NORDISKA KOMMISSIONEN FÖR GEODESI

Nordic Geodetic Commission, Working Group of Reference Frames
Chairman
PASI HÄKLI
Finnish Geospatial Research Institute,
National Land Survey of Finland
Vuorimiehentie 5
FI-02150 Espoo
Finland

NKG Working Group of Reference Frames

Draft Minutes of the working group meeting Riga/online on 19–20 May 2022

Place: Riga + online (marked with *)

Participants:

EST: Karin Kollo, Jaanus Metsar*, Tarmo Kall*, Andres Rüdja*

DEN: Kristian Evers, Mette Weber*

FIN: Pasi Häkli, Sonja Lahtinen

ISS: Dalia Prizginiene

LAT: Ivars Liepiņš, Ksenija Kosenko, Aigars Keiselis, Janis Kaminskis (Fri), Inese Varna*

LIT: Eimuntas Parseliunas*

NOR: Oddvar Tangen*, Arnlaug Høgås Skjæveland*, Sveinung Himle*, Michael Dähnn*

SWE: Tina Kempe, Lotti Jivall*, Christina Lilje*, Tobias Nilsson*, Per-Anders Olsson*, Martin Lidberg*, Tong Ning*

Written by Sonja and Pasi.

The slides of the presentations will be available at the SDFE's FTP server.

Session 1: Scientific presentations

- **Ksenija Kosenko, Latvian new coordinate system:** Latvian has defined a new coordinate system LKS-20. GNSS data from five LATREF stations and 13 EPN station were processed covering 84 daily sessions from spring 2020. The computed IGb14 coordinates were transformed into ETRF14. Next the transformation between the old (LKS-92) and the new system will be defined.

- **Tobias Nilsson, Work on cumulative GNSS solutions at Lantmäteriet:** Tobias has worked with CATREF to expand our knowledge on it. He repeated the combination of the NKG repro update solution, and the results agreed well with the published solution. He also tested adding seasonal signals into the combination model successfully. He also tested to combine a multi-year solution for all ca. 500 SWEREF stations, and to stack

Chairman
PASI HÄKLI
Finnish Geospatial Research Institute,
National Land Survey of Finland
Vuorimiehentie 5
FI-02150 Espoo
Finland

the NKG_EPN solution with the global solution by CODE. The preliminary results looked good in both cases.

- **Kristian Evers: Preparing the Danish and Greenlandic reference frames, coordinate systems and transformations for the EPSG:** Denmark has old reference systems in use that are not well documented and cannot be easily presented using today's EPSG terminology. Kristian presented the problematics and developed fixes to present the old systems with the EPSG terminology.

- **Martin Lidberg, Future positioning services, geodetic reference frames, and the ISO Geodetic Regristry:** Positioning is coming a mass-market product. Several projects are going on related to how to distribute network-RTK correction to mass-market applications on land and at sea. The current methodology via internet is not scalable enough. The positioning will also be increasingly performed in ITRF, but registers/geodata to be stored in ETRS89/SWEREF99. It is important that the positioning and geodata are in the same reference frame and therefore reference frame information should be distributed in the data streams. Geodetic registries with reference frame identifiers are therefore needed. There exist several registries but information may be varying. ISO registry with authoritative maintenance could improve the situation.

Session 2: National reports

Some main points listed here; for all project and details, see the slides.

Denmark

- New organisation: SDFI – Danish Agency for Data Supply and Infrastructure
- CORS stations: One new station was setup in may 2021, and SMID will be replaced by a new station. A new station GREJ00DNK has been installed
- Work for active height reference has continued within the TAPAS project (testbed in Århus for precision Positioning and Autonomous Systems) and geoid related work.
- GNSS observations has been bade on Greenland to realise a new frame there
- InSar transponders installed at most of the CORS stations

Estonia

- ESTPOS: a proposal on renewal of the infra has been prepared. ESTPOS includes currently 29 national stations.
- Assessment of national 2nd order geodetic network has continued using GNSS measurements

Chairman
PASI HÄKLI
Finnish Geospatial Research Institute,
National Land Survey of Finland
Vuorimiehentie 5
FI-02150 Espoo
Finland

- Activities at Vääna metrological baseline has continued. ELB's total station will be calibrated in Nummela in June 2022.
- Estonian-Latvian co-operation is going on to harmonize geodetic systems in border areas in 2021-2022 in a project called GeoRefAct. The project will result into coordinate and height transformation models.

Finland

- Finnref network will be the backbone for the national coordinate, height and gravity reference systems. It consists of 47 stations. Precise levellings and terrestrial measurements of the GNSS stations is going on. Twenty stations have been measured at least once using absolute gravimeter. Furthermore, SAR reflectors will be installed at sites.
- FINPOS is the positioning service, which utilises Finnref stations but also second order roof-top stations. NLS is now using FINPOS for its own operational needs.
- NKG activities; see the next sessions.
- Preparations for the renewal of the Finnish national reference systems have been studied under a project called Karef. The studies have showed that the agreement between active and passive networks is below one cm in horizontal and two cm in vertical, and the NKG2020 transformation produces practically static EUREF-FIN coordinates over a few decades.
- Metsähovi: Development of VLBI and SLR continues. A new main building will be ready soon.
- FGI has moved to the Otaniemi campus area of the Aalto University, Espoo.

Iceland

- IceCORS network includes 33 stations currently, five new stations have been installed recently.
- New Map Viewer for the geodetic infrastructure has been published.
- New INSAR velocity field has been done from Sentinel 1 data between 2015 and 2020
- Re-processing of GNSS data from all CORS stations (118 in total) using Bernese.

Latvia

- Benchmark inspection continued in Vidzeme region in 2021, over 700 benchmarks inspected. The work will continue in western Latvia with over 1500 benchmarks in 2022.

Chairman
PASI HÄKLI
Finnish Geospatial Research Institute,
National Land Survey of Finland
Vuorimiehentie 5
FI-02150 Espoo
Finland

- New online database of the state geodetic network has been published: http://geodezija.lgia.gov.lv.
- Normal heights have been measured for one GPS benchmark and ten levelling benchmarks in 2021.
- LatPos network is providing operational positioning service. The number of users is increasing.
- Latvian-Estonian co-operation: GeoRefAct; see slides both in Estonian and Latvian presentations.

Lithuania

- Contributed to EPN densification project with weekly solution between 2008 and 2021
- Harmonization of Lithuanian-Latvian geodetic systems at border has started.
- Future plans: second re-measurement of the 1st order vertical network of Lithuania in 2023-2025.

Norway

- Realisation of IGS2014 in the active and passive networks have been carried out covering almost 300 CORS and 16 000 benchmarks
- Update of the nationwide separation models between geoid and ellipsoid has been released
- Tide gauge network has been expanded, network consists of 24 permanent tide gauges
- Ny Ålesund: One VLBI telescope is operational and contributing to IVS regular sessions, other telescope has installations going on. The first components of SLR has been installed.
- NMA will replace all old transformation libraries and routines with Proj within next years.
- Positioning service has increasing number of users and about 300 stations currently.
- Many other projects; see slides.

Sweden

- Swepos has now about 500 stations and 9000 users. Lantmäteriet has developed signal disturbances detection system, report available “Lantmäterirapport 2021:1”
- All GNSS antennas older than 20 years at the fundamental stations, except the AOAD/M_B at ONSA, will be replaced within a year.
- Lantmäteriet has published basic instructions on how to use NKG2020 transformation via Proj. Also a new version of Gtrans (own transformation software) has been released.

- Design, tests and installation of InSAR corner reflectors is going on.

Session 3: Project NKG GNSS AC

- **Upcoming defense on reference frames:** Sonja presented highlights of her doctoral thesis summarising the publications related to the NKG GNSS AC. The thesis is available in electronic form at https://aaltodoc.aalto.fi/handle/123456789/114101.
- **Current status in NKG GNSS AC:** The operational work has continued without changes in the processing setup. Some LAC solutions have been delayed several months affecting the operational combination as well. There has also been changes/outages in FTP servers affecting the operational work during the year. In the future, to avoid delays due to incorrect antenna models etc. the LACs are advised to check their own solutions before submitting them. Sonja will provide further help on using the SNXcheck script if needed. The combination results looked good for both combination centres for the weeks which were available. Lots of missing LAC solutions were submitted just before the meeting, so that we are almost in schedule now. The aim is to submit solution within three weeks after ending of the each calendar week.
- **Discussion on procedures:** Each LAC presented their current processing methods, on which platform the processing is performed and what kind of scripts and tools they have in use. Some LACs preferred to control the processing more manually, whereas some LACs preferred more automatic approaches. It was decided that Kristian summarises the main points of the LAC reports and we then pick-up the topics which we could try to solve first. Everyone is also recommended to propose improvements. We aim also to share the scripts etc. basically in GitHub for proper version control.
- **Plans and development:**
    - Operational work: NKG GNSS AC will be a NKG service in the future. We will make a switch to IGS20 frame in the autumn 2022. The exact schedule will be clarified during the summer. It is also a good chance to make improvements to our operational solution related e.g. cut-off angles (do we need 10 deg sol), formats, station configurations.
    - NKG Repro2 will be proposed as a project for the next period. It aims to produce an ITRF2020 compatible multi-year position and velocity solution for the NKG region. Most LACs were tentatively ready to re-process their data history/LAC solutions. Lithuania was still uncertain. The preparations can be started after we have defined the changes in the operational work, most probably during the autumn 2022, and the re-processing to be started in 2023. The details will be discussed in a separate project meeting.

Session 4: NKG transformations

Chairman
PASI HÄKLI
Finnish Geospatial Research Institute,
National Land Survey of Finland
Vuorimiehentie 5
FI-02150 Espoo
Finland

- **Status of NKG_REF17vel and NKG2020:** Pasi presented results of the performance of the NKG2020 transformation with ITRF2014 and ITRF2020. The NKG2020 transformation works well with newer data sets and in time. Most of the planned activity has been completed. The remaining tasks are to finalise and release NKG_RF17vel uncertainties and publish them. NKG2020 transformation is planned to be published in NKG GA proceedings and registered to the EPSG database.

- **Discussion on registering the NKG transformation with the EPSG:** The proper registration of the NKG transformation is important to get them discoverable in GIS software and accessible for many people. Work on registering at least some not-yet-registered national coordinate reference systems and transformations is going on in Denmark, Finland and Norway. NKG transformation is not yet widely used outside geodetic institutes, but at least Sweden has published instruction of how to use it with Proj. It will probably come more actual when e.g. Galileo HAS positioning will be available. It was discussed how to proceed and following steps were agreed: 1) Publish paper on the NKG transformations, 2) Publish local documentation of the transformations, 3) Submit reference implementation to the NKG (DK+FI), 4) The rest of the NKG members follow suit and submit their part of the transformations themselves.

- **Discussion and plans:** EPSG registrations will continue next period. Updating NKG202X transformation with new data sets was proposed, but to be meaningful, it requires a new/updated 2D+1D deformation / land uplift model as well as NKG Repro2 (ITRF2020 coordinates and velocities).

Session 5: Next NKG period

- **Bylaws:** The new bylaws have been prepared. Most notably, the Baltic countries will be official members of NKG. The bylaws also separate NKG “services” and “projects” and at least part of our current projects should be called services in the future. The bylaws will be accepted in General Assembly in September.

- **Recap of the current period and plans for the future:** Pasi summarised the main achievements and activities during the last period. The key activities were completed during the period, some were postponed due to the dependencies of delayed ITRF2020 etc., or not considered reasonable to be prioritised. Both projects/services are proposed to be continued in the next period. A couple of milestones were proposed for both services/projects for the next period. The NKG Repro2 will be the biggest new activity for the period. Furthermore, it was considered important to increase automatization and harmonization of procedures in the NKG AC service as well as making sure that necessary scripts are available for the transformation project. Therefore, sharing of scripts e.g. in Github, are proposed as activities in the both projects/services.

- **WG chair:** Pasi will be proposed as the WG chair for the next period.

Chairman
PASI HÄKLI
Finnish Geospatial Research Institute,
National Land Survey of Finland
Vuorimiehentie 5
FI-02150 Espoo
Finland

Session 6: AOB

- NKG General Assembly will be in Copenhagen in September 5-8, 2022.
- Next meeting will be in spring 2023, the place will be decided after the NKG General Assembly.