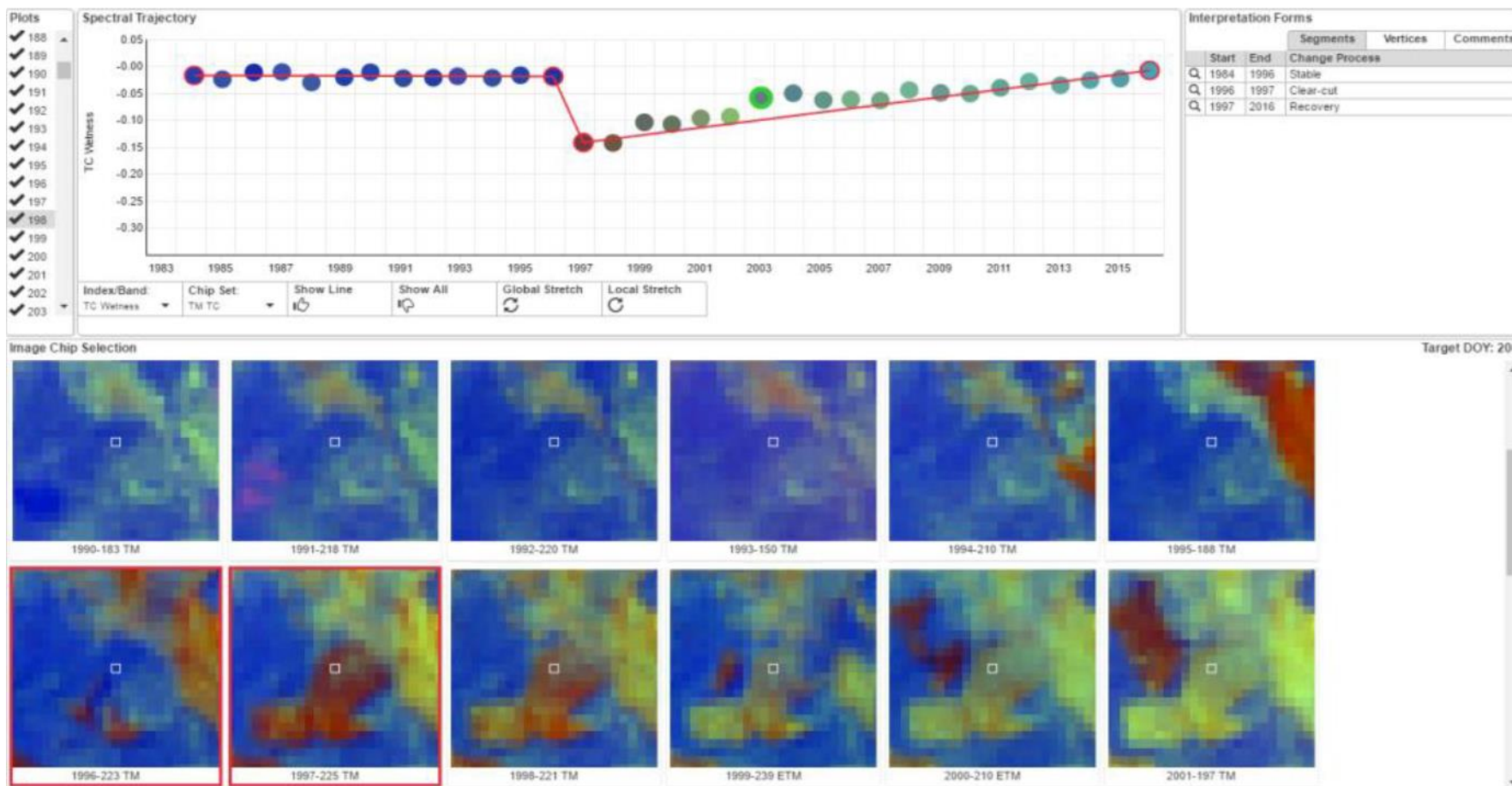
a)

Canal combination (IR, Red, Green)

a)Planet, b) Sentinel-2

4. Results

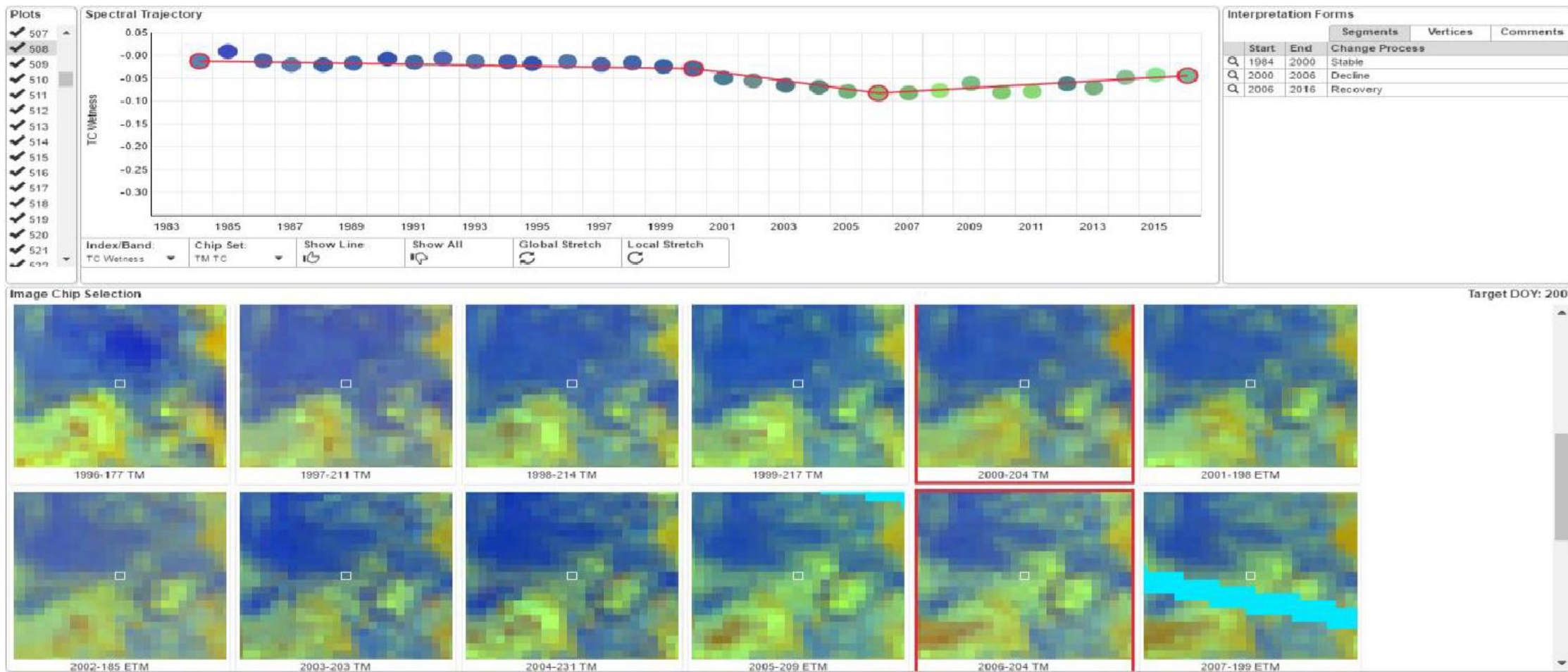
4.3. **Visual** vs Automatic (Distributed, Integrated and Harmonised Forest Information for Bioeconomy Outlooks) DIABOLO-Project Time series of satellite images Clear Cutting



4. Results

4.3. Visual vs Automatic

Time series of satellite images
Dieback of forest stands

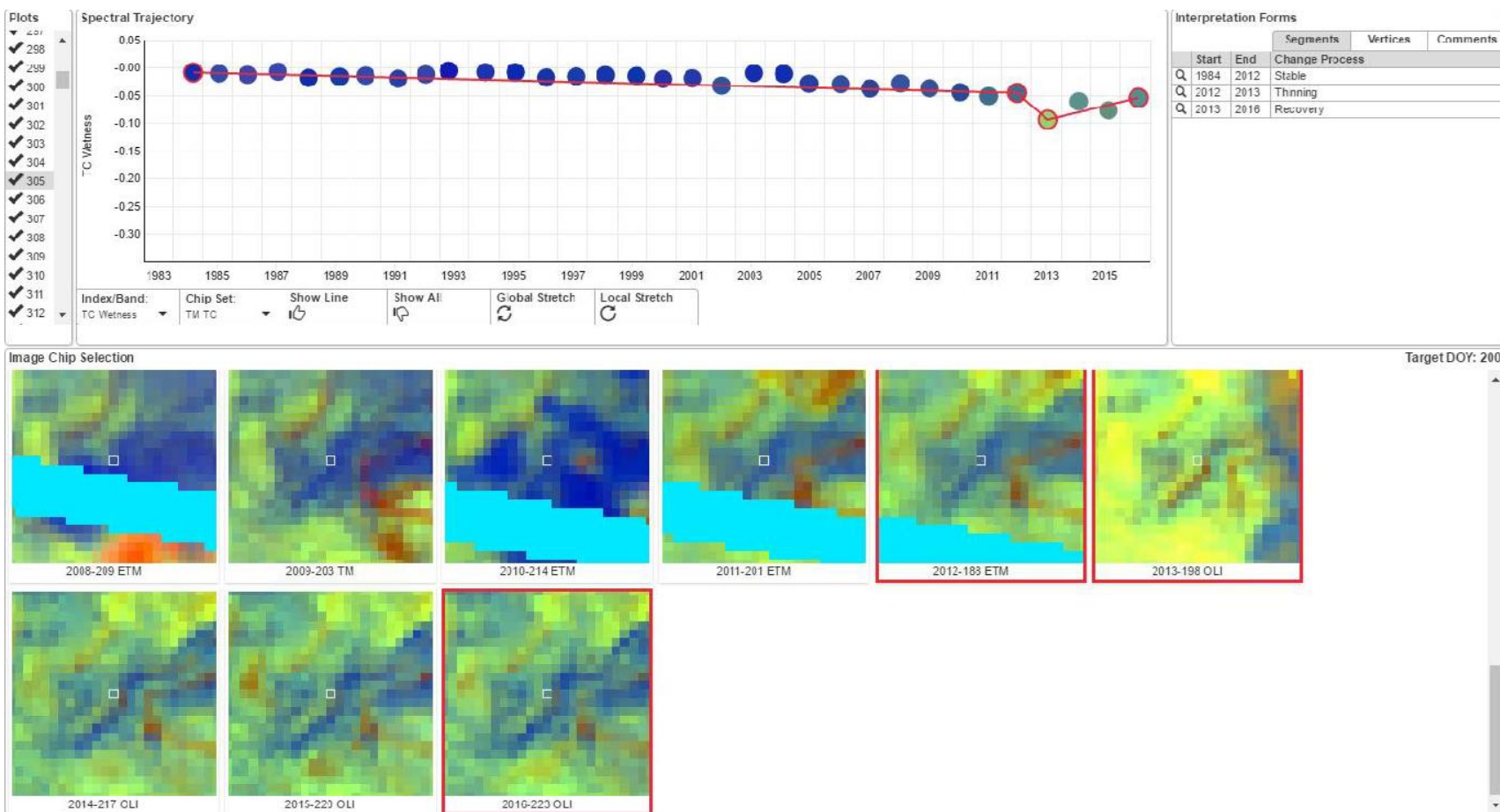


4. Results

4.3. Visual vs Automatic

Time series of satellite images

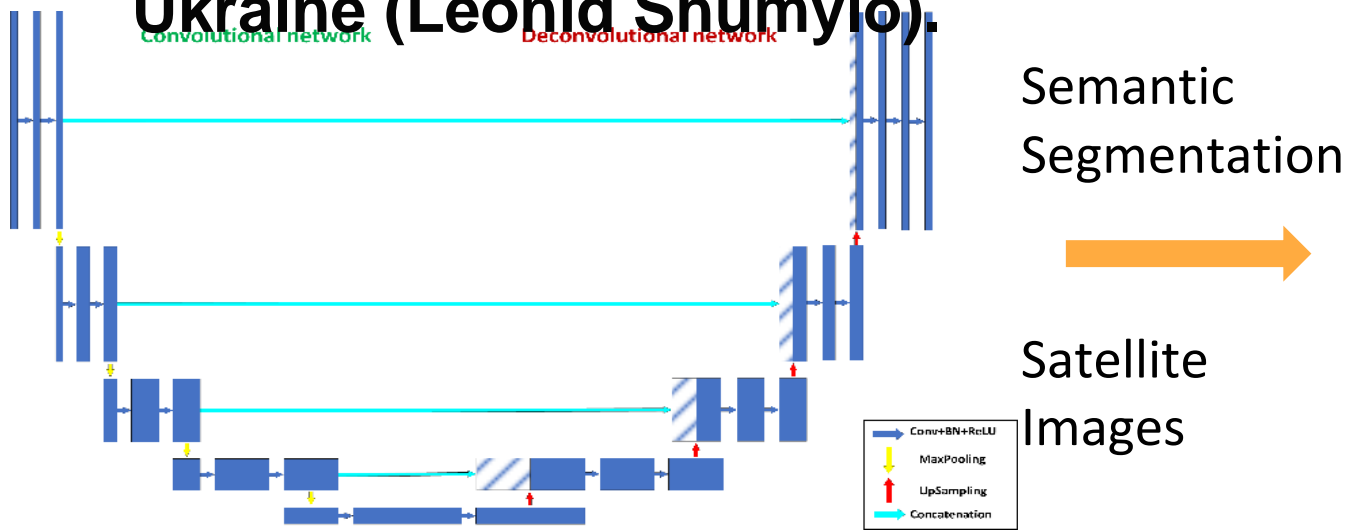
Selective cutting



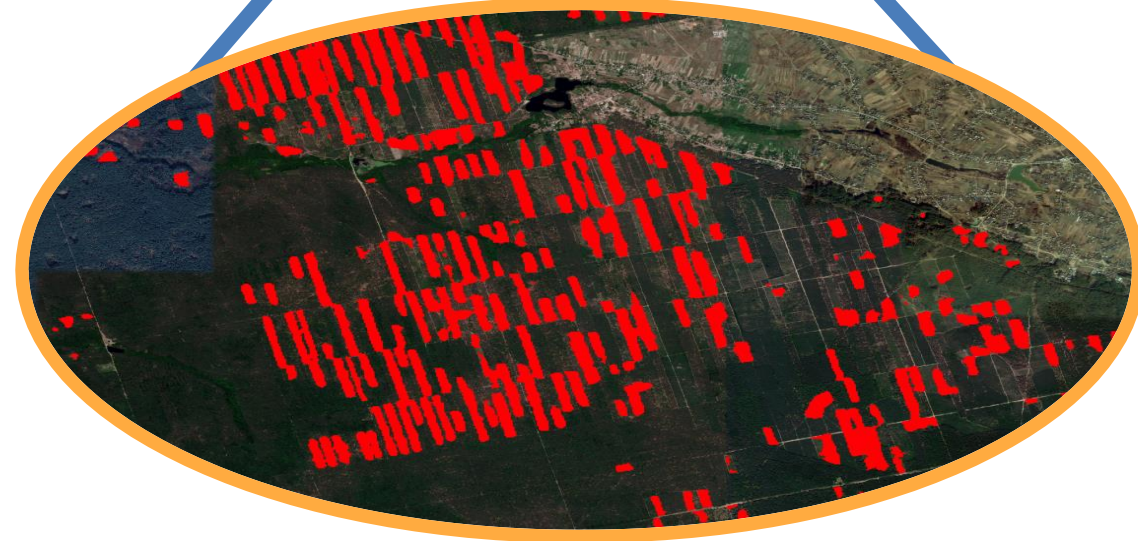
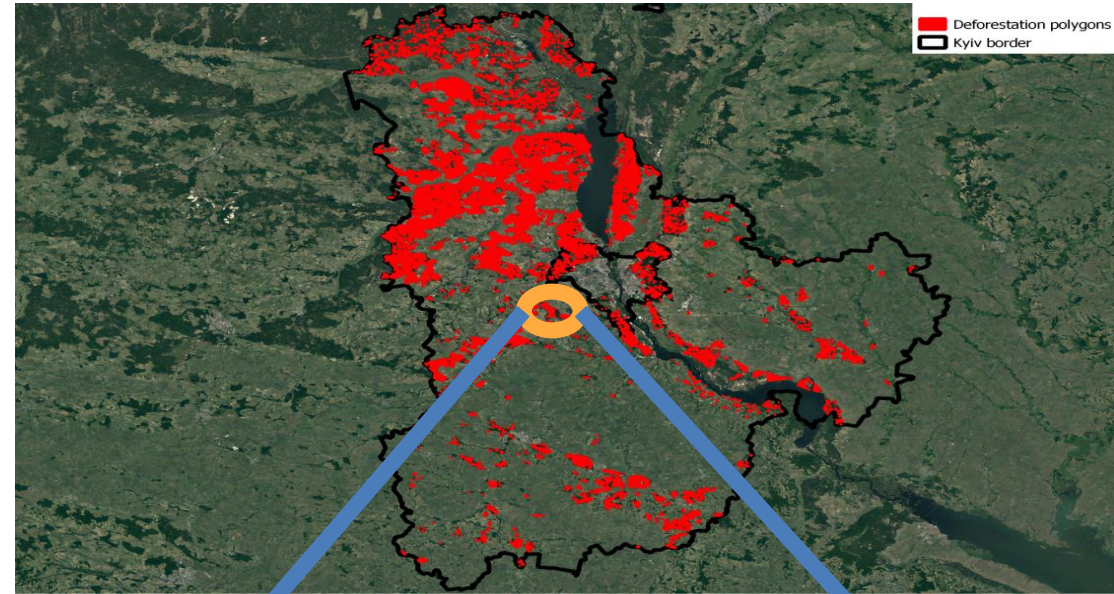
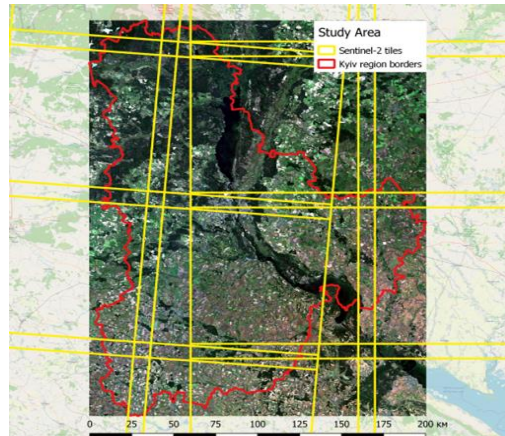
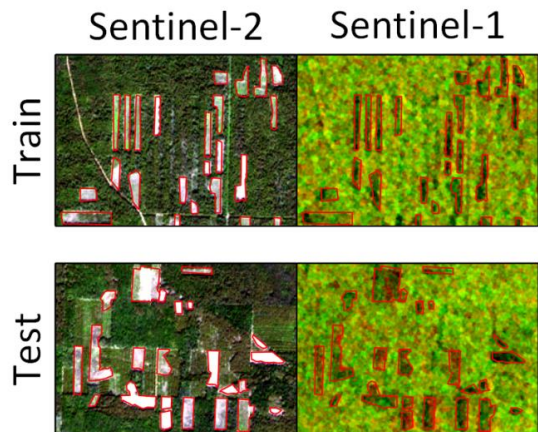
4. Results

4. Algorithms evolution (NDVI vs Computer Vision) **Deep Green**

Ukraine (Leonid Shumylo)

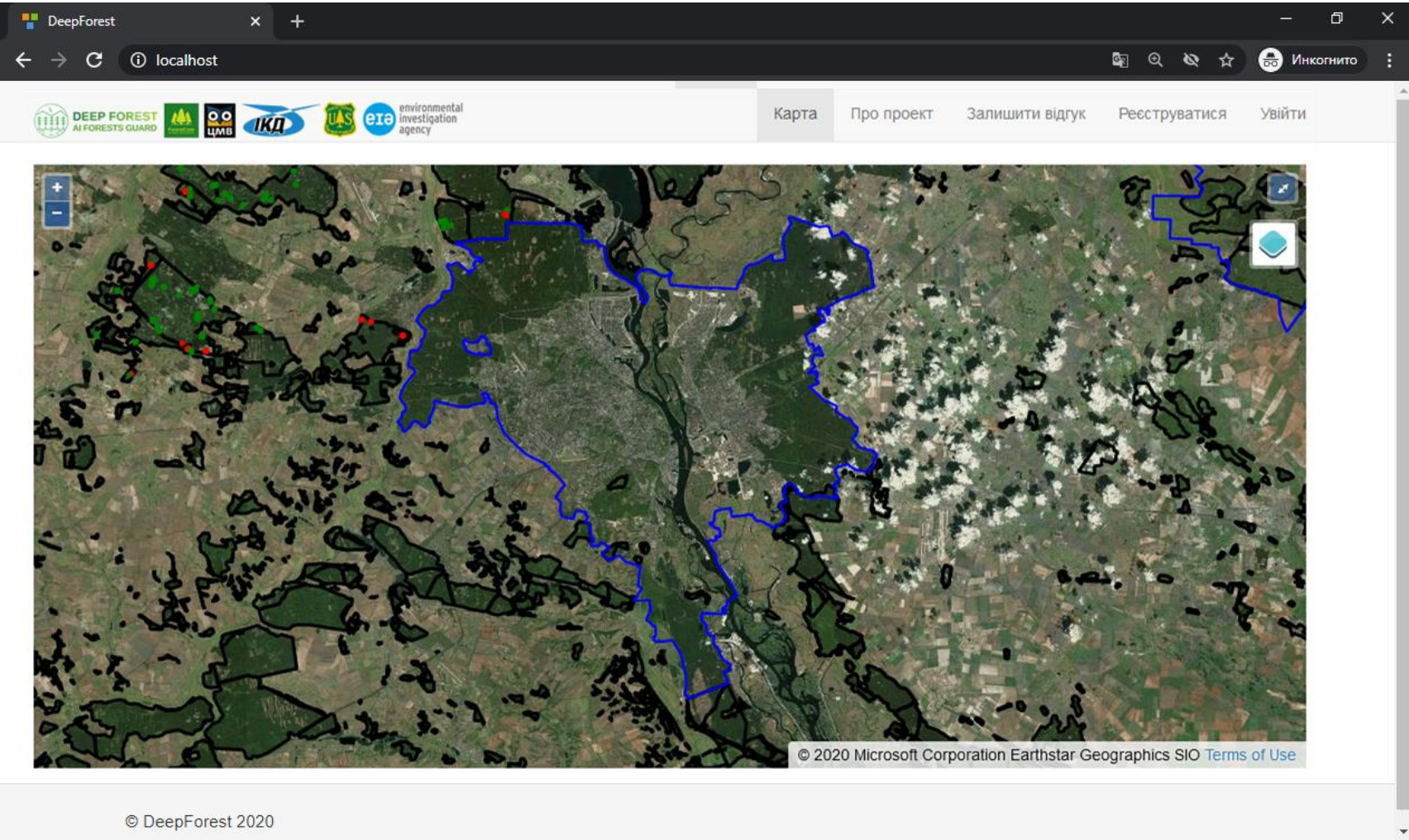


Fusion of Sentinel-1 and Sentinel-2 with 11k ground truth polygons



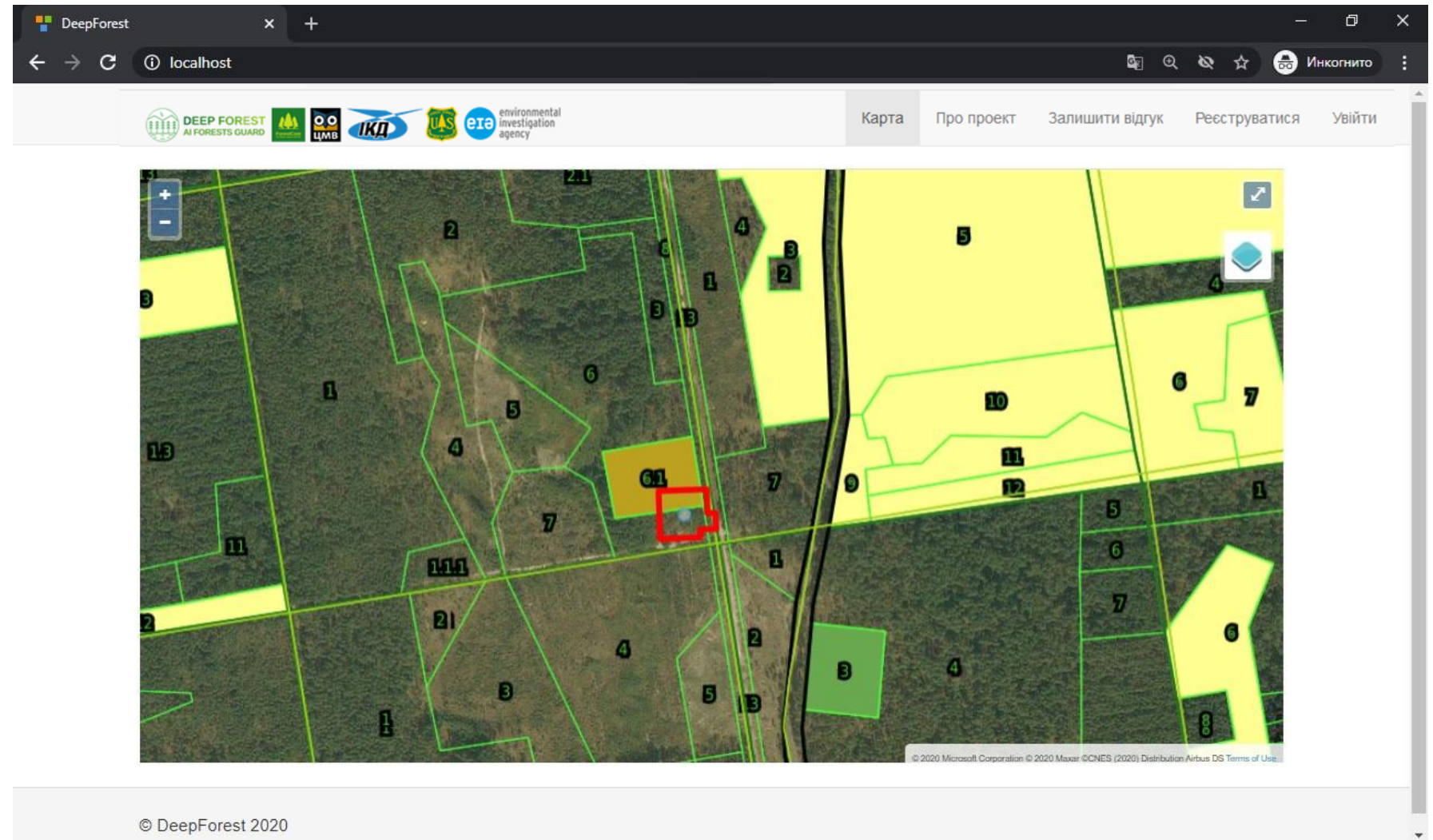
Developing Illegal Logging and Deforestation Alert System in Ukraine

Selecting your AOI



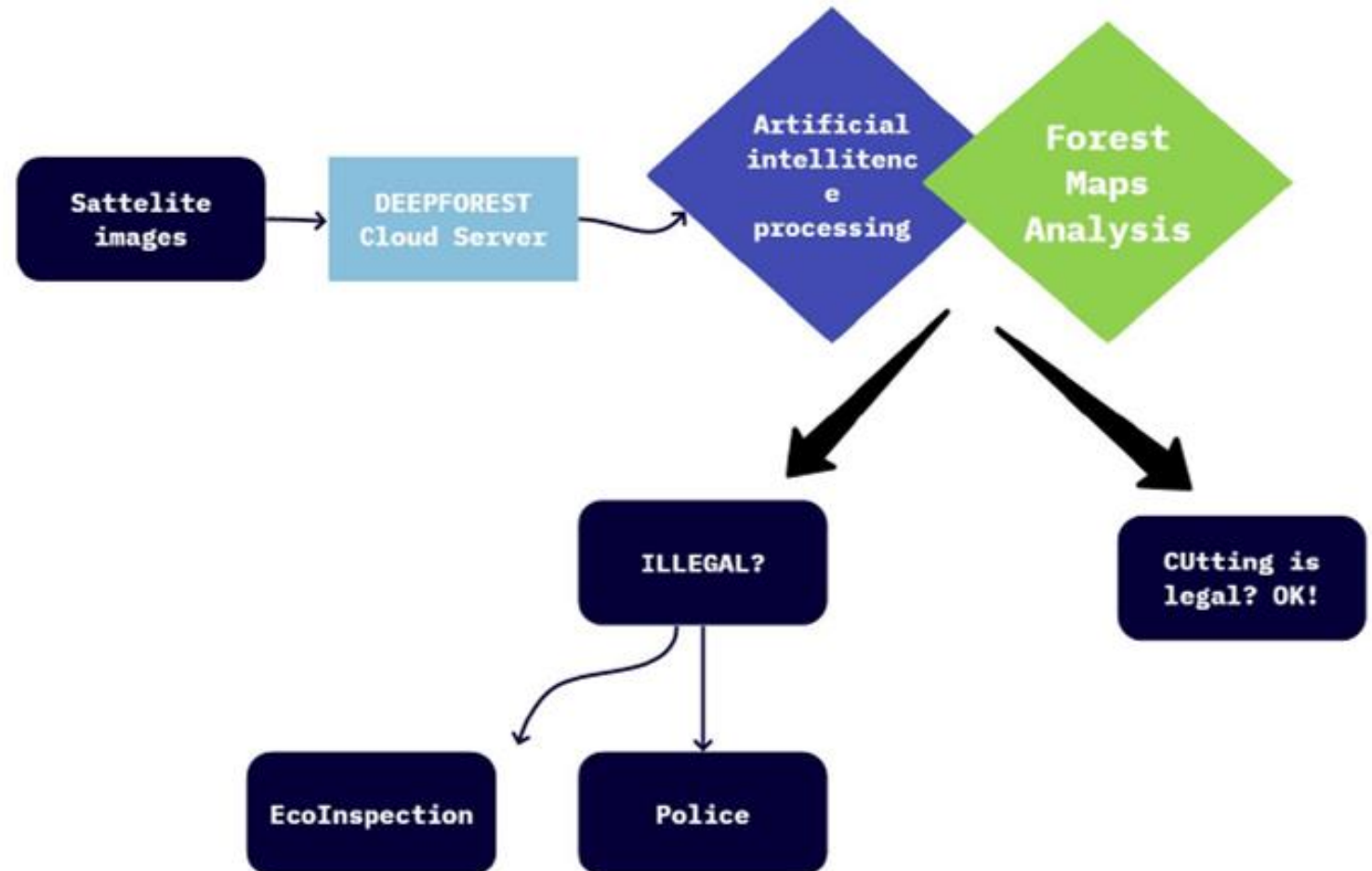
Developing Illegal Logging and Deforestation Alert System in Ukraine

AI applied system algorithms
- finding
deforested places



Developing Illegal Logging and Deforestation Alert System in Ukraine

Further development of the **Deep Green Ukraine** system became possible as a result of winning the **Open Data Challenge** competition conducted within the **USAID/UK** aid international technical assistance project "Transparency and Accountability in Public Administration and Services/**TAPAS**" with the support of **Ukraine's Ministry of Digital Transformation**



Deep Green Ukraine project

🏠 Київ 📧 pressforestcom@gmail.com



👤 Логін / Реєстрація



ПРО НАС

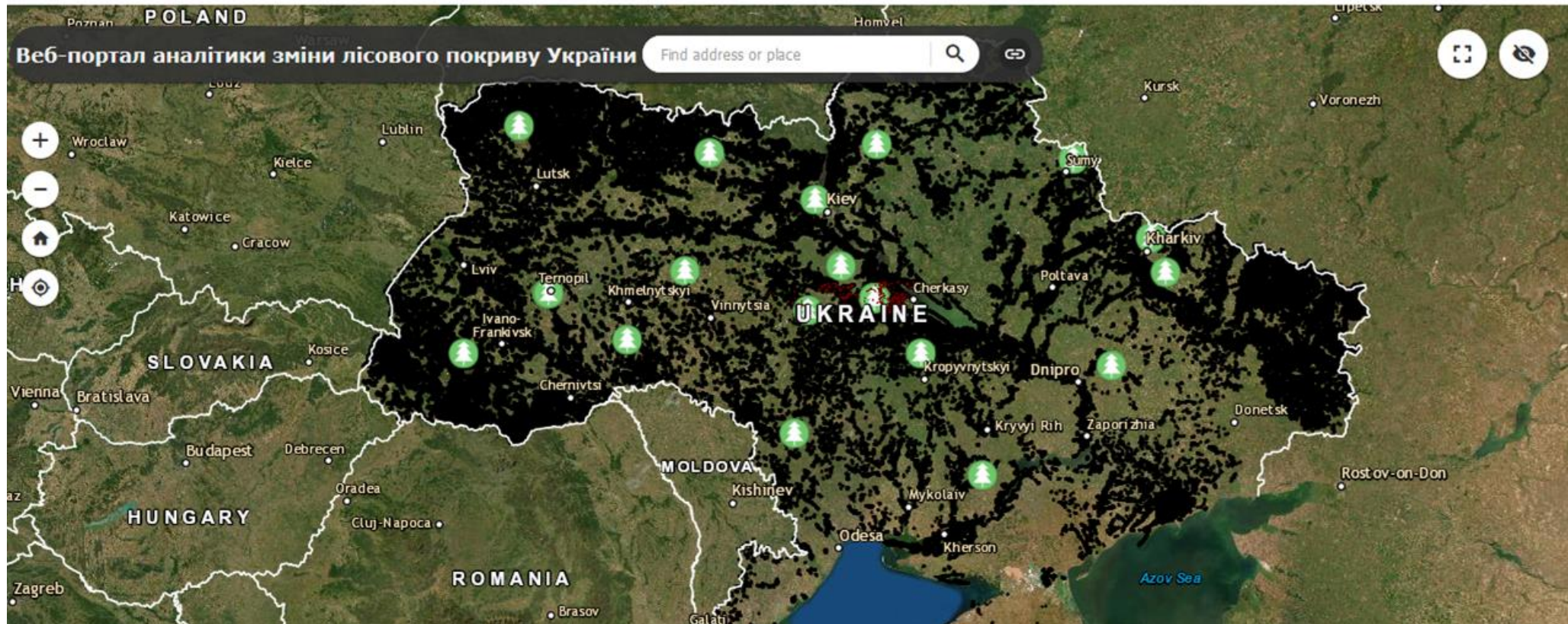
КАРТА

АНАЛІТИКА

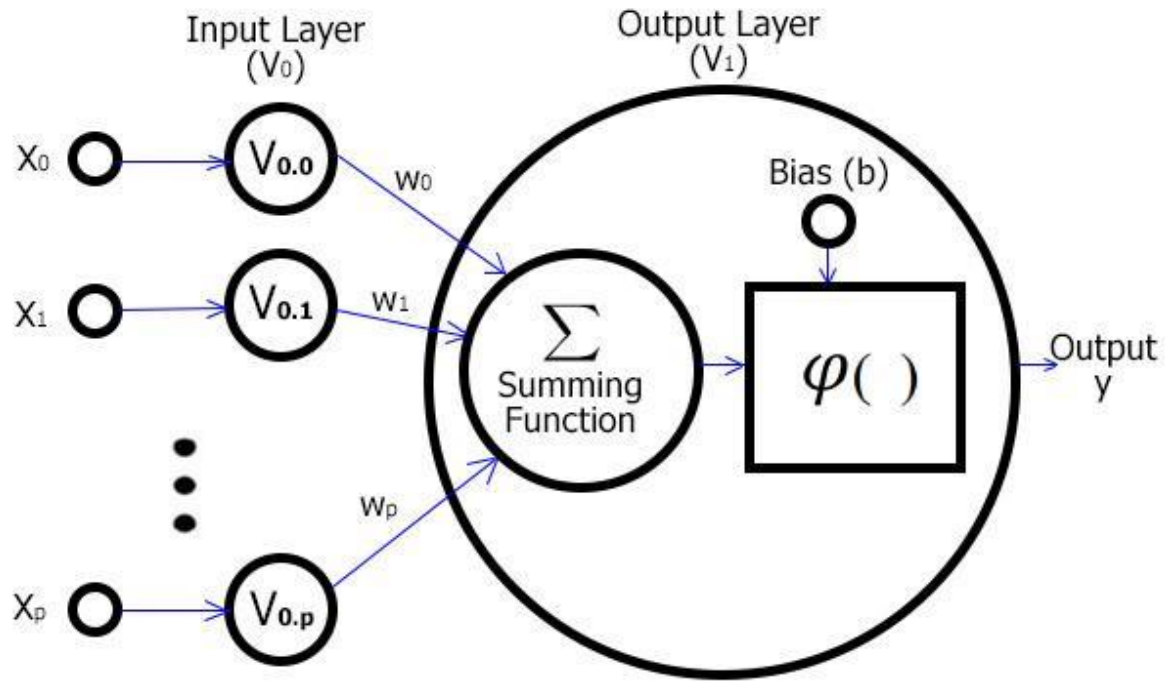
НОВИНИ

ЧАСТІ ПИТАННЯ

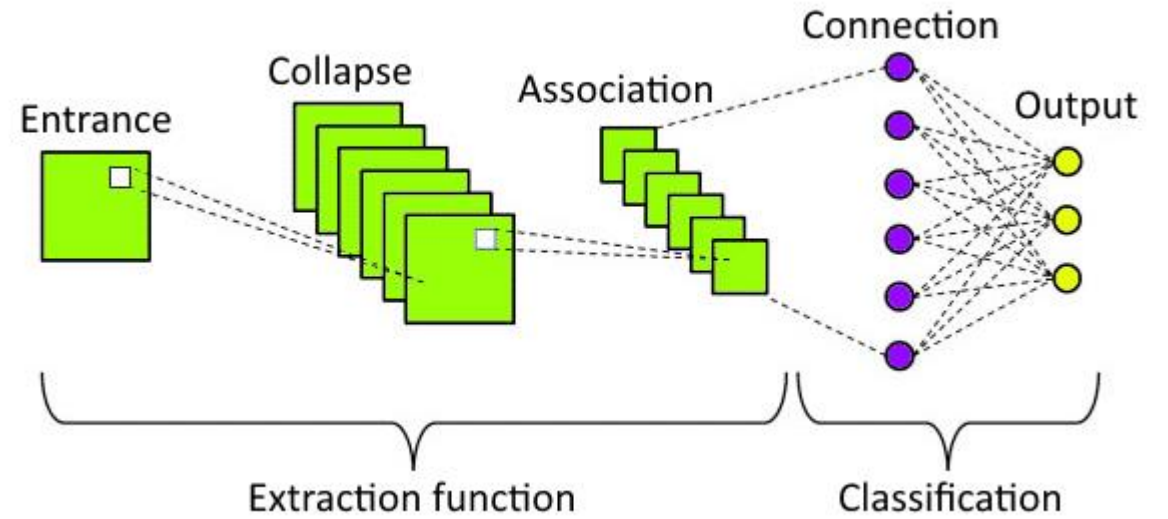
КАБІNET КОРИСТУВАЧА



Artificial neural networks in image analysis (EURIZON-project)



The general model of a direct propagation CMM (perceptron)



A view of a convolutional neural network (CNN)

Methodology of research and training of ANNs

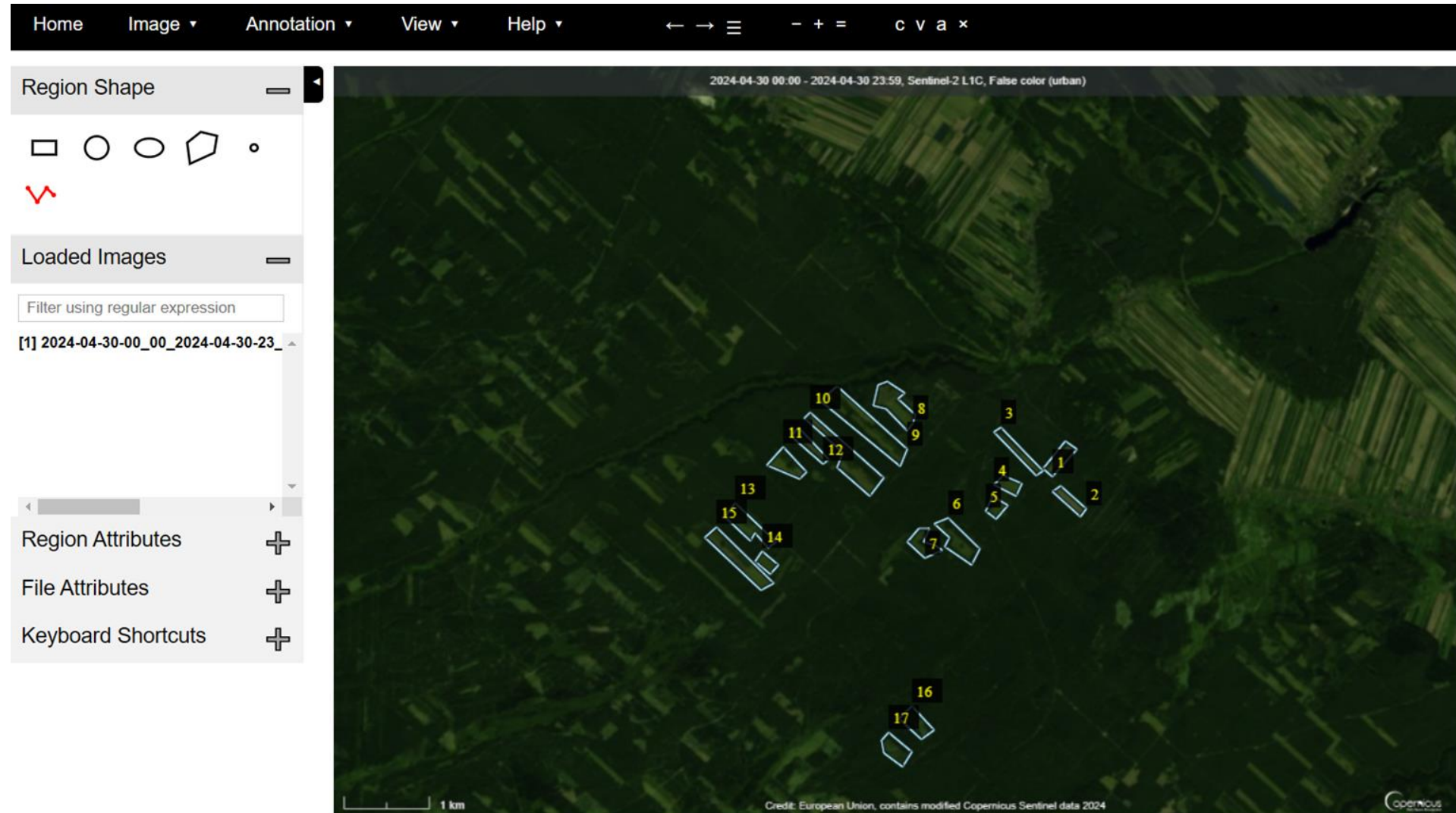
The image shows the Copernicus Browser interface for viewing satellite imagery. The main content is a satellite image of a forest, likely from Sentinel-2. The interface includes a search bar at the top right with the text "Перейти до місця" (Go to location). The left sidebar contains the Copernicus logo, navigation buttons, and a date selection section showing "ДАТА: SINGLE" and "2024-04-30". Below the date selection, there are buttons for "Показати останню дату" (Show latest date) and "Знайти продукти для поточного вигляду" (Find products for current view). The sidebar also shows the selected product "Sentinel-2 L1C" and a list of image processing options under "ШАРИ:" (Layers):

- True color (Based on bands B4, B3, B2)
- False color (Based on bands B8, B4, B3)
- Highlight Optimized Natural Color (Покращена візуалізація природного кольору)
- NDVI (Based on a combination of bands $(B8 - B4)/(B8 + B4)$)

At the bottom of the sidebar, there are buttons for "Показати ефекти і додаткові опції" (Show effects and additional options), "Сховати шар" (Hide layer), and "Поширити" (Share). The bottom of the interface features the Copernicus logo, ESA logo, and navigation links for "About" and "Support". The bottom right corner shows the coordinates "Lat: 50.42760, Lng: 23.12433" and a scale of "1 km".

An example of a satellite image from Sentinel-2

Methodology of research and training of ANNs



An example of annotation of deforested areas in the VGG program

CONCLUSION

- Remote sensing is crucial for monitoring and assessing forest changes in Ukraine. It enables continuous observation of forest health, damage assessment, and pest infestation mapping. The technology is essential for analyzing the impacts of war and climate change on forests. Additionally, remote sensing supports reforestation efforts and biodiversity conservation. It provides valuable data for policy-making and stakeholder engagement. Ultimately, it enhances forest management and recovery strategies through precise and timely information.

Thank you for your attention!



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