

8.WPGI2024

Monitoring deformacji pogórnich z wykorzystaniem reflektorów radarowych i InSAR na przykładzie Kłodawy, Konina i Wapna

*Monitoring of post-mining deformations
using corner reflectors and InSAR on the
example of Kłodawa, Konin and Wapno
areas*

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Państwowy Instytut Badawczy

ABOUT
THE PROJECT



STUDY AREAS



FINAL
REMARKS



METHODS



RESULTS



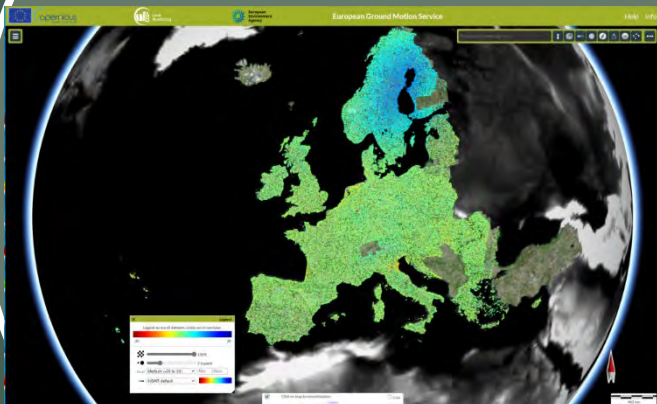
TEREN
KWB „KONIN”
WSTĘP
OZBRONIONY!

ABOUT THE PROJECT



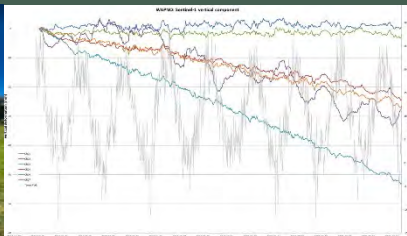
Interferometric Monitoring of the Surface of Poland (InMoTeP)

<https://www.pgi.gov.pl/monitoring-osiadan/o-projeckie.html>

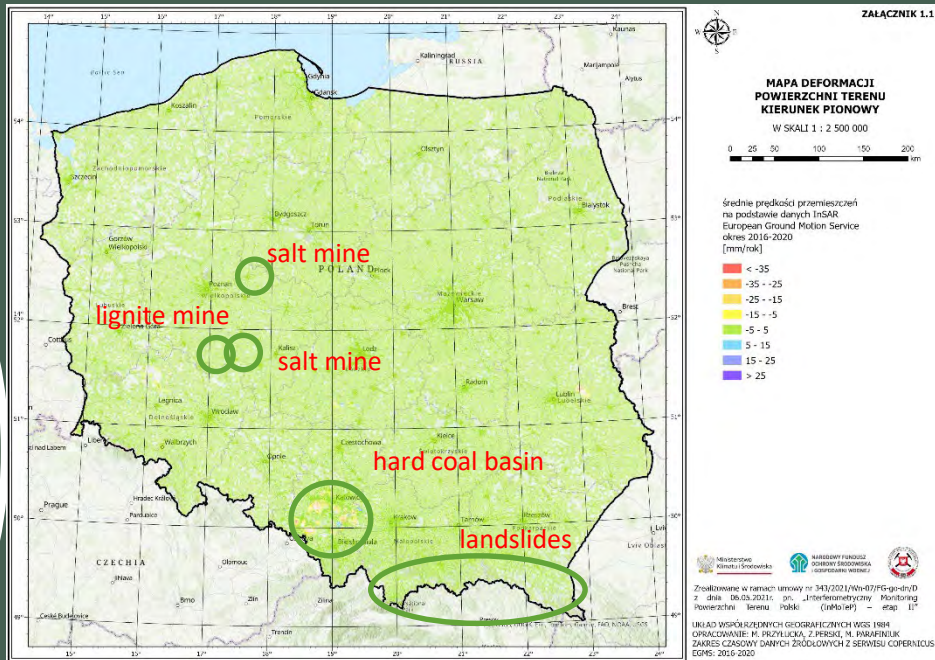


From European Ground Motion Service...

Detailed analysis of key areas with **corner reflectors**, exhaustive displacement characteristics and comparison with other data

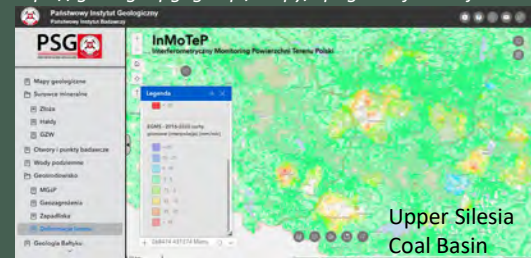


TIME SERIES



...To raster WMS of Poland @ PGI geoportal

<https://geologia.pgi.gov.pl/mapy/?page=Deformacje-terenu>



Upper Silesia Coal Basin



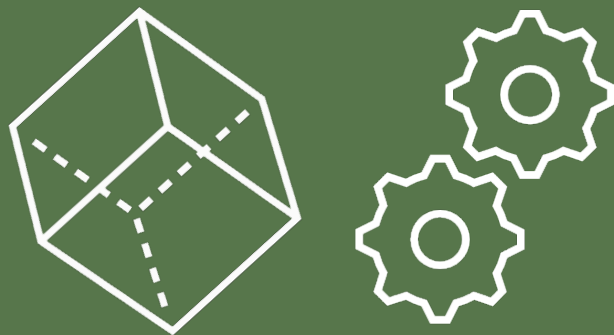
wpgi.pgi.gov.pl

pgi.gov.pl



METHODS

Corner Reflector InSAR



THE REAL THING



InSAR

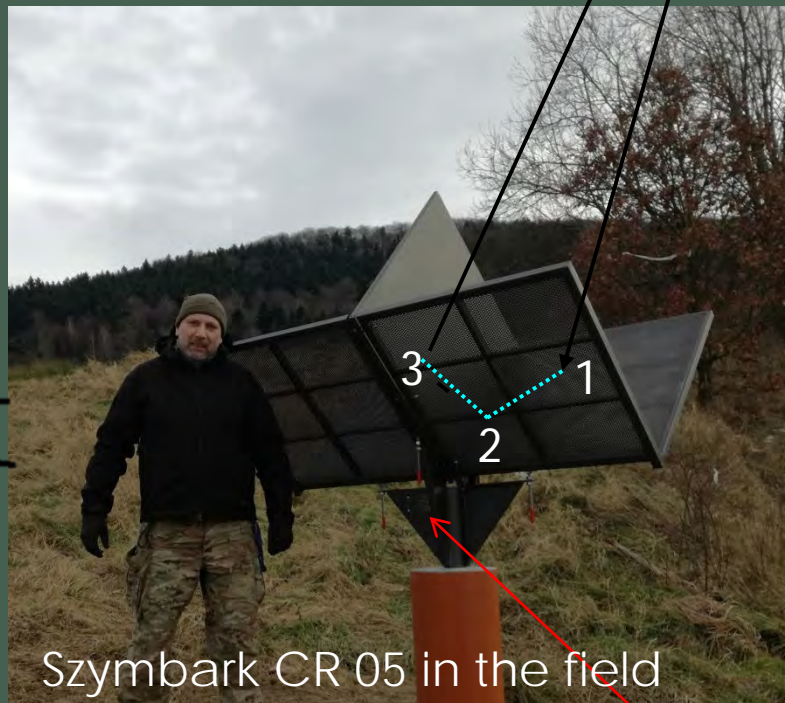
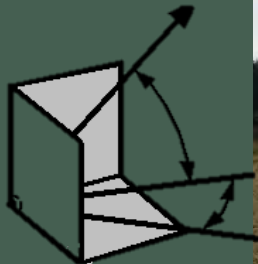
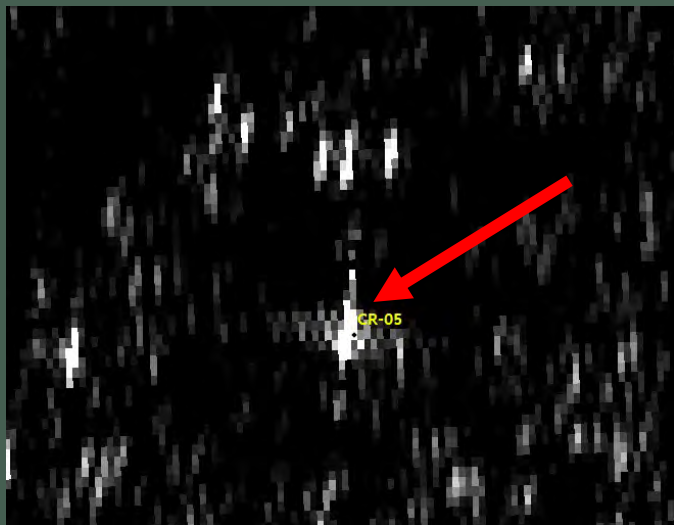


InSAR <-> GNSS
validation



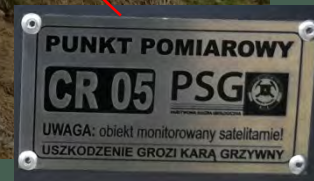
THE REAL THING

We know exactly from where the radar reflection come from!



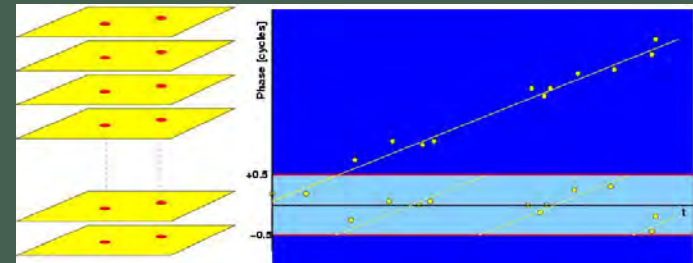
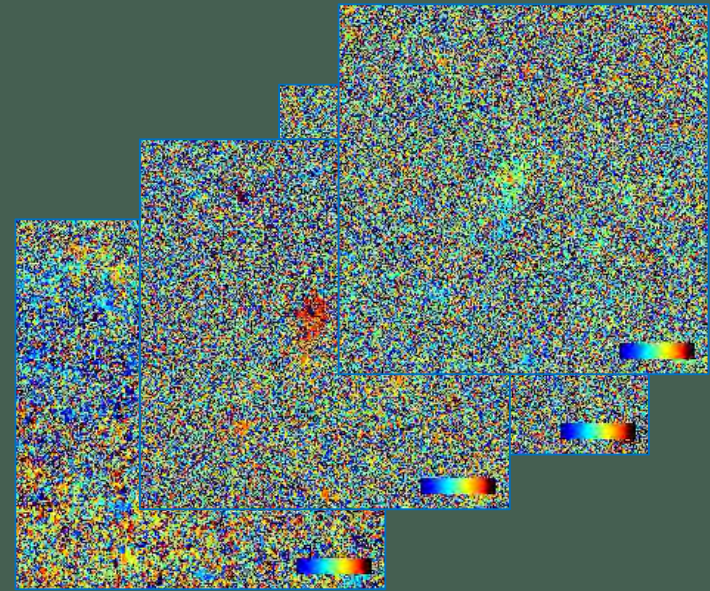
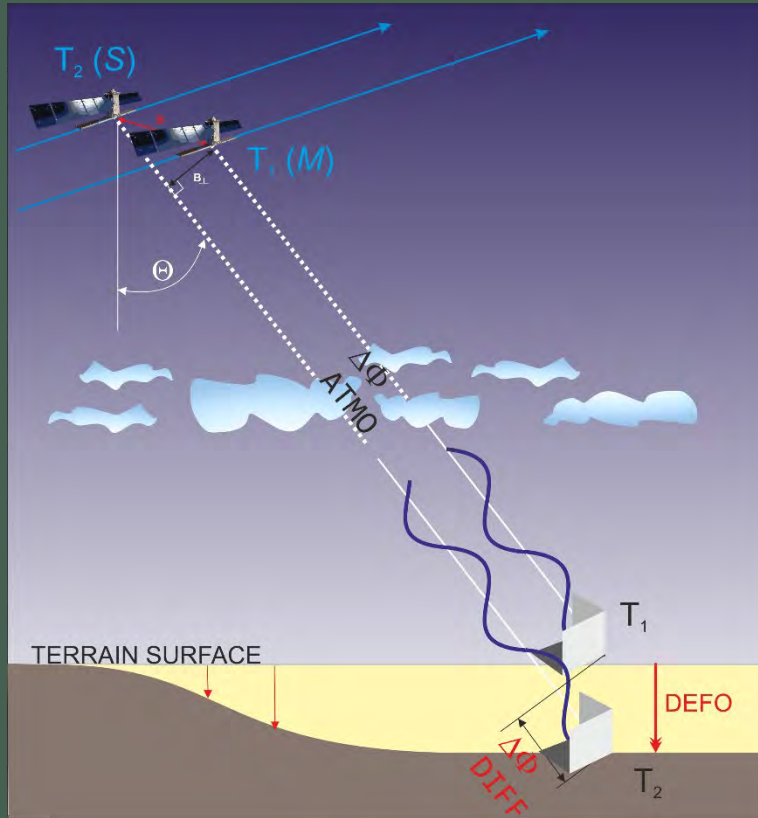
Symbark CR 05 in the field

Symbark CR 05 – SAR amplitude S1



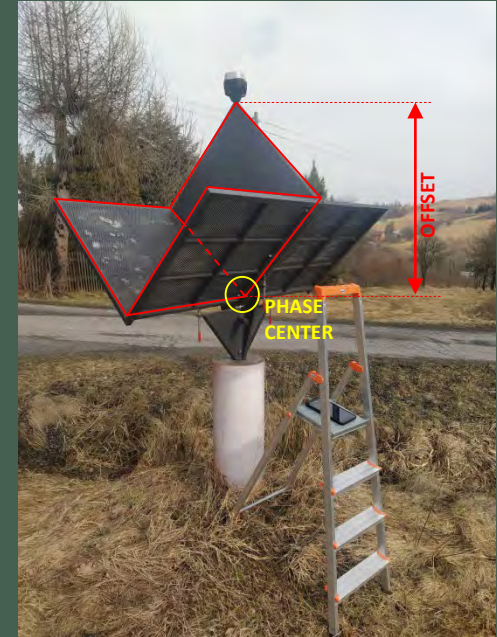
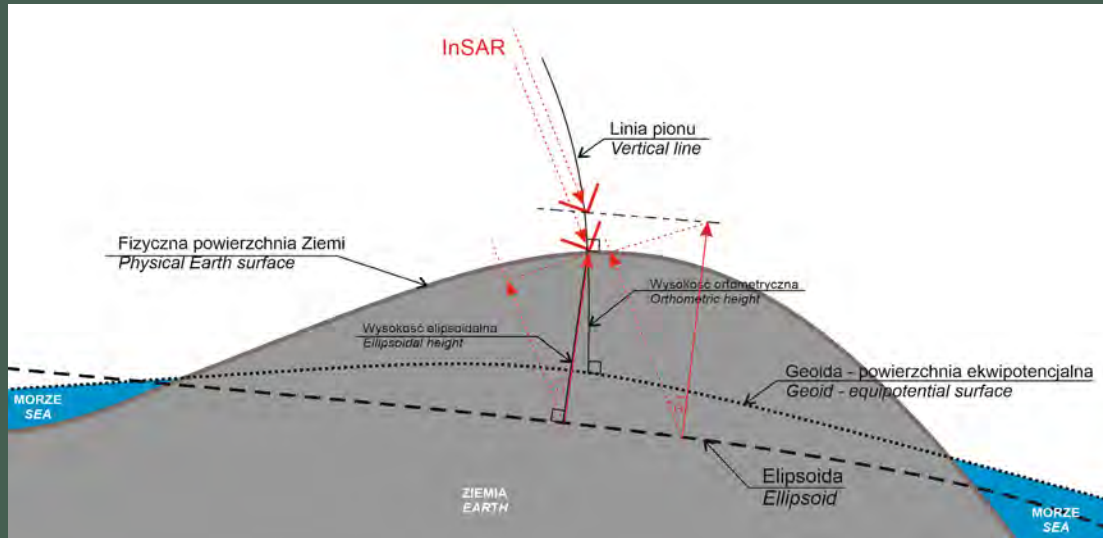
InSAR

SAR Interferometry



InSAR <-> GNSS validation

Leveling, GNSS, CRInSAR are measuring different things!



STUDY AREAS



OPEN PIT MINES

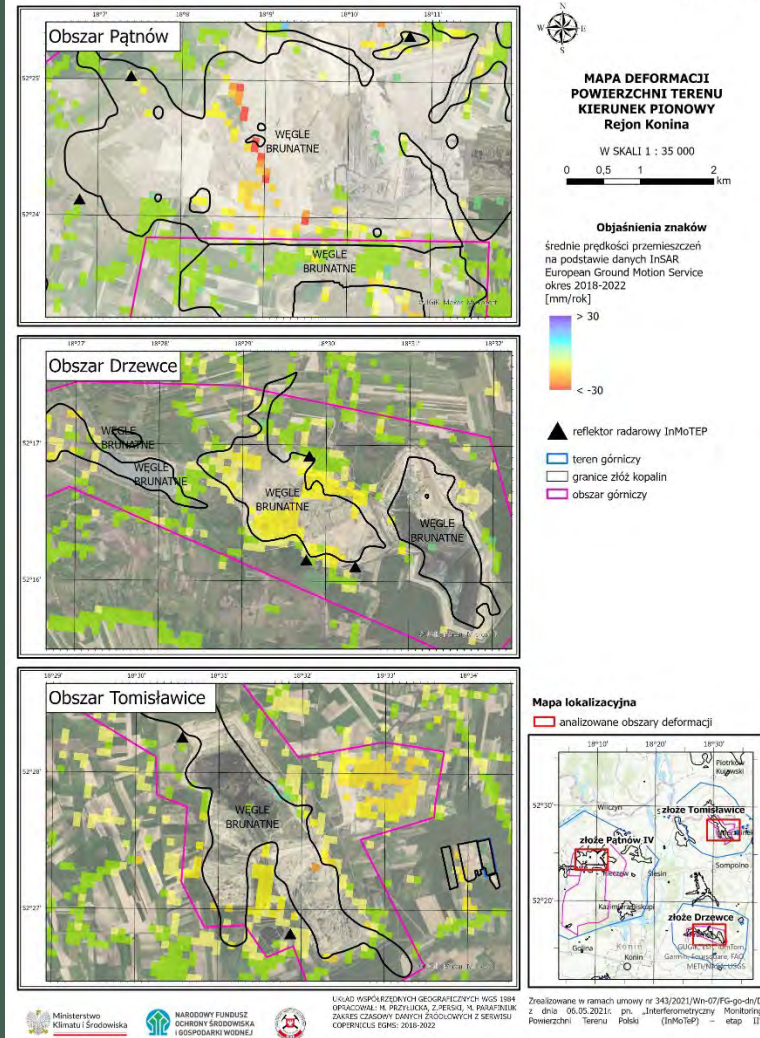


UNDERGROUND MINES



Post mining areas


AREA	RAW MATERIAL	MINING	STATUS	PROBLEMS
KONIN	brown coal	Open pit	Operational / closed	Subsidence / uplift due to drainage



RESULTS

CRInSAR DD processing

Double Differences

- W.r.t. time (1st SAR scene)
- W.r.t. reference CR 

CRInSAR decomposition

LoS =>> 3D

Sentinel-1A/B SAR data

2 x asc + 2 x dsc

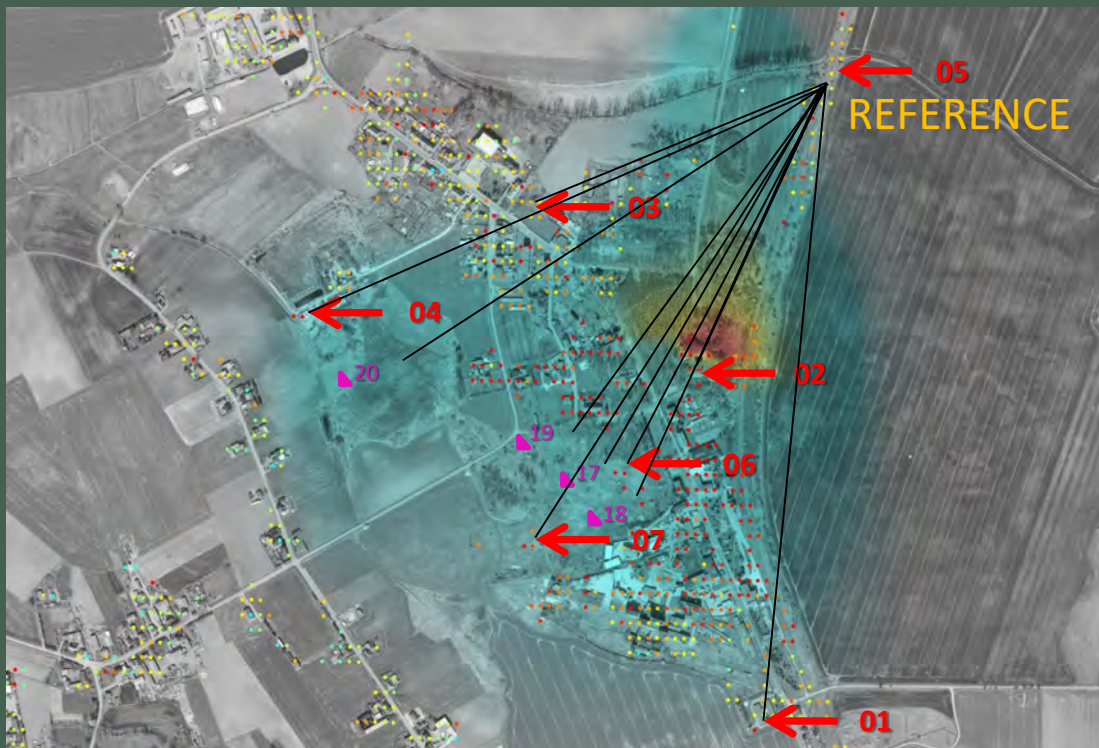
**OPEN PIT
MINES**

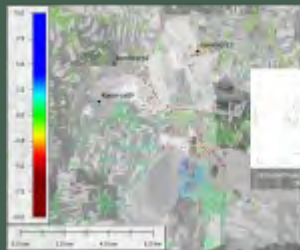


**UNDERGROUND
MINES**

Data analysis:

- ✓ Only **vertical** component!
- ✓ **Visual**: plot comparisons & analysis
- ✓ **Numerical**: time series analysis (ongoing – **longer TS required!**)

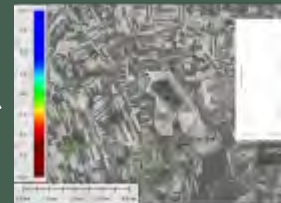




Pątnów



Prezentacja danych z dnia 2024-08-20 10:00:00 (czas lokalny) dla obszaru wokół Pątnowa. Dane pochodzą z sieci pomiarowej GNSS.



Tomislawice



Prezentacja danych z dnia 2024-08-20 10:00:00 (czas lokalny) dla obszaru wokół Tomislawicy. Dane pochodzą z sieci pomiarowej GNSS.

OPEN PIT MINES KONIN



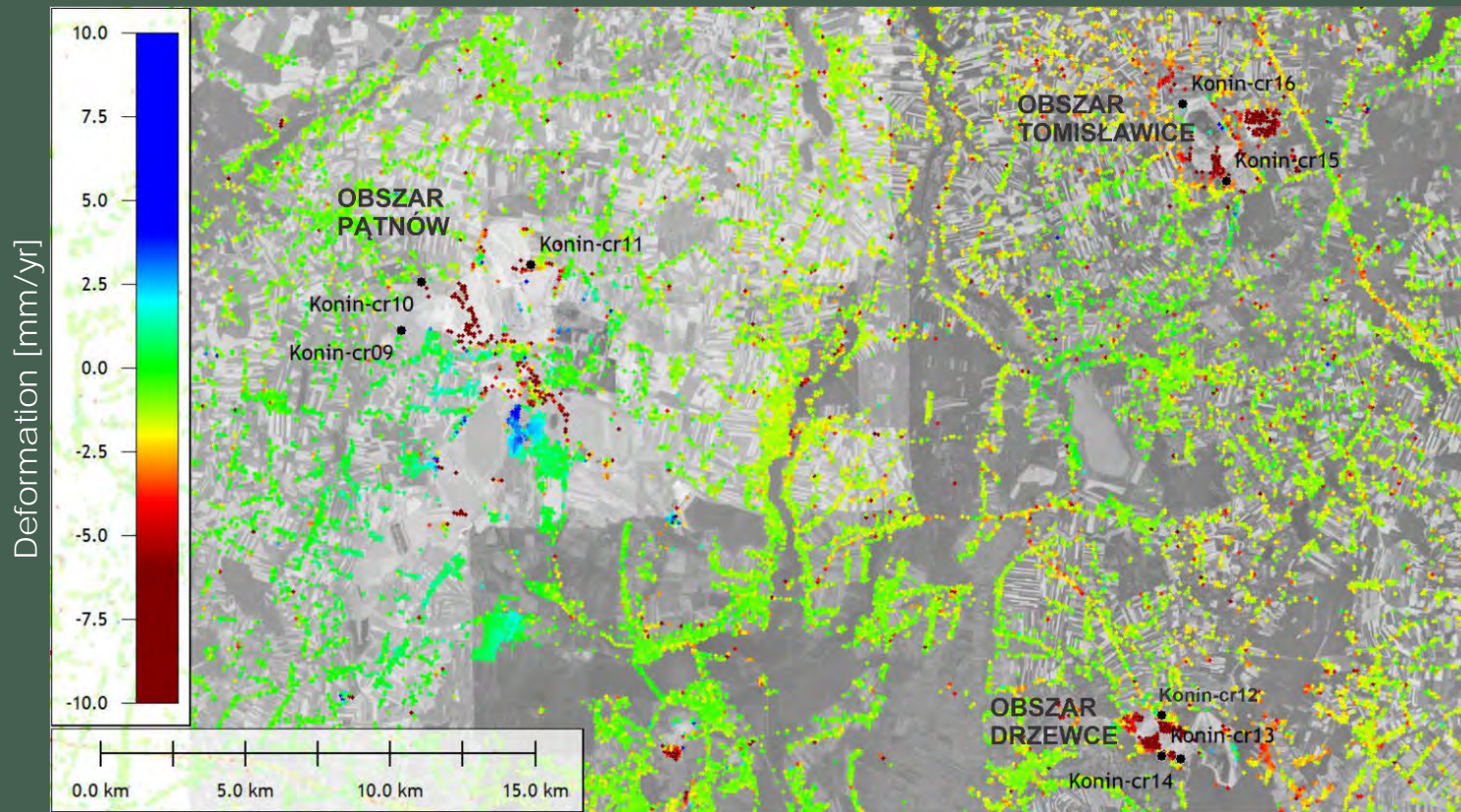
EGMS data and locations of CRs



Drzewce

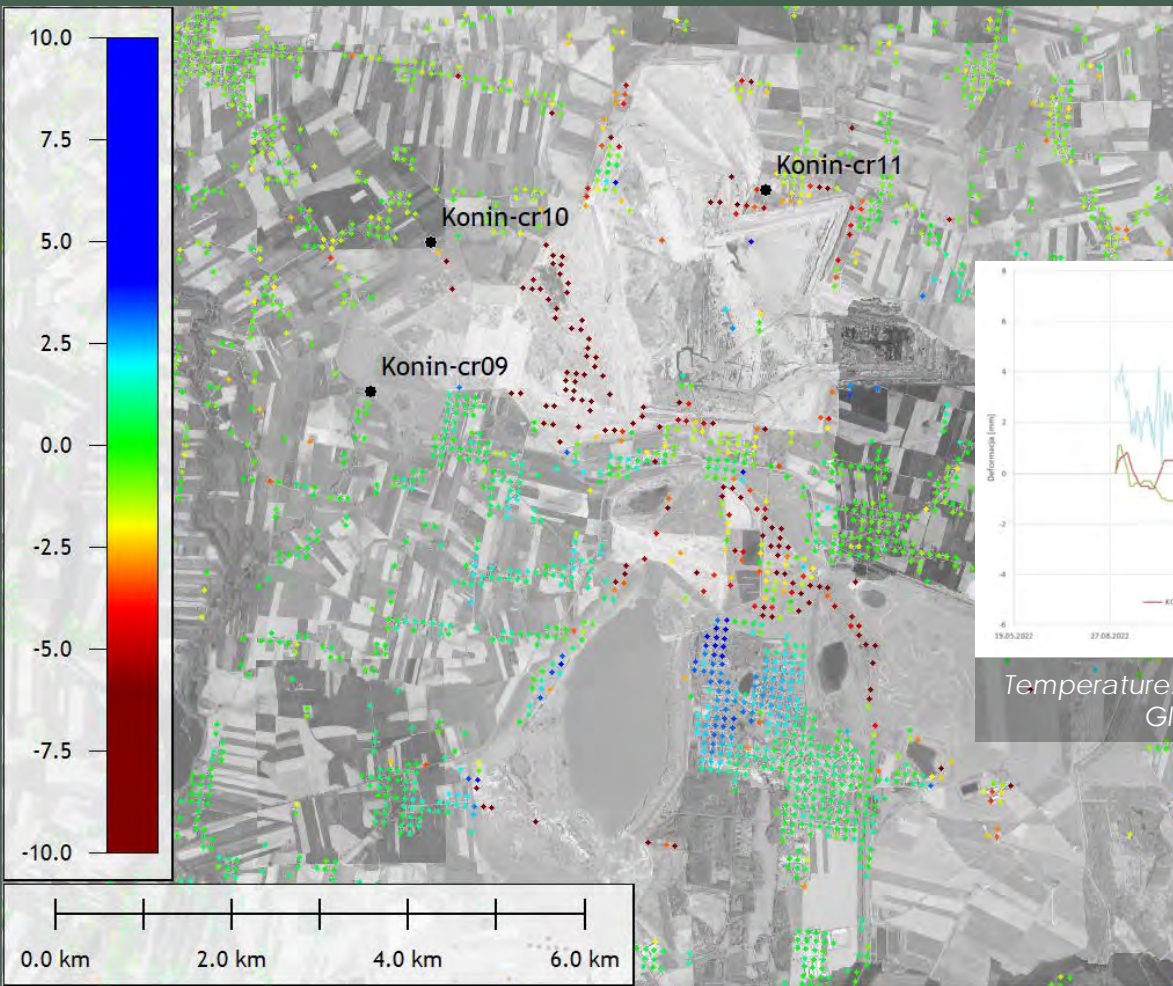


Prezentacja danych z dnia 2024-08-20 10:00:00 (czas lokalny) dla obszaru wokół Drzewca. Dane pochodzą z sieci pomiarowej GNSS.



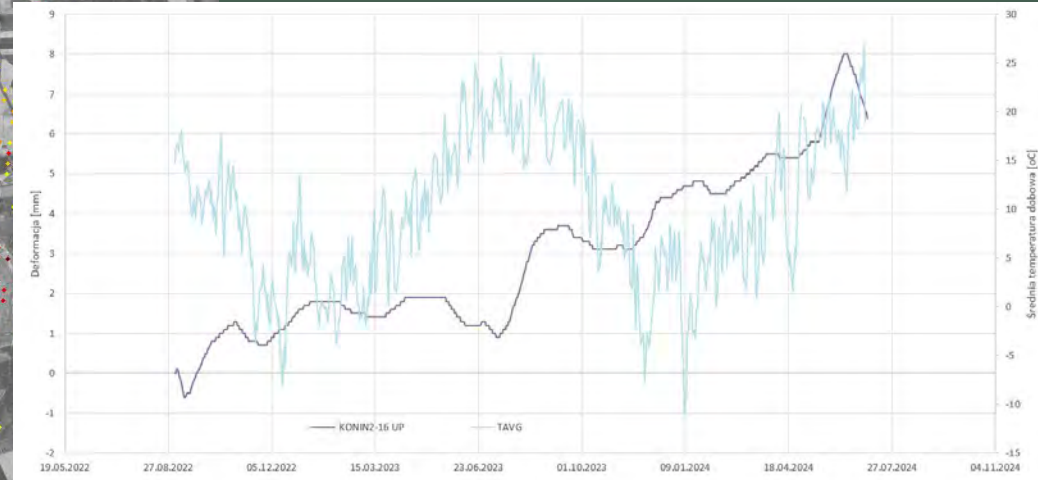
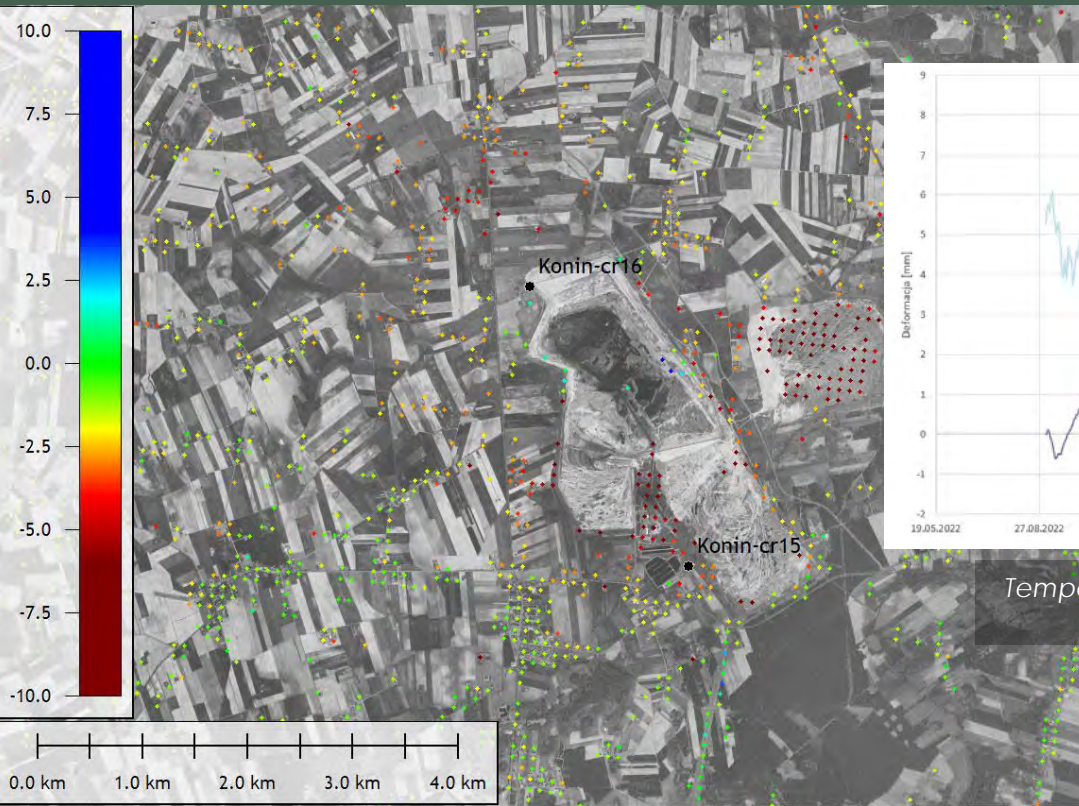
EGMS data and locations of CRs

Państwo



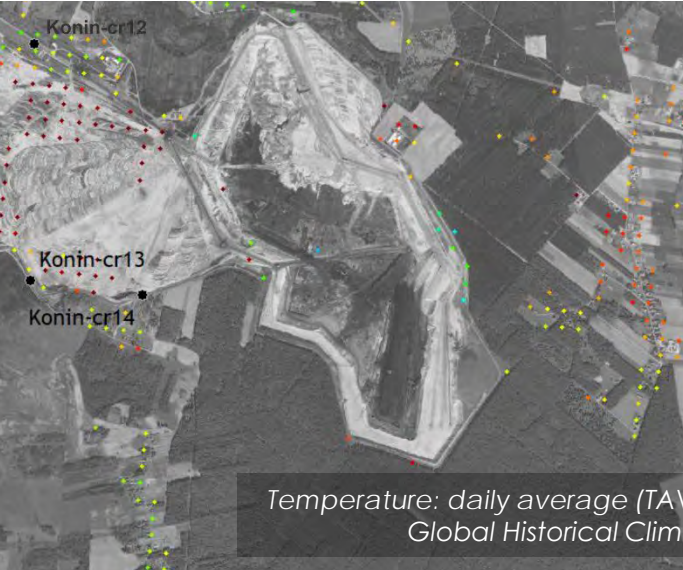
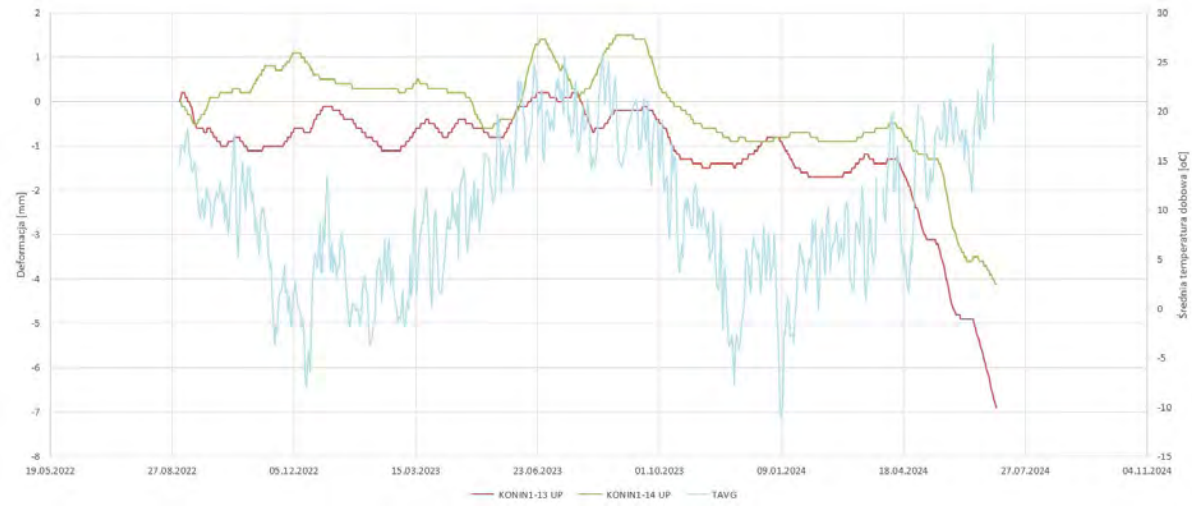
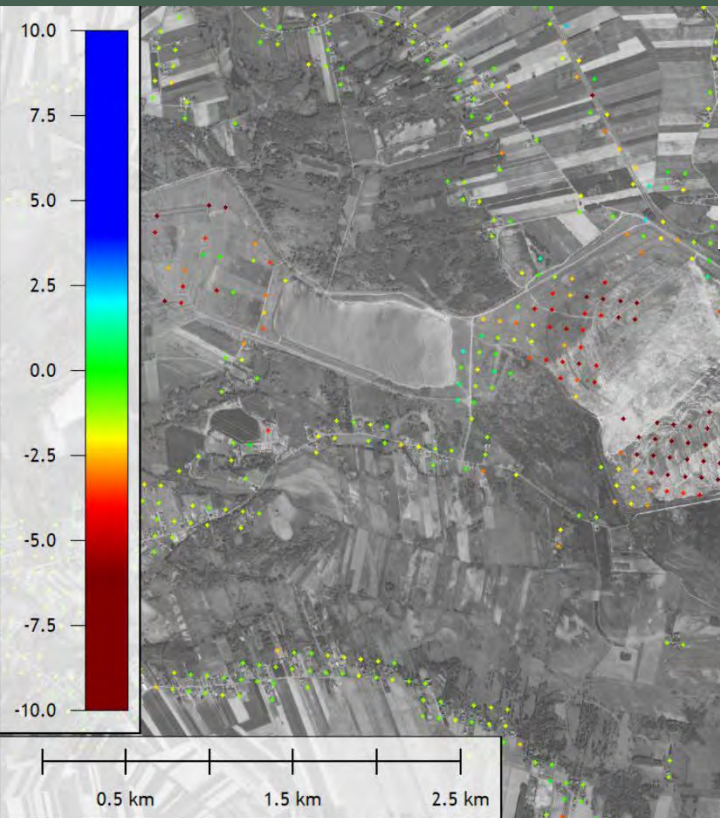
Temperature: daily average (TAVG) data from Poznań Ławica airport
Global Historical Climatology Network (GHCN) - noaa.gov

Tomisławice



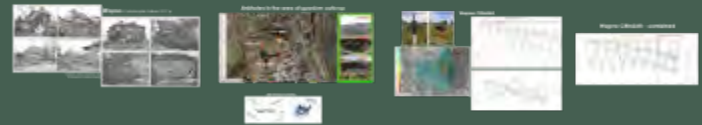
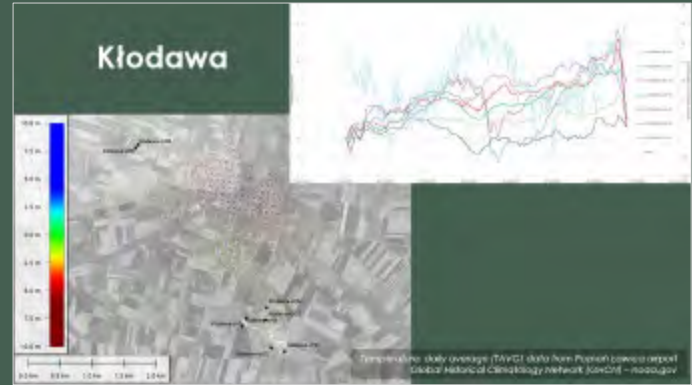
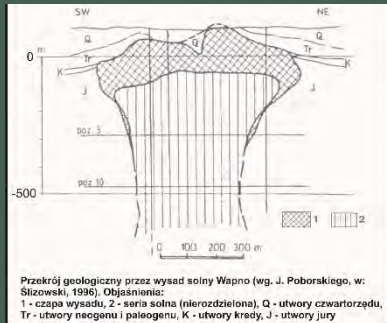
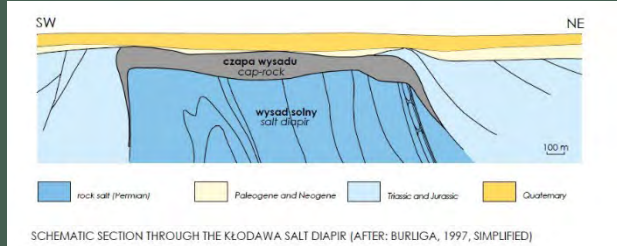
Temperature: daily average (TAVG) data from Poznań Ławica airport
Global Historical Climatology Network (GHCN) - noaa.gov

Drzewce

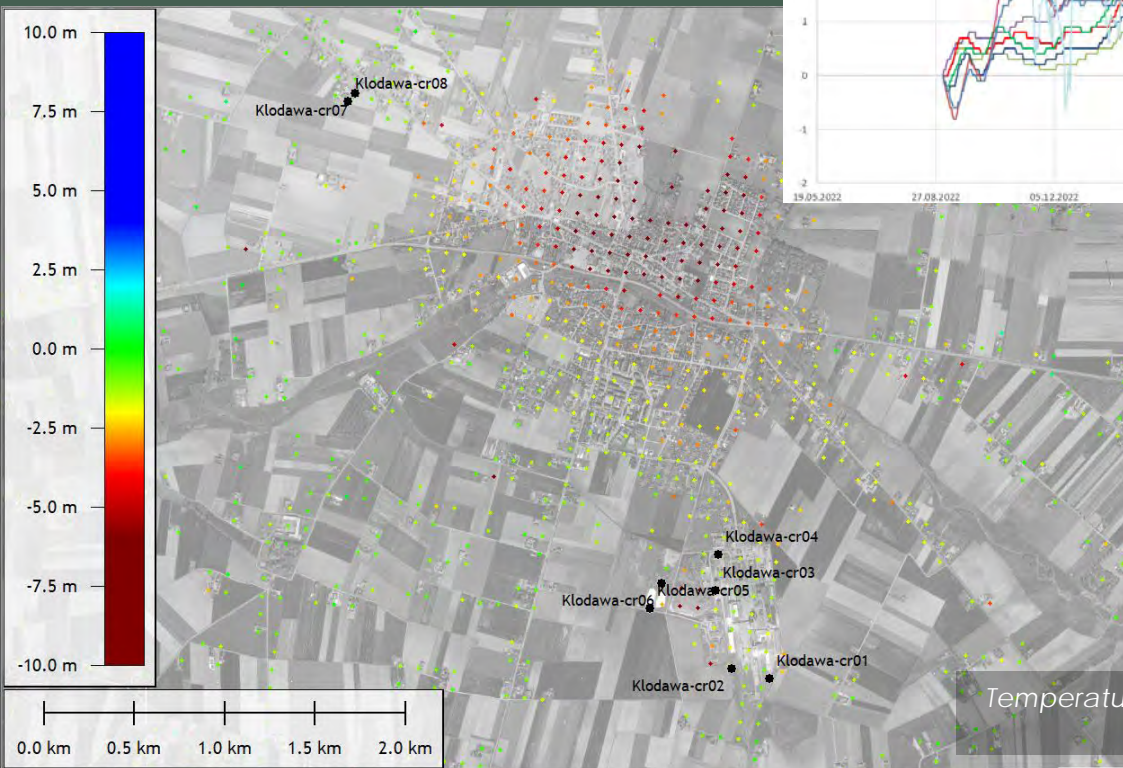


Temperature: daily average (TAVG) data from Poznań Ławica airport
Global Historical Climatology Network (GHCN) – noaa.gov

UNDERGROUND SALT MINES

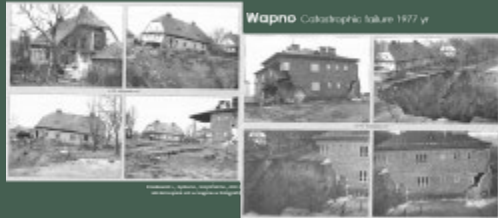


Kłodawa



Temperature: daily average (TAVG) data from Poznań Ławica airport
Global Historical Climatology Network (GHCN) – noaa.gov

Wapno



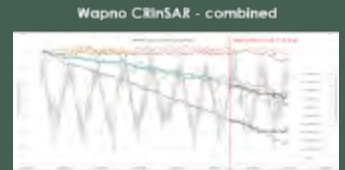
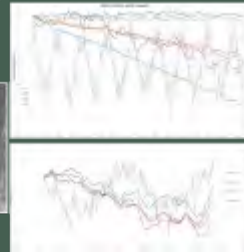
Wapno Ciekostopnia: katastrofa: rok 1977 yr



Sinkholes in the area of gypsium outcrop



Wapno CRIInSAR



Wapno CRIInSAR - combined

Wapno Catastrophic failure 1977 yr



ul. Obr. Stalingrada nr 6.8

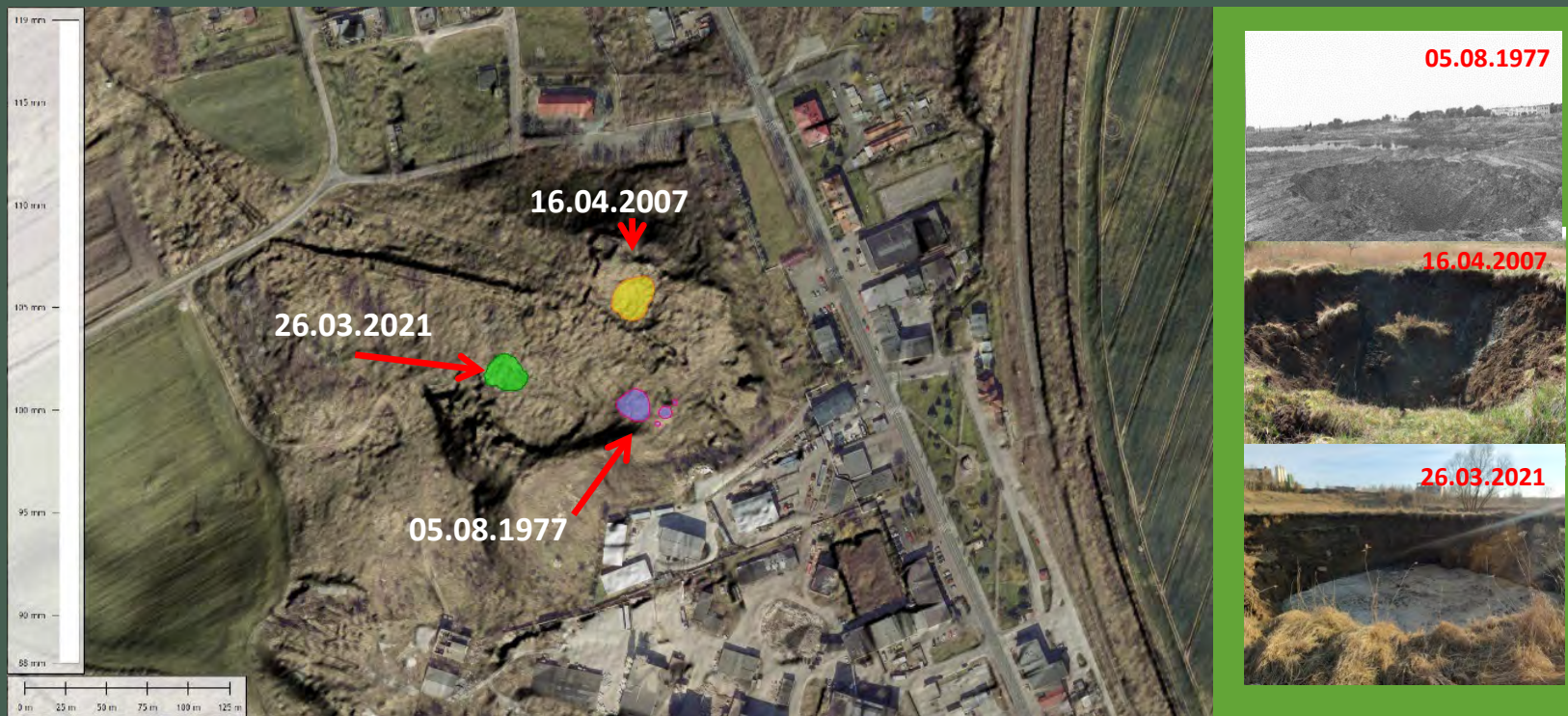


ul. Obr. Stalingrada nr 9

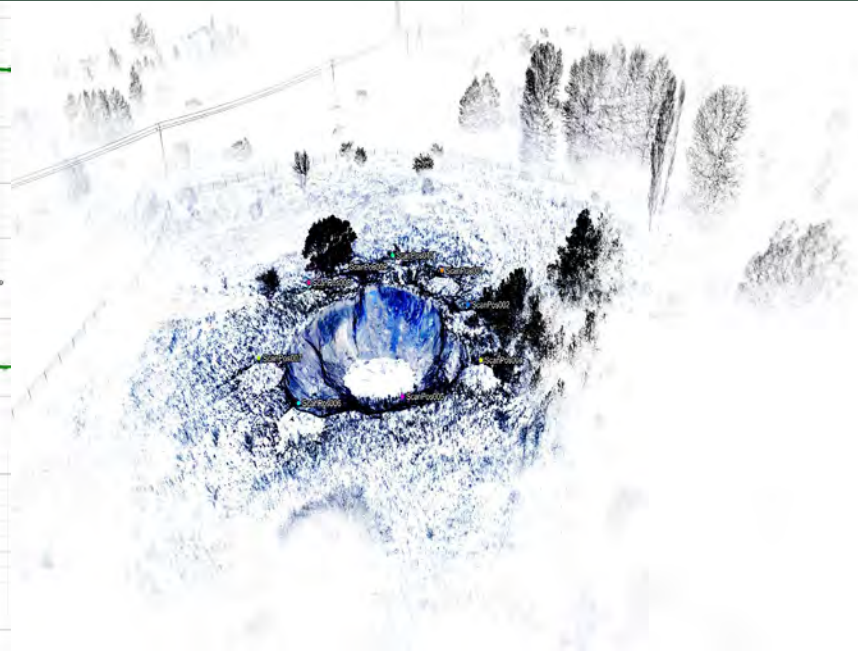
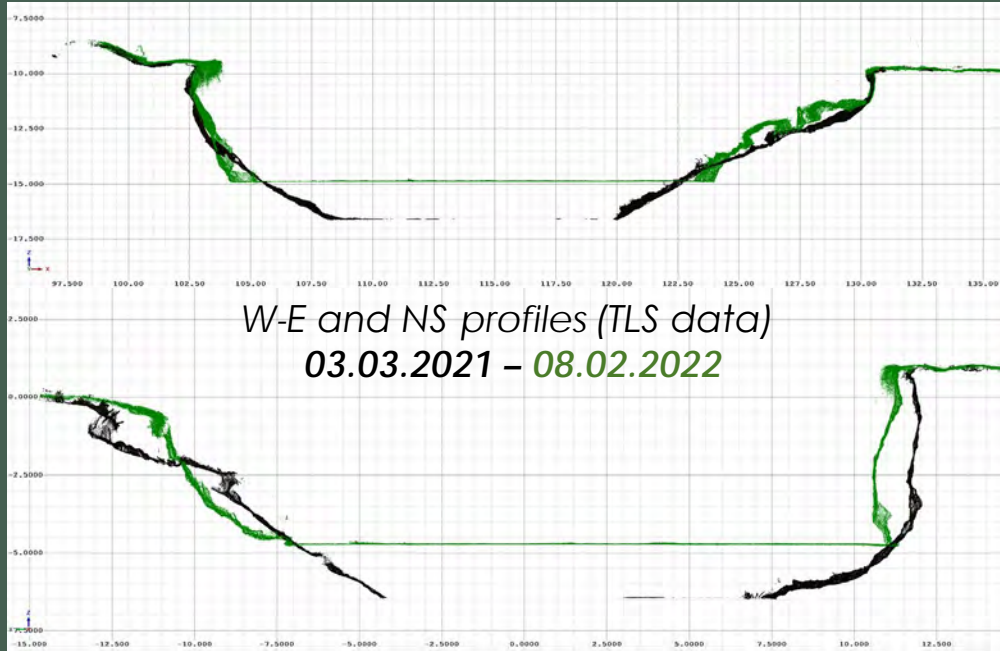


Przesławski L., Ryska M., Wojciński M., 2011
100 lat kopalni soli w Wapnie w fotografii

Sinkholes in the area of gypsum outcrop



2021 Sinkhole monitoring



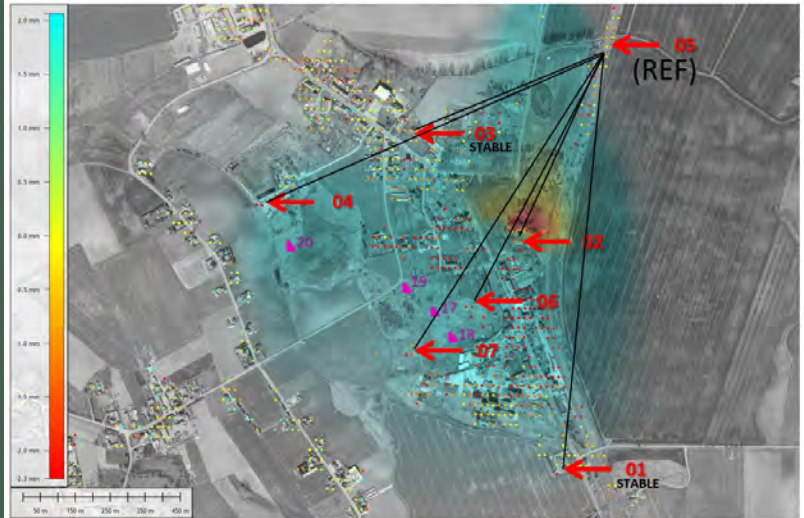
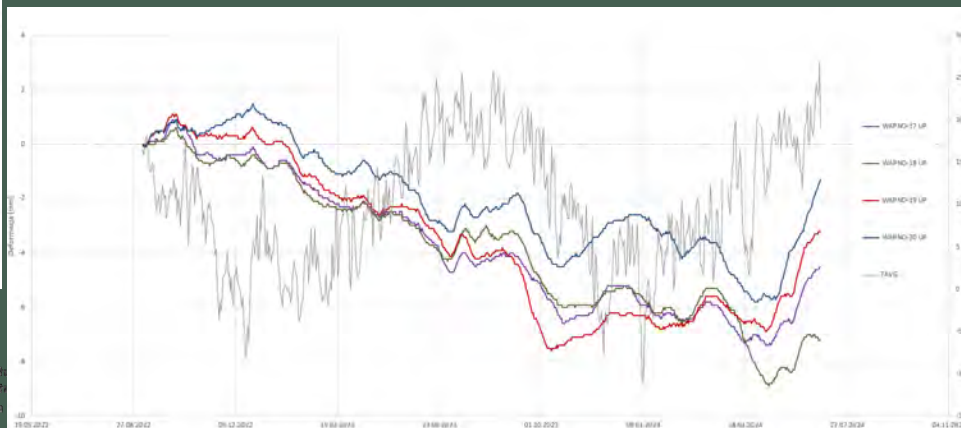
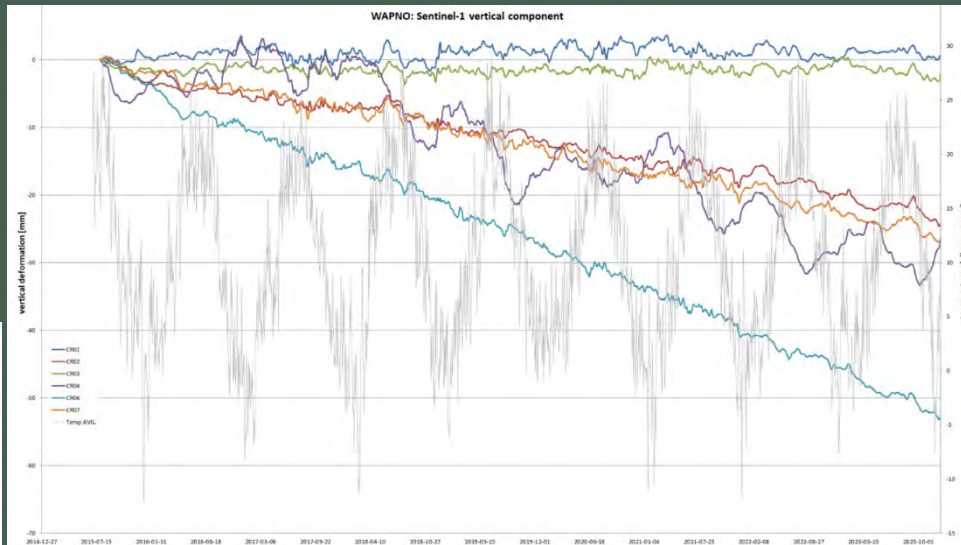
CR-01...07 Instalacja w 2015 r.



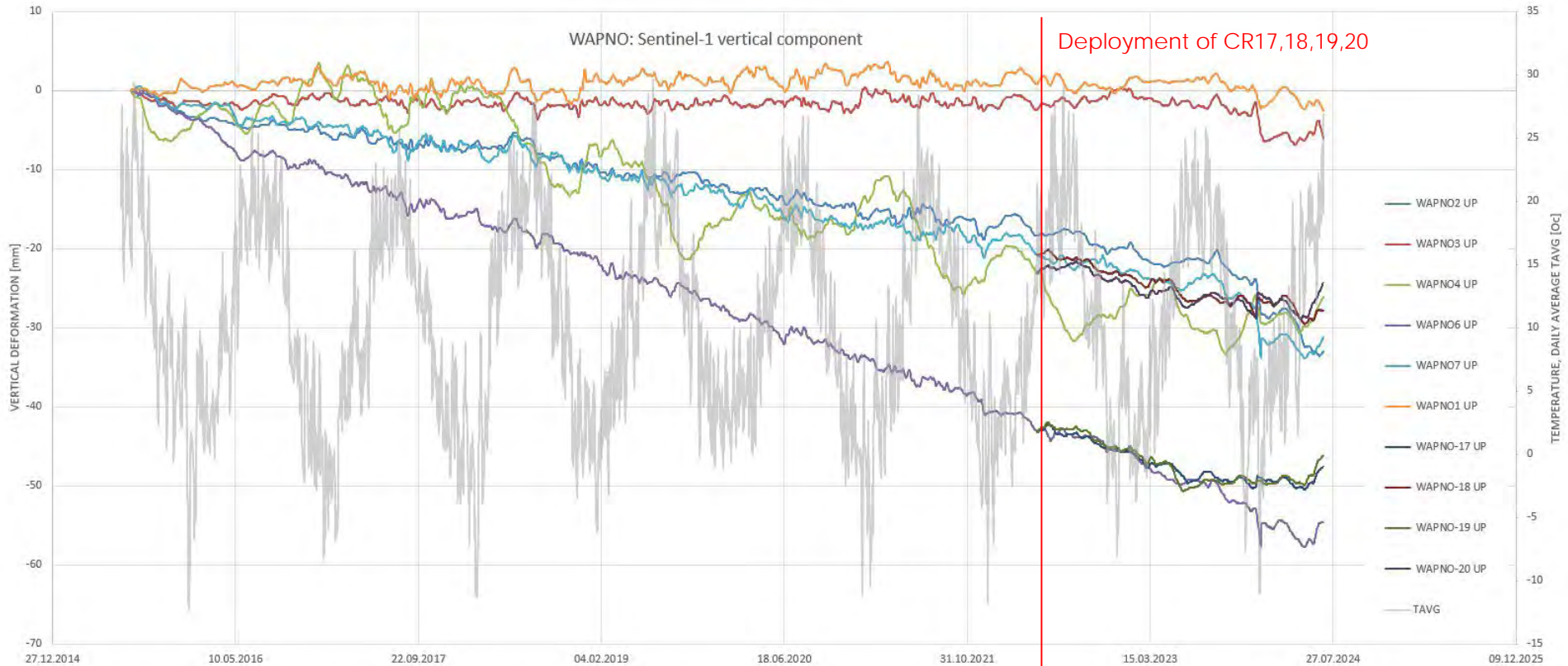
CR-17...20 Instalacja w 2022 r.



Wapno CRInSAR

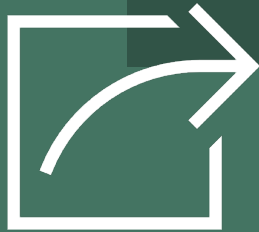


Wapno CRInSAR - combined



FINAL REMARKS

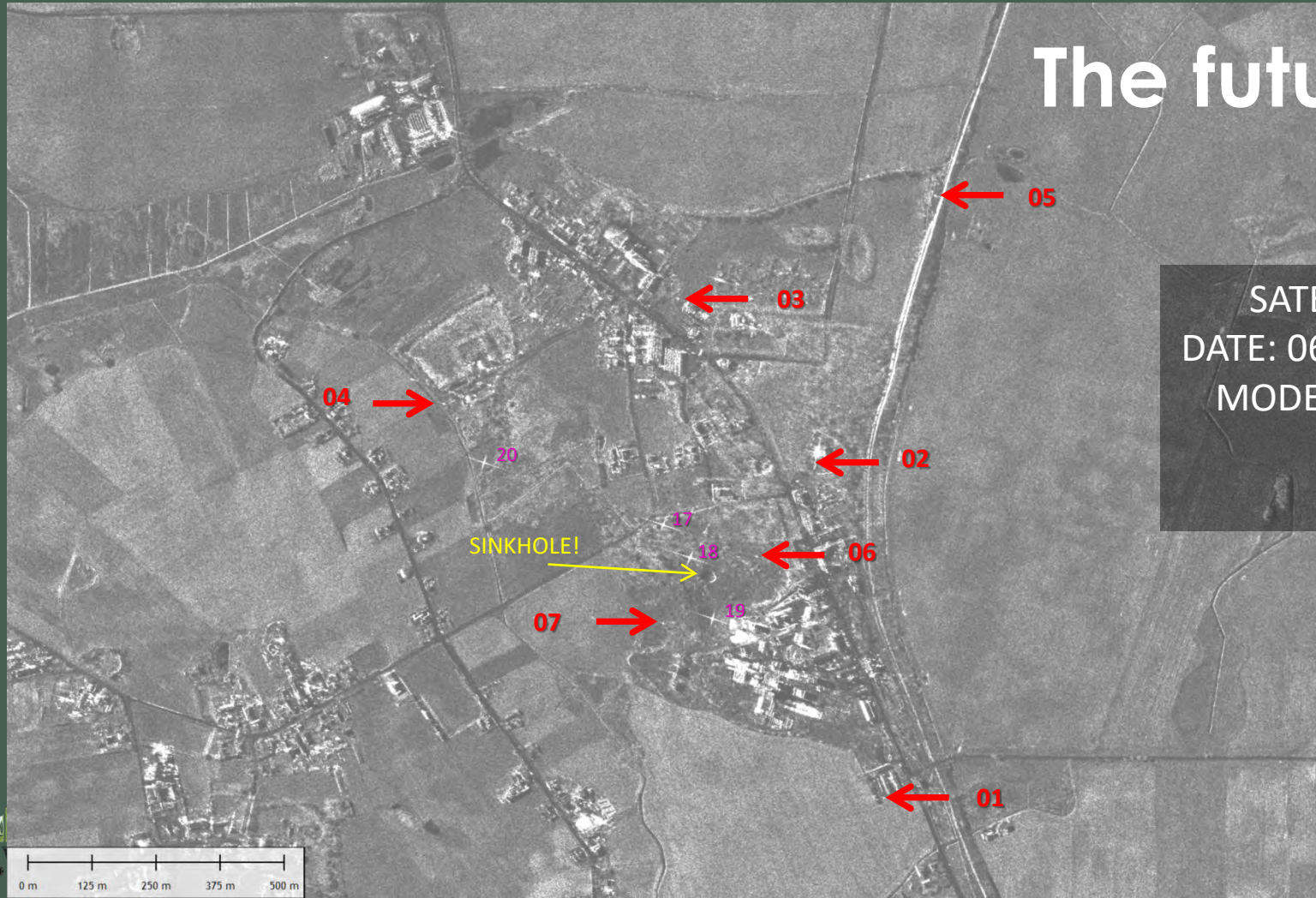
- CR InSAR displacements – temporal sampling high enough to be comparable with hydrological/hydrogeological data
- Seasonal effects correlated with temperature, ground water level (WAPNO CR04, CR20)
- Need for the installation of limnimeters in piezometric boreholes (WAPNO)
- Need for installation of rain gauge (WAPNO)
- To draw any conclusion – long time series (> 5 years) are required!



- **CRInSAR** – good source of data for better understanding of deformation phenomena
- Scientific application only, **not for a warning systems!**

The future...

SATELLITE: ICEYE X8
DATE: 06.12.2023 11:47
MODE: Spotlight High
PRODUCT: SLC
PIXEL: 80 cm



SINKHOLE!

0 m 125 m 250 m 375 m 500 m

8.WP G I 2024



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państwowa służba geologiczna