

Flood and Irrigation Map Using Geographic Information System (GIS) (A Case Study of Ido Catchment Area)

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ARTICLE INFO

Article history:

Received: 20 July 2020;

Received in revised form:

4 August 2020;

Accepted: 14 August 2020;

Keywords

Irrigation Management,
GIS,
TIN,
Flood-Plain,
Catchment Area.

ABSTRACT

Water resources issues and problems in the world's developing countries, or lesser developed countries present special management challenges. Irrigation is one of the most important inputs for an efficient and sustainable Industrial, and agricultural production. Irrigation management in the most projects so far has been essentially water supply based. The dynamics of general water demands are not explicitly considered. Consequently, irrigation systems do not supply the right quantities of water at the right time. The assessment of management strategies requires the analysis of the current irrigation and drainage system and prediction of the potential changes to various parameters. Several layers of map information such as: The Topographical map shows the physiographical features of the catchment area. The Digital Elevation Measurement (DEM) shows the elevations of the catchment area ranging between 86m-276m respectively indicating areas of low and high elevations within the catchment cardinals, Flow Direction, Flood-Plain, Study Area, and land-use map. The Triangulated Irregular Network (TIN) shows region of high and low elevations in coloration, and The Irrigation suitability Zone maps shows that areas of low elevations are more suitable for irrigation system work, and similarly prone to flooding which are of notable height range between 86-100m, 100-120m, 120-140m, 140-160m, and 160-180m, and areas that are advised for industrialization of notable high elevations ranges from 180-200m, 200-220m, 220-240m, 240-260m, 260-276m. Some of the areas that are most suitable for mounting irrigation system in Ido Catchment area due to their ability to conserve water are Ogbontosa, bale, beko, jakaetc and these areas mentioned are as well prone to flood disasters. It is therefore recommended that: The identified surface irrigation potential of the river catchment in the study area can assist in policy decisions during a development of irrigation project and Communities should be strongly discouraged from settling within the flood plains.

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1. Introduction

Water resources issues and problems in the world's developing countries, or lesser developed countries present special management challenges. These issues and problems include inadequate drinking-water supply, lack of sanitation facilities, water pollution, floods, the siltation of river systems and the management of rivers and large dams. These problems are more severe and widespread in the developing countries (Bartram, 2012).

Modern method of irrigation system compensates disadvantages of traditional methods and thus helps in the proper way of water usage. The modern method involves two systems: Sprinkler system, and Drip system. A sprinkler system as its name suggests sprinkles water over the crop and helps in an even distribution of water. This method is much advisable in areas facing water scarcity. This method can also be used in regions where water availability is less (Byjus, 2017).

Irrigated engineering construction and agricultural works generally uses large volume of water. Water resources

limitations caused the water supply to become a critical issue in recent years. Thus, it is important to improve water management practices to save water for expanded engineering construction activities and agricultural activities and for other uses. Monitoring and performance evaluation is the key to the successful management.

Remote sensing and Geographic Information System (GIS) with their capability of data collection and analysis are now viewed as efficient and effective tools for irrigation water management. The capability of GIS to analyze information across space and time would help in managing such dynamic systems as irrigation systems. Soil survey data and GIS are important tools in land use planning. Intertwined, they represent an invaluable and underutilized resource (Minakshi, 2009).

Hence the aim of this research is to generate the flood-plain and irrigation map of Ido Local Government using Geographic Information System (GIS).

2. Study Area

The Irrigation system to be assessed is located in Ido, Oyo State Ibadan. Ido is a Local Government in Oyo state; Nigeria and its headquarters are in the town of Ido. It has an area of 986km² and a population of 103,261 at the 2006 census. Ido Local Government appears on the earth’s surface of central Longitude and Latitude of 7°32’30.29’’N, 3°39’45.78’’E, the uppermost boundary cardinals of 7°45’36.952’’N, 3°40’9.35’’E, the lowest boundary cardinals of 7°16’22.54’’N, 3°43’18.17E’’ also the cardinals to the left and right boundaries are stated as thus, 7°25’33.25’’N, 3°28’52.759E’’ and 7°27’15.53’’N, 3°50’30.87’’E as shown in Fig 1. below. Ido Local Government was among the five in Ibadan district before it was cancelled in 1956 (NIPOST, 2009).

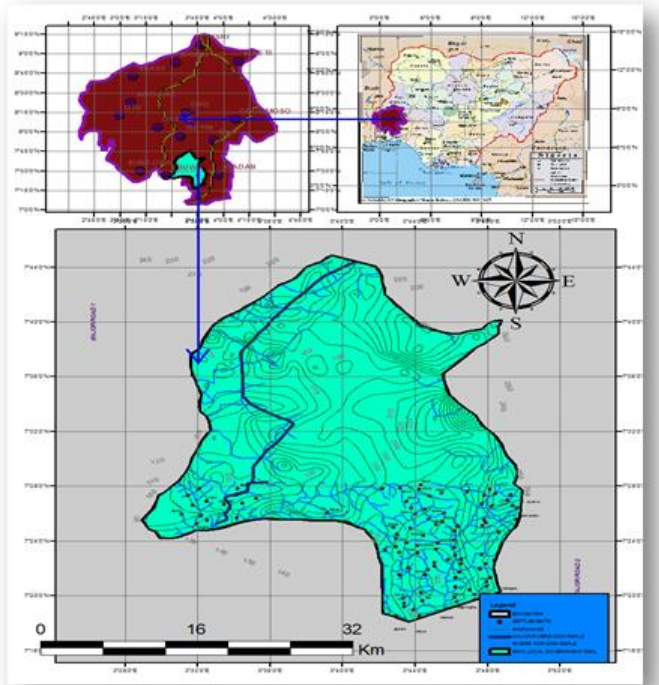


Fig 1. Digitized Study Map of Ido Catchment Area

3. Methodology

The use of GIS to design and plan irrigation systems requires a procedure for adequate analysis and its shown in Fig 2 below.

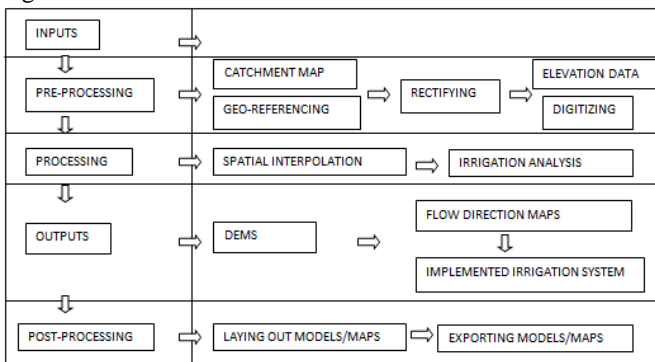


Fig 2. A Flow Diagram Showing Irrigation and Floodplain Maps Generation

4. Results and Discussions

The results of this work including the production of the topographical map and the Digital Elevation Model (DEM) map of Ido catchment, which is subsequently used to generate the flow direction map, and the flow accumulation map of Ido local government as shown in the figures and tables below, are illustrated in this research.

4.1 Topographical Map of Ido Catchment Area

The co-ordinates on the digitized Topographical map have distinctive elevations; the areas that are of the same elevations are connected by a contour line as shown in Fig 3. The generation of the topographical map was digitized from the conjoined western topographical map which comprises of Ogun state, Ijebu-Ode and part of Ibadan, while part of the features of the topographical map was digitized with remote sensing using Google earth map 2019 model.

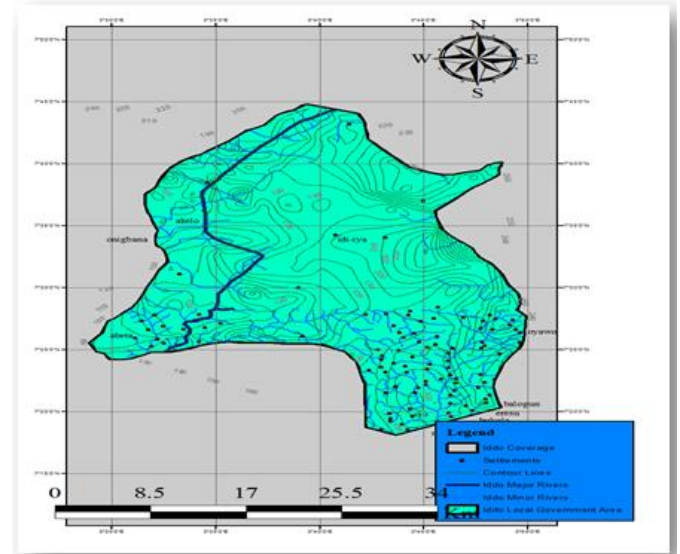


Fig 3. Topographical Map of Ido Catchment Area

4.2 Digital Elevation Measurement (DEM) Map and the Generational Elevation Map of IdoLocal Government Catchment Area
The Digital Elevation Measurement (DEM) map shows the coloration distinguishing factor of the variation in heights, indicating the yellowish, greenish and bluish part to be the lowest terrain, fairly hilly terrain, and the hilly terrain with the highest elevations as shown in Fig 4a, while Fig 4b shows the generational map that was used to create the DEM map. The elevation values ranges between 86m-276m respectively.

The Digital Elevation Measurement (DEM) map can also be used for hydrological purposes to produce the flow direction and flow accumulation map. These are hereby considered in the next section of this chapter.

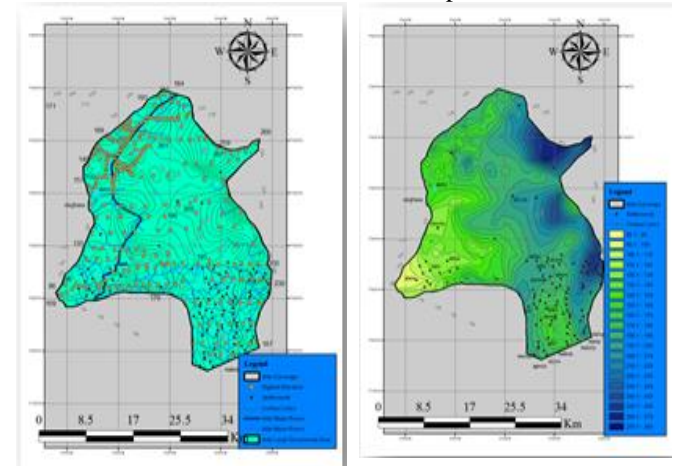


Figure 4a
Fig 4a. The Elevation Map/Generational Map of Ido Catchment Area

Figure 4b
Fig 4b. DEM Map of Ido Catchment Area (2019)

4.3 Hydrological Map of Ido Catchment Area

The hydrological maps of Ido local government are maps that show the features of water flow in the study area, such as

direction of flow of water, and flow accumulation, the flood plain of the catchment area and so on. The maps generated from this chapter are the flow direction map, and the Triangulated Irregular Network (TIN) map.

4.3.1 Flow Direction Map

The distinguishing factor of the flow direction map is the color distinctiveness. Areas that are yellowish, and bluish, in color indicates places of high and moderate flow direction, while the extremely bluish and sky bluish color symbol indicates the area of low flow direction and the extremely low flow direction area, water flow will possibly be directed to areas with yellow color as indicated in Flow direction map of Ido catchment area shown in Fig 5.

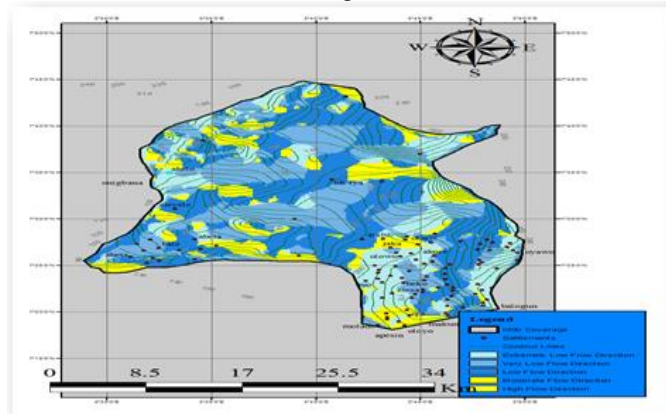


Fig 5. Flow Direction Map of Ido Catchment Area (2019).

4.4 Area of Suitability for Irrigation System Map of Ido Catchment Area

The Triangulated Irregular Network (TIN) of Ido local government catchment topography shown in Fig 6 explains the areas that are suitable for the mounting of irrigation system with the fact that water flows from the region of high elevation to region of low elevation. The TIN map identifies the elevation features of Ido local government catchment in 3D view, as well as merging area formations with the contour line, making the elevation outstretch of the map more visible.

Conclusively areas that are red in colour should be recommended exclusively for irrigation and agricultural purpose which falls in the south-western and western region of Ido local government catchment, examples of south-western region that falls between the red zone areas are abeta, alagba, bale, and olapade.

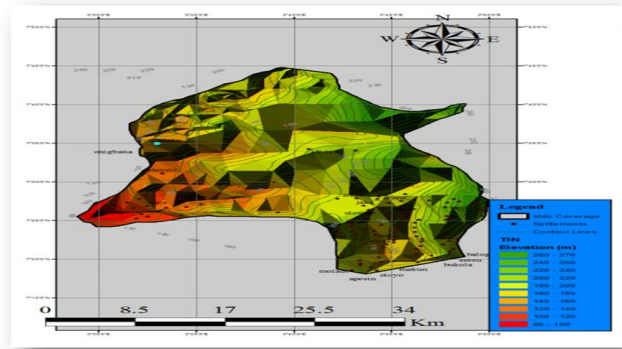


Fig 6. Map Showing the TIN of Suitable Zones for Agricultural Practice in Ido Local Government
4.5 Flood Risk Map of Ido Catchment Area

The advantage of water flow towards the south west of Ido local government which makes it fit for agricultural practice is also a possibility and at disadvantage that the south-western part of Ido local government is prone to flooding hence, Fig 7 shows the flood risk map of Ido local government catchment. The flood elevation map of Ido local government catchment explains the areas that are prone to flood going with the fact that water will flow from areas of high elevation to areas of low elevation. The areas that are black in colour are of low elevation and are therefore at the flood risk zone. The flood risk areas include; Abeta, Ogunde, Eleyele, Bale and Onigbana, and it is therefore suggested that flood zone should be under professional speculations, and main water bodies could also be properly dammed for collective accumulation of water.

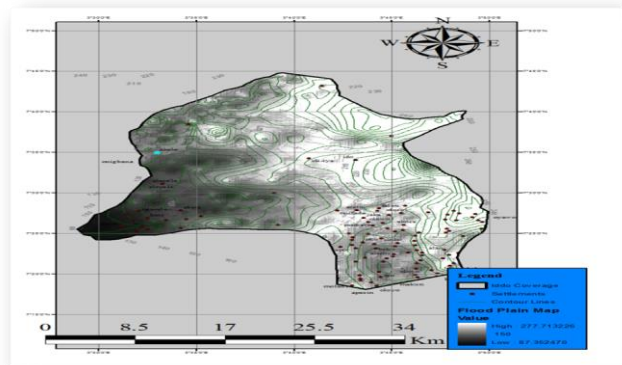


Fig 7. Flood Risk Map of Ido Catchment Area

Table 1. Flow Direction Values of Co-Ordinates in Ido Catchment Area.

S/N	Co-Ordinate	Flow Direction Value	Flow Direction Symbol	Comments
1	3 39' 47.094"E, 7 43' 36.782"N	High	Yellow	Water flows into the area from many directions
2	3 34' 48.601"E, 7 39' 33.566"N	High	Yellow	Water flows into the area from many directions
3	3 39' 10.243"E, 7 39' 44.621"N	Low	Sky Blue	Water flows into the area from minute directions
4	3 42' 47.663"E, 7 35' 22.980"N	High	Yellow	Water flows into the area from many directions
5	3 33' 31.214"E, 7 32' 22.410"N	High	Yellow	Water flows into the area from many directions
6	3 38' 26.022"E, 7 32' 55.576"N	Very Low	Blue	Little or no water flows into this direction.
7	3 41' 4.4810"E, 7 33' 2.9460"N	Low	Sky Blue	Water flows into the area from minute directions
8	3 44' 8.7350"E, 7 33' 10.316"N	Very Low	Blue	Little or no water flows into this direction.
9	3 46' 43.509"E, 7 32' 29.780"N	High	Yellow	Water flows into the area from many directions
10	3 31' 36.976"E, 7 28' 56.045"N	Very Low	Blue	Little or no water flows into this direction.
11	3 32' 50.678"E, 7 28' 15.509"N	High	Yellow	Water flows into the area from many directions
12	3 34' 30.176"E, 7 28' 33.935"N	Low	Sky Blue	Water flows into the area from minute directions
13	3 37' 41.800"E, 7 28' 37.620"N	High	Yellow	Water flows into the area from many directions
14	3 39' 58.149"E, 7 28' 52.360"N	Very Low	Blue	Little or no water flows into this direction.
15	3 44' 1.3650"E, 7 28' 48.675"N	Low	Sky Blue	Water flows into the area from minute directions
16	3 47' 53.526"E, 7 29' 7.1000"N	Very Low	Blue	Little or no water flows into this direction.
17	3 34' 55.971"E, 7 26' 32.326"N	Very Low	Blue	Little or no water flows into this direction.
18	3 36' 39.154"E, 7 26' 21.271"N	High	Yellow	Water flows into the area from many directions
19	3 40' 31.315"E, 7 26' 54.437"N	Very Low	Blue	Little or no water flows into this direction.
20	3 44' 27.161"E, 7 19' 13.801"N	High	Yellow	Water flows into the area from many directions

4.6 Study Area Map and Land Use Pattern Map of Ido Catchment Area.

The land use pattern map (Fig 8b) was regenerated from the study area map (Fig 8a) of Ido local government using the Reclass tool from the interpolation function of ArcGIS software. The land use pattern map of Ido local government demonstrates the features of Ido local government using distinctive colours, the classification of the features on the land use pattern map are the vegetal areas, semi built-up areas, built up areas and water bodies. Similarly the feature deductions were made from the map legend using distinctive colour classification which gives the information about the features of Ido local government land use pattern indicating the greenish part of the area to be vegetal areas, the yellow areas being the semi-built-up areas, the brownish areas being the built-up areas, while the areas represented in blue is that of an existing water body.

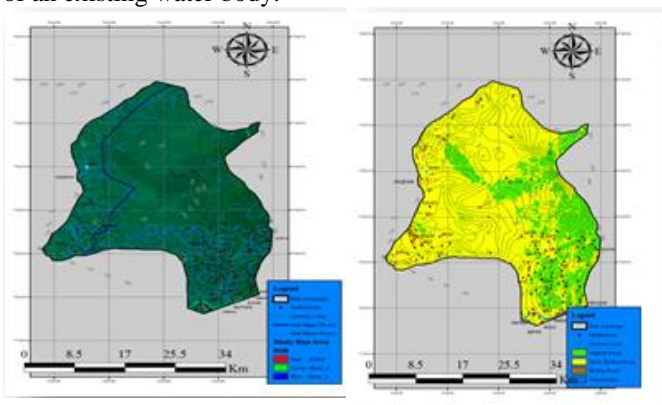


Fig 8a

Fig 8b

Fig 8a. Study Area Map of Ido Catchment Area

Fig 8b. Land Use Pattern Map of Ido Catchment Area

4.6 Irrigation System Suitability Zone Map

The Irrigation suitability zone map as shown in Fig 4.7 indicates the areas that are suitable and extremely suitable for siting an irrigation system facility to be of 25% of Ido local government. Using the legend classification and interpretation method, the map (Fig 9) classifies Ido local government prior to irrigation system in four classifications which are; the slightly suitable zone, the suitable zone, the highly suitable zone, the extremely suitable zone.

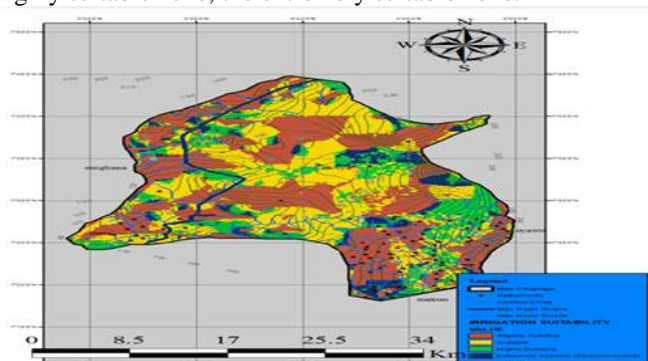


Fig 9. Irrigation Suitability Zone Map of Ido Local Government Catchment

5. Conclusions and Recommendation

The following conclusions were made on the findings from this research;

The topographical and digital elevation (DEM) map of Ido local government catchments shows that the south-western part of Ido local government has the lowest elevation which makes it advantageous for agricultural activities, and the susceptibility to water flow also indicates its vulnerability to flooding as indicated by the flood plain map, hence the reason for the construction of Eleyele dam is justified.

The flow direction map of Ido local government shows that other than agricultural activities Ido local government will perform well in urbanization and industrialization free of risk to flooding due to its extremely high elevation terrain dispersed around its horizon. The land-use pattern map of Ido local government catchment shows that Ido local government is an underdeveloped area due to the famous agricultural activities in about 75-80% of the whole of Ido. Finally, the irrigation suitability zone map shows the detailed area where irrigation system is best to be constructed in Ido local government and which is sure to satisfy the need for irrigation water across all bisected cardinals in Ido local government, of places like Ogbontosa, bale, beko, jaka, etc., where these areas are notably of low elevations.

Irrigation is considered an important investment for improving rural income through increased agricultural production and consistent bounty. However this can be achieved by assessing available land and water resources for irrigation, hence, the following are hereby recommended as a distinct way forward in adequate and sufficient water supply to Agricultural sites and other water consuming activities in the study area.

The identified surface irrigation potential of the river catchment in the study area can assist in policy decisions during a development of irrigation project.

The development of flood contingency master plan for the flood plains in Ido local government catchment and Nigeria at large is imperative and extremely important.

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