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Identification of Suitable Locations for Mini Hydal Power Plants Using Geomatics

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Abstract

Power is a very important infrastructure of the overall development of a nation. It is the basic input for the industrial and economic growth of the country. Hydropower is a key energy resource for power generation. India is blessed with immense amount of hydro-electric potential. The natural topography of the country like India, with large number of rivers and streams provides excellent opportunities to harness the energy stored in flowing waters.

In 1998, Government of India announced "Policy on Hydro Power Development" under which impetus is given to development of hydropower in the country. This was a welcome step towards effective utilization of our water resources in the direction of hydropower development.

The Optimum utilization of water resources plays a vital role in the development of country's economy. India is well endowed with rainfall and is one of the wettest countries in the world with annual precipitation estimated to be around 400 millions hectare-meters.

All the power generation projects have to be justified from the point of view of power requirement, technical feasibility, economic justification and environmental impact.

Introduction

Hydro Power: Hydro power is energy that comes from the force of moving water.

Geomatics: Geomatics is a field of activities which, using a systemic approach, integrates all the means used to acquire and manage spatial data required as part of scientific, administrative, legal and technical operations involved in the process of the production and management of spatial information. Geomatics is the modern scientific term referring to the integrated approach of measurement, analysis, management, storage and display of the descriptions and location of earth-based data, often termed spatial data. The advantages of GIS system is that, it is a systematical storage of existing data, integration of factors such as elevation data, stream network, rainfall data, electricity grid, forest and other reservations with the system, enabling suitability analysis through applications of multi-criteria overlay techniques.

Objectives of the study:

To meet the above requirements, this study is undertaken with the following objectives.

1. To prepare various maps such as Mandal and Village boundaries map, Contour and Digital Elevation Model (DEM) map, Satellite image map, Base map, Soil map, Land use Land cover map and Drainage map in GIS environment.
2. To prepare the longitudinal profile with elevation, latitude and longitude data base.
3. To identify suitable locations for small hydropower plants using Geomatics.

In the present study, various GIS and Remote sensing (RS) techniques are used for identifying the suitable locations for small hydropower stations along the major distributory D-83 canal, of Kakatiya main canal i.e. Sriramsagar right bank canal system on Godavari river basin, Andhra Pradesh, India,

The work involves the use of Remote sensing and GIS through generation of thematic maps. The task of suitable site identification for small hydropower stations is done by integrating multi-source geo-referenced data sets in a GIS platform. The final output comprises the identification various locations of sites suitable for hydropower generation which will go a long way in quick and scientifically based decision making process.

Study Area

Andhra Pradesh is one of States of India. D-83, a major distributor, constructed during the year 1973-1983, takes off from main canal at km 116. Project falls in the region of Godavari river basin area. The distributory has a discharge capacity of 75 cumecs, at its off take and benefits the area of 1, 64,000 Ha, through the minors constructed at required locations.

The distributor also provides water supply through a minor distributory at km 35.774 for Ultra Thermal Power plant of N.T.P.C located at Ramgundam town. The D-83 distributor receives water from Kakatiya Canal, which a right bank main canal drawing water from dam on river Godavari to meet irrigation demand. The total length of D-83 canal is 44.075 kms takes off from main canal and finally joining in Gundaram reservoir. The canal providing Irrigation facilities through the minors constructed, to the villages of Ravalli, Beerumrajupalli, Ragampet, Mallampur, Lambadipally, Kummarikunta, Turka maddikunta, Gollapally, Kachapur, Rangapur, Sabbitam of Choppadandi, Dharmaram, Julapalle and Peddapally mandals of Karimnagar district.

Location map of the study area: The study area is falling in Karimnagar district of Andhra Pradesh, India. The location map of the study area has been prepared from administrative boundary map of India, Andhra Pradesh and Karimnagar district as shown in Fig. 1.

The water flow is available in the canal for a period of 10 months in a year i.e from July to April to provide water for Khariff and Rubby crop seasons. The canal is lined on bottom and both side slopes up to 1 m height above of Full Supply Depth (FSD) with cement concrete of 75 mm thick of M10 grade with a bed width of 16 m at bottom and 28 m at top and with side slopes of 2:1. Full supply depth of the canal is 2.70 m with a bed fall ranging from 1 in 7000 to 1 in 8000.The irrigation on D-83 Canal is yet to be fully established and study shows that inflows in canal have increasing. The capacity of Canal is about 75 cumecs, but present only about 55 to 45 cumecs are released. With time, inflow may get established on higher side.

Methodology

The topographic maps are used namely 56 N/2 and 56 N/6 on a scale of 1:50,000 were collected from Survey of India (SOI), Uppal, Hyderabad for the delineation of study area of canal path.The collected topographic sheets were scanned and registered with tic points and rectified in Arc map of Arc GIS 9.3. Further, the rectified maps were projected and merged together as a single layer. The study area of canal path was delineated in GIS environment.

Satellite image map of study area: the Satellite image map of the study area has been prepared by overlapping the study area with image of Indian Remote Sensing Satellite (IRS) – P6, Linear Imaging and Self Scanning Sensor (LISS – IV) with a resolution of 23.5m as shown in Fig 2.

Soil map: The soil maps were collected from National Bureau of Soil Survey and Land Use, Nagpur which were prepared on a scale of 1:50,000. The collected soil maps are scanned and registered with tic points and rectified. Further, the rectified maps are projected. All individual projected maps are finally merged as a single layer, later, the delineated study area map of D- 83 canal is overlaid on projected soil map and finally, soil map pertaining to the study area was thus extracted in GIS environment. Boundaries of different soil textures are digitized in ARC/INFO and the polygons representing soil classes are assigned different colours for reorganization of hydrologic soil groups. Fig .3 depicts the classification of soils in each sub area.

Base map: Base map with road net work, settlements and tanks within the buffer are generated in GIS environment. Drainage map with streams and tanks within the buffer are generated in GIS environment. Soil map with type of soils within the buffer are generated in GIS environment as shown in Fig 4.

Digital Elevation Model (DEM) map: Contours are polylines that connect points of equal value of elevation. The elevation points are prepared from toposheets 56 N/2 and 56 N/6 on a scale of 1:50,000 collected from Survey of India (SOI), Hyderabad. The collected topo sheets are scanned and registered with tic points and rectified. Further, the rectified maps are projected. All individual projected maps were finally merged as a single layer. The contours are digitized with an interval of 2 m. The contour attribute table contains an elevation attribute for each contour polylines. The contour map was prepared using Arc map of Arc GIS 9.1 and shown in Fig 5. Contour map is a useful surface representation because they enable to simultaneously visualize flat and steep areas, ridges, valleys in the study area.

Land use / Land cover map: Spatial data in the form of satellite imageries for the preparation of Land Use/Land Cover details at sub basin level are procured from National Remote Sensing Centre (NRSC). These satellite imageries for both Khariff and Rabi seasons for two years pertain to Indian Remote Sensing Satellite (IRS) –P6, Linear Imaging and Self Scanning Sensor (LISS –IV) with a resolution of 23.5m.

The collected satellite image is geo referenced in ERDAS 8.7 then rectified and finally projected. The delineated study area in vector form is overlaid on projected satellite imagery to get sub set of the study area. Normalized Difference Vegetation Index (NDVI) was employed as the basis for Land Use / Land Cover classification. This method of classification has been found to be suitable for the study area i.e., D-83 Canal as the data used is pertaining to the past period i.e., years 2000 and 2002 and also the study area is considerably large comprising predominantly of fertile lands as shown in Fig 6. Land use and land cover map with head locations are represented in Fig. 7.0

Power generation capacity: Power generation capacities have been calculated by using Power equation P (kWh) = Head x Discharge x gravity of flow at each head location of the total length of the canal considering discharge available at that particular head location.

Results & Discussions

Identification of suitable locations for small hydro power plants using Geomatics

Analysis to select suitable locations for small hydro power plants along the D-83 branch canal has been elaborated and discussed in this section. Amount of head and discharge calculations are required for hydro power plants. Discharge and head are deciding factors for power generation output calculations. Based on head available, the amount of power generation is calculated in Kilo watt hour (kWh).

The canal path is digitized by using Arc GIS 9.2 version and the path is converted to image by using RS image. A buffer of 1 km on either side of canal is created. Contours of 2m interval are generated using Arc GIS 9.2 version. Soil group particulars map, Drainage map, Base map are generated.

Longitudinal profile of canal: The canal location and alignment is identified on the Google Earth and longitudinal profile of the canal with elevation, latitude and longitude at every 50 m intervals is found for total length of the canal and also shown in Fig. 8, the graphical representation as chainage vs canal longitudinal profile

Power generation capacity calculations at identified locations: Power generation capacities are calculated by using power equation at each head location of the total length of the canal considering discharge available at that particular head location and gravity of flow is taken as 9.81 m/sec: Thus the power generation capacity is calculated by using Power equation P (kWh) = Head x Discharge x gravity of flow, at location of km 9.488 with available head of 3.048 m and available theoretical discharge of 59.00 cumecs and the capacity found is 1,764 kWh. Based on above power calculations small hydropower plants can be proposed with installation capacity of 1,764 kWh. In the similar manner the power generation is calculated at each head location along the total length of the canal with available discharge and also shown in the graphical representation, taking Location vs Power generation capacities in Fig. 9.

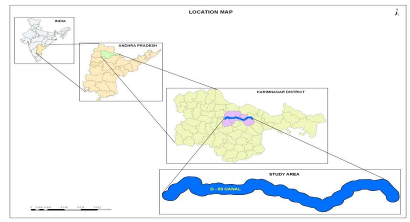

Fig. 1 : Study area

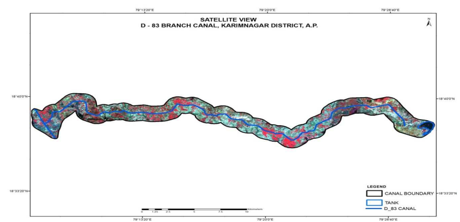

Fig. 2 Study area on Satellite imagery

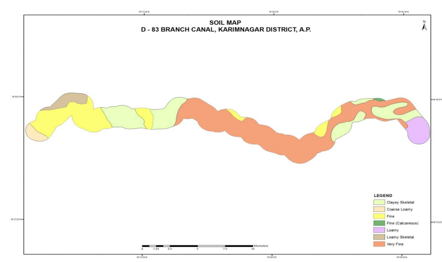

Fig. 3 Soil Map

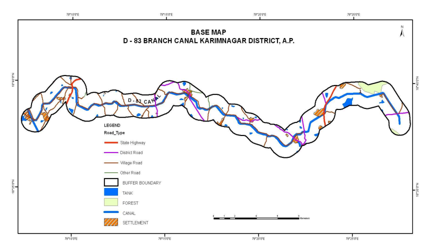

Fig.4 Base Map

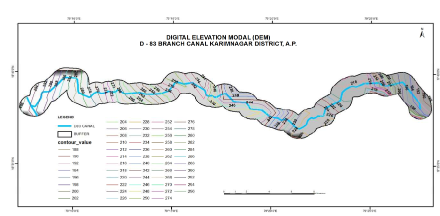

Fig 4.8 Digital Elevation Model (DEM) map of D-83 Branch canal

Fig.5 DEM Map

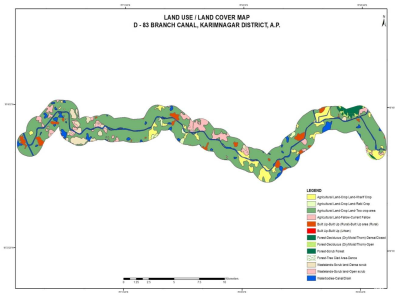

Fig.6 Land Use/ Land Cover Map

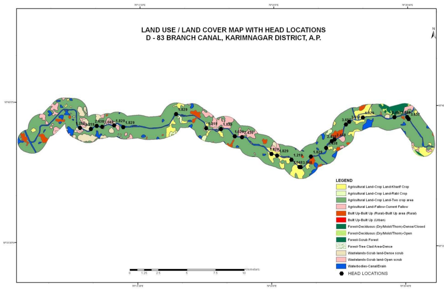

Fig. 7 Land Use/ Land Cover Map With Head locations

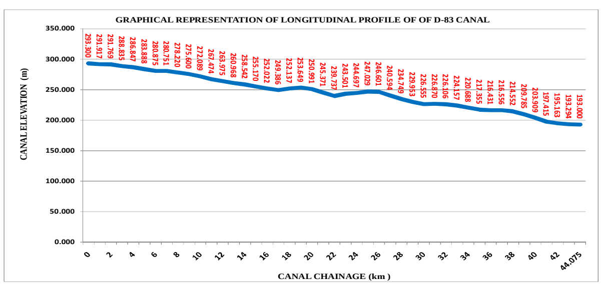

Fig. 8 Longitudinal profile of Canal

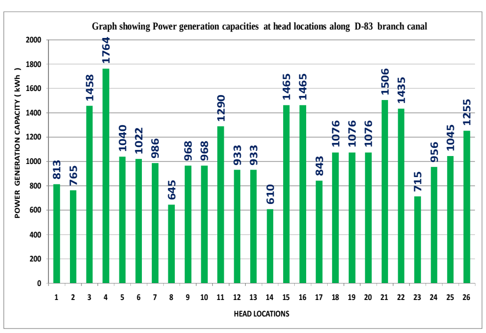

Fig 5.6 Power generation capacities at head locations of D-83 branch canal

Fig.9 Power generation capacity at head locations

Conclusions

The specific conclusions drawn from the present study are as follows

1. The total length of the D-83 branch canal has been found to be 44.075 km in GIS environment.
2. From the longitudinal profile data base for the total length of the canal at every 50 m interval prepared, using Remote sensing technique, 26 locations have been identified along the total length of the D-83 canal and the heads are found to be 1.219m head at 4 locations, 1.829m head at 9 locations, 2.438m head at 6 locations, 3.048m heads at 4 locations and 3.657m heads at 3 locations.
3. Soil map with type of soils groups present within the buffer has been generated in GIS environment. The soil groups at all identified head locations have been studied with help of soil map. The predominant soil group has been found to be Very fine loamy skeletal with 40.799 sq.kms area with 44.92 % of the total area and the least coverage of soil group is found to be Fine calcareous with 0.223 sq. km with 0.25% of the total area.
4. Land Use and Land Cover (LULC) map of the canal buffer area with details of lands of agriculture, forest, built up, waste lands, and water bodies present has generated in GIS environment. The predominant land use land cover has been found to be Agricultural land with 76.24 sq. km area with 83.95 % of the total area and the least land use land cover has been found to be Forest area with 1.95 sq. km with 2.15 % of the total area. The Built up area is found to be with 2.98 sq.kms area with 3.28% of the total area.
5. Base map with road net work, settlements and tanks within the buffer are generated in GIS environment. Drainage map with streams and tanks within the buffer are generated in GIS environment and this analysis is used to identification of suitable locations. The facilities available like road network, nearby settlement details are studied at head locations identified.
6. Power generation capacities using power output equation have been calculated, at 26 identified suitable locations. The power generation capacity is found to be maximum 1764 kWh at 9.488 km with head of 3.048m, and minimum, 610 kWh at km 28.309 with a head of 1.219m and total power generation capacity at all locations is found to be 28,108 kWh.

By taking all the above specific conclusions into consideration, it is finally concluded that the twenty six identified locations are found to be suitable for small hydropower plants by using geomatics. These twenty six locations identified through this study for setting up small hydropower plants will go a long way to meet the energy demand in addition to the already existing six hydropower plants by the state government of Andhra Pradesh.

References

[1] M.M. Dandekar and K.N.Sharma "Water Power Engineering " , 1979

[2] M.K.R Menon M.K.R (1973) "Hydropower Development in India" , Journal of Hydro power, Vol 9: 15-17

[3] Suri L.R(1983) " Hydro power planning in India" , Journal of Hydro power, Vol 29: 30-34

[4] Ashok Kumar Sinha Dr.(2000) "Small hydro plants", Journal of Hydro power, Vol 53: 42-45

[5] Scott Davies " Clean power from water" , 1978

[6] Adam Harvey " A guide to small scale water power schemes", 1978

[7] Jeremy Thake " Installation of small scale hydro power schemes", 1976

[8] F. Forouzbakhsh " Investment analysis of small hydro power plants", 1972

[9] Ministry of power, Government of India 2010 (www.powermin.nic.in)

[10] Sectoral Overview Report on Hydropower Development in India, AHEC, IIT Roorkie, February 2007.

[11] Central Electricity Authority: Power Scenario at a Glance, Central electricity Authority, New Delhi, April 2010.

[12] The Energy & Research Institute (TERI)

[13] India Ministry of Non- conventional Energy Sources (MNES)

[14] National Hydro Power Corporation (NHPC)

[15] Alternate Hydro energy centre IIT, Roorkie, Uttaranchal state, India

[16] A guide to small scale water power schemes – by Adam Harvey

[17] M. ANJI REDDY "Remote sensing and Geographical Information Systems",1997

[18] ARC GIS 9.1 manual

[19] Images from www.googleearth.com.