Global Navigation Satellite Systems (GNSS) in Africa: Applications and Prospects

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Outline

Introduction

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- GNSS are used in all forms of transportation (space stations, aviation, maritime, rail, road and mass transit)
- GNSS plays a critical role in telecommunications, land surveying, law enforcement, emergency response, agriculture, mining, finance, scientific research.

A brief history of space science

From imagination to reality

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In 1903

Russian scientist Konstantin Tsiolkovsky published a paper in which he anticipated human expansion in outer space by using liquid fuel rockets

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- On January 31, 1958, the United States successfully launched Explorer I [1].

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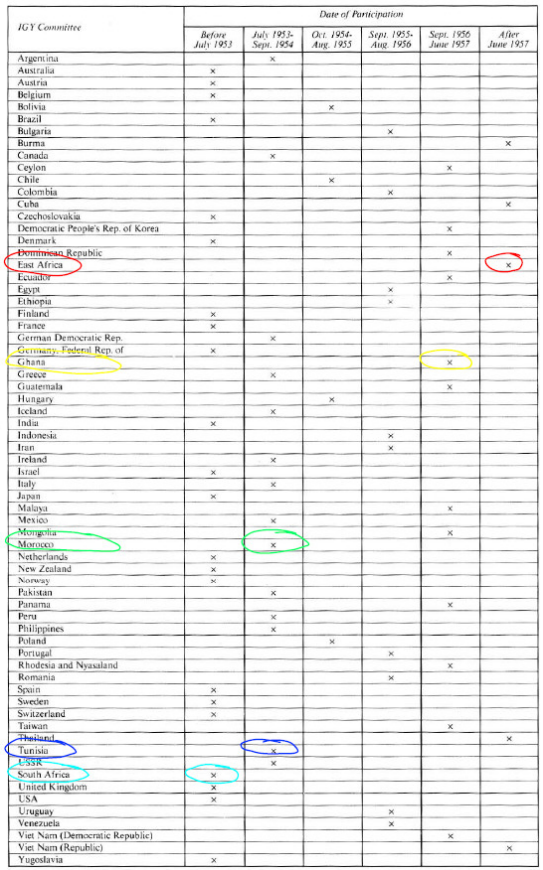
The International Geophysical Year 57/58

During a meeting in May 1950 at Inyoken, near China Lake in California (USA) to discusse the scientific aspect of a possible third International Polar Year.(From N. Nicolet, 1958)

Africa participation to IGY 1957/1958



IGY Committee	Date of Participation: Before July 1953	July 1953-Sept. 1954	Oct. 1954-Aug. 1955	Sept. 1955-Aug. 1956	Sept. 1956 June 1957	After June 1957
Argentina		×				
Australia	×					
Austria	×					
Belgium	×					
Bolivia			×			
Brazil	×					
Bulgaria				×		
Burma						×
Canada		×				
Ceylon					×	
Chile			×			
Colombia				×		
Cuba						×
Czechoslovakia	×					
Democratic People's Rep. of Korea					×	
Denmark	×					
Dominican Republic					×	
East Africa						×
Ecuador					×	
Egypt				×		
Ethiopia				×		
Finland	×					
France	×					
German Democratic Rep.		×				
Germany, Federal Rep. of	×					
Ghana					×	
Greece		×				
Guatemala					×	
Hungary			×			
Iceland		×				
India	×					
Indonesia				×		
Iran				×		
Ireland		×				
Israel	×					
Italy		×				
Japan	×					
Malaya					×	
Mexico		×				
Mongolia					×	
Morocco		×				
Netherlands	×					
New Zealand	×					
Norway	×					
Pakistan		×				
Panama					×	
Peru		×				
Philippines		×				
Poland			×			
Portugal				×		
Rhodesia and Nyasaland					×	
Romania				×		
Spain	×					
Sweden	×					
Switzerland	×					
Taiwan					×	
Thailand						×
Tunisia		×				
USSR		×				
South Africa	×					
United Kingdom	×					
USA	×					
Uruguay				×		
Venezuela				×		
Viet Nam (Democratic Republic)					×	
Viet Nam (Republic)						×
Yugoslavia	×					

The IGY by M. NICOLET

IGY Committee	before July 53	Sept 55 Aug 56	Sept 56 June 57	After June 57
East Africa				X
Egypt		X		
Ethiopia		X		
Ghana			X	
Rodesia			X	
Tunisia	X			
South Africa	X			

GNSS as means of data collection for Scientic Research

Scientific Exploration with GNSS

- Biology
- Archeology
- Seismic monitoring
- Ozone layer monitoring
- Climate change
- Gravity fields
- Atmospheric science
- ground water vapor
- the ionosphere
- space weather

Use of GNSS in Atmospheric Research

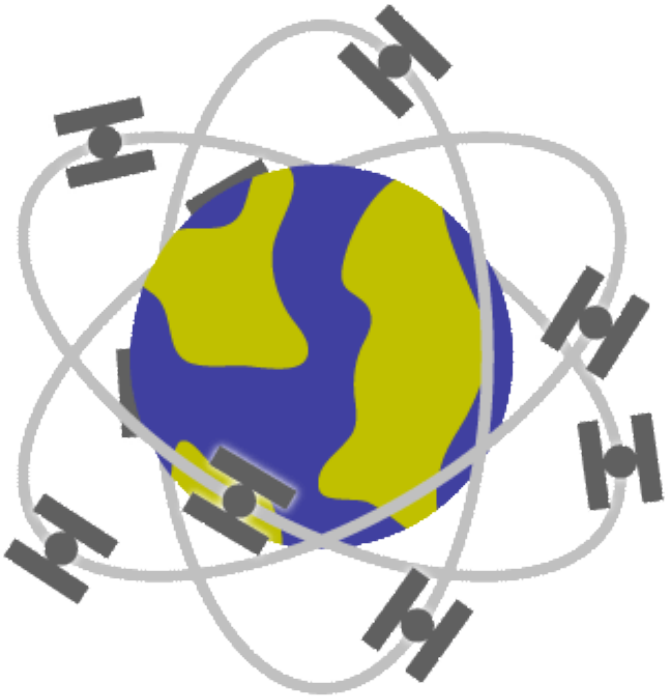
- Characterization of ionosphere using TEC
- Space weather studies
- Scintillation studies
- Atmospheric delay
- TIDs
- Validation and or improvement of existing atmospheric models
- Water vapour estimation

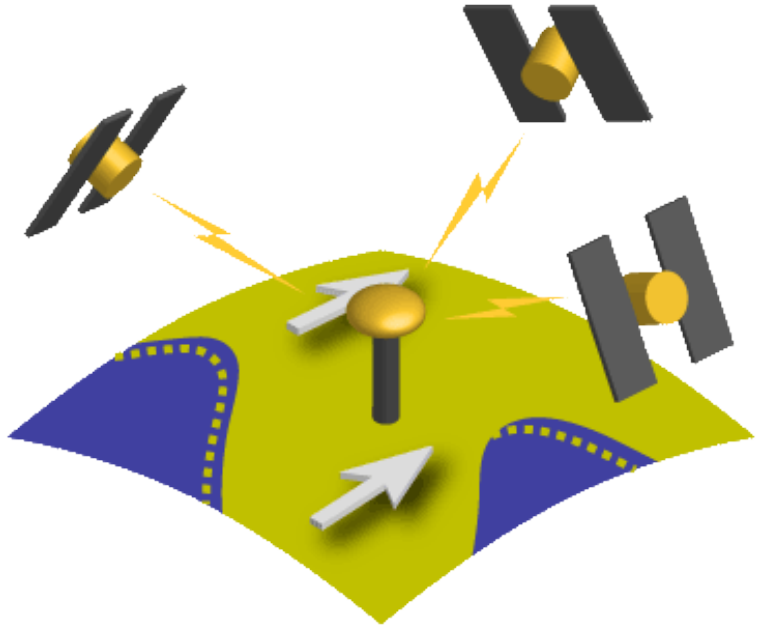
Scientific programs of GNSS in Africa

- TOPOIBERIA
- IGS
- MAGDAS
- AfricaArray
- ESA Monitor project
- AMBER
- SCINDA
- ISWI

TopoIberia

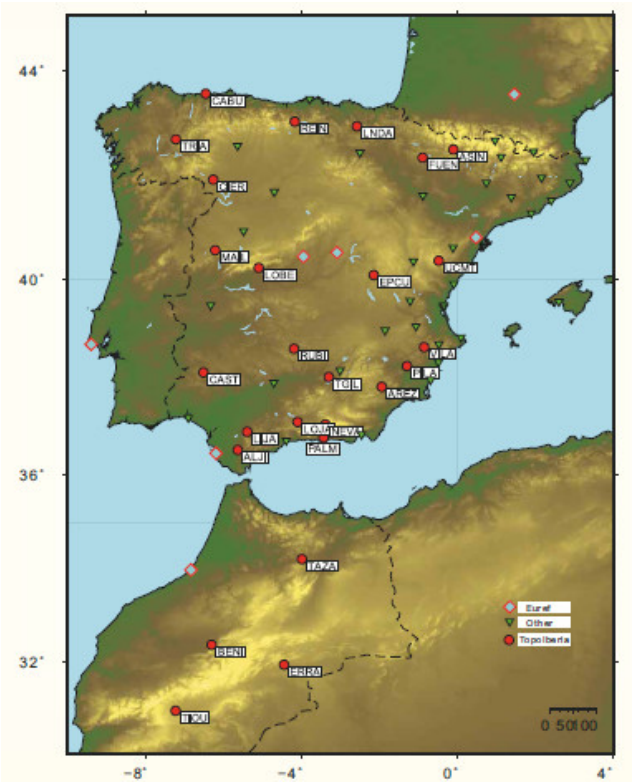
The Topo-Iberia research initiative aims to establish an integrated framework to develop multidisciplinary geoscientific studies on the 'micro-continent' formed by the iberian peninsula and its margins





GPS can be used as a tool for the measurement of the active deformation of the Earth. It provides a way of monitoring active tectonics and the detection of relatively slow movements

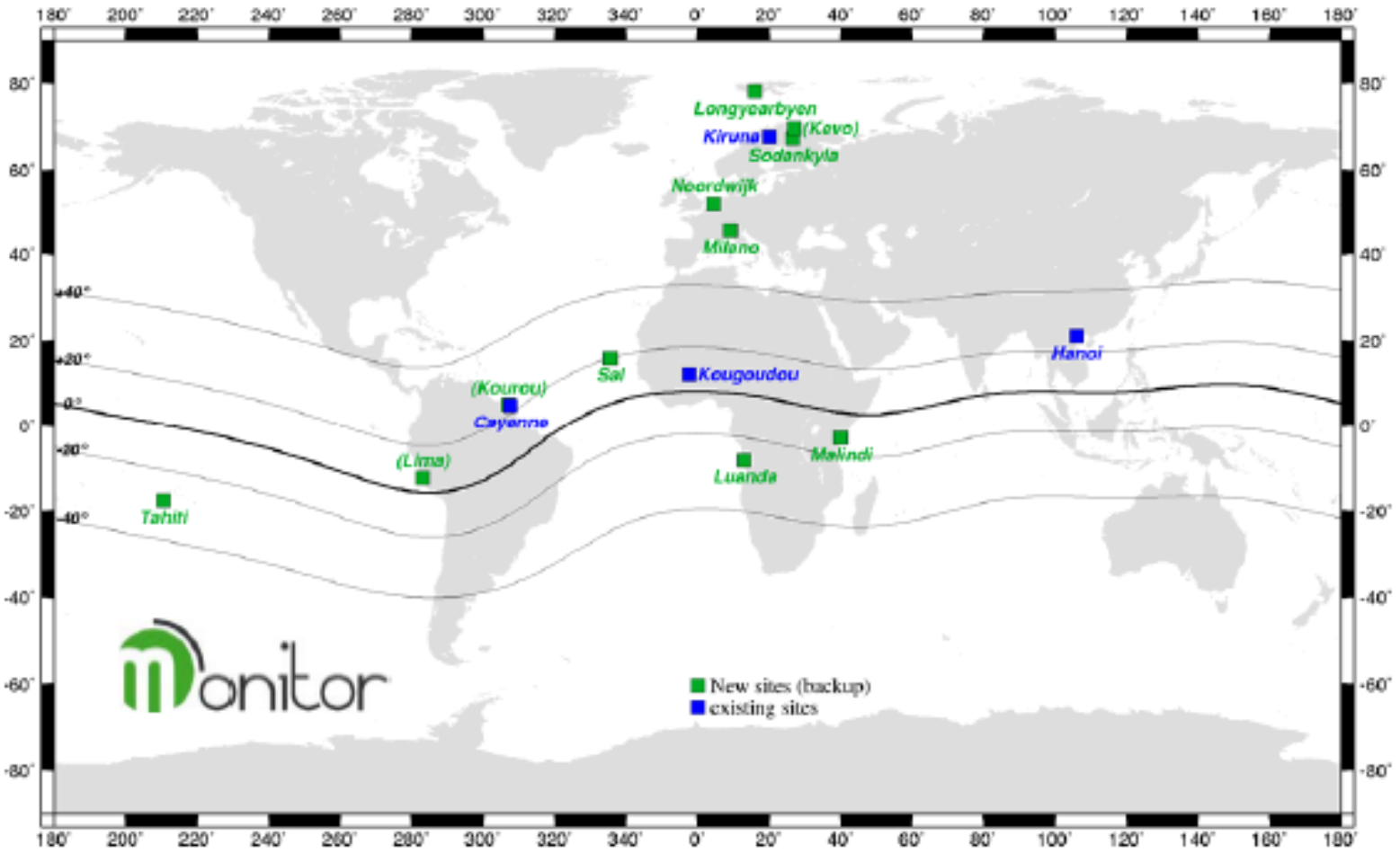
TopoIberia GPS network



TopoIberia GPS network

The TopoIberia GPS station at Taza (Morroco)

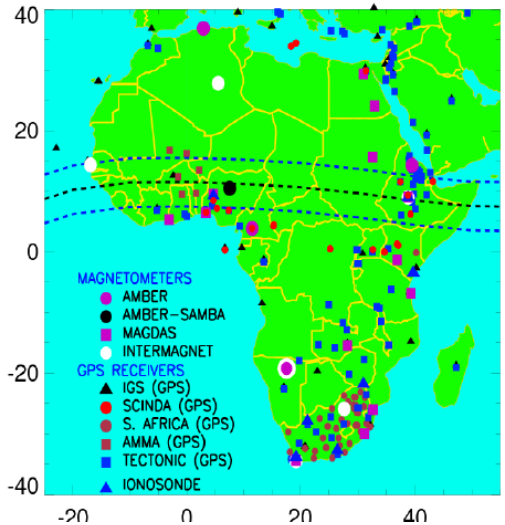
ESA MONITOR project



Monitor Ionospheric Experimental Station (R. Pietro, 2011)

AMBER project

✓ AMBER is African Meridian B-field Education and Research



SBAS in Africa

1. Satellite Based Augmentation Systems (SBAS)
   - SBAS uses additional messages from satellite broadcasts to support signal augmentation.
   - It improves the integrity, accuracy, availability and continuity of existing GNSS.
   - SBAS's main application is in aviation improving safety during approach and landing phases
   - WAAS, MSAS, GAGAN, SDSM and EGNOS.
   - SBAS has not yet been extended into Africa
2. EGNOS and its possible extension to Africa
   - EGNOS (European Geostationary Navigation Overlay Service)
   - The EGNOS satellites cover the entire African continent, it could easily extend the to the African continen
3. Applications and benefits
   - The increase of the overall safety of air transport
   - The reduction of accidents during the airport approach and landing phase
   - The coverage of areas currently not equipped with the traditional navigation aids

GNSS/EGNOS in Africa

✓ Capacity Building for Satellite Navigation Services in Africa

The partners

- ASECNA (Agence pour la Sécurité de la Navigation Aérienne en Afrique et à Madagascar)
- The SAFIR (Satellite navigation services for AFrican Region)
- Egis : A consulting and engineering group working in the fields of transport, urban development, construction, industry, water, environment and energy
- Pildo Labs : is an engineering company specialized in delivering top of the edge technology within the aeronautics and space sectors.
- ESSP : is a navigation services providers from France (DGAC/DSNA), Germany (DFS), Italy (ENAV), Portugal (NAV-P), Spain (Aena), Switzerland (Skyguide) and UK (NATS)

✓ Second ICTP Training Session of TREGA : Training on EGNOS-GNSS in Africa

from 20 January - 12 March

AfricaArray

- ✓ Launched in July 2004
- ✓ The mission

  create new geoscientific research and training programmes

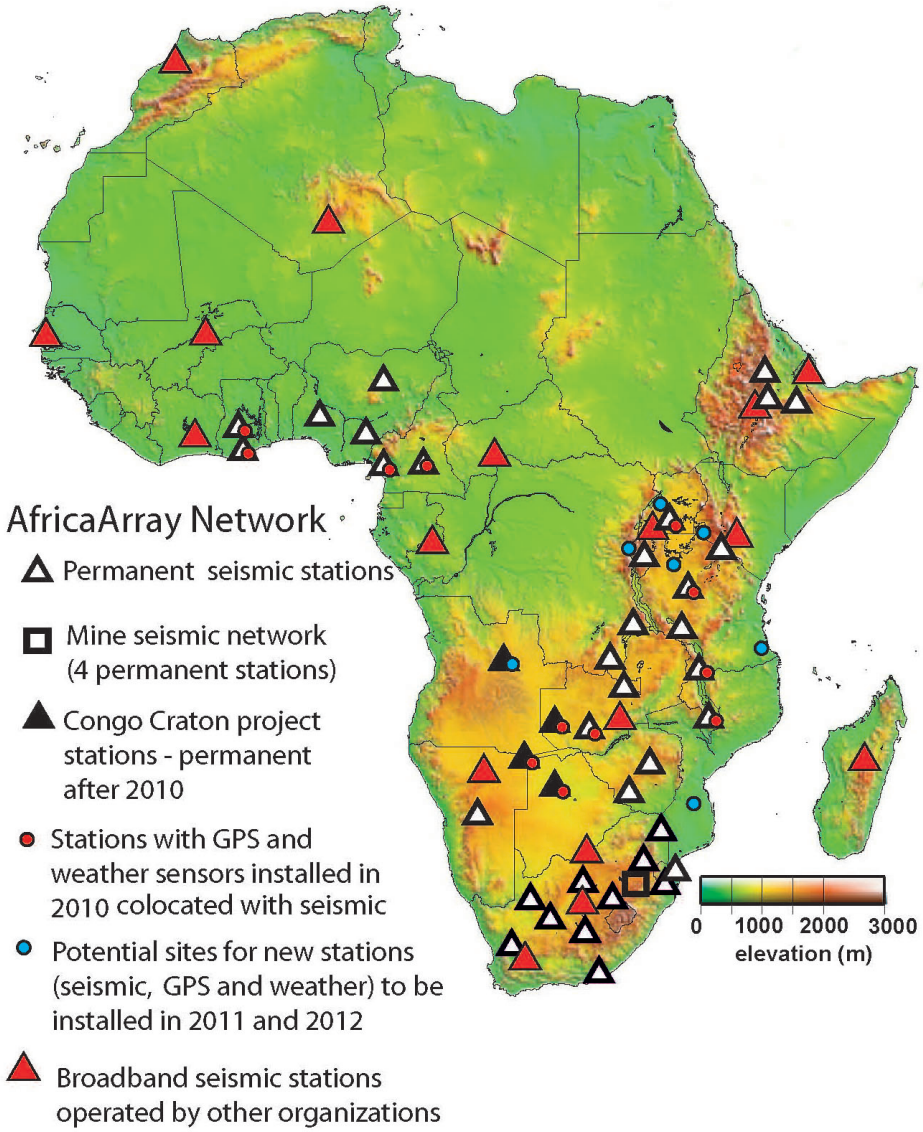
  rebuild existing ones in Africa with Africans and for Africans

  develop a new geophysical training programmes and expanded support of existing ones

  promote geophysical research ; and design and establishment of a network of geophysical observatories

(Adapted from Rabiu, 2013)

AfricaArray stations



Socio-economic impact of GNSS Application

- ✓ Military
- ✓ Aviation
- ✓ Education
- ✓ Economy
- ✓ Agriculture
- ✓ Minerals & oil exploration
- ✓ Disaster monitoring systems
- ✓ Land & maritime transportation
- ✓ Land surveying
- ✓ Health
- ✓ Revenue

GNSS Application to secure public Revenue

- GPS technology has been adopted by the port of Abidjan to track the container transit to boarding countries
- This means has reduced the fraud
- This technology has been adopted also by the port of Lome

GNSS Application to secure farm land tax in Ivory-Coast

Agricultural statistic about Ivory-Coast

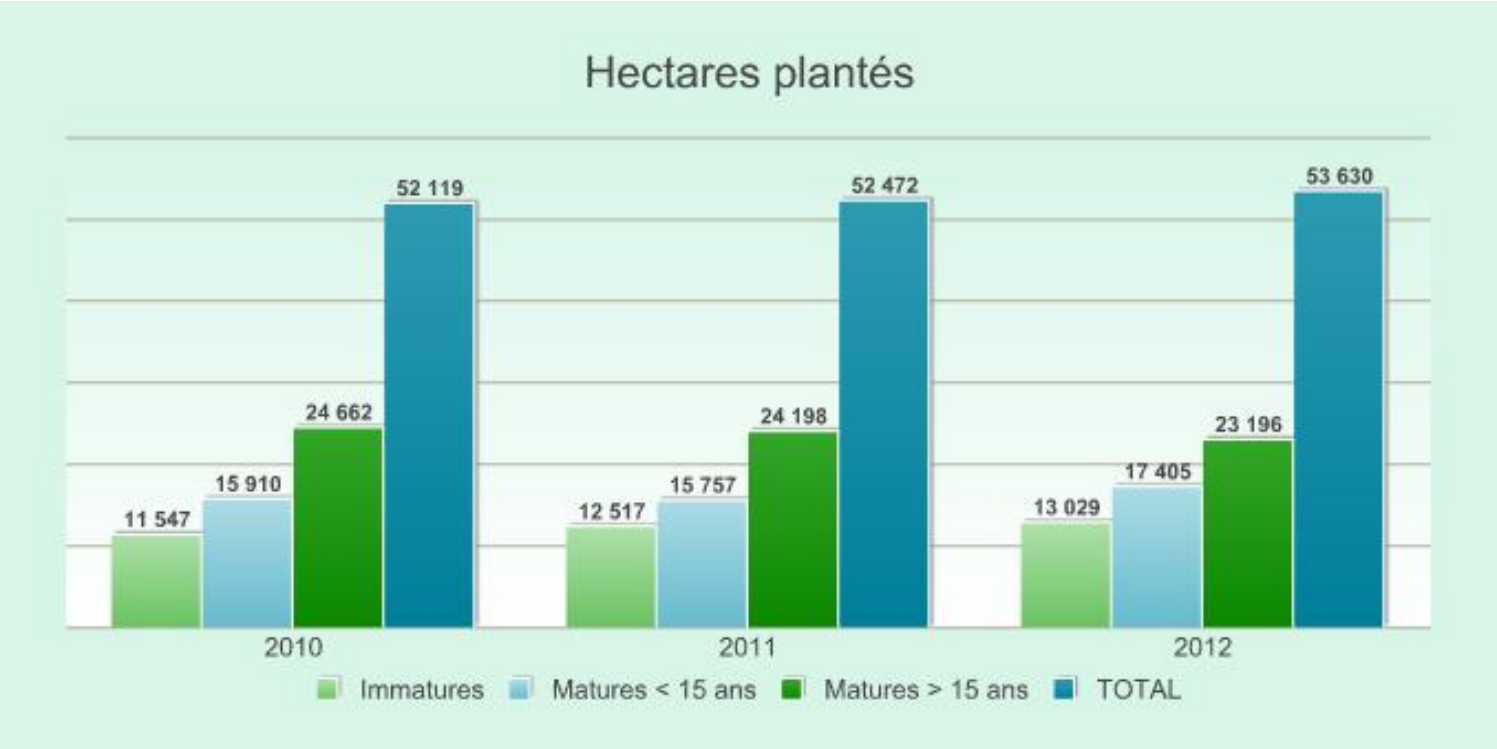
- largest producer of cocoa (1.2 millions of T/year)
- the first African producer of rubber (600 000 T/year)

The goverment pass a law for a new tax.(*Ordonnance n 2011-480 du 28 decembre 2011 portant budget de l'etat pour la gestion 2012*) The company (not the individual famers) who own farm will pay about

- 30UD/ha for rubber
- 20USD/ha for Cocoa, cofee, palm
- 10USD/ha for all over agriculture products excuding food

How much did the goverment collected from SAPH

SAPH is the bigest company of rubber farm.



The total area of SAPH's farms in Ivory-Coast

✓ The goverment has collected $30 \times 53630 = 1,608,900.00 USD$ from SAPH

Farm land cadastral

Locations of rubber farms in Ivory-Coast

Based on that experience, the goverment has initiated a nationwide program of rural land surveying to determine the exact area of each rubber farm.

GSM & GPS

- The mobil communication GSM and GPS are synchronized
- Mobil phone users are trackable in terms of position and time

As a result of this

✓ Crime control

✓ public safety

the arrest of a criminal in Nigeria

read from " http ://www.naijaurban.com/phone-call-to-abu-qaqa-gave-kabiru-sokoto"

✓ The Nigerian secret police has used this technology to arrest Kabiru Sokoto on February 10th, 2012 at 4 am.

(*fromRabiu*, 2013)

prospects

1. Densification of GNSS station in the African continent
2. Capacity bulding trough training program for the young African scientist
3. Public outreach program to pupularise space science in Africa
4. Diplomatic advocacy toward the political leader to support this program
5. Initial regional master and PhD program like the WASCAL

Thanks for your attention

Merci Beaucoup !