



REPUBLIKA SLOVENIJA
MINISTRSTVO ZA OKOLJE IN PROSTOR

GEODETSKA UPRAVA REPUBLIKE SLOVENIJE



GEODETSKI INŠITUT SLOVENIJE

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Najpomembnejši dosežki sekcije geodezija Achievements of section Geodesy 1993-2019

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Geodesy as part of SZGG

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Founding Assembly of Slovenian National Committee of IUGG on
February 23rd 1993

Section Geodesy among sections, founders of Slovenian National
Committee for IUGG

4 geodesists founders of the Slovenian Society of Geodesy and
Geophysics (Bilc, Mišković, Vodopivec, Mravlje)

1997 – 2000, prof. dr. F. Vodopivec: president of the Society

From 2005, prof. dr. F. Vodopivec: Honorary Member

63 presentations of articles

SZGG awards: dr. P. Pavlovčič Prešeren (2003), dr. O. Sterle (2015),
dr. K. Kregar (2016), dr. T. Urbančič (2017)



The most important Achievements

- Strategy of National Geodetic System
- Realization of ESRS in Slovenia
- Horizontal reference frame
 - Realization of ETRS89 in Slovenia
 - National CORS Networks
- Vertical Reference frame
 - Gravimetric network (absolute, relative)
 - Levelling network
 - Geoid, Quasigeoid, Height Reference Surface
- Local to ESRS Transitions
- Legislations regarding National Reference System

Before the beginnings (of organized activities)



- Situation before 2003
 - Inconsistent programs, decreasing financing, lack of staff motivation
 - Outdated legislation
 - No vision, no goals, no projects, no future, no progress
- Pressures
 - EU guidelines, standards, programmes, cooperation (State minimally responded)
 - EUREF Resolutions (...Tromso, Toledo, State did NOT adequately respond)
 - Progress of Science&technology, geodetic methods (State did NOT respond)
 - User demands (privat sector&users) (Geodetic measurements - rational, modern, competitive)
 - Development of new services (State did NOT respond)

EUREF Campaigns 1994, 1995, 1996

- Three EUREF Campaigns in Slovenia:
 - EUREF CRO-SLOV '94 (8 points)
 - EUREF SLOVENIA '95 (47 points)
 - CROREF '96 (5 points)
- Four different computations of three Campaigns:
 - Each individual Campaign
 - Combined Solution
- Results obtained not of needed quality



Participation in UELN (levelling data)

For the needs of unification of height systems in Europe levelling data from European countries were collected:

- Different height systems
- Different origins (tide gauge stations)

Continuous project lasting more than 25 years

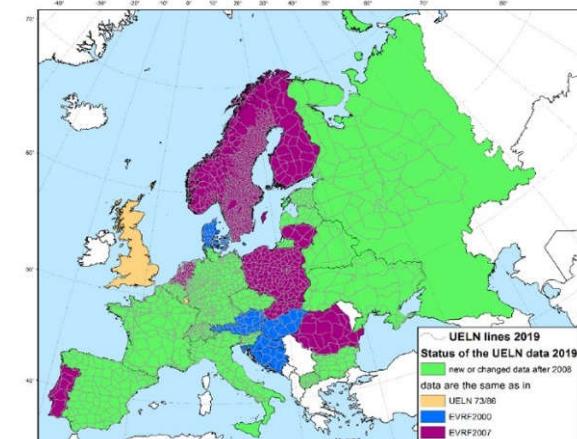
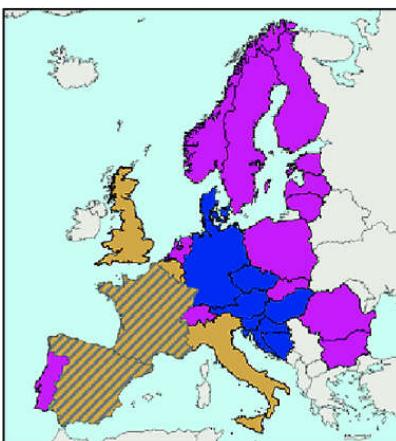
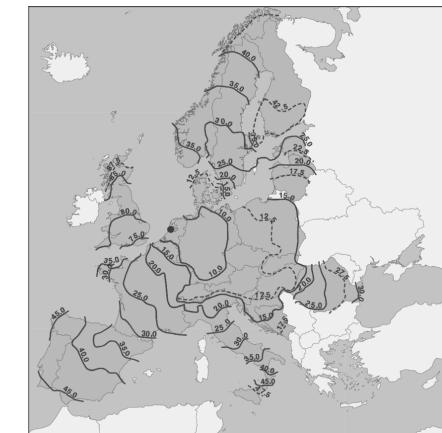


Figure 1: Status of the UELN data 2019



Geodynamic projects

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PIVO (Periadriatic fault-Istria Velocity Observations) 2003:

- September-October 2003 field measurements,

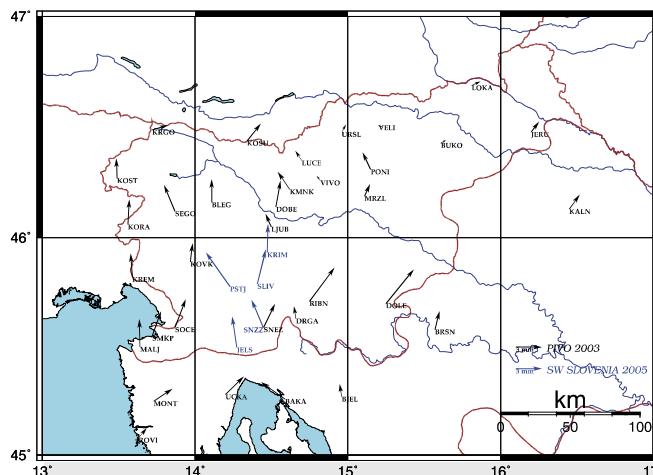
Densification in 2005:

- 30 new geodynamic points with 8-10 years GPS history

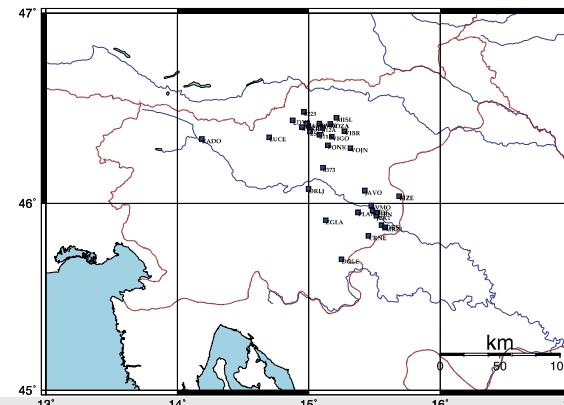
Data processing:

- University of Miami, MGG-Geodesy Lab: GIPSY/OASIS II (release 2.5)
- University of Ljubljana, Faculty od Civil and Geodetic Engineering: Bernese GPS software (release 4.2), recomputation (release 5.0)
- Velocities in ITRF97, ITRF2000 reference frame
- Transformation of velocities: ITRF97, ITRF2000 → stable Eurasia

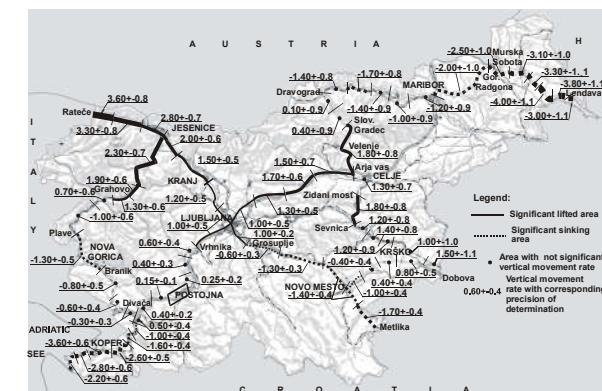
PIVO results



Geodynamic Network Velenje
Geodynamic Network Krško



Vertical velocities at the area



Diapositiv 7

SB1

Stopar, Bojan; 29. 01. 2020

Strategy of National Geodetic Reference System

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- Strategy of National Geodetic System (Document)
 - enable planning (yearly, mid-term) of finances and human resources
 - give base to reorganisation of SMA (no direct financial impact)
- New legislation
 - define new coordinate system (D48 – ESRS)
 - introduce new geodetic methods
 - define new responsibilities
 - delimit public/privat interests
 - financial consequences

Strategy of National Geodetic Reference System

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- Draft material in October 2003
- Expert discussion (finished in January 2004)
 - SMA,
 - UL Geodetic Department of FCGE,
 - Geodetic Institute of Slovenia,
 - Chambers of engineers,
 - private sector
- Harmonisation
 - Ministries, Governmental sectors
- Approved by the Government of the Republic Of Slovenia in May 2004

Goals of the Strategy of the National Geodetic Reference System

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- Achieve homogenous accuracy of all national geodetic networks (materialisation of new coordinate system)
- Enable exchangability of data among European states
- Enable control of time component of position within all kinds of (state) geodetic networks
- Determination of points position with highest achievable accuracy

National Geodetic Reference System



In the Republic of Slovenia we will establish NEW National Coordinate System as integral part of ESRS (European Spatial Reference System)

- Horizontal component – ETRS89
- Vertical component – EVRS



Horizontal component of the NGRS

Horizontal component of the NGRS will be represented by the state network of permanent GNSS stations.

Purpose:

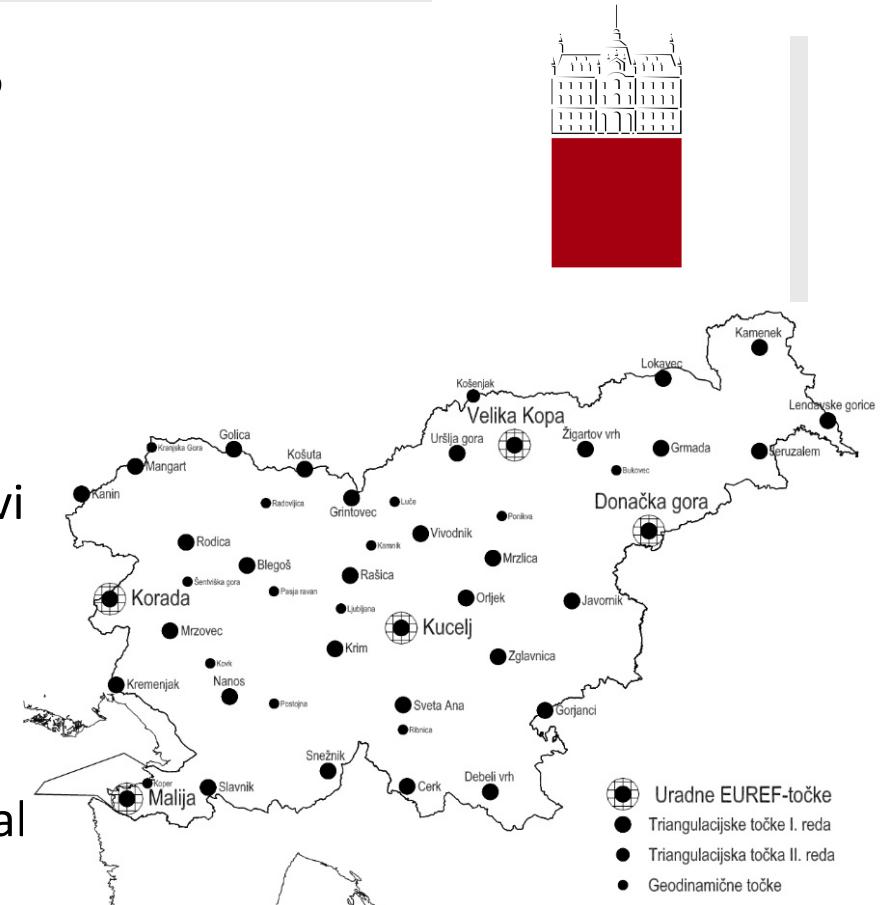
- enable centimeter accuracy of geodetic/surveying GNSS positioning in real time
- active network of permanent GNSS (GPS) stations
- achieve homogenous accuracy on the whole territory of Slovenia
- provide performance of geodetic/surveying positioning in a modern and cost efficient way (private sector)
- enable exchange of spatial data between European states

Horizontal component of the NGRS

Recomputation of EUREF Campaigns 1994, 1995, 1996

(New combined solution of EUREF campaigns)

- ITRF96 (1995.55) coordinate system
- 49 points:
 - 35 first order trig. newtork (complete network),
 - other: second order and geodynamic points,
- Maximum coordinate differences according to previ solutions:
 - CRO-SLOV '94: n: 10.3 mm, e: 14.0 mm, u: 50.7 mm,
 - SLOVENIA '95: n: -12.7 mm, e: -13.2 mm, u: 13.2 mm,
 - CROREF '96: n: -16.8 mm, e: 32.9 mm, u: 13.8 mm.
- Results represent official materialization of National horizontal reference system
- Results verified by the EUREF TWG
- ERTS89/D96; D96/TM



Permanent GNSS Network

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GNSS Network SIGNAL

(SI-Slovenia, G-Geodesy, NA-NAvigation, L-Location)

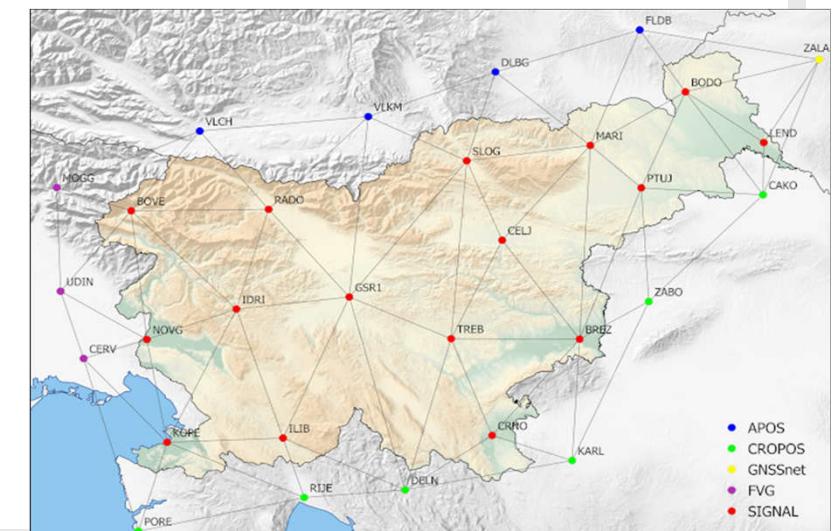
- Operational center (maintenance and control of the GNSS network)
- Analytical center (Supervision of the network, analyses of positions of permanent GPS stations)
- Data distribution center
- Promotional center, cooperation with other disciplines, partnerships (public-private), support and advisory services in use of GNSS technology in private sector

Permanent GNSS Network

SIGNAL network 16 continuously operating GNSS stations
(KOPE is also zero-order station, GSR1 is also EPN station)

Realization and access to horizontal component of NGRS
(ETRS89)

Identical redundant system in 2017 (back-up system) on
Trimble PIVOT platform





Horizontal component of the NGRS

Mini EUREF Campaign 2007

Purpose:

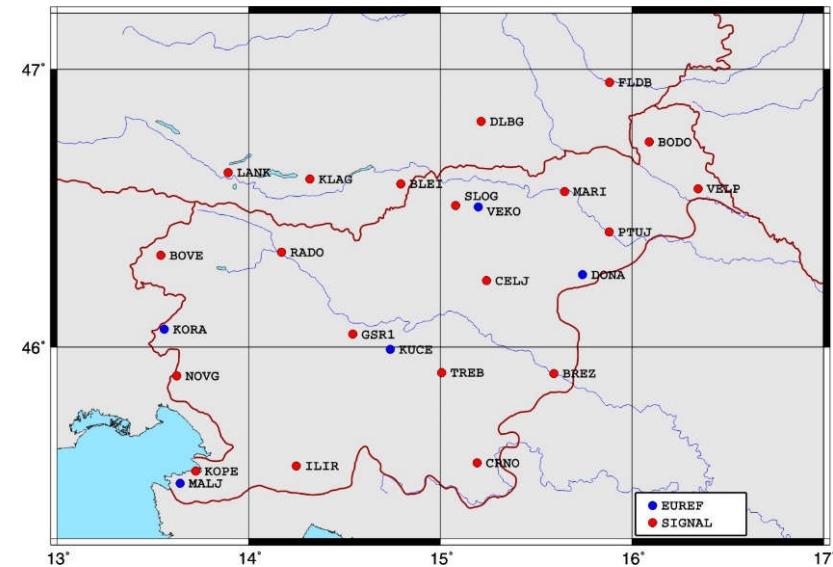
- Connection of national EUREF “non permanent network” and “permanent network”
- Determination of ETRS89 coordinates of SIGNAL network sites,

Observations:

- 72 hours, 5 Official EUREF sites, 15 sites SIGNAL network
- 5 sites APOS network

Procedure:

- Computation in ITRF2005 (2007.258)
- Transformation from ITRF2005 (2007.258) to ITRF96 (2007.258)
- Transformation from ITRF96 (2007.258) to ITRF96 (1995.554) (NNR-NUVEL-1A)
- 7-parameter transformation from ITRF96 (1995.554) to ETRF89
- (5 common points: official EUREF sites)



Horizontal component of NGRS



EUREF Slovenia 2016 GNSS Campaign

Purpose:

- to check the consistency of existing coordinates with ETRS89
- to re-connect the national CORS (SIGNAL) networks with the passive (EUREF) network.

Facts:

- the new D17 realization of ETRS89 in Slovenia (IGb08/ETRF2000) was not directly implemented as the new CRS in Slovenia; we'll still be using the D96 realization
- to improve the quality of the coordinates in the SIGNAL network, but within the existing realization of ETRS89 in Slovenia (*not to bother the cadastral community*).

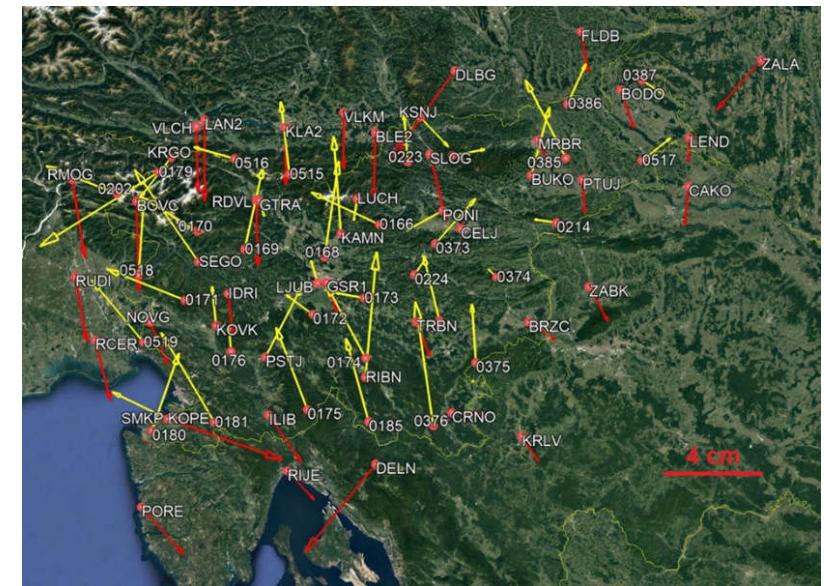


Horizontal component of NGRS



EUREF Slovenia 2016 GNSS Campaign computations

- Preliminary results presented in Padua GB meeting, Feb 2018
- Final results in EUREF 2018 Amsterdam Symposium
- Mean epoch of 2016.75 (D17)
- 57 points were selected
- Direct comparison (D96 vs D17): max. diff. ~8 cm
- Best-fit transformation: max. diff. ~2 cm



National Combined Geodetic Network

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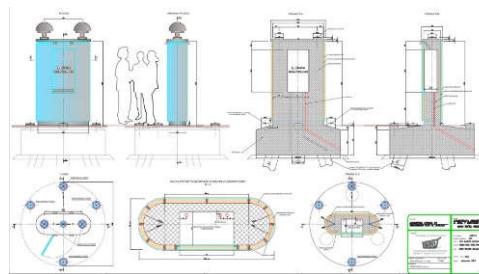
Combined - Zero-Order Geodetic Network

- 6 locations, distances of ~100 km
- 10 continuously operating GNSS stations, 4 “double stations”
- All antennas individual absolute calibration, new DOMES numbers
- Future national spatial reference system realisation



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PROSTORSKE
PODATKOVNE
INFRASTRUKTURE
ZA ZMANJŠANJE
TVEGANJ IN
POSLEDIC POPLAV

eea
grants
norway



National Combined Geodetic Network

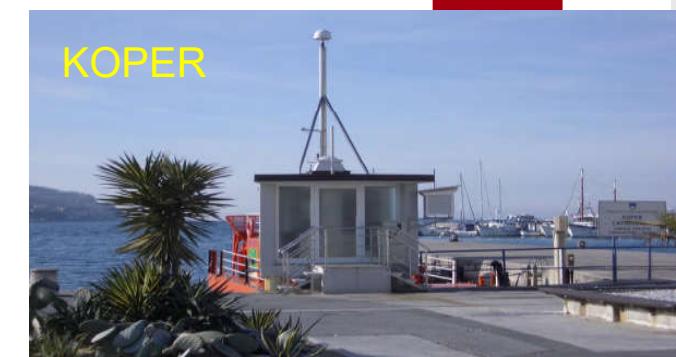
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Co-location with other measurements techniques

- Tide gauge station (KOPER)
- Absolute gravity benchmark (AREH)
- 1st order triangulation point (KORADA)
- Seismologic station (KOG)



Vertical component of NGRS



- Vertical component will be based on levelling/gravity networks
 - Establish gravity network
 - Establish levelling/gravity based height system
 - Establish connection of GNSS based and physical heights
 - Convert/connect existing heights to EVRS.

Vertical component of NGRS

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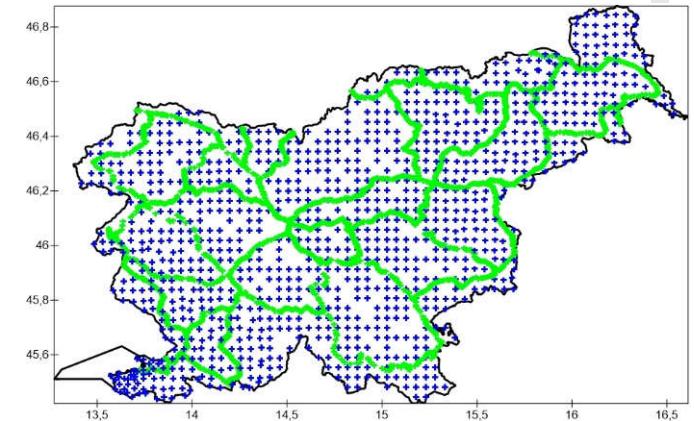
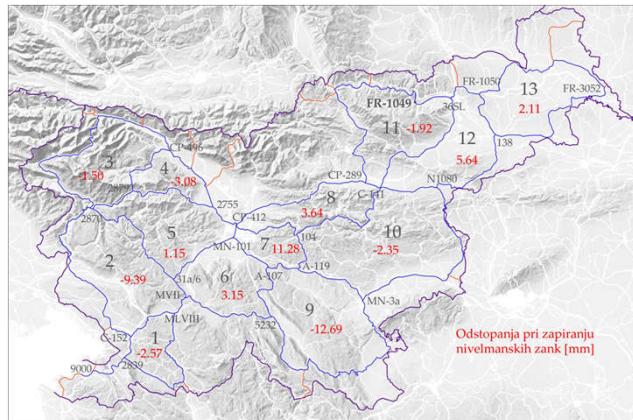
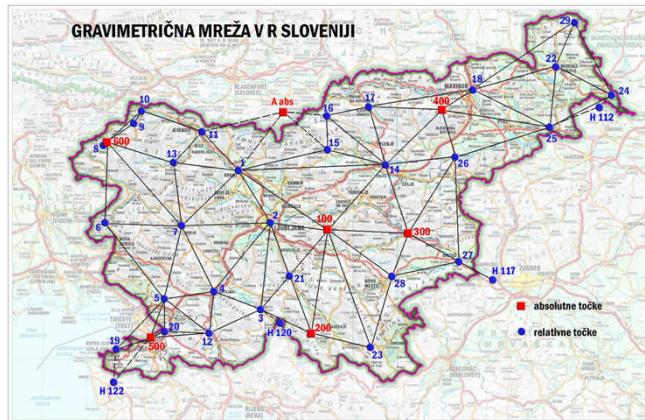
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New (renewed) gravimetric network (absolute, relative)

New (renewed) levelling network

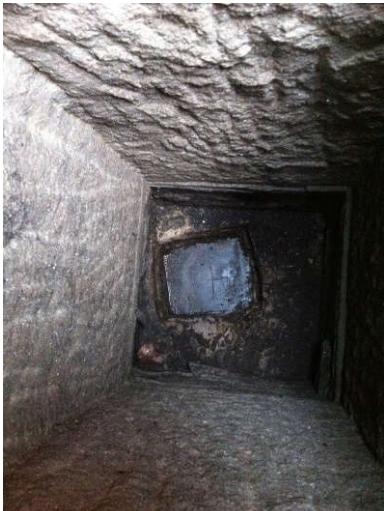
New network of gravimetric points (regional gravimetric survey) in grid min. 4 x 4 km



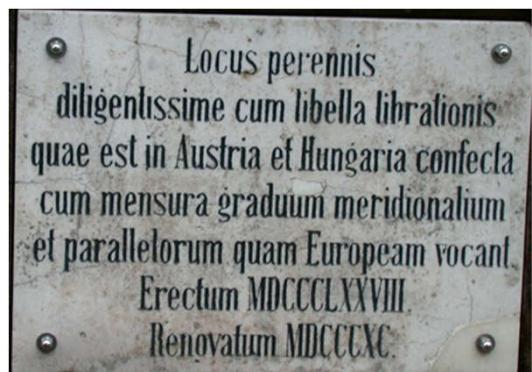
Vertical component of NGRS



23.04.2009



Vir: Geodetska družba d.o.o.



Normal Benchmark FR1049

- Austro-Hungarian Empire (Bundes Wehr Höhemark No. 147)
- Set up in 1878
- Altogether 7 in levelling network (only 2 preserved)
- The horizontal surface is an embossed stone (above 1 dm²)
- Inscription in latin



Vertical Component of NGRS

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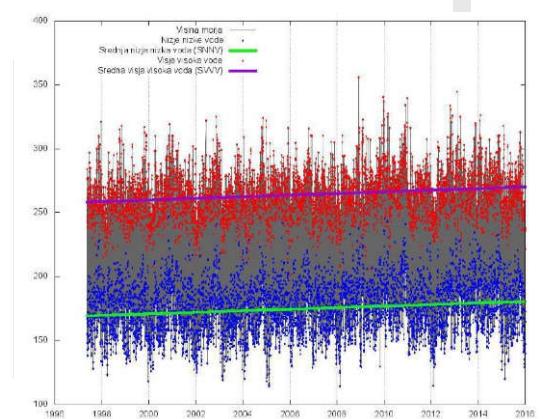
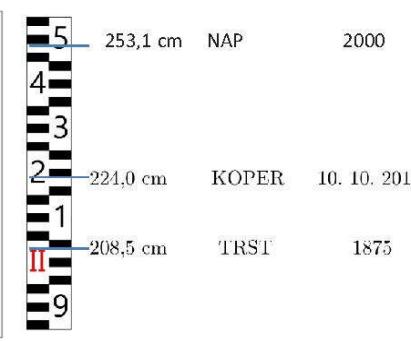
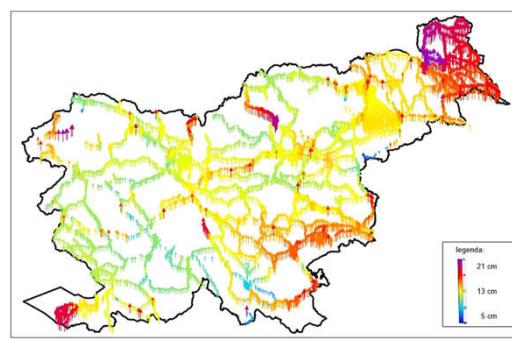
New Height Reference System → 1. 1. 2019

Changing from

- normal orthometric, datum Trieste (yr. 1875) to
- normal heights, datum Koper (yr. 2010)

Shift – 132 mm (from – 14 mm to – 308 mm)

New 1st order levelling network (~2000km) → contribute to UELN



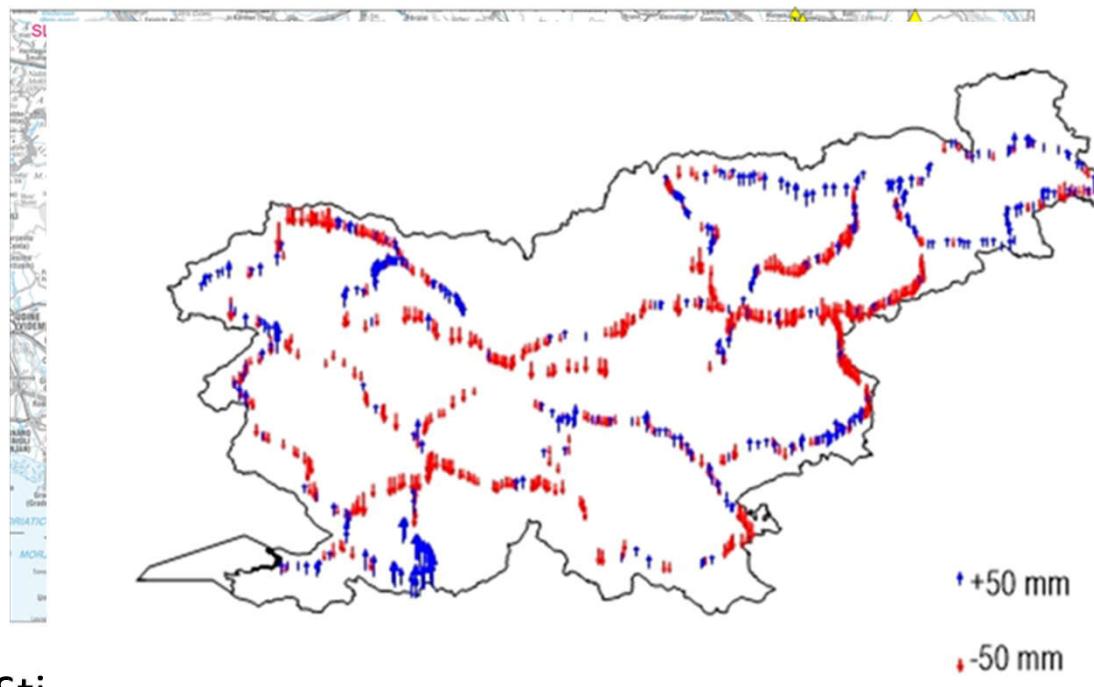
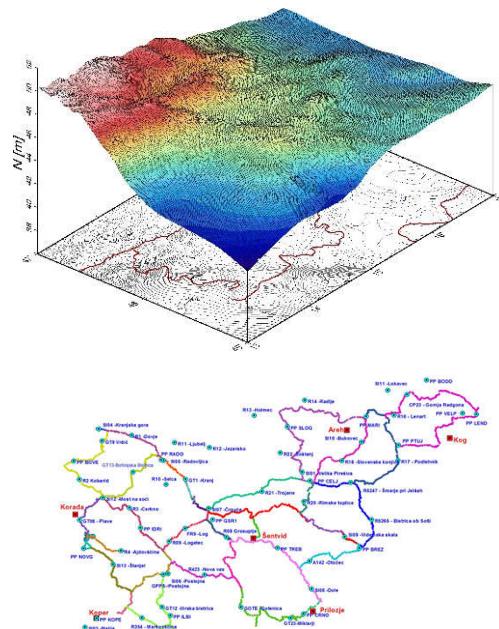
Vertical Component of NGRS

New Quasi-Geoid Model (Height reference surface)

Accuracy estimation based on 871 benchmarks

(GNSS/levelled)

St. dev = 2,6 cm



Sti
SVS 2000 (~~old height reference surface~~)

Transition from old to new NGRS

Establish conditions to enable conversion of data between both systems

- quality control of coordinates of existing geodetic networks
- enable transformation of existing coordinates to ESRS
- transformation of coordinates of other spatial data to ETRS89,
- achieve direct comparability and connectibility of spatial data with spatial data of other states



Transition from old to new NGRS

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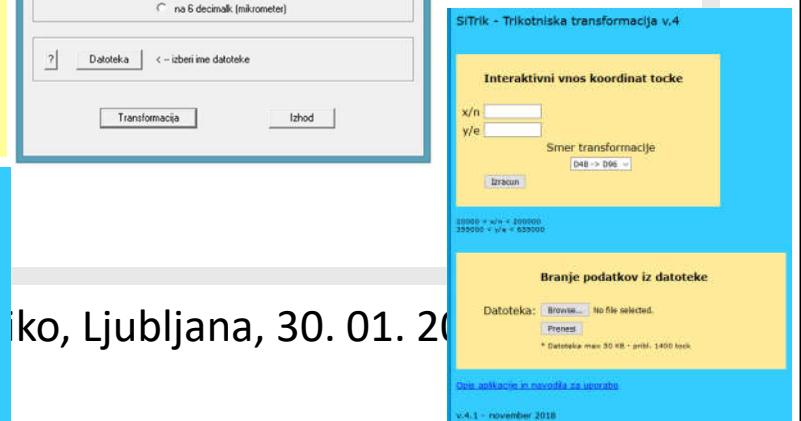
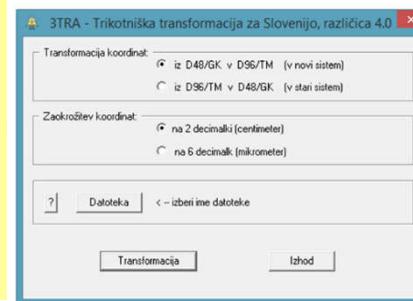
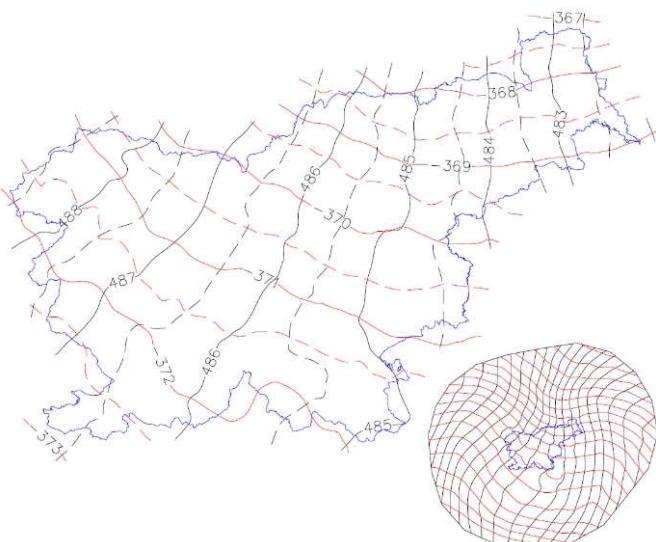


National old to new (ETRS89) Transformation Model of Slovenia published in 2017

Freeware tool for transformation

(<http://www.e-prostor.gov.si/aplikacije/page/2/>)

Transformation of all spatial data (including cadastral) by the end of 2018

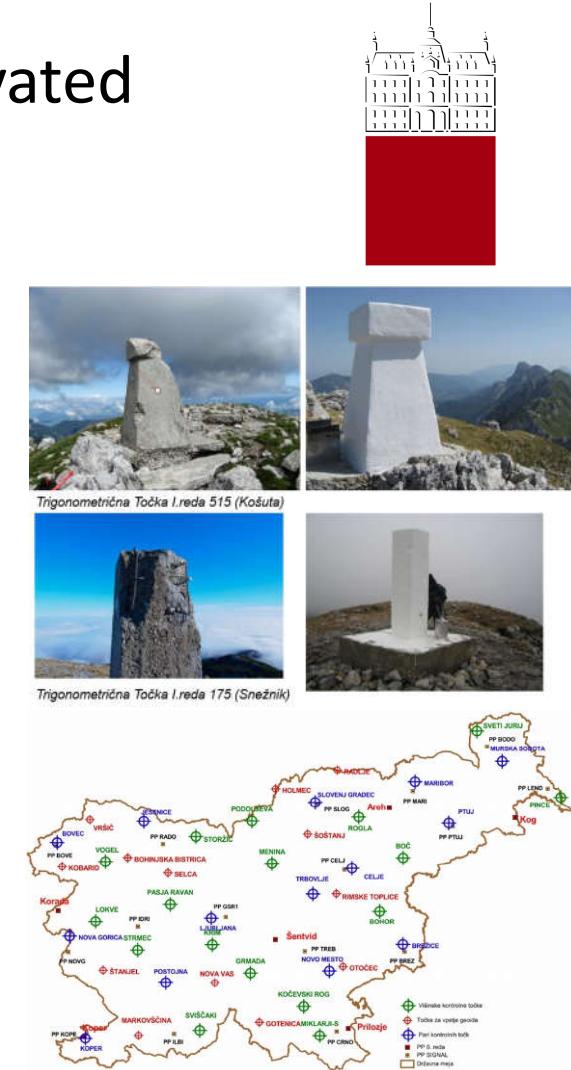


Database of geodetic points

The database of geodetic points will be renovated both in quality and quantity

Purpose:

- maintain and provide (for private sector) data
- height/levelling points
- GNSS points
- transformation parameters (for different regions/parts of Slovenia)
- reduce number of lower order geodetic points (not used and not maintained)
- introduce tariffs



Renewal of legislation



Renewal of legislation regulating national geodetic system and of geodetic/surveying (private) activities

Purpose:

- cancel old/existing legislation (1974) and define new concept of NGRS
- define competences and responsibilities of the State and private sector

Act on Georeference System

A geodesy-related act
[Act on Georeference System, 2014].



This act introduces:

- new, modern national spatial reference system, which is based on the European Spatial Reference System (ESRS), and
- new national topographic system together with the new map-grid system.

Partnership and cooperation in implementation of the strategy

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In the implementation of the strategy we will actively cooperate with profession and users

- Geodetic Institute of Slovenia, UL FCGE, NGRS Commission
- Chamber of Engineers of RS
- Government/Ministries
- IAG, EuroGeographics

Purpose:

- assure professional credibility of decisions and implementation
- assure acceptance on the user side
- become partner internationally.

Evaluation of the impact of the Strategy

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Impact on:

- organisation of SMA
- national programmes of geodetic activities
- geodetic profession (educ. programmes, training)
- all real estate registers and spatial data of SMA

and on:

- all spatial data of other sectors
- cooperation with other states
- cooperation of public and private sector
- other users



Thank you for your attention