



2025-21

Satellite Navigation Science and Technology for Africa

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GNSS Challenges in Africa

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Outline



About Africa

- Applications of GNSS in Africa
- Status quo
- Challenges facing the utilization of GNSS
- Way out....







Africa !

- A continent
- 54 individual nations
- Multi-lingual structure
- English, French, Portuguese, Arabic, Spanishered, Statestered, St
- ~ 30 billion km^2
- ~ 850 million people
- ~14% of the World population







Scanty Applications









on increasing level

- Desitioning services,
- surveying & mapping,
- Boundary mapping
- food security,
- disaster management,
- e air, land & sea navigation,
- Land administration
- emergency response
- Wild life management



Impact of GNSS



✓ Military
 ✓ Aviation
 ✓ Education
 ✓ Economy
 ✓ Agriculture

Minerals & oil exploration
 Disaster monitoring systems
 Land & maritime transportation
 Land surveying
 Health
 Revenue



Abuja Geographic Information Systems (AGIS)

- A viable tool for promotion of Good Governance
- a system for land & property management, registration & taxation
- being used to increase revenue, revenue planning and collection.
- Additional System features include data storage, information management, quick and easy data access, as well as retrieval of Statistical data and updated reports from the office & field.
- proved to be highly efficient and has greatly changed the landscape of town-planning services and land administration
- Uncovered some past corrupt practices
- is being extended to other cities

http://www.abujagis.com/index.html

Digital mapping & enterprise GIS

Lagos State Government of Nigeria, July 19th 2008 – a project with following components

- Geodetic Control & Digital Aerial Photo Acquisition;
- Determination of Geoid Model &
- establishment of Continuous Operating Reference Station & Orthophoto
- Contour Lines and Digital (vector) Mapping;
- GIS Database and Enterprise GIS
- Bathymetry Survey of Lagos lagoons & creeks
- supply of equipments; training & public enlightenment/education.



Fadama rice plantation (Agriculture)

control of meningitis disease

desertification control and

monitoring of encroachment of ocean along the coast

Mapping of Bitumen deposit in SW Nigeria

Climate change related studies





GNSS products are capable of

- producing good governance
- inhibits corruption
- create job opportunities
- advance wealth creation
- promote quality of living
- Secure society
- provide platform for sustainable manpower and economic development













African's Unique Equatorial Ionosphere



Adapted from Keith Groves (SCINDA)

Opportunity for ionospheric research

Satellite Navigation Science & Tech for Africa 2nd April 2009 Abdus Salam ICTP, Trieste, Italy

Africa has the broadest overland segment of the dip equator





Status quo









The African Geodetic Reference

a unified geodetic reference frame for Africa

Indamental basis for the national & regional three-dimensional

reference networks

I fully consistent and homogeneous with the International

Terrestrial Reference Frame ITRF

Densification of GNNS networks with its products in Africa

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





visible set = 12

Reducing 54 Reference frames to 1







Consequences of using reference systems that are not consistent !



Combrinck (AFREF Presentation Berlin GNSS 2008)



Int'l GNSS Service IGS

/isible sat = 12







Example: 3 CORS donated by Leica

Geosystems to the AFREF initiative in 2007, were installed in:

- ✓ Nigeria (lle-lfe)
- ✓ Ghana (Accra) &
- ✓ Kenya (Nairobi)

These added to the existing sparse continuous operating reference stations (CORS) GNSS network in Africa.





Typical CORS in Africa



International Heliophysical Year IHY

- A major program, which has facilitated increase of stations that can serve as CORS in Africa in recent time
- IHY activity has increased the CORS in Africa by 7

✓ Nairobi ✓ Lagos ✓ Addis Ababa ✓ Cape Verde



✓ Abidjan ✓ Akure ✓ Ilorin

International Heliophysical Year IH

- An international cooperation
- endorsed by United Nations as a Basic Space Science Initiative BSSI
- commemorate 50 years of International Geophysical Year IGY
- UNOOSA, through the UNBSSI, offer platform for scientists and engineers from all 192 UN member states to participate in IHY activity
- IHY facilitated contribution of ground based scientific facilities for space experiments by instrument providers to willing host institutions mainly in developing countries



29 Africa countries participated

GNSS technology is adapted in various IHY observational facilities deployed to Africa, viz: ✓ Global Positioning System GPS in Africa ✓ Scintillation Network Decision Aid SCINDA ✓ Sudden Ionospheric Disturbance SID monitor ✓ Atmospheric Weather Educational System for **Observation and Modelling of Effects (AWESOME)** ✓ Magnetic Data Acquisition System MAGDAS Remote Equatorial Nighttime Observatory for Ionospheric Regions (RENOIR) http://www.unoosa.org/oosa/SAP/bss/ihy2007/index.html.

HY observatories over Africa

13 units of MAGDAS
7 units of GPS including SCINDA,
4 units of AWESOME

20 units of SID monitors

data obtained from these facilities are being used to improve our understanding of space weather as it affects the performance of GNSS





GNSS Africa



- a major project of IHY.
- Aimed at increasing the number of real-time dual-frequency GPS stations worldwide for the study of ionospheric variability.
- Of particular interest is the response of the TEC during geomagnetic storms over the African sector.
- serves the relevance of providing supplementary services for the existing GNSS reference stations as it has special GNSS equipment installed to continuously receive signals from satellites, which can be used to calculate the parameters for practitioners to enter in their equipment so that determined positions would be in the same reference system
- IHY increased the number of usable CORS in Africa



GPS AFRICA





SCINDA & AWESOME facilities at Akure, Nigeria



GNSS: for accurate permissible precision



- ✓ AWESOME, RENOIR, & MAGDAS measure timedependent ionospheric and geomagnetic variables as the case may be to accurate permissible precision using GPS receivers attached to every unit
- timing signal from the GPS is used to synchronize the timing of measurement and so ensure high precision acquisition of data with time
- Results from these facilities give better understanding of the variability in the ionosphere and the effects this variability has on critical satellite navigation & communication systems







Knowledge & technological transfer

Capacity Building in GNSS

International collaboration

Availability of teaching & research facilities

internationally competitive research

Windows of postgraduate opportunities

Control of brain drain

Development of Research in BSS

intra-continental partnerships







Proposed UN BSSI







Challenges







- The socio-economic advantage is under-explored
- possibility of using a multimedia GIS database for tourism industry
- personal navigation
- Society surveillance
- public safety security of life and properties
- crime control
- Traffic excesses and crime can be tracked with excellent precision using GNSS.

Real problems: do they exist?

- lack of basic supporting infrastructure
 - > Epileptic power supply
 - Poor Internet connectivity
- Political will
- a special enlightening outreach and education program targeting the ruling class and policy makers in the region
- Diverse nature of the Continent rooted in non-uniform underdevelopment





Way out....



Solutions



- Capacity building in GNSS Science, Technology and Applications
- Provision of basic infrastructures
- Densification of working CORS in Africa
- Awareness: special enlightening outreach and education program targeting the ruling class and policy makers in the region





A new approach ...



R & D Approach

- Intensify complimentary efforts at densifying the GNSS ground infrastructures
- University based National GNSS Network
- Continental GNSS Network
- MAGDAS is a model





visible sat = 12

(MAGnetic Data Acquisition System/Circum-panPacific Magnetometer Network)









Yes!

we can get there with precision and accuracy





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