

Harnessing the power of Earth Observation for Official Statistics

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Dominik A. Rozkrut

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Yesterday's extraordinary becomes today's banal and today's extreme becomes tomorrow's norm

> **Stanisław Lem** "Running nose"







Statistics of yesterday and tomorrow

Yesterday

eus

Dane osobowe zebrane w badanlach przez ankieterów statystycznych:

- są przetwarzane zgodnie z przepisami ROBO Rozporządzenia Parlamentu Europejskiego Rady (UE) 2016/679 z dnia 27 kwietnia 2016 r. w sprawie ochrony osób fizycznych w związku z przetwarzaniem danych osobowych i w sprawie swobodnego przepływu takich danych oraz uchyleniadymktywy 95/46/WE
- 2) są objęte tajomnicą statystyczną na podstowie art. 10 ustawy z dnia 29 czerwice 1995 r. o statystyce publicznej, a za naruszenie tajemnicy, grozi odpowiedzialność karna określona w art. 54 i 55 ustawy z dnia 29 czerwice 1995 r. o statystyce publicznej.

Data ważności leg tymacji



Legitymacja ważna jest z dowodem osobistym

Telefon kontaktowy w celu potwiercizen ia tożsamości ankietera



Tomorrow





Advantages of remote sensing data

Feature	Remote sensing data	Field data
Costs		×
Execution speed		×
Data availability		×
Accuracy	\checkmark	×
Labour outlays		×
Independence from weather conditions	×	×
Digitalization		×



Earth Observation

Satellites systems quick facts

- · United States: 1 425
- · Russia: 172
- [•] China: 382
- · Europe: 360
- [•] Other: 448

2020-07-31 – 2 787 satellites

2018-11-11 – 1 886 satellites

http://apps.agi.com/SatelliteViewer





Earth Observation

EO satellites quick facts





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1995

Earth Observation Missions



https://www.isprs.org/PROCEEDINGS/2018/2018-Dehradun-IPAC-Session/A6_ESA-Copernicus-HOSFORD.pdf



Earth Observation Missions





EO in the Copernicus program



Source: https://eur-lex.europa.eu/



EO in support of the Sustainable Development Goals





https://earthobservations.org/documents/publications/201703 geo eo for 2030 agenda.pdf



SDG 11 and Earth Observation





Source: Urban extent, Kampala/Uganda, based on ENVISAT ASAR and Landsat-5 TM/7 ETM 2002-2014 (left) and Sentinel-1-C-SAR and Landsat-8 OLI2014-2015 (right), DLR/ESA Sat4Urban



SDG indicators for statistics

Statistical layer

thematic maps:

- · crop maps (CS1, CS3),
- · soil cover map (CS2),
- open public spaces map (CS4),
- Weighted Urban Proliferation index map (CS5),
- land use/land cover maps (CS5, CS7, CS8, CS9)

statistical indicators:

- area under cultivation and cropped area (CS1, CS3),
- proportion of agricultural area under vegetation cover in winter – SDG indicator 2.4.1 (CS2),
- average share of the build-up area of cities that is open space for public use for all, by sex, age and persons with disabilities – SDG indicator 11.7.1 (CS4),
- Weighted Urban proliferation index (CS5),
- indicators of the evolution of the area occupied by the Eucalyptus and a related indicator concerning the susceptibility of the forest to fire (CS9)
- products supporting and enriching statistical production (CS6, CS7).





Case 1 Agriculture



Agriculture - Statistics Poland SATMIROL project

Estimation of the main agricultural and horticultural crops in 2020 based on satellite image analysis

• Enhancement of the identification and monitoring of agricultural crops

 Improvement of methods to assess the impact of extreme weather events on crop condition

• Implementation: 2019 - 2021

Statistics Poland Polish Space Research Centre Institute of Geodesy and Cartography



Agriculture - Statistics Poland SATMIROL project





Agriculture - Statistics Poland SATMIROL project

1,35 mln ha

Area of triticale in 2021 was determined to be 1.35 million hectares on the basis of EO

Source: Statistics Poland

264 thousand ha

Area of sugar beet determined on the basis of the experimental method of crop identification on the basis of satellite images in 2020.

Preliminary estimation of the main agricultural and horticultural crops in 2021.

Example:

- Observation period for triticale: 15.03-15.07.2021
- EO data: 531 scenes of SLC data + 1250 (SAR) of Sentinel-2
- Average accuracy: Kappa coefficient 0.80-0.85

Cultivation	area in [ha]	F-score*	OA*	KIA*
sugar beets	263 620	0.91		
charlock	327 057	0.44		
buckwheat	204 954	0.65		
spring barley	292 215	0.85		
winter barley	251 757	0.93		
maize	1 411 633	0.94		
cereal mixtures	383 365	0.50		
oat	427 070	0.71		
fruit tree plantations	589 309	0.80		
fruit shrub plantations	634 199	0.61		
millet	132 335	0.72		
spring wheat	242 027	0.53		
winter wheat	1 798 152	0.93		
spring triticale	839 782	0.50		
winter triticale	932 659	0.85		
spring rape	76 100	0.23		
winter rape	929 264	0.95	0.84	0.83
legumes	281 250	0.74		
grasses and grasslands	4 212 695	0.93		
strawberry	178 497	0.75		
tobacco	59 774	0.87		
vegetables	208 538	0.70		
potatoes	153 037	0.88		
herbs and spices	192 211	0.62		
rye	619 086	0.88		
Total	15 640 586			

Agricultural monitoring... time flies

1997



Values of vegetation index compared to average year

2015





Forecast of winter wheat yield 2021







Linking other data

Satellite images Aerial images/UAV images Other elaborations (maps, databases) Administrative data Surveys



Linking administrative data

Poland (done!)

agricultural plots vector data from Land Parcel Identification System1 (over 11 mln records, 8GB of data) used for masking, segmentation and extraction of learn/control samples

arable land vector data from Land Parcel Identification System (over 10 mln records, 9GB of data) used for masking

Europe

Belgium, Germany, and the United Kingdom have an LPIS for each region; all other EU Member States have one covering the whole country; there are currently2 44 LPISs in total, containing over 135 million reference parcels

> Land Parcel Identification System (LPIS) is an IT system based on photographs of agricultural parcels used to check payments made under the Common Agricultural Policy (CAP).
> based on data from 2016



Characteristics of the reference parcel types

	Agricultural parcel	Cadastral parcel	Farmer's block	Physical / Topographical block	
Main features	- Single crop group - Single farmer	 One or more farmers Based on ownership One or more crop groups 	- Single farmer - One or more crop groups - No natural boundaries	 One or more farmers Area bordered by certain features (ditches, hedges, walls, etc.) One or more crop groups 	
Main data source	Farmer's application	Cadastre, land register	Farmer's application	Administrative classification	

Source: European Court of Auditors and European Commission (JRC).

LPISs by type across the EU



Source: European Court of Auditors based on the 2014 and 2015 LPIS Quality Assessment Reports.

Use of LPIS administrative data in Statistics Poland

- excluding non agri area over the satellite image;
- choosing representative parcels for insitu;
- segmentation (extracting homogeneous areas) within agriculture areas;
- extracting samples for machine learning and image classification;
- extracting samples for validation



Cadastral parcels (LPIS)



EO for agriculture – main findings

Limitations

Complex processing Low spatial resolution (10m) can eliminate small parcel Terrain influence Distinction between some crops is impossible due to similarity in plant structure

Huge potential of EO data

Access to data Size of study area (from small scale to global) Reliable results (high accuracy based on group of crops) Increased accuracy Cost reduction in statistical production is possible – standard surveys can be replaced



EOStat Agriculture Poland Services for Earth Observation-based statistical information for agriculture

Developing an EO-based system to support

• operational activities of Statistics Poland related to gathering statistical information on agriculture

• verification of farmers' obligations under the Common Agricultural Policy (for ARMA)





Case 2 Land cover



Land cover - CORINE

CORINE Land Cover 2018 (CLC 2018) - from land cover information to statistic data



Source: https://sdi.eea.europa.eu/



Land cover - DEGURBA

Degree of urbanisation (DEGURBA)

Main aims:

- 1. Comparability improvment of territorial units (EU)
- 2. Spatial units consistence in statistical surveys (EU)
- Creation possibility of aggregates for individual types of areas at the national level
 - a) Town-and-country planning
 - b) Delimitation of Functional Urban Areas (FUA)

Three classes:

- 1. Cities
- 2. Towns and suburbs
- 3. Rural areas



Source: https://stat.gov.pl/



Land cover – Urban Atlas

Urban Atlas - land cover in urban areas

Potential uses in statistics:

- Development density reaserch
- Estimation of artifical surfaces increase Urban Atlas Change maps
- Ports and airports surface, railway areas
- Water surface in the cities
- Green areas in the cities Street Tree Layer
- Average building height in European capitals Building Height Layer
- Many others uses e.g. agricultural areas, forests, land without current use, etc.





Source: https://alinagerlee.pl/urban-atlas/



Land cover classification 2020 (POLSA)

- Data created by Space Research Centre of Polish Academy of Sciences
- The map was generated based on Sentinel-2 images recorded on 01/04/2020 – 30/09/2020







Source: https://mapy.geoportal.gov.pl/imap



Land cover - cooperation

Polish Space Agency (POLSA) data – land cover 2020





Case 3 Environmental protection



Environmental protection

Projekt TanDEM-X

- mission operations: German Space Operations Center
 - high Resolution Interferometric SAR Mission(radar)
 - source: satelita TerraSAR-X i TanDEM-X



http://www.igik.edu.pl (crop identification)



https://www.dlr.de(forest/non-forest areas)

products:



https://www.dlr.de (air pollution)



Case 4 **Tourism**





Projekt DeFrost Detailed and Fast Remote Observation of Snow for Tourism



Source: https://business.esa.int/projects/defrost

Case 5 Forest management

Forest management

Source: https://globbiomass.org/

ESA project – GLOBBIOMASS

- Consortium: Germany, UK, Sweden, Austria, Finland Switzerland, France, Poland, the Netherlands
- Period: 2015-2017
- Goal: integration EO data with in situ measurements and ecological understanding to provide improved biomass estimates

Forest management Sweden

Source: https://globbiomass.org/

Forest management Indonesia/Kalimantan

Source: https://globbiomass.org/

Source: https://globbiomass.org/

GlobBiomass products:

- Global Biomass Map
- Regional Maps for the reference year 2015
 - Uncertainty Maps
- Change Maps for all three regional mapping epochs (2005, 2010, 2015)

Case 6 Crisis management

Crisis management

Copernicus programme, Spain/La Palma

Source: https://twitter.com/CopernicusEMS

Statistics Poland

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Case 7 Environmental monitoring (air)

Environmental monitoring (air)

Copernicus Sentinel-5P data

Nitrogen dioxide concentrations over Italy

Nitrogen dioxide concentrations over France

Source: https://www.esa.int/

Case 8 Climate changes (ozon)

Climate changes (ozon)

Source: https://atmosphere.copernicus.eu/

Case 9 Water managment NASA/NOAA

Water managment NASA/NOAA

SatBałtyk project – Monitoring of the Baltic Sea based on satellite imageries Methods: interferometry, AVHR, SAR

Source: www.satbaltyk.pl, Baltic Sea surface temperature map - 11.01.2017.

Source: satbaltyk.pl, Chlorophyll concentration map at the surface of the Baltic Sea - 07.03.2017

Case 10 Transportation

Transportation

BDES 2020 - Big Data for European Statistics

Source: https://ec.europa.eu/eurostat/cros/sites/default/files/06_WPC_Michal_Bis_Anna_Bilska_Poland_Fishing_Fleet_ 2020_11_19.pdf Examples

Average (maximum, minimum):

distances travelled by a fishing ship depending on the season and/or weather conditions,

of uses

- time of activity of fishing fleets depending on the season and/or weather conditions,
- speed / draught of the fishing fleet for defined fishing areas and a given period.

Case 11 **Photovoltaic**

Photovoltaic – world

CHINA - Shanxi

JAPONIA – jezioro Yamakura

Source: https://www.ysgsolar.com/

CHINA - Tangshan

USA – Kalifornia, pustynia Mojave

Worldwide growth of photovoltaic

Source: https://www.iea.org/publications

Photovoltaic – Europe

The biggest photovoltaic plant in Europe (Spain)

Source: https://www.iberdrola.com/about-us/lines-business/flagship-projects/nunez-de-balboa-photovoltaic-plant

Photovoltaic – Poland

https://jaw.pl/2020/12/farma-fotowoltaiczna-taurona-w-jaworznie/

Concluding remarks

Cominig next

Source: https://www.esa.int/About_Us/Ministerial_Council_2016/What_is_space_4.0 Source: Sources: https://www.techsledge.com & https://www.thalesgroup.com

Entering the fourth era of space exploration

Increasing the temporal, spectral and spatial resolution

Placing entire constellations of artificial satellites in orbit around the Earth

Lowering of orbits and popularization of pseudosatellites;

Miniaturization (nanosatellites) and cost reduction

Challenges for official statistics

Insatiable demand for insight Exploding data ecosystems Skyrocketing number of actors Overwhelming complications of complexity New data sources vs outdated modes of access Lacking skills, competencies, resources

Remarks

Traditional official statistics data sources are relatively shrinking

Need to adopt new data sources

We'll not a be a monopoly, but there's important role too play

ESS is a great advantage

Need to push actual implementation: innovation agenda

Data Science Academy Statistics Poland

Internal data sciency capacity development program

OVERARCHING GOAL:

build a modern organization, able to anticipate and target fast-changing information needs by tapping into a multitude of data sources

Data Science Academy Statistics Poland

OBJECTIVES:

Integration of new data sources in statistical production: experimental & official

Raise data science competencies:

the use of new data sources, methods, tools & techniques

Build a community:

cooperation, knowledge-sharing, exchange of experiences, mentoring

Facilitate access and exchange of information:

develop an internal communication platform ("a campus").

LEM¹2021

Technology is not infectious, but it is spreading faster than an epidemic

Stanisław Lem "That's what I say"

<u>stat.gov.pl</u> <u>twitter.com/StatPoland</u>