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Assessment and Management of Watershed of Machhu Dam III,Morbi,Gujarat Using Geoinformatics Technology

Jaysukh C.Songara
L.E.College, Morbi, India
jayukhsongara@gmail.com

N.M. Joshipura
Asst. Professoer
L.E.College, Morbi, India

Khalid Mehmood
Project manager
BISAG, Gandhinagar

Dr. Indra Prakash
BISAG, Gandhinagar
indraprakash52@yahoo.co.in

***Abstract*:-Machhu Dam III is located across Machhu River in the Morbi Taluka of Rajkot district. Remote sensing and GIS has been used in determining ground and hydrological conditions of the catchment area. Various thematic layers have been developed, integrated and analyzed for the assessment and management study of the sub watershed area of the Machhu River. Geoinformatics technology has been helpful in the assessment of watershed area of Dam prior to filling of the reservoir for planning and management considering present land use pattern and future water requirements and land use plan.**

Keywords: Watershed management techniques, Geographic information system, Remote Sensing, Curve Number

I. Introduction

A watershed is an area of land that drains rain water or snow into one location such as a stream, lake or wetland. These water bodies supply drinking water, water for irrigation and industry and also used for recreation and helps in the development of habitat. In recent time watershed health has been affected due to human intervention and unplanned development causing rapid erosion, siltation and pollution. Therefore, it is required to protect the natural environment of watershed and carry out development in the area in planned way. For this systematic watershed management study is to be carried out irrespective size of the catchment area.

Watershed management means the process of creating and implementing plans, programs and projects to sustain and enhance watershed functions that affect the environment, vegetation, animal and human communities within a watershed boundary. Watershed management includes managing of natural resources, land use pattern and human activities. Watershed management study of Machhu dam III within the natural boundary of Machhu River between Machhu Dam II and III has been carried out for understanding problems of the catchment area and suggesting remedial measures.

Effective watershed management can prevent community water shortages; improve water quality, check flooding and erosion. Watershed management also helps to improve the ground water conditions. Watershed management is used for optimum use of the available water resources in the catchment area.

Main objective of the study of the catchment area of Machhu Dam III is to assess the ground and hydrologic conditions for the proper management of watershed area after the completion of the dam.

II. Methodology

The methodology adopted for the present study includes:

1. Creation of thematic Maps (Land use, Drainage, Contours, Slopes, hydrology, Soils, etc.) with the help of LISS-III, LISS IV and Cartosat images and using remote sensing and arc GIS software.

2. Collection and integration of collateral Data such as Administrative boundary, State boundary, District Boundary, Taluka Boundary, Meteorological Data and Hydrological Data with the thematic layers.

3. Assessment and visualization of catchment conditions with the help of Geoinformatics technology and development of Watershed Management plan.

III. Watershed Study Machhu Dam-III

Machhu dam III is located near village juna sadulka of Morbi taluka in Rajkot District is on river Machhu. The Dam site is located about 2 km. Upstream of village-Juna sadulka and 8 k.m. downstream of Morbi city (Fig.1). The scheme is proposed for Irrigation purpose only. It is in the final Stage of completion.

A. Catchment Area

The catchment area of Machhu III lies in Machhu river basin in Morbi taluka of Rajkot district. Machhu River is one of the major North flowing river of Saurashtra region in Gujarat state. The study area falls under Survey of India sheet number 41J16 between latitude 22^0 44' & 22^0 56' and longitude 70^0 40' & 700 59'. Altitude of the catchment area varies between Elevations 27m and 96 m. This catchment area falls under the category of sub watershed as per the size (24212.123 hectare).

Major part of catchment area is occupied by agriculture land where groundnut and cotton crops are being grown presently during monsoon. Wheat and cumin are also grown during winter season. For the present study LISS III, LISSIV and Cartosat images have been used.

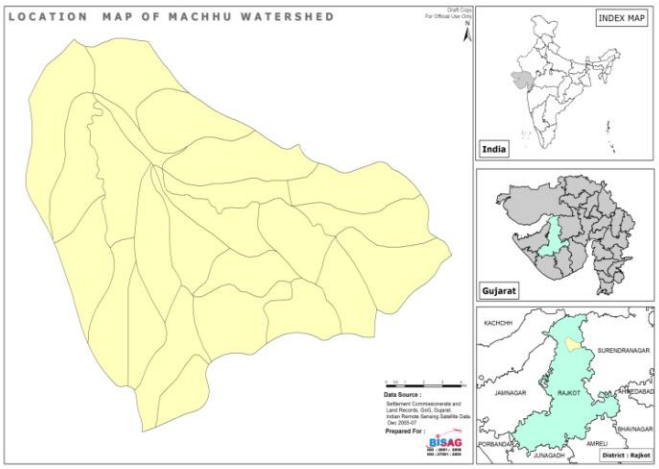

Figure.1 Location map of study area

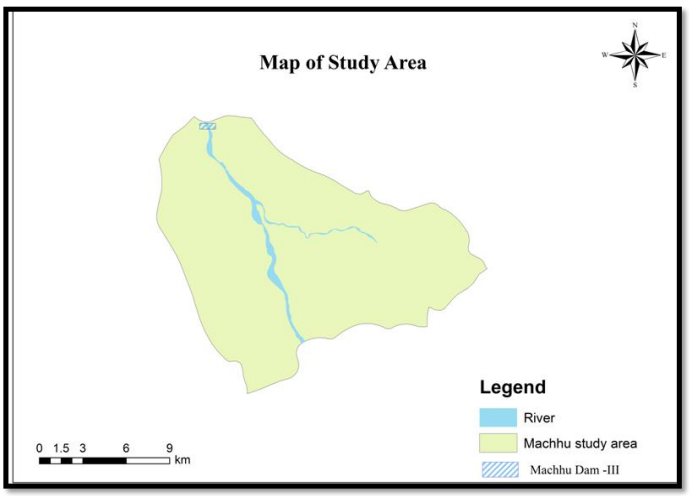

Figure.2 Location of River & Dam of study area

B. Remote Sensing Study

Remote sensing is the science of acquiring, processing and interpreting images that record the interaction between electromagnetic energy and matter. It is the science and art of obtaining information about an object, area, or phenomenon through the analysis of data acquired by a device that is not in contact with the object, area, or phenomenon under investigation. In the present study LISS III, LISS IV and Cartosat images have been used for development of various thematic layers such as topography, geology, hydrology, DEM, Land Use etc (Fig.2,Fig.3,Fig.4,Fig.5,Fig.6,Fig.7). Remote sensing data analysis has been carried out with the help of Arc GIS and Envy software.

C. GIS Study

A geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data. In the present study various thematic layers such as soil, wetland, land use, topography, hydrology etc. have been overlaid and compared to determine the correspondence between various hydrologic conditions. By overlaying various layers in conjunction with field data assessment and management study of the catchment area has been done for proper management of the watershed.

D. Thematic Maps of the watershed area

***1. Land Use/Land Cover Map*:**

Land use depends on the natural and anthropogenic activities. These maps have been developed using Envy and Arc GIS software. In the catchment area Crop land, Fallow land, Lakes / Ponds, Land with Scrub, Land without Scrub, Industrial Waste, Prosophis, Reservoirs, River, Towns/cities (Urban), Villages (Rural) have been identified and delineated (Fig.3).

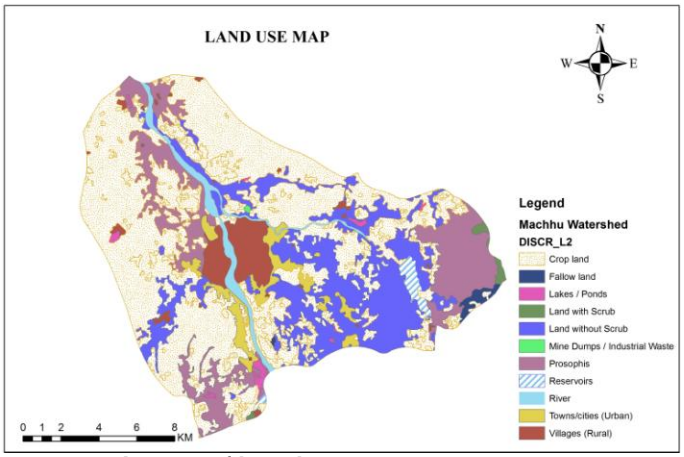

Figure.3 Land use Map of the study area

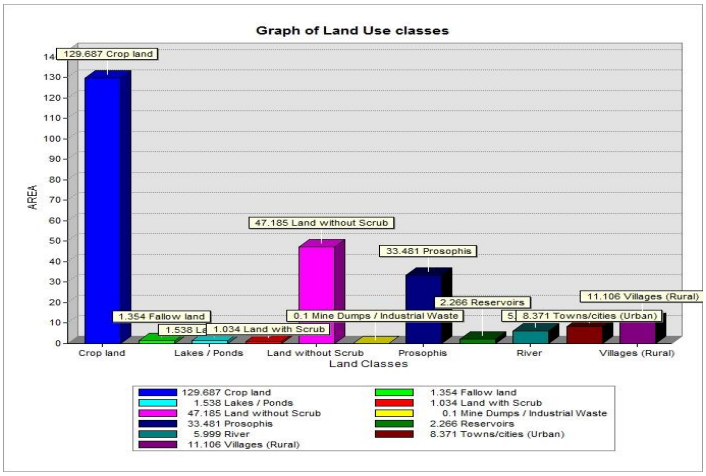

Figure.4 Evaluation of land covers classes

4	Land with Scrub	Fine	C	00
		Clayey	D	0.13
5	Land without Scrub	Fine	C	6.64
		Clayey	D	24.74
6	Industrial Waste	Fine	C	0.09
		Clayey	D	00
7	Prosophis	Fine	C	10.28
		Clayey	D	10.63
8	Reservoirs	Fine	C	0.03
		Clayey	D	2.06
9	River	Fine	C	2.04
		Clayey	D	0.54
10	Towns/cities	Fine	C	4.4
		Clayey	D	2.81
11	Villages (Rural)	Fine	C	1.57
		Clayey	D	1.57

2. Soil and Hydrologic Soil Map:

Two types of soils have been identified in the area. Statistical analysis of the area with the help of Arc GIS has been done which gave the values for fine sand as 42.40% and Clayey 40.71% (Fig.5). Percentage of Hydrologic Soil Group (HSG) is mentioned in the Table I. The HSG group includes Crop land, Fallow land, Lakes / Ponds, Land with Scrub, Land without Scrub, Industrial Waste, Prosophis, Reservoirs, River, Towns/cities (Urban), Villages (Rural).

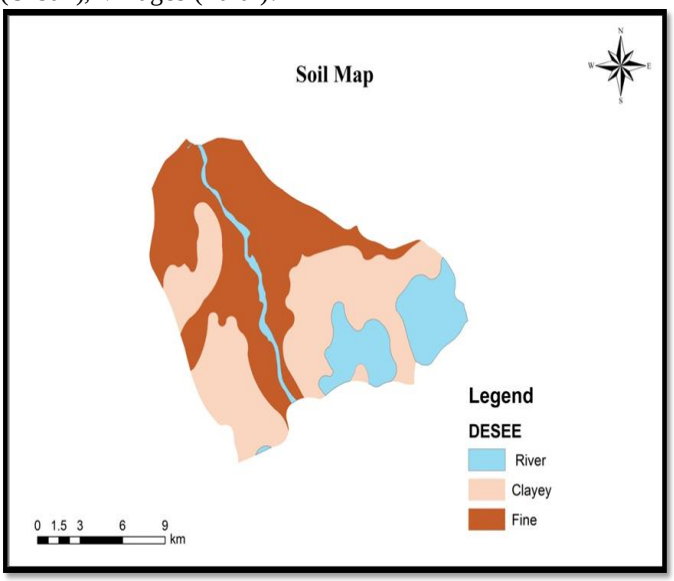

Figure.5 Soil map of the study area

Table I: Types of Soil and Hydrologic Soil Group (HSG)

Sr.No	Different Classes	SoilType	HSG	Area(%)
1	Crop land	Fine	C	66.85
		Clayey	D	56.75
2	Fallow land	Fine	C	0.02
		Clayey	D	0.07
3	Lakes / Ponds	Fine	C	0.76
		Clayey	D	0.69

3. Drainage Map

A drainage system is described as accordant if its pattern correlates to the structure and relief of the landscape over which it flows. Drainage in the Study area is of dendritic pattern type (Fig.6).Drainage analysis has been done to know the drainage density in the sub-catchment.

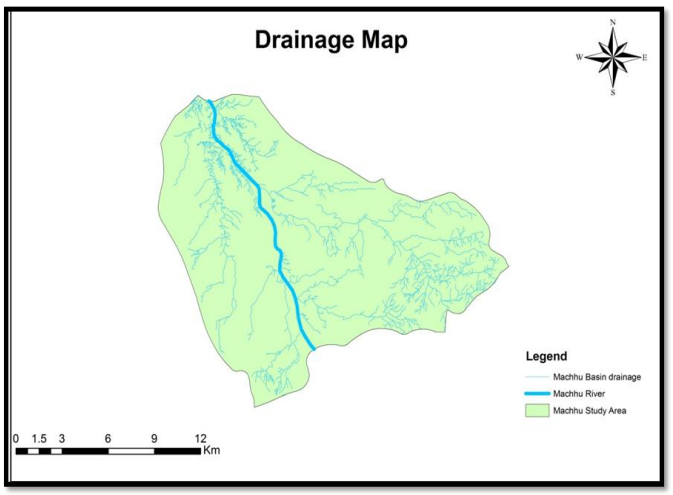

Figure.6 Drainage map of the study area

4. Slope Map

Slope map has been prepared from DEM and analysis has been done to find out various categories of slopes and their percentage (Fig. 7). In the study area it has been observed that about 98 % of land is having less than 1 percent slope and remaining land 1-3 percent except a few isolated patches in the southeastern part of the area where slope is higher due to local topography. Slope is the measure of change in surface value over distance and can be expressed in degrees or as a percentage.

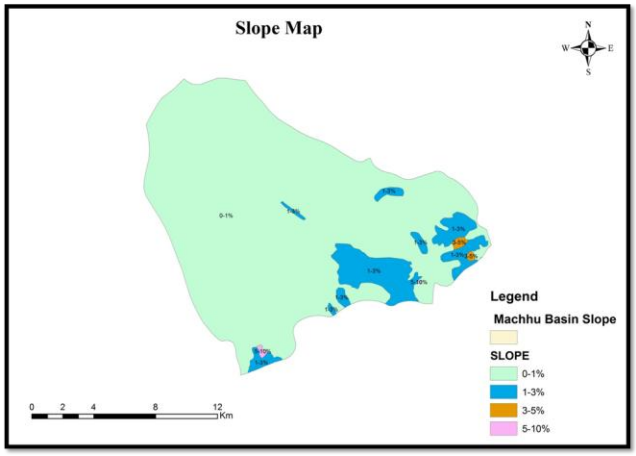

Figure.7 Slope map of the study area

E. Runoff Study:

Year wise runoff in the catchment area has been calculated with the help of Curve Number (CN) Method (Fig.8). Maximum Runoff has been observed during the year 1994 and 2010.

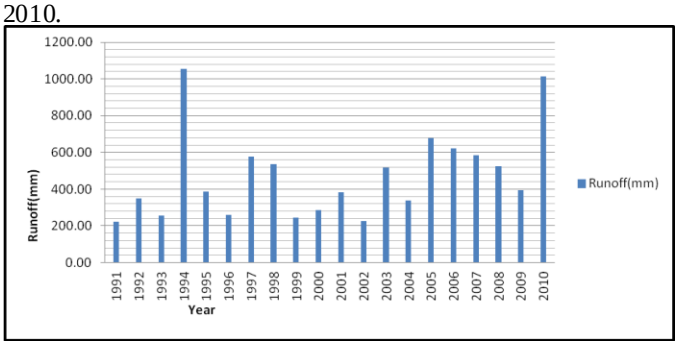

Figure.8 Average annual runoff(mm) over last 20 year in the study area

F. Submergence area study

Using GIS technology submergence area study has been done. Prior to the filling of the reservoir the area occupied by the water body is (20522.93 hectare). After the submergence up to FRL the land submergence would be (3674.04 hectare). The submergence area has been superimposed on the land use map and number of land submergence classes has been identified (Fig.9, Fig.10) for the better visualization of submergence at various levels DEM has been used.

The given below area under submerge Machhu Dam III:

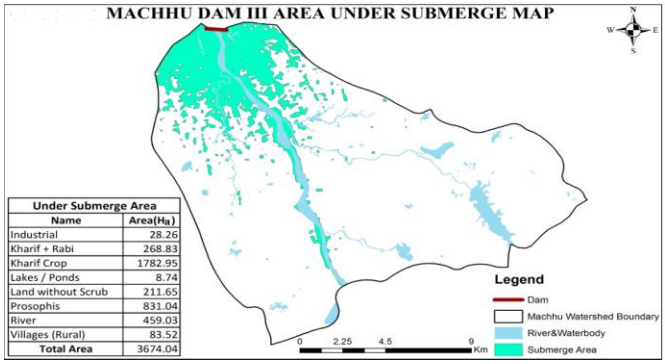

Figure.9 under Submerge area in the study area

The given below area without submerge Machhu Dam III

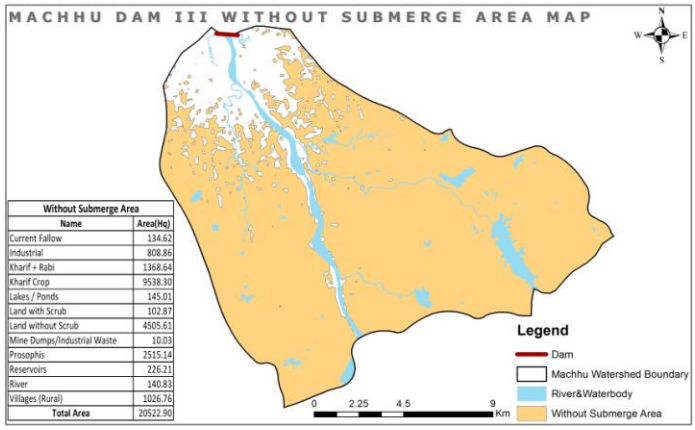

Figure.10 Without submerge area in study area

IV. Conclusions

Study of the watershed area of the Machhu Dam III with the help of Geoinformatics technology has been carried out to understand ground and hydrological conditions of the catchment area for the proper planning and management of the water resources. The study reveals that major part of the catchment area is occupied by the agriculture activity. The area statistics of the various land use pattern have been determined with the help of Arc GIS tools. Percentage wise land use pattern has been delineated and analyzed which shows area occupied by Crop land-53.57 ,Fallow land-0.56 , Lakes / Ponds-0.64 , Land with Scrub-0.43 , Land without Scrub-19.50 , Industrial Waste- 0.04 , Prosophis-13.80 , Reservoirs-0.90 , River-2.5 , Towns/cities (Urban)-3.46 , Villages (Rural)-4.59. Pre and post scenario of the submergence of the Machhu dam III reservoir has also been generated with the help of DEM. Depending on the ground conditions, hydrological study, present land use pattern and future land use requirements a suitable management plan of the watershed area can be evolved using remote sensing and GIS technology.

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[3](http://en.wikipedia.org/wiki/Drainage_system (geomorphology)

Author profile

Jaysukh C. Songara received the B.E. degree in Civil Engineering from Govt. Engineering College-Bhuj in 2012. Presently 2013-2015, he is pursuing his M. E. in Civil Engineering with specialization in Water Resources Management from L.E .College, Morbi, India.