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SATELLITES AS A TOOL FOR ENERGY BIOMASS MONITORING AND YIELD/ENERGY ESTIMATION

Warszawa 27.02.2015

Project Title: "Bioenergy as the key to economic growth of the regions-EO Based Service Supporting Energy Crops Cultivation (SERENE)."

Funding Institution: European Space Agency

Call: 1st Polish Industry Incentive Scheme

Project duration: 1 April 2014 – 31 March 2016

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The Project Idea was developed as an answer to the needs of Bioenergy Market in Poland.

The Project and future Service are designed to deliver products which will unite the bioenergy market into economically effective mechanism in Poland.

The biomass needs in Energy Sector in Poland is significant, as nowadays the coal is the major source of energy.

The decrease of CO_2 is urgently demanded by the government.

There is the attempt to obtain biomass from different sources and due to lack of centralized data base concerning the biomass availability in Poland, there is often import of the biomass from Africa, Asia and even South America.

Import from such distant countries causes very high transport costs and additional emission of greenhouse gases.

The Proposed Service is designed to provide solutions to above presented problems through delivery of the following products:

the amount of biomass available in Poland, with the regional distribution, the amount of currently growing biomass, yield prediction, localization of plantations, indications of places for new plantations establishment, technologies of energy crops cultivation as well as estimation of production costs.

One of the Project aims is to shorten the distance between the energy crops plantations and the recipients of biomass in order to decrease the transportation costs and CO_2 emission and in particular to stimulate the economic growth of the regions – local markets.

The proposed Service would also support the development of local energy sources, such as biogas stations, which would be supplied with the biomass from the same region.

Such cooperation would result into upgrowth of the rural regions and increase of wealth of the local communities.

Within the Project, the development of the Operation Service of Energy Crops Plantations Monitoring applying satellite data, the use of Sentinel satellites within COPERNICUS Programme has been planned.

The following activities are being scheduled within the proposed project:

✓Identification of energy crops areas in selected regions used for energy units and biogas stations based on satellite data and ancillary data, estimation of energy productivity from these plantations as well as determination of biomass balance for energy units and biogas stations;

✓Determination of areas suitable for particular energy crops type cultivation and in estimation of potential biomass yield, energy production from its utilization, and profits;

✓Space-based system for monitoring energy crops plantations: monitoring of plantations actually existing and planned for establishment, assessment of energy crop growth conditions and yield prediction;

✓Development of Operational Service of Bioenergy Crops Plantations Monitoring in Poland.

The Proposed Service was found very interesting and promising by several key Actors of Energy Market in Poland.

Ministry of Economy support the project, according to the policy of increase of renewable energy sources , there is the urgent need of limiting the energy biomass import to Poland.

Ministry of Agriculture considers the project being interesting giving the possibilities of development of rural areas and possibilities to increase the wealth of local communities.

Energy Regulatory Office found the project useful because currently there is no tool which would enable them to verify the amount of energy crops yield and to control the source of biomass, which is declared by the energy producers.

Agency of Restructuration and Modernization of Agriculture is very interested in Project results because it needs the reliable source of information of the localization of plantations.

The most significant energy producers in Poland are vividly interested in following products: possibility of localization of existing plantations – source of biomass and estimation of currently growing biomass and yield prediction as well as indication of areas of new plantations establishment.

The Energy Manufacturers are awaiting the products concerning the localization of existing energy crops plantations and energy units collecting this biomass.

Project Consortium:

Project Coordinator: RG Consulting Ryszard Gajewski

Project Partners (Subcontractors):

- Institute of Geodesy and Cartography
- REO Foundation
- National Supporter of Economic Growth – www.farmer.pl
- Polish Chamber of Biomass

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IGiK

POLSKA IZBA BIOMASY
www.biomasa.org.pl

farmer.pl

reo.pl

Project Objective:

The main technical objective of the proposal is to build up the advisory energy crops focused service on the www.farmer.pl portal, dedicated to various actors in Energy Biomass Market in Poland.

SERVICE OBJECTIVES AND PROBLEMS TO SOLVE:

Where are the plantations?

What is the biomass balance in the regions?

Where new plantations could be established?

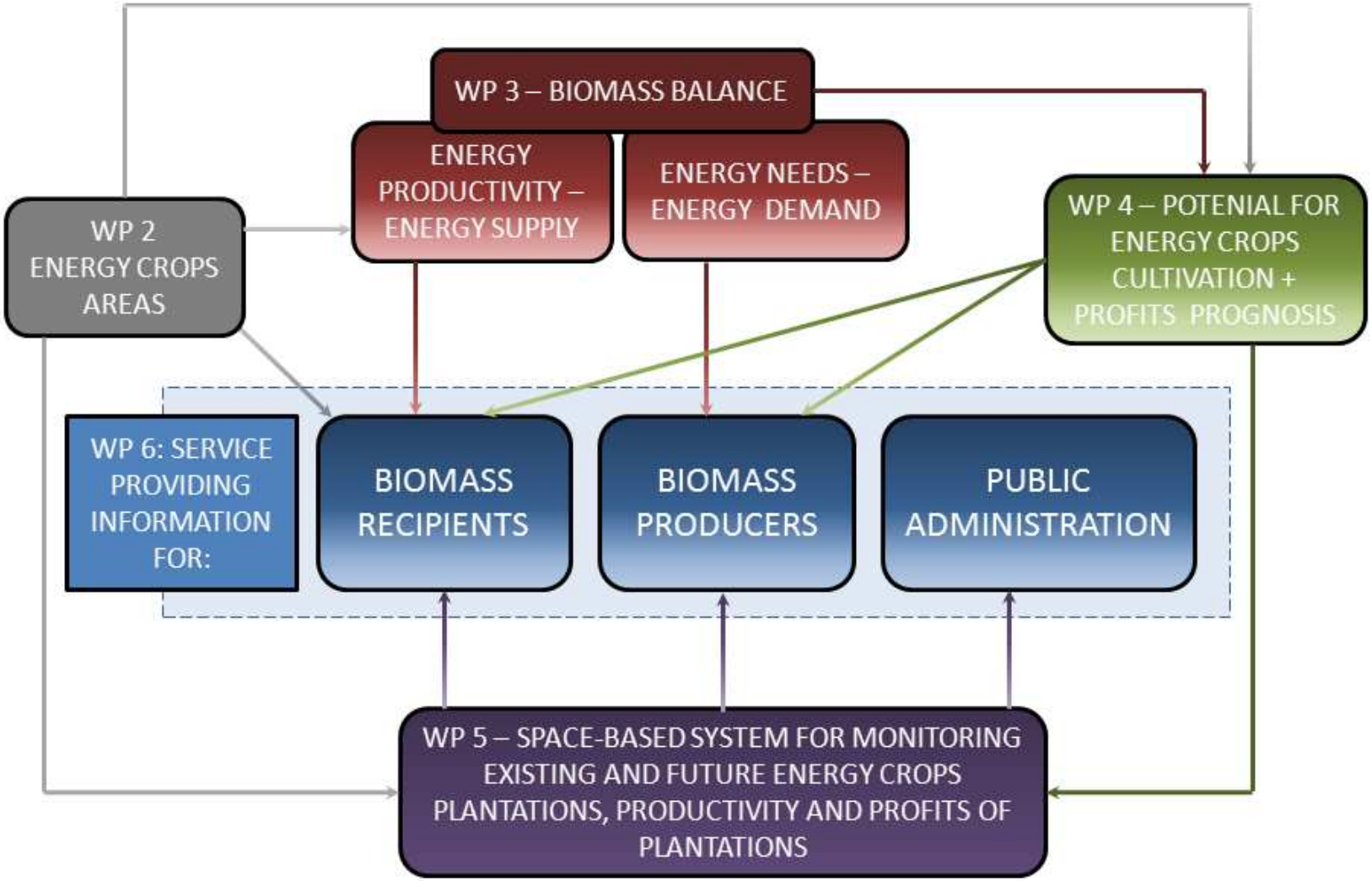
Productivity and yield prognosis

Service for plantations monitoring established and operating

Solutions proposed by the Service:

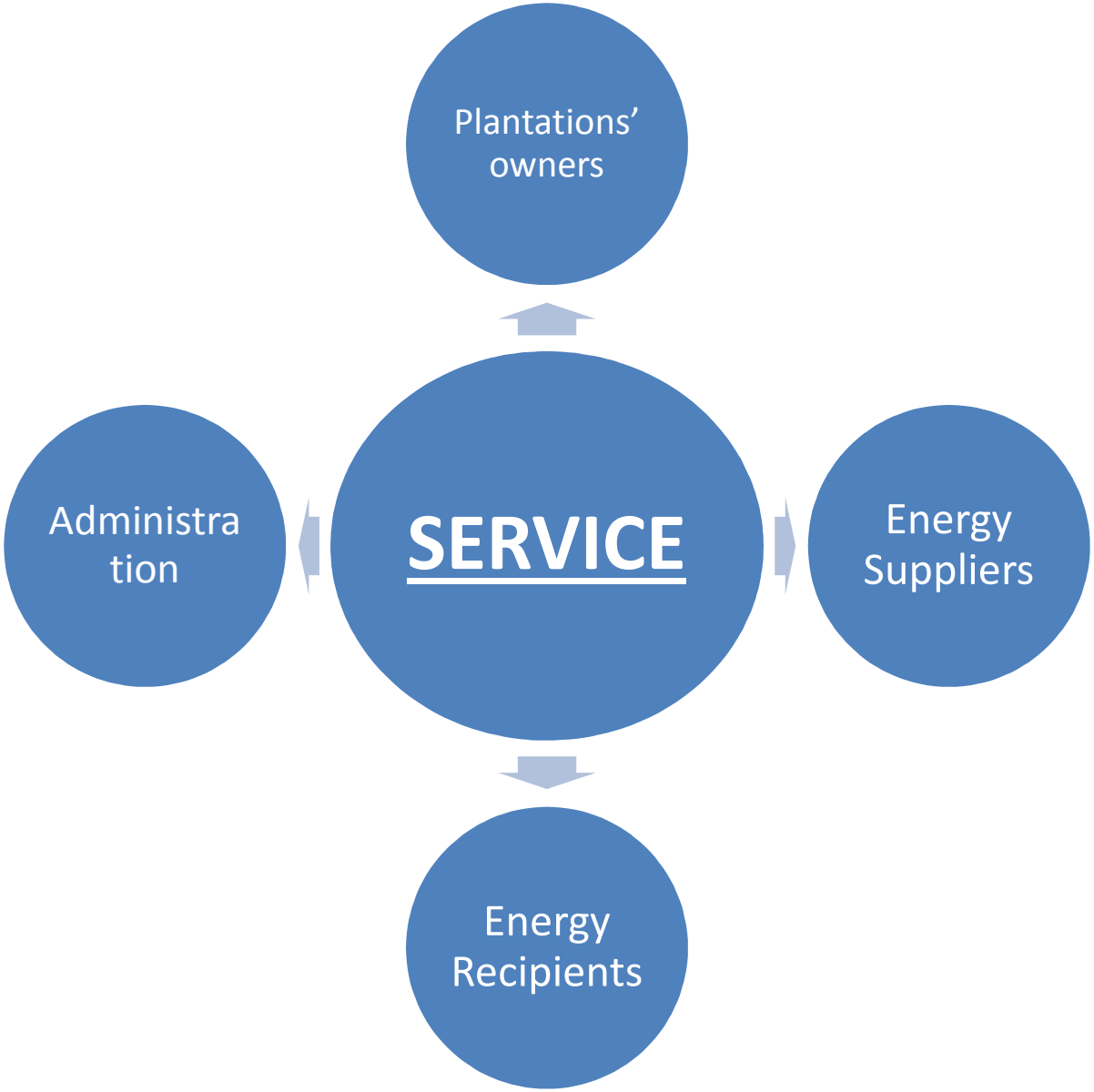
Maps of plantations in regions	Maps of selected regions potential for bioenergy productivity	Monitoring of energy crops condition and yield prognosis
Estimation of potential energy productivity from plantations	Reccommended crops	Soil moisture within plantations monitoring
Energy balance in the regions	Prognosis of energy productivity and yield prognosis	Prognosis of energy productivity and income

Work flow in the Project

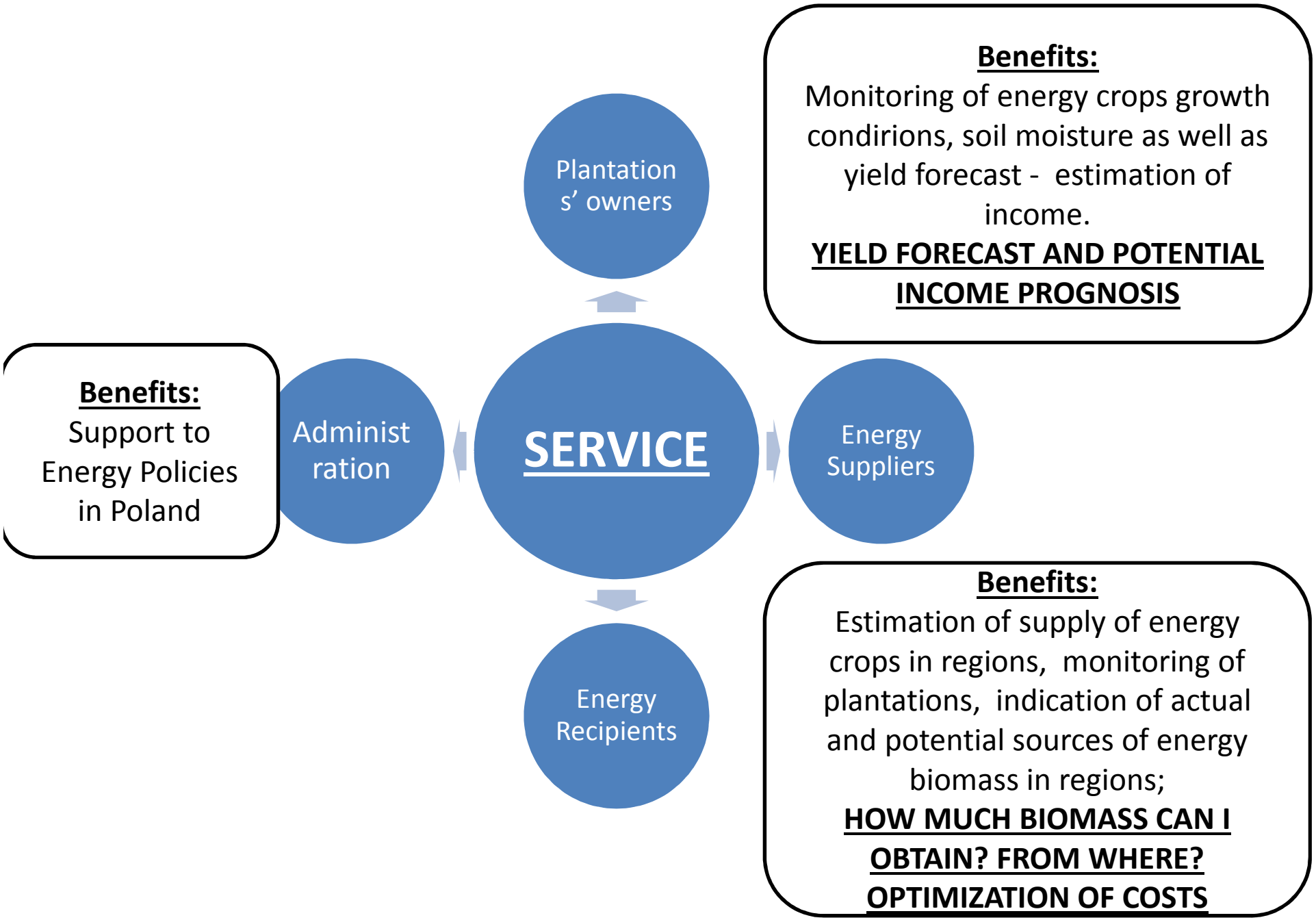


USERS NEEDS AND REQUIREMENTS' DRIVEN SERVICE

Recommendation given by the users – the service shape and content will be driven by the users' opinion and needs


Plantations' owners
Administra tion
SERVICE
Energy Suppliers
Energy Recipients

Foreseen benefits?


Plantation s' owners
Benefits:
Monitoring of energy crops growth condirions, soil moisture as well as yield forecast - estimation of income.
YIELD FORECAST AND POTENTIAL INCOME PROGNOSIS
Benefits:
Support to Energy Policies in Poland
Administ ration
SERVICE
Energy Suppliers
Energy Recipients
Benefits:
Estimation of supply of energy crops in regions, monitoring of plantations, indication of actual and potential sources of energy biomass in regions;
HOW MUCH BIOMASS CAN I OBTAIN? FROM WHERE?
OPTIMIZATION OF COSTS

The Service will be delivering the following set of products to the end-users:

Products available on the Service:

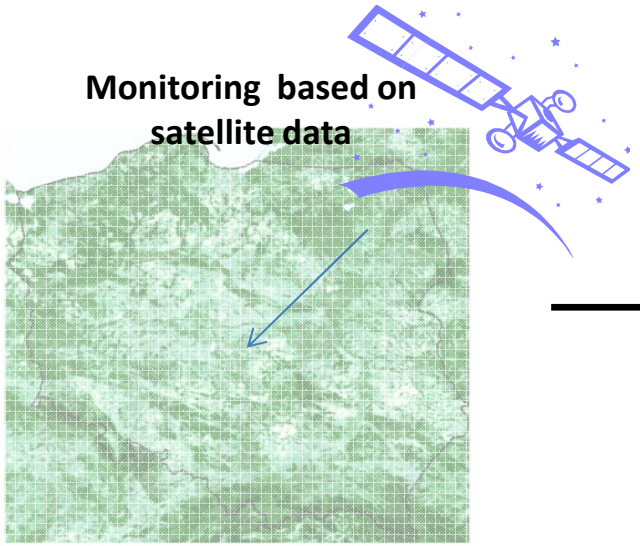
- The areas of energy crops plantation cover;
- The areas potentially useful for energy crops cultivation;
- Energy crops growth conditions such as: soil moisture, biomass;
- Energy crops biomass yield prognosis.

Analytical reports based on space-derived and in-situ information:

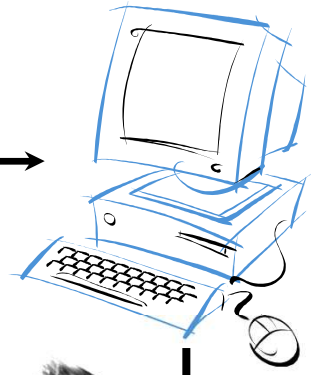
- The roles and utility of energy crops at farm to regional and national levels from economic, agronomic and environmental perspectives;
- Biomass recipients requirements and expectations with respect to bioenergy production in Poland;
- Report on deficit in biomass balance for energy units and biogas stations;
- Selection of adequate energy crops for the given areas identified as potentially useful for cultivation;
- Energetical and economical analyses of the profitability of the energy production from particular plantations and regions.

Cultivation of multiple year energy crops in ha:

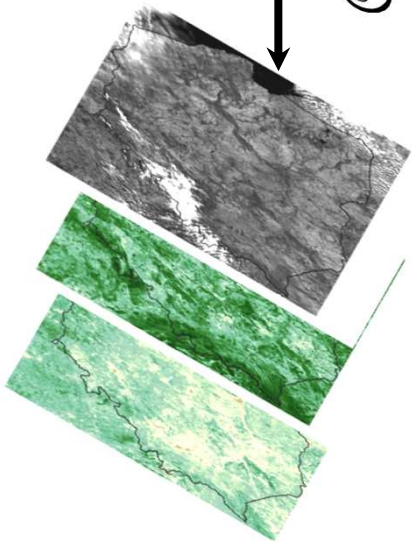
	2010	2011	2012	2013
Dolnośląskie	623,62	642,88	863,49	978,03
Kujawsko-Pomor	186,10	272,18	268,28	319,49
Lubelskie	351,95	418,53	538,76	568,79
Lubuskie	787,23	881,44	757,83	789,26
Łódzkie	128,84	244,64	288,21	316,88
Małopolskie	105,85	121,00	127,68	154,50
Mazowieckie	331,27	472,46	523,15	510,25
Opolskie	169,12	277,72	282,72	295,39
Podkarpackie	883,74	940,29	1045,58	1146,08
Podlaskie	345,59	472,43	511,46	434,07
Pomorskie	547,24	669,27	1700,27	1745,60
Śląskie	105,49	259,19	274,16	306,27
Świętokrzyskie	174,65	181,37	183,38	200,99
Warm-Mazur	523,19	791,14	2019,79	2566,57
Wielkopolskie	196,43	405,71	426,45	450,70
Zachodniopomorskie	678,34	568,92	532,82	725,68
Razem	6192,65	7619,17	10344,00	11508,55



Processing of data



Renewable energy experts – energy crops



Soil moisture maps

Crop condition maps → biomass

Yield prognosis

Prognosis of energy productivity and income

Free data

farmer.pl

Data available on commercial basis

Opinions, requirements, engagement, interest of users

Project Webportals:

- http://www.farmer.pl/projekty/serwis-serene/

On the Farmer.pl portal, the objectives of the proposed service are presented. The Potential Users as well as the benefits for them offered by the Service are also indicated. The Scheme of Service Operation is also presented.

- Serene na Reo.pl

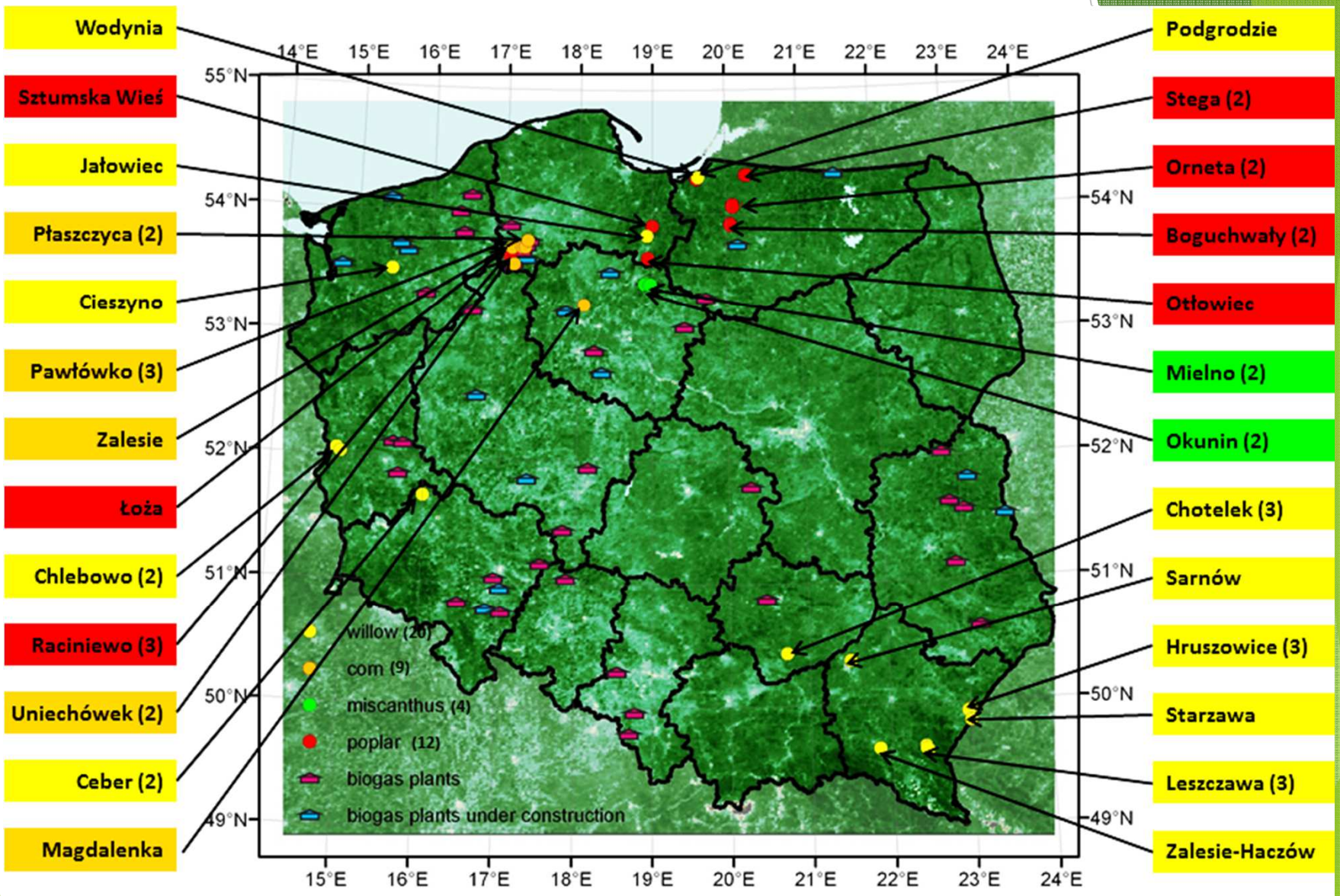
On Reo.pl Portal, the Project SERENE will be presented. The Project objectives, workflow and schedule of work will be described. Moreover on the Reo.pl website some educational materials concerning the possibilities of application of satellite data for energy crops monitoring and energy productivity and profits estimations will be presented.

Already achieved results:

- Classification on energy biomass plantations in 11 voivodeships in Poland – Landsat 8 data;
- Maps of biomass increase and biomass amount for selected plantations;
- Soil moisture maps of selected plantations;

- In 2014, 51 energy crops plantations have been monitored through whole vegetation season – in-situ measurements and satellite data monitoring

Monitored plantations vs. biogas stations



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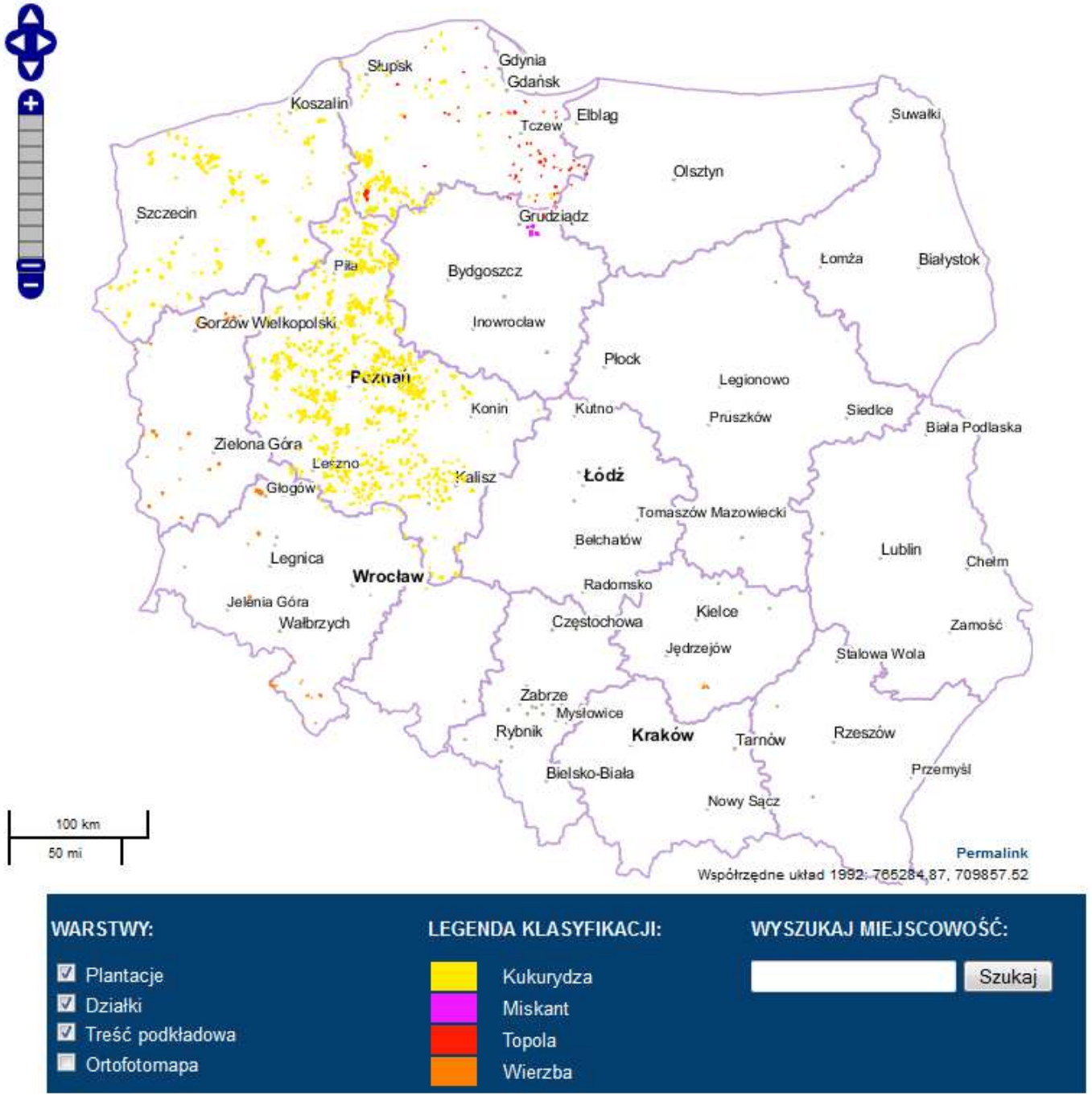
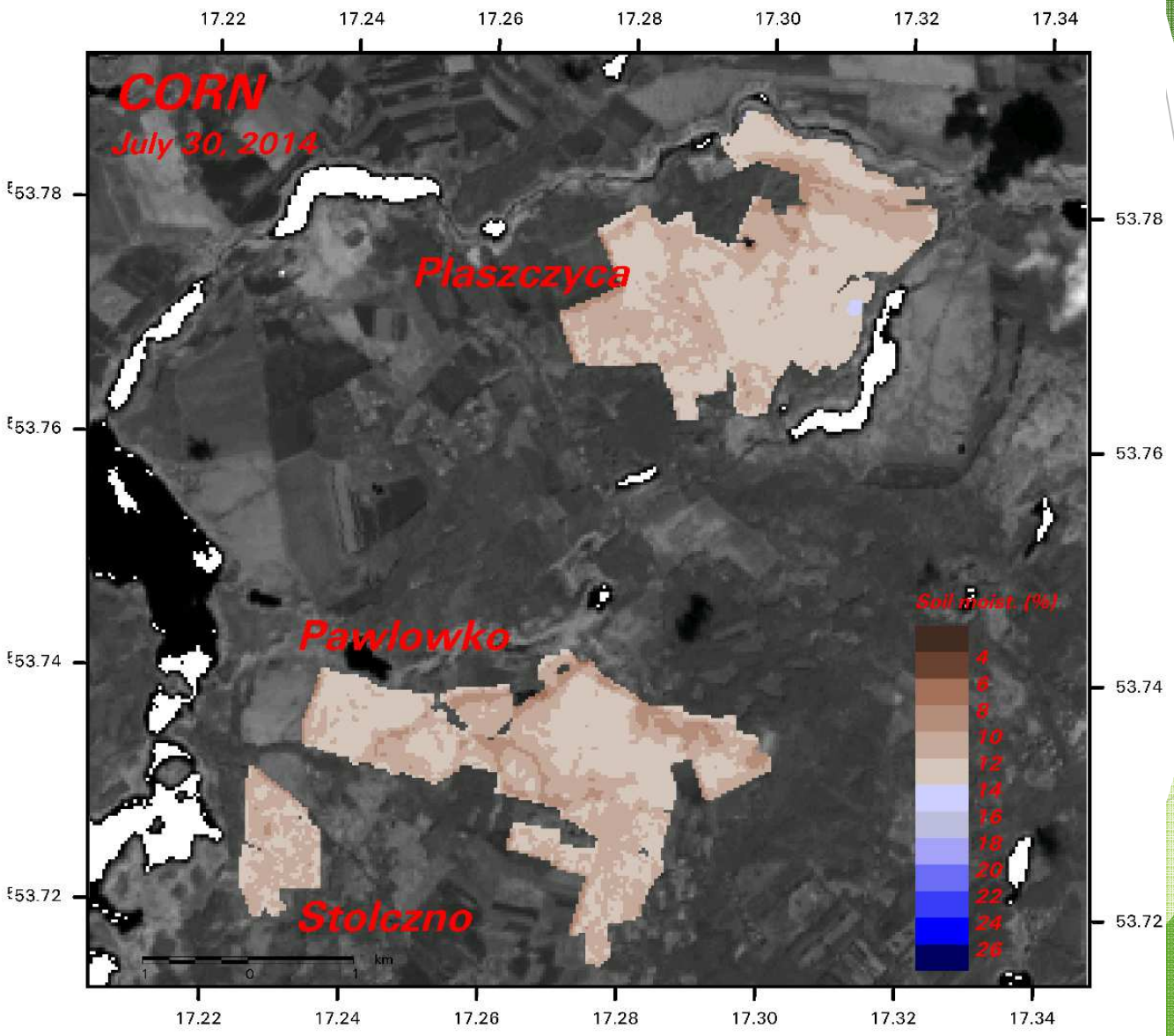
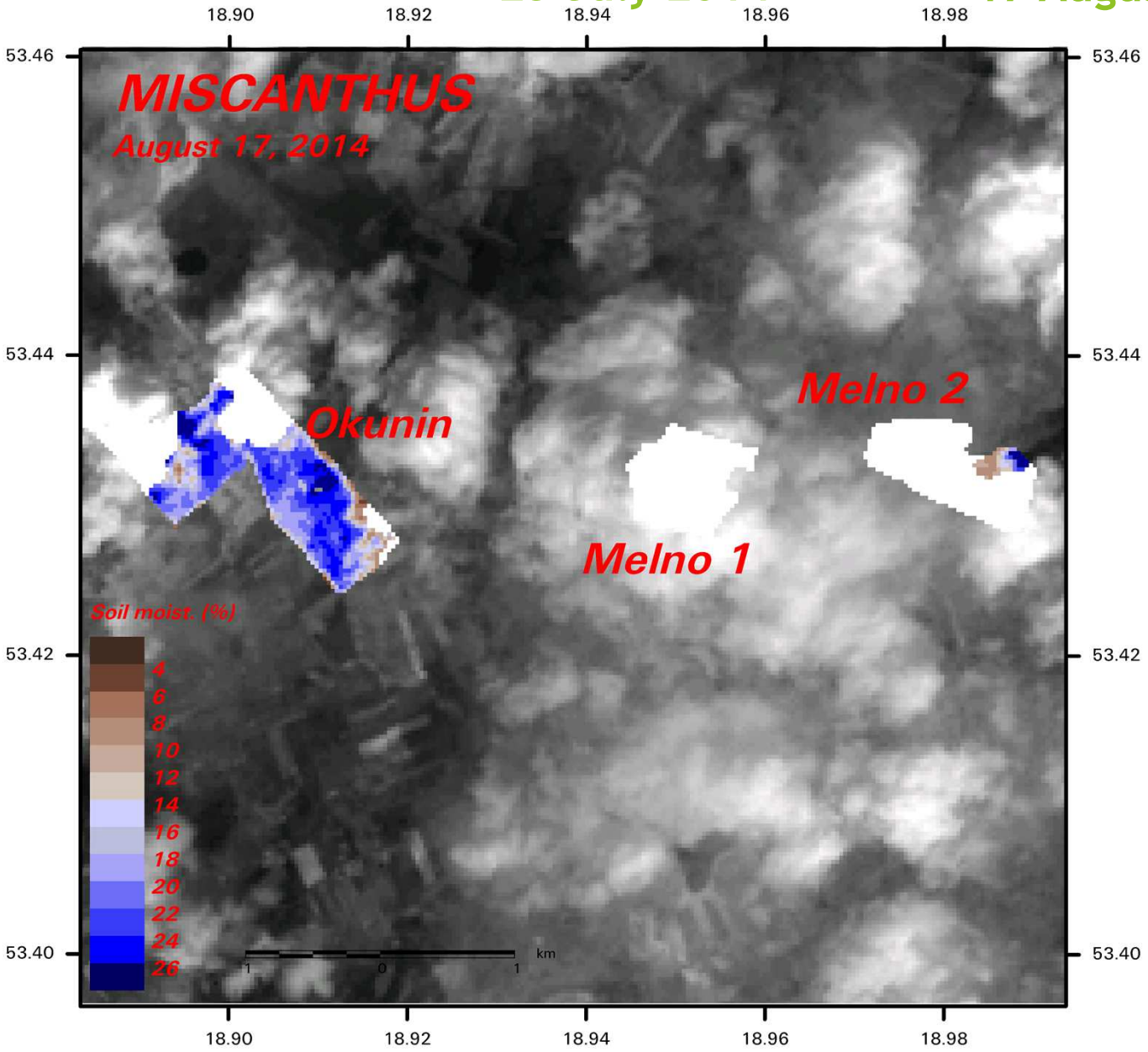


Soil moisture map – Corn plantations; 30 July 2014

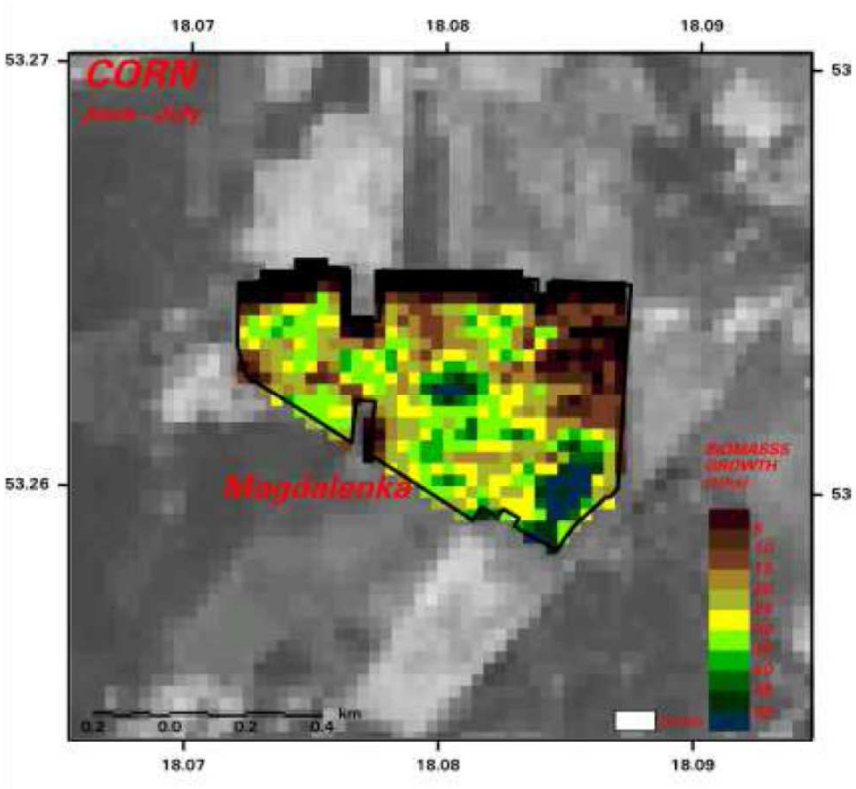


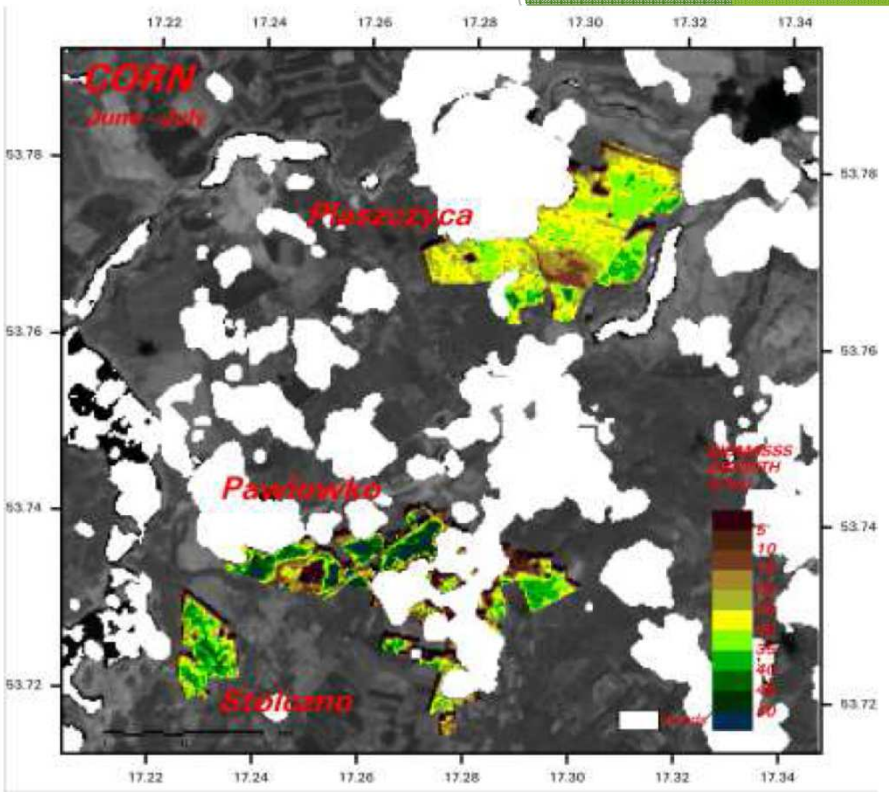
Soil moisture map – Miscanthus plantations;

5 June 2014 23 July 2014 17 August



Map of biomass of selected plantations



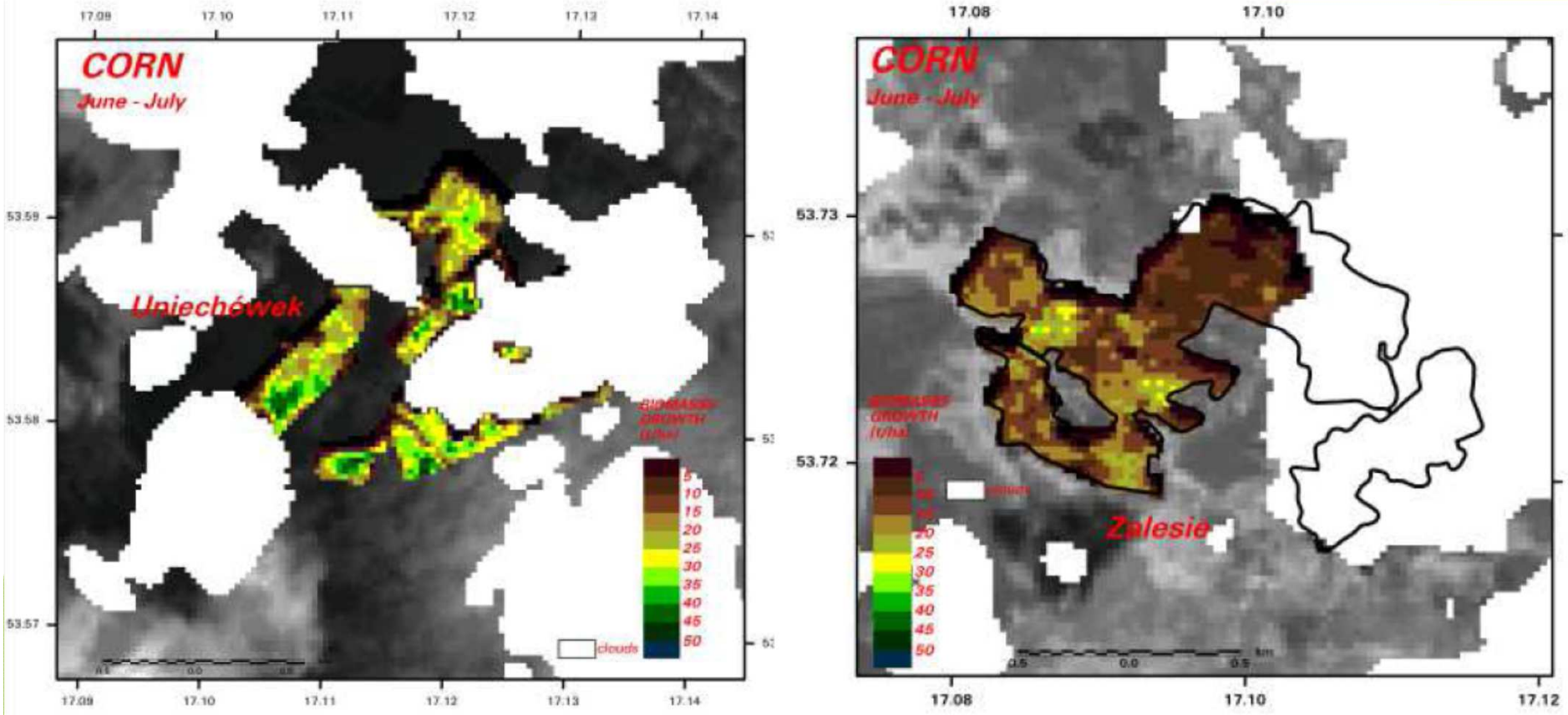


$$\Delta \mathbf{B}(July\text{-}June)/\mathbf{B}(June) = 2.31 * \Delta \mathbf{NDVI}(July\text{-}June)/\mathbf{NDVI}(June)$$

Mean biomass growth July – June (t/ha):

Magdalenka:	20.9	**Biomass(July)**= 10.52 + 20.90 = **31.42 t/ha**
Plaszczyca:	25.4	**Biomass(July)**= 5.96 + 25.43 = **31.39 t/ha**
Pawlowko2:	17.5	**Biomass(July)**= 8.75 + 17.54 = **26.29 t/ha**
Pawlowko3:	27.0	**Biomass(July)**= 10.24+ 27.04 = **37.28 t/ha**
Stolczno:	27.8	**Biomass(July)**= 8.30 + 27.85 = **36.15 t/ha**

Map of biomass of selected plantations

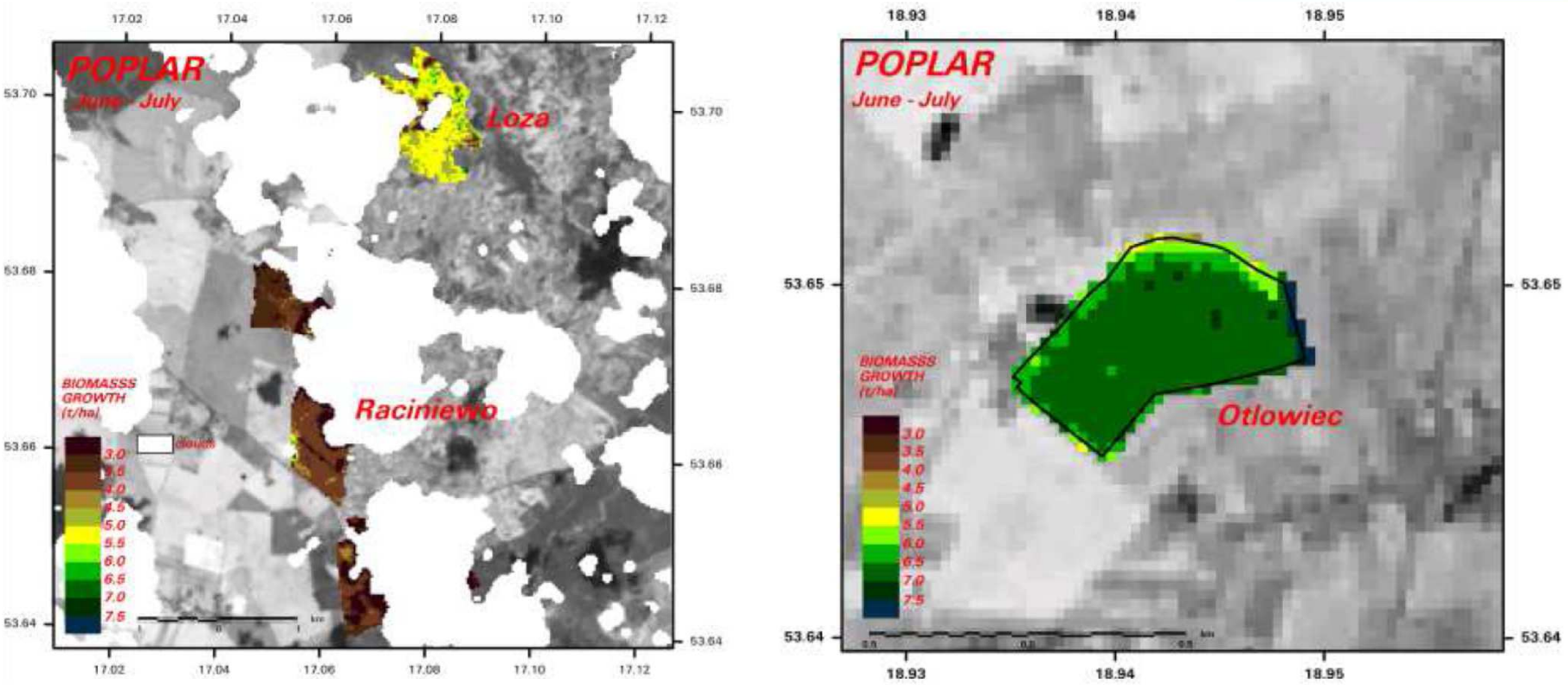


***July-June*)/B(*June*) = 2.31*ΔNDVI(*July-June*)/NDVI(*June*)**

Mean biomass growth July – June (t/ha):

Uniechowek1:	16.5	**Biomass(July) = 9.50 + 16.50 = 26.00 t/ha**
Uniechowek2:	18.1	**Biomass(July) = 10.56 + 18.11 = 28.67 t/ha**
Zalesie:	10.3	**Biomass(July) = 7.14 + 10.31 = 17.45 t/ha**

Map of biomass of selected plantations

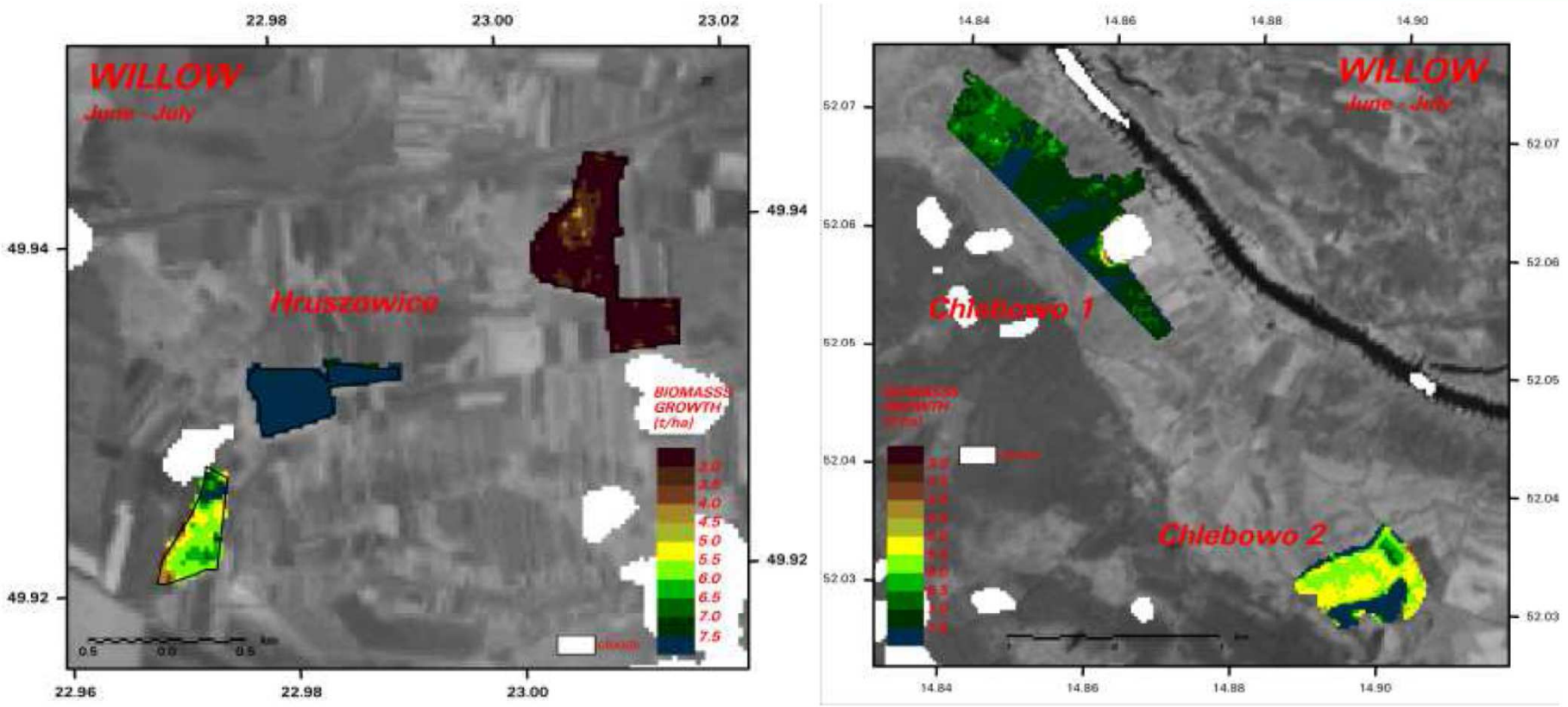


$$July\text{-}June)/B(June) = 2.31*\Delta NDVI(July\text{-}June)/NDVI(June)$$

Mean biomass growth July – June (t/ha):

Raciniewo1:	3.29	**Biomass(July)= 16.34 + 3.29 = 19.63 t/ha**
Raciniewo2:	3.63	**Biomass(July)= 18.81 + 3.63 = 22.44 t/ha**
Raciniewo3:	3.12	**Biomass(July)= 18.01 + 3.12 = 21.13 t/ha**
Loza:	4.9	**Biomass(July)= 26.07 + 4.96 = 31.03 t/ha**
Otlowiec:	6.6	**Biomass(July)= 32.42 + 6.65 = 39.07 t/ha**

Map of biomass of selected plantations

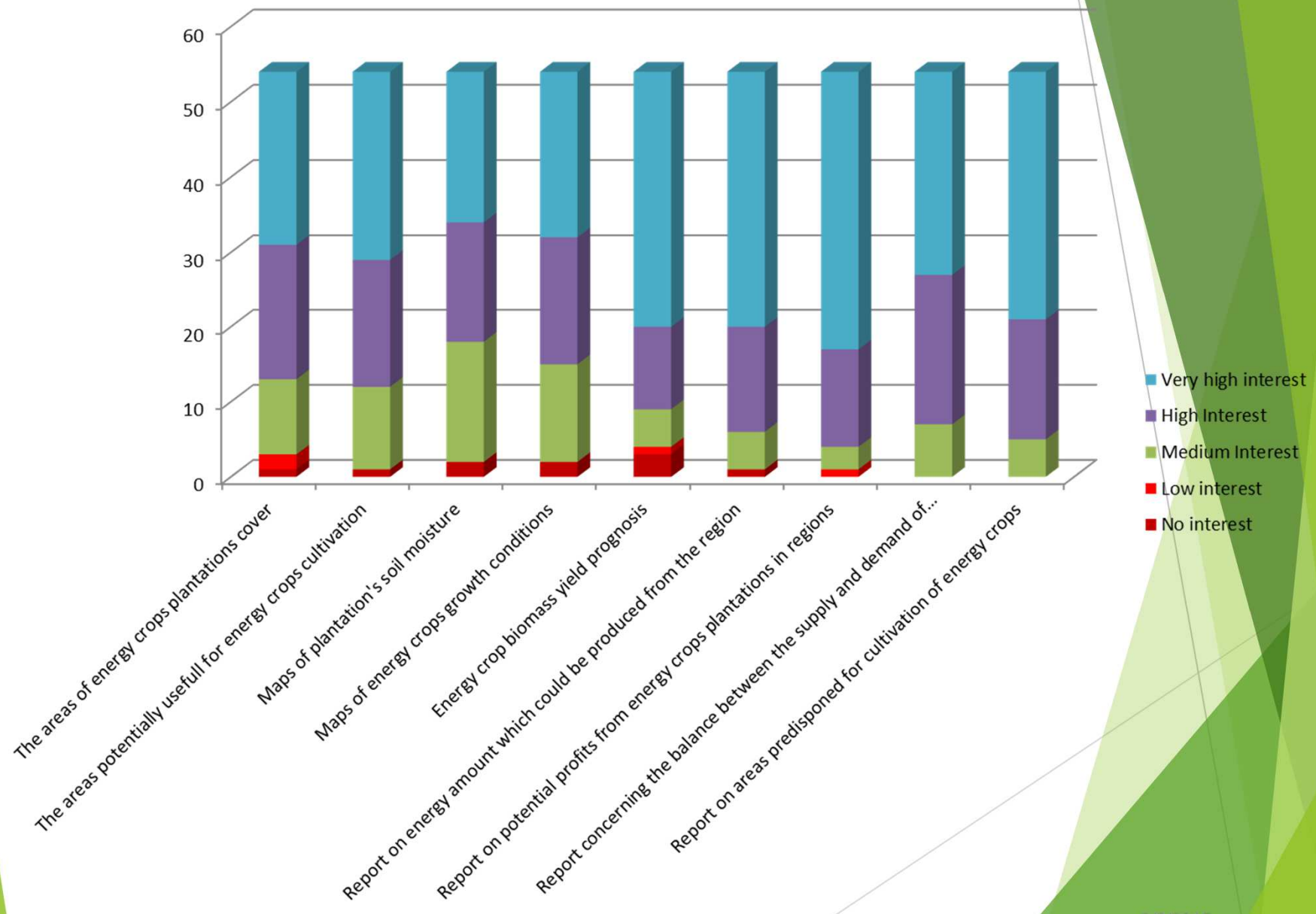


$$\Delta B(July\text{-}June)/B(June) = 2.31 * \Delta NDVI(July\text{-}June)/NDVI(June)$$

Mean biomass growth July – June (t/ha):

Hruszowice1:	2.8	**Biomass(July)= 17.77 + 2.83 = 20.60 t/ha**
Hruszowice2:	9.9	**Biomass(July)= 65.37 + 9.96 = 75.33 t/ha**
Hruszowice3:	5.7	**Biomass(July)= 33.38 + 5.75 = 39.13 t/ha**
Chlebowo1:	7.6	**Biomass(July)= 40.67 + 7.56 = 48.23 t/ha**
Chlebowo2:	7.0	**Biomass(July)= 31.15 + 7.01 = 38.16 t/ha**

Users' interest into SERENE Service Prodfucts:



Results to be achieved in 2015

- Classification maps elaborated for surroundings of selected bio-gas stations (existing and under construction);
- Maps of soil moisture, actual biomass and yield to be collected for selected plantations;
- Maps of areas predisponed for energy crops cultivation and reccomendations for energy crops;
- Technology of energy crops cultivation.

Seminar for USERS to be organised in 2015 – please visit reo.pl and farmer.pl portal for actual information!

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