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The FAO Africover Project and a Possibility of a Unified Geodetic Datum for Africa (UGDA)

Abstract

The FAO executed AFRICOVER Project aims at the Production of a homogeneous land cover mapping at scales of 1/250,000 to 1/100,000 covering the whole of the Continent of Africa. To carry out this momentous objective, it has been planned to start with the harmonization of the geodetic datum, mapping spheroids and projections. The WG84 has been selected as the geodetic datum to be used together with IAG-GRS80 reference spheroid.
This is indeed an ambitious decision and very important for Africa. For if it is successfully implemented, at the end of the project, Africa will have a unified datum and spheroid. This is the goal the geodetic community have been straining to achieve for nearly a century since the 30th Arc Meridian network was conceived by the South African astronomer, Sir David Gill at the end of the 19th Century.
In this paper, the author proposes that the geodetic community should cooperate with FAO and all concerned with the AFRICOVER project to ensure that the resulting unified Datum meets geodetic standards. Following this project, the remaining geodetic networks of Africa could then be transformed into the World Geodetic System, so linking Africa to the rest of the world.

1. Introduction

Efforts to establish a Unified Datum for Africa started after the 1963 1st United Nations Regional Cartographic Conference in Africa. To this end, the African Doppler Survey (ADOS) project was conceived and implemented between 1981 and 1986 in which more than 300 points were established using the Doppler positioning technique and which covered more than 45 countries of Africa. Although the main aim of this project was to compute a Unified Datum for the continent, for various constraints, this goal was not achieved.

At the end of the project, it was left to each member state to use the data (and up to now only a few countries have used the ADOS results) to compute transformation parameters for their networks.

The IAG has tried to supplement the efforts made by AOCRS and ECA to develop another project through which a Unified Datum for Africa can be achieved. In this paper, the author proposes the use of the FAO executed AFRICOVER project to achieve this goal. The main output of the AFRICOVER project is a homogeneous landcover mapping for Africa at scales ranging between 1/250000 to 1/100000.

To achieve this momentous objective, the project implementation will start by the harmonisation of the geodetic datum, reference spheroids and map projections. Although it has been decided that all geodetic datums of Africa will be transformed into WGS 84, a Unified Geodetic Datum for Africa is not even noted as a major output of this project. This means that the effort put into the transformation exercise will be so as to achieve mapping accuracies at the 1/250000 scales. These need not be geodetic accuracy specifications.

In this presentation, we propose that the African geodetic community, the IAG, AOCRS, ECA and International Geodetic Organisations such as DMA, IFAG, IGN, etc should cooperate with FAO so that in establishing the mapping datum for AFRICOVER, geodetic standards are achieved. This will enable the geodetic community to compute a Unified Geodetic Datum for Africa (UGDA) which would be linked to the WGS 84, using GPS data collected during the AFRICOVER project campaign.

2. Role of the International Association of Geodesy (IAG)

The IAG Commission for Geodesy in Africa, was abolished by the Executive during the 21st IUGG General Assembly meeting held in Boulder, Colorado in July, 1995.

The main reason for this was that this Commission had become almost inoperative mainly for lack of funding and plausible programmes. The geodetic activities for Africa were however not abandoned.

Instead, these would come under Commission X - Continental Networks, and the African geodetic datum project comes under this Commission.

Further work would also be coordinated by the IAG- Committee for Developing Countries (IAG-CDC) formed in 1992. The purpose of this committee is to coordinate geodetic activities as they affect development in all developing countries.

At present this committee is chaired by Prof Sanso of Italy, the 1st Vice President of IAG. Its membership is drawn from each of the continents of Africa, South America and Asia.

During the IAG meetings at Boulder in July 1995, it was further endorsed that the establishment of an African Geodetic datum should be given a higher priority. A preliminary Working Group was formed with the IAG and Nairobi Regional Centre as the convenors.

No meeting has been called up to now. The reason islack of funds necessary to convene such a meeting. Lack of funds will continue to hinder the implementation of this important project. This is why we now propose that IAG should seize this opportunity and participate in the planning and collection of GPS data to be used for the AFRICOVER project. In doing this, IAG will ensure that the data meets geodetic standards and can later be used to compute a unified geodetic datum for Africa.

3. Use of the ADOS Data

In the computation of the North America Datum of 1983 (NAD 83), the United States used data collected from as far back as 1800s. This data included observations for astrofixes, triangulations, traverses, baselines, longitudes, and azimuths. The data also incorporated the current data obtained from Doppler Satellites and Very Long Baseline Interferometry (VLBI) observations.

We learn from here that Doppler data is acceptable for establishing and strengthening datums. The difference with the African situation is that whereas NAD83 was an improvement of only one Datum, that is NAD 27, in Africa there are more than 20 Datums of all sorts of uncertainties and these have to be unified to get one datum.

The North American experience has shown that we can use good Doppler data (ADOS) to compute a new datum provided all the inputs are in place. On analysing the ADOS results, it was found that of the 310 points established during ADOS, more than 165 points were located on existing control points whose local data is known as shown in Table 1.

NO.	COUNTRY	NO OF ADOS PTS ON EXISTING POINTS AND LOCAL DATA	DATUM USED	ELLIPSOID USED	REMARKS
1.	Algeria	Nil	North Sahara 1959/VOIROL 1960	Clarke 1880	"
2.	Angola	"	"	"	
3.	Benin	1+4*	Point 58 "	Clarke 1880	*Point on Exi-sting T.Point
4.	Botswana	9	Arc 1950	Clarke 1880	
5.	Burkina Faso	2	Point 58	Clarke 1880	
6.	Burundi	4	Arc 1950	Clarke 1880	
7.	Cameroon	4	Minna 1977/ Adindan	Clarke 1880	
8.	Canary Islands	Nil + 6*	N.I	N.I	"
9.	Cape Verde	7	Diff for each Isl.	Inter-national	
10.	C.A.Republic	1+5*	Bangui Local	Clarke 1880	"
11.	Chad	Nil	N.I	Clarke 1880	"
12.	Congo	1 + 4*	Point Noire 1948	Clarke 1880	"
13.	Djibouti	1	CFS(Ayabole)	Clarke 1880	
14.	Egypt	16	EU50,NE50,OE	Intern./Hel-mert 1906	
15.	Eq.Guinea	3 + 3*	N.I	GRS 80	
16.	Gabon	4	Mporaloko	Clarke 1880	
17.	Gambia	Nil	N.I	N.I	
18.	Ghana	8	Leigen(GCS 121)	Clarke 1880	
19.	Guinea	4	Dabola	Clarke 1880	

20.	G. Bissau	3	Bissau	Interna-tional	
21.	Cote d' Ivoire	3	IGN.Astro	Clarke 1880	
22.	Kenya	12	Arc 1960	Clarke 1880	
23.	Lesotho	5	Cape	Clarke 1880	
24.	Liberia	2	Liberia 1964	Clarke 1880	
25.	Malawi	6	Arc 1950	Clarke 1880	
26.	Mali	2	Adindan/ Point 58	Clarke 1880	
27.	Mauritania	Nil + 5*	N.I	N.I	
28.	Morocco	15	Merchich	Clarke 1880	
29.	Mozambique	Nil	N.I	N.I	
30.	Namibia	3	SCHWARZECK	Bessel	
31.	Niger	1	Point 58	Clarke 1880	
32.	Nigeria	9	Minna	Clarke 1880	
33.	Rwanda	Nil + 8*	N.I	N.I	
34.	Senegal	Nil + 3*	Adindan	Clarke 1880	
35.	Seychelles	4	SE Isl.Datum	Clarke 1880	
36.	Sierra Leone	4	Sierra Leone 1960	Clarke 1880	
37.	Somalia	Nil + 3*	Afgooye	Krassovsky 1940	*Point on Existing T. Point
38.	South Africa	6	Cape	Mod.Clarke 1880	
39.	Sudan	3	Adindan	Clarke 1880	
40.	Swaziland	4	Arc 1950	Clarke 1880	
41.	Tanzania	7	Arc 1960	Clarke 1880	
42.	Togo	Nil + 3*	N.I	N.I	"
43.	Tunisia	5	Carthage	Clarke 1880	
44.	W.Sahara	Nil + 5*	N.I	N.I	"
45.	Zaire	Nil + 5*	Arc 1950	Clarke 1880	"

46.	Zambia	Nil + 5*	Arc 1950	Clarke 1880	"
47.	Zimbabwe	6	Arc 1950	Clarke 1880	

Table 1:Country ADOS Stations with Local Geodetic Data.

Others were located on existing trigonometric points but no local geodetic coordinates were provided.

If the concerned member states provided the required data, then more than 200 of the 310 points could be available for analysis to compute the local transformation parameters from the ADOS data. Looking at Table 1, it is difficult to see how the transformation parameters obtained from this data could be used to compute a unified datum for Africa. From this data only, there are more than 20 datums used by about as many countries. After computing the transformation parameters for each country, the problem will be the combination of all these to get one set of parameters for the more than 50 countries of Africa.

IAG could commission a working group to carry out this computation. Alternatively, the computation could stop at the transforming all the national geodetic networks into the Doppler datum. This could now be followed by a GPS survey in which a number of the ADOS or transformed points would be occupied. The relationship between Doppler Transit system and WGS 84 is well known.

Discrepancies from these transformation values and those obtained through observations would then be treated as errors to be used in adjustment process to get the final datum in WGS 84.

4. The AFRICOVER Project Strategy

The strategy for the implementation of the AFRICOVER project is that it will be divided in phases.

The first phase is to start with 12 countries of North-Eastern Africa, starting from Egypt in the North to Tanzania in the South, bounded by Zaire in the West.

After this phase, the other zones will be implemented at sub-regional or national levels. However, the agreed strategy is that the first step will be to unify and harmonise the mapping datum together with the reference spheroid and map projection for the whole continent. The selected mapping datum is WG 84 and all the existing datums in Africa have to be transformed and unified into WGS 84. The vehicle to this goal is the Global Positioning System (GPS). Six years were required to carry out the ADOS project. The total budget for this project is not known because observations were carried out through bilateral agreements.

The only task which was carried out centrally was the processing and publication of results.

This experience could be used for the implementation of a GPS project to establish a datum for Africa. Bilateral agreements would be used for the densification stage in each country. However, there will be need to have a main project to establish about 30 GPS points uniformly distributed across Africa.

These points must be coincidental with ADOS stations and must all be on known existing national geodetic points.

This network of 30 points will enable the computation of transformation parameters between ADOS and GPS which is on WGS 84 datum.

The next step is for each bilateral team to compute the transformation parameters between the national points (as transformed into ADOS) and the WGS84 points. This will be followed by densification in each country and the transformation of all mapping control into WGS 84 for the AFRICOVER project.

5. Recommendation

In the endeavour to achieve a unified and homogeneous datum for Africa through the FAO AFRICOVER project, it is recommended that the following steps should be implemented.

5.1 The African Doppler Survey (ADOS) data should be analysed and its relationship to WGS 84 established.

5.2 For each country with the ADOS points on existing national geodetic control compute the (NATIONAL-ADOS) transformation parameters.

5.3 Analyse the above (NATIONAL-ADOS) shifts for the whole continent and find out if there is any useful pattern to enable them to be combined.

5.4 If no pattern, analyse the values obtained under 5.1, compute (WGS 84-NATIONAL) shifts and see if there is any pattern for points scattered across Africa. If pattern found, select 30 uniformly distributed points and recommend them for an African GPS (AGPS) Campaign.

5.5 Compute this network and new shift parameters for use in datum densification for each subregion or country. This is the new African Datum.

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