EPOS – European Plate Observing System

Densification of the GGOS infrastructure in Poland in the framework of EPOS-PL

K. Sośnica[1], J. Bosy[1], J. Kapłon[1], W. Rohm[1], T. Hadaś[1], J. Sierny[1], I. Kudłacik[1], R. Zajdel[1], J. Kryński[2], P. Dykowski[2], A. Araszkiewicz[3], G. Mutke[4], A. Kotyrba[4], D. Olszewska[5]

1. Wroclaw University of Environmental and Life Sciences, Institute of Geodesy and Geoinformatics, Grunwaldzka 53, 50-357 Wrocław, Poland
2. Institute of Geodesy and Cartography, Modzelewskiego 27, 02-679 Warszawa, Poland
3. Military University of Technology in Warsaw, Kaliskiego 2, 01-476 Warszawa, Poland
4. Central Mining Institute, plac Gwarków 1, 40-166 Katowice Poland
5. Institute of Geophysics Polish Academy of Sciences, Księcia Janusza 64, 01-452 Warszawa, Poland

European Funds
Smart Growth

European Union
European Regional Development Fund

EPOS- European Plate Observing System

POIR.04.02.00-14-A0003/16

Priority IV: **INCREASING THE RESEARCH POTENTIAL**
Action 4.2: **DEVELOPMENT OF MODERN RESEARCH INFRASTRUCTURE OF THE SCIENCE SECTOR**

Period of realization: 2016 - 2021
Project value: 62 558 323,87 PLN
ERDF co-financing: 47 399 281,47 PLN

Beneficiary: Instytut Geofizyki Polskiej Akademii Nauk

Konsortium members:

CYFRONET GIG IGiK WAT POLSKA GRUPA GÓRNICZA

PROJECT **EPOS - EUROPEAN PLATE OBSERVING SYSTEM** IS CO-FINANCED BY THE EUROPEAN UNION FROM THE FUNDS OF THE EUROPEAN REGIONAL DEVELOPMENT FUND (ERDF)

European Funds Smart Growth
European Union European Regional Development Fund

GGOS

The Global Geodetic Reference Frame is fundamental for monitoring changes to the Earth including the continents, ice caps, oceans and the atmosphere. It is also fundamental for mapping, navigation and universal timing.

The ability to position both information and objects accurately will be an increasingly important driver of productivity into the next decade.

Photo: Geoscience Australia

The Global Geodetic Reference Frame is a key enabler for monitoring disasters - and recovering from them.

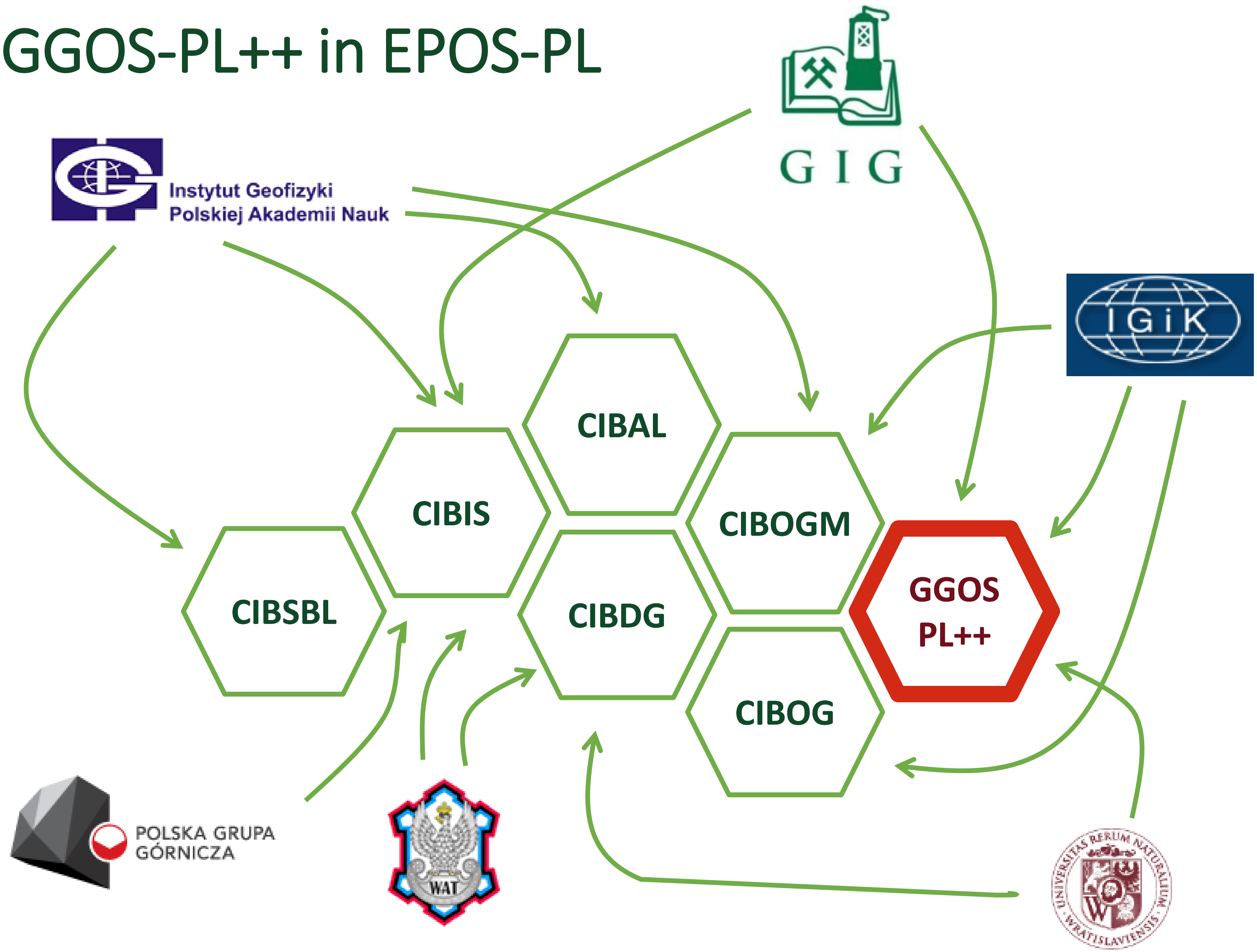
Photo: Geospatial Information Authority, Japan.

Monitoring sea level changes, plate movements, land uplift and ice sheet and glacier changes – so that global society can follow changes to the Earth system and plan accordingly on a local, regional and global level.

United Nations Committee of Experts on Global Geodetic Reference Frames
http://www.unggrf.org/

UN General Assembly urges the sharing of geospatial data to benefit People and Planet

GGOS-PL++ in EPOS-PL

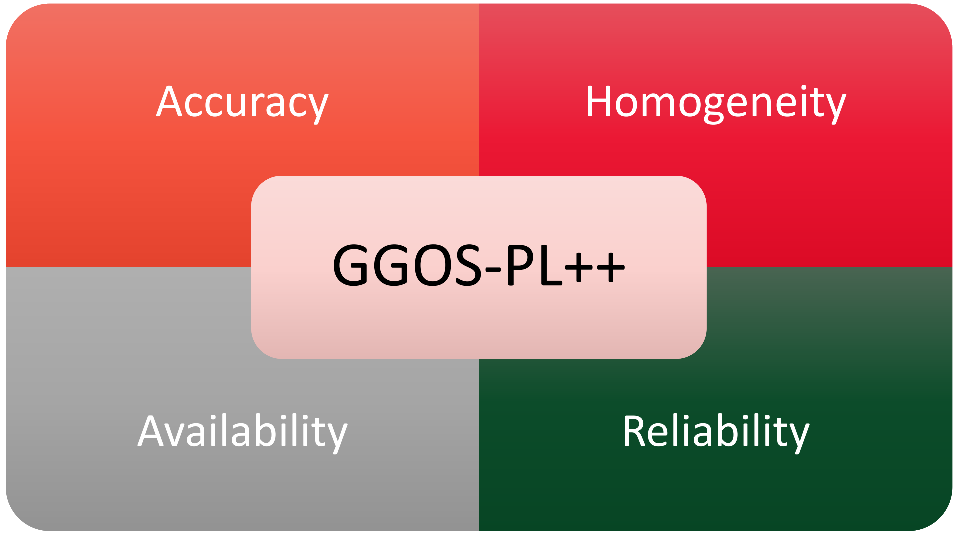


GGOS-PL++ in EPOS-PL

The project European Plate Observing System for Poland (EPOS-PL) was launched in January 2017 with a main objective of observing surface land deformations and seismicity affecting inhabitants, environment, infrastructure and buildings in the region of Upper Silesia, south Poland, where intensive activities related to coal exploitation take place or have recently been terminated. EPOS-PL engages scientists and industrial experts from many fields: geophysics and seismology, geodesy, mining, geology, geomagnetism, and gravimetry with a common goal of providing comprehensive and complementary information on the measured results and reasons of surface land deformations.

European Funds Smart Growth
European Union European Regional Development Fund
epos pl

GGOS-PL++ requirements



Reference measurements at the same time must comply with all the conditions:

- Accuracy (geodetic observations with the highest possible accuracy).
- Homogeneity (observations must be homogeneous on the scale of reference points to avoid systematic errors of measurement associated with, for example, different types of antennas and GNSS receivers);
- Availability (availability of real-time or near real-time solutions to enable rapid alert for possible threats);
- Reliability (observations are considered as reliable when different measurement techniques or different approaches guarantee the same or similar results).

Current status of GGOS infrastructure in Poland

Parameter	EKSPLA PL-2250	Continuum Surelite III
Stand	Optical table	Optical table
Frequency	10 Hz	10 Hz
Pulse energy	0.05 J	0.45 J
Pulse length	60 ps	3-5 ns
Peak power	833 MW	112.5 MW
Average power	0.5 W	4.5 W

SLR station in Borowiec

Absolute and tidal gravimeters

About 380 GNSS stations (most of them are GPS+GLONASS, some of them are multi-GNSS)

Glass-fibre connection for time transfer **UTC(AOS)** - **UTC(PL)** [Borowiec - Warsaw, at the of **distance 420 km]**

Hydrogen maser operated with a cesium fountain

Radiometers

European Funds
Smart Growth

European Union
European Regional Development Fund

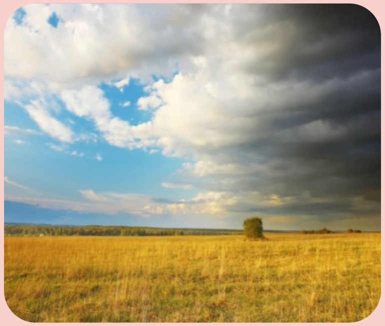
Goals of GGOS-PL++

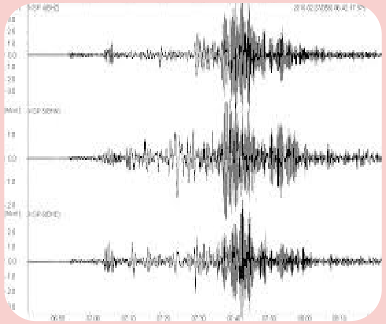
Currently, GGOS-PL infrastructure mainly provides geometric (surface) observations, which are realized through a network of GNSS stations and one SLR laser station. This solution has two major drawbacks: (1) there is no direct linkage of surface processes with geodynamic / geophysical processes under the surface, (2) GNSS geometry provides information on the effects of displacement but does not provide information on their sources. Only integration of precise geometric observations (made by the GNSS technique) with geophysical data (gravimeters, seismometers) allows for a full causal analysis of the geodynamic phenomena and provides the appropriate spatial reference systems.

The goal of this task is to expand the existing GGOS-PL infrastructure to provide accurate, homogeneous, quickly accessible and reliable geodetic reference frames by integrating surface deformation (GNSS) and geophysical observations, which only together may fully explain the surface deformations by an analysis of the both: sources and measurable effects of geodynamic processes.

European Funds
Smart Growth
European Union
European Regional Development Fund

GGOS infrastructure





multi-GNSS

Radiometer

Gravimeter

Seismometry

geometry

geophysics

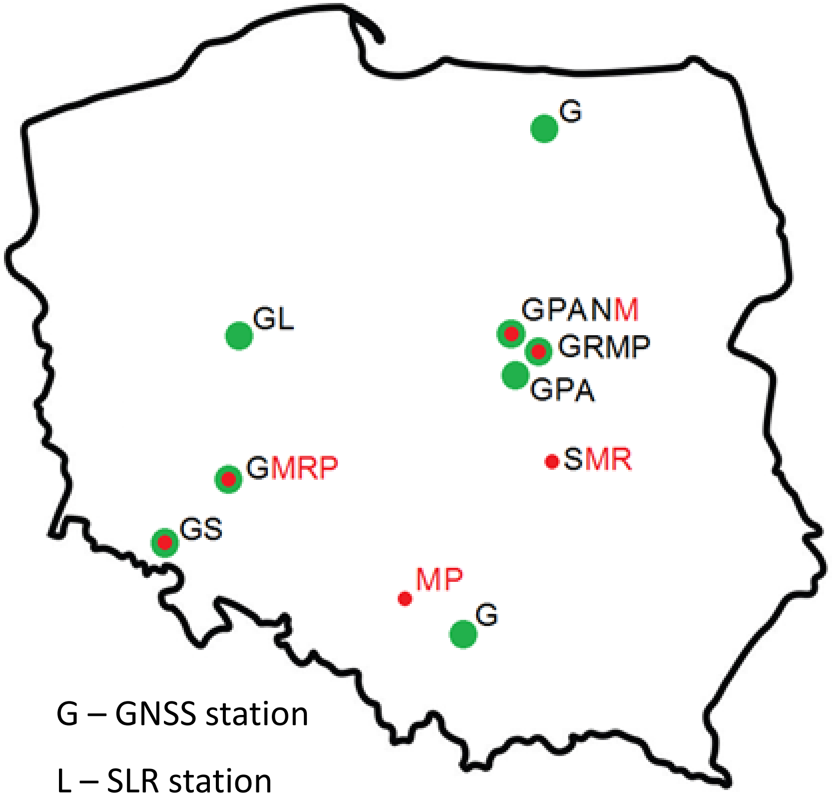
Consequences of surface displacements

Causes of surface displacements

Current status of GGOS infrastructure in Poland

The goal of the GGOS-PL++ will be realized through a network of reference stations equipped with integrated measuring techniques, which include:

- Multi-GNSS stations providing multi-system GNSS (GPS, GLONASS, Galileo, BeiDou) observations that provide homogeneous surface observations (using the same GNSS receivers and antennas)
- Radiometers that support multi-GNSS stations by providing information on tropospheric status and tropospheric delay, which significantly improves the accuracy and reliability of multi-GNSS positions.
- Tidal gravimeters and absolute gravimeter - allowing causal analysis of the observed surface deformation by integrating the GNSS and geophysical observations in the analysis of the dynamics of the earth's crust over large areas.



G – GNSS station

L – SLR station

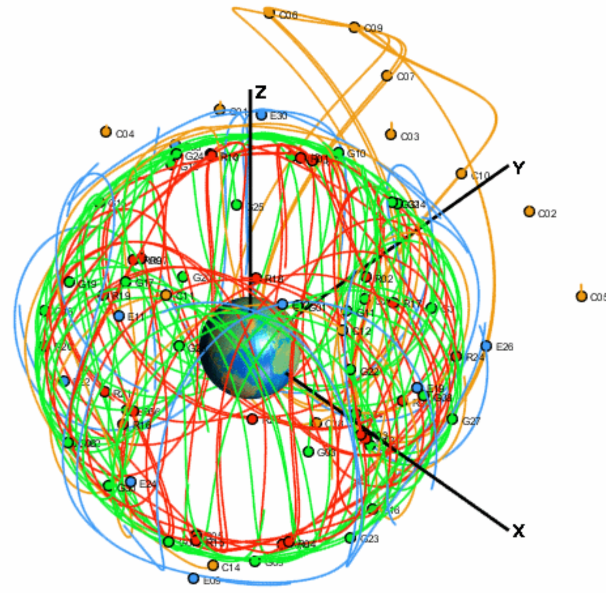
S – Seismometer

A – Absolute gravimeter

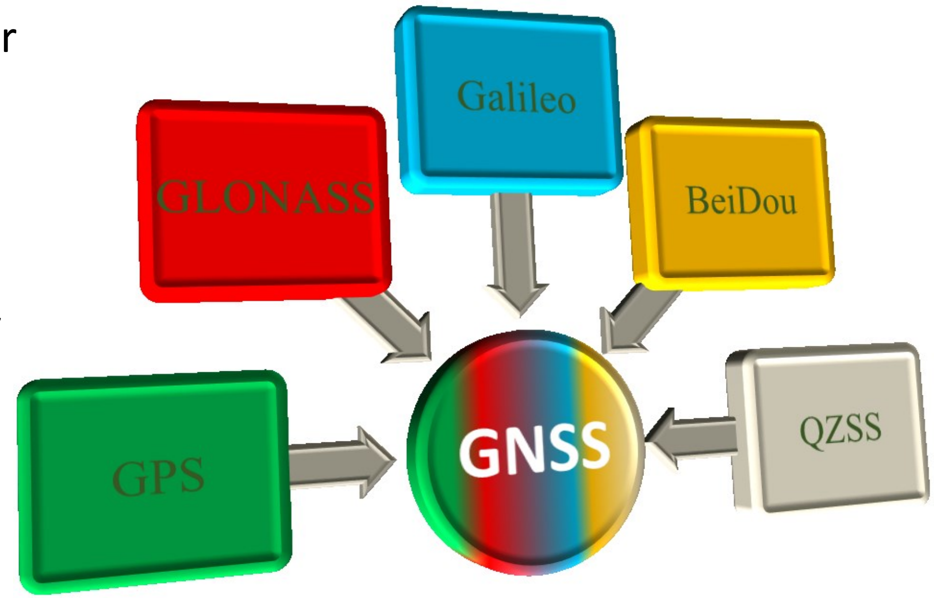
P – Tidal gravimeter

M – 5-system multi-GNSS

Multi-GNSS receivers



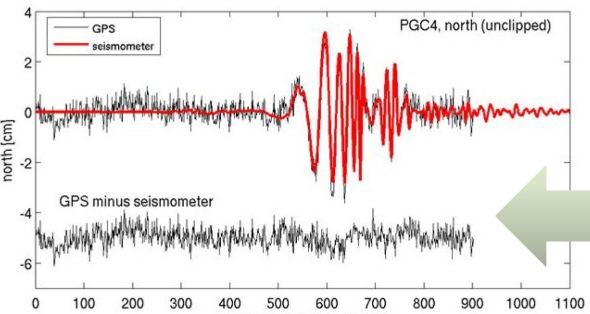
- GNSS tracking: GPS (L1, L2P, L2C, L5); GLONASS (L1, L2P, L2C); Galileo (E1, E5a, E5b, AltBOC); BeiDou (B1, B2); QZSS (L1, L2C, L5); SBAS (WAAS, EGNOS),
- Recording frequency: minimum 10Hz,
- Internal memory (HDD, SDCARD, etc.) allowing recording of minimum 48 hours of data at 10Hz interval.
- Simultaneous transmission of streams (10Hz for observations): minimum 2 x RTCM 3.x or 2 x manufacturer's own format (+ real-time decoder), 1 x NMEA.
- GNSS Antenna: having the absolute IGS calibration parameters (igs08.atx) or individually calibrated for GPS + GLONASS minimum, supporting all tracked signals,
- Software to convert streams and files to RINEX 2.11 and RINEX 3.1 or later.



Multi-GNSS co-location

Radiometers

External frequency standards

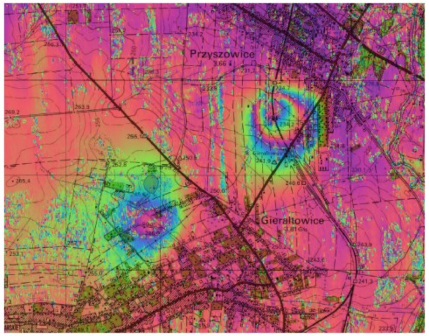


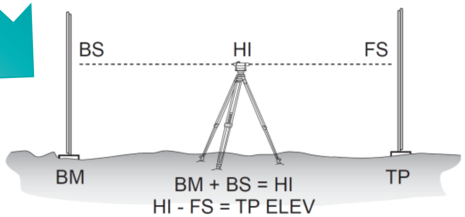
Seismometer

Multi-GNSS receivers

Tidal gravimeters

InSAR





Precise leveling

European Funds
Smart Growth
European Union
European Regional Development Fund
epos pl

Summary

New GGOS infrastructure in Poland for monitoring industrial areas:

- tidal gravimeters – 2+1 pcs.,
- 10 Hz multi-GNSS state-of-the-art reference receivers - ~4 pcs. with the time synchronization for min. 1 receiver,
- 10 Hz multi-GNSS receivers - ~5 pcs. for monitoring surface displacements,
- radiometers - 2 pcs,

Co-location of 10 Hz multi-GNSS receivers with:

- Seismometers (detecting of Earthquakes),
- InSAR reflectors (detecting of long-term displacements),
- Inclinometers,
- Gravimeters,
- Time frequcency standards (atomic clocks).

EPOS – European Plate Observing System

Thank you for your attention

European Funds
Smart Growth

European Union
European Regional
Development Fund