

# The Africa Reference Frame Project – AFREF & South Africa's TrigNet System

Richard Wonnacott  
International Committee on GNSS  
Pasadena, California  
9 December 2008



# **The Africa Reference Frame Project – AFREF**



# Overview

- **Background**
- **Rationale**
- **Objectives**
- **Institutional acceptance**
- **Structure**
- **Progress**
- **Present situation**
- **Comments and concerns**
- **Conclusion**



# 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.
- Understand the necessary geodetic requirements of participating national and international agencies.



## 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.



# Structure 1

**The structure reflects the broad concepts of AFREF that:**

- It is to be designed, managed and executed from within African;**
- It is to be organized on a regional basis;**
- It is to be executed at the national level; and**
- Technical expertise and support will come from the international geodetic community such as IAG, IGS etc.**



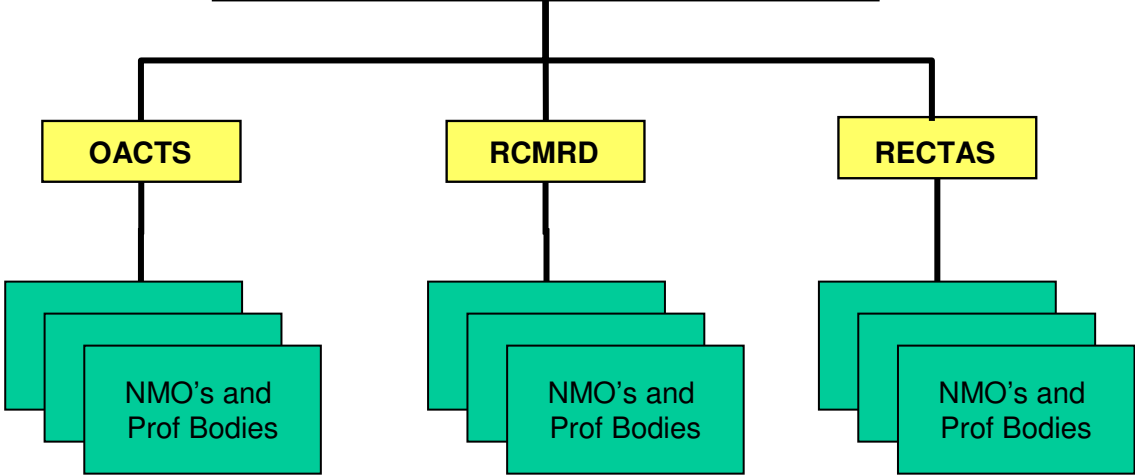


# Structure 2

**Technology Advisory Group**  
Made up of scientists from Africa

**CODI**  
Chair plus Representatives from  
CAFREF  
EAFREF  
NAFREF  
SAFREF  
WAFREF  
IAG Sub Commission 1.3d  
HartRAO

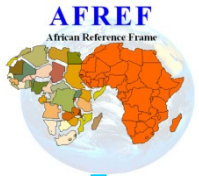
**International Organizations**  
IAG            UNECA CODI  
IGS            FIG  
UNAVCO       ISPRS  
UNOOSA       ICA  
NEPAD ??





# Progress to Date 1

- **Cape Town March 2001:**
  - to gauge level of interest among NMO's in region
  - 8 countries attended and supported project
  - IAG/IGS, EUREF, NIMA supported project
- **Lusaka July 2002**
  - UNOOSA / USA sponsored series of workshops on Use and Applications of GNSS
  - One of the outcomes was recommendation to
    - Establish a continental reference for Africa or AFREF consistent with ITRF
- **Windhoek Dec 2002**
  - 8 Southern and East African countries represented
  - Representative from UN ECA CODIST also present
  - Prepared what has become known as “Windhoek Declaration”



# Progress to Date 2

- **Addis Ababa August 2004:**
  - **UNECA CODI-ST Accepted “Windhoek Declaration”**
- **Other meetings**
  - **Nairobi October 2004**
  - **Cairo April 2005 FIG Working Week**
  - **Accra March 2006 FIG Regional Conference**
- **Cape Town July 2006:**
  - **Technical Workshop**
  - **Co-sponsored by 6 organizations incl. IAG, UNAVCO, UNOOSA**
  - **~40 delegates and 15 presenters**



# Progress to Date 3

- **Nairobi August 2007 and August 2008:**
  - Technical Workshops
  - Organized by RCMRD in conjunction with the University of Lisbon, the University of Beira-Interior (Portugal) and Hart RAO
  - Dealt with GNSS reference stations and processing of GNSS data
- **Johannesburg June 2008:**
  - Joint meeting to discuss co-operative efforts between:
    - AFREF (Geodesy)
    - Africa Array (Geophysics)
    - IHY (Space physics)
    - AMMA-GPS (Meteorology)
  - Very successful meeting



# Institutional Acceptance 1

- **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 June 2008 workshop
- **IAG (International Association of Geodesy)**
  - Have created structures to co-ordinate the project and provide technical assistance and expertise



# Institutional Acceptance 2

- **IGS (International GNSS Service)**
  - Has strong commitment to support AFREF
- **FIG (International Federation of Surveyors)**
  - Sponsored workshops in Cairo and Accra
- **UNAVCO (University NAVSTAR Consortium Inc.)**
  - Have strongly supported the project through travel support.



# Present situation 1

- **There are about 20 IGS stations in Africa**
  - **CDDIS gives about 30 stations**
    - **Some of these in clusters**
    - **Some not operational**
    - **Some appear to be experimental eg GLONASS only with very little data**
  
- **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.**
  - **South Africa has network of 49 continuous base stations.**
  
- **There are a number of contractors setting up own local systems such as in oil and mining industry .**



## **Present situation 2**

**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**

**Morocco**

**Namibia**

**Rwanda**

**Swaziland**

**Tunisia**

**Zambia**

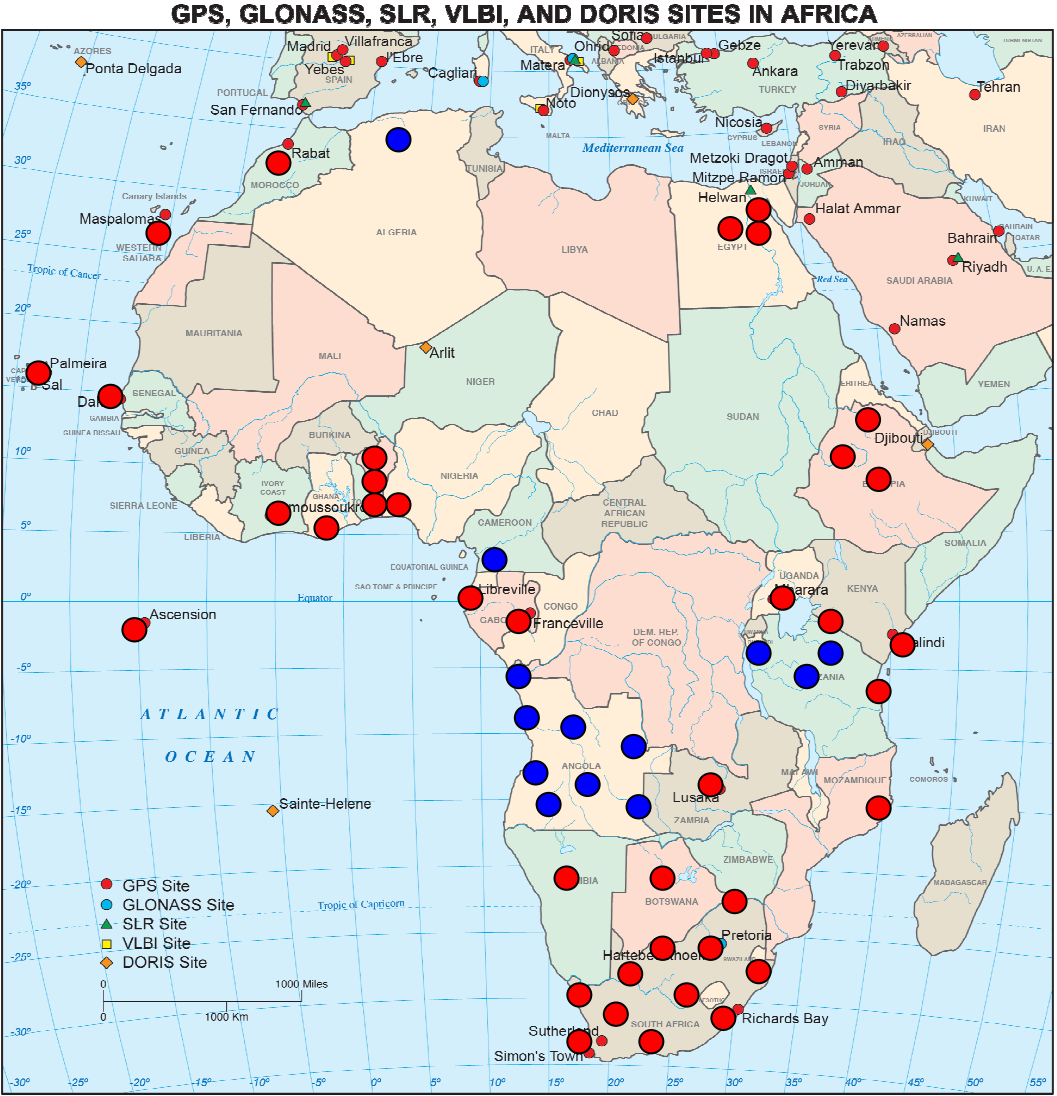




# Present situation 4

Some known installed and planned GNSS station June 2008  
(Not all stations shown for clarity)

- Installed
- Planned





# Concerns 1

- **Funding**
  - Would appear to be funds available but how does one access such funds?
  - Seem to be able to get money for workshops etc
  - Manufacturers willing to donate equipment
  - Difficult to get money for long term running costs
- **Political Buy-in**
  - Get AFREF recognised by African political leaders
- **Co-ordination of efforts**
  - There are a number of groups installing or are prepared to install
  - Lack of information on these initiatives
  - Result in duplication of effort



## Concerns 2

- **Internet in Africa**

- **Africa's population :** ~1 bn
- **Percentage of population with access to Internet :** ~3.6%
- **Average Connection speed:** 56 kbps
- **Reliability :** Poor
- **Routing:** Indirect
- **Cost of bandwidth in Africa vs. US:** 1000 greater
- **Yearly increase in internet speed worldwide:** 30%
- **Africa's connectivity :** 10-20 years behind
- **Forecast :** The gap is widening

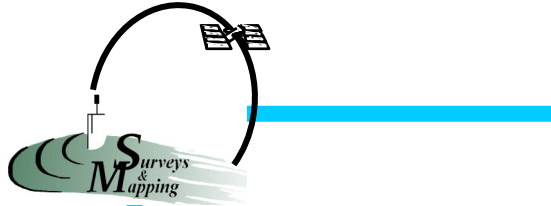
### **Extracted from:**

**symmetry - September 2008 - Mapping the Digital Divide - Les Cottrell**  
**[www.symmetrymagazine.org](http://www.symmetrymagazine.org) (Volume 5 Issue 4)**

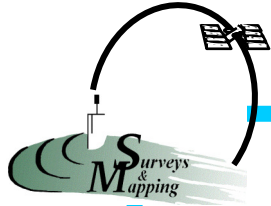


# Comments

- **Don't loose sight of aims & objectives of AFREF**
  - Groups installing for specific scientific reasons in name of AFREF but not keeping primary objectives of AFREF in mind.
  - NMO's excluded or superficially included.
  - AFREF is a project to be managed and executed by African NMOs and Universities with International assistance
- **IGS**
  - Supported various workshop
  - Assisted with preparation of CfP
  - Obtained financial support from UNAVCO for Cape Town Workshop July 2006 and other travel
  - Highlight importance of AFREF at every opportunity
  - Point of contact with “assisting agencies” – both technical and financial

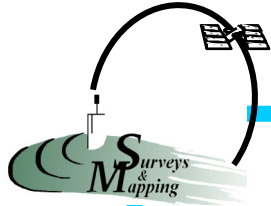


# **TrigNet – South Africa’s Network of Permanent GNSS Base Stations**



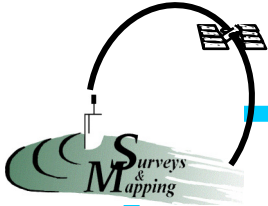
# Overview

- **Background**
- **Distribution**
- **Services offered**
- **International project participation**
- **Non-positioning applications**



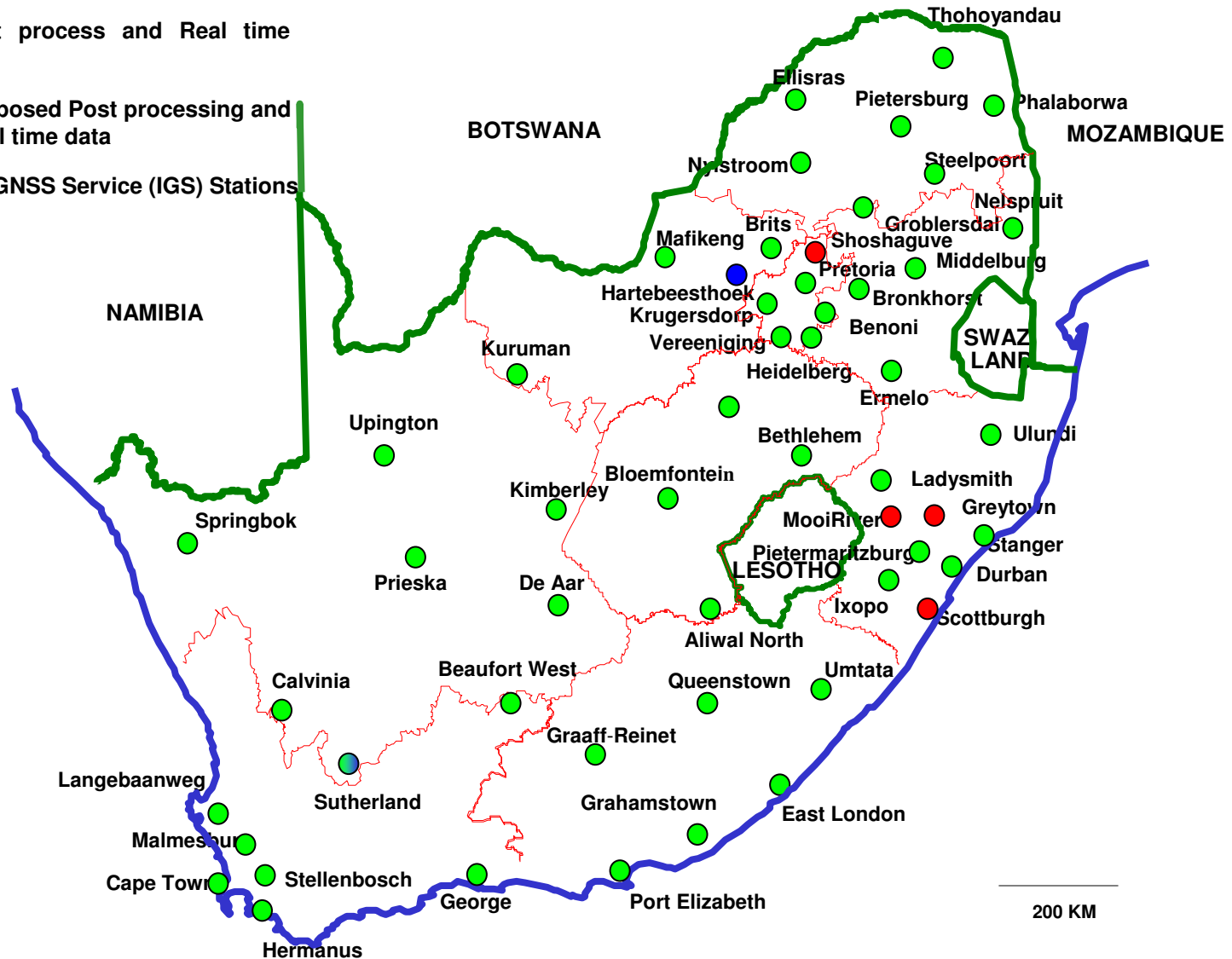
# Background

- **The Chief Directorate Surveys and Mapping is mandated to establish and maintain a National Control Survey Network.**
- **Currently have ~58000 passive control points throughout the country.**
- **Commenced with the installation of network permanent GNSS base stations in 1999.**
- **Currently have 49 stations continuously feeding 1 sec dual frequency data to a central control centre near Cape Town.**
- **Of the 49 stations 12 are providing GPS/GLONASS data and the rest GPS only.**

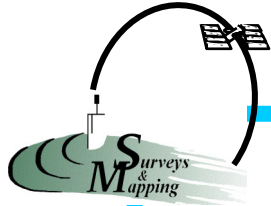


# Distribution at Nov 2008

- Post process and Real time data
- Proposed Post processing and Real time data
- Int GNSS Service (IGS) Stations

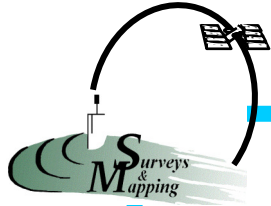






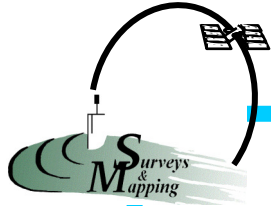
# Products

- **Post Processing RINEX Data**
  - 1 sec L1, L2 Daily and hourly files
  - 5 sec L1 only Daily and hourly files
  - 30 sec L1, L2 Daily files
  - Customized RINEX files
- **Real Time RTCM Data**
  - DGPS via NTRIP country wide (VRS Network solution)
  - RTK via NTRIP
    - Single base from all stations
    - VRS Network solution from three clusters
      - Gauteng
      - KwaZulu Natal
      - Western Cape
- **All data and services are free of charge!!!!!!**



# International Projects

- **International GNSS Service Real Time Working Group (IGS RTWG)**
  - Trying to establish whether or not a Global Real Time service is feasible
- **International GLONASS Service (IGLOS)**
  - Tracking of GLONASS satellites for orbit estimation and integration of data into IGS framework
- **Constellation Observing System for Meteorology, Ionosphere & Climate (COSMIC)**
  - GPS/MET research - meteorological data collection, using the Global Positioning System



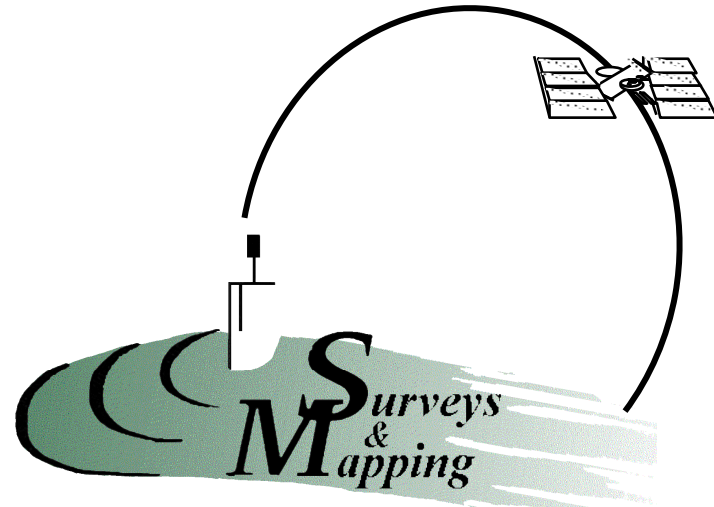
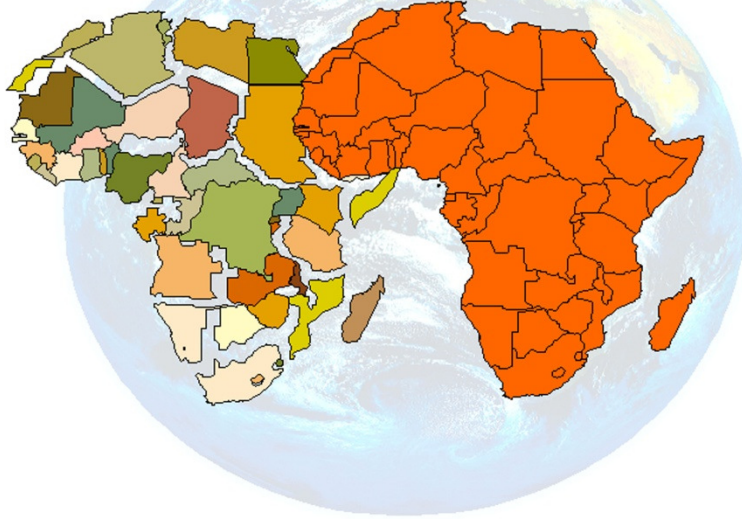
# Non-Positioning Applications

**TrigNet data has been used for:**

- **Geophysics**
  - Plate tectonics
  - Geo-hydrology
- **Space weather**
  - Ionosphere mapping
- **Meteorology**
  - Weather forecasting
  - Climate monitoring

# AFREF

African Reference Frame



## THANK YOU

<http://geoinfo.uneca.org/afref>

<http://www.trignet.co.za>