

# **Geographic Information Systems (GIS); A Tool for Disaster Management**

**Israel TAIWO, Oyedokun ABIODUN, Felix AJIBADE, Nigeria**

**Key words:** GIS, Disaster, Management

## **SUMMARY**

The need to pre-empt upcoming disasters, mitigate the effect of disasters, minimize losses and ensure most efficient utilization of resources during disaster calls for an effective planning, designing and implementing tool like Geographic Information systems. This work describes Disaster Management and the efficacy of Geographic Information systems in managing Disasters. It is hoped that the processes described in this work will be effective in managing disaster in Nigeria, Africa and environ.

# **Geographic Information Systems (GIS); A Tool for Disaster Management**

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## **1. INTRODUCTION**

Disaster; like other events can be suspected, planned for, reduced or better still prevented from occurring. In most underdeveloped, developing and some developed countries; disaster management is being given a reactive approach rather than the required proactive approach. Disaster with its characteristic suddenness and swiftness requires a swift response, necessary to reduce its effect. During disaster, losses become very high due to inability to manage the situation in a timely manner. If the survival of Man and its environment has to be secured; coherent, perceptible, transparent and pragmatic decisions have to be made before, during and after a disaster by governments, organizations and individuals.

Disaster risk zoning, flood modelling and prediction, Disease mapping and prediction, Land degradation and monitoring, Food security and environmental monitoring, Monitoring urban sprawl and monitoring volcanic eruptions among others are capabilities of a GIS. To minimize the impacts of hazards, reduce vulnerability and enhance coping and adaptive capacity in the environment, thereby putting in place rehabilitation processes that could rebuild resilience for future disaster, the knowledge, technology, expertise, institutional capacities, management skills and practical experience available in GIS has to be utilized.

### **1.1 GIS : Geographic Information Systems**

Understanding the past, Present and future of the environment will give rise to an informative and efficient disaster management information system. Geographic information system according to Murai, 2003, is an information system to input, retrieve, process, analyze and output geographically referenced data or geospatial data in order to support decision making for planning and management of natural resources and environment.

All objects in the environment can be geographically defined either absolutely or temporarily. It is obvious that to obtain an effective disaster management, both spatial and non-spatial data has to be effectively managed. This is what GIS as a tool offers disaster management; the necessity of acquiring, organizing, analyzing visualizing and disseminating data inform of information necessary for disaster management.

Below is a conceptual framework of GIS operations in disaster management.

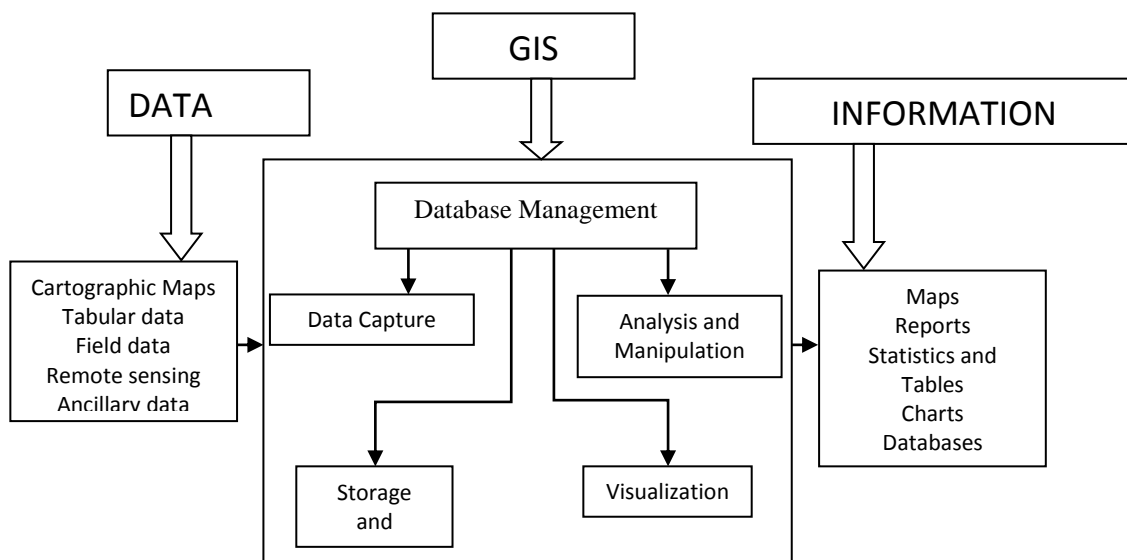


Fig 1 synoptic of GIS in disaster management  
Source: Otukei, 2008.

## 1.2 Phases of Disaster Management

Disaster management phases; though not independent, can be grouped into five phases. If life, property and the environment has to be protected adequately, the following phases should be considered.

### 1.2.1 Planning

Designing strategies against disasters become imperative if disaster has to be well managed. The planning phase of disaster management involves the operations required to analyze the possibility of a disaster and its potential consequences on man and its environment. Consequently, Mitigation Preparedness, Response and Recovery schemes are then identified and organized.

### 1.2.2 Mitigation

Mitigation involves the process of preventing suspected disasters from occurring by identifying areas susceptible to certain types of disasters, as well as creating solutions to such problems. For example, Flood disaster is associated with areas of low elevation, nearness to water bodies, bad drainage facilities. GIS can help to superimpose this information, predict when flooding is likely to occur, then suggest solutions against the suspected flood disaster such as; dredging the water body or constructing viable drainage systems in the area.

Mitigation may also include: legislation activities against the erection of buildings in disaster prone area, establishing stringent codes against the release of carbon monoxide into the air, or arms build up to deter enemy attack.

### 1.2.3 Preparedness

When Prevention is been denied, it becomes unavoidable to prepare for disasters. Preparedness phase includes activities of the government, organizations and individuals to save lives and minimize the impacts of the occurrence of non-avoidable disasters. This includes: installing warning systems preparing emergency response personnel with the necessary equipment and training.

### 1.2.4 Response

Providing emergency assistance for victims and reducing the probability of secondary damage are the major activities to be carried out as response scheme against disaster. Like other phases above, response phase is as well interrelated with Recovery phase.

### 1.2.5 Recovery

During and after a disaster, returning all systems to normal or better is necessary. Short-term recovery includes the distribution of basic necessities to affected victims, while long-term recovery scheme is to bring succor to man and its environment after a disaster. This process may involve redevelopment loans, legal assistance and community planning.

## 2. GIS IMPLEMENTATION

A simple and yet affordable approach was implemented in the creation of Geodatabase for the staff quarters of The Federal Polytechnic Ado-Ekiti, Ekiti State, Nigeria. The Geodatabase was created using different data sources, part of which includes Global Positioning system data used georeferencing the imageries obtained.

S/No	Easting (mE)	Northing (mN)	Description
1	753777.425	840010.451	Abuja Bus stop /Round about
2	754115.073	840472.517	RCF Junction
3	753240.193	840193.162	FPA 11s Book Shop Junction
4	753351.820	840121.275	FPA 9s Bus stop
5	753453.226	840861.719	FPA 56s

**Table 1: List of Coordinates**

Questionnaires were served out to the occupants of every building in the polytechnic staff quarters.

FEDERAL POLYTECHNIC ADO-EKITI  
SCHOOL OF ENVIRONMENTAL STUDIES  
DEPARTMENT OF SURVEYING AND GEOINFORMATICS

**Introduction**

This questionnaire is intended for residents of the polytechnic staff quarters. The primary aim of this survey is to obtain information as input for the designing and implementation of a geo-database of the Polytechnic Staff quarters. The users' requirement survey is purely for research and academic purposes. **All responses will be treated with utmost privacy and answers will only be used as part of the contribution into this thesis.** It would be highly appreciated if you could please study the questions carefully and provide answers accordingly. If the space provided to answer any question is not sufficient, please write at the back of the page. The research student will give more explanation where questions are not clear. Please accept our gratitude for sparing your precious time in answering these questions.

**Personal Data**

1. Name: .....  

<i>Surname</i>	<i>Other names</i>
----------------	--------------------
2. Mobile: .....
3. Gender :      Male       Female
4. Marital Status:      Single       Married            Divorced
5. What is your official Status?      Academic Staff       Non Academic Staff
6. Department/Unit: .....
7. Rank/Post: .....
8. Block No :       Flat No :
9. Number of People in your household: - .....
10. What is the major source of water supply? (You can list more than one)  

Well <input type="checkbox"/>	Borehole <input type="checkbox"/>	Rainfall <input type="checkbox"/>
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11. What is your major source of Power supply? (You can list more than one)  

PHCN <input type="checkbox"/>	Personal Generator <input type="checkbox"/>	School Generator <input type="checkbox"/>
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12. How do you dispose your waste? Burning       Recycling       Refuse Dump
13. What is the state of your flat?      Good       Fair       Bad
14. Do you at anytime have to carryout repair work on your flat on your own? Yes  No
15. Have the flat being renovated by the school authority since you moved in? Yes  No
16. How often is your flat renovated?      Monthly       Yearly       Never
17. How will you rate the maintenance department on your request for maintenance in your flat?  

Excellent <input type="checkbox"/>	Good <input type="checkbox"/>	Fair <input type="checkbox"/>	Poor <input type="checkbox"/>
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**Fig 2. Sample of Questionnaire**



**Fig. 3 Poly 2 Imagery**

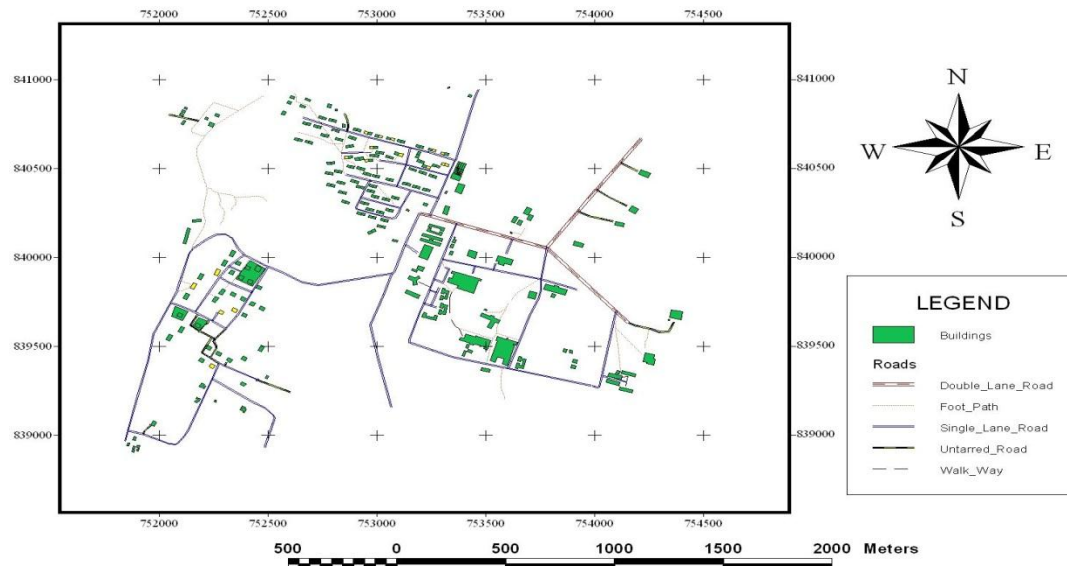
Below is the data dictionary used in implementing the GIS.

Attributes	Representation	Data Types
Name of Occupier	Name_of_occupier	Text
Mobile Number	Mobile_number	Numeric
Gender	Gender	Text
Marital Status	Marital_Status	Text
Official Status	Official_Status	Text
Dept/Unit	Dept_Unit	Text
Rank/Post	Rank_post	Text
Number of inhabitant	Number_of_inhabitant	Numeric
Source of water supply	Water_source	Text
Source of power supply	Power_Source	Text
Waste disposal method	Waste_disposal	Text
Flat ID	Flat_ID	Numeric
Occupier ID	Occupier_ID	Numeric
State of flat	Flat_State	Text
Repair Work on your own	Repair_Work	Yes/No
Flat renovation by school	Reno_School	Yes/No
Time of flat renovation	Reno_Time	<b>Text</b>
Maintenance department	Maintenance_Rating	<b>Text</b>

**Table 2 Data Dictionary**

The satellite imagery above was digitized, attribute data was added to the resultant vector map, and from it; queries were carried out to obtain prompt solution to disaster related problems. For example, considering a scenario of student riot, where academic staffs of the polytechnic is the target of students, a query was performed to show the houses of academic staffs that live on the polytechnic staff quarters, for immediate security measures.

### FEDERAL POLYTECHNIC ADO-EKITI



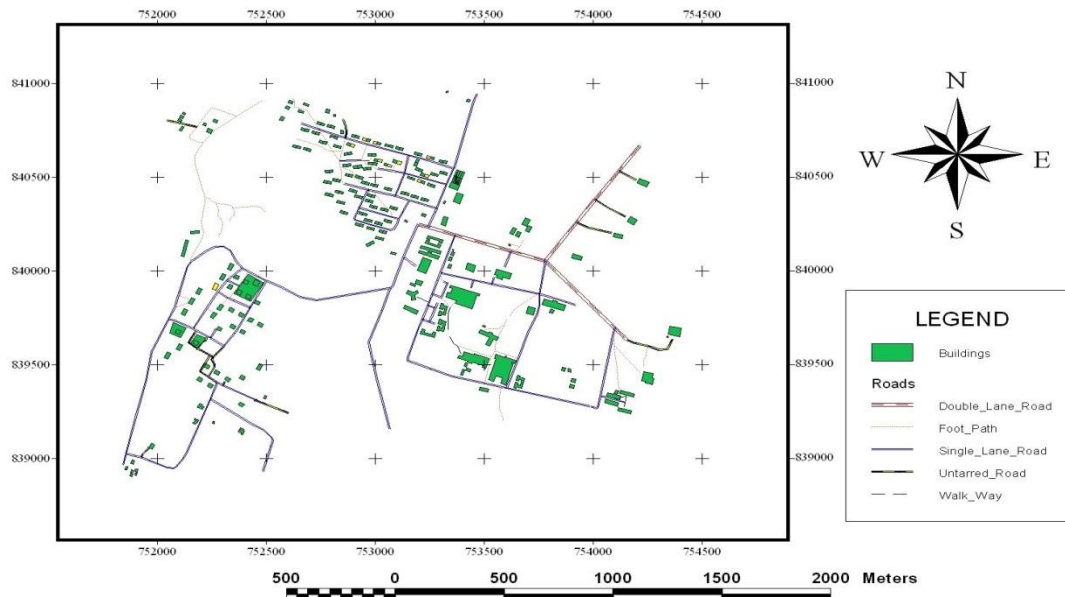
**Fig 4 Query Showing Where Official Status of Occupants Is Academic Staff within the polytechnic Staff Quarters**

DIGITIZED_	NAME_OF_OC	MOBILE_NU	GEND	MARIT	OFFICIAL_S	DEPT_UNIT	RANK_POST	N	WATER_SOUR	POWER_SOUR	WASTE_D	FLAT_OCCU	FLAT	REPA	REN	REN	MAINT
EST_SQ_B23_26	Dada.R.T.	08066892429	Female	Married	Academic_Staff	Accountancy	Senio_Lecturer	5	Borehole	PHCN	Burning	52.0	29.0	Bad	No	No	Never Fair
EST_SQ_B25_30	Olamide_E.Victor	08062647872	Male	Married	Academic_Staff	Urban_and_Regio	Lecturer	6	Borehole	PHCN_School_Generator	Burning_Re	48.0	28.0	Fair	Yes	No	Never Fair
EST_SQ_B6_11			Male	Single	Academic_Staff	Mechanic_Dept	Auto_Unit_Level_13	4	Borehole	PHCN_Personal_Generator_School_Generator_Inw	Burning_Re	9.0	9.0	Fair	Yes	No	Never Poor
EST_SQ_B8_16	Abilogun_J.M.	08035062944	Male	Married	Academic_Staff	Electrical_Electro	Chief_Technologist	8	Borehole_Rainfall	PHCN_Personal_Generator_School_Generator	Burning	14.0	13.0	Bad	Yes	No	Never Poor
EST_SQ_B1_2	Odekina_Abinmaje		Male	Married	Academic_Staff	Office_Technology_Management		5	Borehole	PHCN_School_Generator	Burning	2.0	2.0	Fair	Yes	No	Never Good
EST_SQ_B11_2	Fakunle_Emanuel_A.	08066893496	Male	Married	Academic_Staff	Civil	Lecturer_I	5	Borehole	PHCN_School_Generator_Personal_Generator	Burning_Re	18.0	17.0	Fair	Yes	No	Never Fair
EST_SQ_B21_24	Eke.E.N.	08032172617	Male	Married	Academic_Staff	Secretarial_Studies		5	Borehole	School_Generator	Burning	56.0	31.0	Fair	Yes	Yes	Never Fair
EST_RV_12	Oyinlana_Adekanbi	08035800541	Male	Married	Academic_Staff	Business_Administ	Chief_Lecturer	2	Borehole_Rainfall	PHCN_School_Generator	Refuse_Durr	73.0	40.0	Fair	No	No	Never Good
EST_RV_6	Oladipo_Isaac_Ola	08033888989	Male	Married	Academic_Staff	Agric_Engineering	Lecturer	5	Borehole_Rainfall	PHCN_School_Generator	Burning	74.0	41.0	Fair	Yes	No	Never Fair
EST_RV_9	XYZ		Male	Married	Academic_Staff	Food_Technology	Principal_Lecturer	3	Borehole	PHCN_School_Generator	Refuse_Durr	79.0	44.0	Fair	Yes	No	Yearly Fair
EST_RV_17	Arc_Ifesanya_Kunle	08037202436	Male	Married	Academic_Staff	Architectural_Dept	HOD	2	Borehole_Rainfall	PHCN_Personal_Generator_School_Generator	Refuse_Durr	68.0	39.0	Fair	Yes	No	Never Good
EST_SQ_B18_15	Famokun_ZA	08051934332	Male	Married	Academic_Staff	Electrical_Electro	Principal_Lecturer_I	3	Borehole_Rainfall	PHCN_Personal_Generator_School_Generator	Burning_Re	61.0	35.0	Fair	Yes	No	Never Fair
EST_RV_2	Ukpong_Gordian_Efiong	08062669417	Male	Married	Academic_Staff	Science_Tech/Phys	Chief_Technologist	0	Borehole	PHCN_School_Generator	Burning	82.0	45.0	Fair	Yes	No	Never Fair
EST_SQ_B7_13	Ojo_OI		Female	Single	Academic_Staff	Library	Librarian_II	3	Borehole	PHCN_School_Generator	Burning	11.0	11.0	Fair	No	No	Never Fair
EST_SQ_B2_3	Aboloma_Rita.I.	08028463161	Female	Married	Academic_Staff	Science_Technology	Senior_Lecturer	6	Borehole	Personal_Generator_School_Generator	Refuse_Durr	3.0	3.0	Fair	Yes	No	Never Poor

**Table 3 Query Showing Where Official Status of Occupants Is Academic Staff within the polytechnic Staff Quarters**

Another scenario considered after the creation of this system is if lack of electricity is to be considered as a potential disaster within the polytechnic staff quarters, three methods of electricity generation has been identified within the polytechnic, hence questions could be asked to know where all methods are used, then locations that does not have access to some could be noted for attention. Next is a query showing locations within the polytechnic staff quarters where source of power supply is Power Holding Company Nigeria limited (PHCN), Personal Generator, School Generator.

## FEDERAL POLYTECHNIC ADO-EKITI



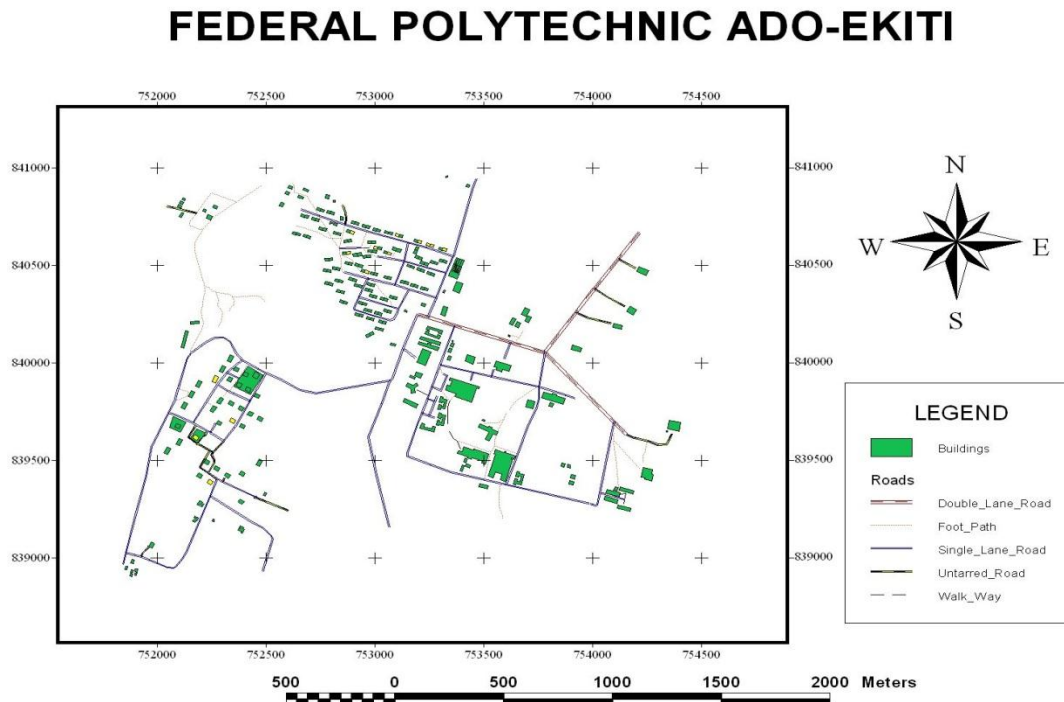
**Fig 5 Query Showing Where Power Source of occupant is PHCN, Personal Generator, School Generator within the polytechnic Staff Quarters**

DIGITIZED	NAME_OF_OC	MOBILE_NUM	GENDER	MARITA	OFFICIAL_S	DEPT_UNIT	RANK_POST	NUWATER_SOUR	POWER_SOUR	WASTE_DISP	FLAT/OCC/FLAT	REF/REN	RENO	TIME	MAIN
EST_SQ_B15_10	Ige F.F.	08035273794	Female	Married	Non_Academic_Staff	Registry	Senior_Assistant_Registra	6 Well, Borehole	PHCN, Personal_Generator, School_Generator	Burning	28.0 21.0	Fair	Yes/No	Never	Poor
EST_SQ_B7_14	Oiketuyi G.M.	08035689540	Female	Married	Non_Academic_Staff	Health_Centre	Principal_Nursing_Officer	4 Borehole	PHCN, Personal_Generator, School_Generator	Burning	12.0 12.0	Fair	Yes/No	Never	Fair
EST_SQ_B8_16	Abilogun J.M.	08035062944	Male	Married	Academic_Staff	Electrical_Electronics_Engineering	Chief_Technologist	8 Borehole, Rainfall	PHCN, Personal_Generator, School_Generator	Burning	14.0 13.0	Bad	Yes/No	Never	Poor
EST_SQ_B2_4	M.O. Adelus	07032333581	Male	Married	Non_Academic_Staff	Catering_Unit	Assistant_Catering_Officer	5 Borehole	PHCN, Personal_Generator, School_Generator	Refuse_Dump	4.0 4.0	Fair	Yes/No	Never	Fair
EST_SQ_B20_19			Male	Married	Non_Academic_Staff	Sports	Chief_Sports_officer	7 Borehole	PHCN, Personal_Generator, School_Generator	Burning	57.0 32.0	Bad	Yes/No	On_Request	Good
EST_SQ_B19_17	Adewole M.M.	08035193003	Female	Married	Non_Academic_Staff	Exams_and_Records	Executive_Officer	7 Borehole	PHCN, Personal_Generator, School_Generator	Refuse_Dump	58.0 34.0	Fair	Yes/Yes	Yes	Fair
EST_SQ_B10_19	Ogunmola T. Kayode	08035062869	Male	Married	Non_Academic_Staff	Physical_Planning	Principal_Technical_Officer	5 Borehole, Rainfall	PHCN, Personal_Generator, School_Generator	Refuse_Dump	63.0 37.0	Fair	Yes/No	Never	Poor
EST_RV_17	Arc. Ifesanya Kunle	08037202436	Male	Married	Academic_Staff	Architectural_Department	HOD	2 Borehole, Rainfall	PHCN, Personal_Generator, School_Generator	Refuse_Dump	68.0 39.0	Fair	Yes/No	Never	Good
EST_SQ_B18_15	Famokun ZA	08051934332	Male	Married	Academic_Staff	Electrical_Electronic_Engineering	Principal_Lecturer_(Retired)	3 Borehole, Rainfall	PHCN, Personal_Generator, School_Generator	Burning, Refuse Dump	61.0 35.0	Fair	Yes/No	Never	Fair
EST_SQ_B14_7	Akinwamide Joseph		Male	Married	Academic_Staff	Marketing	Principal_Lecturer	4 Borehole	PHCN, Personal_Generator, School_Generator	Burning	21.0 18.0	Fair	Yes/No	Never	Poor



**Table 4: Query Showing Where Power Source of occupant is PHCN, Personal Generator, School Generator within the polytechnic Staff Quarters**

Another query to identify where waste disposal is by refuse dump within the polytechnic staff quarters is shown below.



**Fig 4.5: Query Showing Where Waste Disposal Method is Refuse Dump within the polytechnic Staff Quarters**

DIGITIZED_	NAME_OF_OC	MOBILE_NO	GENDER	MARITAL	OFFICIAL_S	DEPT_UNIT	RANK_POST	NL	WATER_SOUR	POWER_SOUR	WASTE_DISP	FLAT OCC	FLAT REF	RENO	RENO	MAIN		
EST_SQ_B32_11	A.O. Adebajo Oyetunji		Male	Married	Non_Academic_Staff	Business_Administration	Secretary	14	Borehole	PHCN	Refuse_Dump	43.0	24.0	Fair	Yes	No	Yearly	Fair
EST_SQ_B25_29	Klari Sakirat	0803731854	Female	Married	Non_Academic_Staff	Maintenance_and_Services	Maintenance_officer	3	Borehole	School_Generator	Refuse_Dump	47.0	27.0	Fair	Yes	Yes	Yearly	Good
EST_SQ_B5_10	Osuya Happy	08035226058	Male	Single	Comper	Surveying_and_Geoinformatics	Graduate_Assistant	9	Borehole	PHCN_School_Generator	Refuse_Dump	8.0	8.0	Bad	No	No	Never	Poor
EST_SQ_B2_4	M.O. Adelus	07032333581	Male	Married	Non_Academic_Staff	Catering_Unit	Assistant_Catering_Officer	5	Borehole	PHCN_Personal_Generator_School_Generator	Refuse_Dump	4.0	4.0	Fair	Yes	No	Never	Fair
EST_SQ_B20_20	Inegbu Stanly Kalu	07065269374	Male	Single	Non_Academic_Staff	Maths_and_Statistics	Secretary	7	Borehole	School_Generator	Refuse_Dump	58.0	33.0	Fair	Yes	No	Never	Fair
EST_SQ_B19_17	Adewole M.M.	08035199003	Female	Married	Non_Academic_Staff	Exams_and_Records	Executive_Officer	7	Borehole	PHCN_Personal_Generator_School_Generator	Refuse_Dump	59.0	34.0	Fair	Yes	Yes		Fair
EST_SQ_B10_19	Oyinmola T. Kayode	08035028298	Male	Married	Non_Academic_Staff	Physical_Planning	Principal_Technical_Officer	5	Borehole_Rainfall	PHCN_Personal_Generator_School_Generator	Refuse_Dump	63.0	37.0	Fair	Yes	No	Never	Poor
EST_RV_12	Oyinlana Adekanbi	08035000541	Male	Married	Academic_Staff	Business_Administration_and_Marketing	Chief_lecturer	2	Borehole_Rainfall	PHCN_School_Generator	Refuse_Dump	73.0	40.0	Fair	No	No	Never	Good
EST_RV_9	WZ		Male	Married	Academic_Staff	Food_Technology	Principal_Lecturer	3	Borehole	PHCN_School_Generator	Refuse_Dump	79.0	44.0	Fair	Yes	No	Yearly	Fair
EST_RV_17	Arc. Ifesanya Kunle	08037202436	Male	Married	Academic_Staff	Architectural_Department	HOD	2	Borehole_Rainfall	PHCN_Personal_Generator_School_Generator	Refuse_Dump	68.0	39.0	Fair	Yes	No	Never	Good
EST_RV_5	Adewumi James Alaka	08033611824	Male	Married	Non_Academic_Staff	Bursary	Bursar	9	Borehole	School_Generator	Refuse_Dump	75.0	42.0	Good	Yes	Yes	Other	Fair
EST_SQ_B3_5	Eseyin E.J.	08065238114	Female	Married	Non_Academic_Staff	Student_Affairs	Higer_Executive_Officer	7	Borehole	PHCN_School_Generator	Refuse_Dump	5.0	5.0	Fair	Yes	Yes		Fair
EST_SQ_B2_3	Abiodun Rita L	08028463161	Female	Married	Academic_Staff	Science_Technology	Senior_Lecturer	6	Borehole	Personal_Generator_School_Generator	Refuse_Dump	3.0	3.0	Fair	Yes	No	Never	Poor
EST_SQ_B1_1	Kayode Ousola		Male	Single	Non_Academic_Staff	Senior_Staff_Club	Manager	0	Well	Personal_Generator	Refuse_Dump	1.0	1.0	Fair	Yes	Yes	Yearly	Fair

**Table 4.5: Query Showing Where Waste Disposal Method is Refuse Dump within the polytechnic Staff Quarters**

### **3. CONCLUSION & RECOMMENDATION**

#### **3.1 Conclusion**

Data is the fundamental part of any management tool, Geographic Information System offers the integration of data on its spatial characteristics, and hence, efficiency is maximized.

#### **3.2 Recommendation**

The effectiveness of a GIS is dependent on the comprehensiveness, consistency and integrity of its database. Therefore joint effort is to be made by government, organizations and individuals towards the creation of a disaster relevant geodatabase, so as to create a disaster free environment.

All disasters as well as their effects on man and its environment can either be prevented or reduced. Disaster management programs are developed and implemented through the analysis of information. Therefore, in planning against disasters; Government, Organizations and Individuals are to be highly informed so as to reduce the rate at which ignorance impedes effectual disaster management in the world today.

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## BIOGRAPHICAL NOTES

Israel TAIWO, Oyedokun ABIODUN and Felix AJIBADE are academic staffs of The Federal Polytechnic Ado-Ekiti. Israel is a Technologist while Oyedokun and Felix are Lecturers, all from the department of Surveying and Geoinformatics of the institution.

## CONTACTS

Geographic Information System (GIS); A tool for Disaster Management.  
Israel TAIWO, Oyedokun ABIODUN, Felix AJIBADE, Nigeria  
The Federal Polytechnic Ado-Ekiti, Ekiti State Nigeria.  
+2348062865973, +2348033829383, +2348035781691  
[israeltaiwo@gmail.com](mailto:israeltaiwo@gmail.com), [doks78@yahoo.com](mailto:doks78@yahoo.com), [felixajibade@yahoo.com](mailto:felixajibade@yahoo.com)