The AfricaArray network of seismic, GPS and weather sensors in Subsaharan Africa: a major networking challenge

D. Delvaux[1, 2]; A.-P. Tokam[2]

damien.delvaux@africamuseum.be

[1] Royal Museum for Central Africa (RMCA), Belgium

[2] University of the Witwatersrand (Wits), South Africa

Wireless Networking for Science in Africa Workshop, ICTP, Trieste 11-22 March, 2013

AfricaArray initiative

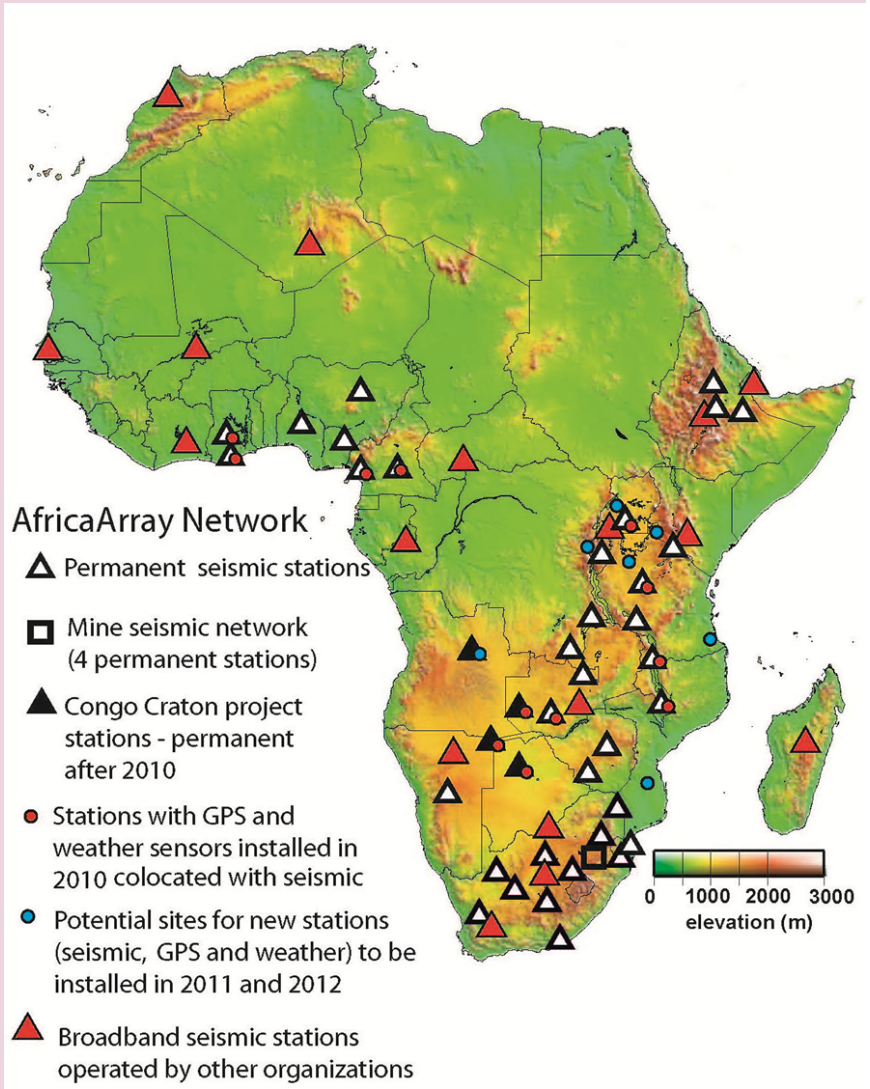
- Innovative program to promote, strengthen and maintain a workforce of highly trained African geoscientists and researchers for Africa's sustainable development and management of natural resources and environmental change
- Pan-African long-term initiative started in 2005
- Based on Arrays of
  - Continenteal-wide linked research projects
  - Shared training capacity-building programmes
  - Observational networks, permanent and temporary

AfricaArray structure

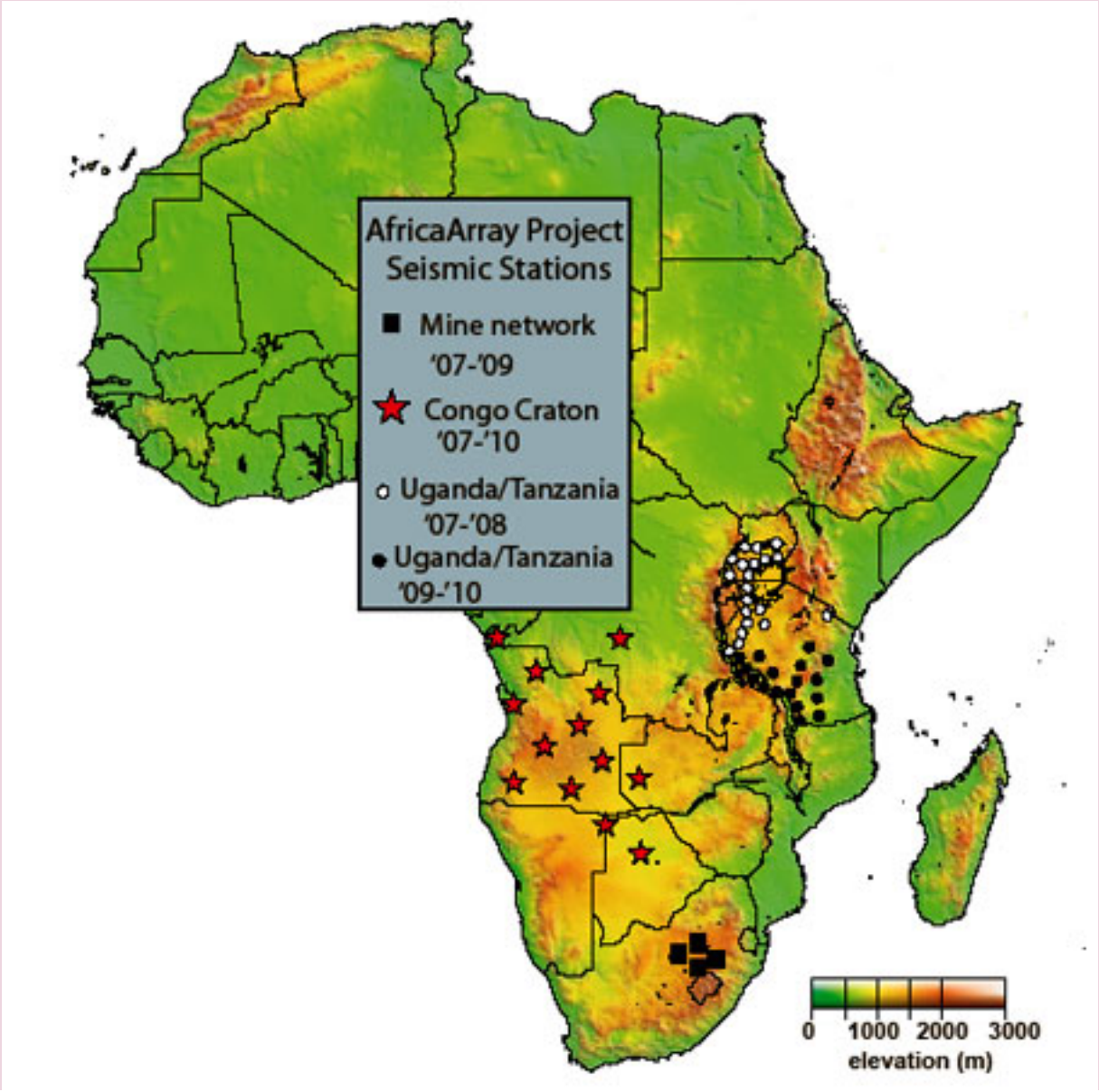
- Founding Partners:
  - University of the Witwatersrand (Joburg, South Africa)
  - Council for Geosciences (Pretoria, South Africa)
  - PennState University (USA)
- Sponsoring and Affiliated Partners
- Funding on the basis of research, capacity building and instrumentation projects
- Light management structure and flexibility
- Based on a network of permanent observatories

AfricaArray network of observatories

- Observatories in 16 countries: Botswana, Cameroon, DRC, Ethiopia, Ghana, Kenya, Malawi, Mozambique, Namibia, Nigeria, Rwanda, South Africa, Uganda, Tanzania, Zambia, Zimbabwe
- 51 Seismic stations
  - Data archived at IRIS data center
- 20 GPS with Weather sensors
  - Data archived at UNAVCO data center



AfricaArray temporary observatories



Temporary deployments (6 months) for seismic experiments

Network management

- General management: PennState University
- Operational management: Witwatersrand University
- Technical support: Council for Geosciences
- Country management: local partners (geological survey, university, research centers…)

Equipment and operations

- Equipment provided by AfricaArray, remaining property of AfricaArray (mainly on NSF funding)
- Equipement provided by associated partners (e.g. Royal Museum for Central Africa, Belgium)
- Observatory site provided by country partners
- Current maintenance and data downloading operations by country partners
- Data management and transfer to database by Wits

Data Policy

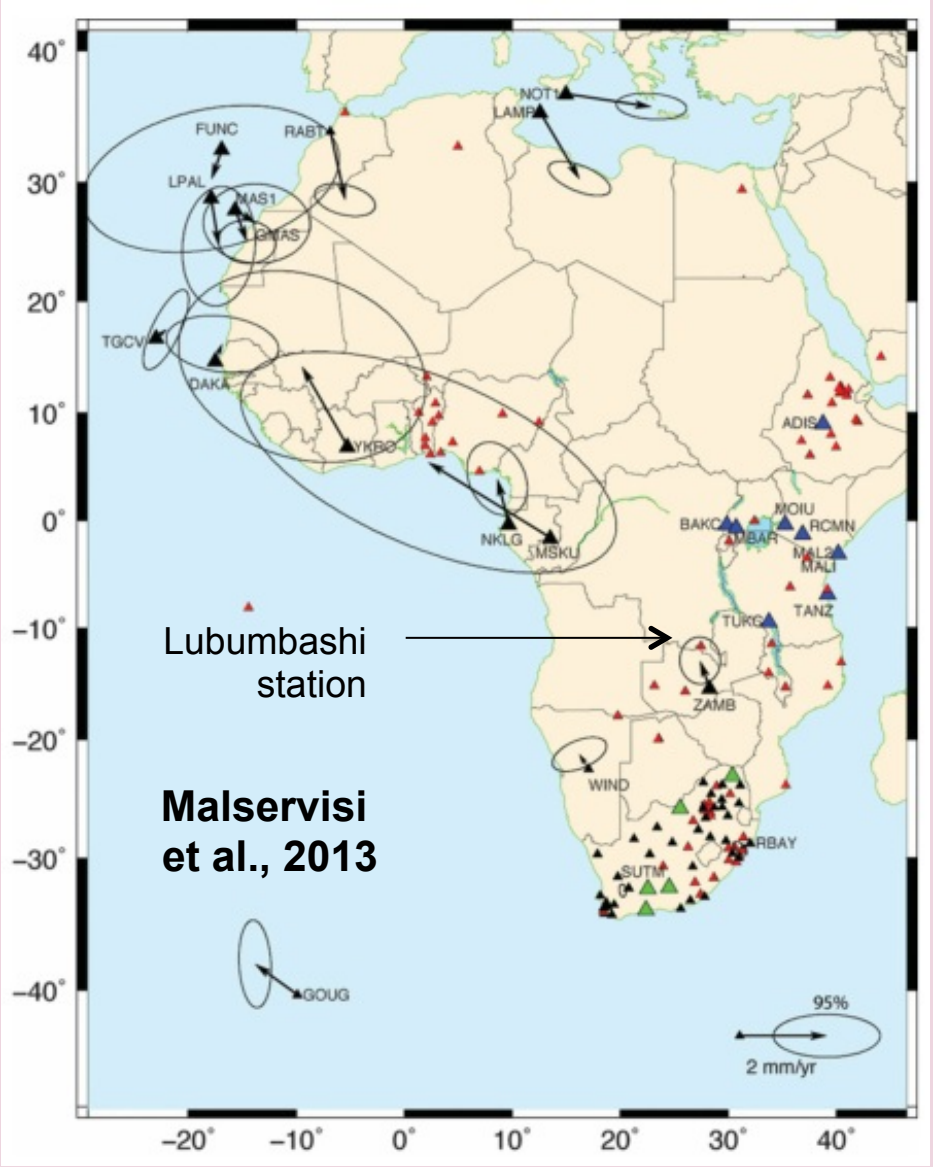
- Seismic data:
  - Access via the IRIS web site
  - One station per country free of access
  - Other stations: data restricted for 3 years to protect ongoing research project and PhD studies
- GPS and Weather
  - Access via the UNAVCO web site
  - No limitation of access

Data use & research projects

- Seismic data used for mantle and crustal structure studies by PhD students at PennState/Wits
- GPS data used for plate kinematic and athmospheric studies (outside AfricaArray)
- Meteorological to be used by new partners (sensors just installed)
- To develop: local access and use of data
  - Seismicity monitoring & constitution of seismic catalogues
  - Meteorological and hydrological studies for agronomy

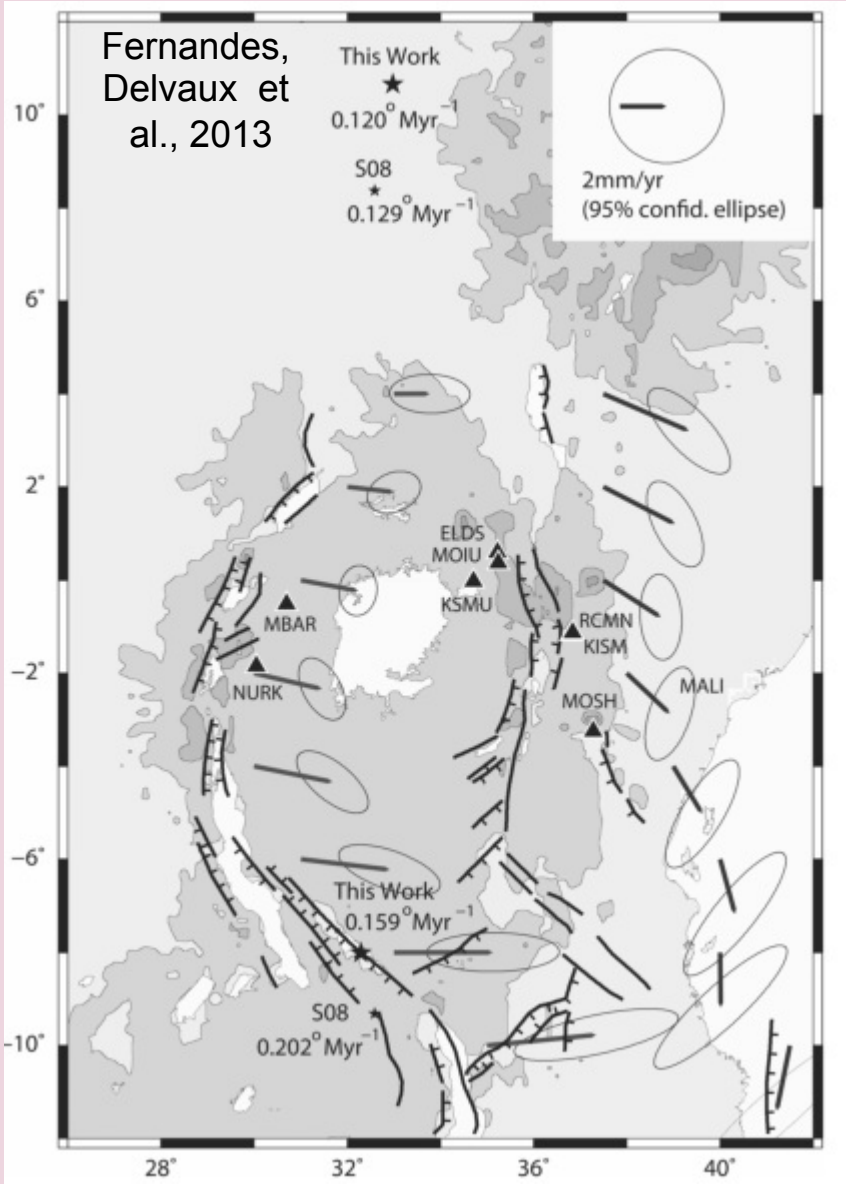
Externalisation of data processing: GPS deformation field

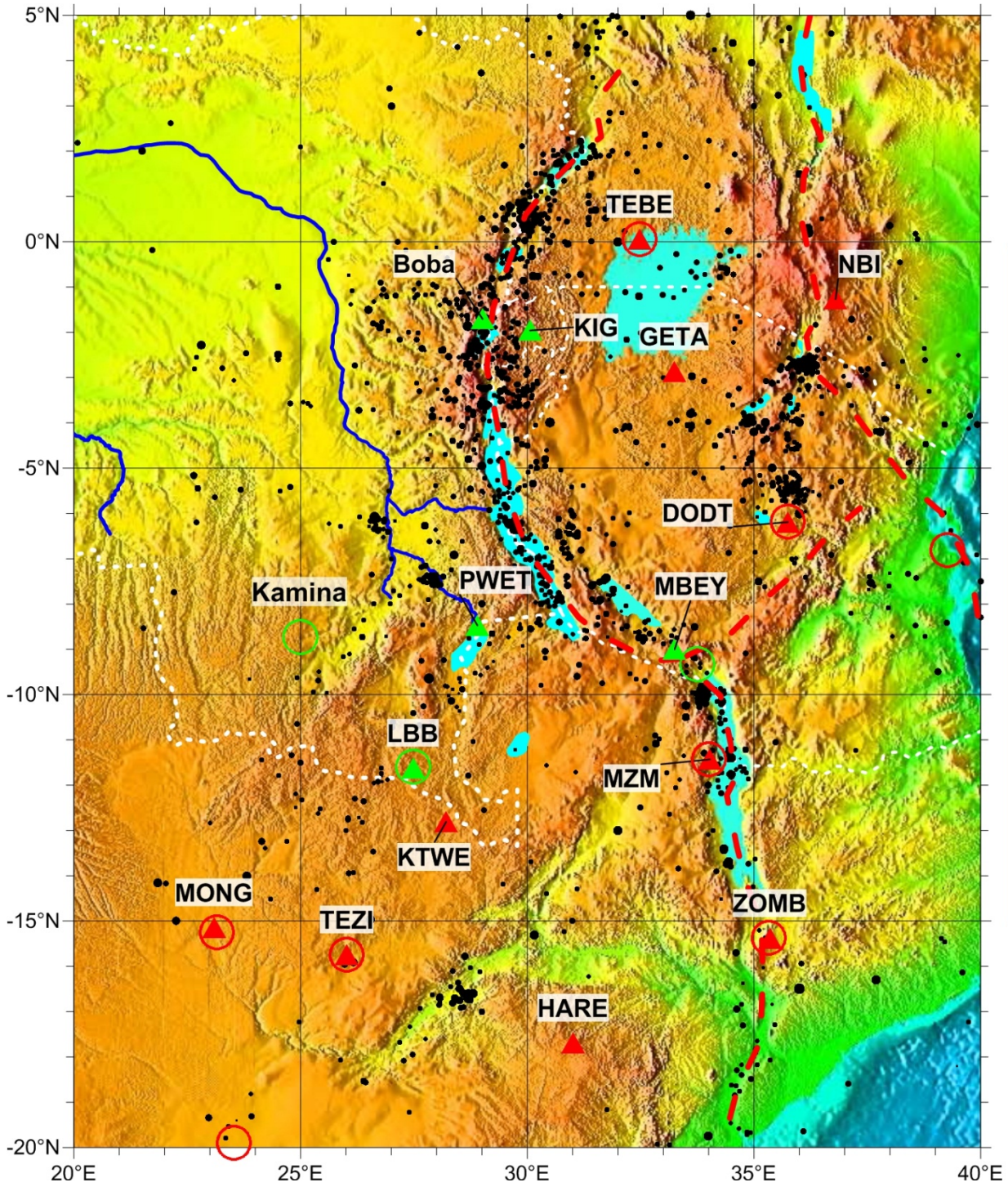
- Need long and continuous time series (>= 5 years) for an accuracy in velocity of 1 mm/yr.
- Need data from a large number of stations over entire Africa with a good distribution
- Need highly specialised skill in geodesy for data processing
- Principle: Feeding the scientific community with data to get the desired results
- We install the GPS and we get the processing results we need for seismic hazard assessment from other teams



Externalisation of data processing: GPS deformation field

- Participation in another study for knowledge on regional dynamics
- Still not using AfricaArray data
- Provides reasonable constraints on the opening of the western rift branch, (one of the most seismically active regions in Sub-saharan Africa)





Africa Array

AfricaArray network in the East African rift

Lubumbashi:
(seismic + GPS)

Located in the central yard in the Geology building of the University.

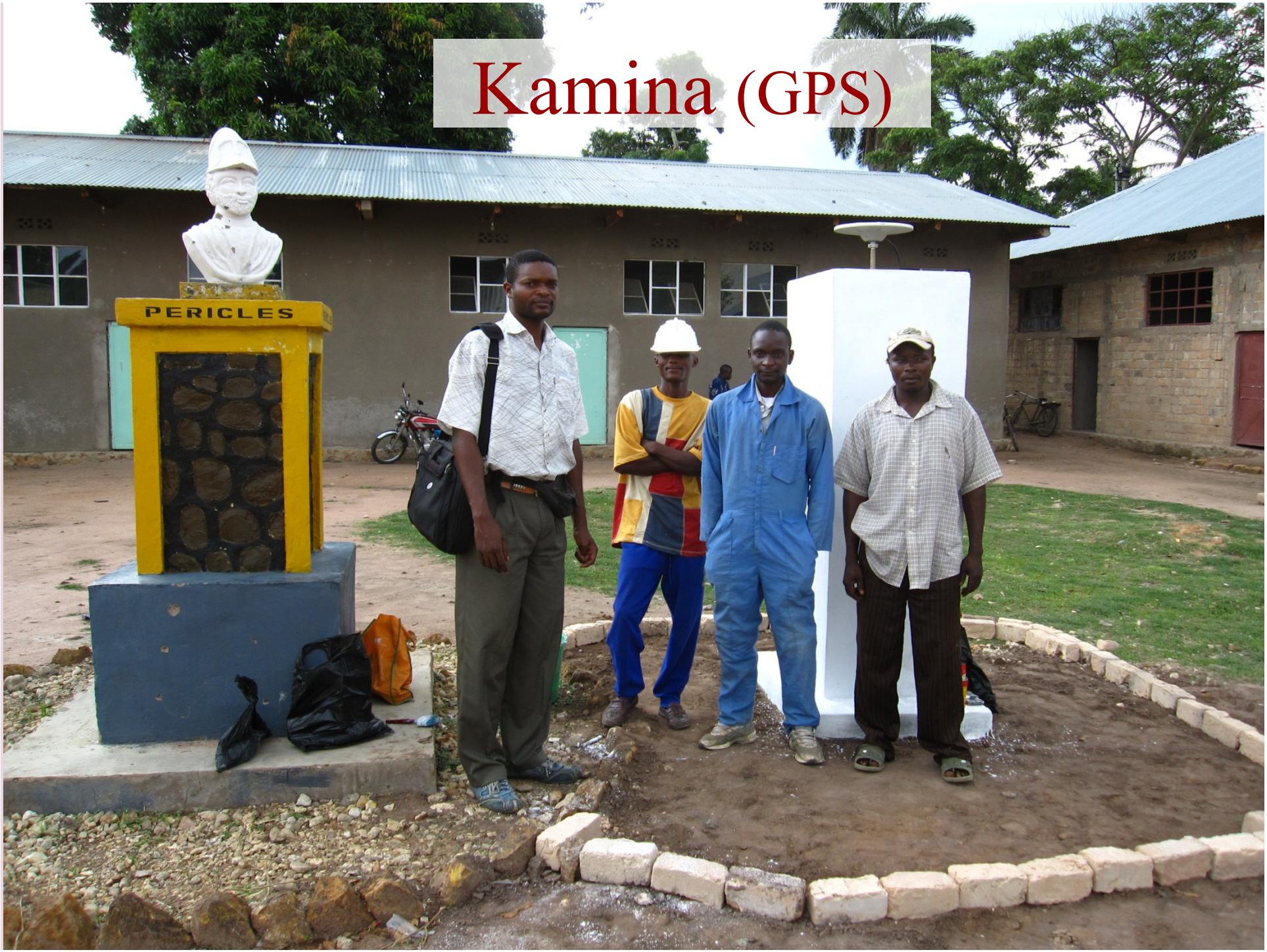
Problems:
water infiltration, power supply, poor/no Internet


STATION SISMIQUE
DE
L'UNILU
INAUGURATION OFFICIELLE
LE 29.6.09

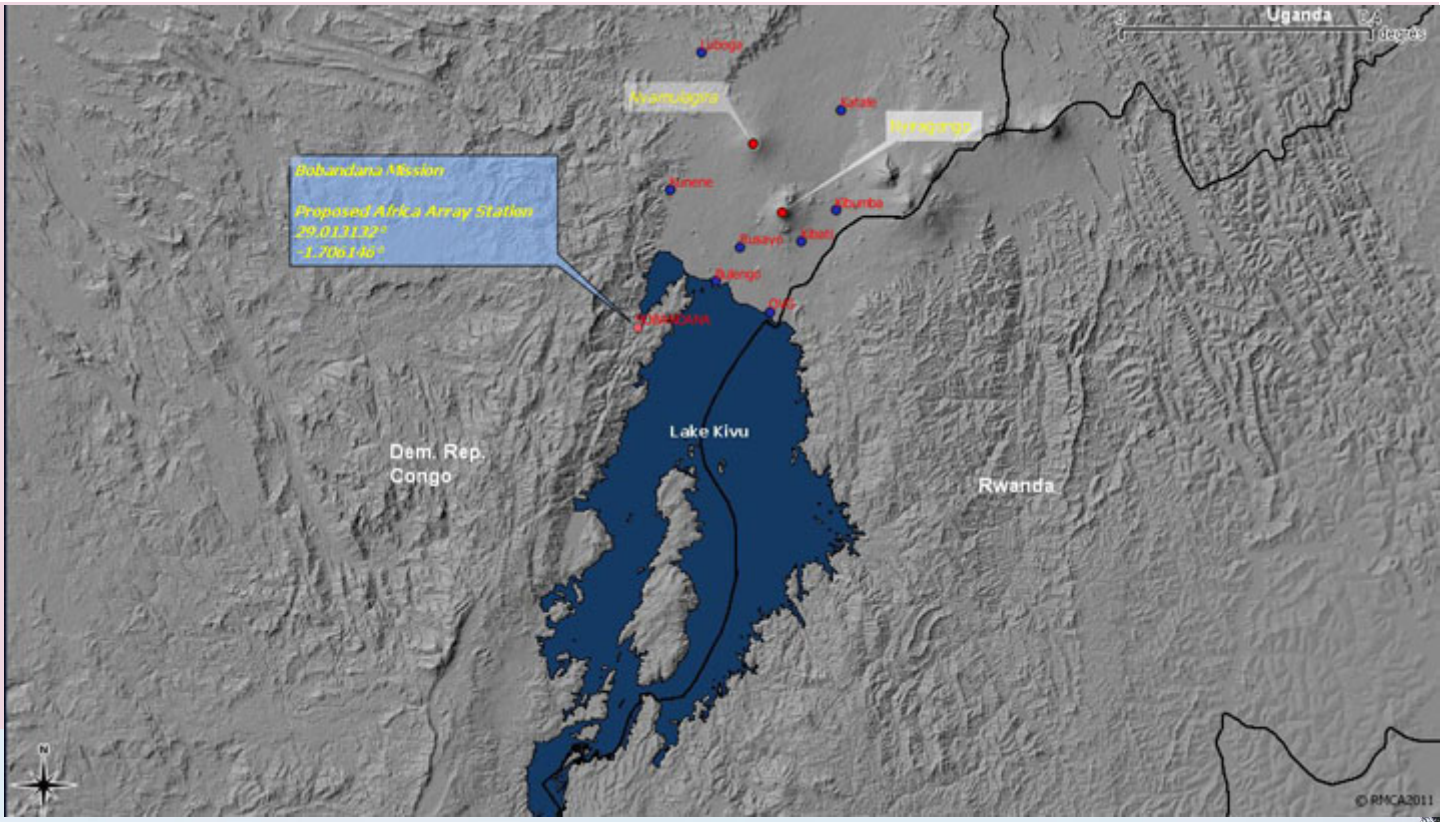
Pweto (seismic)

Located in a mission.
Problems: accessibility, no Internet.

Kamina (GPS)

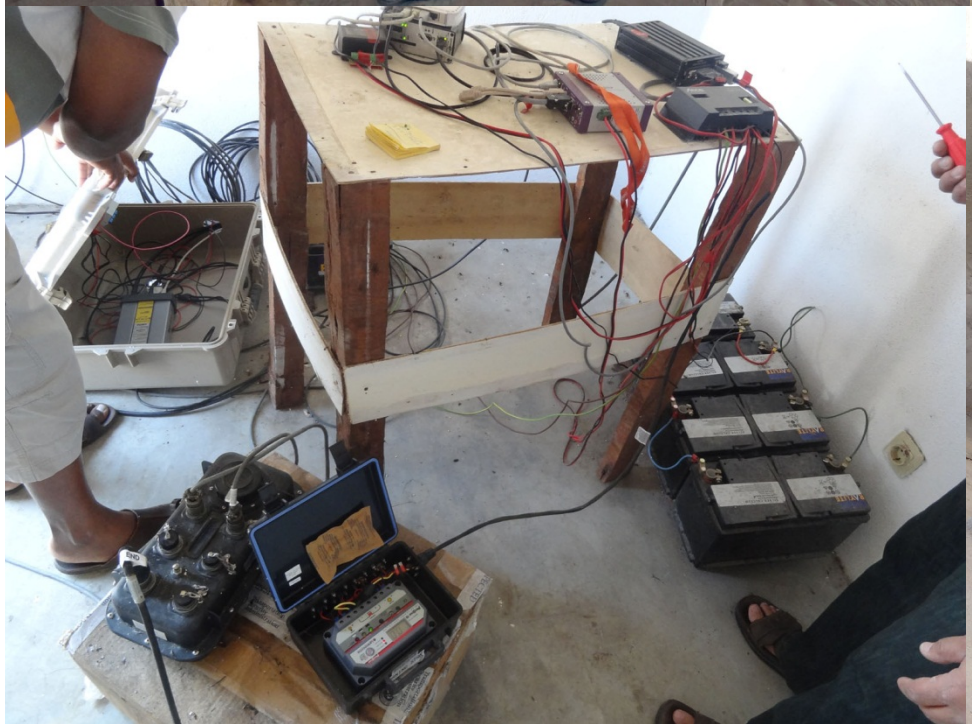


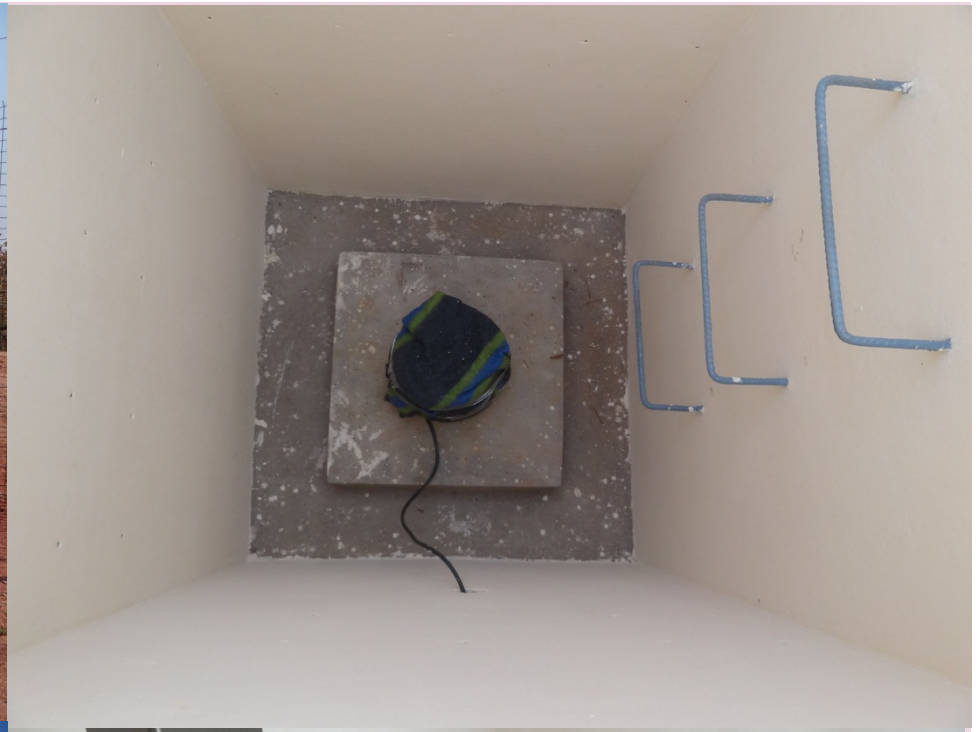
Bobandana on Lake Kivu (seismic)



Mozambique operational campaigns:

6 stations, 10 days, 6500 Km





Budget and funding

More easy to fund equipment than work force

	€	
•Instruments:	100.000	OK
•Constructions:	20.000	OK
•Training :	5.000	+/- OK
•Staff support:	100/M	difficult
•Guards:	50/M	very difficult

Sustainability

- Network level
  - Data as open as possible
  - Monitoring for scientific projects / for society
- Country/Station level:
  - Critical: maintenance, operation and security
  - Key factors: appropriation by local partners
  - Condition: possibility to use the data locally
  - Additionnal sensors in function of local interest
  - Train technicians/scientists to process data locally at basic level for local use

Data flow (1)

- From station to data base: real-time
  - some South-African stations
  - communication by GSM modem and satellite for few stations (experimental)
  - Problem: need fix IP (Maun, Botswana)
- From station to local FTP server
- Periodic physical visit to the stations and transfer to network manager
  - accceptable for research but not for monitoring
  - long delay before problems are detected

Data flow (2)

- From network manager to Database
  - Pre-processing and quality check before uploading to data base FTP site
  - Due to asymetric Internet trafic, slower to upload, faster to download
  - Even from South Africa, too slow to pull large datafile (> 1 Gb for 2 months of data = 12hrs)
  - Solution: uploading from Belgium

Data flow (3)

- Back to local user
  - Downloading from database too slow and unstable in many African countries
  - Transfer on DVD
  - Need physical transmission

Data management

- Seismic data
  - Accessible from the IRIS web site
  - Data from one station per country freely accessible (NSF requirement)
  - Data from other stations restricted during 2-3 years for AfricaArray partners and students
- GPS and Weather data
  - Accessible from the UNAVCO web site
  - Non restrictions

AfricaArray Business model

- Combination of Monitoring, Training and Research
- PanAfrican, trans-border
- Simple management structure allowing flexibility and rapid decision making
- Long-term vision, not project-bounded
- Funding by large number of small to medium-scale projects
- Involvement of local partners (individuals, universities, geological surveys,…)
- Equipment ownership kept by AfricaArray

RMCA contribution

- Combination of Monitoring, Capacity building and Research
- Focusing on poorly monitored border areas of Central Africa
- Combination of funding from different programmes: Research networks, research for development, capacity building
- Partnership with AfricaArray

Networking Challenges

- Attract African partners and making them working together and exchanging data
- Station maintenance and data flow
- Continuous generation of projects and funding
- Motivation of partners and return for their own country
- Scope broadening with addition to GPS and meteo sensors

Thanks