Nigerian Satellites as an Option in Flood Disaster and Emergency Management

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Abstract-Nigeria as a nation experienced flooding incidents that claims many lives render many homeless and also disrupts environmental and socio-economic activities in recent times. With the 2012 flood, causing a devastating effect on the country especially states along the rivers Niger and Benue with huge destruction to the rural and urban infrastructure. In a way to mitigate the extent of damage and casualties during a flood disaster, the study is aimed at promoting the use of Nigerian Satellites in flood disaster preparedness, and response for emergency management. The study also identifies the stakeholders in disaster and emergency management to collaborate with the National Space Research and Development Agency (NASRDA) and National Emergency Management Agency (NEMA) towards attaining a sustainable disaster risk management in Nigeria, and adopt a conceptual framework for improving flood disaster preparedness and response in emergency management using Nigerian Satellite data and other ancillary data. The approach employed was a combination of satellite imagery, imagery intelligence and geospatial information with the help of Information Communication Technology to plan ahead for any flood event during the pre-disaster phase. The incorporation of geospatial techniques using the Nigerian earth observation and communication satellites in flood disaster and emergency management will help emergency relief distribution and budget planning for any flood disaster provided there is synergy, commitment and information sharing among stakeholders.

Keywords: Flood, Preparedness, Response, Disaster, Satellites, Remote sensing, Geographic Information Systems.

1. INTRODUCTION

Flooding incidents have claimed many lives, rendered many others homeless and disrupted a wide range of environmental factors and socio-economic activities related to agriculture, vegetation and sustenance of human and wild life [7]. According to [5], flood can be defined as a natural phenomenon that results in the temporary submerging with water of a land that does not occur under natural conditions. According to [4] floods have affected over 40 million people in Asia especially in India rendering lives and properties useless. African nations too have been badly affected by floods with Benin recording over 600, 000 displaced people after being hit by flood [3].

In Nigeria, floods cause almost 90 percent of damages resulting from natural hazards [1]. With the 2012 flood, causing a devastating effect on the country especially states along the rivers Niger and Benue with huge destruction to the rural and urban infrastructure (farmlands/crops, roads, buildings, drainages, bridges, power lines etc) and socio-economic lives of the area [8]. The obvious reasons for flooding especially in municipalities and coastal areas in Nigeria are the attraction of human settlements to low-lying coastal areas and river flood plains due to fertility or ancestral home, poor drainage system and blocked existing drainage with municipal waste, refuses and eroded soil sediments [6]; [9].

Reducing the risk of flooding will depends largely on the kind and amount of information about such environment that is available. Also the local knowledge of the areas that is likely to be affected during a flooding event in order to develop proper mitigation and prevention measures.

With the increasing number of urban dwellers worldwide, the number of people at risk or vulnerable to flood hazards is likely to increase. Any increase in disasters, whether large or small, will threaten development gains and hinder the implementation of the Millennium Development Goals [10]. Space based information can be used to assist public agencies to prepare for, avert and reduce the consequences of emergencies and improve the response capability of emergency responders [2].

Satellite remote sensing has the potentiality of acquiring geospatial information about a disaster and disaster prone areas spatial temporarily and in a consistent manner. Spatial information is

important in the disaster preparedness phase, especially related to the prediction and forecasting of disasters (eg drought and floods), the design of early warning systems and (community based) disaster preparedness programs [2]. With the launch of NigeriaSat-2, NigeriaSat-X and NigComSat IR satellites, Nigeria can promote the use of its space technology and also utilizes her capacity in geospatial analysis in any flood disaster emergency management by proper planning and cooperation among relevant agencies.

1.1 Aim

The aim of the study is to promote the use of Nigerian Satellites in flood disaster preparedness, and response for emergency management.

1.2 Objectives

1) Identify the stakeholders in disaster and emergency management to collaborate with the National Space Research and Development Agency (NASRDA) and National Emergency Management Agency (NEMA) towards attaining a sustainable disaster risk management in Nigeria.
2) Adopt a framework for improving flood disaster preparedness and response in emergency management using Nigerian Satellite data and other ancillary data.

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1.3 Justification of Study

Geospatial techniques have been an integral part of the techniques used in solving flood disaster and emergency management in several parts of the world. Nigeria has two earth observation Satellites (NigeriaSat-2 and NigeriaSat-X) and a communication satellite (NigComSat IR) presently in space, there is need to utilize our satellites in solving our socio-economic needs in which mitigating flood disaster is key towards attaining an environmental friendly sustainability.

The harnessing of the Nigerian Space Capabilities and potentials through a collaborative effort between the National Space Research and Development Agency (NASRDA) and other stakeholders in flood disaster and emergency management will go a long way towards achieving an environmental sustainability in our nation at large. This will help in mapping out risk areas to flooding, knowing how changes in land use and land cover influences flooding events, show assessable routes for the evacuation of the affected victims, showing the safest point to establish a temporary shelter camps and help amount for the extent of destruction caused by floods in a particular area.

1.4 Nigerian Satellites and Applications

In 2011, Nigeria launched the NigeriaSat-2, NigeriaSat-X (earth Observation satellites) and NigComSat-1R (a communication satellite) in to the space orbit in August and December respectively. NigeriaSat-2 is a high resolution satellite with spatial resolutions of 2.5m panchromatic and 5m multispectral and with area coverage (swath width) 20km by 20km with the ability to rapidly produce accurate mapping to updates the existing information and acquiring new mapping information. It is has the Red, Green, Blue and Near–infrared band. The Nigeria Sat-2 application areas are environmental and disaster management, infrastructure mapping, settlement classification, development of urban green spaces, service provision maps, and access control mechanisms regional planning, security.

NigeriaSat-X was launched in August, 2011 alongside NigeriaSat-2. It was designed and built by Nigerian Engineers at the Surrey Satellite Technology Limited (SSTL), England. It is a medium resolution satellite with a resolution of 22m multispectral. It is has the Red, Green and Near –infrared band with a swath width of 600km. The NigeriaSat-X allows for data for mapping, agricultural monitoring, environmental and

disaster management. NigcomSat-IR is a replacement for NigComSat1. It is an important tool to drive the National Information Communication Technology (ICT) revolution in providing revenue diversification for the nation and offering cost effective solution and affordable access to meet Nigeria's telecommunications, broadcast, aviation, maritime, defense and security needs. The satellite has a life-span of 15 years and was designed to meet the needs of telecommunications, maritime, defense, broadcast media in Africa and parts of Europe and Asia. It has 28 active transponders, and band of Ku, Ka, C-Band and L-Band.

Figure 1.0: Nigerian Satellites in Orbit (Adopted from Aderoju et al., 2014)

2.0 METHODOLOGY

The listed agencies and major actors are the key stakeholders that contribute directly or indirectly to disaster risk and emergency management in Nigeria is displayed in table 1. The criteria for selecting these stakeholders is based on their mandate, mission and vision statements and finally their level of intervention in past disaster occurrence.

Table 1.0: List of identified Stakeholders in Disaster Risk Management

S/N	ACRONYM	FULL MEANING
1	NEMA	National Emergency Management Agency
2	NASRDA	National Space Research and Development Agency
3	NIMET	Nigeria Meteorological Agency
4	FFS	Federal Fire Service
5	OSGOF	Office of the Surveyor General of the Federation
6	SECURITY AGENCIES	Nigeria Military, Nigeria Police Force, State Security Service, etc
7	NGOs	Non Governmental Organizations
8	FRSC	Federal Road Safety Commission
9	IFRC	International Federation of Red Cross and Red Cresent Society
10	SEMA	State Emergency Management Agency
11	UNDP	United Nation Development Program
12	FMoE	Federal Ministry of Environment
13	WB	World Bank
14	LGA ACTORS	Local Government Area Actors
15	NPC	National Planning Commission
16	ECOWAS	Economic Community of West African States
17	NSCDC	Nigeria Security &Civil Defence Corp

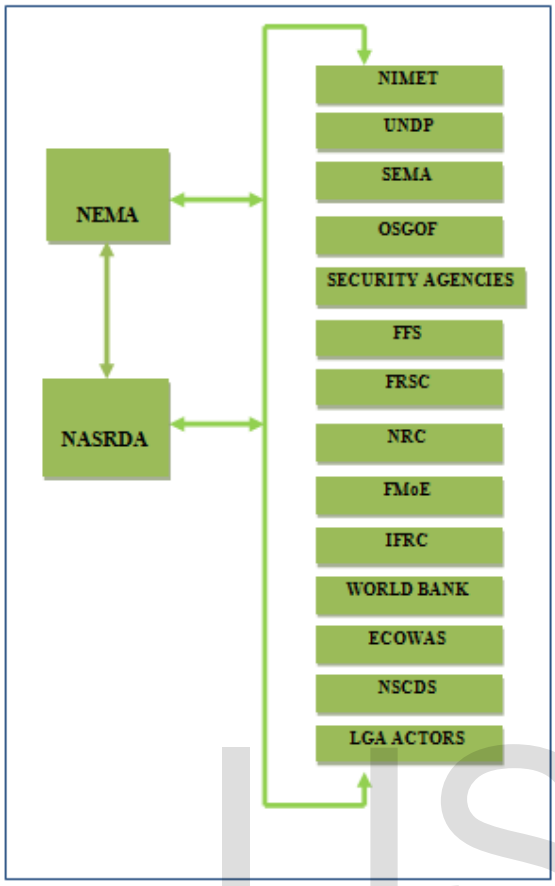

Figure 2.0: Major Actors in Disaster Risk Management

The identified agencies listed in table 1.0 are the major actors in disaster risk management in Nigeria with National Emergency Management Agency (NEMA) as a principal actor of all the agencies. National Space Research and Development Agency (NASRDA) whose satellites are (NigeriaSat-2, NigeriaSat-X and NigComSat-1R) with of its major goal is monitoring and managing disasters plays a major role in flood disaster and emergency management. National Emergency Management Agency (NEMA) and NASRDA have a strong collaboration in areas of disaster management under the platform of UN-SPIDER with NASRDA hosting the UN-SPIDER regional support office in Nigeria.

The UN-SPIDER mission statement is to ensure that all international and regional organizations have access to and develop the capacity to use all type of Space-based information to support the full disaster management cycle. The utilization of the Nigerian satellites in the area emergency management will enhance a positive mitigation achievement and speedy resilient provided there is synergy and information sharing among stakeholders. The schematic workflow is a simple framework on how all the agencies must work together, share information and also very importantly defining each and every actor's role in attaining sustainability in flood disaster preparedness and response.

2.1 Flood Emergency Management and Geospatial Techniques

The figure 3.0 is the conceptual framework that describes how data from the NigeriaSat-2, NigeriaSat-X and NigComSat-1R can be used in flood disaster mitigation and response. In this framework, Imageries from the Nigeria earth observation satellites are processed using geospatial software and expert in the field of satellite remote sensing and Geographic Information Systems (GIS) interprets the information observed from the satellite imagery as geospatial information. This geospatial information is extracted through a process of vectorization using geospatial software and furthermore geospatial analysis is done to enhance spatial modeling, simulations for disaster mitigation, monitoring and prediction for any sustainable development. The use of NigComSat-1R through Information Communication and Telecommunication (ICT) helps in the area of information dissemination through broadcast, internet networks and video conferencing during early warnings, awareness creation programs and also in the areas of Tele-medicine when there are critical medical cases.

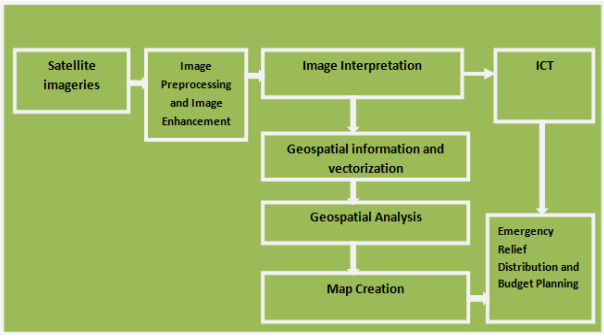

Figure 3.0: Framework for Geospatial Flood Emergency Management

3.0 SPACE TECHNOLOGY IN FLOOD EMERGENCY MANAGEMENT

Remote sensing and GIS technology can be especially useful and desirable when applied during the planning and decision making that involves both natural and man-made disaster occurrence. In flood emergency management, the preparedness and response to any form of disaster is vital.

3.1 Flood Disaster Preparedness

Identification and planning in the preparedness phase of flood disaster management cycle is usually done long before the occurrence of a disaster. In this particular phase, humans, facilities, infrastructures and other assets in the community which are vulnerable to natural and man-made disaster in possible identified disaster prone areas by Satellites (NigeriaSat-2 and NigeriaSat-X). After the identification of these assets for proper inventory, the planning ways to get these assets and humans protected follows. With the advent of space technology, remote sensing and Geographic information system (GIS) can help in the hazard zoning of the community which depends on the vulnerability assessment and human settlements. It can also help in assets identification and mapping of these assets for proper planning in order to combat possible occurrence of any disaster. The preparedness phase is mainly tasks to be done to prepare for an imminent disaster and this is done long before the occurrence of a disaster. In the case, the identification of hazard prone areas is identified by remote sensing satellite and the imageries are for proper mapping of the whole area showing infrastructures, hazard prone areas, hydrology and relief, and other geospatial information present. The Nigeria communication satellite NigComSat-1R plays a vital role in flood preparedness disaster in the areas of early warnings, awareness creation program through media broadcast, mobile phones communication, and internet services. The vulnerability assessment and Risk maps can be done with the help of Geographic information systems (GIS) because of its statistical and analytical capabilities.

The pre-disaster planning is usually done with the help of information dissemination during early warnings and media broadcast, maps and scenarios can be analyzed and response measures can be designed and planned. Evacuation routes can be planned and displayed for use by emergency managers since Geographic information systems (GIS) is a supportive tool in decision making, and planning.

3.2 Response

This is in the post disaster phase of the disaster management cycle which happens during and after the occurrence of a disaster. During this phase, the evacuation route is the map of the affected community is used to evacuate people from their homes. This is the effort to minimize the damage caused by disaster and it involves the following;

a) Evacuation: During the course of any disaster, the people living in affected areas are evacuated and they are relocated to a hazard free area. This is done using existing maps, land use maps, terrain and relief maps aerial photographs of the affected area.

b) Emergency Relief: In this case the rescue team should provide immediate assistance to save lives, improve health and support morale of the affected populate. Through this, the affected people are relocated to a safe place where temporary camps are provided for shelter. This will deal with meeting the basic needs of the people until when permanent and sustainable solution can be found. The emergency team (NEMA, SEMA etc) provides medical facilities, water, food, aid blankets and clothes. The NigComSat-1R also provides facilities for the use of video conferencing in providing medical aid that requires special attention like

surgery through the telemedicine program. The telemedicine program has been flagged up by the National Space research and Development Agency (NASRDA) in conjunction with some major specialist hospitals in Nigeria to provide immediate and special medical aid to severe medical situation during a disaster. The telemedicine program encompasses multidiscipline like medical practitioners, computer scientist, system engineers and many among others.

c) Damage Assessment: Satellite data (Remotely sensed data) and Geographic Information Systems (GIS) provides vital information on the affected community by a disaster. Here satellites provide comprehensive synoptic and multi-spectral coverage of large area in real time. Identify the affected areas, map extent of damage with the help of GIS and the map before and after the occurrence of the disaster. This is used to determine the extent of damage (destroyed facilities, affected lives) hence helping in determining the costs for easy planning after a disaster.

4.0 CONCLUSION

Successful utilization of the Nigerian Satellites (NigeriaSat-2, NigeriaSat-X and NigComSat-1R) in flood disaster and emergency management, and also synergy among the stakeholders can accelerate a country's resilience to flood disaster and also help transform its people's socioeconomic prospects. The conceptual framework towards flood disaster mitigation in the preparedness and response phase of the disaster management cycle shows that the inclusion space science and technology yields a greater efficiency in retrieving information and speedier access to information for emergency situations. This also enhances the ability to build scenarios and explore a wider range of "what-if" alternatives for decision support system for prediction and monitoring flood disaster risk management. This will lead towards achieving proper contingency plan, reduce the excessive budget towards emergency relief and aids and also provide an opportunity to improve living standards in the country which could reduce the loss of life and property during the course of flood disaster.

5.0 RECOMMENDATION

National actors must work together in a coordinated manner for the benefit of Nigeria. The role of all stakeholders must be defined and information sharing must be encouraged to attain substantial results. Concurrent capacity building in geospatial technology must be encouraged and also the use of data from the Nigerian satellites for a major disaster risk preparedness and emergency response. Awareness creation at the grassroots level on the capability of space technology in disaster monitoring and forecasting by both the local government and communities actors should be encouraged to make them identify their own role as a contributor towards attaining a disaster resilience environment.

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