Realization of DFHRS and CoPaG/DFLBF Databases for Albania

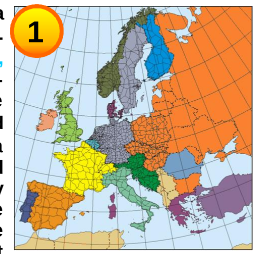
[1)]Reiner Jäger, [2)]Simone Kälber, [1)]Sascha Schneid, [3)]Gjergji Qeleshi, [4)]Bilbil Nurce, [5)]Ilir Cekrezi

[1)] University of Applied Sciences (FH) Karlsruhe; Department Vermessung und Geomatik and International Department Geomatics (Msc); Moltkestrasse 30, D-76133 Karlsruhe, Germany. URL: www.dfhbf.de; [2)] D-76227 Karlsruhe, Germany; [3)] Sherbimi Gjeologjik Shqiptar,Qendra Gjeofizike, Blloku Vasil Shanto, Tirana, Albania, Tel.and Fax:++355 42 27360, e-mail:qeleshi@yahoo.com; [4)]Universiteti Politeknik i Tiranes,Fakulteti i Inxhinjerise se Ndertimit,Departamenti i Gjeodezise, Tirana, Albania.Tel.and Fax:++355 42 290 45, e-mail:bnurce@hotmail.com; [5)]Instituti Gjeografik Ushtarak i Shqiperise, Tirana, Albania.Tel.and Fax:++355 42 63427.

Introduction and Motivation.

As concerns the georeferencing of position data in modern data bases, the availability of GNSS (GPS / GLONASS / GALILEO) related code- and phase-measurement DGNSS-correction data, which are provided in different ways by different GNSS positioning services (SA*POS*, ascos, SIGNET etc.) in and outside Europe leads to the replacement of the classical geodetic reference systems by GNSS-consistent ITRS-based reference systems. So the transformation of the old plan position data $(N,E)_{class}$ related to the classical reference systems to the ITRS/ETRS89 datum $(N,E)_{ITRS}$ becomes urgently necessary all over Europe (1) and the world respectively. A sophisticated and general solution of this transformation problem has to include a data base concept for the provision of the corresponding transformation parameters for GIS, GNSS navigation and surveying purposes. This is provided by the CoPaG-Concept. Further the capacity of a one-cm-positioning by GNSS services, such as e.g. SA*POS*® and ascos® in Germany, is also appropriate for a GNSS related heighting. The GNSS-based determination of sea-level (orthometric, normal) heights H requires the transformation of the ellipsoidal GNSS heights h_{ITRS} to the respective physically defined height reference surface (HRS). A general concept for the evaluation of height reference surfaces (HRS) on the national and also on European level (E_HRS) is provided by DFHRS. Both the DFHRS and the CoPaG/DFLBF database standard are broadly accepted by the GIS(E1) and GNSS (E2) industry.

1



Albanian Reference Frames and Data used for CoPaG/DFLBF/DFHRS DB Computation

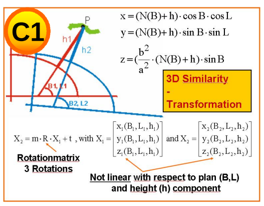
The state of Albania is situated between latitude 39°38'- 42°39' North and longitude 19°16'-42°04' East und extends over an area of 28.748 km^2 (land 27,398 km^2, water 1,350 km^2).The terrain is mostly mountainous (highest point 2753m) and hills with small plains along coast. Albania is affected from natural hazards such as destructive earthquakes, tsunamis and draughts. The present national horizontal geodetic network ALB87 is referring to Krassowski ellipsoid and UTM projection. Five common points were used to transform by a 7PT similarity transformation further 16 points $(X,Y,Z)_{ITRF}$ from ITRF96.1998.0 to ETRS89 (Nurce, B.:The New Albanian Network and GPS measurement campaigns. Veröffentlichungen der Bayerischen Kommission für die Internationale Erdmessung. Heft Nr.61.München, 2000,238-241). So a total number 21 of points $(N,E)_{class}$ related to ALB87 could be used to compute a first COPAG/DFLBF_DB set for transformations ALB87 ↔ ETRS89 and a second set for transformations ALB87 ↔ ITRF96.1998.0. The vertical datum of Albania is referring to MSL Adriatic Sea. The DFHRS_DB was computed with respect to a ETRS89-georeferencing using a number of 17 identical points (B, L, h; H) and the EGG97 observations. So Albania is ready for the installation of a GNSS positioning service ALBPOS such as e.g. SA*POS*® , ascos®.

CoPaG

www.geozilla.de

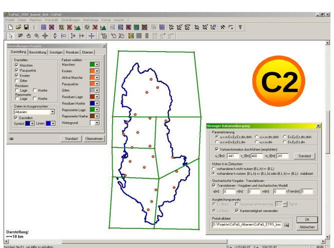
The CoPaG concept is dealing with the precise and continuous transformation of plan positions $(N,E)_{class}$ to the ITRS/ETRS89 datum $(N,E)_{ITRS}$. From the theoretical point of view a respective transformation can not renounce completely on height information (C1). The so-called CoPaG (Continuously Patched Geoferencing) concept however, has the advantage that the point height information is needed only on a poor accuracy level in the target system. If precise height information is available in both systems, it can be introduced as third observation equation in system C1. Further basic considerations and a respective problem solution for the plan datum transition are due to the occurrence and the mathematical treatment of 'weak-forms' (C3 left). These are long-waved deflections of the shape of classical networks, reaching a range of several meters in the nation-wide scale, e.g. for the size of Germany (C3, left). This requires the partition of the total network area into a set of different "patches" in a FEM similar to DFHRS (C2, C3, right). The introduction of continuity conditions along the patch borders analogue to the DFHRS (D1) implies restrictions between the transformation parameters d of neighbouring patches (C3, right). Because of its mathematical strict-ness and general validity the CoPaG concept has a broad and far-reaching application profile in the context with the big amount of similar datum transition problems occurring world-wide in the upcoming GNSS-age. C2 shows the patch-layout for the <(3-5)_cm_CoPaG_DB Albania (see accuracy contour-lines, C4). The inverse problem of transformation of GNSS positions $(B,L,h)_{ITRS}$ to national reference systems and grids $(N,E)_{class}$ is solved by DFLBF_DB (www.geozilla.de).

C1

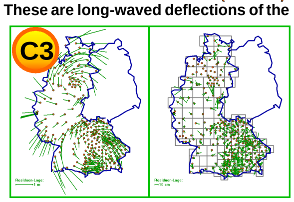


$$x=(N(B)+h)\cdot\cos B\cdot\cos L$$
$$y=(N(B)+h)\cdot\sin B\cdot\sin L$$
$$z=(\frac{b^2}{a^2}\cdot(N(B)+h)\cdot\sin B$$
$$X_2=m\cdot R\cdot X_1+t\ \text{, with } X_1=\begin{bmatrix}x_1(B_1,L_1,h_1)\\y_1(B_1,L_1,h_1)\\z_1(B_1,L_1,h_1)\end{bmatrix}\ \text{and } X_2=\begin{bmatrix}x_2(B_2,L_2,h_2)\\y_2(B_2,L_2,h_2)\\z_2(B_2,L_2,h_2)\end{bmatrix}$$

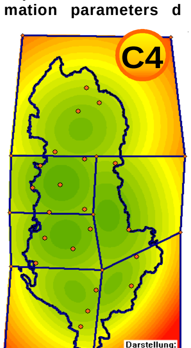
C2



C3



C4



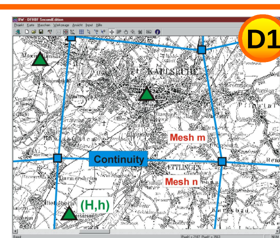
E1

GIS-Companies				
Company	Logo	Software	CoPaG DFLBF	DFHRS
Walter Software GEOConsult (WSG) http://home.t-online.de/home/w-s-g/	WSG WALTER Software GEOConsult	• PAGEWIN	-	R
AKG Software www.akgsoftware.de	AKG Software®	• VESTRA	R	R
euroGIS www.eurogis.de/	euroGIS IT-Systeme	• euroGIS-Sofware	R	R
infoGraph www.infograph-gmbh.de/	infoGraph	• GISMobil	R	R

DFHRS

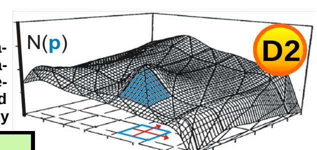
www.dfhbf.de

D1

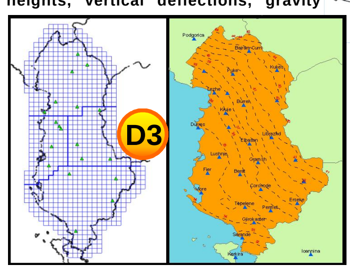


The DFHRS (Digital-Finite-Element-Height-Reference-Surface) concept allows a GNSS height positioning by a direct online conversion of ellipsoidal heights h into standard heights H referring to the height reference surface (HRS). The DFHRS is computed and modelled as a continuous HRS with parameters p in arbitrary large areas by bivariate polynomials over a grid of Finite Element meshes (FEM) (D1, D2). Geoid heights, vertical deflections, gravity anomalies and identical points are to be used as observations in a least squares computation to derive the DFHRS-parameters (D4). Any number of geoid models may be introduced simultaneously and geoid models may be parted into different "patches" with individual datum-parameters in order to reduce the effect of existing medium- and long-waved systematic errors. So the resulting DFHRS parameters p, set up as a DRHRS database, provide a correction DFHRS(p|B,L,h) to transform by H=h-DFHRS(p|B,L,h) ellipsoidal GNSS heights h into standard heights H (D4, top). The DFHRS-correction consists of the FEM surface of the HRS ("geoid-part") as function of (B,L) and an additional "scale part" as function of h (D4, top). The present "high-end" of a HRS representation and the DFHRS-correction DFHRS (p,m|B,L,h) respectively is the level of less than 1 cm, provided by so-called "<1_cm _DFHRS_DB". These "<1_cm_DFHRS_DB" are characterized by a mean reproduction quality of less than 1 cm (www.dfhbf.de). D3, left shows the meshing and patching design for the computation of the <10_cm_DFHRS_DB Albania and D3, right shows the isolines of the final HRS result. An improvement to a three centimetre level could be achieved by introducing a number of further 20 height points (B, L, h, H).

D2



D3



D4

DFHRS-Correction:

$$H = h - NFEM(p\,|\,B,L) - h\cdot\Delta m$$
$$= h - DFHBF(p,\Delta m\,|\,B,L,h)$$

Functional-Model for the Computation or DFRHS-Databases

$$h+v=H+h\cdot\Delta m+NFEM(\mathbf{p}\,|\,B,L)$$
$$N_G(B,L)^j+v=NFEM(\mathbf{p}\,|\,B,L)+\partial N_G(\mathbf{d}^j)$$
$$\xi+v=-\mathbf{f}_B/M(B)\cdot\mathbf{p}+\partial B(\mathbf{d}_{\xi,\eta})$$
$$\eta+v=-\mathbf{f}_L/(N(B)\cdot\cos(B))\cdot\mathbf{p}+\partial L(\mathbf{d}_{\xi,\eta})$$
$$H+v=H$$
$$C+v=C(\mathbf{p})$$

DB-Content: - Mesh Topologie
- per Mesh

$$p=[(a_{oo},a_{1o},a_{o1},a_{11},\ldots)^i,\Delta m]$$

E2

GNSS-Companies				
Company	Logo	Software	CoPaG DFLBF	DFHRS
ALLSAT www.allsat.de	ALLSAT	• GART2000	[illegible]	R
GeoNav www.geonav.de	GEONAV	• DCTOOLS	R	R
BS www.ib-seiler.de	Ingenieurbüro Geoinformatik Seiler	• OLGA_PRO • USE3DIM	R	R
LEICA Geosystems www.leica-geosystems.com	Leica	• SKI-PRO • SR530 Controller Software • GeoSamos	R	R
THALES www.thales-navigation.com	THALES	• GART2000	R	R
TRIMBLE www.trimble.com	Trimble ADDING VALUE TO GPS	• Trimble Office • 5700 Controller Software • Map500 - Graphisches Feldinformations-system	R	R
Topcon www.topcon.com	TOPCON Topcon America Corp.	• GART200 • GeoSamos	R	R
Breining www.breining.de	Ingenieurbüro Breining GmbH	• GeoSamos	R	R