National Report Denmark

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Status of EUREF in Denmark

The basic network called REFDK has been described in the 1999 report.

It is decided to make the network more dense to a 10 km 3-dim. network over all of Denmark. The densification is planned to be fulfilled in the years 2000-2003.

Local Danish map projections / EUREF in Denmark

The intension has for some years been to go from using the old local Danish map projection called System 1934 (cadastral and technical purposes) and from the old ED50 datum (mapping purposes) to use a map projection in the EUREF/ETRS89datum called EUREF89. This intension is now feasible because the technical obstacles are solved and the mental obstacles are taken care of.

Technical solution.

The technical solution should make it possible to convert any coordinate from the old datum to the EUREF89 datum within the accuracy of the foundation of the coordinated stations i.e. 2 cm.

The traditional 7-parameter datum shift is giving a fairly poor accuracy when shifting from one well defined datum (as implement through the coordinates of the fundamental stations) to a poorly defined (or elder) datum. The 7-parameter datum shift gives in Denmark a mean error about 20 cm in the plane and 1 cm in the vertical (ellipsoidal height). In some areas may discrepancies exceed 3 m.

The 3-dim coordinates EUREF89 are by the 7-parameter datum shift shifted to the 3-dim ***technical coordinates ED50***.

The accuracy in the plane is obviously not sufficient to meet the needs mentioned above.

The remedy is then to model the differences of say the *UTM zone 32 technical coordinates ED50* and the coordinates of System 1934 . To meet the need of the accuracy the modelling should be made not only on a few stations having coordinates in both systems; - but should be made on **as many stations as possible**.

All observation made since 1930 in the geodetic network extended with many GPS measured 3-dim vectors has therefore been readjusted in the UTM zone 32 EUREF89 (some stations also including ellipsoidal height). A total of 34182 stations have been coordinated on the **cost of 3/4 of a man years work**.

These UTM zone 32 EUREF89 coordinates have been datum shifted to the *UTM zone 32 technical ED50 coordinates*. The differences to the System 1934 coordinates have been modelled with some 2-dim. polynomial functions up to degree 13 having a mean error less than 1.7 cm.

The same procedure has been used towards the UTM zone 32 ED50 coordinate system giving polynomial functions up to degree 15 also having a mean error less than 1.7 cm.

Introduction of new map projections in Denmark

With the accurate transformation system, which was ready in 1999 and finally implemented in the beginning of year 2000, it was possible to speed up the process in changing the used map projections in Denmark to a common European coordinate system and new map projections connected to ETRS89 (in Denmark known as EUREF89) instead of the old used projections UTM/ED50 and System 1934. The discussion was already started back in 1995, but decisions had to wait for the technical solution. The discussion has mostly been taking in a standing council in Denmark called "The Council for Denmark's Reference Network" (established in 1986). The council members represent besides KMS the municipalities, the counties, Road and railroad directories, the charted surveyors and surveying firms among other.

The Council recommended ultimo 1999 KMS to introduce two different map projections in the EUREF89 datum. A standard UTM projection and three Transversal Mapping (TM) map projections called KP2000 for use in Denmark. The KP2000 map projections are defined especially to fulfill the needs for a map projection with a distance correction not more than +/- 5 cm/km. The Central meridian and the false easting is elected so that the projection is traceable from the easting coordinate and a weak knowledge of location.

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Zones	Central Meridian	Scale	False Easting	E Values
Jutland and Funen	9.5°	0.99995	200 km	100 - 300 km
Zealand	12.0°	0.99995	500 km	400 - 600 km
Bornholm	15.0°	1	900 km	850 - 950 km
UTM32/EUREF89	9.0°	0.9996	500 km	400 - 750 km

From March to June 2000 a proposal was send out in a general hearing to all parts in Denmark who have an interest in such a decision. The idea in the proposal is, that the new map projections should be introduced as new standards in Denmark in first hand in co-existence with the old map projections. The hearing asked for comments on:

- the SYSTEM2000 : KP2000 and DVR90 (Danish Vertical Reference 1990, se below).
- how, when and in which pace the shift from the old systems to the new ones would be performed.
- the interest for establishing a co-operation project with KMS to facilitate the shift.

Organisations would then know the new standards and would be able to act towards a shift from using the old systems to use the new standard.

Parallel to the official hearing an intense campaign was started towards all "map owners" in Denmark, with the main goal to introduce the new map projections and to tell why the new systems should be used and how to change to the SYSTEM2000.

Answers from the hearing is not yet received from all the organisations, but the main impression is that the new map projections is accepted overall in Denmark, and some organisations will start changing to the new projections in a years time from now.

It has facilitated the introduction of the SYSTEM2000 that the transformation system will be available on the internet **free of charge**.

Height system

The new Danish height system DVR90 (Danish Vertical Reference) is the outcome of the third precise levelling (1986-1992) and the Danish sea level observations during the past century. The new heights, referring to the reference year 1990, are Helmert heights above the Danish mean sea level in 1990. The heights are adjusted in units of GPU with astronomical correction applied to the observations.

The height network contribute to the UELN adjustment. In Denmark the UELN-95/98 heights are bit larger than the DVR90 heights. The differences, ranging below the ½-cm level at the German border in Jutland, are increasing up to almost 2cm in Skagen and 2½cm on Lolland. The tilt to the north is caused by the fact that tidal corrections have been omitted in the UELN -adjustment, whereas the tilt to the east is coming from the closing error (-5½cm, approx.) of the Danish/German loop connecting Lolland and Fehmarn.

Concerning the differences between the new height systems in Denmark and Germany it has been found that

DVR90-DHHN92=-3.5cm

in the Lolland /Fehmarn region and about +2cm at the German border in Jutland.

A new link between Denmark and Sweden has been established in the spring 2000 by motorized levelling along the new tunnel (4½km) and the new bridge (11km) between Copenhagen and Malmø. The raw measurements apparently confirm that the difference DVR90-RH70 is about +5½cm in the Øresund region.

Introduction of DVR90

A new height system is only fully useful for the society if it brought into play. Therefore another part of the hearing already mentioned in connection with introduction of new map projections was to introduce DVR90 as official height system from 2003. The plan is that all benchmarks should become heights in DVR90 in the coming years through an adjustment of all new(er) observations. Some benchmarks will become new heights in DVR90 through a transformation from the old height system. In the years 2001 to 2003 the new height system will co-exist with the old systems (3 in use in different parts of Denmark), but from 2003 old systems will only be used as historical information.

The information campaign mentioned earlier has as a natural second goal the introduction of DVR90.

The main problem in introducing a new height system is not to give new heights to the benchmarks. The main problem is the derived height data; - first of all the heights used in the sewer systems, and in road planning. A lot of efforts is therefore put into problems in how to change the heights in all the databases, and secure, that all analog heights are labelled with information about which system the height is referring to.

As mentioned earlier the answers from the hearing is not yet arrived, but the height problem probably raise more problems to introduce than the new map projections.

Permanent GPS stations in Denmark

The 3 permanent stations in operation in Denmark have been included in the EUREF network. Unfortunately are the type of antennas (Dorn Margolin Ashtech : P/N 700936) unknown to the community so the inclusion has had no effect.

A homepage containing phase data from the permanent stations is under preparation.

Geodetic activities in Greenland

Four primary stations along with four permanent stations in Greenland form the backbone for an ongoing densification to 20 major towns and settlements in Greenland.

All observation made from 1920 in the geodetic network extended with some GPS measured 3-dim vectors has therefore been readjusted in the UTM zone 22 ETRF96 including ellipsoidal heights and mean sea level heights. A total of 3825 stations have been coordinated on the west coast on **cost of one man years work**. The project will continue on the east coast.

In the coming years the GPS measurements will be extended to more parts of the network. It is expected that 50% of all stations will have an accuracy better than 12 cm and 90% an accuracy better than 25 cm and in remote areas an accuracy poorer than 25 cm.

The permanent GPS stations in Greenland Thule is giving 1 second data to the global IGS network and in the IGEX network, the station in Kellyville is in the global IGS network

On the East coast Kulusuk is operated by the University of Colorado and has no facilities for data transfer on a regular basis. Scoresbysund is operated by National Survey and Cadastre. Data from this station will be made available to the international community as soon as the dataflow has been automated.

References

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