Selection of Inter-Linking Canal Alignment from Kadana Dam to Watrak Dam, Gujarat, using Remote Sensing and GIS

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Abstract

The idea of linking water surplus Himalayan Rivers with water scarce parts of western and peninsular India has been done for the past 150 years. Inter basin transfer means linking two or more water bodies, one with surplus water and another with scarce water, by creating a network of manually created canals. The present study deals with the surplus water diversion via canal from Kadana Dam to Watrak Dam, Gujarat. The study area includes two districts namely Panchmahal and Sabarkantha of north-east Gujarat. 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. Several alignments may be possible between the source and destination of a canal, but command area and alignment possible with minimum cutting and filling works based on topography is finalized. Further construction of civil engineering structures are identified to design the new interlink canal from Kadana Dam to Watrak Dam.

Keywords: Canal system, GIS, Remote Sensing, River Interlinking

I. INTRODUCTION

Water is considered as precious natural resource for humans. It is the basic human need and important gift to mankind. River is defined as a fresh naturally flowing water that reaches either an ocean; sea or another river. It is part of hydrological cycle where fresh water is collected from precipitation or surface runoff. River interlinking means linking of two or more rivers by a network of natural or artificially created reservoirs and canals. Basic purpose of interlinking is to control flood in surplus region and supply water to water deficit region. In the present scenario there is great increase in demand for fresh water; thus proper planning is important for judicious utilization of water to create the balance between the availability and demand of water supply. River interlinking is considered as the solution to the two water problems: flood and drought. Further the efficient planning of river interlinking can increase water supply in deficit region which leads to additional irrigation, hydropower generation, domestic and industrial water supply, navigational facilities, etc. The basic criteria for river interlinking is that the surplus water is available in basin is at least after meeting the irrigation needs of 60% of cultivable area in the basin and only this water can be diverted to deficit basin. On the other hand the water deficit basin should have 30% of cultivable area under irrigation.

Rains in the Gujarat are not regular and sufficient to solve the water shortage to solve the water shortage problem which is increasing day by day due to population growth and rapid industrialization and city development. Therefore it is urgent need to properly utilize surface and ground water considering the present and future need. With this objective, the present study has been conducted to propose the interlinking of Kadana and Watrak dam which is at northern part of Gujarat. This region is dependent mainly on canal irrigation.

II. STUDY AREA

The present study focuses on area from kadana dam to watrak dam that covers two districts namely Sabarkantha, Panchmahal and three talukas namely Kadana, Malpur and Khanpur
A. Geography:
Sabarkantha district is situated between 23.03 and 24.30 North Latitude and between 72.43 to 73.39 East longitude. total geographical area of Sabarkantha district is 7390 Sq.Km. Panchmahal is situated between 22° 30’ and 23° 30’ latitudes and 73° 15’ and 74° 30’ longitudes. The total area of Panchmahal district is 5210 sq km

B. Climate:
The climate in Sabarkantha is marked with large variation in temperature from 8 °C to 48°C with an average rain fall for 690 mm in the Sabarkantha district. Panchmahal district comes under heavy rainfall areas in Gujarat, having sub-tropical climate with moderately low humidity.

C. Geology:
The proposed area is passing through metamorphic phylite, schist, Quartzite, rocks of oldest of aravali group. These rocks are folded faulted and sheared at places. The area is covered with their layer of soil in general and thick alluvium in river valley section.

D. Soil:
The soil type of the canal is loamy. Hence the slope ratio as per IS standard for loamy type soil is adopted to meet the cutting and filling of soil.

III. DATA COLLECTION AND DATA GENERATION

A. Data Collection:
Satellite (IRS P-6) LISS-III image data and Geo spatial data like Land Use map are obtained from Bhaskaracharya Institute for Space Application and Geo-Informatics, (BISAG), Gandhinagar, Gujrat, India. Hydrological data like water use data, overflow data and available storage data Irrigation Department.
**B. Data Generation:**

The digital elevation model (DEM) and IRS-P6 LISS-III digital data were used for data generation. From this DEM data contour of 10m intervals and Slope Map was generated. Also thematic maps like river-body map and geology were generated

**IV. METHODOLOGY**

1) Indian Remote Sensing Satellite (IRS P-6) LISS-III digital data were geo-referenced for thematic map development.
2) Thematic layers were developed with the use of Arc Map software of ARC GIS by using visual interpretation technique.
3) Contour map with 10m contour interval and slope map using DEM data with 30m resolution were generated.
4) Canal alignment was proposed with specific criteria based on I.S. code of lined canal.
5) Three alignments were proposed out of which final alignment was identified.
6) The detailed sections of final canal were studied to identify topography and geology using Google Earth.
7) Layer of water bodies and rivers were overlaid on proposed canal alignment to locate cross drainage structure.
8) Identification of ridges was done requiring different structures along the canal.

**V. ALIGNMENT OF CANAL**

To establish a suitable alignment from source to destination various features on earth surface like rivers, lakes, forests, roads, railways, in the given area have been considered. For alignment of canal some of the basic criteria were followed as below:

1) Depending on slope and contour, the alignment of canal was selected in such a way that flow of water is gravity flow and no pumping is required as far as possible.
2) Populated and built up areas have been avoided.
3) The area selected has minimum cutting and filling operations which reduce the cost of the project.
4) As far as possible, diversion of surplus water has been done through the natural drainage so that minimum land acquisitions are required.
5) The alignment has been provided in such a way that the canal crosses the natural stream or reservoir at its narrowest point in the vicinity so that it can feed them if there is any future requirement.

**VI. PROPOSED CANAL ALIGNMENTS**

Three alignments of canal are studied based on hydrology, geology, and land use out of which one is selected as most suitable alignment based on topographic conditions and satisfying the criteria of canal alignment.

**A. Canal Alignment 1:**

The canal alignment was proposed between Kadana Dam to Watrak Dam. The alignment starts at weir cross drainage and ends at Watrak dam. This alignment avoids all the hilly regions as shown in dark red regions of LISS-3 image. It covers 3 talukas namely Kadana, Malpur and Khanpur.

1) **Limitations:**

   This alignment starts at a lower level at Kadana and ends at higher level at watrak dam. Therefore pumping is required at two points to connect the link. So this alignment is not selected.
Fig. 2: Alignment 1.

B. Canal Alignment: 2

The alignment starts at weir cross drainage and ends at Watrak dam. This alignment avoids all the hilly regions as shown in dark red regions of LISS-3 image. It covers 3 talukas namely Kadana, Malpur and Khanpur. Limitations: The FRL of Kadana is at lower level than FRL of Watrak dam. So pumping is required. But in this alignment pumping is required twice looking at the topography. Also major roads and rivers are crossed at given alignment. Thus this alignment is not appropriate as per given topography.

Fig. 3: Alignment 2
C. Canal Alignment 3:
The canal from kadana to bhadar is a gravity canal and after bhadar dam, water is pumped to Watrak dam. It crosses major roads at two crossings.

1) Advantages:
Entire alignment is designed as per the contours and topography of the study area. The soil type of the canal is loamy. Hence the slope ratio as per IS standard is adopted to meet the cutting and filling of soil. As per criteria of canal alignment, the alignment does not crosses any buildup area or city center.

VII. Detailed sections of final alignment

A. Section 1:
This section starts at 00 to 5km horizontal distance from Kadana dam. It crosses sujalam sufalam canal at chainage of 0.7km and hence cross drainage work is provided at that point. At chainage of 1km a major road crosses the canal. Hence a over bridge needs to be constructed at that crossing point. Both cross drainage and overbridge at the chainage line are shown in fig:5. Also at alignment between 2 to 4 km is constructed as per contour but contour is neglected at some points to avoid the cross drainage works.
B. **Section: 2**
This section starts at 5km to 10km horizontal distance from Kadana dam. It crosses river at chainage and hence cross drainage work is provided at that two points. Both cross drainage for alignment line are shown in fig. Also at alignment between 5km to 10 km is constructed as per contour but contour is neglected at some points to avoid the cross drainage works.

C. **Section: 3**
This section starts at 10 to 14km horizontal distance from Kadana dam. It crosses sujalam sufalam canal at chainage of 13 km and hence cross drainage work is provided at that point. At chainage of 10km a major road crosses the canal. Hence a over bridge needs to be constructed at that crossing point. Both cross drainage and overbridge at the chainage line are shown.

D. **Cutting and Filling in Canal:**
The soil type of the canal is loamy. Hence the slope ratio as per IS standard is adopted to meet the cutting and filling of soil
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Fig. 8: Cutting and Filling in Canal

VIII. RESULT AND CONCLUSION

The detailed study of hydrology, topography and land use pattern of the area between Kadana dam and Watrak dam has been carried for the selection of suitable interlinking canal to transfer surplus water from the Kadana dam to Watrak dam through Bhadar dam. Various alternative proposals have been considered based on the GIS study considering economy, suitability and land use requirement. While selecting the canal alignment, ground contours, drainage, civil engineering structures such as roads, bridges, etc. have been considered in the study. Initially canal between Kadana and Bhadar dams of approximately 14 km length has been proposed. Total length of interlinking canal up to Watrak dam would be approximately is 38 km. This canal is mainly gravity canal passing through loamy soil having gentle to hilly areas. In the present study zones of cutting and filling reaches have also been identified.

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