



# AFRICAN GEODETIC REFERENCE FRAME

## (AFREF)-NEWSLETTER

Regional Centre for Mapping of Resources for Development (RCMRD)

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### Introduction

The purpose of this newsletter is to inform AFREF members the status of the establishment of AFREF within the African countries. It also creates a forum for discussion and exchange of information and experiences in the implementation of AFREF.

The objective of the AFREF initiative is to unify and modernize the geodetic reference frame in Africa. The initiative encourages African governments through their national mapping agencies to modernise their geodetic networks using modern GNSS technologies including establishments of a network of CORS providing a variety of services including DGPS/RTK correction and supporting variety of applications including mapping, engineering, cadastral, weather, geodynamics and so on. When fully implemented especially at national level, it will consist of a Real Time Networks (RTNs) where raw data and RTK/DGNSS correction would be available for various economic applications.

This newsletter highlights the status of AFREF implementation since inception in 2005. This is what the author could gather. However, it is possible that there could be countries that have already implemented AFREF or modernised her geodetic network and this may not be captured in this report. Please let others know your geodetic modernization status!

African countries particularly through their national mapping organisations are encouraged to establish RTNs and contribute GNSS data to AFREF data holding centre.

Other national and international organisations establishing CORS in the continent for various applications such as research on earth sciences are encouraged to disseminate GNSS data to AFREF data holding centres.

RCMRD wherever possible is willing to source for hosting organisations within member States for those international organisations willing to support establishment of CORS in Africa.

GNSS data from AFREF CORS is currently being achieved at AFREF Operational Data Centre, (AODC), <http://www.afrefdata.org/> currently being hosted by National Geo Information (NGI) agency in South Africa. One may check the current status. Other documents relating to AFREF can be found at [AFREF website at UNECA](#) and at [RCMRD](#)

AFREF Newsletter is a publication of RCMRD as it strives to keep the AFREF project running!

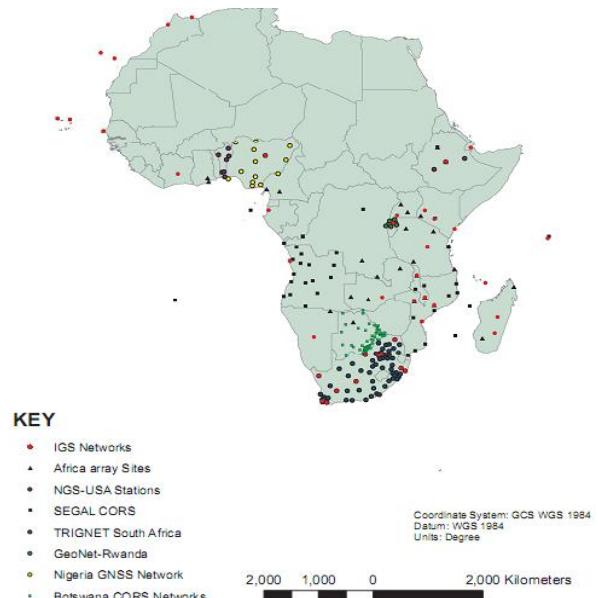
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### AFREF Status Report (since 2005)

#### Background and Objectives

AFREF was established and launched in 2005 under the Committee for Development Information – Geo-Information, (CODI-GEO) of the United Nations Economic Commission for Africa (UNECA) with endorsement from International Association of Geodesy (IAG), International Global Navigation Satellite System (IGS), United Nations Office of Outer Space Affairs (UNOOSA) and Federation of International Surveyors (FIG)

The primary goal of the AFREF project was *"to unify the horizontal and vertical geodetic reference systems, datum and references frames in Africa in support of the ideals of NEPAD"*. ([For the ideals of NEPAD see The New Partnership for Africa's development \(NEPAD\) October 2001](#)). This was to be achieved through unification and modernization of African datum and coordinate systems using Global Navigation Satellite Systems (GNSS), Altimetry and Gravity technologies and establishment of Continuously Operating Reference Stations. It was envisioned that implementation shall be done at national level and coordinated through regional bodies such as RCMRD/RECTAS and ECA at continental level. This was to ensure same standard was maintained and assist in data/CORS sharing and border areas. Implementation at National means that countries would modernize their geodetic networks and establish CORS through their own budget and contribute at least a single CORS for AFREF computation.



Many international organizations have supported this initiative since inception including IGS, AfricaArray, Segal, Trimble, Leica, training and research organizations, and regional geo-information organizations and mapping organizations in Africa by donating and hosting GNSS equipment, disseminating and training African stakeholders.

The implementation strategy was “implement national, coordinate regional and continental” through establishment of national CORS networks and contribute some CORS data to AFREF computations.

#### Current Status of CORS Establishment in Africa

Currently over 100 CORS have been established to date and more are being established. Most CORS however have been established through the efforts of international organizations including IGS, AfricaArray, National Geospatial Service-USA (NGS-USA) and Segal. Some African countries have also established CORS networks as shown in the map.

**International GNSS Service (IGS)**, is a network of voluntary organizations of over 200 self-funding agencies, universities, and research institutions in more than 100 countries. IGS has established over 400 CORS and is continuously establishing more in the world for scientific advancement for public benefit. It provides GNSS data and products freely via [IGS data holding centers](#). Some IGS stations in Africa also participate in IGS Real Time Project and therefore disseminate RTK/DGNSS corrections via [IGS Caster](#).

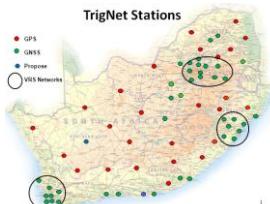
**AfricaArray**, is a public-private partnership supporting training & research in earth, atmospheric and space sciences in Africa. It was established and launched in July 2004 under the Organization for African Unity's New Partnership for Africa's Development (NEPAD). AfricaArray has established over 25 CORS in Africa since 2009. Station data and information are available at [AfricaArray data archive](#)

**Space & Earth Geodetic Analysis Laboratory (SEGAL)** [SEGAL](#) is a collaborative scientific venture between University of Beira Interior (UBI) and Institute Geophysical Infante D. Luiz (IDL). SEGAL, in collaboration with many institutions, has installed and is maintaining a network of over [100 GNSS stations](#) distributed across Europe, Africa, South America, and Asia.

**National Geodetic Survey (NGS)-USA** is the national mapping organization in USA. NGS established CORS in some countries such as Ghana and Ethiopia through USA millennium development fund. Ghana has seven (7) CORS while Ethiopia has three (3) from this initiative. These CORS are currently being manned by the respective countries but data and products are available at [NGS data holding site](#). The data and products could also be available from the respective mapping organizations.

#### National Mapping Authorities

Some countries have established CORS networks through their own national budget and donor agent. The following are some countries that have established and are maintaining CORS.



**TrigNet** is CORS network in South Africa. It has over 55 CORS station. (see map). It provides raw data RINEX files, Single and Network RTK/DGNSS South Africa.

**RwandaGeonet** real time geodetic network in Rwanda. It has 8 CORS stations distributed all over Rwanda. It provides raw data RINEX files, Single and Network RTK/DGNSS corrections. Data and products are available freely on [registration](#) to all users in Rwanda.



**BotswanaNet** real time geodetic network in Botswana with over 55 CORS stations distributed all over country including two from neighboring TrigNet of South Africa.



Botswana has been establishing an average of 10 CORS per year since this project started in 2011. It provides raw data RINEX files, Single and Network RTK and DGNSS corrections. Data and products are available on [registration](#).

**NIGNET**, is a CORS network for Nigeria that has established fifteen (15) Global Navigation Satellite System (GNSS) Continuously Operating Reference Stations (CORS) across the country.

Other countries planning to establish a network of CORS this year include Kenya, Uganda, and Namibia.

Feasibility studies on establishment of CORS geodetic network and determination of optimum number of CORS have been done at RCMRD for some of her member States including Botswana (under implementation), Ethiopia (2013), Rwanda (already implemented), Mauritius (2016), Swaziland (2014), Zambia (2016) and Zanzibar (2012).

Most of the CORS that have been implemented so far were established by international research related organizations like IGS, SEGAL, and JAXA but unfortunately most of the hosting countries do not use these CORS even for post processing purposes. Members are encouraged to use and integrate these CORS in their Real Time National geodetic frameworks including generating RTK and DGNSS solutions for wider applications to support their national development.

Hardware and software are becoming cheaper with the increase in GNSS manufacturers and development of cheaper and open source software to manage CORS networks.

#### RCMRD/JAXA Partnership in the Establishment of CORS in Africa.

Japan Aerospace Exploration Agency (JAXA) satellite Navigation Unit in collaboration with RCMRD has established a CORS at Dedan Kimathi University (DKUT) Nyeri, Kenya for Multi-GNSS Monitoring Network (MGMNNet). JAXA donated Trimble NetR9 and JAVAD RingAnt-DM GNSS Antenna. The CORS is tracking GPS, GLONASS, Galileo and Bedouin satellite signals. RCMRD is also contributing to GNSS data stream of RCMN CORS MGMNNet. RCMN is an IGS CORS station housed in RCMRD compound in Nairobi, Kenya. RINEX files are available from [JAXA ftp site](#)



RCMN also contributes data to IGS and IGS real-time project. RINEX data are available from [IGS ftp sites](#) and RTK corrections are available from [IGS caster](#) at mount point RCMN0. RCMRD also disseminates RINEX files, RTK and DGNSS corrections of RCMN and DKUT via [AFREF site](#).

## African Action Plan on Global Geospatial Information Management (AAP-GGIM)

The United Nations Global Geospatial Information Management ([UN-GGIM](#)) initiative was established and adopted by United Nations Economic and Social Council (UNEC) resolution 2011/24 to create a formal geospatial information coordination mechanism involving Member States as the key stakeholders.

The need for a global coordination mechanism for Geospatial Information Management (GIM) has been further emphasised by the United Nations (UN) 2030 Agenda for Sustainable Development and the African Union (AU) Agenda 2063.

The African Action Plan on Global Geospatial Information Management ([AAP-GGIM](#)) is an implementation tool of [UN-GGIM for Africa](#) which responds to the recommendation of the African GGIM Preparatory meeting held in August 2011 urging Member States, the Economic Commission for Africa (ECA) and the African Union finalize and implement African Action Plan on Geospatial Information Management.

The Action Plan proposes the following on AFREF under section A2.2.1.1 to A2.2.1.4:

- Undertaking an inventory of already established COR in every country through a questionnaire/online;
- Designing a regional CORS network to optimize the design of national networks;
- Designing national networks to guide second administrative levels in locating CORS in their jurisdictions;
- Establishing about 44 CORS to ensure at least 1 per country.

## Feasibility study on implementation of AFREF in Zambia and Mauritius

### Zambia CORS Network

The Zambian Geodetic Network is comprised of Primary Trig Stations (ZP) of the first order network, Secondary Stations (ZS) and Tertiary Stations (ZT) triangulation and Pillars. These were based on old triangulation surveys. Most of the primary stations and a few secondary stations were re-surveyed in 2006 during the SEED Support to Economic Expansion & Diversification (SEED) Programme using by GPS static survey approach.

The survey was linked to the AFREF (Africa F Reference E Frame) network through the local IGS CORS Station, ZAMB at Lusaka. Other surveys including International Boundary GPS observation campaigns (Zambia/Malawi & Zambia/Mozambique) and Land Audit Programme have also linked to this CORS.

The study established that the Zambia can be adequately covered by almost 70 CORS stations for Networked RTK solutions, but proposes progressive implementation by first establishing CORS

for single point RTK solutions at the 10 (red in the map) regional Centers followed later at district (green in the map) Centers.

### Mauritius CORS Network

Mauritius has a modern static geodetic network in line with AFREF requirements referred to as Geodetic Datum of Mauritius 2008 (GDM 2008). It's tied to ITRF 2005 and WGS84 Reference Ellipsoid and Grid Coordinates is as Map Grid of Mauritius (MGM 2008) based on Universal Transverse Mercator (UTM) Zone 40 and Zone 41 South. GDM2008 is composed of 19 primary and 62 secondary points.

The transformation parameters from old Le Pouce Grid to GDM2008 are also been determined. Le Pouce grid was based on Clarke 1880 ellipsoid and Lambert Conical Orthomorphic projection at Le Pouce PTP01 point as the origin. The 3 Parameter transformation is based on Molodensky's Formula while 7Parameter Transformation on Bursa-Wolf Method. Mauritius has also a local grid determined in 2012 and is based on GDM2008 and Lambert Conformal Conic Two Parallel project at Verdun PTP0391 as the point of origin.



Two CORS stations are available in Maurice Rodrigues Island and are manned by SEGAL/JAXA. The study proposes that both CORS be upgraded to disseminate DGNSS and RTK solutions to be more beneficial to the hosting country. Single base RTK solutions from each would cover each Island. To cover wide area of Mauritius waters, the study proposes the establishment of three (3) CORS in the North (RIVIERE DU REMPART), south eastern (GRAND PORT) and south western (BLACK RIVER) region. This would ensure that RTK and DGNSS solutions are available within 70km and 150km respectively beyond the mainland of Mauritius.

The study for both Zambia and Mauritius were carried out by RCMRD.

## Workshops and Training announcements

### Training on AFREF and Global Navigation Satellite System (GNSS) Data Processing

Training on African Geodetic Reference Frame (AFREF) and Processing of Global Navigation Satellite System (GNSS) workshop is scheduled from 5<sup>th</sup> to 17<sup>th</sup> September 2016 at RCMRD, Nairobi, Kenya. This is an annual training held at RCMRD.

The main objective of the course is to build the required technical capacity to implement and operate the Africa Reference Frame (AFREF) project. It is designed to provide practical skills in setting up CORS, processing of GNSS data and operationalization of AFREF project at national level. The topics to be covered will include GNSS technology, CORS instruments and set up, observation requirements and planning, CORS geodetic network design, reference systems and coordinate systems and GNSS data processing.

For more information please check the training [brochure](#) or contact [muyack@rcmrd.org](mailto:muyack@rcmrd.org)