



The African Geodetic Reference Frame AFREF

ESESA User Need Workshop

Thread 2: Status of Current GNSS Applications in South Africa

R Wonnacott

Somerset West

2 March 2011



Overview

- **Background**
- **Rationale**
- **Objectives**
- **Institutional acceptance**
- **Progress**
- **Global Context**
- **Comments and concerns**



Background

- Fundamental point of departure for projects, services or products requiring geo-spatial information is a uniform & reliable co-ordinate reference frame.
- Over 50 countries in Africa each with their own geodetic reference system and frame and some with 2 or more systems.
- Although there are many areas of conflict there are also areas where peace has been restored and require a lot of development.
- It is known that many private commercial enterprises are setting up their own reference frames particularly in the oil and mining industries.
- **AFREF is, therefore, an African initiative to unify the geodetic reference frames of Africa based on the ITRF through a network of GNSS base stations at a spacing such users will be at most within ~1000 km of a base station.**



Rationale

- **Surveying & Mapping**
- **Security**
 - Unique international boundary definition
- **Science**
 - Atmospheric research
 - Geophysics research
- **Disaster mitigation**
 - 59% of disasters in Africa are hydro-meteorological in nature
 - drought and flooding (climate monitoring & weather prediction)
- **Infrastructure planning & development**
- **Gap in global coverage & contribution to Global Geodetic Observing System (GGOS) part of GEO etc**



Objectives of AFREF 1

- **To determine a continental reference system for Africa consistent and homogeneous with the global reference frame of the ITRF as a basis for national 3-d reference networks.**
- **To realize a unified vertical datum and to support efforts to establish a precise African geoid.**
- **To establish continuous, permanent GNSS base stations at a spacing such that the users will be within 1000km of a base station and that data is freely available to all nations.**



Objectives of AFREF 2

- **To determine the relationship between the existing national reference frames and the ITRF** to preserve legacy information based on existing frames.
- **To provide a sustainable development environment for technology transfer** so that these activities will enhance the national networks and other applications.
- **Assist in establishing in-country expertise** for implementation , operation, processing and analysis of modern geodetic techniques, primarily GNSS.



Institutional Acceptance

- **UN ECA CODIST (Committee on Development Information, Science & Technology)**
 - Have adopted the Windhoek Declaration
 - Created a Working Group to deal specifically with AFREF
- **UN OOSA (UN Office for Outer Space Affairs)**
 - Have recognized the importance of AFREF for variety of applications
 - Supported travel for some AFREF activities
- **IAG (International Association of Geodesy)**
 - Have created structures to co-ordinate the project and provide technical assistance and expertise
- **IGS (International GNSS Service)**
 - Has strong commitment to support AFREF



Progress to Date 1

- **Inter-disciplinary meetings**
 - Johannesburg June 2008
 - Washington June 2010
 - Joint meetings to discuss co-operative efforts between:
 - AFREF (Geodesy)
 - Africa Array (Geophysics)
 - IHY (Space physics)
 - AMMA-GPS (Meteorology)
 - And others
- **Provisional network computations were completed in 2008 and 2009 to test procedures and methodologies but used data sets from a number of non-publically available stations**



Progress to Date 2

- **There are about 20 IGS stations in Africa**
 - **CDDIS gives about 30 stations**
 - **Some of these in clusters**
 - **Some not operational**
- **There are others which have been installed at academic institutions or airports but are not registered as IGS stations.**
 - **Many of these stations need little or no upgrade to meet IGS standards.**
 - **Apart from IGS stations, South Africa has network of 58 continuous base stations.**
- **There are a number of contractors setting up own local systems such as in oil and mining industry .**



Progress to Date 3

Number of activities underway to install permanent base stations or move towards ITRF

Algeria

Benin

Cameroon

Ethiopia

Kenya

Malawi

Mozambique

Nigeria

South Africa

Tanzania

Uganda

Angola

Botswana

Egypt

Ghana

Lesotho

Moroco

Namibia

Rwanda

Swaziland

Tunisia

Zambia



Progress to Date 4

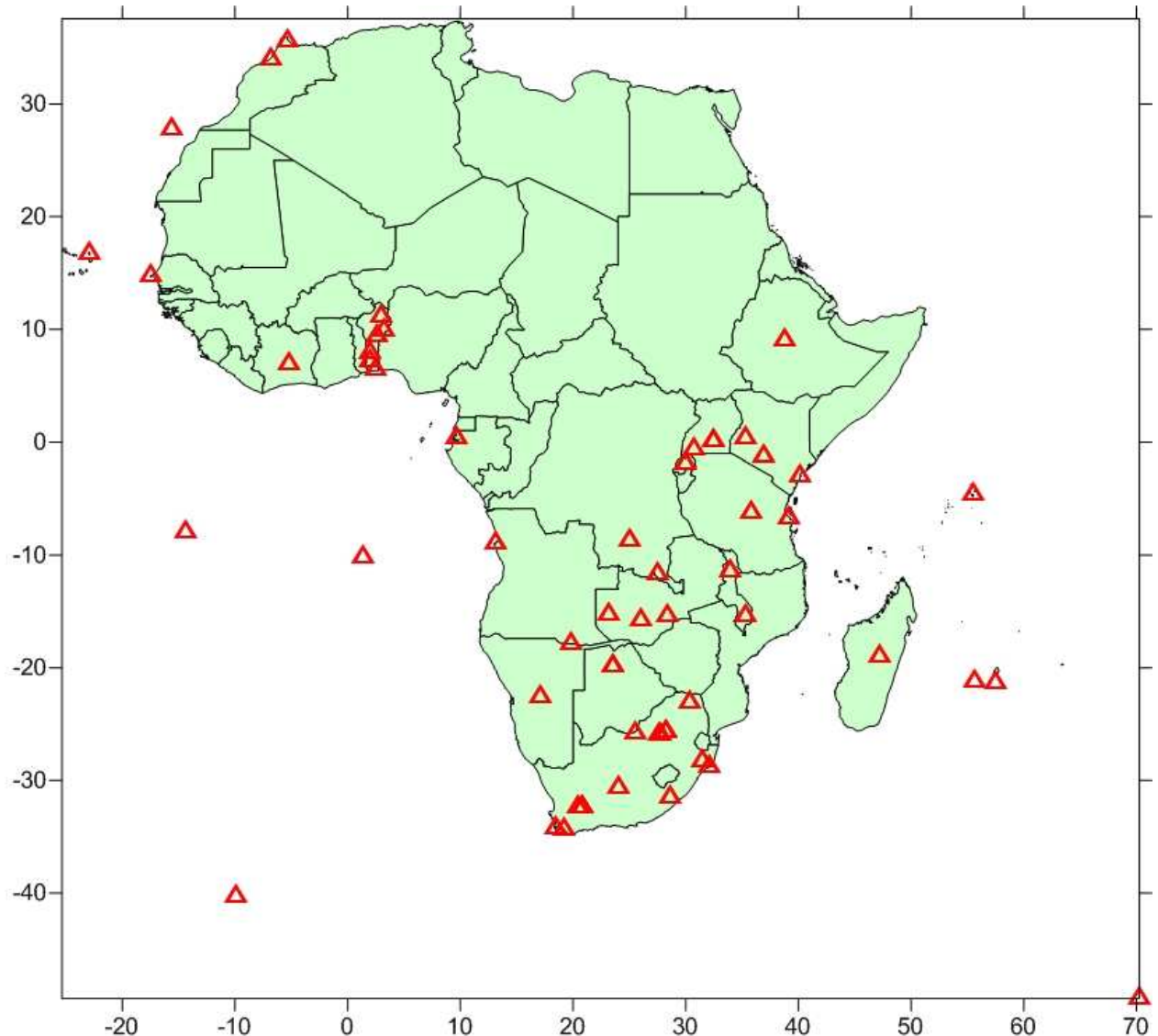
An Operational Data Centre has been established

- www.afrefdata.org or [ftp.afrefdata.org](ftp://ftp.afrefdata.org)
- Data from 45 continuous stations brought together from number of data centres into one place. Data centres include:
 - CDDIS
 - HartRAO
 - NGS
 - TrigNet
 - UNAVCO
- Number of stations listed for which no data available - it is known that these stations are operating but data not available
- Number of campaign stations listed hence only periodic data available



Progress to Date 5

△ Active stations
being archived
at the AFREF
Operational
Data Center
(February 2011)

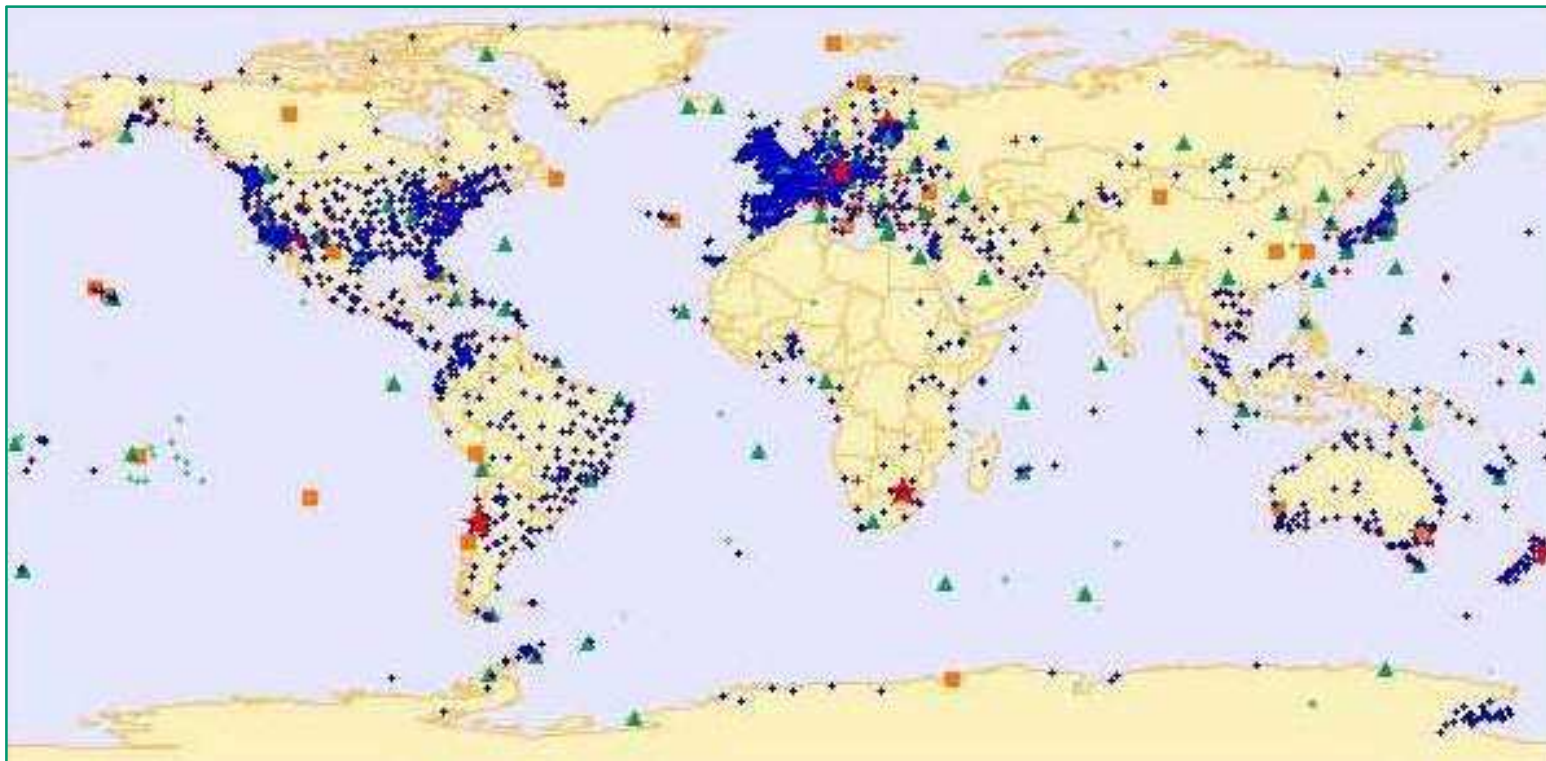




Global Context 1

Global distribution of four space based positioning techniques **available** for realization of International Terrestrial Reference Frame (ITRF)

+ GPS Only ; + DORIS only; + SLR Only; + VLBI Only
★ 4 Techniques; ■ 3 Techniques; ▲ 2 Techniques





Global Context 1

The True Size of Africa

A small contribution in the fight against rampant *Immappancy*, by Kai Krause

Graphic layout for visualization only (some countries are cut and rotated)
But the conclusions are very accurate: refer to table below for exact data

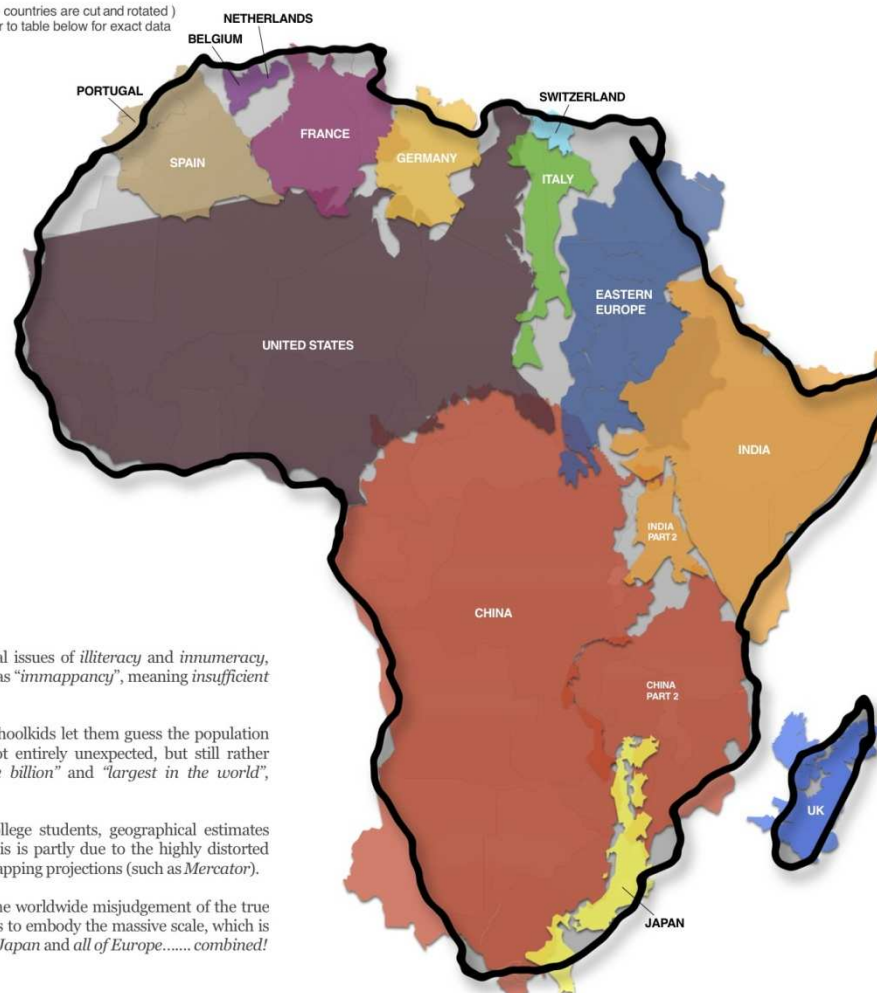
COUNTRY	AREA x 1000 km ²
China	9.597
USA	9.629
India	3.287
Mexico	1.964
Peru	1.285
France	633
Spain	506
Papua New Guinea	462
Sweden	441
Japan	378
Germany	357
Norway	324
Italy	301
New Zealand	270
United Kingdom	243
Nepal	147
Bangladesh	144
Greece	132
TOTAL	30.102
AFRICA	30.221

In addition to the well known social issues of *illiteracy* and *innumeracy*, there also should be such a concept as "*immappancy*", meaning *insufficient geographical knowledge*.

A survey with random American schoolkids let them guess the population and land area of their country. Not entirely unexpected, but still rather unsettling, the majority chose "1-2 billion" and "largest in the world", respectively.

Even with Asian and European college students, geographical estimates were often off by factors of 2-3. This is partly due to the highly distorted nature of the predominantly used mapping projections (such as *Mercator*).

A particularly extreme example is the worldwide misjudgement of the true size of *Africa*. This single image tries to embody the massive scale, which is larger than the *USA*, *China*, *India*, *Japan* and *all of Europe*.....combined!



Top 100 Countries

Area in square kilometers, Percentage of World Total
Sources: Britannica, Wikipedia, Almanac 2010

	AREA km ²	%
Russia	17.098.242	11,50
Canada	9.984.670	6,70
China	9.596.961	6,40
United States	9.629.091	6,40
Brazil	8.514.877	5,70
Australia	7.692.024	5,20
India	3.287.263	2,30
Argentina	2.780.400	2,00
Kazakhstan	2.724.900	1,80
Sudan	2.505.813	1,70
Algeria	2.381.741	1,60
Congo	2.344.858	1,60
Greenland	2.166.086	1,50
Saudi Arabia	2.149.690	1,40
Mexico	1.964.375	1,30
Indonesia	1.860.360	1,30
Libya	1.759.540	1,20
Iran	1.628.750	1,10
Mongolia	1.564.100	1,10
Peru	1.285.216	0,86
Chad	1.284.000	0,86
Niger	1.267.000	0,85
Angola	1.246.700	0,85
Mali	1.240.192	0,83
South Africa	1.221.037	0,82
Colombia	1.141.748	0,76
Ethiopia	1.104.300	0,74
Bolivia	1.098.581	0,74
Mauritania	1.025.520	0,69
Egypt	1.002.000	0,67
Tanzania	945.087	0,63
Nigeria	923.768	0,62
Venezuela	912.050	0,61
Namibia	824.116	0,55
Mozambique	801.590	0,54
Pakistan	796.095	0,53
Turkey	783.562	0,53
Chile	756.102	0,51
Zambia	752.612	0,51
Myanmar	676.578	0,45
Afghanistan	652.090	0,44
Somalia	637.657	0,43
France	633.834	0,43
C. African Rep	622.984	0,42
Ukraine	603.500	0,41
Madagascar	587.041	0,39
Botswana	582.000	0,39
Kenya	580.367	0,39
Yemen	527.968	0,35
Thailand	513.120	0,34
Spain	505.992	0,34
Turkmenistan	488.100	0,33
Cameroon	475.442	0,32
Papua New Guinea	462.840	0,31
Uzbekistan	447.400	0,30
Morocco	446.850	0,30
Sweden	441.370	0,30
Iraq	438.317	0,29
Paraguay	408.752	0,27
Zimbabwe	390.757	0,26
Japan	377.930	0,25
Germany	357.114	0,24
Rep. d. Congo	342.000	0,23
Finland	338.419	0,23
Vietnam	331.212	0,22
Malaysia	330.803	0,22
Norway	323.802	0,22
Côte d'Ivoire	322.463	0,22
Poland	312.685	0,21
Oman	309.500	0,21
Italy	301.336	0,20
Philippines	300.000	0,20
Burkina Faso	274.222	0,18
New Zealand	270.467	0,18
Gabon	267.668	0,18
Western Sahara	266.000	0,18
Ecuador	256.369	0,20
Guinea	245.857	0,17
United Kingdom	242.900	0,16
Uganda	241.038	0,16
Ghana	238.539	0,16
Romania	238.391	0,16
Laos	236.800	0,16
Guyana	214.969	0,14
Belarus	207.600	0,14
Kyrgyzstan	199.951	0,13
Senegal	196.722	0,13
Syria	185.180	0,12
Cambodia	181.035	0,12
Uruguay	176.215	0,12
Suriname	163.820	0,11
Tunisia	163.610	0,11
Nepal	147.181	0,10
Bangladesh	143.998	0,10
Tajikistan	143.100	0,10
Greece	131.957	0,09
Nicaragua	130.373	0,09
North Korea	120.538	0,08
Malawi	118.484	0,08
Eritrea	117.600	0,08
TOP 100 TOTAL		132.632.524



United States



Europe



India



Japan



China

AFREF

African Reference Frame

