Geospatial Modelling Approach for Inter-Linking Canal Alignment from Jayakwadi Dam to Dudhana Dam Reservoir, using Remote Sensing and GIS

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Abstract - The main cause of the protracted droughts and floods that occur in different regions of the country is poor water resource management, which also impedes national development. The only solution is to build a canal from the neighboring dam or rivers to the drought-affected communities. GIS and remote sensing can be used to conduct multidisciplinary research on agricultural and horological elements, which is necessary for the enormous task of building canals. With consideration for geomorphology, soil, land use and land cover, slope, and DEM (digital elevation model), this project outlines the design of an appropriate canal building route from Jayakwadi Dam to Dudana Dam. Rivers can also be connected by canals. The SOI data provides digital topography and drainage pattern information, whereas the LISS III picture provides land use/cover pattern information. Using the ASTER DEM picture, 1 meter contours were created. The canal was aligned horizontally and vertically using the Digital Elevation Model (DEM), which was obtained by interpolating contour lines. A number of possible options have been considered based on the GIS analysis. When determining the canal alignment, the study considered a number of elements, including slope, drainage, ground contours, and DEM. First, a proposed 84-kilometer canal between the Dudana and Jayakwadi dams has been put forth. The interlinking canal would be around 102 km long up to the Dudana Dam. Gravity is this canal's main purpose. In the current study cutting and filling reach zones have also been identified.

Key Words: Canal system, Remote Sensing, GIS, DEM

1.INTRODUCTION

A canal can be created where no stream presently exists. Either the body of the canal is dug or the sides of the canal are created by making dykes or levees by piling dirt, stone, concrete or other building materials. The water for the canal must be provided from an external source, like streams, lakes or reservoirs. India is blessed with abundant water resources, which are unevenly distributed in space and time. When one part of the country is reeling under severe water scarcity, floods damage another part. An irrigation canal is a waterway, often man-made or enhanced, built for the purpose of carrying water from a source such as a lake, river, or stream, to soil used for farming or landscaping. One of the difficulties with irrigation canals is providing a reliable flow of water. When the canal is directly connected to a water source like a lake or a river, the water supply is fairly reliable, but care must be exercised to avoid using so much water that other areas suffer. When an irrigation canal traverses a great distance or must navigate changes in elevation, other strategies must be employed. A contour canal is an artificially-dug navigable canal which closely follows the contour line of the land it traverses in order to avoid costly engineering works such as boring a tunnel through higher ground, building an embankment over lower ground, or constructing a canal lock (or series of locks) to change the level of the canal. Because of this, these canals are characterized by their meandering course.

2. PROBLEM STATEMENT

Since agriculture is the foundation of the nation, it is crucial to irrigate agricultural areas. The canal system is a very efficient irrigation technology. Since some of the villages lack irrigation water supplies, it is crucial to supply water to them. By connecting various canals and water bodies, canal interlinking projects seek to enhance water management and address issues related to water scarcity. In order to facilitate the movement of water from areas with surpluses to those with deficits, these projects entail the building of canal networks. Planning, carrying out, and overseeing canal interlinking projects all heavily rely on Geographic Information System (GIS) technology. However, using GIS effectively in these projects comes with a number of difficulties and problems.

3.STUDY AREA

Jayakwadi is one of the longest earthen dams in Asia. Its height is approx. 41.30 m and length of 9.998 km (10 km approx.) with total storage capacity 2,909 MCM (million cubic meters) or 190 tic ft. The total catchment area of dam is 21,750 km2. There are total 27 water gates for the dam. Jayakwadi Dam is also called as Nath Sagar Dam. Fed by the Godavari and Pravara rivers the reservoir is about 55 km long and 27 km wide and spans over 350 km2. Total submergence area due to the reservoir is approx 36,000 hectares.The Jayakwadi project is one of the largest irrigation projects in Maharashtra of India . Dudhana lower Dam is a last point of alignment where interlinking is ends.6581.20 m long earth dam with the maximum height of 18.52 m and 438.80 m long masonry/concrete dam of the maximum height of 28.60 m having 65 m long left non-overflow blocks, 303.30 m long gated spillway and 70.50 m long right non-overflow blocks across river Dudhna near Brahma-Wakdi village in Selu Taluka of Parbhani district.

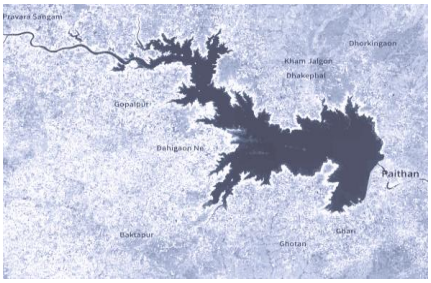

Fig-1 Study Area

4. AIM

Implementation of remote sensing for the interlinking of river by using GIS software.

5. OBJECTIVE

1. To interlink Jayakwadi dam to Dudhana dam.
2. To determine the best route for connecting the Jayakwadi Dam and Dudhana Dam Reservoir.
3. To expand the area under irrigation by rerouting excess water through canals, ducts, and drains.
4. To determine the region's elevation in order to determine the most cost-effective route for interlinking.

6.METHODOLOGY

1) LISSIII digital data from the Indian Remote Sensing Satellite (IRS P6) was utilised, and the same IRS P6 digital data was georeferenced.
2) Next, using the study area shape file and satellite pictures, ARC GIS's arc map software digitises a variety of maps, including land use maps, thematic layers of thetransportation network, water bodies, and village boundaries, using a visual interpretation technique.
3) ArcGIS is used to create a slope map and contour map with a 10 m contour interval using 30 m resolution DEM data.
4)The canal alignment is suggested with particular criteria following the creation of the required theme layers.
5) To identify cross drainges, a layer of rivers and water bodies is superimposed on the suggested canal route.
6) Lastly, canal falls are situated at appropriate chainages along the canal's ground level and bed level in accordance with the canal's design.

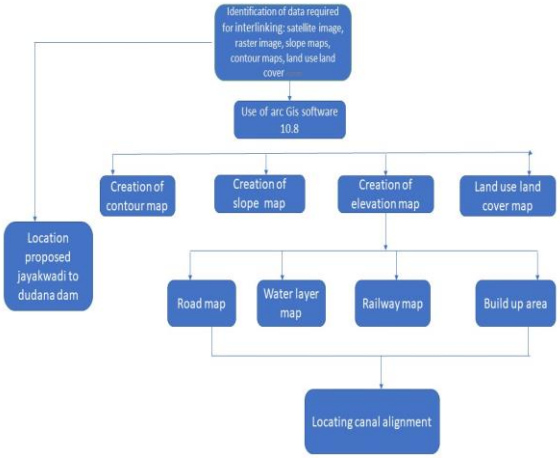

Fig-2 Methodology (Flow Chart)

7. LITERATURE REVIEW

Akruti K Pate, et al (2015) stated that the present study is to deal with the surplus water diversion via canal along with consideration of various ground features, contours and slope of the study area using GIS and Remote Sensing. Location of canal falls and location of cross drainage work is also presented in the present study. Swathi Lakshmi (2014) concluded that interlinking of rivers is one of the best solutions to transfer the surplus flood waters to deficit/drought prone areas. Geospatial modelling provides a holistic approach to generate probable interlinking routes of rivers based on existing geoinformatics tools and technologies. Anupriya, et al(2018) The basic idea behind river interlinking is to provide water in the region which faces worst water scarcity is most part of the year. The concept through which this river interlinking project is undertaken is to divert some water from heavy discharged rivers into dry rivers. Maghrabi, et al (2022) Water scarcity is the major issue faced by the world and it is rapidly rising in India. To overcome this problem many methods have been adopted, interlinking of rivers is one of them. Heena K Kanjani,et al (2016) predicted that for interlinking, consideration of various ground features, contours and slope of the study area is done using GIS and Remote Sensing. The data obtained from thematic maps are integrated that helps in planning of alignment of canal. Selection of alignment for a canal is critical in terms of cost and execution time. Aravinda Bharathi, et al (2014) Canals are also used for interlinking rivers. The digital information on topography, soils type, drainage pattern is obtained from SOI data and the land use/land cover pattern from LISS III image. 1 meter contours were prepared using ASTER DEM image. Rambabu Palaka1 et al (2014) have taken various thematic layers such as watershed, streams, contours are prepared. ArcGIS 10.2 desktop software and Google Maps API is used for data preparation, analysis and planning for canal alignment of feeder canal to Wankamamidi Tank. MARY C. GEORGE , et al stated that The interlinking of rivers is a major endeavor to create additional storage facilities and transfer water from water-surplus regions to more drought-prone areas through inter-basin transfers.

8.DEM (DIGITAL ELEVATION MODEL)

With the aid of the Dem model, which is a basic and essential requirement for making maps, createdtopographic, slope, hill shade, and other terrain maps using DEM.It is an illustration of the different topographical features.
The terrain map, elevation map, and chronological map have all been graphically displayed.Dem map, a fundamental requirement in gis software, is used to construct land use and land cover maps.Aerial photos, Li DAR Detection data, satellite photography, and ground survey measurements are some of the common sources from which DEM data is obtained.A continuous picture of the topography is produced by interpolating the elevation values from several data sources, which record elevation information at multiple locations throughout the Earth's surface.acquired digital elevation data for the region under study.Governmental organisations, satellite imagery suppliers, and Li DAR data providers are just a few of the places where this might be obtained.Make sure the data is in a format that your GIS programme can use.The open topography provided the shape file that was utilized to create the Dem map

HIGH ELEVATION 787.92
LOW ELEVATION 304.862

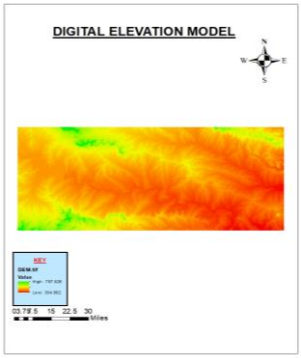

Fig-3 Digital Elevation Model (DEM)

9.CONTOUR

To determine the most appropriate path for water flow by following the contour line, which gave us multiple places at the same elevation. The kind of geology of the land can be determined by examining the contour map's varicose values. Created a contour map with Gees software and utilized it to depict the area's contours. The map displays the counter values about three districts: Jalana, Beed, and Aurangabad. The contour line information is provided by the contour map between Jaykwadi Dam and Dudana Dam of area's 500, 490, 480, 460, 450, 430, and 420 contour layers to ensure a perfect water flow, there are around 50 places of elevation in total.

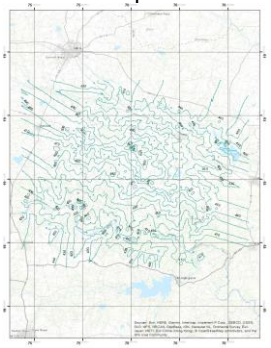

Fig-4 contour map

10.SLOPE

A slope map, sometimes referred to as a slope gradient map or a slope raster, shows how steep or sloping the surface of the terrain is in a certain location. It illustrates the rate at which the topography rises or declines and how elevation varies over the area.

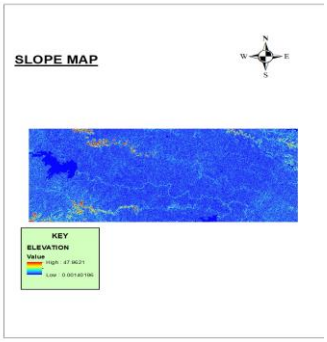

Fig-5 Slope map

11. LAND USE LAND COVER

The data site for downloading land use data is called ESRI Land Use Land Cover, and we have created maps using that data. The activities and uses of land by humans are referred to as land use. Residential neighborhoods, business districts, industrial zones, open spaces, recreational places, transportation infrastructure, woods, and water bodies are some of the categories it encompasses. How people have changed or altered the land to meet different requirements and purposes is referred to as land use.

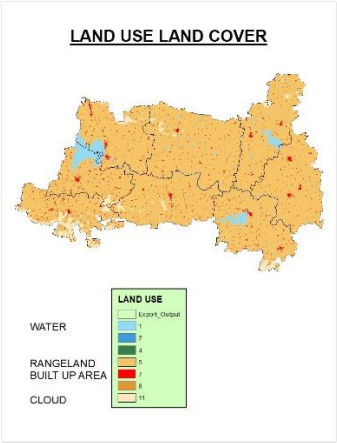

Fig-6 LULC Map

Table -1: Details LULC of study area

L 1	L2	Aurangabad	Bid
Agriculture	Crop land	6665.97	8355.84
	Current Shifting cultivation		
	Fallow	1508.25	499.22
	Plantation	55.83	3.45
Barren/uncultivable/Wastelands	Barren Rocky	17.73	42.77
	Gullied / Ra vinous Land	0.58	
	Ran		
	Salt Affected Land		
	Sandy Area		
	Scrub Land	417.17	1174.50
Built-up	Mining	7.74	6.59
	Rural	97.77	89.07
	Urban	145.89	69.86
Forest	Deciduous	605.68	110.22
	Evergreen/Semi evergreen		
	Forest Plantation		
	Scrub Forest	319.34	107.36

	Swamp / Mangroves		
Grass / Grazing	Grass / Grazing		
Snow and Glacier	Snow and Glacier		
Wet lands / Wate bodies	Inland Wetland		
	Coastal Wetland		
	River/Stream/Canals	73.38	94.78
	Water bodies	297.67	206.35

12.HILL SHADING

Open Topography is a website that offers many kinds of maps and the shape file for any given area. Retrieved the data for our study region from the Diva GIS after downloading the hill shade map from the open topography. added a hill shadow layer to the contour map to improve the way the terrain was visualized. By simulating the effects of light and shadow on the topography, hill shading gives the map a three-dimensional aspect. By adding depth and relief, hill shading can enhance how the contour lines are interpreted.

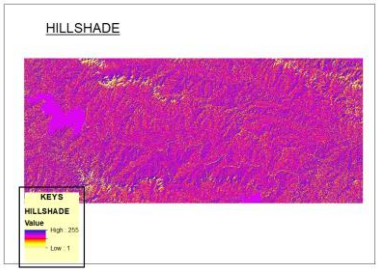

Fig-7 Hill-Shade

13.Water body layer

The distribution and size of various water bodies, including rivers, lakes, ponds, reservoirs, oceans, and other water features, are depicted on a water body map. This map displays lakes and other bodies of water along a canal's path to determine the direction of the water flow and to determine the elevation at which no bodies of water should be present so that as many people as possible might benefit from the canal alignment. Water bodies are represented by water body dams and able to estimate the number of rivers and Nahlas along the route with the use of the water-body map.

Fig-8 Map of Waterbodies

14. ROAD MAP

A road map is a particular kind of map created specially to offer details about transportation routes, road networks, and other relevant elements. It is mostly utilized for planning and navigation, assisting users in getting from one place to another and comprehending how connected the roadways are in a particular area. We used the GIS software to extract the road map so that we could determine how many roads were present in the river's alignment. The road map also helped us determine how many cross drainages we needed to supply in the canal's alignment. The maps for the several roads might be downloaded using Diva GIS. Numerous road types, including expressways, highways, main district roads, and village roads, have appeared along the canal's path.

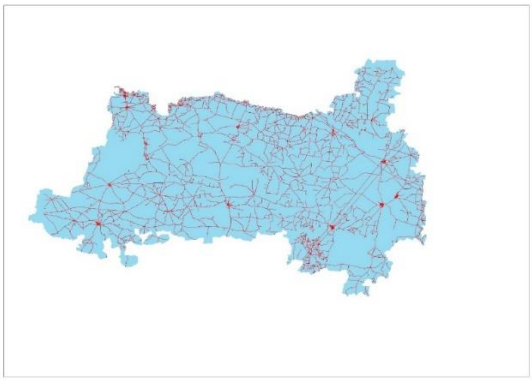

Fig-9 Road Map

15.Road, River, Govt. Land, Water Bodies Map

To give us an indication of the number of barriers on our path, the all the layers of roads, water bodies, and locations into a single map. There are roads throughout the route where drainage is required, and there are some waterways that we must cross.

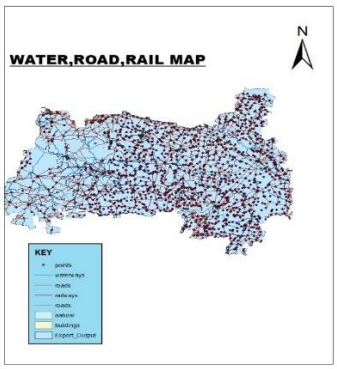

Fig-10 Water, Road & Rail map

16.Alignment of the canal:

After examining every layer in the research region, determined the optimal path for canal alignment. In order to keep costs down during the actual site construction of a canal, the alignment is kept as short as possible. Through Aurangabad, Jalna, Beed, and Sellu, the canal is passing.

The canal's alignment begins at the Paithan and terminates at Sellu. The canal will begin at the Jayakwadi Dam and terminate at the Lower Dudhana Dam. When choosing a canal's route, information about land cover and use is useful. As much as possible, alignment is avoided on government property.

The contour at the beginning of the alignment, which is located at 19°31'7"N 75°22'23" E, is 490 m. From there, we obtained the next point, which is 480 m above sea level. Similarly, we

made the canal alignment course as the rate of elevation values decreased. in order for the water to flow at the speed of gravity.

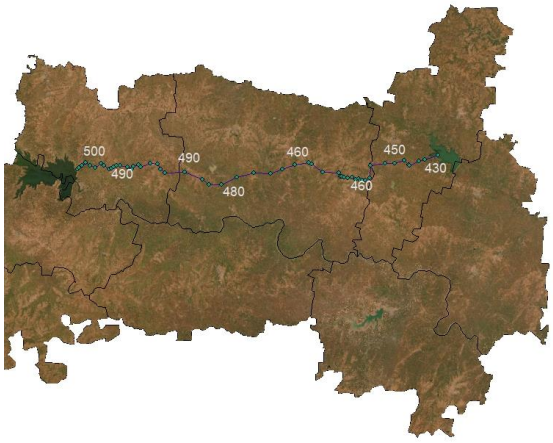

Fig -11 Alignment of Canal

17. RESULT

Obtained height values for several locations along the contour line, including 490, 480, 470, 450and 430, using Gis software. then used those elevation points to determine the best alignme nt that may result in the ideal water flow.
About 84 km separate Jayakwadi and Lower Dudhana Dam, while 105 km separate the canal alignment made with GIS.Sam bhaji Nagar and Jalna are the two districts that the alignment p asses through.There are seven river streams between the canals .The following are the points that have been chosen for the map: There are five main roads along the canal's course. The analysis and planning of canal network system alignment greatly benefits from the use of remote sensing and GIS. The Jayakwadi Dam and the Dudana Dam are in this alignment. This canal's route will supply excess water from the Jayakwadi Dam to the Dudana Dam and then to the Dhatarvadi II Dam.

18. CONCLUSION

Study's findings to determine which regions had the most water accumulation. Compared to areas at higher altitudes, it's likely that areas in low-lying regions actually see less water buildup. Determining how to connect the rivers is made very simple by the horological data of the research region and the individual rivers. Water transportation in low-lying areas is made much easier if there is more water in high-elevation areas. It is necessary to construct appropriate routes on the elevation map. Analyzing the project becomes simple with the path that has been established.
The administrative authorities may find this information particularly helpful in managing the water resources in the study region and in planning the construction of reservoirs, check dams, and percolation tanks to increase the availability of water. Using this programme to analyse such environmental issues is a significant step in the right direction.
On the basis of the GIS investigation, several different solutions have been taken into consideration. Ground contours, drainage, slope, DEM, and other factors were taken into account in the study when choosing the canal alignment. Initially, a projected 84-kilometer canal has been proposed between the Jayakwadi and Dudana dams. Up to the Dudana Dam, the interlinking canal would be roughly 102 km long. The primary function of this canal is gravity. Zones of cutting and filling reaches have also been discovered in the current investigation.

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