TECHNOLOGICAL ADVANCEMENT IN SURVEYING AND MAPPING: THE NIGERIAN ADAPTATION

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"ENVIRONMENT FOR SUSTAINABILITY"

INTRODUCTION

- The Surveying profession is one of the oldest professions in Nigeria.
- Survey practices were initially geared towards areas of cadastral surveys essentially for the acquisition of land for the Crown and for developments of estates, mineral resources, road and rail designs, and survey control establishments.
- Framework controls have been established nationwide using triangulation, traversing, trilateration, geodetic levelling and trigonometric levelling methods.
- The Nigerian horizontal geodetic network has its origin at a station near Minna, designated L40. Its geodetic coordinates were arrived at after taking the mean of astronomical values projected through four arms of the Nigerian triangulation network and the astronomically derived coordinates of L40.

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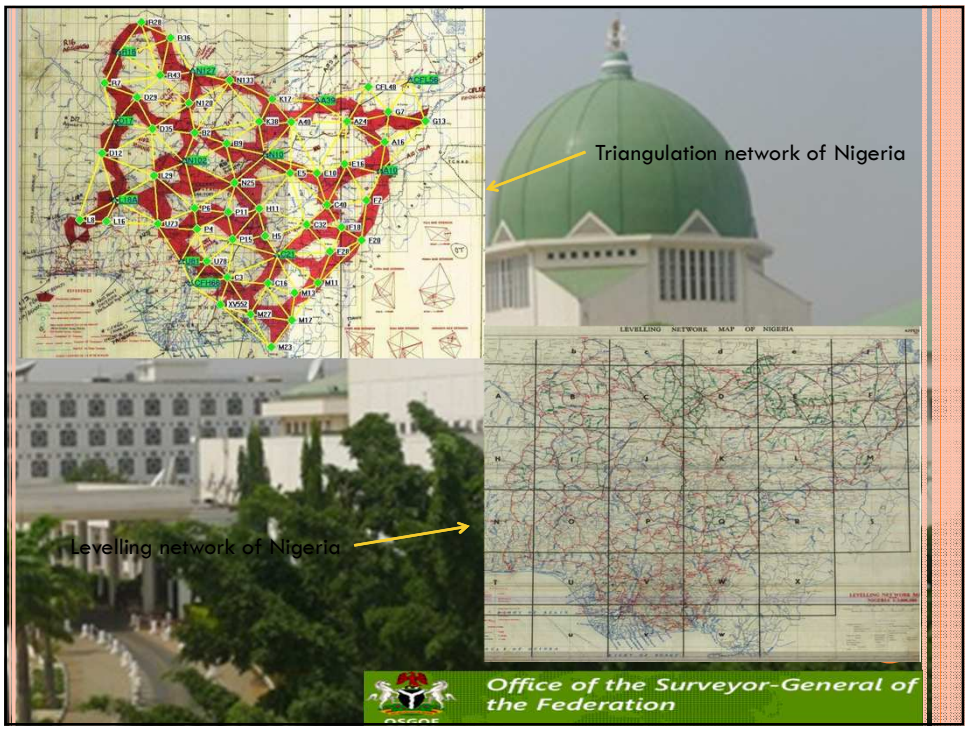

TECHNOLOGICAL INNOVATIONS AND SYSTEMS

- Several technologies and systems have affected the development of Surveying and mapping in Nigeria.
- When surveying and mapping came into existence in Nigeria, our data capturing techniques were essentially by use of compass, Vernier theodolites and chains/tapes.
- Development moved to optical theodolites and electronic distance measurements (EDM).
- About the same time, satellite technology came into existence with its doppler applications in the determination of controls and this was used in Nigeria to strengthen our triangulation network.
- In the seventies, the mainframe computers which occupied whole large rooms and with the resultant large packs of punch cards were in use.
- Today, computers have been miniaturised

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TECHNOLOGICAL INNOVATIONS AND SYSTEMS

Unification of Geodetic Datum in Africa

- The concept to establish a unified geodetic datum for Africa using satellite techniques created the African Doppler Survey (ADOS) project in the seventies.
- The project did not go too far in Nigeria in particular and Africa in general due to the fact that member countries did not understand fully the rationale behind the project and the field procedures.
- The other aim of the project was to create a Zero order set of controls for future Geodetic networks for mapping.

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African Reference Framework (AFREF)

- Sequel to the objective to establish a unified African Reference Framework (AFREF) that is consistent with the International Terrestrial Frame (ITRF), twenty-one (21) Continuously Operating Reference Stations (CORS) have been established at different locations in the country.
  - Office of the Surveyor General of the Federation (OSGOF) - 11 CORS
  - Presidential Committee on Land Reforms - 4.
  - Osun state – 3
  - Lagos State – 1
  - National Space Research & Development Agency (NASRDA) – 1
  - Regional Centre for Training in Aerospace Surveys (RECTAS) -1
- Such network of CORS shall form the basis of and act as focal points for the establishment of national GNSS networks.

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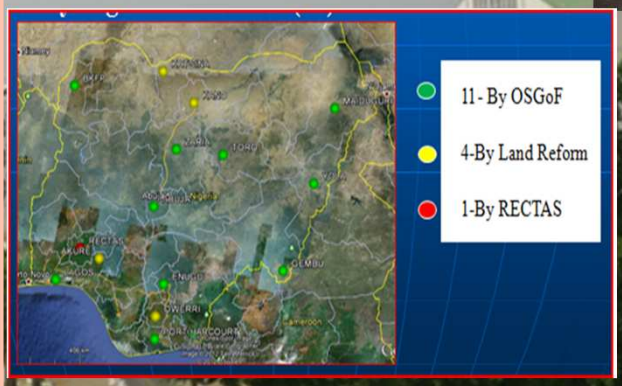
COR Station Pillars at Lagos State



Locations of some COR Stations in Nigeria

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Digital Mapping and GIS Project

- A Mapping project is one that brings about the transformation of a nation.
- The country at State levels have advocated for digital information system and use of new technology for planning and effective management of resources.
- OSGOF apart from converting all old maps to digital formats, has updated and produced new map series at 1/25,000, 1/50,000 and 1/100,000.
- Some State government have carried out digital mapping and GIS projects – Lagos, Ogun etc.
- The primary purpose of the mapping project in the States is to produce orthophotos, digital maps and GIS database for the implementation of various development programmes of the states.
- This will serve as a veritable tool for orderly development control mechanism for the states.

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In Lagos State for example, the area mapped measures approximately 4000 sq. km. covering both land areas and water bodies, creeks, lagoon and coastline of Lagos State.

- The Lagos State project designed, created and implemented a Database which meets ISO/Federal Geographic Data Committee (FGDC) standards.
- Mapping and GIS Projects have revolutionalised the practice by Surveyors, town planners, GIS practitoners and Engineers in the States that have mapped in a way never imagined.
- The Lagos state mapping has made land management more effective and efficient.
- GIS practioners execute their projects faster and better since the base data for their practice is available.

The Mapping Exercises have specifically addressed the following areas

- Land Registration and Management
- Increased Income Generation
- Tourism
- Agriculture
- Transportation
- Physical Planning
- Security
- Environmental Monitoring and Control
- Mineral Resources Development
- Population Census

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Airborne LIDAR and Aerial Photography Technologies

- LiDAR uses lasers attached to planes and other equipment to digitally map the topography of the Earth. It is often more accurate than traditional surveying methods.
- LiDAR data is used by surveyors, cartographers, and photogrammetrists to provide spatial information to specialists in geology, seismology, forestry, construction and other fields.
- Airborne LIDAR technology has been applied in Nigeria to generate Digital Terrain Model (DTM) of land areas and in water-depth measurement and for oil prospecting in the Niger delta.
- In the Lagos State digital mapping, LiDar and aerial photography were the two set of imageries contained in the project specification.

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Global Navigation Satellite System (GNSS)

- Nigeria has since embraced the use and applications of GNSS technologies particularly GPS technology which is very accessible, precise, economical and sustainable.
- Prior to the GPS was the Doppler satellite technology. This is similar to the GPS but based on Doppler with its datum on WGS72.
- OSGOF has used GPS receivers to establish 60 Zero order controls that are connected to ITRF. The Office is in the process of establishing another 24 stations.

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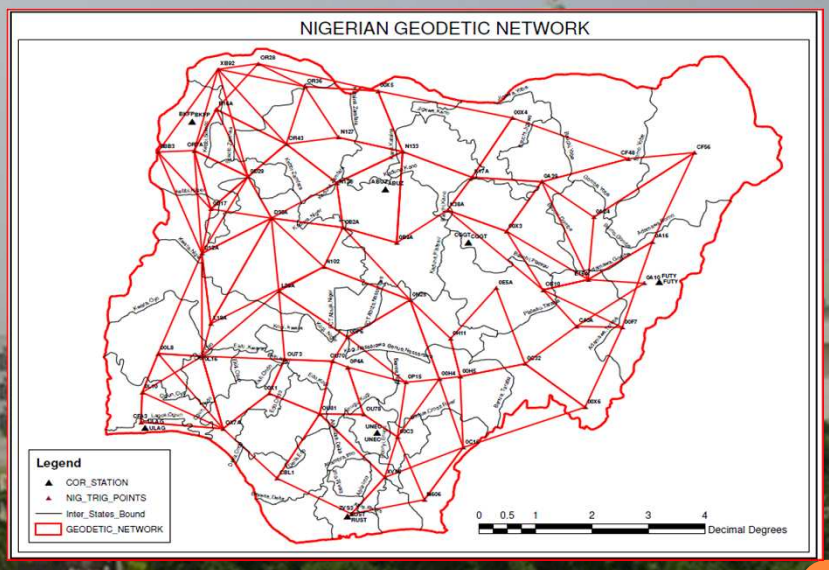

Map showing Zero Order Control stations in Nigeria

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Nigerian Tidal Network

- A number of tide gauge stations are set up in Nigeria.
- The main objective is to enable a continuous time series of sea level determination and for datum determination.
- OSGOF has established tide gauges in Calabar, Port-Harcourt, Warri, Lagos (Apapa) and a recent one at the University of Lagos.
- Tide gauges also exist at Bonny and Forcados.
- The Nigerian Navy releases annual Tidal Observations and Tidal Prediction Tables for some stations.

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Height Modernisation System (Geoid Determination)

- For the optimisation of the potentials of GNSS, there is need for Geoid determination.
- The Geoid assists to transform the geodetic height to the orthometric height which is what is used for most practical purposes.
- The need for best possible geoid at good precision for relative geoid height cannot be over stated.
- This will serve for homogeneous vertical datum for the nation. All gravity measurements needed are acquired.
- Software for the computation for the Geoid parameters has been developed. The determination of the Geoid has commenced.

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Photogrammetric and Satellite Imagery methods

- Cutting-edge Photogrammetric Technology has been implemented in Nigeria to produce files containing 3-D vector buildings with fully textured photo-realistic facades and a large scale 3D Geospatial Cityscapes.
- The first application of photogrammetric methods for mapping took place in 1946 and most of the 1/100,000; 1/50,000 and 1/25,000 maps were from aerial photos.
- This method is still very popular for large scale mapping.

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Gravity Network

- In the 1980s, surveys to establish the gravity network for the country were embarked on. However, progress was mired due to paucity of funds.
- The Department of Surveying and Geoinformatics of the University of Lagos in the late eighties to early nineties carried out two campaigns to collect gravity data in the country.
- These data were very useful in the determination of the geoid for the country.
- The third campaign covering the Benue trough was carried out by the Oil prospecting companies.
- The Nigerian Geological Survey Agency recently carried out gravity campaign mainly in the southern part of the country.

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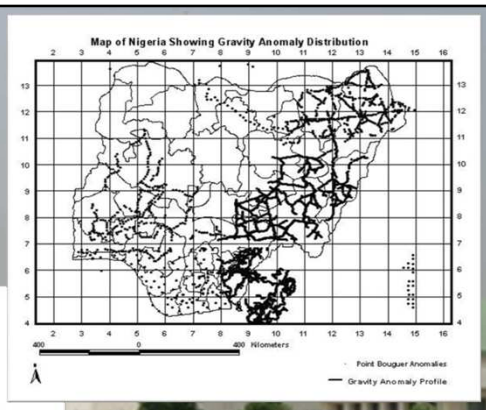
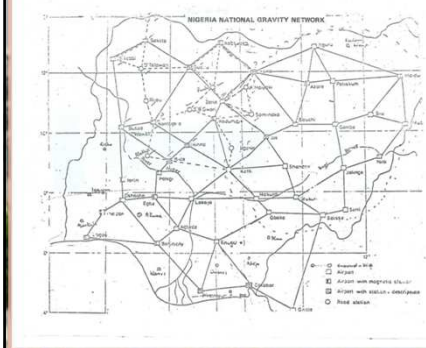
Lines of Gravity Observations





Nigerian Gravity Network

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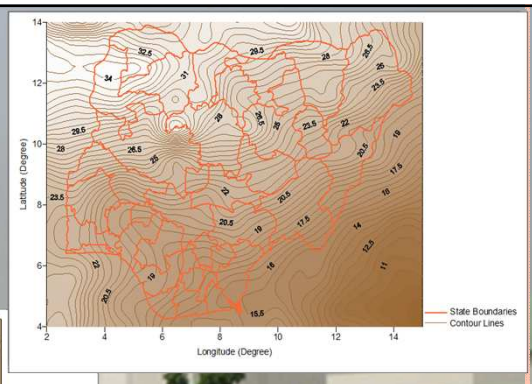
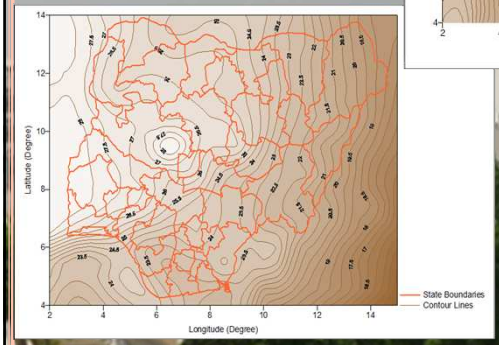
Contour Map of Geoidal Undulations from Satellite Altimetry & Potential Coeff. (Contour Interval 0.5m)





Contour Map of Geoidal Undulations from Potential Coeff (Contour Interval 0.5m)

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Sonar Technology

- To improve the navigability of the lagoons and creeks, Lagos State Government has carried out bathymetric survey of the Lagos and Lekki Lagoons and all the adjoining creeks.
- As part of the survey, wrecks, pipes and other obstructions along the waterways were captured using Sonar technology and other appropriate equipment.
- Its applications are in port and harbour security, underwater construction, Ship hull scanning, dredging and rock dumping, Scour monitoring, search and recovery, inspection of bridges, dams, harbour walls, Pipeline touchdown inspection and placement, Bathymetry, Subsea metrology and fisheries research to mention a few.

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Human Resource Development

- The rapid change and modernisation introduced into surveying and mapping techniques would not be meaningful if they are not supported by an equally up-to-date dynamic workforce.
- The technological advancement therefore, have fostered the training of personnel at home and abroad in GPS, GIS, Remote Sensing, Photogrammetry, CORS Station Operation, Digital Mapping, ICT, Change Management and web-enabled enterprise GIS.

Sales of Digital Data

- Digital data are currently sold. This has provided an open access to geospatial information, which enables anyone to obtain up-to-date survey and mapping information as well as promote the use of digital data and development of spatial data related activities.

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CHALLENGES

- The developing countries are increasingly finding it difficult to cope at the rate the changes are taking place in technologies and systems.
- This is because these changes take place at a very fast rate. Also, they are not endowed with the competence to develop the technologies and systems.
- They only mainly purchase and do not in most cases have the competence to maintain the equipment and the systems. In the past, this was not the case.
- With recent efforts, we expect that this situation be reversed so that employment opportunities could be created, time of equipment availability increased and funds flight reduced.

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CONCLUSION

- In this paper, we have provided a genealogy of the evolution of technologies and systems in Surveying and mapping in Nigeria.
- We have largely been receptive of new innovations but have failed to maintain these systems due to paucity of funds and low human capacity building.
- While we are still open to the adoption of new technologies, it is imperative to note that sustained development can only be brought about if we focus more on human capacity building and creation of conducive environments to effectively handle and sustain these technologies.

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THANK YOU