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Selection of Sites for Water Harvesting Structures in part of Sabarmati River Basin, Gujarat, India using Remote Sensing and Geographical Information System

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Abstract:- *The present study is an attempt to Determine suitable site for Water Harvesting Structures like check dam, Gully plugs in Mazum River, Gujarat, India using Remote sensing and Geographical Information System (RS & GIS). The study area has been facing sever water scarcity due to intensive agriculture for the past few years. The Indian Remote Sensing Satellite (IRS)-P6 Linear Imaging Self Scanner (LISS)-III satellite imagery of Mazum river basin is used and land use/land cover classes have been derived from it. ASTER DEM used for the Generating the different thematic maps. The various thematic maps such as land use map, group map, hydrological soil slope map and drainage map are laid over each other and five check dams are proposed for construction. Geographical Information System is the technique which is used for preparation of thematic maps and combining all the layers and performance analysis.*

Keywords:- Waters Harvesting Structures, Remote Sensing and Geographical Information System

I. INTRODUCTION

Water harvesting structures are extremely important to conserve precious natural resource like, soil and water. Water is essential for all life forms and is used in different ways such as for food production, drinking, domestic, industrial, power generation and recreation. Out of 2.5% global fresh water only 1% is available for human consumption (Anon., 2002). The ground water table is rapidly depleting due to over exploitation of groundwater. Statistics on water budget indicates that our country gets about 400 Mha.m of precipitation annually, out of which 200 Mha.m is lost in evapo-transpiration. About 135 Mha.m is available on the surface and remaining portion of precipitation joins groundwater through percolation. As per estimate about 92 Mha.m of the available surface water ultimately goes to the sea despite of construction of large dams, reservoirs, check dams, water harvesting structures etc.

The precipitation in India is highly variable over time and space due to monsoon climate and land-mountain topography. In order to conceptualize the runoff occurring from the humid regions, Zade et.al.(2005) used the remote sensing images and Natural Resources Conservation Services (NRCS) curve number approach to estimate the annual runoff from 12 major river basins of India. The need and importance of water harvesting and water conservation has been given weightage in national water policy and national agricultural policy of government of India. The various rainwater harvesting structures viz., check dams, farm ponds, nala bunds, percolation tanks etc are constructed at appropriate site that check flood, conserve soil and provide irrigation to downstream.

GIS is an effective tool not only for collection, storage, management and retrieval of a multitude of spatial and non-spatial data, but also for spatial analysis and integration of these data to derive useful outputs and modelling (Gupta and Srivastava 2010; Srivastava et al. 2011). By prioritization of watersheds, one can conclude which watershed can lead higher amount of discharge due to excessive amount of rainfall. Recently, Singh et al. (2009) have represented a case study to select suitable sites for water harvesting structures in Soankhand watershed, Punjab by overlaying of DEM, soil map and slope map using RS and GIS approach. Geo-visualization is being used in creating various scenario of water levels in the catchment and in the downstream flood affecting land use pattern depending on the topography (Khalid Mehmood et. al**.** 2014 and MacEachren 1994).

The present study is focused on the identification of suitable sites for positioning of water harvesting structure such as check dams in Mazum River based on GIS. Mazum River is a tributary of Watrak River which are located in

Sabarmati basin. This study is an attempt to identify water harvesting site based on the Remote Sensing and GIS study to increase water potential of the area for irrigation and domestic purpose.

II. STUDY AREA

The study area of the Mazum river watershed falls in different part of district of Gujarat such as Arvalli, Sabarkantha, Gandhinagar and Kheda but major part in Aravalli district (782 Km2). Mazum River is geographically located at latitude 23°12′to 23°57′and longitude 73°to 73°50′. The Arvalli district includes 676 villages and 306 village panchayats with a total population of 1.027 million and is the most literate tribal district in Gujarat. The average annual rainfall in the Arvalli district is 857.8mm. The day temperature during may are the highest, being about 41.5º C. After mid-November both day and night temperatures decrease rapidly till December which is the coldest month. This watershed is mainly a part of the Watrak river basin which is a tributary of Sabarmati River.

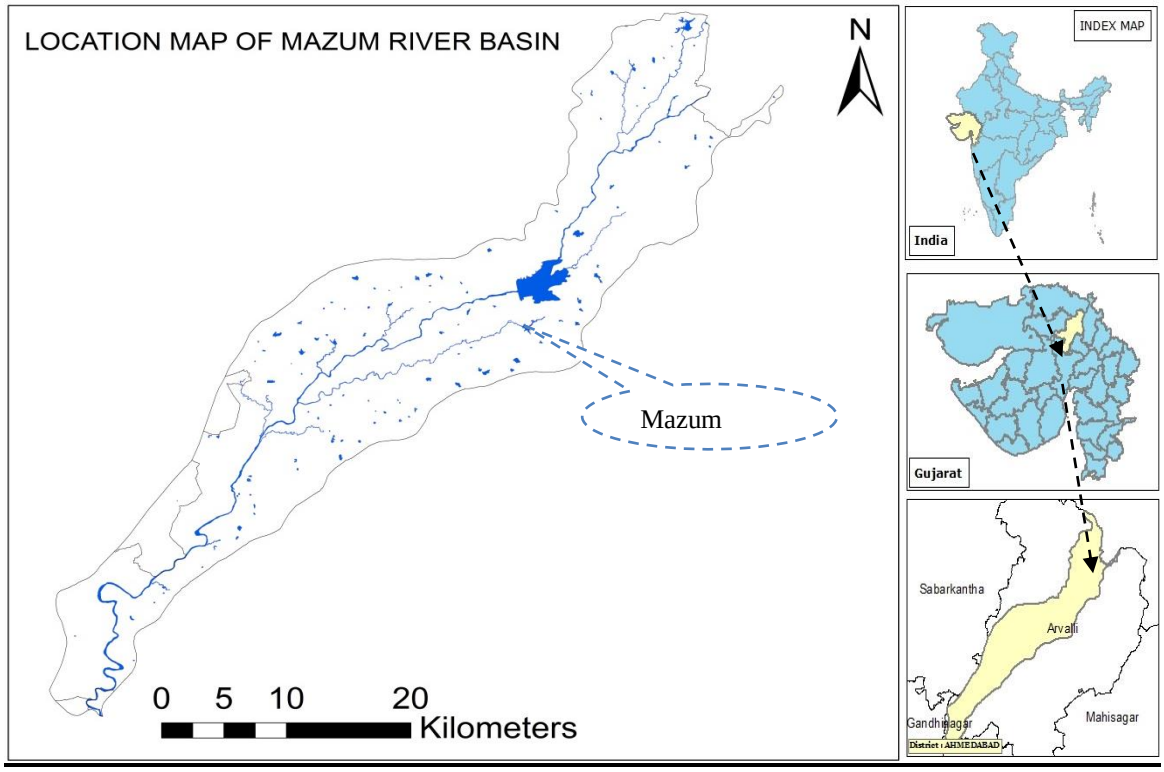

Fig. 1 Location map of study area

III. METHODOLOGY

Various thematic maps such as drainage, land use, soil and slope have been prepared using remote sensing and GIS technology. The stepwise method for preparation of various maps is presented through flowchart.

3.1 Decision rules for site selection of water harvesting structures

The following criteria for the selection of check dams have been adopted as per guidelines of Integrated Mission for Sustainable Development (IMSD 1995):

- The slope should be less than 15 per cent.
- The land use may be barren, shrub land and riverbed.
- The infiltration rate of the soil should be less.
- The type of soil should be sandy clay loam.

Spatial and non-spatial data has been collected from various agencies such as Bhaskaracharya Institute for Space Applications & Geo-informatics, State Water Data Centre (SWDC) and National Aeronautics and Space Administration (NASA).

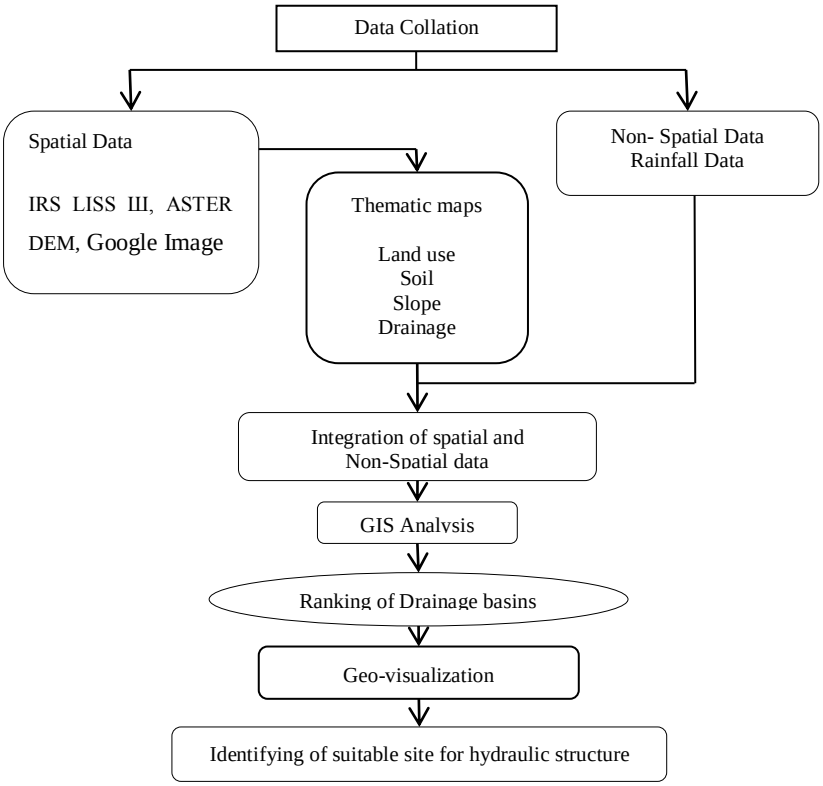

Fig. 2 The flow chart of methodology adopted for Study**.**

IV. THEMATIC MAPS AND DATA ANALYSIS

Land use map

The land use map shows the spatial extent of agriculture land including cropped areas during Kharif and Rabi season, built up area, Forest area, Waste land, Water body etc. The domain used in Arvalli, Sabarkantha, Gandhinagar and Kheda taluka is agriculture which occupies 80.74% of total geographic area. Built up area is 1.40% of the total study area. The forest plantation, deciduous forest and naturally grown forest plantation occupies 8.89% of total study area. The class of land includes ponds, lakes, depression storage, perennial river/stream, etc. Water body category occupies a small area of about 2.32% of the total study area.

Slope map

The slope map was prepared from SRTM and contour map. 3D analyst tool is then used to convert digitized contours into Triangulated Irregular Network (TIN) model and then to DEM (Fig.). From this DEM, slope map was generated using this process: Arc GIS Fig 3D Analyst tool- Surface analysis- Slope- Percentage function. Slopes are classified on the basis of the guide line mentioned in Integrated Mission for Sustainable Development (IMSD) document. The study area show a different category of slope ranging from 0-1%,1-3%,3-5%,5-15%,15-50%.

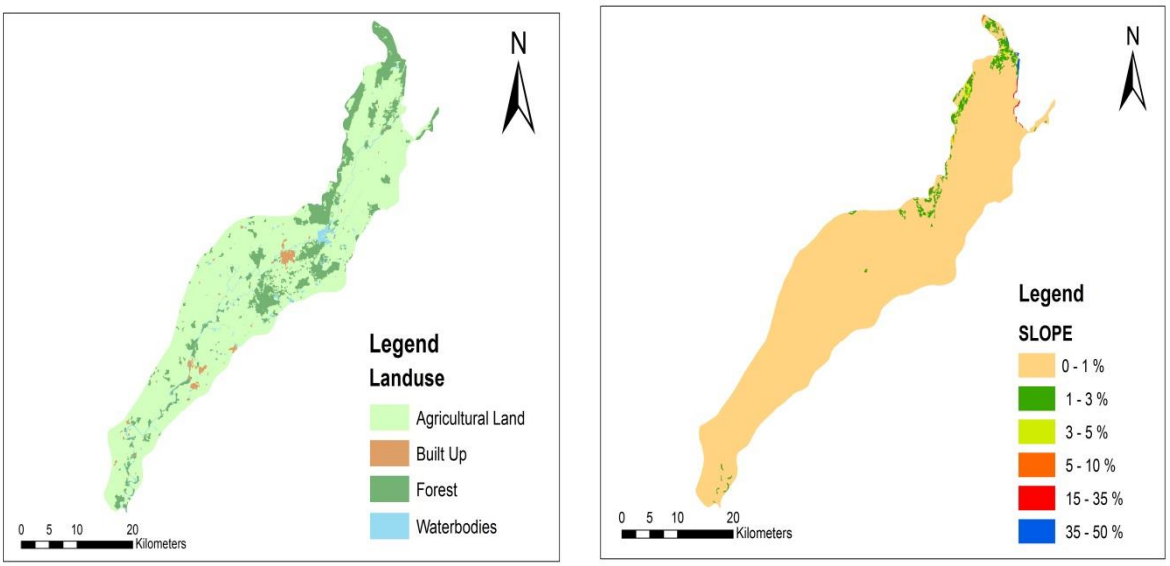

Fig.3 Land use map and Slope map

Soil map

Soil map is prepared by Bhaskaracharya Institute for Space Applications & Geo-informatics (BISAG) Gandhinagar, Gujarat. In study area 5 types of soil associations are available such as Clayey, Coarse loamy, Fine, Fine loamy, Loamy.

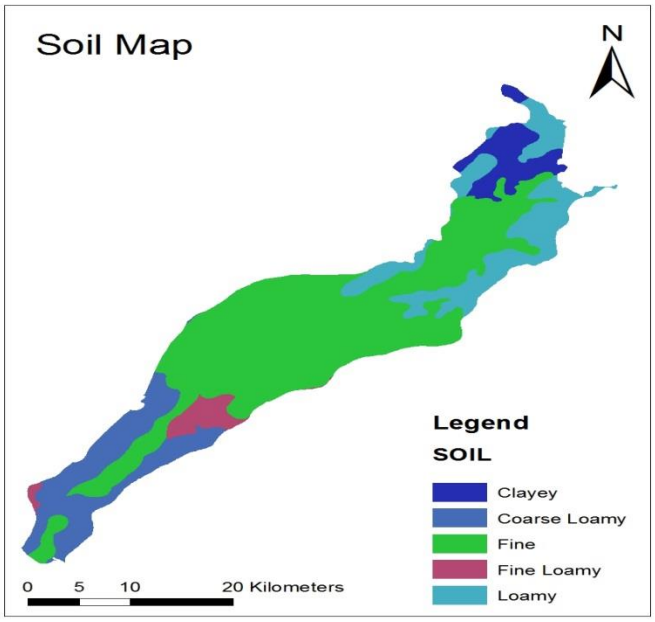

Fig. 4 Soil map

Drainage

Drainage map of the study area has been delineated using satellite imagery the drainage map has been later used to delineated sub-watershed boundaries. The same concepts are used while delineating sub-watershed boundaries as in the case of study area map (base map) preparation. Stream order also calculated from GIS Analysis. Stream order will helpful for the applying IMSD criteria for check-dams.

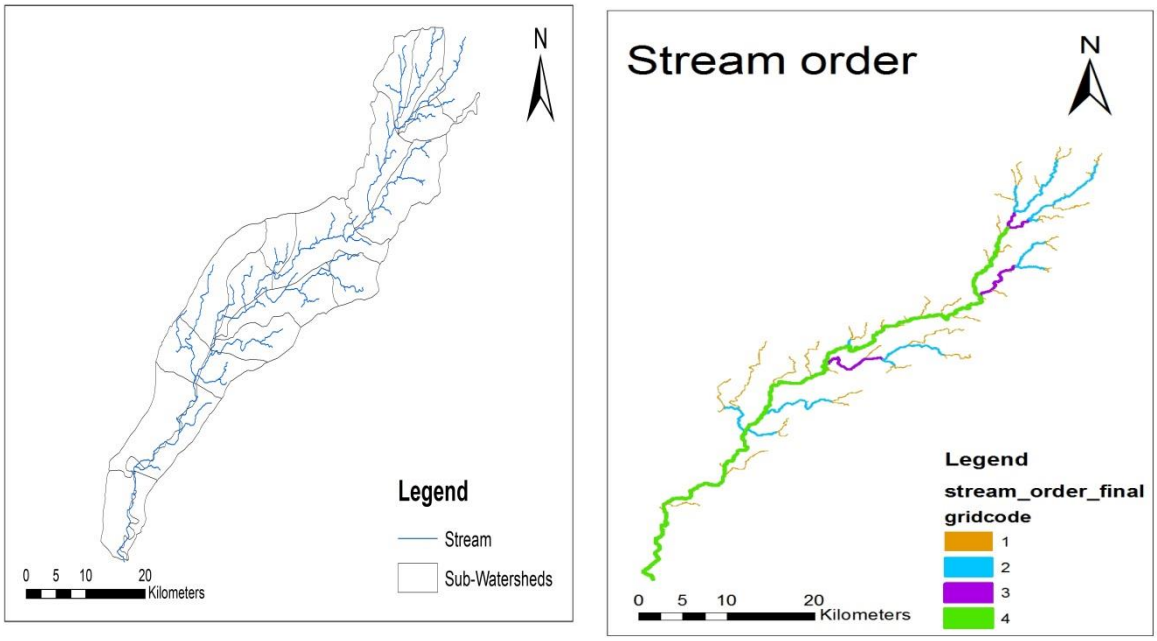

Fig. 5 Drainage Map & Stream Order

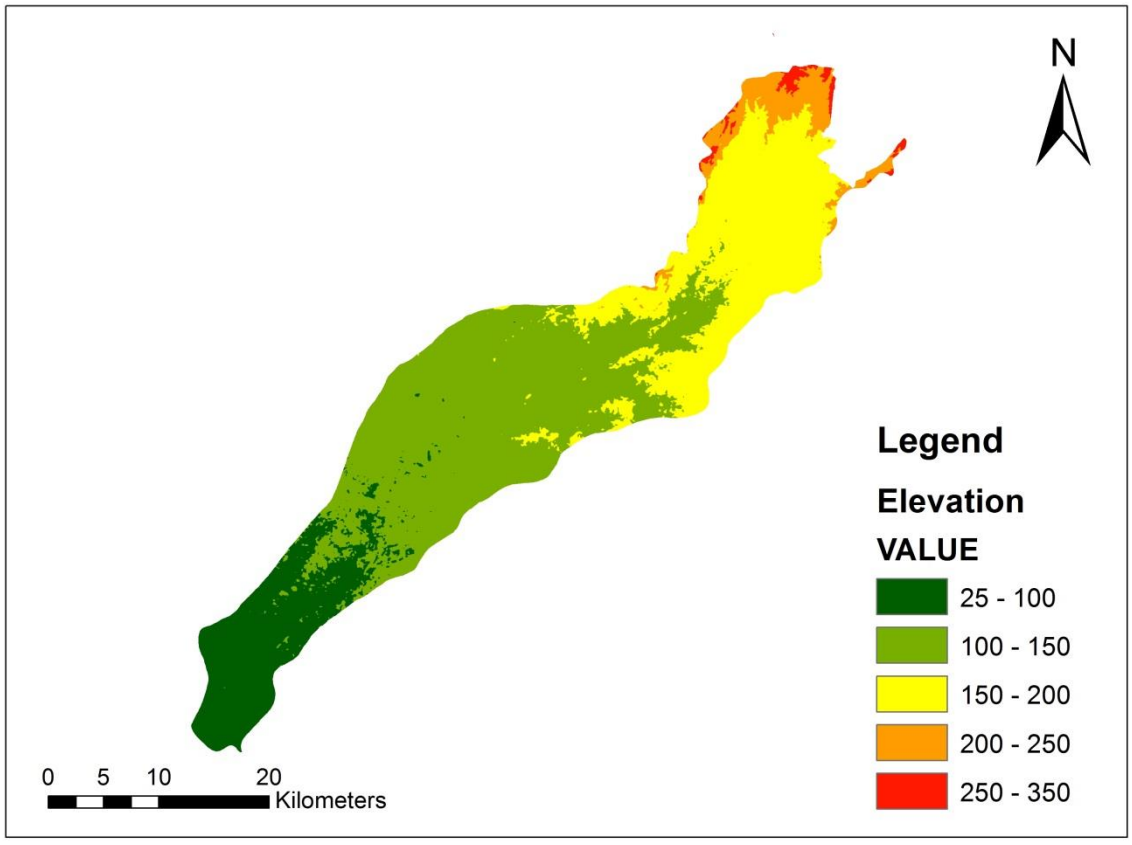

Fig 6 DEM of Study Area

V. RESULT AND CONCLUSIONS

The suitable sites for water harvesting structures were identified with the application of remote sensing and GIS. The watershed boundary map, drainage map, land use map, soil map and DEM were prepared using satellite imagery of Mazum river basin. The slope of Mazum river basin is flat (less than 1%) therefore it has been neglected in Overlay analysis. The overlay operation of land use map, soil map, stream order map and slope map was carried out for the selection of suitable site for the check dams.

These sites are located on second and third order drainage as per IMSD guidelines. Eleven suitable sites for the check dams have been identified. Out of these five sites are coinciding with the Government of Gujarat already constructed structures. Thus validating the criteria of selection of dams.

The remaining proposed check dams could be very useful for supplementing irrigation during the dry season, and for the cultivation of suitable kharif/rabi crops.

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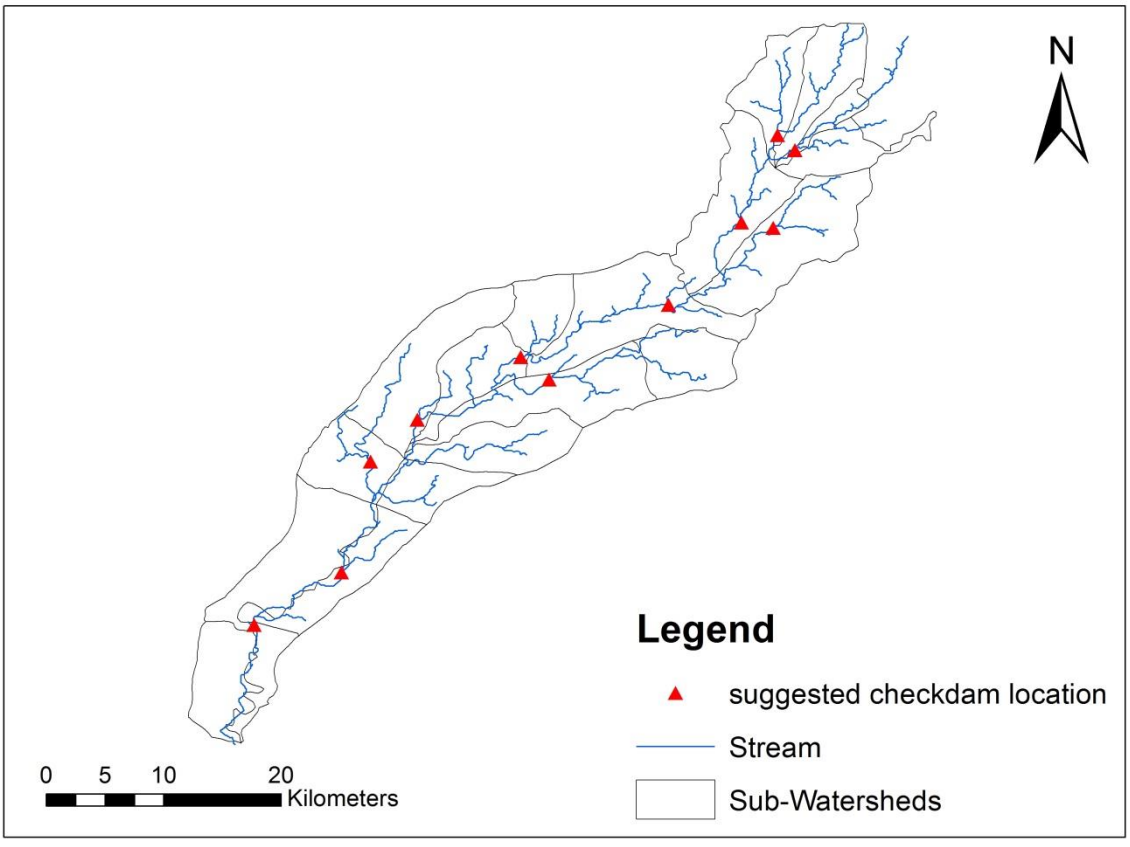

Fig. 7 Proposed Check-dam at Mazum river

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