Introduction

The purpose of this newsletter is to create a forum for discussions 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 for Africa. When fully implemented, it will consist of a network of continuous, permanent GPS stations such that a user anywhere in Africa would have free access to the generated data.

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A First Processing of AFREF Co-ordinates
By Richard Wonnacott

What stations to be used

The AFREF Steering Committee in a meeting held in Nairobi in October 2012, reported and agreed that a set of static co-ordinates should be computed for a number of permanent GNSS base stations in Africa. As a result, the AFREF Operational Data Centre (ODC) proceeded to monitor the number of stations for which data was being archived on a daily basis to identify a period of approximately two weeks during which data from a large number of stations was archived.

 The ODC currently has access to approximately 110 permanent stations, not all of which provide data on a regular basis or are providing data at all. A peak period was identified between Days 337 and 350 (2-15 December 2012) during which data from an average of 49 stations was archived daily at the ODC. A similar peak has not been reached since then and it was decided therefore to use data from this period to compute a set static co-ordinates.

In identifying the period to be selected for computation it became apparent that a number of stations are located very close to one another. Some stations are less than 5km apart while, in

one instance, we have two stations as close as 36 metres from one another. I would like to appeal to agencies and organizations contemplating to
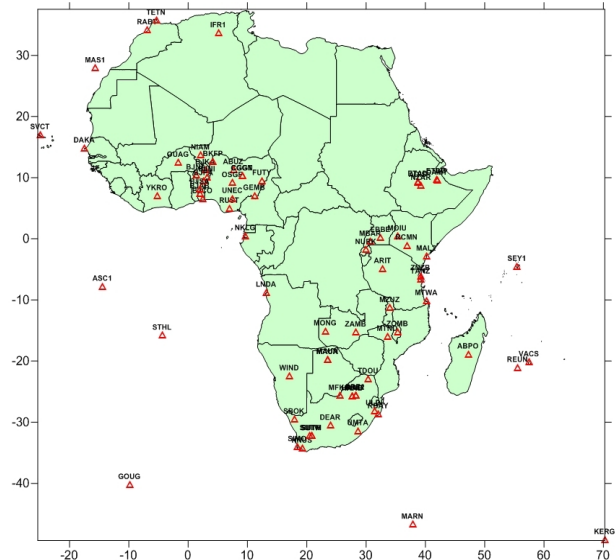

Figure 1 Stations for which data is archived in the AFREF ODC as at 4 January 2013

the install permanent GNSS base stations, to contact the AFREF Steering Committee to find out what stations are located close to the area in which a new station installation is being planned. Figure 1 is a broad overview of stations to which the ODC has access.

What is a set of static co-ordinates?

It is well known among geodesists, surveyors and geophysicists that the continents and tectonic plates within the continents are continually moving and consequently any permanent GNSS base station to be used as a reference for geospatial positioning will move with the plates. It is common practice to include the estimation of a velocity vector for base stations when computing their positions at any given epoch which in effect means that station co-ordinates need to be continuously updated to cater for the motion. The continuous changing of station co-ordinates is not very practical for National Mapping Authorities (NMAs), surveyors and GIS practitioners who have to refer all surveys and mapping projects to a same set of co-ordinates. A set of static co-ordinates is, therefore, computed based on reasonably

short interval (two weeks) of GNSS data to which all surveying and mapping projects will, in future, be referred. The survey of an international boundary between two or three countries for example must be related to co-ordinates of the same epoch.

How the Co-ordinates are to be computed

Five centres have agreed to carry out the computation independently of one another using different high level GNSS processing software. The centres are:

> ➢ Ardhi University, Tanzania / University of Purdue, USA - Elifuraha Saria.
> ➢ Centre for Geodesy and Geodynamics, Nigeria – Joseph Dodo.
> ➢ Hartebeesthoek Radio Astronomy Observatory, South Africa - Ludwig Combrinck.
> ➢ Surveying and Mapping Division, Ministry of Lands, Tanzania – Peter Morgan.
> ➢ University of Beira Interior, Portugal - Rui Fenandes.

The computation will include approximately 50 globally distributed GNSS based stations selected by Zuheir Altamimi at the Institut Geographique National in France. They will also combine the results from each center's computation to provide a set of static co-ordinates based on the 2008 realization of the International Terrestrial Reference Frame (ITRF08) at the epoch of the observation period i.e. between days 337 and 350 of 2012. It is hoped that an individual center's computations and the combination of the results can be completed before the end of April 2013. The results will be scrutinized before being released for general use. The second phase of the project will be the regular computation of the network and the inclusion of new points into the network as well as the computation of velocity vectors for each station.

The AFREF Steering Committee would like to thank all agencies and organizations that have established and maintain permanent GNSS base stations and make the data openly and freely available for the AFREF project and the geospatial information community in general. Without your commitment this project cannot succeed.

Status of the Implementation of the CORS network in Botswana, by Muya

The Department of Surveys, Mapping and Land Board of Botswana in conjunction with RCMRD have been working together in the establishment of a Real Time GNSS network. On completion, the network is expected to disseminate DGPS and RTK solutions cross the whole country.
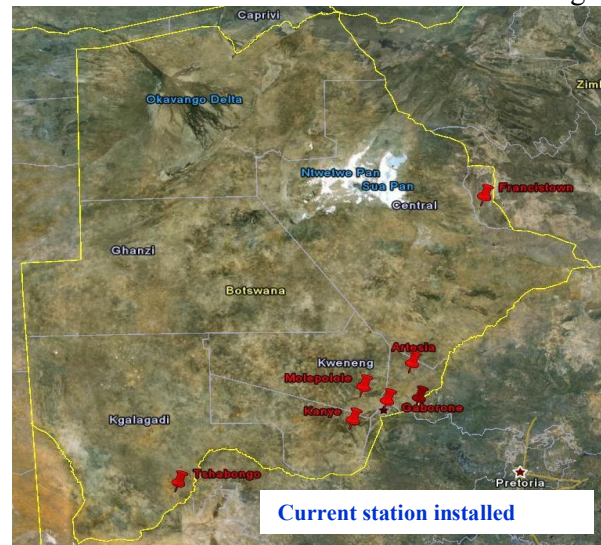

Figure 2: An installed Trimble NetR9 GNSS Receiver

The RCMRD is acquiring the GNSS receivers And other necessary hardware and software including the server systems for the project. To date, twenty three (23) Trimble NetR9 receivers have been procured, seven (7) of these have been installed by team of surveyors from DSM, Land Boards and RCMRD. The rest shall be installed in May and June. DSM and Land Board surveyors are expected to install the rest of GNSS receivers as they are procured. Network Management Software, The Trimble Pivot Platform (TPP), has been acquired and installed at the DSM offices. Training on the installation, configuration and testing was carried to DSM during installation.

The system is configured to disseminate both RTK and DGPS real time products. RTK Network products 30-70km spans around 30-Gaborone at Gaborone, Kanye Molopolole, Artesia and Mathubudukwane while Single
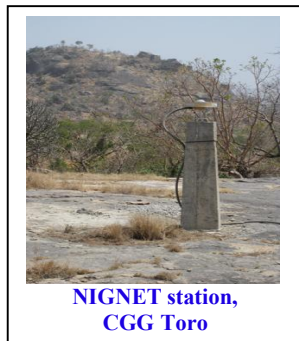

Current station installed

RTK products from major towns at Francistown and Tsabong. Rover tests were carried out using

internet radio during the systems configuration. Physical rover tests could not however be carried out during the configuration since there was no ready static IP address to access the TPP servers. During writing of this, IP address was still not assigned.

The Centre for Geodesy and Geodynamics (CGG), Nigeria By: Dr. J. D. Dodo

The Centre for Geodesy and Geodynamics (CGG), Toro, Nigeria is one of the activity centres under the National Space Research and Development Agency (NASRDA). It was established by the National Space Research and Development Agency of the Federal Government of Nigeria in 2002.

The Centre is charged with the primary responsibility of carrying out scientific research and monitoring activities in crustal and coastal deformation and subsidence that could lead to earthquake, tremors, and volcanic eruption through participation in Global Earth Observation Systems and a Global Crustal Deformation Monitoring Scheme.

NIGNET station, CGG Toro

The Centre was admitted into the International GNSS Community in 2011 with the adoption of the GNSS tracking station at the Centre as a Global GNSS Station (IGS Station). The Centre now contributes data to the global GNSS data repository at CDDIS. The Centre ID is CGGN with domes number 33812M001.

The Centre hosts one of the Nigerian Permanent GNSS Reference Network (NIGNET). The goal of the NIGNET is to implement new reference frame for Nigeria as recommended by AFREF initiative under United Nation Economic Commission of Africa (UNECA) through Committee on Development, Information Science and Technology. Data from CGGT is stream to the Office of the Surveyor General in Abuja.

CGG Toro has been involved in different GNSS research activities. These include among others; Development of Geocentric Datum of Nigeria (the Nigerian Reference Frame Project); the Nigerian Geoid Project; Subsidence

Fig Congress 2010 FS-2H , Rui & others

monitoring using GNSS; GNSS seismology; Troposphere and Ionosphere modelling etc. The centre's capability in these areas makes it possible to become one of AFREF Data Processing and Analysis Centre. The centre uses High GNSS Scientific Software such as the Bernese GNSS Software and other in-house programme to carry-out her research work. The data from NIGNET can be obtained from **http://server.nignet.net/data/**

Feasibility Study on the Establishment of Continuous Operating Reference Stations (CORS) in Zanzibar. By Muya

A Team from RCMRD undertook a mission to Zanzibar from 24th September to 28th September 2012 and in consultation with department of Surveying & Mapping (DSM) undertook the study The aim of the study was to

Fig. 1 GPS receiver donated by Boston University

review the current geodetic network and efforts being undertaken to upgrade it, identify, meet and assess possible partners and users in Zanzibar for the implementation of the CORS project, establish the optimum number of required CORS, carry out a Training Needs Assessment of Department of Surveys and Mapping in the implementation and

Fig 2. CORS Antenna

management of CORS Network, and conduct sensitization workshop on CORS Applications to stakeholders.

Zanzibar currently has one (1) CORS (green buffer in fig. 3) housed in Ugunja Island, at Karume Institute of Science and Technology (KIST), IT Building. The Antenna is erected on the roof top and anchored on the flat concrete roof. The CORS was installed and currently being managed by SEGAL (Portugal) for earth sciences studies and supported by DSM locally. Data to SEGAL is being transmitted through the internet. Static data is available to DSM via manual download at the site. The proposed that the CORS be upgraded to transmit both DGPS and RTK products to widen its use and make more useful in Zanzibar.
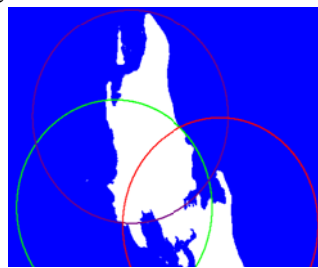

Fig 3. Buffers at 30km radius

The study also proposed establishment of two(2) more CORS at Uganja Island at Panje Ntule (red buffer) in the South and Mkwajuni in the north. Suitable sites were also identified on the rooftops of the buildings.
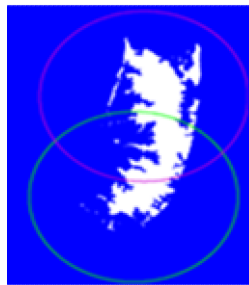
In Pemba Island, two(2)

Fig. 4, Pemba Island, buffers at 30km radius

CORS were proposed at Wete (pink buffer) and Mkoani (green buffer). Both are large towns in the north and south of the Pemba Island and have adequate utilities for the establishment of CORS.

AfricaArray workshop in January 2013 in South Africa

The 8th Annual AfricaArray Workshop, 15 - 18 January 2013, School of Geosciences, University of the Witwaterssrand, Johannesburg, South, Africa. For information, download the proceedings from http://www.africaarray.psu.edu/

Upcoming Workshops and Trainings

AFREF and GNSS Data processing
Annual AFREF and data processing workshop this year would held from 2nd September to 13th September 2013 at RCMRD, Nairobi Kenya. The objectives of the course will be to provide technical skills in the installation and management of GNSS base stations, data handling, dissemination and processing towards AFREF realization. The training would cover Introduction to Global Navigation Satellite System (GNSS); Reference systems, datum and coordinate systems; use of IGS data and products including from data from AFREF stations; AFREF concepts and progress; Establishment of National Real Time GNSS Networks; Practical field works on Static and RTK surveys; practical post and online GNSS data processing. GNSS Registration is currently on-going. For more information, contact Muya Kamamia at muyack@rcmrd.org

GNSS Data Application to Low Latitude
A workshop on GNSS Data Application to Low Latitude Ionosheric Research, 6 - 17 May 2013, Abdus Salam International Centre for Theoretical Physics (ICTP), Trieste, Italy. For more information, http://www.ictp.it/programmes.aspx

ION GNSS+ 2013 Call for Abstracts
Organized by the Institute of Navigation (ION), GNSS+ 2013, the 26th International Technical Meeting of the Satellite Division, is open for abstract submissions. The conference will take place on 16-20 December 2013 at the Nashville Convention Centre, Nashville, USA.
ION GNSS+ 2013 is the world's largest technical meeting and showcase of GNSS technology, products and services and brings together international leaders in GNSS and related positioning, navigation and timing fields to present new research, introduce new technologies, update current policy, demonstrate products and exchange ideas. This year's conference will feature pre-conference tutorials on 16th and 17th September, a policy and panel discussion, a commercial and applications oriented track and more than 250 technical papers on a diverse array of topics. For more information, www.ion.org