Land cover for Ukraine: the harmonization of remote sensing and ground-based data

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Introduction

Rapid land use – land cover changes of recent decades in territories of Ukraine caused the situation that currently there is no any land cover map of sufficient accuracy for the country. Global remote sensing products do not provide information of satisfactory quality due to substantial zonal diversity and high spatial fragmentation of land cover. Use of remote sensing products of fine resolution is cost and time consuming. The major objective of this study is development of methodology of land cover mapping of medium resolution based on integration of multi-sensor remote sensing information and on-ground data. Based on the above technology, a georeferenced forest land cover data set at a 300 m resolution was developed. The accuracy of the map is satisfactory for environmental modeling.

Methodology

(1) Three global remote sensing products (GlobCover 2009; MODIS Land Cover and GLC-2000) was compared for territories of Ukraine using **a fuzzy logic methodology** (Fritz and See, 2005) in order to capture the uncertainty in the classification of land cover by the mentioned above products.

(2) A special optimization algorithm has been developed based on the results of comparison of the RS land cover products and an analysis of a dataset of randomly distributed validation points for different land cover types over Ukraine

(3) The developed algorithm has been applied to generate a forest land cover type map.

The raster map contains a **forest expectation index** that was calculated for each pixel. Forest land was then allocated based on forest inventory data at the local level. Areas with a higher forest expectation index were allocated as forest until the results matched the forest statistics.

Forest expectation index:

$$I_{for} = W_{VCF} \cdot I_{VCF} + W_{GlobCover} \cdot I_{GlobCover} + W_{ModisLC} \cdot I_{ModisLC} + W_{GLC2000} \cdot I_{GLC2000} \quad (1)$$

$W_{VCF}, W_{GlobCover}, W_{ModisLC}, W_{GLC2000}$ – corresponding weights of the remote sensing products, calculated as an accuracy of each product in forest recognition;

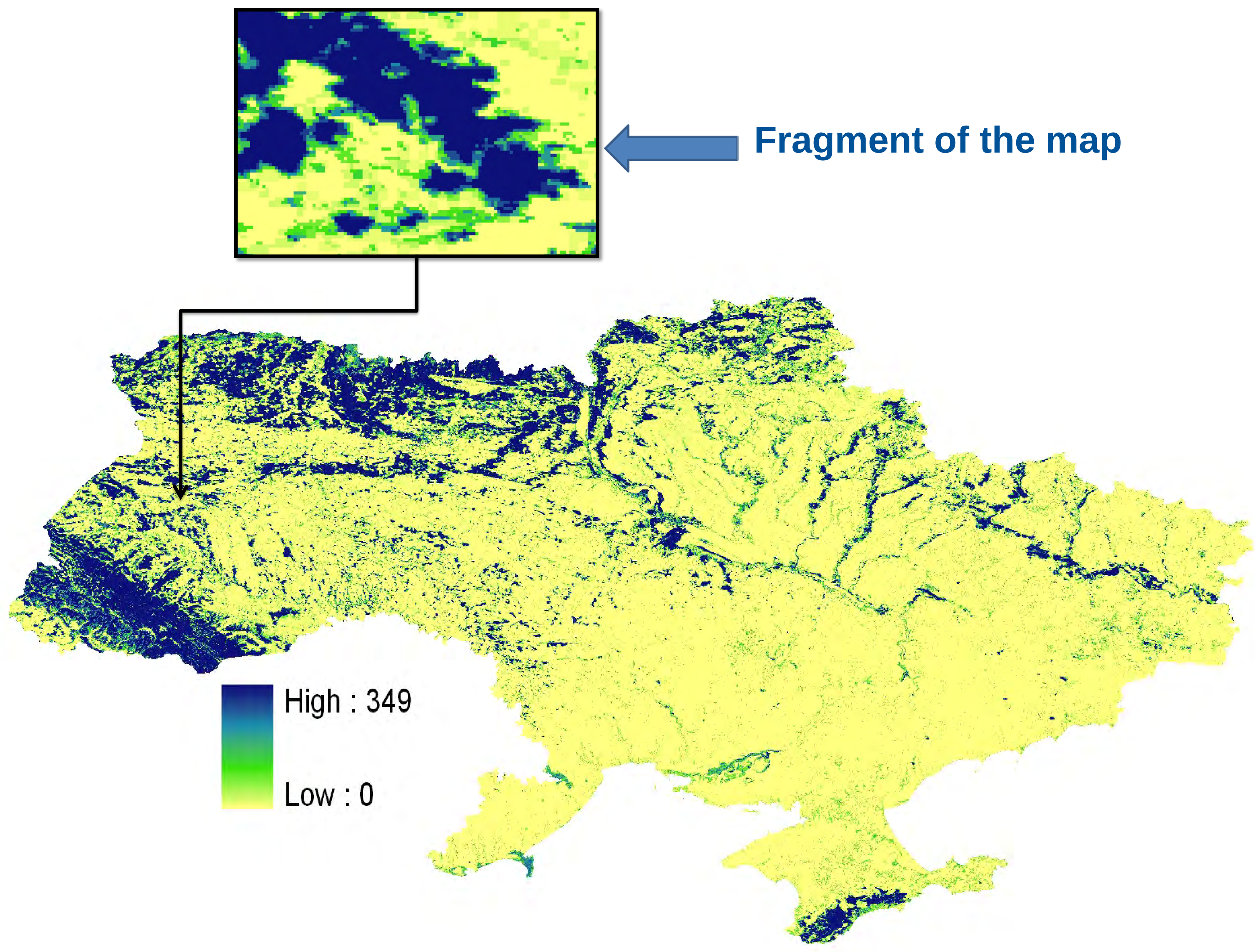
I_{VCF} – an index that has a value “1” if forest canopy > 26%, otherwise “0”;

$I_{GlobCover}$ – an index that has a value “1” if it is forest land cover type and “0” if it is not forest land;

I_{Modis} – a n index that has a value “1” if it is forest land cover type or “0,33”(1/3) if it is “forest mosaic, or “0” if it is neither forest land cover type nor forest mosaic;

$I_{GLC2000}$ – an index that has a value “1” if it is forest land cover type or “0,11”(2/9) if it is “forest mosaic ,or “0” if it is neither forest land cover type nor forest mosaic.

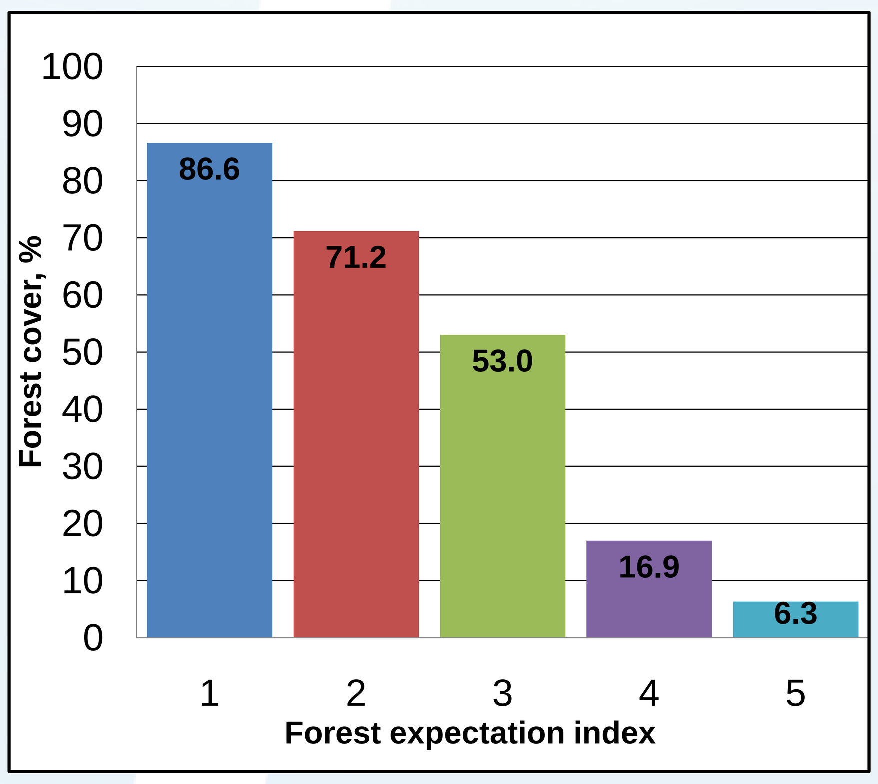
(4) An accuracy of the created map of forest was estimated based on: dataset of points randomly generated and validated using online tools of **geo-wiki.org** (Fritz et al., 2012).



Map of forest expectation index (300m resolution)

Input datasets

- ✓ Vegetation Continuous Fields (VCF) MODIS 2010 at 250m resolution;
- ✓ GlobCover 2009 at 300m resolution;
- ✓ GlobCover 2005 at 300m resolution;
- ✓ MODIS Land Cover 2005 at 500m resolution;
- ✓ GLC 2000 (Northern Eurasia) at 1km resolution;
- ✓ Dataset of validation points of forest land cover of Ukraine;
- ✓ Data of area of land covered by forest at local level (derived from national forest account);
- ✓ Digital maps of borders of administrative units.



Correspondence of a value of **forest expectation index** and **percentage of forest cover** of a pixel

In this histogram the values of forest expectation index were classified into 5 classes:

Class 1: 300-349

Class 2: 200-300

Class 3: 100-200

Class 4: 50-100

Class 5: 0-50

Accuracy of land cover type ‘forest’ of the global land cover products for the territory of Ukraine

Global land cover product	Accuracy of land cover type = forest (product weights in equation 1)
Vegetation Continuous Fields	82%
GlobCover 2009	65%
GlobCover 2005	77%
MODIS Land Cover 2005	68%
GLC 2000 (Northern Eurasia)	56%

Comparison of global products for the territory of Ukraine GlobCover2009 / MODIS LC / GLC2000

Fuzzy agreement, %	GlobCover2009, MODIS LC	MODIS LC, GLC2000	GlobCover2009, GLC2000	**GlobCover2009, MODIS LC, GLC2000**
max	56,15	86,18	71,26	**69.94**
min	45,39	76,78	51,69	**65.02**

Conclusion

(1) The developed forest map at 300 m resolution is more accurate than the global remote sensing products used. However, the accuracy substantially depends upon availability of forests by regions. The accuracy is much higher for the regions with a higher percentage of forest cover (i.e., in northern part of Ukraine, in the Carpathian and Crimean Mountains). For territories with low percentage of forest cover (<10-15% that is typical for Steppe and southern Forest-Steppe regions), the accuracy is less due to fragmentation of land cover and small areas covered by forests.

(2) The developed algorithm could be used for mapping of different land cover types in other regions of the world.

Results

- Developed optimisation algorithm based on the results of comparing land cover products and an analysis of a dataset of validation points for different land cover types;
- Map of forest of Ukraine with a 300m resolution and accuracy = 90 %

References

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