ISSN 2656-6176
Zambrut
International Journal of Zambrut
Sciences; Economics & Business; Social, Politics & Humanities; Law; Engineering & Industry; Biology, Physics & Matematics; Agriculture & Agribusiness; Health, Nursing, & Medicine; Informatics, Technology & Computers; Food & Nutrition
Research & Review
Proceeding & Conference
Thesis & Antithesis
Novelty & Findings

Roles of Satellite Remote Sensing in Monitoring the Impact of Deforestation on Forests

A.S. Alli-Balogun

A.S. Alli-Balogun
Forestry Research Institute of Nigeria
Jericho-Hill, Idi-Isin, Ibadan, Nigeria

Abstract: *Forests in Nigeria are managed several objectives like: maintenance of wildlife habitat, timber and other commodities production; recreation; water quality protection; wilderness and open space preservation; and as a buffer against deforestation. To manage these resources effectively both public and private requires reliable and timely information about their status and trends. To this end, the federal government, states, and the private sector must be ready to put much effort on ways by which adequate forest resources can be monitored. Though there are existing monitoring techniques but new techniques like the use of satellite remote sensing should be used for proper and accurate monitoring of forest resources new technologies may be able to satisfy the nation's forest information needs. An important development over the past quarter-century has been the deployment of Earth observing satellites and rapid improvements in computing power and algorithms to interpret space-based imagery. These technologies must be well integrated into forest monitoring practice. This review paper discussed on the roles of satellite remote sensing in monitoring the impact of deforestation on forests in Nigeria.*

Keywords: *Satellite Remote Sensing, Monitoring, Deforestation & Forest Resources.*

1. INTRODUCTION

Over the years, forests have played a central role in the economic, social, and cultural development of Nigeria. The forests were used primarily to produce commodity goods, such as fur, game, and timber, which contributed few quotas to drive Nigeria expansion and economic growth. Over the last 30 years, public behaviour towards resources coming from the forest and their uses has shifted dramatically. Whereas forests were once seen solely as a frontier from which resources could be extracted, they now are seeing it as precious islands that serve as refuges for nature and recreation and act as buffers for preservation of environmental debasement. This shift in values has been most noticeable in terms of the country's public forests. As the valuation of forest resources has evolved, the management tasks for forest managers and policy makers have grown increasingly complex. Presently, the nation's forests reserve, both public and private, are managed for a host of uses: timber and other commodity production, recreation, maintenance of wildlife habitat, forests also are managed as a place

Zambrut

for atmospheric carbon and a buffer against climatic change. The use of remote-sensing techniques for forest monitoring is a very important topic, both globally and regionally. On the global scale, there have been many initiatives aimed at applying low- and medium-resolution satellite data to derive information on the state of forests and changes therein (Blackard et al., 2008). Observational data and model simulations are the foundations of our understanding of the climate system (Overpeck, J. T et al. 2011).

Satellites imagery have been in use for several decades for the acquisition of information in a wider form about the earth's surface, starting from military devices to monitoring of global weather patterns, surface vegetation, ocean currents and temperatures, polar ice fluctuations, pollution, and many other areas. Satellite Remote Sensing Technology has introduced the way to the advancement of hyper-spectral and multispectral sensors around the world, a tool that can be used to map specific materials by detecting specific chemical and material bonds from satellite and airborne sensors. Remote sensing is the process of measuring object or the environment without being in physical contact with it. Satellite remote sensing makes it possible to collect data on dangerous or inaccessible areas such as forest. There are two major forms: passive remote sensing and active remote sensing. Passive sensors detect radiations which are naturally emitted or reflected by the object or surrounding area being observed. Reflected sunlight is the major source of radiation measured by passive sensors. Examples of passive remote sensors include radiometers, charge-coupled devices, film photography, and infrared. However, active remote sensing detects and collects emitted energy to scan objects and areas. Example of an active remote sensing is radar which aid the measuring of time delay between emission and return, height, establishing the location, direction and speed of an object.

Satellite remote sensing (SRS) — which is used in collecting information about the Earth's is an important component of climate system observations. Ever since the first space observation of solar irradiance and cloud reflection was made with radiometers onboard the Vanguard-2 satellite in 1959 (Yates, H. W 1977), SRS has gradually become a leading research method in climate change studies (Li, J., Wang et al. 2011). Satellite remote sensing allows the observation of states and processes of the atmosphere, land and ocean at several spatio - temporal scales. It is one of the most efficient approaches for monitoring land cover and its changes through time over a variety of spatial scales (Bontemps, S. *et al* 2011, Gong, P. *et al* 2013). Satellite data are mostly used with climate change models to simulate the dynamics of the climate system and to improve climate projections (Ghent, D. et al. 2011). Satellite data also contribute significantly to the improvement of meteorological reanalysis products that are widely used for climate change research, for example, the National Center for Environmental Prediction (NCEP) re-analysis (Saha, S. *et al.* 2010). The Global Climate Observing System (GCOS) has listed 26 out of 50 essential climate variables (ECVs) as significantly dependent on satellite observations (World Meteorological Organization, 2011). Data from SRS is also widely used for developing prevention, mitigation and adaptation measures to cope with the impact of climate change (Joyce, K. E. et al., 2009). Availability of data is one of primate importance for analysis of climate change and global warming. However, many developing countries lack measuring equipment and long-term records; Africa generally lacks long-term observational data to aid hydrological research (Niang, et al., 2014). Since the available data is insufficient there is no opportunity to monitor forest resources accurately. This review paper is focused on the importance and wide range benefits of using satellite imagery to monitor forest resources in Nigeria.

2. FACTS ABOUT NIGERIA

Nigeria covers a total area of 923,768 km square with a population of 140,431,790 in 2006 (NPC 2009). As a result of its large land area, the country covers different climatic and ecological zones. Nigeria is rich in biodiversity, with an array of fauna and flora. This includes about 20,000 species of insects, almost 1,000 species of birds, 247 species of mammals, 123 species of reptiles, about 1,000 species of fish and about 7,895 species of plants (Federal Government of Nigeria 2001). Tropical forests are incredibly rich ecosystems and they contributed fundamental role in the functionality of the earth. Rain forests are home to probably 50 percent of the world's species, making them an extensive library of biological and genetic resources. In addition, rainforests help maintain the climate by

Zambrut

regulating atmospheric gases and stabilizing rainfall, protect against desertification, and provide numerous other ecological functions. Figure 1 shows the map of Nigeria.

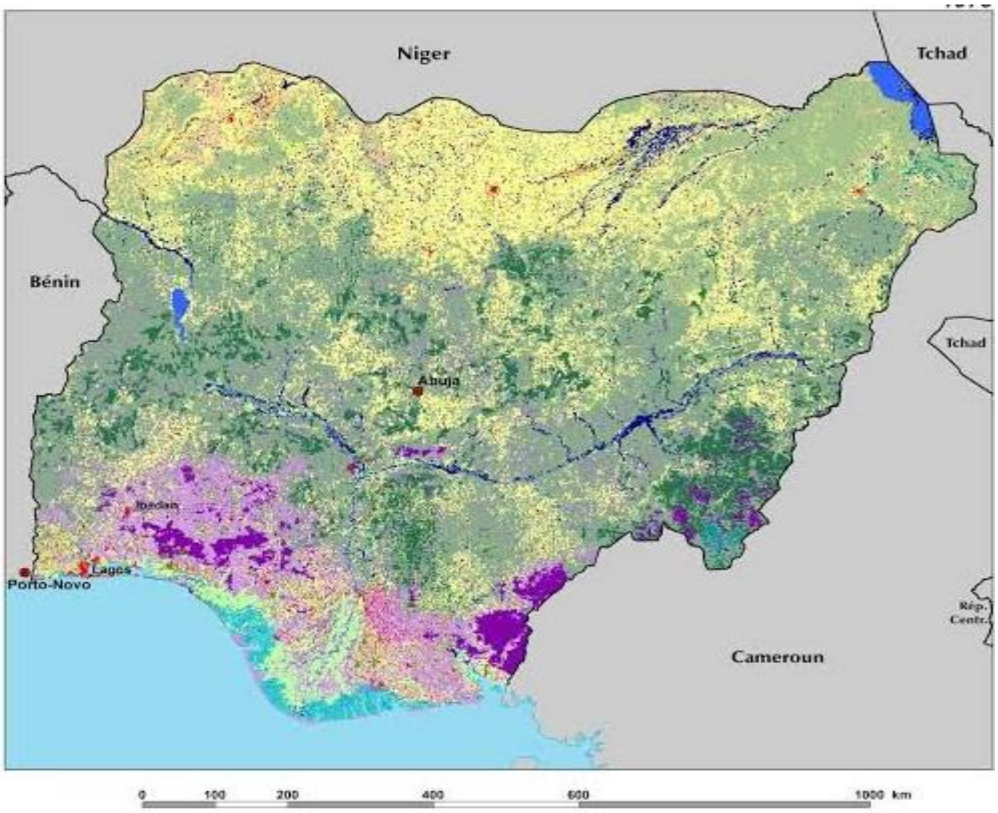

Figure 1. shows the map of Nigeria.

3. FOREST RESERVES IN NIGERIA

The Food and Agriculture Organization of the United Nations (FAO, 2011), the leading source for information on the status of the world's forests, defines forests as land with a tree canopy cover of more than 10 percent and an area of more than half a hectare. FAO says that "forest" includes natural forests and forest plantations but specifically excludes stands of trees established primarily for agricultural production (i.e. fruit tree and oil palm plantations) and trees planted in agroforestry systems, (FAO). Other organizations use different standards for defining forests. For example, the United Nations Environment Programme (UNEP) uses 40 percent cover as the threshold for "closed forests" and 10-40 percent covers for "open forests." Forest reserves are areas designated by state governments for the protection of timber and other forest resources. Harvesting of timber may be allowed under permit and under special concession to people in surrounding communities. Harvested timbers are mostly replaced with exotic tree species. Most of these forest reserves are also poorly managed by the various State Ministries of Agriculture and Natural Resources (Usman, B. A. and Adefalu, L. L., 2014). Forest reserve is estimated to cover total area of 10 million ha which is about 10% of the total land area of Nigeria (World Bank 1992). However, it is of great importance to note that forest resources that falls within the different forest reserves in Nigeria vary according to ecological classification. Therefore, forest reserves in the Savanna and Sahel regions may not necessarily have adequate resources when compare to those at the lowland rain forest areas of southern Nigeria. All these forest reserves are under the possession of each State Governments of the federation and are been oversee by the State Forestry Departments (SFDS). The SFD have professional and technical staff including uniform guards who have direct interaction with the various forest and its resources. Forest establishment was started during the colonial era when land was reserved for forest purposes. Other efforts to expand the forest reserve area have not been successful overtime. Hence, only about 10% of the land area of the country is currently under forest reserves.

4. FOREST RESOURCES DEGRADATION

Anadu *et al*., 1988, Eguavoen, 2007 and Osehobo, 2013 reports that the Okomu forest reserve is under immense pressure from large scale illegal logging, rapid expansion of oil palm plantations and incursion of a growing human population. Due to increase in the annual rate of human population in Edo state, the demand for meat is now on the increase thus resulting in uncontrolled hunting of wildlife within forest reserves (Oates, 1995). These products are mostly sold to city dwellers rather than being consumed locally (Anadu *et al*., 1988) and this negatively impacts on wildlife conservation in the forest reserve. Each day at least 80,000 acres (32,300 ha) of forest disappear from Earth. At least another 80,000 acres (32,300 ha) of forest are degraded. Along with them, the planet loses as many as several hundred species to extinction, the vast majority of which have never been documented by science. As these forests fall, more carbon is added to the atmosphere, climactic conditions are further altered, and more topsoil is lost to erosion (FAO). Regardless of the increased awareness of the importance of these forests, deforestation rates have not reduced. Analysis of figures from the Food and Agriculture Organization of the United Nations (FAO) shows that tropical deforestation rates increased 8.5 percent from 2000-2005 when compared with the 1990s, while loss of primary forests may have expanded by 25 percent over the same period. Rate of primary forest loss has doubled since the 1990s in both Nigeria and Vietnam's, while Peru's rate has tripled. In total, FAO estimates that 10.4 million hectares of tropical forest were permanently destroyed each year in the period from 2000 to 2005, an increase since the 1990-2000 periods, when around 10.16 million hectares of forest were lost. Among primary forests, annual deforestation rose to 6.26 million hectares from 5.41 million hectares in the same period. On a broader scale, FAO reports that primary forests are being replaced by less bio-diversified plantations and secondary forests, (www.fao.org). Due to a significant increase in plantation forests, forest cover has generally been expanding in North America, Europe, and China while diminishing in Africa. Industrial logging, conversion for agriculture (commercial and subsistence), and forest fires—often purposely set by people—are responsible for the bulk of global deforestation today. FAO defines deforestation as "the conversion of forest to another land use or the long-term reduction of the tree canopy cover below the minimum 10 percent threshold." forest depletion to tree crown that covers greater than 10 percent (say from 90 percent to 12 percent) is regarded as forest degradation. According to FAO deforestation statistics, Logging falls under the category of forest degradation. Due to this fact, forest degradation rates are considerably higher than deforestation rates. (FAO). The rate of deforestation in Nigeria is one of the highest in the world. The National population has grown overtime at a rate of about 2.8 percent per annum while urban population has been growing at the rate of 4.5 percent per annum. Since the population is still predominantly rural, these rates must be checked before the number of people that will be residing in urban centres by 2020 increase beyond normal (Geomatics International Inc. in 1996). Forest clearing has been spotted as one of the most significant causes of deforestation in different parts of the world. Deforestation rate very alarming in West Africa due to spontaneous population growth and land use (Myers, 1988). For example, recent estimates indicate that over 350,000ha of forest and natural vegetation are being lost annually due to farming (NEST, 1991). Ola Adams (1996) reported that over 11,300 hectares of forest being cleared annually in Omo Forest Reserve in Nigeria for the establishment of monoculture plantation of indigenous and exotic tree species. These results present a clear and direct role of forest clearing for farming in forest loss. It has been established that the highest rates of forest modification have occurred in areas with heavy dependence on forest land for subsistence and shifting agriculture largely found in developing countries. (Allen and Barnes, 1985a). Sufficient scientific study aimed at estimating the actual level of disturbance which threatens forest reserve is currently lacking. This information will serve as a valuable resource to both federal and state government and other stakeholders saddle with the responsibility of managing this fragile forest ecosystem.

5. ROLES SATELLITE REMOTE SENSING IN MONITORING OF FOREST RESOURCES

Venema et al (2005) noted that proper forest monitoring and management can only be achieved by using remote sensing techniques and creating spatial representations such as maps to know the exact locations and extent of deforestation. In 1998, the Center of Biodiversity and Conservation (CBC) had established the Remote Sensing and Geographic Information System (RS/GIS) facilities. Its technologies had been of immense help in identifying potential survey sites, analyze deforestation rates in focal study areas, incorporate spatial and non-spatial databases and create persuasive visual aids to enhance reports and proposals. A remote sensing device is used in records response and this is based on differs functionality of the land surface, including natural and artificial cover. An interpreter uses the element of tone, texture, pattern, shape, size, shadow, site and association to derive information about land cover. Multi spectral Use of satellite data helps bridge the data gap by providing ancillary data (imagery, elevation, altimetry etc.) that can be used to quantify the effects of SLR on the Niger delta. An effective means of assessing change in forest cover, such as deforestation, is through utilising the capabilities of remote sensing and geographic information system (Htun et al., 2009, Phua et al., 2008, Curran et al., 2004). To assess and quantify changes over time, comparison against historical imagery are made using spectral and temporal characteristics of multi-temporal images (Armenteras et al., 2006, Onojeghuo and Blackburn, 2011). Data collection through ground surveys is time consuming and costly therefore the engagement of satellite remote sensing to monitor the changes in the forest cover over time and the spatial extent of these changes is more efficient and time effective. Below are the lists of some of those applications:

a. Satellite remote sensing provides satellite imagery data at different spatial, spectral and temporal resolutions for forest monitoring, crop health, climate change detection and environmental management analysis.
b. Satellite remote sensing provides information about change in forest area which helps in management of forest area.
c. Satellite Remote Sensing (SRS) provides important data and images for many critical applications such as resources management environmental monitoring etc.
d. Satellite Remote sensing helps in monitoring places that are at risk like areas hit by earthquakes, landslides and avalanches, flood prone areas, , tsunamis, cyclones etc. It maps them.
e. Satellite images is used to identify changes in terrain conditions, missile guidance, mapping enemy territory, it proves helpful in defense [5].

There are few limitations associated with satellite imaging technology and some of these limitations are listed below:

a. The instruments are very expensive to build and install.
b. To interpretation the data can be very difficult therefore there is a need for the researcher to have theoretically knowledge on how measurements are made.
c. Cloud cover affects quality of the images.
d. The images take up a lot of data storage space.
e. One must be licensed to use the imagery of commercial satellite companies because they do not place their imagery into the public domain and do not sell their imagery.

6. CONCLUSION AND RECOMMENDATIONS

Satellite remote sensing is of great importance for accurate monitoring of forest resources and it should be widely used in the collection of data in abundance on forest preservation in Nigeria Based on these reports, the following recommendations are to be considered:

a. Clear national forest management priorities should be put in place.
b. Mandatory forest monitoring standards across all Forest Service divisions should be implemented.
c. There should be allocation of federal funding dedicated to in situ forest monitoring on a national scale.

7. REFERENCE

Allen, J. C., Barnes, D. F., 1985a. The Causes of Deforestation in Developing Countries, *Annals of Association of American Geographers*, 75, 163-184.

Armenteras, D., Rudas, G., Rodriguez, N., Sua, S. & Romero, M. 2006, ‘Patterns and causes of deforestation in the Colombian Amazon’, *Ecological Indicators*, vol. 6, pp. 353-368.

Anadu, P., Elamah, P. & Oates, J. F. 1988, ‘The bushmeat trade in southwestern Nigeria: a case study’, *Human Ecology*, vol. 16, pp. 199-208.

Blackard, J.A., Finco, M.V., Helmer, E.H., Holden, G.R., Hoppus, M.L., Jacobs, D.M., . Riemann, R. (2008). Mapping US forest biomass using nationwide forest inventory data and moderate
Resolution information. Remote Sensing of Environment, 112(4), 1658–1677. doi:10.1016/j.rse.2007.08.021

Bontemps, S. *et al.* Revisiting land cover observations to address the needs of the climate modelling community. *Biogeosci. Discuss.* 8, 7713–7740 (2011).

Curran, L. M., Trigg, S. N., Mcdonald, A. K., Astiani, D., Hardiono, Y. M., Siregar, P., Caniago, I. & Kasischke, E. 2004, 'Lowland forest loss in protected areas of Indonesian Borneo', *Science*, vol. 303, pp. 1000-1003.

Ghent, D., Kaduk, J., Remedios, J. & Balzter, H. Data assimilation into land surface models: The implications for climate feedbacks. *Int. J. Remote Sens.* 32, 617–632 (2011).

Gong, P. *et al.* Finer resolution observation and monitoring of global land cover: first mapping results with Landsat TM and ETM+ data. *Int. J. Remote Sens.* 34, 2607–2654 (2013).

Htun, N. Z., Mizoue, N., Kajisa, T. & Yoshida, S. 2009, 'Deforestation and forest degradation as measures of Popa Mountain Park (Myanmar) effectiveness', *Environmental Conservation*, vol. 36, no. 3, pp. 218-224.

Joyce, K. E., Belliss, S. E., Samsonov, S. V., McNeill, S. J. & Glassey, P. J. A review of the status of satellite remote sensing and image processing techniques for mapping natural hazards and disasters. *Prog. Phys. Geog.* 33, 183–207 (2009).

Li, J., Wang, M. H. & Ho, Y. S. Trends in research on global climate change: A Science Citation Index Expanded-based analysis. *Glob. Planet. Change* 77, 13–20 (2011).

Myers, N., 1988a. Tropical Deforestation and Remote Sensing, *Forest Ecology and Management*, 23, 215-225.

Nigerian Environmental Study/Action Team, (NEST) 1991. The challenges of Sustainable Development in Nigeria, *T. Nest Ibadan*, 1, 6-12.

Onojeghuo, A. O. & Blackburn, G. A. 2011, 'Forest transition in an ecologically important region: patterns and causes for landscape dynamics in the Niger Delta', *Ecological Indicators*, vol. 11, pp. 1437-1446.

Oates, J. F. 1995, 'The dangers of conservation by rural development–a case-study from the forests of Nigeria', *Oryx*, vol. 29, pp. 115-122.

Overpeck, J. T., Meehl, G. A., Bony, S. & Easterling, D. R. Climate data challenges in the 21st century. *Science* 331, 700 (2011).

Phua, M.H., Tsuyuki, S., Furuya, N. & Lee, J. S. 2008, 'Detecting deforestation with a spectral change detection approach using multitemporal Landsat data: A case study of Kinabalu Park, Sabah, Malaysia', *Journal of Environmental Management*, vol. 88, pp. 784-795.

Saha, S. *et al.* The NCEP climate forecast system reanalysis. *Bull. Am. Meteorol. Soc.* 91, 1015–1057 (2010).

Yates, H. W. Measurement of the Earth radiation balance as an instrument design problem. *Appl. Opt.* 16, 297–299 (1977).

Zambrut Journal, Link Access;
https://zambrut.com
https://zambrut.com/satellite-deforestation/

© Copyright International Journal of Zambrut | Zambrut, Inc.