AFREF: TOWARDS A UNIFIED REFERENCE SYSTEM

An Africa-led Initiative for Africa

The internationally supported African initiative Africa Reference Framework project (AFREF) aims at using GNSS to unify the coordinate reference systems within Africa to produce a uniform and consistent coordinate system for all regional and continental geo-spatial information and planning and development projects.

One of the long-term objectives of the New Partnership for Africaâ€™s Development (NEPAD) is "to eradicate poverty in Africa and to place African countries, both individually and collectively, on a path of sustainable growth and development and thus halt the marginalisation of Africa in the globalisation process". NEPAD was developed by African leaders and is based on national and regional priorities and development plans for the renewal of the continent. Effective planning and efficient implementation of regional development programmes requires maps and other geo-information. Because of the importance of geo-information, the NEPAD science and technology platform includes an objective to "promote cross-border co-operation and connectivity" and action to "establish regional co-operation on product standards development and dissemination, and on geographic information systems."

Geo-referencing Needs

The fundamental point of departure for any project, application, service or product reliant on some form of geo-referencing must be a uniform and reliable coordinate reference system. One does not build a house without a foundation or secure frame. Most countries have developed coordinate reference systems and frames which are used for national surveying, mapping, remote sensing, GIS and development programmes. Although these systems are in existence in many countries the state of repair and extent of their applications varies considerably. All the 53 countries in Africa are considered as developing nations, each with its own difficulties and challenges, and each has its own coordinate reference system and frame. Indeed, some countries have more than one system, each based on a different datum.

AFREF is therefore considered a unified frame for Africa. It will be the fundamental basis for the national 3D reference networks, fully consistent and homogeneous with the International Terrestrial Reference Frame (ITRF). When fully implemented it will consist of a network of continuous, permanent GPS stations such that a user anywhere in Africa will have free access to and will be at most 1,000km from such stations. Full implementation will include unified vertical datum and support for efforts to establish a precise African geoid, in concert with African Geoid project activities.

Previous Attempts

Perhaps the earliest attempt at unification was measurement of the Arc of the 30th meridian, initiated in 1879 by Sir David Gill and completed in 1954. This arc extended from a point near Port Elizabeth in South Africa to a point west of Alexandria in Egypt. As a result, a number of countries along the arc adopted the Clarke 1880 reference spheroid and the Cape Datum coordinate system as their national frame. However, there have been local adaptations of the system, which has resulted in slight differences between realisations from country to country of what is in name and basic definition the same system.

Lessons from ADOS

The next attempt came with the African Doppler Survey (ADOS) in the 1980s. ADOS used the US Navy Navigation Satellite System (US NNSS) as the primary observing tool. This system was commonly known as the Doppler positioning system, from the principle of transmitted frequency shift upon which it was based. The main objectives of the ADOS project were to provide:

- zero-order control for future geodetic networks for mapping control
- control for datum unification and strengthening
- an accurate geoid for Africa.

The project was planned and implemented by the International Association of Geodesy (IAG) in conjunction with the African Association of Cartography (AAC), the United Nations Economic Commission for Africa (UNECA) and the Regional Centre for Mapping of Resources for Development (RCMRD). African National Mapping Organisations (NMOs) and international geodetic organisations carried out the field observations under bilateral agreements. Although nearly three hundred zero order points were established by the end of 1986, the goal of unifying geodetic datum in Africa was not met. The reasons for this are summarised below.

- The logistics of carrying out the observations simultaneously proved exceptionally difficult and limited the amount of suitable data.
- The rationale was not fully understood by participating countries, resulting in a lack of motivation and enthusiasm.
- The project was planned almost entirely by the IAG and the international community, with little input from African countries.

Nevertheless, ADOS taught several valuable lessons. Perhaps the most significant differences between the two projects has been:

- the change in positioning technology by the introduction of GPS
- the concept of continuously operating GPS base stations
- the establishment of the International GPS Service (IGS) by IAG and its global network of GPS base stations.

It is now no longer essential that all roving receivers operate simultaneously, since one is able to rely on the IGS network. In addition, African countries are actively involved in the planning, managing and execution of AFREF, a major positive difference between it and ADOS.

Making Progress

Since the Global Spatial Data Infrastructure meeting held in Cape Town in March 2000, where the need for a unified reference frame for Africa was first expressed, many meetings and workshops have been held addressing AFREF. Currently, more than 25 countries throughout Africa have expressed interest in the initiative, while the number of international organisations with interest in AFREF has also increased since the project was first proposed. There have been three important institutional milestones since 2000, setting the project on a sound footing:

- an IAG-created AFREF Sub-Commission through which scientific and technical support will be channelled; full commitment on the part of IGS to support the project
- an UNECA-created AFREF working group within its Committee for Development Information (CODI)
- recognition by United Nations Office for Outer Space Affairs (UNOOSA) (see websites and GIM International, February 2005, pp. 14-17) of the importance of the project; a recent report on the use of GNSS recommended the establishment of "a continental reference frame for Africa (AFREF), consistent with the International Terrestrial Reference Frame (ITRF)."

AFREF Objectives

Apart from these institutional arrangements, the aims of AFREF have been set out.

- Define the continental reference system of Africa. Establish and maintain a unified geodetic reference network as the fundamental basis for the national 3D reference networks, fully consistent and homogeneous with the global reference frame of the ITRF.
- Realise unified vertical datum and support efforts to establish a precise African geoid, in concert with IAG African Geoid project activities.
- Establish continuous, permanent GPS stations such that each nation or user has free access to and is at most 1,000km from such stations.
- Provide a sustainable development environment for technology transfer so that these activities will enhance the national networks and numerous applications with readily available technology.
- Understand the necessary geodetic requirements for participation in national and international agencies.
- Assist in establishing in-country expertise for implementation, operations, processing and analyses of modern geodetic techniques, primarily GPS.

NEPAD Objectives

The goals and objectives of AFREF will support and satisfy many of the objectives of NEPAD. An organisational structure is in place that reflects the fundamental principle that the project be planned, managed and executed by African countries with technical assistance and support from the international geodetic community. The project must not be considered as a short-term one and will take a number of years to complete, requiring the long-term commitment of NMOs.