Central Statistical Office of Poland

Uses cases of potential sources for the agricultural domain

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Alghero, 07.05.2017

Cooperation:

ITP

INSTITUTE OF TECHNOLOGY AND LIFE SCIENCES

I - NDVI

- **The Normalized Difference Vegetation Index**

based on contrast between high reflectance values of emission for vegetation in near infrared band (channel 14) and low values in red emission band (maximum absorption) and is expressed with formula:

NDVI = (NIR – R) / (NIR + R)

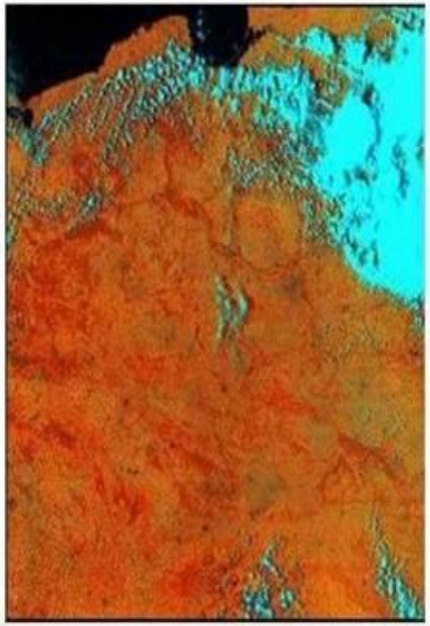
- Together with values from range (-1, 1) we obtained information on the development state and condition of vegetation, and high values of index correspond to the areas overgrown with thick vegetation of good condition.

Work Station

Photo correction

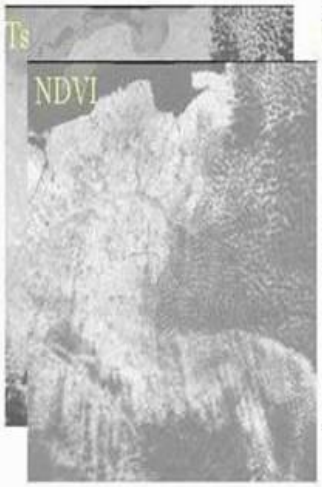
NOAA/AVHRR

Cut out country area, masking clouds

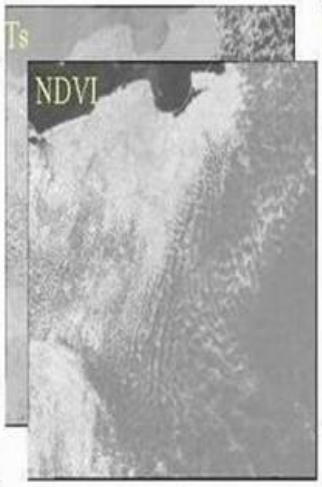


Poland

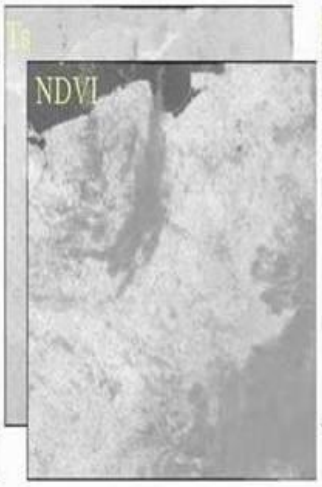
Calculation of radiation temperature and NDVI index



11 May



12 May



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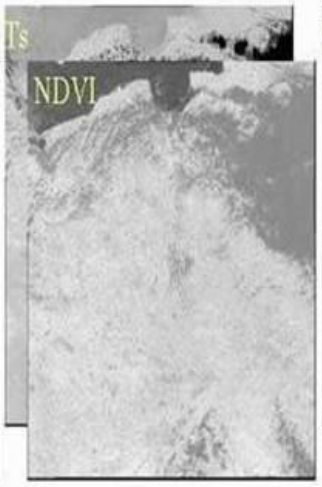
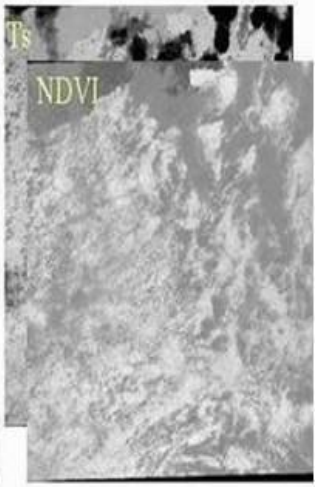


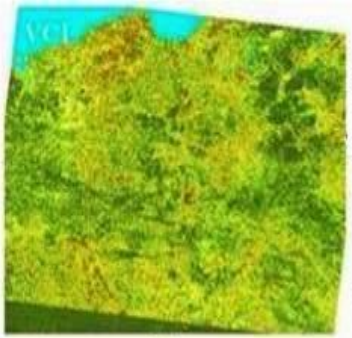
14 May

15 May

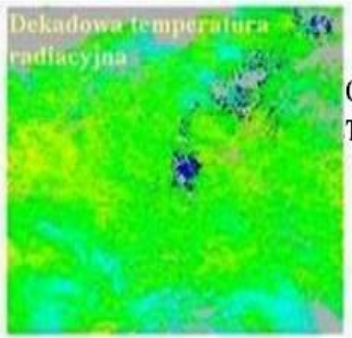


16 May

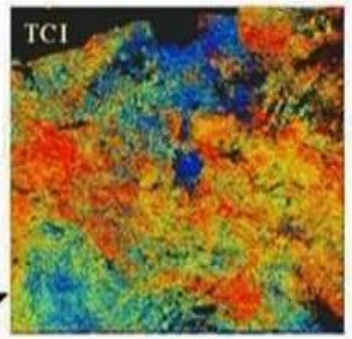
Create a decade

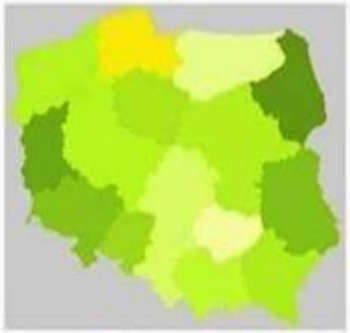


Calculating the VCI index

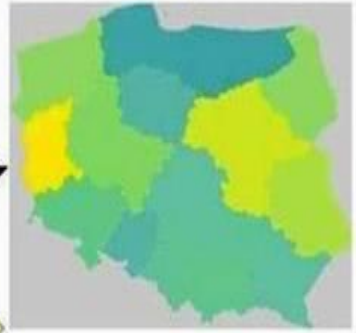


Calculating the TCI index





Satellite database



Database of yields from central Statistical Office

Data modeling

NDVI, VCI, TCI

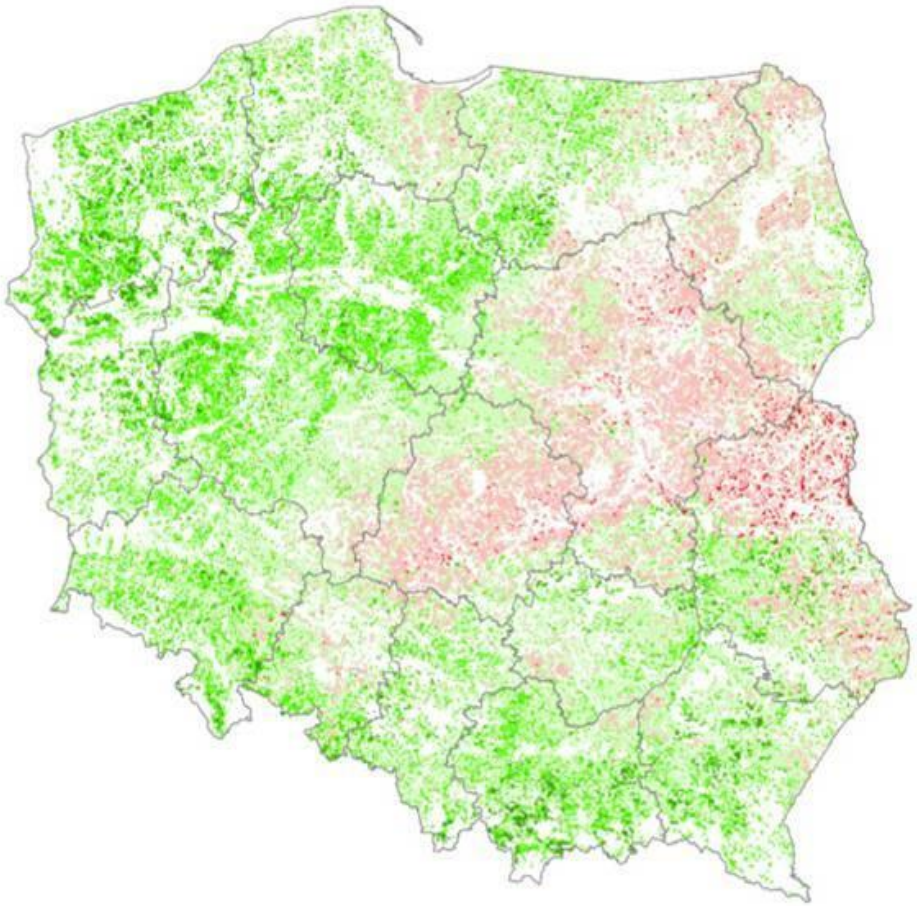
Regression

Time series analysis

Forecast yield for each voivodship

Comparison of plant condition

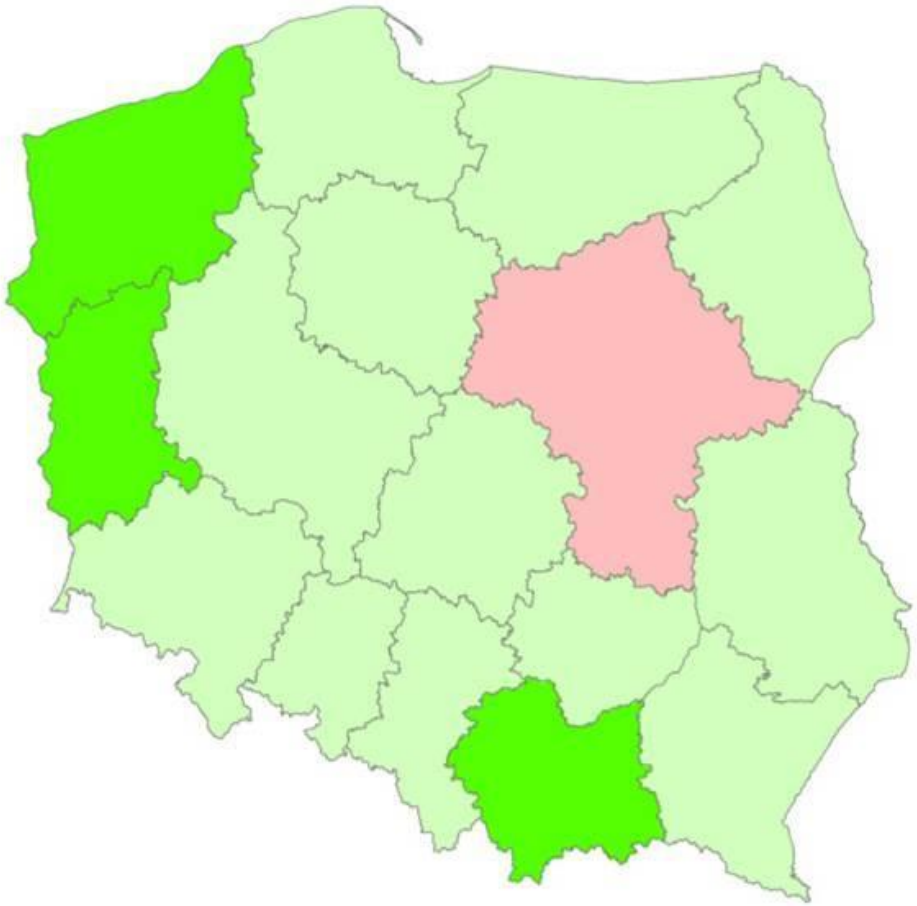
The index value of greenning
2009 vs 2008
Decade 13 1-10 May 2009



Source of information: digital analysis of satellite images
NOAA

Comparison of plant condition by voivodships

The index value of greenning
2009 vs 2008
Decade 13 1-10 May 2009



Source of information: digital analysis of satellite images
NOAA

Values of NDVI distribution ratio compared to the average year

April - June 2015

APRIL

DEKADA 10

DEKADA 11

DEKADA 12

MAY

DEKADA 13

DEKADA 14

DEKADA 15

JUNE

DEKADA 16

DEKADA 17

DEKADA 18

II – Pilot Estimation of grassland production using by drone and hyperspectral camera

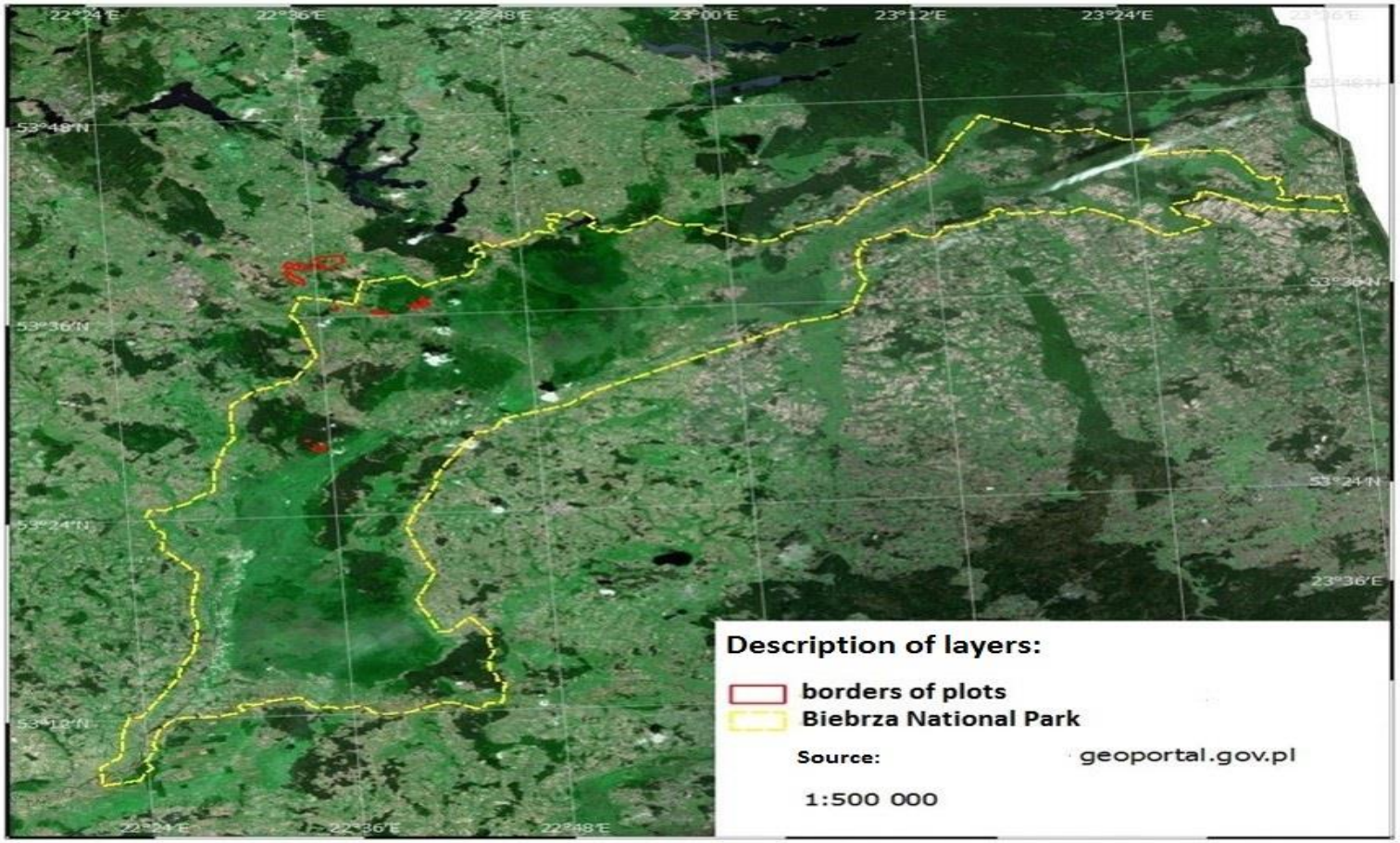
- Eurostat grant –*„Pilot studies to develop methodological improvements to agri-environmental statistics and statistics on grassland production”*
- CSO of Poland (the Employer) in Warsaw
- Institute of Geodesy and Cartography (IGiK) in Warsaw (the Contractor)
- The Institute of Technology of Sciences
- Statistical Office in Olsztyn
- Centre of Life Sciences of the Warsaw University

Purposes

- Comparing previous methods of estimating grassland production.
- Developing methodology of classification of permanent grasslands using an example of a single voivodeship.
- The creation of the current map grassland- region
- Analysis methodology for estimating yields and harvested from grasslands with the possible use of NDVI ratio and photos from the type of Landsat satellite.
- Develop and test new methodological approaches for the classification and production of grassland.

Area Frame

- 21 plots indicated by the Employer
- 460.2 hectare
- Biebrza National Park
- 2 field campaigns
- 74 points (LAI)
- Landsat 8
- Drone


22°24'E
22°36'E
22°48'E
23°00'E
23°12'E
23°24'E
53°48'N
53°36'N
53°24'N
53°12'N
23°36'E
Description of layers:
borders of plots
Biebrza National Park
Source:
geoportal.gov.pl
1:500 000


5D
5D

Drone (Multicopter VersaX6)

- 6 rotors
- weight 4 kg
- weight up to 1.5 kg
- autonomous flight handling
- 1,000 – 2,000 m
- altitude of 150 or 200 meters

Hyperspectral Camera (Rikola, Oulu, Finland)

- the range of 480-890 nanometers
- weight 780 g
- 9 mm fixed focal length lens with field of view of 36.5^{o}
- 10 ms of automatically changing spectral channel
- 16 spectral channels (480, 515, 550, 580, 610, 670, 700, 705, 710, 720, 740, 750, 780, 800, 840 and 885 nm)
- total time of acquisition 900 - 2020 ms

Landsat 8

- 9-channel OLI (Operational Land Image) and and 2-channel TIRS (Thermal Infrared Sensor)
- single scene is 170 x 185 km
- 16 days
- two scens from 25 May and 10 June 2015

NDVI

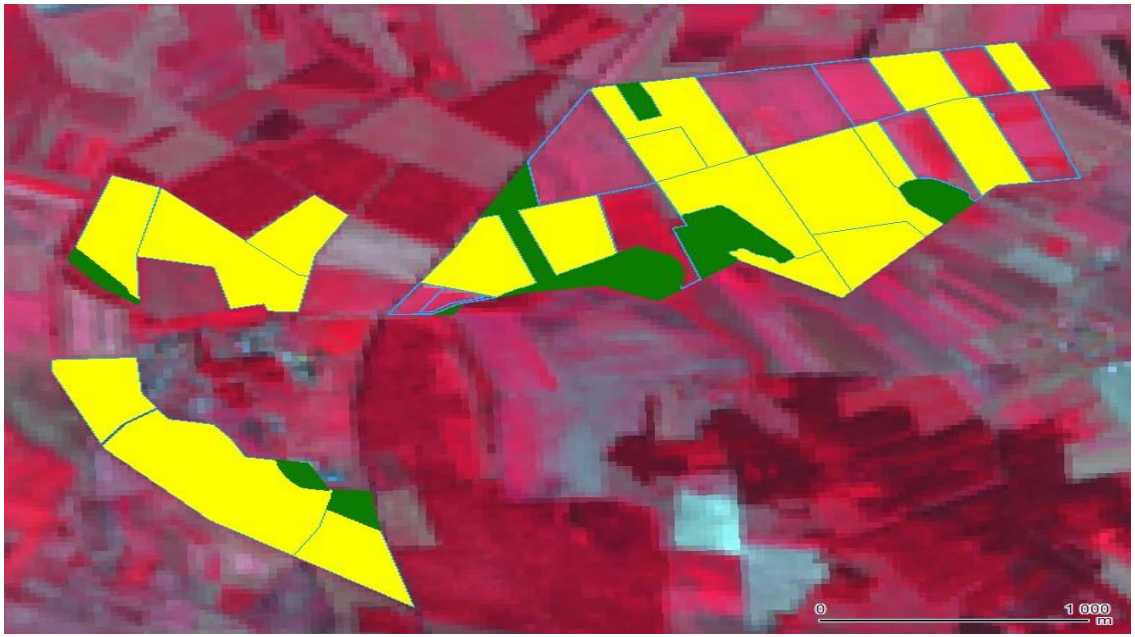
- **The Normalized Difference Vegetation Index**

based on contrast between high reflectance values of emission for vegetation in near infrared band (channel 14) and low values in red emission band (maximum absorption) and is expressed with formula:

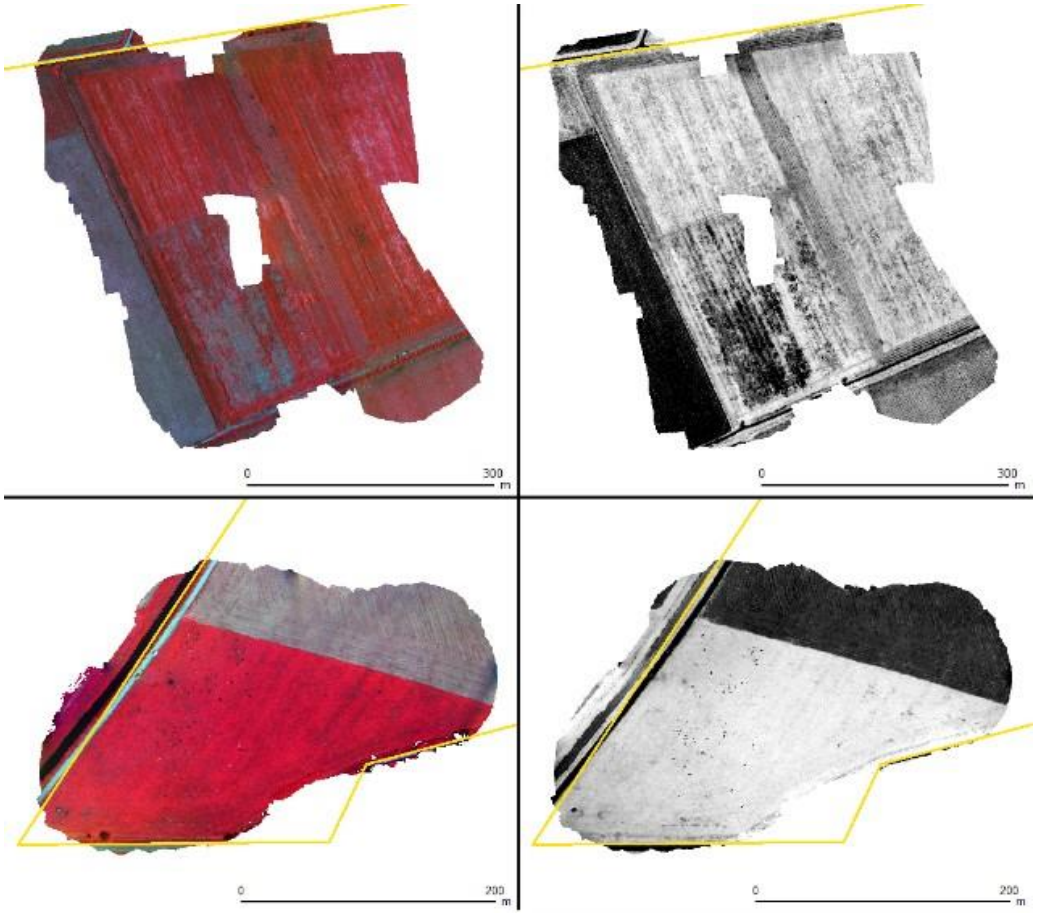
NDVI = (NIR – R) / (NIR + R)

- Together with values from range (-1, 1) we obtained information on the development state and condition of vegetation, and high values of index correspond to the areas overgrown with thick vegetation of good condition.

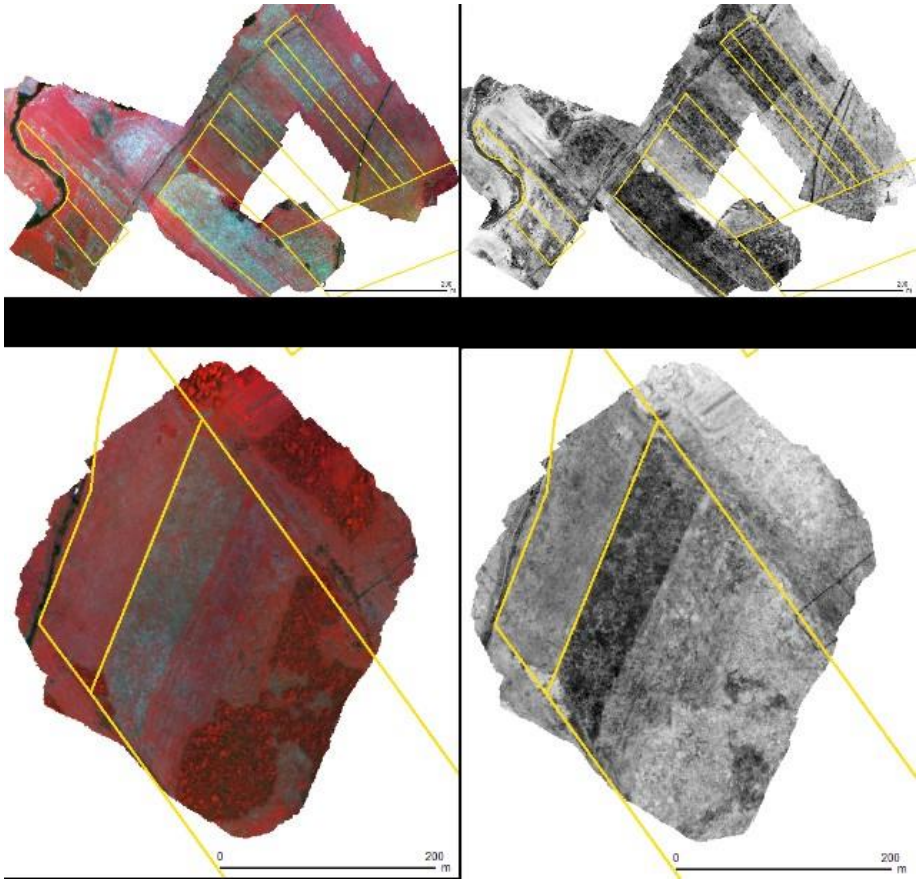
Yellow colour – area, the grassland analysis of which uses data from Landsat 8, green colour – areas excluded from the analysis (basis: data from Landsat 8 satellite, date of acquisition 10.06.2015, coloured composition 5-4-3).



Two examples of data obtained from drone; the composition of channels 16-6-4 on the left, established NDVIs on the right.



Two examples of data obtained from drone; on the left, the composition of channels 16-6-4 (bluish areas correspond to sections of meadows with larger share of dry vegetation) on the right established NDVIs.



Spatial distribution of quantity values of fresh biomass and the average biomass per one hectare for particular fields (basis: data from Landsat 8 satellite, date of acquisition 10.06.2015, coloured composition 5-4-3).

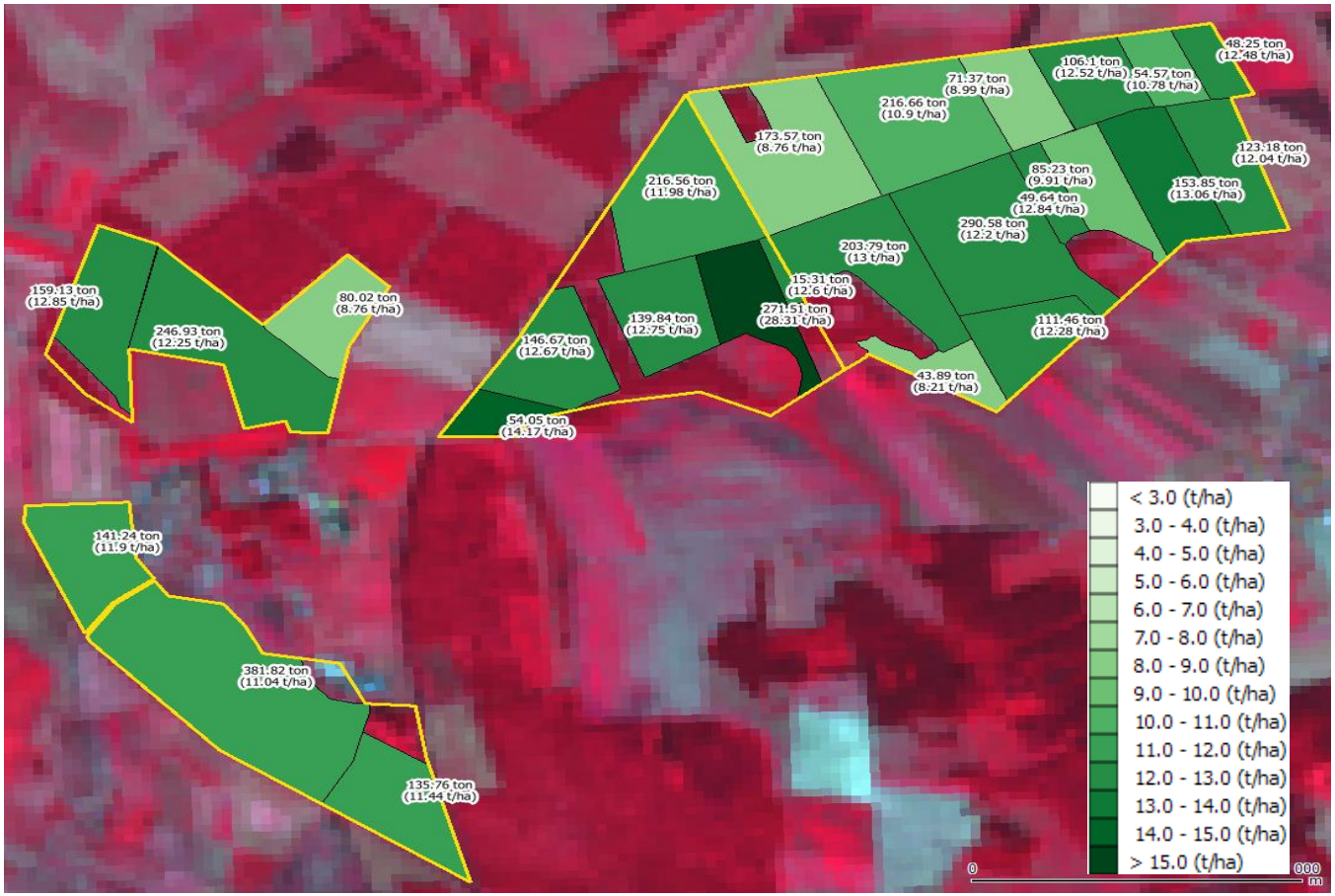


Table with summary of the quantity of fresh biomass and the average biomass per one hectare for particular plots of the Sołki district.

	NUMBER OF THE PLOT	SURFACE OF THE PLOT (ha)	AREAS BEYOND THE ANALYSIS (ha)	ARABLE LANDS (ha)	BIOMASS (tons)	BIOMASS (tons/ha)	DRYMASS (tons/ha)
SOŁKI district	200404_5.0018.193/12	2.30	0.09	2.22	25.65	11.58	5.0
	200404_5.0018.215/2	27.60	4.59	23.02	130.20	5.66	2.5
	200404_5.0019.62	5.05	-	5.05	47.28	9.37	3.0

(+)

- 397.65 ha; 4402 tons; 11.07 tons/ha
- Pictures at low hights
- 200m / 12 cm
- Mobility, flexibility and relatively small cost / single flight
- Good recognition of the imaged areas by drone operator

(-)

- ca.15 minutes/one flight
- high dependence on weather conditions
- eye contact
- camera (one lens vs many lens)

Simulation 2015

- one voivodship - NUTS 2
- Total area = 20 180 km^2
- Agriculture area = 10 741 km^2
- daily area = 1 km^2
- working days = 2 685
- Daily costs = 210 euros
- Over **0.5 mln** euros

III - Pilot research to isolate particular groups of crops and land cover classes

- CSO - RSO Olsztyn
- Space Research Centre - Polish Academy of Science

Data sources already collected

- **The Integrated Administration and Control System (IACS)** – complex administrative information system
- **The Land Parcel Identification System (LPIS)** – part of the National Register of Producers
- **LUCAS** – Land Use and Coverage Area frame Survey
- **Copernicus** – previously known as GMES – Global Monitoring for Environment and Security programme (Sentinels)

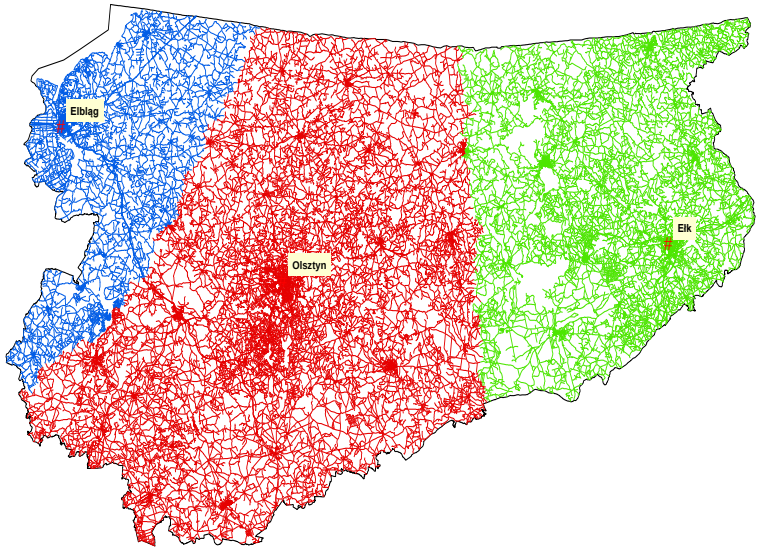
Methodology and technical aspects

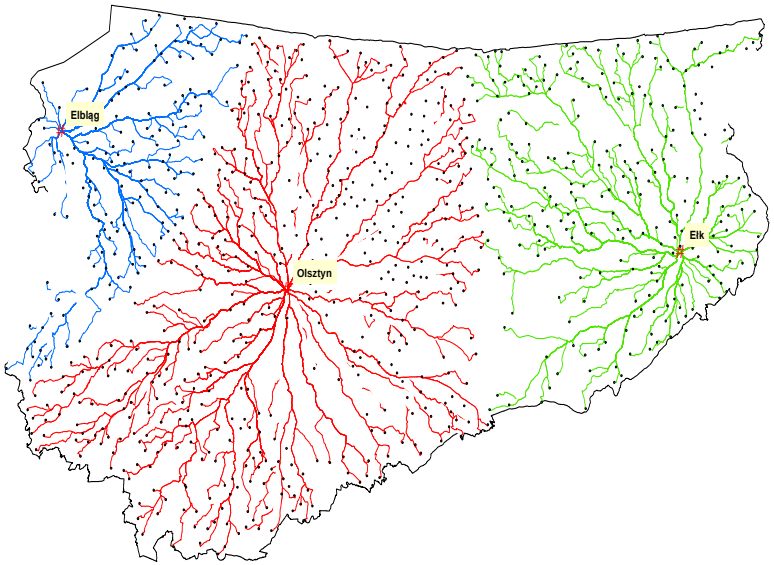
- Dedicated software for teledetections
- Data calibration
- Data combining
- Machine Learning
- Volume size for Pilot Use Case
  - 1.5 TB for 2015 for 1 of 16 voivodships
  - 3.5 TB for 2016 for 2 of 16 voivodships

Detailed methodology:

- time series for classes of spectral reflections for each crops interviewers
- analyzes network communication system
- allocation of network zones for each interviewer
- get directions to points
- photos (series of geo-tagged images)

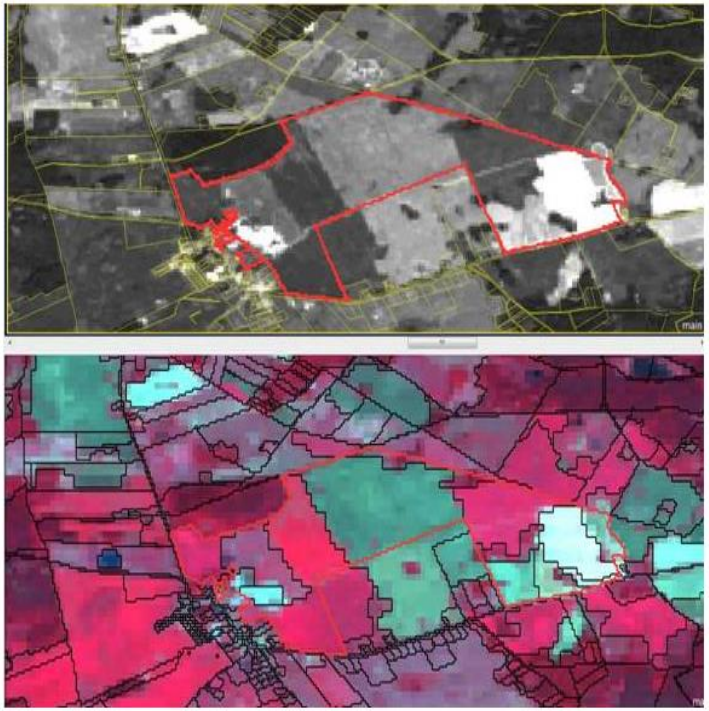
The network zones allocation to interviewers in relation to the transport system in the Warmińsko-Mazurskie Voivodship (Poland)





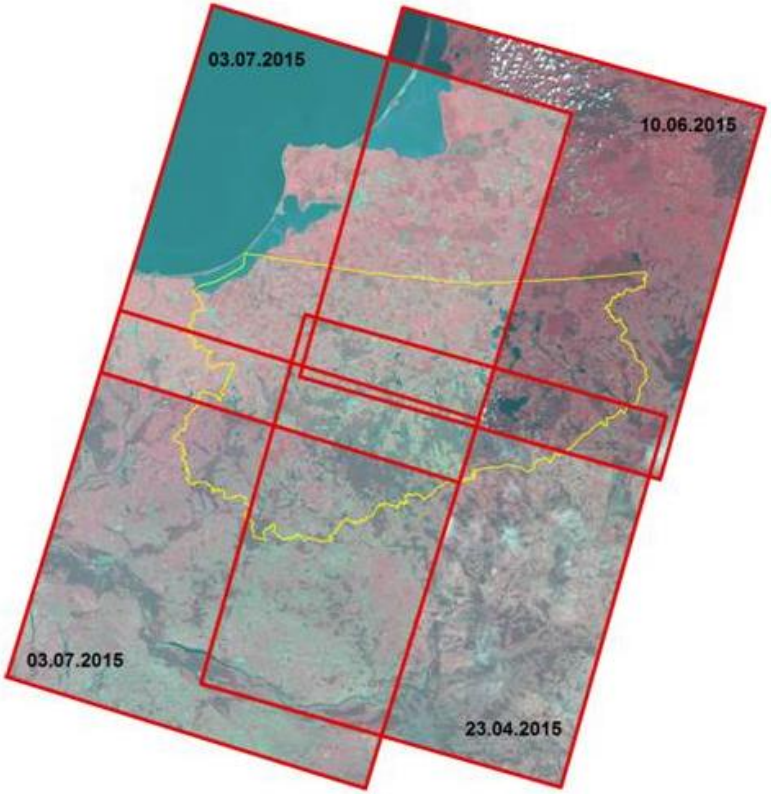
Data segmentation

- administrative vector data (LPIS)
- radar satellite images
- optical satellite images
- Depending on the actual data quality and availability, one or several segmentation methods can be used.
- Fitting the type of crop to the satellite pixel.



Data classification

- Support Vector Machine (SVM),
- Decision Trees (DT),
- K-Nearest Neighbours (KNN) including the following classification parameters:
- Sigma,
- Entropia,
- Alfa,
- multi-temporal indicators,
- Wishard distribution.



Data aggregation

- analysing the training fields classification error matrix,
- analysing the calculations accuracy,
- making comparisons with administrative data,
- making comparisons with statistical data.

Summary (I-III)

- Benefits
- The development of satellite techniques (Sentinel constelations)
- The future of agricultural statistics/ Big Data
- The role of **End Users**

Thank you for your attention

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