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Application of Digitized Topography Information to Curb the Menace of Flooding and Its Health Implications at Ogbia Local Government Area

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Abstract This research was carried out with the aim of using digitized topography information to study the natural drainage pattern that will in the long run assist in the design of a workable drainage system. The research was engendered by the incessant flood experience by Bayelsa state on a yearly basis and the urge to curb the menace impose by the flood. To achieve this objective, 498 sampled coordinate points along with their elevations were extracted from an image map. The coordinates and the topography information were developed into contour maps, which depict the distribution of topographic information within the area under investigation. The analyzed results have revealed that the topographic distribution of the elevations within the landmass is very heterogeneous with no definite regional pattern. Hence, it is difficult to tie or delineate the direction of the natural drainage pattern to the existing topographic structure. However, detail studies have revealed that the natural drainage systems are majorly directed south west and south east towed major river channels that flows north south. It was also discovered that the yearly flooded Onuebun road leading to Federal University Otuoke was majorly due to overflow from the major Onuebun River in addition to the contribution from the small river channel that flows across the road. It was recommended that the road should be raised to an appreciable height with a culvert placed under to allow for free movement of water. In addition, a major 5 km embankment should be built along the bank of Onuebun River to curtail the annual overflow from the river bank. A combine analysis of the image map and the contoured topographic maps revealed that majority of the linear Bayelsa settlements are clinging to the river channels, which implies that most of the houses are built on flood plain. A closer examination revealed that there are high elevations, adjoining most of the structures that are built within the flood plain. It is therefore recommended that future development should be sited at the adjoining upland that is about 27 m above mean sea level, were there will naturally be immune to flood of large magnitude. Conclusion from the water analysis revealed that all the flooded area shows poor water conductivity, low total dissolved solid. The entire water sample shows a DO below the WHO standard. The physiochemical parameters for the water samples show that they might increase the wares and tares of any materials they are used to clean.

Keywords Topography, Flood, Bayelsa, Ogbia, health

1. Introduction

The devastating effect of flooding each time and any where it take place cannot be over emphasized. It can lead to wanton damage of basic infrastructure, loss of lives and properties, wide spread of infections and diseases, pollution to source of drinking water, increase in stress, anxiety and depression. The level of impact of flooding in any given community is directly related to location, topography of the region, human demographics and the characteristic of the building pattern and location.

It is very glaring that the developers of the current existing drainage system don't have adequate knowledge of the landscape topography and the direction of the natural drainage pattern. Hence most drainage systems are directed in the wrong direction and ends up abruptly, thereby constituting more public nuisance than it is trying to solve. Therefore, the rational for carrying out this research is to study the land topography, determine the natural drainage pattern, carry out a comprehensive water analysis and proffer a lasting solution on how to construct and reconstruct an effective drainage system that will entirely liberate Ogbia Local Government from the incessant flood that has bedevil it on a yearly bases.

Bayelsa would continue to experience flood, owing to the vulnerability of the topography. The devastation of last year's flood cannot be quantified, as it brought poverty, developmental challenges, lives were lost, institutions (Federal University, Otuoke) shut down, amongst others [1].

The idea behind Sustainable drainage system is to try to replicate the drainage patterns of natural systems by using cost-effective solutions with low environmental impact [2].

Improved water management is of utmost importance for Bangladesh, as nearly 80 million people live and farm on the floodplains. Water management abounds on these floodplains and various flood protection and drainage measures have been taken by both stakeholders and the government [3].

Collins, 2014, has earlier stated that "detail survey should be carried out to ascertain the local topography and the natural drainage pattern before the design and construction of any drainage system in any part of Bayelsa State" [4].

"The immediate health impacts of floods include drowning, injuries, hypothermia, and animal bites. Health risks are also associated with the evacuation of patients (e.g. patients with Ebola virus, Monkey pox virus), loss of health workers, and loss of health infrastructure including essential drugs and supplies" [5]. "Flood can potentially increase the transmission of the following communicable diseases: waterborne diseases, such as typhoid fever, cholera, leptospirosis and hepatitis A. Vector borne diseases, such as malaria, dengue and dengue haemorrhagic fever, yellow fever, and West Nile Fever [6].

Going by the findings and experience from these previous works it becomes absolutely necessary to investigate ways by which flooding can greatly be minimized, if not eliminated. One of the best ways of doing this is to look at the natural topography in a given environment, evaluate the natural drainage pattern, and tailor the design of drainage system that eliminates flooding in that direction. This methodology will be more effective, if in addition the already poorly designed existing drainage systems are redirected by applying corrective measure from findings, and a comprehensive water analysis is carried out.

2. General Objective (Aim)

This research proposal is aimed at studying the natural drainage pattern, and the characteristics of the flood water at Ogbia Local Government that will facilitate in the design of an effective drainage system, and to analyze the quality of water samples from flooded area around Ogbia and some metropolis in Yenagoa.

2.1 Specific Objectives

- Defining the areas under investigation both on the ground and on the map for the purpose of defining scope of the work.
- Collection of Global Positioning System (GPS) coordinates at defined points and along major boundaries, for the purpose of delineating the area under investigation.
- Digitization of the topography coordinates along flight lines, to capture adequate detail in the survey area under investigation.
- Collect water samples and run comprehensive analysis.
- Contouring and 3D modeling of the area topography, and determination of the natural drainage pattern, for the purpose of determining the direction of flow.
- Recommendation of the direction and design of drainage patterns to be constructed.
- Evaluation of the direction of the already existing drainage pattern to determine if it complies with this recommendation.

Proffer a lasting solution that should be implemented as corrective measure for the already existing drainage systems.

3. Statement of the Problem

Ogbia Local Government Area where Federal University Otuoke is located is a flood prone environment, either because the major landmass is located in a flood plain or because of the gentle topography that characterize the swampy coastal region. The region under investigation is subjected to continuous flooding on a yearly basis, an outright example is the Onuebun road leading to Federal University Otuoke that is flooded on a yearly basis, as shown in figure 1 (picture taking 23rd October, 2017). Other examples include a residential building (figure 2) that is flooded to the extent that the occupant can only access it with boat. The immediate impact of environmental flooding is loss of lives and properties, increase in stress and untold hardship. The urgent need to carry out a comprehensive study of the terrain and the nature of flood water and design an effective drainage system that will prevent the yearly flooding cannot be over emphasized.

Figure 1: Road leading to Federal University Otuoke completely submerge under water

Figure 2: Flooded Residential building accessed by boat

4. Significance of Study

This research work will help in reducing flooding and the effect of flooding at Ogbia Local Government Area and its environs. It will help to reduce sickness and deceases that are engendered by flooding, by helping to eliminate standing water which could act as a breeding ground for vector like mosquito, or eliminate unhygienic

environment that promote cholera or typhoid fever. It will produce a baseline data, methodology and results that could be applied elsewhere for remediation.

5. Area under Investigation

The area under investigation is Ogbia Local Government where Federal University Otuoke is located. It is bounded by the following latitude and Longitude 4°48'43.29"N, 6°11'43.70"E; 4°49'4.58"N, 6°25'53.94"E; 4°40'23.85"N, 6°25'56.94"E; 4°39'51.23"N, 6°12'21.95"E; with an average height of 18 m above mean sea level. The image map of the survey area is shown in figure 3.

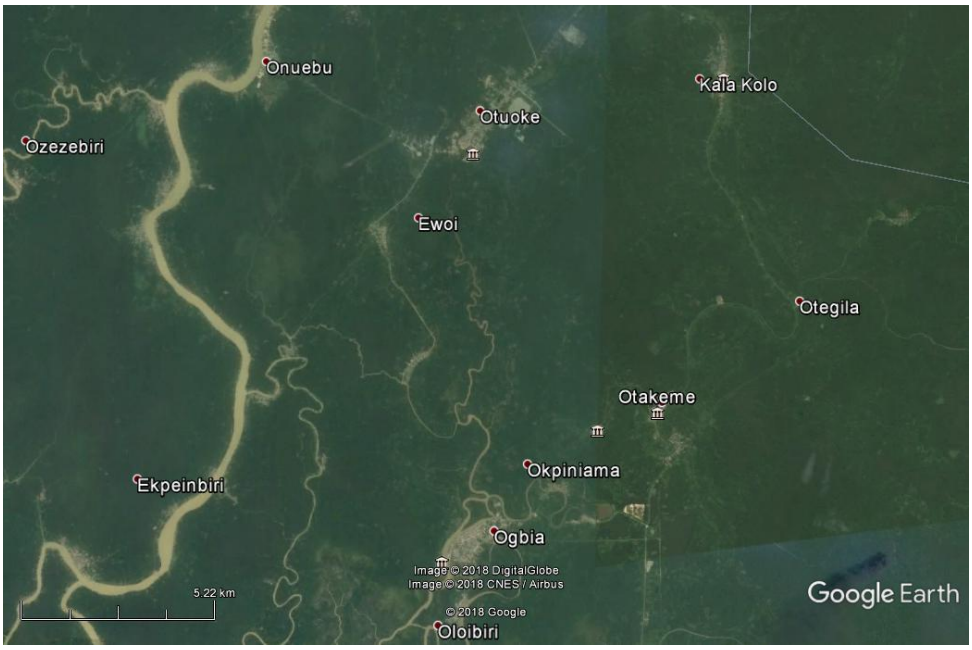

Figure 3: Image Map of the area, showing the scope of the work and survey extent

6. Methodology

The methodology used in carrying out this investigation involves identification of the areas under investigation, both on map and on ground. The next step was acquisition of location coordinates of selected points alongside their corresponding elevation values above mean sea level, in each locality as the baseline data as shown in table 1 and figure 4 to 10. These initial baseline data was used to identify the location of each area on the map. The location coordinate and elevation of each area were extracted along digitize flight lines on the digital image map, as shown in figure 11. The generated data were used to build a contoured model that depicts the direction of flow of natural drainage pattern in a given locality. This gave a major overview of the direction of the natural drainage pattern, which every subsequent design drainage system has to follow for effective flood management. The existing drainages were evaluated to determine whether they conform to the natural pattern. This was carried out by measuring the depth of the drainage system at consecutive intervals of 50 m. This was used to determine the direction of flow of the waters, and how effective is the existing drainage system. Water samples were collected at various strategic locations, and analyzed. In addition, the result of the water analysis will also helped to ascertain the health risk of people using the water that are exposed to flood.

The methodology used for water analysis involves collection of water samples from seven different locations within Ogbia and Yenagoa communities (Oloibiri-Ibelebiri, Imiringi, Emeyal II, Otuoke River, Sanni-Abacha, and Alamieyesigha). They were properly identified and labelled before transportation to the laboratory for analyses. Parameters analyzed include pH, dissolved oxygen, total dissolve oxygen, biochemical oxygen demands, and conductivity, while the heavy metals analyzed are lead (Pb), arsenic (As) copper (Cu), Chromium (Cr), cadmium (Cd) and mercury (Hg).

Water from all the communities contain As apart from Oloibiri-Ibelebiri community, Pb was present in water samples from Otuoke River, Sanni-Abacha, Alamiesiegha, and Epie II, copper was present in Oloibiri-Ibelebiri, Imiringi, Emeyal II, Otuoke river, and Epie II. Cadmium and mercury was present in water samples from Alamiesigha road. The pH of all the water samples were below 7.0 apart from the water sample from Oloibiri-Ibelebiri which was 7.02. All the water samples from the 7 communities had low conductivity, reflecting low total dissolvable solids.

Table 1: Location coordinate of selected points

S/N	Points	Eastings	Northings	Elevation Above Mean Sea Level
1	First Point A	6°21'32.80"E	4°54'4.40"N	17 m
2	Second Point B	6°22'34.42"E	4°52'8.62"N	10 m
3	Third Point C	6°22'36.20"E	4°48'30.00"N	8 m
4	Fourth Point D	6°18'32.20"E	4°47'0.80"N	11 m
5	Fifth Point E	6°17'12.20"E	4°47'30.90"N	19 m
6	Sixth Point F	6°20'39.80"E	4°56'52.00"N	17 m
7	Seventh Point G	6°18'21.70"E	4°53'50.50"N	16 m

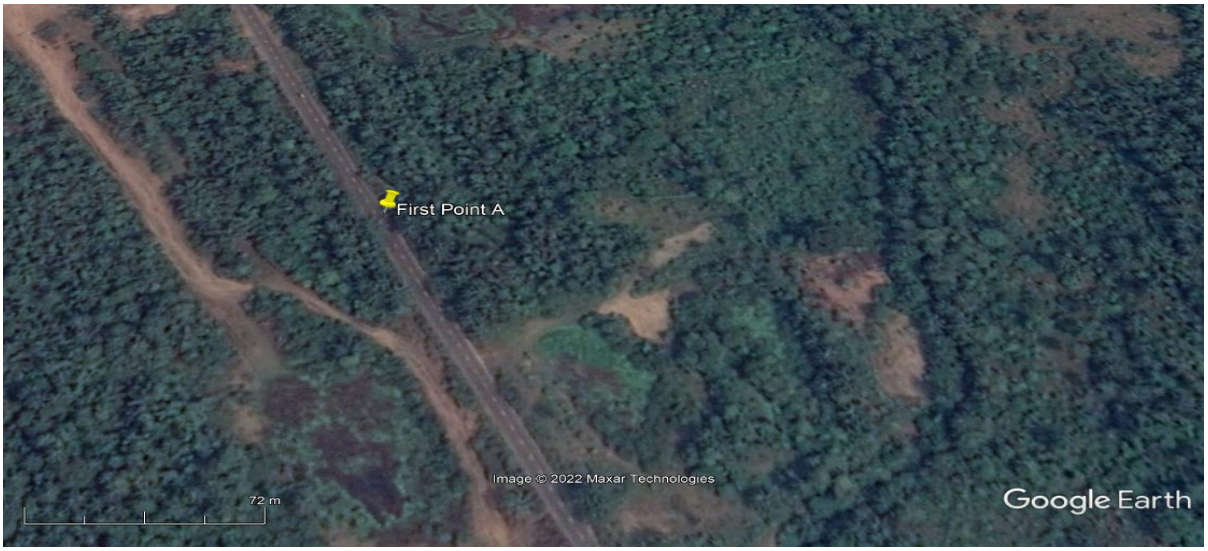

Figure 4: First Coordinate A baseline points

Figure 5: Second Coordinate B baseline points

Figure 6: Third Coordinate C baseline points

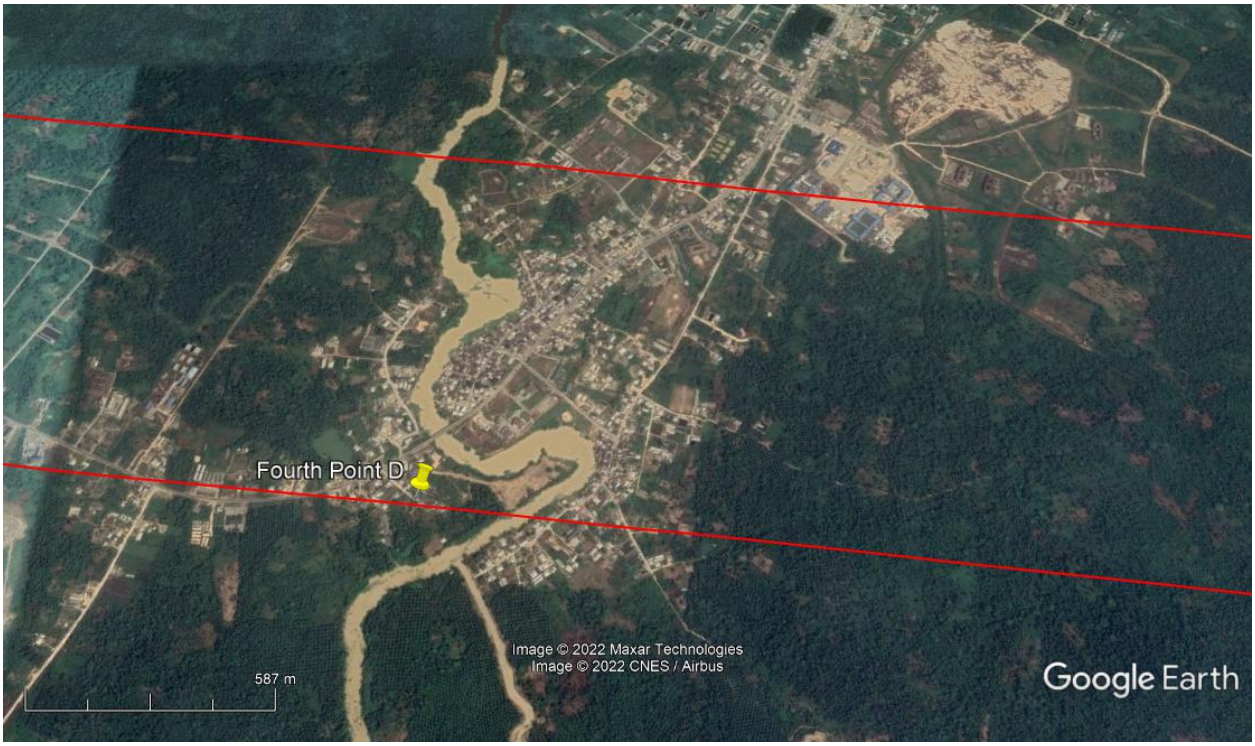

Figure 7: Fourth Coordinate D baseline points

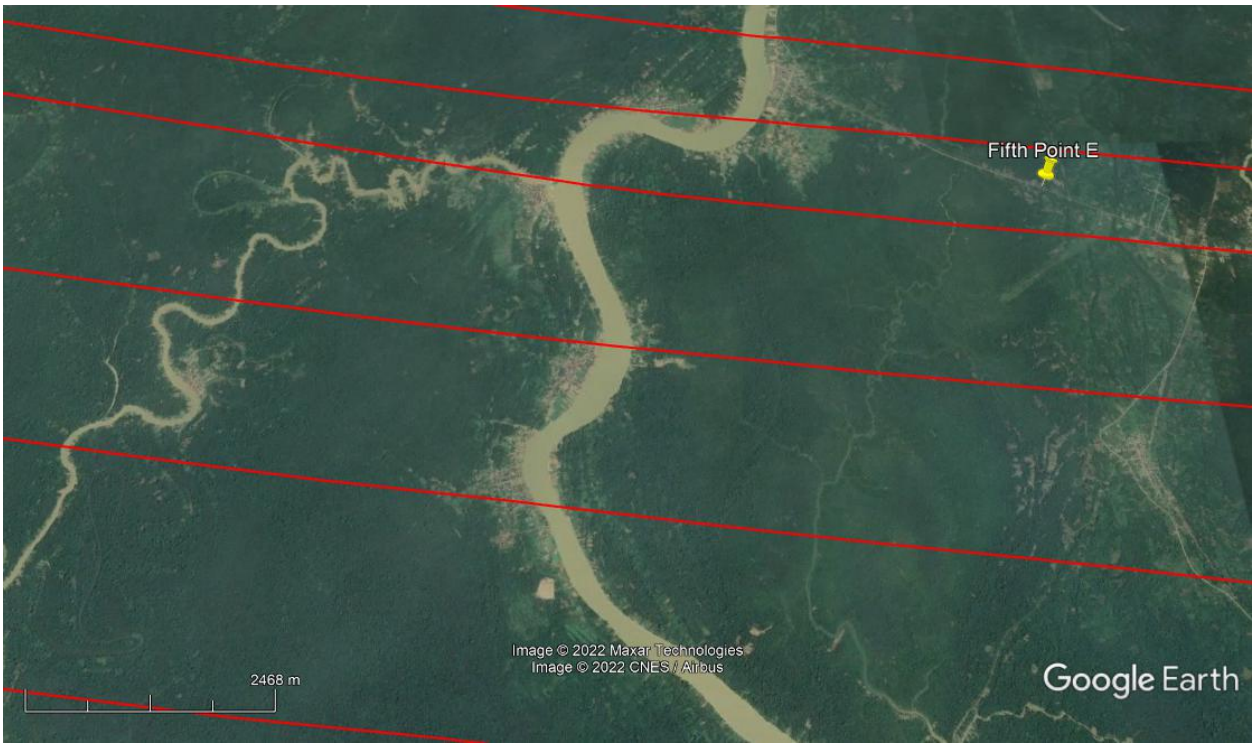

Figure 8: Fifth Coordinate E baseline points

Figure 9: Sixth Coordinate F baseline points

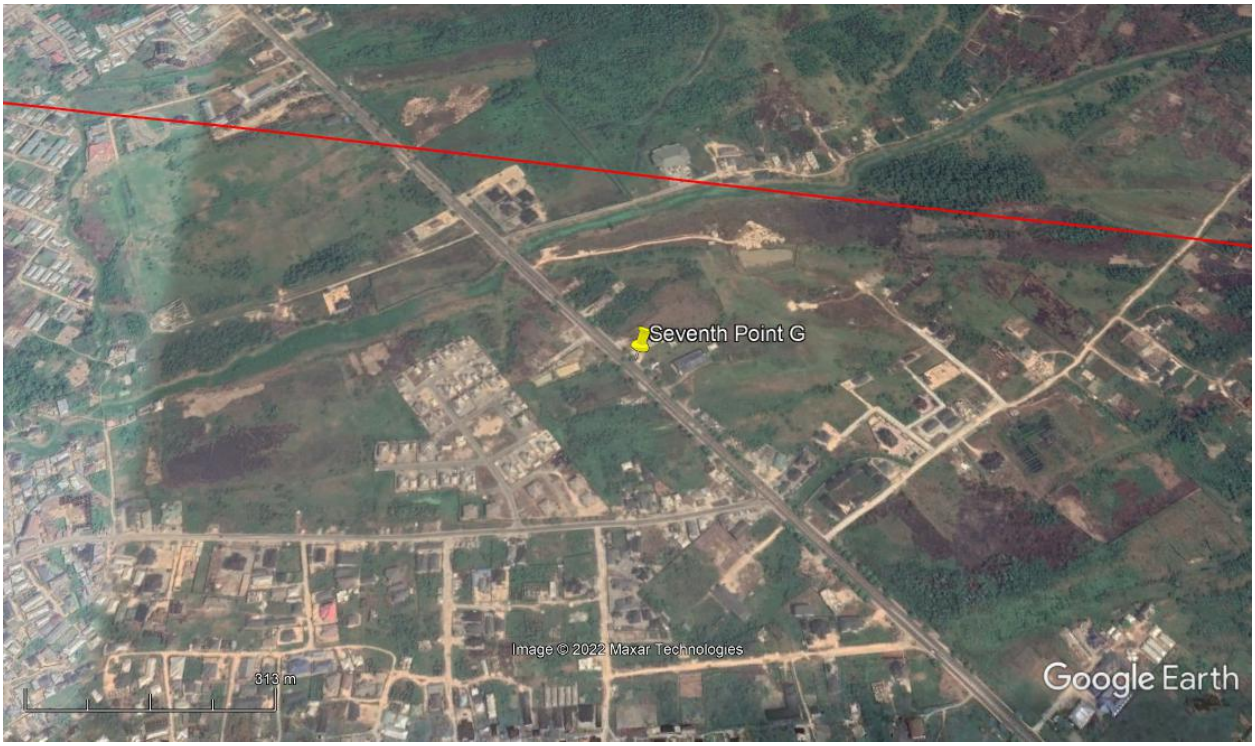

Figure 10: Seventh Coordinate G baseline points

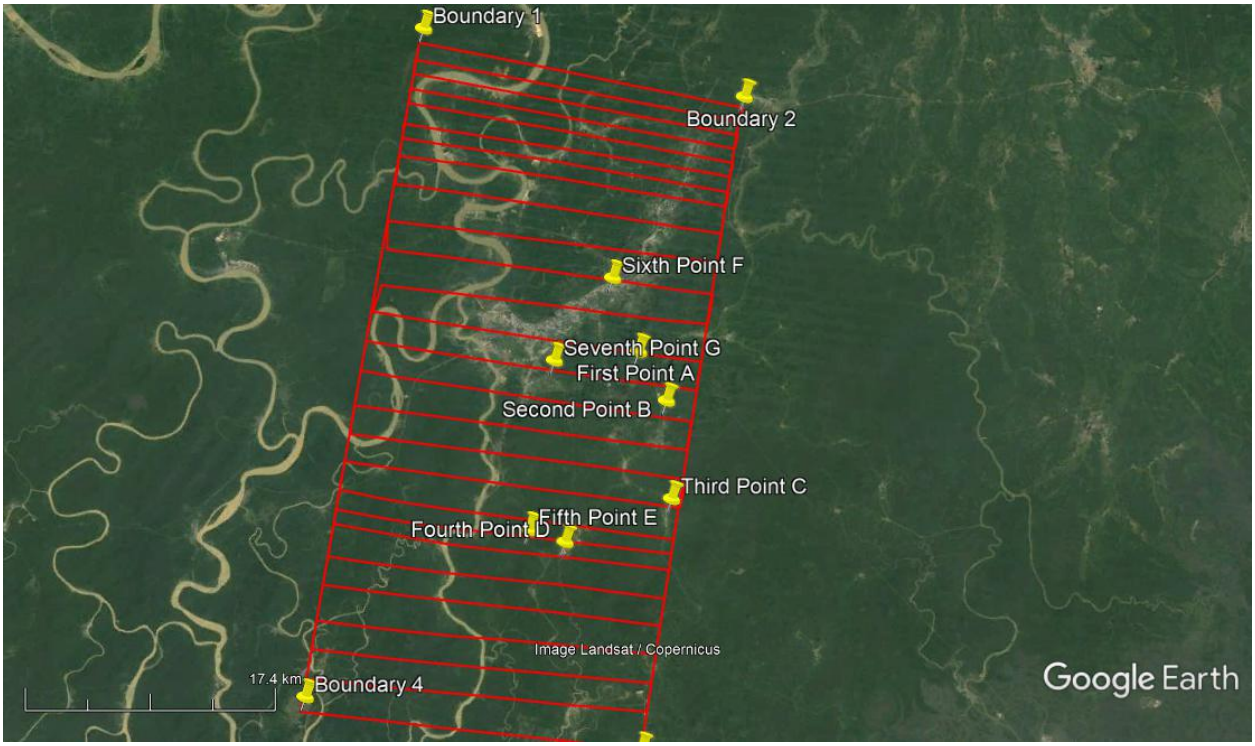

Figure 11: Location coordinates and elevations of each area extracted along digitize flight lines

7. Data Processing

The extracted location coordinates and the elevations of points along flight lines were placed on a spread sheet, where the "seconds" and "minutes" values of the extracted coordinates were converted to "degrees", part of the converted coordinates are displayed in table 2. These values were used to generate contour map of the entire regions under investigation as shown in figure 12 and 13.

Table 2: Part of the Extracted coordinates along flight lines

East (Degree)	North (Degree)	Elevation (m)
6.2309	5.107855556	21
6.239402778	5.106244444	22
6.248625	5.104005556	23
6.257380556	5.101925	21
6.266216667	5.099938889	20
6.274952778	5.098080556	18
6.28375	5.095894444	16
6.292555556	5.093936111	24
6.301258333	5.092036111	17
6.310138889	5.089858333	17
6.318927778	5.087811111	21
6.424005556	5.062711111	20
6.432975	5.060797222	19
6.430391667	5.051972222	19
6.421644444	5.053891667	19
6.412852778	5.055822222	19
6.404016667	5.057763889	20
6.395230556	5.059752778	21
6.386405556	5.061694444	19
6.377611111	5.063797222	23

6.368825	5.065775	19
6.360069444	5.067797222	17
6.351322222	5.069763889	19
6.342430556	5.072008333	22
6.430391667	5.051972222	19
6.421644444	5.053891667	19
6.412852778	5.055822222	19
6.404016667	5.057763889	20
6.395230556	5.059752778	21

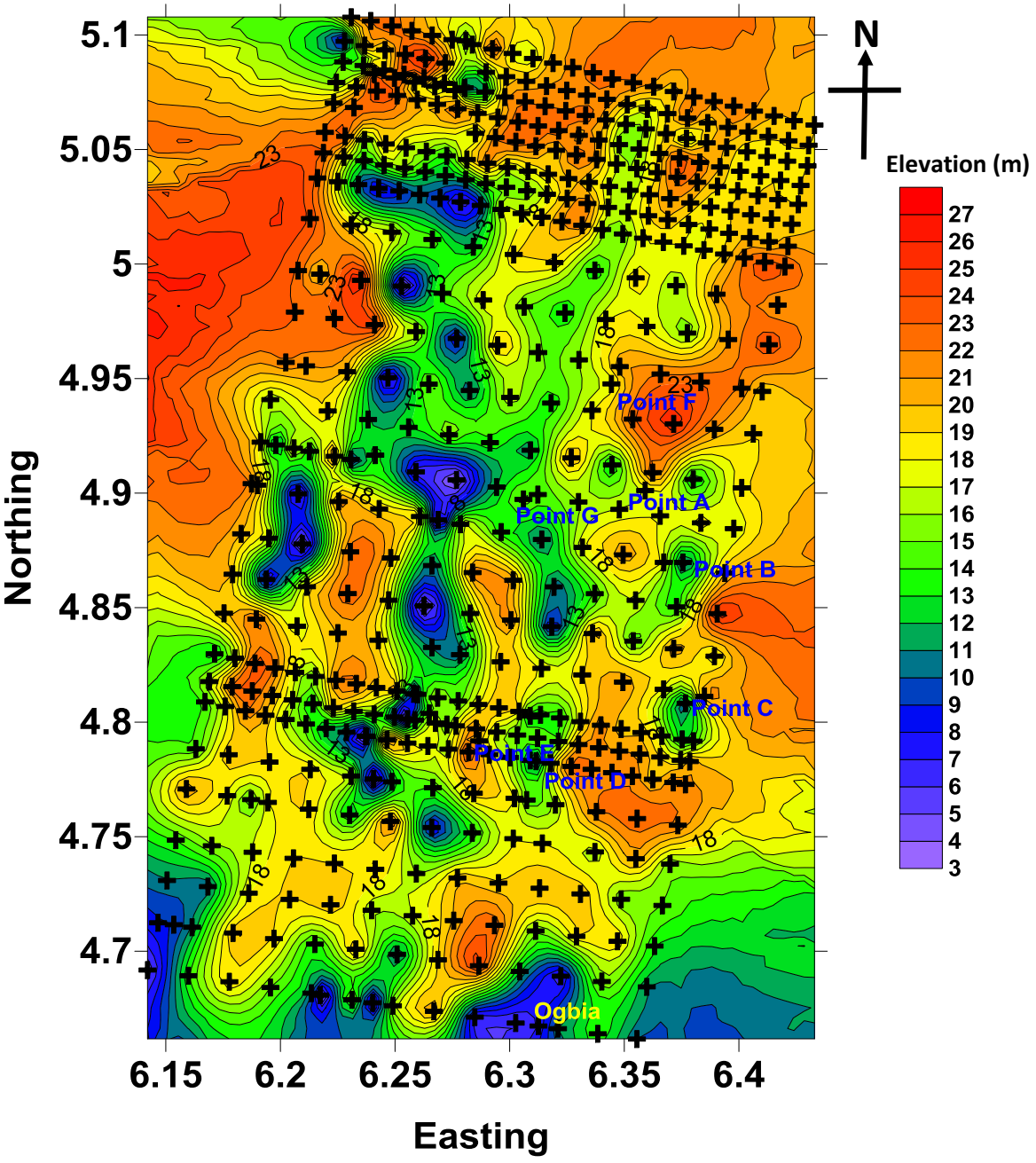

Figure 12: Contour Map of the entire region showing sampled point

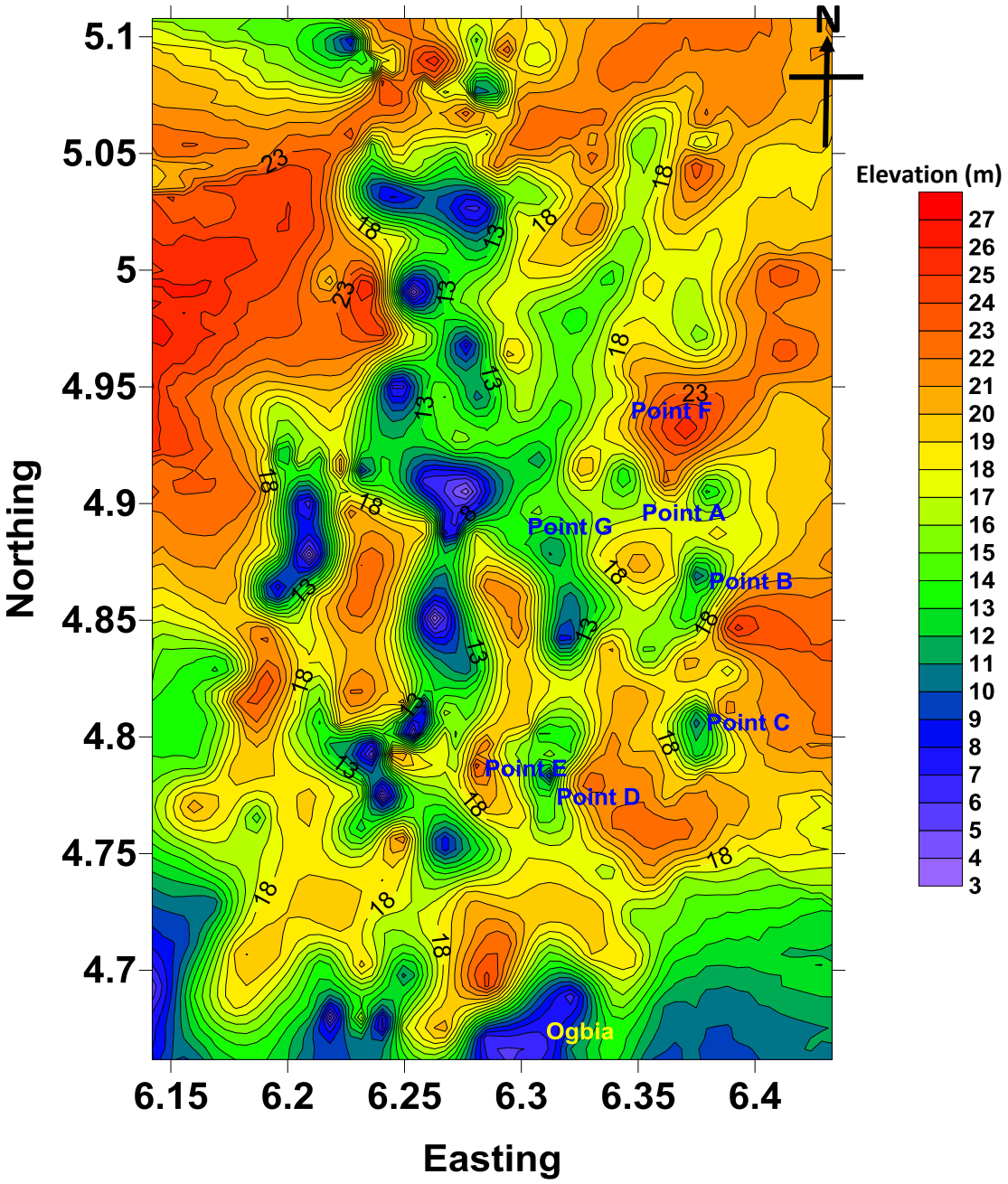

Figure 13: Contour Map of the entire region showing variation in elevation

8. Results and Discussion

A close examination of figure 13 gave a clear indication that the Land topography (elevations) within the region under investigation is highly heterogeneous, without a regular define patter and changes abruptly at short distances. The range of elevation is between 3 m along the river channels and 27 m around the elevated high lands. The heterogeneous nature of the landscape makes it very difficult to attach a well defined drainage pattern to the existing land topography. Hence the contour map was narrow down to specific areas to get a clearer view of the land topography. Figure 14 gave a clearer picture of the land topography, it showed areas of low elevation that is flanked in most cases by regions of high elevation. A vector map of the land topography was generated to ascertain possible direction of drainages within the area, and it was observed that the drainage pattern from most of the elevated high lands are pointing South West (SW) and South East (SE), converging at a river channel which most times if an obstacle is not encountered is flowing North South (NS). Therefore it is recommended

that the designed internal drainage patter should be directed SW and SE toward the major river channels. The investigation carried out on the existing drainages showed that majority of them did not conform to the direction of the natural drainage.

The coordinate data within figure 1 and 8 regions were also contoured, as shown in figure 15. It shows that the road is located in a region with moderately high elevation surrounded by large water bodies. However, the image map and contoured map has shown that the road is susceptible to flooding once there is an overflow from the surrounding major Onuebu River in addition to the contribution of the smaller river that runs across it. It is suggested that to avert the flood that usually occupy the road, the channel of the river that runs across the road should be well dredged, in addition a major embankment of about 5 km should be built along part of the major Onuebu River to curtail the overflow. The road should also be raised with a culvert under to allow free movement of surface water.

A closer examination of the image maps of figure 5 to 10 and 16, and the contoured map of figure 14 to 17 gave a clear indication that Bayelsa settlements are linearly cling to major water bodies, avoiding the elevated high lands surrounding the major water bodies. These styles of settlements have made most structure in Bayelsa to be prone to flood. The houses are built along flood plain with an average elevation of 8 m above mean sea level, while behind those structures are landmass with an average elevation of 26 m above mean sea level. It is recommended that future development should be directed toward the high lands, than clinging to low land surfaces prone to flood.

8.0.1 Water analysis result and Discussion

Table 3 shows the physiochemical parameters of water samples collected from 8 different locations. Values are compared with WHO. Comparing the pH value of the various locations shows that they all fall within normal pH. The table shows that the DO, TDS, and conductivity were below the WHO standard, while the BOD of all the water samples from different locations falls within the normal range set by WHO. Oloibiri-Ibelebiri, Imiringi, Emeyal II, Otuoke River, Sanni-Abacha, Alamieyesigha.

Table 3: The physiochemical parameters of water samples collected from 8 different locations.

S/N	Sample	Location	pH	DO (mg/l)	TDS (mg/ml)	Conductivity (uS/cm)	BOD (mg/l)
1	A	Oloibiri-Ibelebiri	7.02	4	30	60	1.9
2	B	Imiringi	6.65	4	40	80	1.8
3	C	Emeyal II	6.75	4.2	65	130	2.0
4	D	Otuoke River	6.9	4.4	30	60	2.2
5	E	Epie II	6.72	4.5	60	120	2.3
6	F	Sanni-Abacha expressway	6.81	4.3	30	60	2.2
7	G	Alamie	6.86	4.2	55	110	2.0
WHO				6.5-9.5	ND (200-500)	200-1000	2-8

Table 4 shows the concentration of some heavy metals in water samples from different locations in addition to the water standard set by water regulators in Nigeria. The table shows that water samples from Otuoke River, Epie II, Sanni-Abacha expressway, and Alamiesigha contain Arsenic that exceeds the Nigeria standard. The concentration of Pb in water samples from Alamiesigha was above the Nigeria standard, Cu, and Cr in all the samples were either absent or low compared to the standard Nigeria. Cadmium was absent in all the water samples apart from Alamiesigha, where the concentration of were above the standard set by Nigeria water regulatory agency.

Water with extremely low concentrations of TDS may also be unacceptable to consumers because of its flat, insipid taste; it is also often corrosive to water-supply system

Table 4: The concentration of some heavy metals in water samples from different locations

S/N	Sample	Location	As (ppm)	Pb (ppm)	Cu (ppm)	Cr (ppm)	Cd (ppm)	Hg (ppm)
1	A	Oloibiri-Ibelebiri	-	-	0.005	-	-	-
2	B	Imiringi	0.008	-	0.005	0.012	-	-
3	C	Emeyal II	0.008	-	0.005	0.012	-	-
4	D	Otuoke River	0.115	0.004	0.005	0.013	-	-
5	E	Epie II	0.192	0.009	0.015	0.013	-	-
6	F	Sanni-Abacha	0.085	0.009	-	-	-	-
7	G	Alamie	0.038	0.011	-	-	0.026	0.002
		Nigeria	0.01	0.01	0.2-1.0	0.05	0.003	0.001
		Health implication	Cancer	Cancer, interference with Vitamin D metabolism, affect mental development in infants, toxic to the central and peripheral nervous systems	Gastrointestinal disorder	Cancer	Toxic to the kidney	Affects the kidney and central nervous system

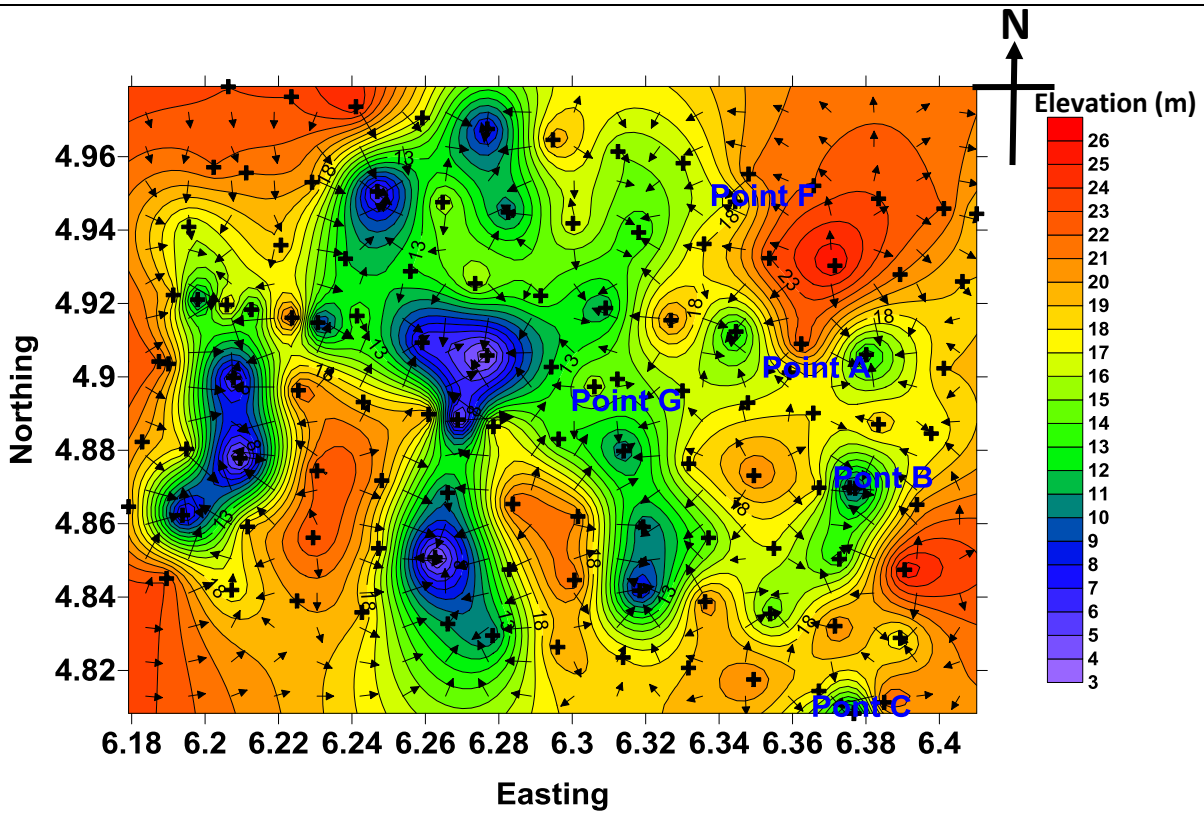

Figure 14: Detailed Contour Map of the survey area

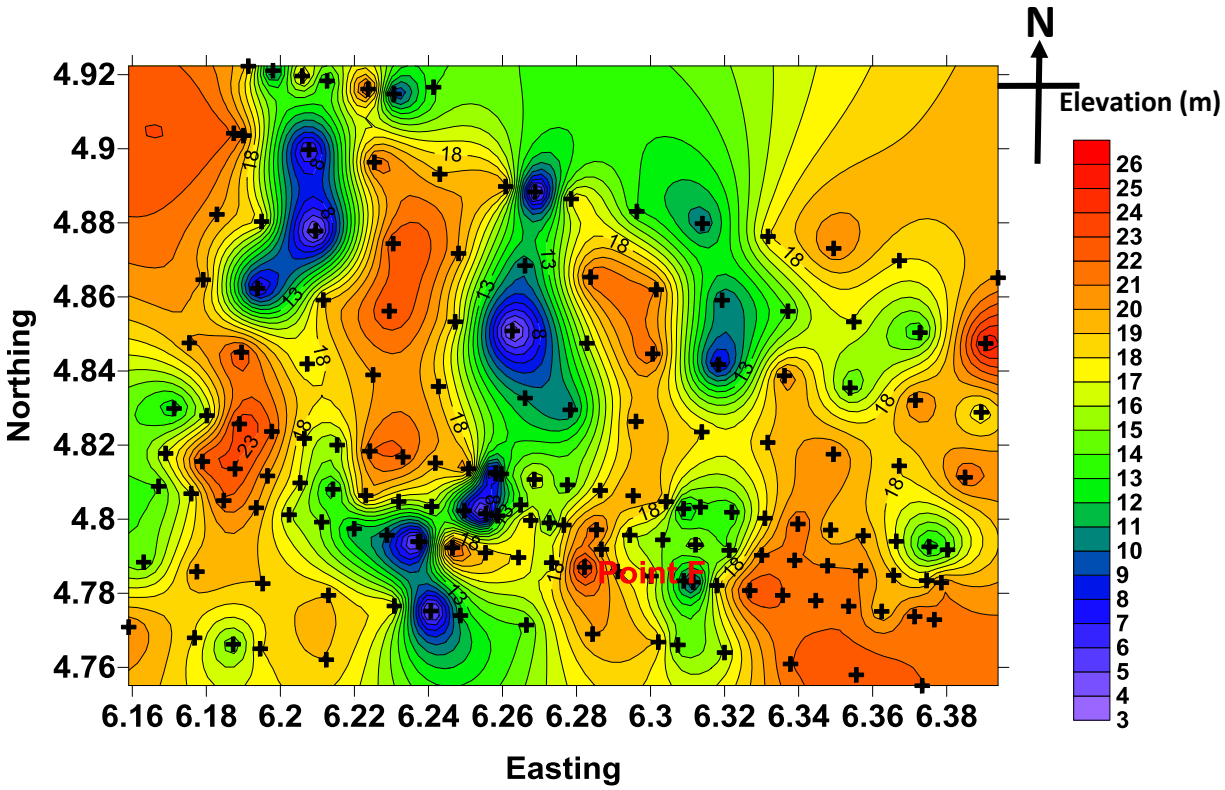

Figure 15: Contoured Map of the flooded road to Otuoke

Figure 16: Image map of Ogbia Town

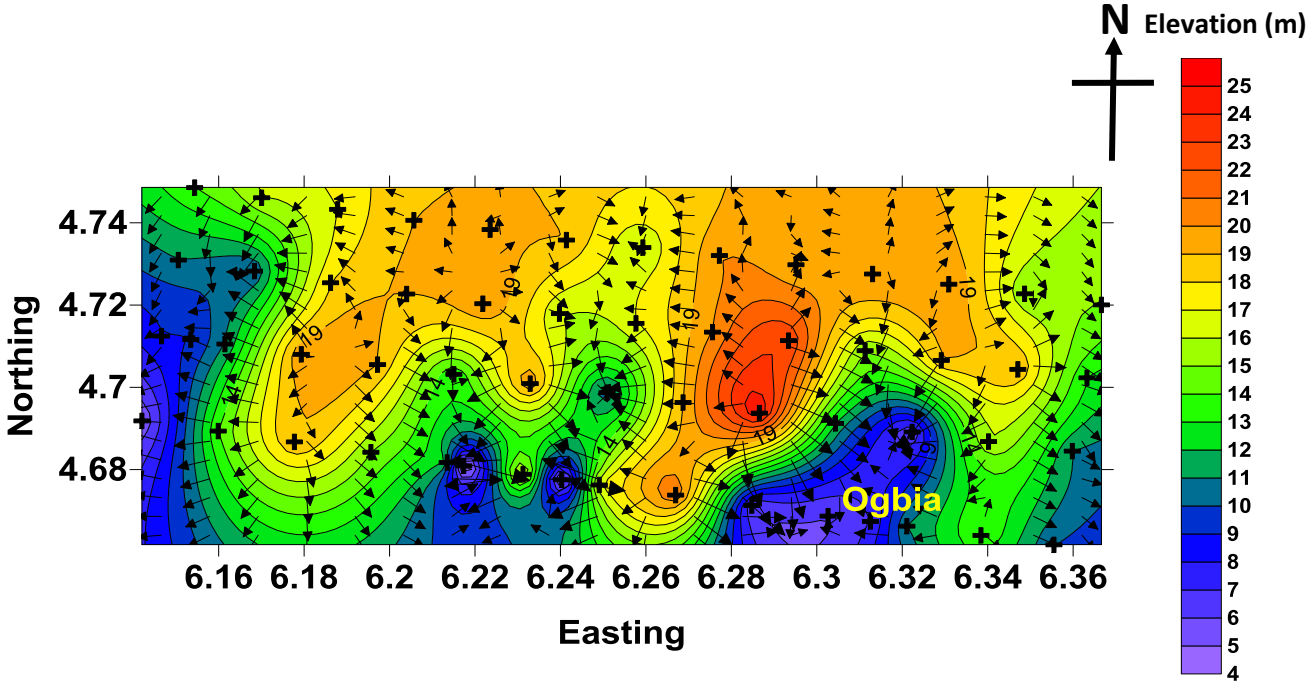

Figure 17: Contoured Map of Ogbia Town

9. Conclusion and Recommendation

The analysis has revealed that the topography within the landmass under investigation is very heterogeneous, with no definite regional pattern; hence it is difficult to predict the direction of the natural drainage pattern. Detail analysis however, has revealed that the natural drainage pattern within each locality is directed SW and SE toward the major river channels that flows NS. It is therefore recommended that the drainage channels should be directed SW and SE toward a major river channel that most times flows NS, for an effective drainage.

Detail analysis of the contoured map and image map has raveled that the yearly flooded Onuebu road leading to Federal University Otuoke is as a result of the spillover from the flooded major river that overflow its bank and contribution from the smaller river that runs across. Therefore it is recommended that the channel of the smaller river be well dredged, with the road raised and a culvert put under to allow for free flow of water. Major embankment of about 5 km should be constructed along the bank of the Onuebu River to curtail the spillover that result to flooding on the road.

Close observation of the image maps and contour maps have revealed that Bayelsa state settlement is linearly cling to the river channels within the flood plain, away from the elevated adjoining high lands. Therefore it is recommended that future development should be moved towards the high lands that will be naturally immune to flood of large magnitude.

9.0.1 Conclusion from the water analysis

Conclusion from the water analysis revealed that all the flooded area shows poor water conductivity, low total dissolved solid. The entire water sample shows a DO below the WHO standard. Though water from these locations is not used for rinsing, they are used for domestic purpose, such as washing cooking utensils and clothes. The physiochemical parameters for the water samples show that they might increase the wares and tares of any materials they are used to clean.

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