Applying Earth Observation Data for Detection and Estimation of Woody Biomass Volumes of Agricultural Areas Accessible for Energy Production

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Abstract. The need for renewal energy supply is increasing due to EU2020 aims. At the same time, agricultural areas in rural regions of Central and East Europe are being abandoned due to urbanization processes. Uncontrolled landuse changes after abandonment are leading to spontaneous growth of biomass, which is resulted by the spread of weeds and opportunistic invasive species. Our EUREKA financed technology development project aimed to provide information about the location, the volume and the dynamic tendencies of these biomass sites in order to make them operatively accessible for utilization in (bio-) energy supply. In Northern-Transdanubia we located with satellite imagery over 3000 agricultural areas with over 8000 ha area, which are affected with woody increment. In local sample regions we carried out biomass volume estimation with the integrative utilization of Copernicus Sentinel-1 imagery.

Keywords: biomass, rural regions, Earth Observation, Sentinel-1, detection, volume estimation

1 Introduction

T-BEA (Tool for Biomass Energy Accessibility) project (EUREKA, 2015) is a development project supported by EUREKA Programme, carried out with the coordination of GeoData Services Ltd. (Hungary), partnering Gauss Ltd. (Romania). The aim of the project is to develop operative technologies for the detection and volume estimation of spontaneously up-growing woody biomass in agricultural areas. The project targets the synergies between fighting against harmful land use changes and sustainable supplying of raw material resources of bio-energy production. Since the project approaches to its end, this publication intends to summarize the technical achievements, and to give an overview of the already operational new services.

Proceedings of the 7th International Conference on Information and Communication Technologies in Agriculture, Food and Environment (HAICTA 2015), Kavala, Greece, 17-20 September, 2015.

2 Earth Observation – Background Technology

T-BEA project utilizes high-tech data source of Earth Observation for the detection and volume estimation of biomass stocks. The actuality of the development project emerges from the new availability (since October 2014) of Copernicus Sentinel-1 datasets. The C-Band synthetic aperture RADAR sensor provides entire Europe coverage every 12 days (6 days with near future Sentinel-1/B satellite pair).

Due to the all-weather quality and the sensor's independence from daylight conditions, Sentinel-1 datasets provide unprecedented opportunity for biomass monitoring and volume estimation (Figure 1). We utilized the fusion of Sentinel-1 (12,5 m spatial resolution) and Landsat-8 OLI (15 m spatial resolution) for the technology test and demonstration.

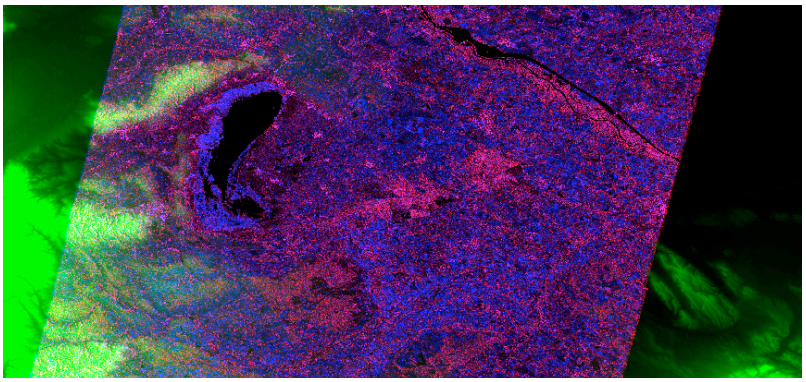

Fig. 1. Sentinel-1 data (VH and VV channels above DEM) of Northern-Transdanubia.

3 Results – Detection and Volume Estimation Statistics

With the utilized datasets we have detected (Fülöp et al 2015) in the test region (28 750 km^2) more than 3000 abandoned, biomass-containing agricultural sites, with more than 8000 ha. After sampling validation more than 85% of the detected sites were plausible. The mean site area is 2,38 ha (st. dev 0,56 ha).

During the in situ validation, in case of more than 75 sites also biomass estimation was carried out with 10 t/ha resolution. These training information were used for the development of the volume estimation technology, which is relying on the regression between the ground-truth volume values and the Earth Observation digital values.

The Earth Observation datasets – consisting of more than 35 layers - were setting up five significant factors. Between the factors and the ground-truth information regression were built (Table 1). The Stepwise method lead to the inclusion of three factors, while the overall power of the model was over limit (0,705 R-square), which allowed us to use the model for biomass estimation with an average 31 t/site - thus 13 t/ha – reliability in the first round.

Table 1. Volume estimation regression model built from training test sites

	Unstand. Coeff.		St. Coeff.		
	B	SE	Beta	t	SL
Const.	72,988	6,349		11,497	,000
cl4f1	-,531	,157	-,368	-3,390	,001
cl3f2	,793	,146	,441	5,450	,000
cl8f3	,678	,310	,240	2,186	,033

4 Application and Model Development

The T-BEA estimation information is being operatively utilized by biomass energy production industry organizations, for the planning of biomass harvest. The model is recursively developed (recent number of training sites: 205) with the accurate information of the mined biomass volumes. Due to this precision within-site biomass categorization has begun (Figure 2).

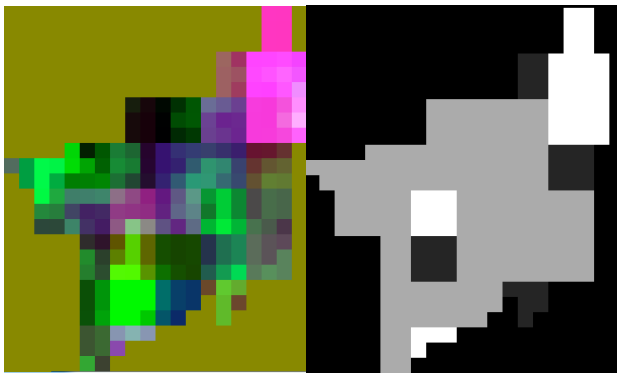

Fig. 2. Abandoned agricultural site (2,5 ha) in the raw imagery fusion (Landsat OLI and Sentienl-1); woody biomass categorization (5 operational management categories)

Acknowledgments. We are thankful for the support of EUREKA Programme (E!7651), and the project partnering efforts of NFKIA (Hungarian National Development, Research and Innovation Office) – EUREKA_HU_12-1-2012-0042.

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