

TOWARDS THE GNSS INSAR INTEGRATION IN THE HUNGARIAN GEODETIC INFRASTRUCTURE



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2022: CONSTRAINTS AS MOTIVATION



OUTDATED GEODETIC INFRASTRUCTURE

- height network 40 years old, no chance for re-levelling;
- active GNSS network only partially multi-GNSS;
- Sunspot maximum years approaching;
- good memories of the EUREF2018 InSAR tutorial;

INFRASTRUCTURE RECONSIDERATION - **DO SOMETHING TOTALLY NEW**

- new integrated reference benchmarks - multitude of foreseen applications;
- opportunity to change physical to digital height reference

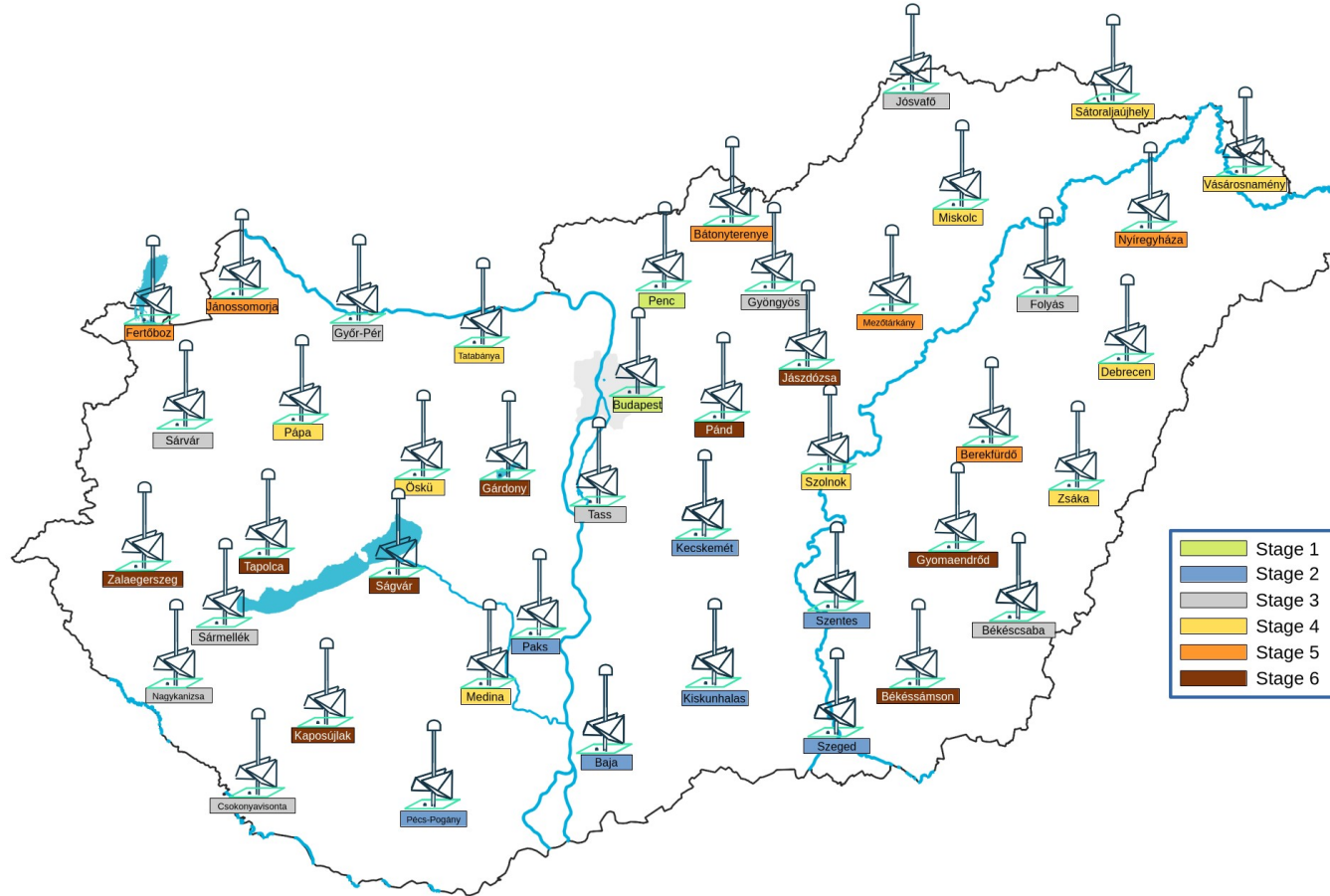


Physical infrastructure: IGRS



- Complete replacement of active stations on buildings;
- 40+ integrated stations → GNSS markers from buildings down to ground - **program finishes 2026**
- Integrated reference markers - CORS+CR
 - Geometric reference: GNSS+InSAR+(HhN)
 - Serve as primary levelling benchmarks
 - **Opportunity for displacement monitoring**
 - Gravimetric reference

INTEGRATED STATIONS AS OF Q4 2026



Digital infrastructure

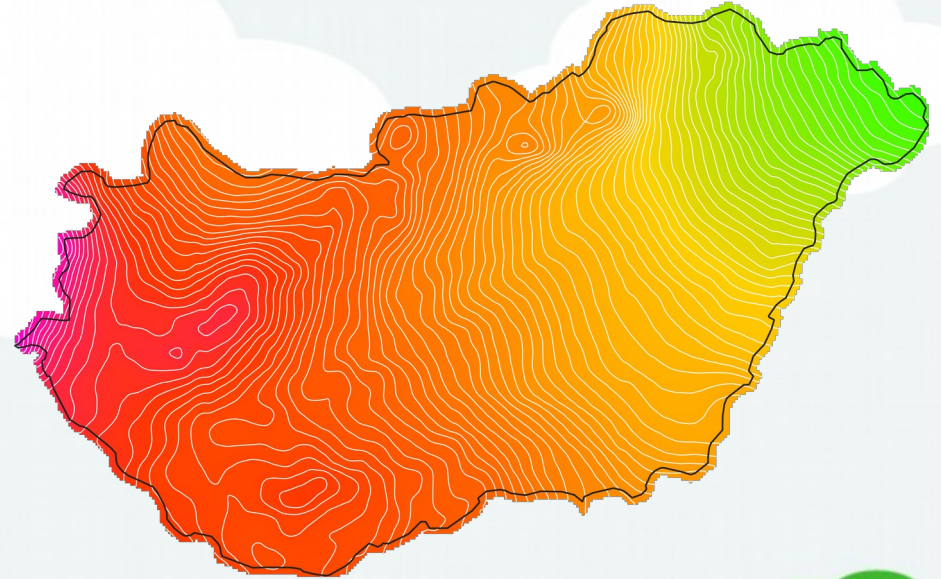


- Static (hardwired) → (semi)-kinematic HRS with given reference epoch from GNSS and InSAR;
- Height reference as a 4D grid holding the ground motion information and used for converting spatial coordinates into local frames;
- Long term opportunity for the regular levelling network maintenance;
 - Revision of the 1st and 2nd order network lines;
 - Regular (annual) network maintenance
- Scientific applications

Built up of the Height Reference Surface

I. - static component

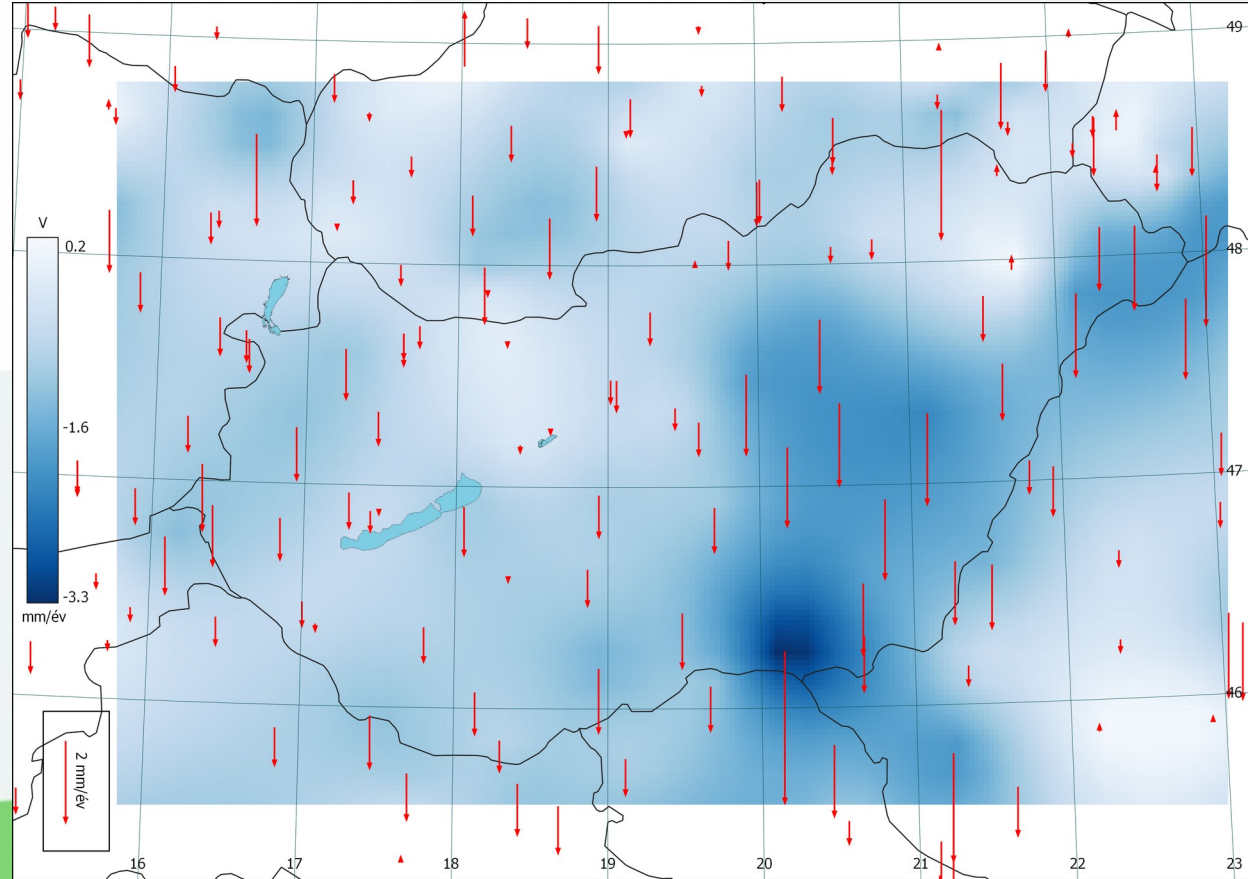
- New gravimetric geoid based on Radial Basis Function approach;
- Integration with existing GPS/leveling data to remove long wavelength biases;
- epoch definition, related to GNSS campaigns.



HRS - GNSS velocity model

Velocity grid based on EPND:
extended LS Collocation with
smoothing, as reference
model for the InSAR analysis

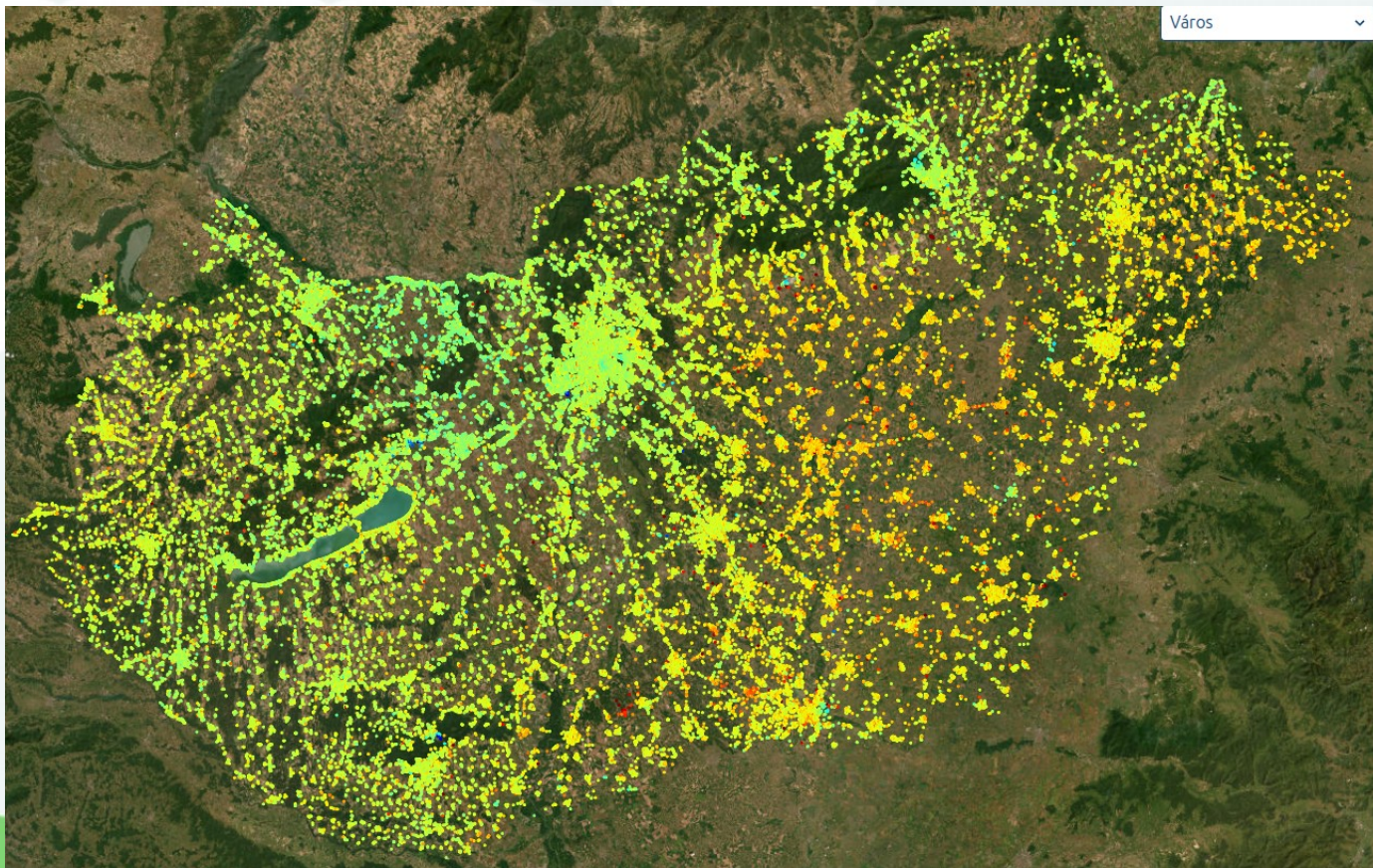
Merged grid serves as the
newly defined time dependent
height reference surface.



HUNGARIAN GROUND MOTION SERVICE



- Interactive web tool for browsing
- Based on Sentinel-1 data from 2016-2022
- EPND as velocity reference

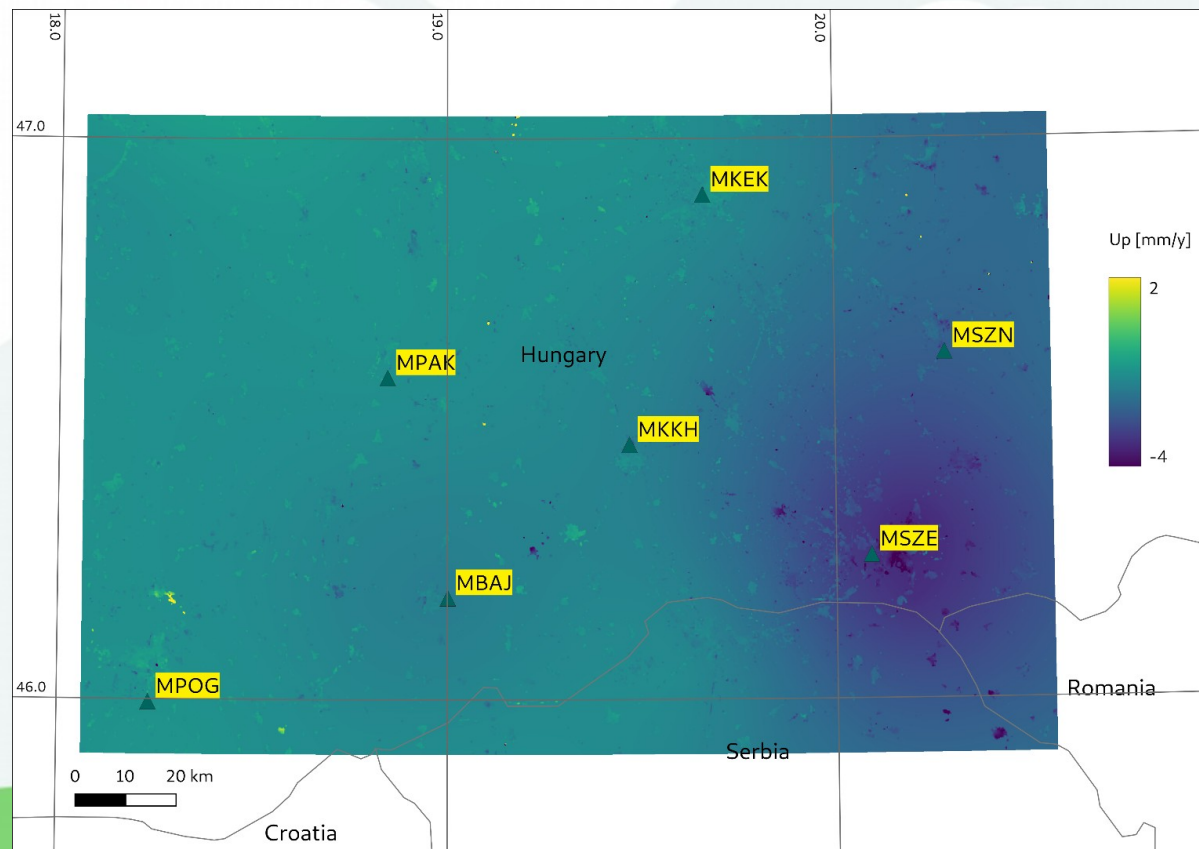


Hybrid height reference

- static part from the geoid
 - epoch dependent component from GNSS/InSAR velocity grid
- $$t_0 + (t - t_0) \times V$$
- t_0 is 2014 from geoid GPS leveling combination

$$H(\text{lev}) = h(\text{ell}) - N(\text{hybridHR})$$

Key: epoch harmonization



SUMMARY

- A resilient, multi-purpose geodetic reference infrastructure had been defined and started to be built, serving RTK positioning, heighting and scientific applications;
- We defined and realized a modernized, space technology-supported height reference system and the option for long term maintenance;
- The solution had been locally tested and its reliability was proved. Implementation is in progress, **beta-test is expected in 2027.**

HAVE NICE SUMMER HOLIDAYS!

