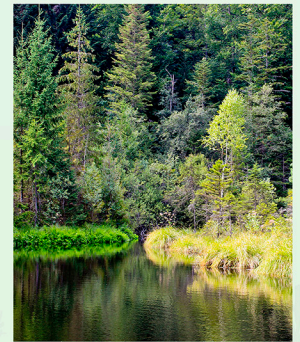
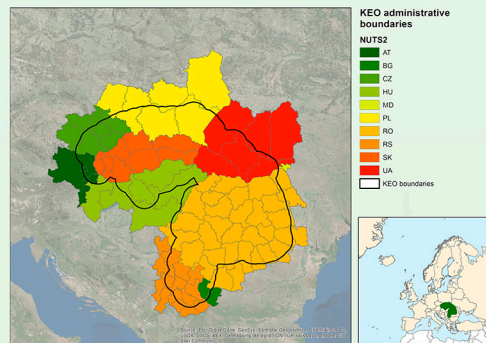


Regional indicators to support forest ecosystem management in the Carpathian Mountains

Outline

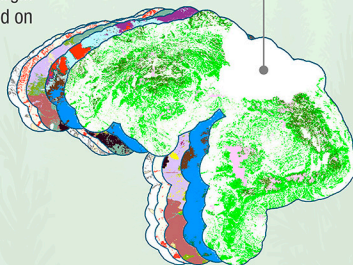
The Carpathian Mountains are one of the most important forest ecosystems in Europe due to the high concentration of virgin forests. The “protocol for sustainable forest management”, signed by Carpathian convention Parties is formalising the need to preserve the richness and ensure sustainable use of its resources. Our research, in agreement with the Carpathian Convention Secretariat and the Environmental European Agency (EEA) is supporting this protocol with the identification and harmonization of dataset from multiple sources including Earth Observation, to combine and provide spatial indicators to support monitoring and management of forest for the Carpathians Environment Outlook (KEO) area.



Material and Methods

The spatial information collected supplied essential information on the land cover, forest type and density, tree species distribution and tree habitat suitability, virgin forest (various initiatives e.g. PIN-MATRA project) and on the protection measures in place in the region.

Earth Observation data extracted from satellite images, including Landsat and Sentinel 2, were used to fill data gaps, mainly for Ukraine.



Why is needed an harmonization of the datasets?

- Different resolution
- Different time coverage
- Unharmonised regional data
- Data gaps in EU datasets
- Validation of global products
- Statistic data not available in spatial format

Regional	Year	Resolution ~
Primeval Forest Romania	2009	N/A
MANTRA project	2008	N/A
Primeval Forest Hungary	2009	N/A
Growing stock	2000	1km
Forest statistics (country level)	2014	N/A

Provider	European	Year	Resolution ~
Copernicus	High Resolution Level Forest	2011/2013	25m
EEA	Corine Land Cover	2006/2012	100m
EEA	Protected Areas	2012	N/A
EEA	High Natural Forest	2006	100m
EEA	Forest Carbon Content	2012	1km
EEA	EUNIS Forest Classification	2014	N/A
EFI	Dominant species	2011	1km
JRC	Forest erosion	2015	100m
ESA	Global corine	2009	500m

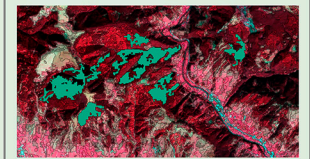
Provider	Global	Year	Resolution ~
UNEP	Protected areas	2015	N/A
JAXA	Palsar	2014	25m
Un.Maryland	Global forest	2014	25m
USGS	Landsat	2014/2015	30m
ESA	Sentinel 2	2015	10/20m

Vegetation indices

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

$$EVI = \frac{G \cdot (NIR - Red)}{NIR + C_1 \cdot Red - C_2 \cdot Blue + L}$$

Object based classification

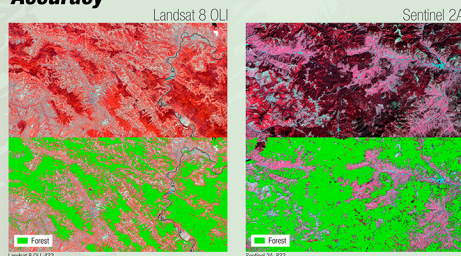


Preliminary results

Forest coverage

The resulting datasets, validated through statistical methods, enabled an accurate differentiation of the forest cover from other land cover classes in the region, making possible the development of harmonised and accurate regional datasets covering the whole Carpathian forests.

Accuracy



Spatial correlation with other datasets

High Resolution Forest

Accuracy: **89.47%**

Omission error: 11.53%

Commission error: 12.13%

Corine Land Cover 2012

Accuracy: **91.02%**

Omission error: 8.98%

Commission error: 11.38%

PALSAR Forest Map

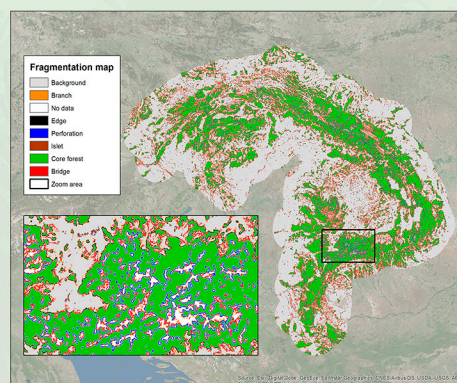
Accuracy: **83.54%**

Omission error: 16.46%

Commission error: 10.82%

Fragmentation

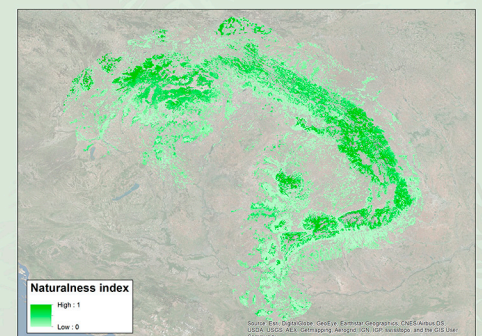
Forest fragmentation map is obtained by applying a geometric model namely Guidos Toolbox (Vogt P., 2016) and offering a picture of the forest structure, differentiating Morphological Spatial Patterns (Soille P. et al., 2008). This indicator showed a high level of un-fragmented forest for Carpathian Mountains, being higher than 77% of core forest.



Naturalness

The Naturalness indicator (ETC/SIA, 2014) is calculated considering the biogeographical regions maps and the linkages between dominant forest species types under each biogeographical region. The naturalness indicator (N_i) is equal to the relation between the high percentage of natural species presence (DA) and the percentage of forest coverage (TF).

$$N_i = DA / TF$$



Outlook

- Ongoing research to improve the results;
- Validation with local experts and with local data wherever available;
- Discussion with stakeholders, Member States, Carpathians parties.