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The Impact of Geographical Information System (GIS) on Emergency Management and Economic Recovery by NEMA in Bayelsa and Rivers State

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ABSTRACT
This study examined the impact of geographical information system (GIS) on disaster management and economic recovery in Rivers and Bayelsa State. Dsaster management was measured in terms of situation awareness, field operation and decision support system. Survey design was adopted for the study. The study population was 115 NEMA staff in Rivers and Bayelsa State. Structured questionnaire was used to collect data from respondents. Mean, standard deviation, Pearson correlation and Regression were statistical tools used for data analysis. The study result reveal that the use of GIS had significant impact on situation awareness, field operation, decision support system and economic recovery system of NEMA in Rivers and Bayelsa State. Thus, the study concluded that GIS is a veritable tool in disaster management and economic recovery in Rivers and Bayelsa State.
Keywords: Geographical information system, disaster management,

INTRODUCTION

Security is a fundamental prerequisite for a stable social order and for sustainable human development. Security is a priority in all human societies and is the responsibility of governments to ensure peace and security within the society. Tragedies on the other hand, occur naturally or are man made and have the ability to disrupt peace and security within a society. Tragedies have been with man for as long as civilization on earth. Its occurrence has been attributed to numerous factors. Tragedies are usually associated with destructive occurrences that leave man with a great sense of loss and despair. Any such incidence that leaves man helpless could be referred to as an emergency (Twigg, 2000). Civil strife, sabotage, outbreak of epidemics and aggression are some of the crises that constitute national emergencies.

An emergency can sometimes turn out to be a disaster or crisis requiring urgent action to mitigate the effect of such an occurrence. Disaster, hazard, crisis, catastrophe and upheaval are commonly used to describe such an occurrence (Blaikie, 2004). Disaster means, "greater or sudden misfortune" (Gosh, 2001). It is an event or hazard; natural or man-made, sudden and or progressive, which impacts with such severity that leaves a community helpless and miserable (Nick, 1991).

Examples of man-made disasters includes the chemical explosion at Union Carbide Corporation Bhopal India in December 1984 that left 4,000 people dead with many still suffering from the attendant health related problems (Ologundudu, 2007). Similarly, the Hiroshima and Nagasaki bombings of the Second World War in Japan, speaks volumes. An instance of natural disasters is the Hurricane Katrina that hit Florida, the United States of American (USA) on 25 August 2005 (Huricane, n.d). Several other examples of disasters abound with monumental loss of lives and properties.

Unfortunately, disasters tend to occur more frequently world wide due to increase vulnerability of societies to hazards with the attendant losses when compared to few decades ago. This assertion is

supported by the United Nation disaster estimates, which noted that between 1994 and 2003 at least 2.5 billion people were killed by the effects of disasters worldwide, while about 478,000 people were killed by the effects of natural disasters such as hurricane, earthquakes and floods (Nathus, 2005).

Africa has equally had a series of painful experiences of disaster in the past. In August 1986, the volcanic eruption in the highland of Western Cameroon led to the death of about 1,700 people while 330 sheep, 300 herds of cattle and thousands of other livestock were also lost (Adamu, 2006). Drought as a hazard is no stranger to South Africa, nor is the threat of wild fires, flash floods or other disasters. Examples of these is Laingburg flash floods in 1995 where 173 lives were lost (Adamu, 2006). Nigeria has had its own share of national disasters which has impacted negatively on the socio-economic well-being of the nation. These include the Ogunpa flood of 1977 in Dugbe Ibadan city. Over 400 houses and hundreds of lives were lost in the flood incidents between 1960 and 1963 alone (Ayeni & Ojo, 2006).

There are also many man-induced disasters in Nigeria. These include the C-130 plane crash in 1992, the EAS crash of 2002 Belleview and Sosoliso air crashes of 2005 where more than 200 people lost their lives with many more maimed (Ayeni & Ojo, 2006). There was also the Jos Terminus Main Market inferno of 12 February 2002 which destroyed over 56 million Naira worth of goods (Ayeni & Ojo, 2006). Another man made disaster was the Ikeja Military Cantonment Ammunition Transit Depot (ATD) explosion on 27 January 2002 resulting in massive damage to the cantonment with about 1,100 people reportedly killed (UNDA, 2002).

Another worrisome dimension to man made disasters in Nigeria is that of internal crises. Some of these crises manifest in the form of ethno-religious crises or the quest for resource control. These are threats that have occurred recently and are becoming frequent. Results of these crises are massive loss of human lives and properties in large proportions tantamount to man made disasters.

Despite an increasing toll from disasters in terms of human suffering, death, infrastructural damage, loss of income and the attendant psychological trauma, feasibility measures to mitigate disasters are not adopted by most developing countries. Presently, there are no internationally agreed standards for disaster management institutions, structure and legislation, there are however some agreements on codes. Some of such are building codes and transportation of dangerous materials. These are however, far from Inter-continental. Although the United Nations (UN) and Non-Governmental Organisation (NGOs) have made significant efforts at promoting and formulating strategies for Disaster Risk Reduction (DRR) and response, many countries including Nigeria are become increasingly vulnerable. Some examples quoted could have been avoided through better planning, control measures, warning systems, community development and preparedness.

Disasters and emergencies impact negatively on sustainable national development. Frequent occurrences of disasters and the need to manage them more effectively have made most developed and some developing nations like South Africa to adopt proactive measure by forecasting hazard prone areas in order to prevent or mitigate the impact of disasters. In this regard, central coordinating machineries were put in place to manage disasters.[14]

In Nigeria, there are many stakeholders in the management of emergencies and disasters. These include the Nigerian Armed Forces, Nigeria Police (NP), Federal Road Maintenance Agency (FERMA), Federal Road Safety Corps (FRSC), and the Nigeria Fire Service (NFS). Others are the National Security and Civil Defence Corps (NSCDC), the Red Cross and United Nations High Commission for Refugees (UNHCR) and some individuals among others. However, the extent to which the various activities of these stakeholders are harmonised coordinated and synchronised in situations of national emergencies and disasters leaves much to be desired.

The foregoing challenges necessitated the establishment of the National Emergency Relief Agency (NERA) in 1976 before Decree No 12 of 1999 amended by Act No 5 of 1999 with a broadened scope transformed it to the National Emergency Management Agency (NEMA). NEMA was among other things, designated to effectively coordinate the management of emergencies and disaster efforts of all the stakeholders. However, despite the NEMA's establishment, response to disaster in Nigeria has fallen short of expectation. This has largely been attributed to inadequate capacity building and integration of effort. Moreover, NEMA's intervention has continued to be focused largely on relief efforts as against proactive approaches.

With regard to NEMA and disaster management, a handful of recent studies have been identified. For example, Idris (2012) studied on the response of NEMA to disaster risk management and came up with the finding that the agency makes significant progress whenever they are on ground but their response capacity is low. Obeta (2014 in Igwe, 2016) study on institutional approach to flood disaster management in Nigeria, observed the clumsy institutional method of managing the disaster. The findings came to the conclusion that response were rather ad-hoc, ineffective and poorly coordinated, reactionary rather than proactive. Odulari (2016) and Kolawale (2016) on the other hand engaged in a similar study of the institutional capacity of NEMA in terms of management of disasters in Nigeria. Remarkably, both studies came to the conclusion that NEMA"s institutional capacity is constrained by the Nigerian factor of corruption which further undermine their ability to function optimally in times of disaster management.

While it is easy to see that the studies of Idris, Odulari and Kolawale came relatively close in terms of providing understanding on disaster management by NEMA in Nigeria, they did not sufficiently provide knowledge on how NEMA coordinates and manages disaster through the use of GIS. The recurrent and increasing occurrences of disasters have presented the critical need for a more effective, holistic and proactive approach to disaster management in Nigeria. This approach ought to be community based and federally funded and coordinated. There is the need therefore, to focus on disaster risks and the vulnerability of communities with emphasis on multi-levels and multi-dimensional coordination. The use of geographic information systems (GIS) within emergency management (EM) has enhanced the ability of practitioners to plan for, respond to, and aid in recovery from natural- and human-induced hazards in a more comprehensive fashion than ever before (Gunes and Kovel, 2000; Cutter et al., 2007). Current and future developments in geospatial technology promise to strengthen the use of geographic data in disaster response and recovery to save lives, protect property, and reduce the economic impacts of hazards (Brown, 2008; Mills et al. 2008). This paper seeks to examine the impact of GIS on emergency management and economic recovery in Bayelsa and Rivers State.

Aims/Objectives of the Study

The aim of this study is to examine the impact of GIS on emergency management and economic recovery by NEMA in Bayelsa and Rivers State. Specifically, the study seeks to determine:

1. The impact of GIS on situation awareness of NEMA in Bayelsa and Rivers State.
2. The impact of GIS on field operation of NEMA in Bayelsa and Rivers State.
3. The impact of GIS on the decision support system of NEMA in Bayelsa and Rivers State
4. The impact of GIS on economic recovery system of NEMA in Bayelsa and Rivers State

Hypotheses

H_{o1}: GIS does not have any significant impact on situation awareness of NEMA in Bayelsa and Rivers State

H_{o2}: GIS does not have any significant impact on field operation of NEMA in Bayelsa and Rivers State.

H_{o3}: GIS does not have any significant impact on the decision support system of NEMA in Bayelsa and Rivers State

H_{o4}: GIS does not have any significant impact on economic recovery system of NEMA in Bayelsa and Rivers State.

METHODOLOGY

The study adopted the survey research design. Surveys make it easy to gather information that are easily analyzed for generalization. Interviews and questionnaire administration are key components of the survey method. The use of survey makes it easy to draw necessary data that help in determining the link between GIS and disaster management by NEMA in Rivers and Bayelsa States. The population of the study are all 125 staff of the National Emergency Management Agency (NEMA) operating in the Rivers and Bayelsa State. Block sampling was adopted as all the population was used as sample since the population of 125 is a manageable one. Data collection methods applied in this study was the used of structured questionnaire. The tool for data analysis was simple linear regression.

RESULTS

H_{o1}: GIS does not have any significant impact on situation awareness of NEMA in Bayelsa and Rivers State.

Summary of Simple linear regression analysis on the impact of GIS on situation awareness of NEMA

Variable	β	Std. Error	t-Statistic	Prob.
Constant	1.865	0.212	8.777	0.0000
GIS	0.422	0.064	6.543	0.0000

R	0.384	df 1	1
R-squared	0.148	df 2	110
Adjusted R-squared	0.144	F-statistic	42.809
S.E. of regression	0.74674	Prob(F-statistic)	0.000

Source: Field Survey, 2018 (Based on results from SPSS, v.23 Output)

The speculation test model in table above demonstrates the association between GIS and situation awareness of NEMA in Rivers and Bayelsa State

Situation Awareness = $\alpha_0 + þ_1(GIS) + e$ (.05).

The above model summary table produced a correlation coefficient, 'R' of 0.384 which show that there is a moderate positive correlation between between GIS and situation awareness. The R^2 stood 0.148 which implied that about 14.8% of the variations in the situation awareness are due to changes in GIS.

The above ANOVA[a] table produced F-value of F(1, 110) = 42.809, p=0.000 which shows that the regression model predicts the dependent variable significantly well. Thus, explained that there is no significant outlier (from the line of best fit) between the predictor (GIS) and situation awareness of NEMA In Rivers and Bayelsa state.

Also, the Table presented the coefficient of the model. It showed a constant estimation of 1.865 and the estimation for the predictor (GIS) = 0.422 demonstrating that, for each unit change of GIS (0.422), the situation awareness will change by 42.2%, respectively holding other variables at constant. T-estimated yielded 6.543, p = 0.000, for GIS. This implied that the predictor variable (GIS) significantly predicts the outcome (situation awareness).

Summarily, from the data so analyzed, Hoi is rejected with a p-value of 0.00 < 0.05. Base on this the Ho1 is restated in the alternative form which states that GIS significantly impact the situation awareness of NEMA in Bayelsa and Rivers State.

H_{o2}: GIS does not have any significant impact on field operation of NEMA in Bayelsa and Rivers State.

Summary of Simple linear regression analysis on the impact of GIS on field operation of NEMA in Rivers and Bayelsa State

Variable	β	Std. Error	t-Statistic	Prob.
Constant	1.807	0.193	9.347	0.0000
GIS	0.342	0.059	5.828	0.0000

R	0.348	df 1	1
R-squared	0.121	df 2	110
Adjusted R-squared	0.117	F-statistic	33.963
S.E. of regression	0.67932	Prob(F-statistic)	0.000

Source: Field Survey, 2018 (Based on results from SPSS, v.23 Output)

The speculation test model in table above demonstrates the association between GIS and field operation of NEMA in Rivers and Bayelsa State in Port Harcourt

Field operation = $\alpha_0 + þ_1(GIS) + e$ (.05).

The above model summary table produced a correlation coefficient, 'R' of 0.348 which show that there is a moderate positive correlation between GIS and field operation. The R^2 stood 0.121 which implied that about 12.1% of the variations in the organization's field operation are due to changes in GIS.

The above ANOVA[a] table produced F-value of F(1, 110) = 33.963, p=0.000 which shows that the regression model predicts the dependent variable significantly well. Thus, explained that there is no significant outlier (from the line of best fit) between the predictor (GIS) and field operation of NEMA in Rivers and Bayelsa State in Rivers state.

Also, the Table presented the coefficient of the model. It showed a constant estimation of 1.807 and the estimation for the predictor (GIS) = 0.342 demonstrating that, for each unit change of GIS (0.342), the field operation will change by 34.2%, respectively holding other variables at constant. T-estimated yielded 5.828, p = 0.000, for GIS. This implied that the predictor variable (GIS) significantly predicts the outcome (field operation).

Summarily, from the data so analyzed, Ho_2 is rejected with a p-value of 0.00 < 0.05. Base on this the null hypothesis is restated in the alternative form which states that GIS significantly impact field operation of NEMA in Rivers and Bayelsa State.

H_{o3}: GIS does not have any significant impact on the decision support system of NEMA in Bayelsa and Rivers State.

Summary of Simple linear regression analysis on the impact of GIS on decision support system of NEMA in Rivers and Bayelsa State

Variable	β	Std. Error	t-Statistic	Prob.
Constant	1.879	0.183	9.347	0.000
GIS	0.267	0.059	5.828	0.000
R	0.293	df 1		1
R-squared	0.086	df 2		110
Adjusted R-squared	0.082	F-statistic		23.114
S.E. of regression	0.64438	Prob(F-statistic)		0.000

Source: Field Survey, 2019(Based on results from SPSS, v.23 Output)

The speculation test model in table above demonstrates the association between GIS and decision support system of NEMA in Rivers and Bayelsa State in Port Harcourt

Decision support system = $\alpha_0 + þ_3(GIS) + e$ (.05).

The above model summary table produced a correlation coefficient, 'R' of 0.293 which show that there is a low positive correlation between GIS strategies and decision support system. The R^2 stood 0.086 which implied that about 8.6% of the variations in the organization's decision support system are due to changes in GIS.

The above ANOVA[a] table produced F-value of F(1, 110) = 23.114, p=0.000 which shows that the regression model predicts the dependent variable significantly well. Thus, explained that there is no significant outlier (from the line of best fit) between the predictor (GIS) and decision support system of NEMA in Rivers and Bayelsa State in Rivers state.

Also, the Table presented the coefficient of the model. It showed a constant estimation of 1.879 and the estimation for the predictor (GIS) = 0.267 demonstrating that, for each unit change of GIS (0.267), the organizational performance will change by 26.7%, respectively holding other variables at constant. T-estimated yielded 5.828, p = 0.000, for GIS. This implied that the predictor variable (GIS) significantly predicts the outcome (economic recovery system).

Summarily, from the data so analyzed, Ho_3 is rejected with a p-value of 0.00 < 0.05. Base on this, the null hypothesis is restated in the alternative form which states that GIS significantly influence decision support system of NEMA in Rivers and Bayelsa State

H_{o4}: GIS does not have any significant impact on economic recovery system of NEMA in Bayelsa and Rivers State.

Summary of Simple linear regression analysis on the impact of GIS on economic recovery system of Paint Manufacturing Firms

Variable	β	Std. Error	t-Statistic	Prob.
Constant	1.420	0.181	7.829	0.000
GIS	0.630	0.062	10.223	0.000
R	0.545	df 1		1
R-squared	0.297	df 2		110
Adjusted R-squared	0.294	F-statistic		104.511
S.E. of regression	0.67804	Prob(F-statistic)		0.000

Source: Field Survey, 2018 (Based on results from SPSS, v.23 Output)

The speculation test model in table above demonstrates the association between GIS and economic recovery system of NEMA in Rivers and Bayelsa State

Economic recovery system = $\alpha_0 + þ_4(GIS) + e$ (.05).

The above model summary table produced a correlation coefficient, 'R' of 0.545 which show that there is a high positive correlation between recruitment strategies and economic recovery system. The R^2 stood 0.297 which implied that about 29.7% of the variations in the organization's economic recovery system are due to changes in GIS.

The above ANOVA[a] table produced F-value of F(1, 110) = 104.51, p=0.000 which shows that the regression model predicts the dependent variable significantly well. Thus, explained that there is no significant outlier (from the line of best fit) between the predictor (GIS) and economic recovery system of in NEMA in Rivers and Bayelsa State.

Also, the Table presented the coefficient of the model. It showed a constant estimation of 1.420 and the estimation for the predictor (GIS) = 0.630 demonstrating that, for each unit change of GIS (0.630), the economic recovery will change by 63.0%, respectively holding other variables at constant. T-estimated yielded 10.223, p = 0.000, for GIS. This implied that the predictor variable (GIS) significantly predicts the outcome (economic recovery system).

Summarily, from the data so analyzed, Ho_3 is rejected with a p-value of 0.00 < 0.05. Base on this the null hypothesis is restated in the alternative form which states that GIS significantly impact economic recovery system of NEMA in Rivers and Bayelsa State.

DISCUSSION

The process of emergency management has several phases beginning from planning to mitigation and preparedness (as pre-emergency phase) and response and recovery (as during and post-emergency phases). However, in each of these phases, emergency management requires accurate and dependable information about the current situation of emergency, existing sources and facilities (Mobaraki et al., 2007). Emergency management or disaster management deals directly with loss of human life and property damage. The tragic event of Hurricane Katrina in the US in September 2005 showed how significant disaster management is.

The implementation of disaster management systems can save thousands of lives, but when it poorly implemented it can cause considerable casualties, damage and loss in various dimensions when the disaster actually happens. In the management and reduction of disasters, knowledge of the environment is provided by geoinformation and space technology tools. The main components of these tools are: up-to-date topographical maps, remote sensing, GIS database, appropriate Spatial Data

Infrastructure (SDI), early warning systems through international cooperation, as well as Mobile and Web GIS. In order to create a comprehensive disaster management system, government and agencies concerned in its implementation need to rely on advanced geospatial technologies and services. Indeed, in the present era, mobile GIS are essential technologies for the future development of disaster management systems.

GIS is useful for hazard zone mapping and during emergency conditions mitigation of people can easily possible using these maps. GIS and RS are beneficial in mitigation strategies and preparedness plans. Real time geographic data can improve the allocation of resources for response. GIS technologies are very useful in modeling of disaster risks and human adaptations to hazards. It is also provides decision support system in disaster management. Disaster response is one part of a widely accepted disaster management life-cycle of planning, response, recovery and mitigation [see: FEMA (2013) for general discussion of the disaster cycle and Anthopoulos et al. (2013) for insights into the transition from response to recovery specifically]. The aim of the recovery phase is to restore the affected area to its previous state. Recovery efforts are concerned with issues and decisions that must be made after immediate needs are addressed.

CONCLUSIONS

The application of remote sensing and GIS has become a well developed and successful tool in disaster management, as we have our location observation programmes and the requisite for hazard mitigation and monitoring rank high in the planning of new satellites. GIS allows for the combination of different kinds of data using models. It allows for the combination of the different kinds of spatial data with non-spatial data, attribute data and use them as useful information in the various stages of disaster management.

Various disasters like earthquake, landslides, flood, fires, tsunamis, volcanic eruptions, and cyclones are natural hazards that kill lots of of people and destroy property and infrastructure every year. The rapid increase of the population and its increased concentration, often in hazardous environment, has escalated both the frequency and severity of natural disasters. Among the tropical climate and unstable land forms, coupled with deforestation, unplanned growth propagation non-engineered constructions which make the disaster prone areas sheer vulnerable, slow communication, poor budgetary allocation for disaster prevention, developing countries suffer more or less unceasingly by natural disasters.

GIS technology is an effective tool for monitoring and measures disaster. risk assessment parameter such as slope, flow direction, stream network can be easily extracted using GIS. The limitation of the process is the availability of satellite data, which is not always guaranteed for the time of peak flood. But, as GIS data and satellite images are relatively cheap and dependable so, local authorities should adopt this technology. This technology can be very useful for a planner to generate an effective strategy to prevent this disaster. Hence this tool can be used by a policy maker, which will help them to make a decision before the flood to prevent more economic and social loss.

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