AFREF - Lesson Learnt After the First GNSS Reference Station Launched

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Key words: AFREF, GNSS, Geodetic Network, Reference Frame

SUMMARY

The African Geodetic Reference Frame (AFREF) is conceived as a unified geodetic reference frame for Africa - the fundamental basis for the national and regional reference networks.

In March 2007, the first permanent GNSS reference station was launched in Kenya. Leica Geosystems supports the project with its knowledge, as well as via donation of a complete system.

Currently, African countries each maintain their own geodetic reference system. In the past, this resulted in mismatched maps at national borders or even in the same country; in Kenya alone there are currently two different mapping coordinate systems in use.

The African Geodetic Reference Frame (AFREF) shall build a fundamental basis for a continent-wide reference network system, consisting of permanent Global Navigational Satellite Systems (GNSS) stations. The goal is to provide users free access to GNSS data and products, with a maximum distance of 500 km from the next reference station - anywhere in Africa.

In March, the Regional Centre for Mapping of Resources for Development (RCMRD) established the first permanent reference station in Kenya as part of the AFREF project. “As we move toward more regional integration and adopt regional approaches to peace and security, environmental management, trade and industry, we require maps that are accurate-both within each country and also across national boundaries. This will now be possible through the establishment of a common geodetic reference frame”, stated Prof. Kivutha Kibawana, Minister of Lands in Kenya, during the opening ceremony.

Leica Geosystems supports the AFREF projects with both its knowledge, and financial sponsorship by donating the complete system. The first AFREF Reference Station consists of a Leica GRX1200 Pro GG receiver, a Leica AT504 GG Choke Ring antenna and the Leica GPS Spider Software and Site Server as well as the Leica GNSS QC Software for permanent quality control and data analysis. The author said: “AFREF will serve both the sub-Saharan region and the international community. It will increase capacity, modernize and harmonize geodetic reference networks in the country, thus strengthening survey work and providing accurate data to support the private sector as well as business and policy makers. As a global acting company, it is within our interest to help establish a geodetic network for Africa with the most advanced technology!”

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1. INTRODUCTION

The African Geodetic Reference Frame (AFREF) is conceived as a unified geodetic reference frame for Africa - the fundamental basis for the national and regional reference networks.

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Fig 1: Joel van Cranenbroeck, Leica Geosystems explains the reference station to the Minister of Natural Resources, Environment and Lands and his delegation.

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2. FROM THE FIRST AFREF WORKSHOP TO THE FIRST REFERENCE STATION

2.1 AFREF Technical workshop on July 2006

The UNAVCO Facility, in support of NASA GGN and IGS activities, participated in the AFREF Technical workshop at the University of Cape Town in South Africa on July 9-13, which was attended by approximately 40 delegates from national surveying and mapping agencies around Africa.

The AFREF project is organized under the auspices of UNECA, the United Nations Economic Commission for Africa, to promote the establishment of consistent geodetic control throughout Africa. UNAVCO participated as part of an international team of geodetic experts to help build technical capacity within Africa to implement and manage the project.

UNAVCO also funded travel for twenty of the delegates to attend the workshop on behalf of NASA. The workshop was deemed highly successful, with many of the participating delegates committing their support and resources to the project.

Fig 2: AFREF Technical Workshop participants

Leica Geosystems participated also at that time to that workshop and support financially the

event.

Despite a large enthusiasm and commitment from all the delegates and an intensive and exhaustive review of the Reference Station technology by the academics it appeared well however that the fundamental key of the success for AFREF would be also the financial capacity for the African countries to deploy and maintain effectively their contribution where Internet connectivity would play a significant role to gather and disseminate the observations.

2.2 The African Doppler Campaign ADOS 1981 - 1986

AFREF is not the first attempt to bring Africa a unified geodetic network and already in 2000 Aleksandra BUJAKIEWICZ Professor at the Institute of Photogrammetry and Cartography, Warsaw University of Technology, Poland reported in the International Archives of Photogrammetry and Remote Sensing. Vol. XXXIII, Part B6. Amsterdam 2000. (http://www.isprs.org/proceedings/xxxiii/congress/part6/48_xxxiii-part6.pdf)

"In Africa, the awareness on advantages of geo-information technology has been growing continuously from the number of years because of information transfer through electronic networking, participation in international, regional and national workshops and seminars, many internationally sponsored projects, long and short term training of African professionals in Europe, USA and African regional training centers (such for example as within Southern Africa the Regional Centre for Services in Surveying Mapping and Remote Sensing in Nairobi, Kenya or Satellite Applications Centre in Pretoria, South Africa), and implementation of principles of geo-information technology to the national education programmes. Therefore, this technology has been already accepted in a long term plans of most of African countries. However, the speed of implementation of this technology is much slower than in other parts of the World because of organizational, institutional and technical problems and restrictions.

The main problem is lack of up-to-date geometric, Geo- referenced digital information on terrain which is required as a frame for various thematic information's, particularly;

- The up-date, accurate and uniform geodetic networks,
- The up-date digital maps (topographic and large scale) and 3D digital data bases used for cadastre, utilities, and other applications.

The Geo-referenced information which must be consistent and homogeneous can only be available if there is a homogeneous Geodetic Network, which is the basis for any further surveys on the land.

In most countries the geodetic networks were established a few decades ago and the accuracy, reference systems and other required standards are not uniform and sufficient.

The importance of such homogeneous Geodetic Network for African countries has been recognized and the African Doppler Survey campaign (ADOS), which was coordinated by the

International Association of Geodesy (IAG) and the International Union of Geodesy (IUGG) and sponsored by many countries and organizations, took place from 1981 to 1986.

The results of the ADOS campaign showed that the main problems were not solved. The UN has subsequently recognized that except for Kenya and Zimbabwe, most African countries have not maintained their geodetic network, their base-map stock and their mapping capacity.

The implementation of GPS technology in most of African countries would help to solve this very important task but it still might take quite long time. The Regional projects, internationally sponsored, for establishment of the homogeneous Higher order regional GPS networks, have been started (like for example for the part of Southern Africa Region) but it will take time to finish it and subsequently to correct and adjust all national lower order networks."

The author has been confronted to the reality of the ADOS campaign results when in November 1987 he managed for the Belgian National Geographic Institute, Department of Geodesy, the stereo preparation along the Ruzizi River between the Kivu and the Tanganyika lakes using the first time GPS technology.

At that time the Royal Observatory of Belgium was one of the computation centres for ADOS and on the way to release the first results. We were expecting to use at least some of the benchmarks surveyed using the Doppler Navigation based technology and processed for the ADOS campaign but all of them were just demolished.

2.3 Motivation and sustainable donation

The main motivation from Leica Geosystems and the author were then to contribute on a sustainable way to the creation of AFREF, motivated by our experience of geodesy in Africa.

Instead of looking for used and second hands equipments we make it clear that for being serious in our participation the equipments must be of the most advanced class supporting GNSS signals and not only GPS with the software's capacity to produce RINEX and Networked Transport of RTCM via Internet Protocol (NTRIP) to feed the AFREF computation centre and the IGS Real Time Data center.

The donation consisted of three full GNSS Reference Station including hardware (GNSS Receiver and choke ring antenna with cables and power converter) and software's with support on the installation, training and maintenance by Leica experts.

During the workshop, the participants welcomed that proposal and decided that the RCMRD in Nairobi, Kenya, the RECTAS in Ile Ife, Nigeria and the Space Center of Benin would host the donation.

However, we made it clear from the beginning that we would like to enter in a "win-to-win" agreement and be considered as well as participants to the AFREF program.

The other point that we made it mandatory is for the hosted organizations to build a serious pillar and to care about the IT infrastructure with a dedicated PC and Internet connectivity to be in place before the delivery of the equipments.

The first institution who complied with the initial conditions was the RCMRD in Nairobi, Kenya.

The Regional Centre for Mapping of Resources for Development (RCMRD) was established in Nairobi, Kenya in 1975 under the auspices of the United Nations Economic Commission for Africa and the then Organization of African Unity, today African Union.

It is an inter-governmental organization and currently has 15 contracting Member States in the Eastern and Southern Africa Regions namely; Botswana, Burundi, Comoros, Ethiopia, Kenya, Lesotho, Malawi, Mauritius, Namibia, Rwanda, Seychelles, Somalia, South Africa, Sudan, Swaziland, Tanzania, Uganda and Zambia. Their vision is to be a premier Centre of excellence in the provision of Geo-Information and Information Technology applications in Africa and beyond.

The second institution was the Regional Centre for Training in Aerospace Surveys (RECTAS)

Located at the Obafemi Awolowo University (O.A.U) Campus, Ile-Ife, Osun State, Nigeria RECTAS was established in 1972 under the auspices of the UN Economic Commission for Africa (UNECA) with a mandate for Training, Research, Consultancy and Advisory Services in Geo-informatics. The Centre is a joint project of African countries, the participating countries at the moment are: Benin, Burkina, Cameroon, Ghana, Mali, Niger, Nigeria and Senegal.

Both institutions are covering a significant number of African countries and ready to play a major role in education as capacity builders for AFREF.

Our expectations were to have both centers fully equipped and able to demonstrate practically what a GNSS AFREF Reference Station looks like and the necessary steps in the construction, setting-up, configuration and maintenance.

3. LESSON LEARNT

The author will present the lessons he learnt from the first installation and will present the different steps of the setup as well as some conclusions that may interest the audience to bring AFREF as a reality that bring a high expectation for bringing peace in Africa and develop the capacity for the continent to take share in the modern economy.

BIOGRAPHICAL NOTES

Joël van Cranenbroeck is currently Business Development Manager for Geodetic Monitoring at Leica Geosystems AG, Heerbrugg, Switzerland. He has led the development of hardware and software solutions for GNSS Network-RTK since 2001 and has made significant contributions in geodetic monitoring development and applications such as the method for aligning high rise structures (such as the Burj Dubai). Joel is Chair of Working Group 6.2 in FIG Commission 6, was awarded in 2009 the title of Honored Lecturer of the Siberian State Academy of Geodesy in Novosibirsk, and is senior scientist consultant for two universities in Belgium. He has designed numerous projects for structural monitoring applications such as bridges, dams, tunnels, etc. He worked at the Belgian Cadastre organization, at the Geodetic Department of the Belgian National Geographical Institute and in Star Informatic – a GIS software based Belgian company – before he joined Van Hopplynus, the Leica Geosystems exclusive representative in Belgium in 1993 as product specialist in GPS, GIS, Engineering and Industrial applications.

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