International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 10, October 2017
www.ijarse.com
IJARSE
ISSN 2319 - 8354

PLANNING AND DESIGNING OF CHECK DAM USING ADVANCED TOOLS (GIS) NEAR KANDALI VILLAGE

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ABSTRACT

In the countries like India, Conservation of water is very necessary because of problems like water shortage, aridity and depletion in ground water in many places due to poor rainfall rate. The best solution for these problems is to construct water detention structure at nearby locality.

The present project aims at constructing micro water shed as a check dam near Kandali village of Hassan district, for the supply of water for domestic purpose and to the K.I.A.D.B Industrial area, N.D.R.K Institute of Technology (N.D.R.K.I.T) and to the area surrounding it.

The study such as Demand, Location, Rainfall data has been conducted.

The study reveals that 0.026TMC of water demand required for surrounding villages. The Yagachi catchment is getting 17TMC of annual storm water. For efficient usage of this excess water, the one possible way is to construct a micro water shed in the form of check dam at a suitable site.

For selection of dam site, an advanced tools were utilized such like Geographic Information System (GIS), Google earth etc. Several possible dam locations were selected using toposheets and Digital Elevation Model (DEM) data and the Capacity of each location were calculated separately.

Along with the Software, an onsite study was conducted for higher accuracy in dam position Using Total Station.

By using all the above data, paper works were carried with an analysis to compare the different site and to get an Economical Site with optimum usage. Then the best possible location was obtained for dam construction near Bylahalli at upstream side of Railway Bridge over Yagachi River.

Keywords: Digital Elevation Model (DEM); Geographic Information System (GIS), Toposheets, Total Station, Yagachi River.

I. INTRODUCTION

The present project aims to plan supply of water for drinking and industrial use for the Narayani D R Karigowda Institute of Technology (NDRKIT) and some nearby (KIADB) industries in and around Kandali and Thimmanahalli. NDRKIT is located on the bank of river Yagachi which is the tributary of river Hemavathi. As part of planning a water supply project, proposed a composite dam across the river. To propose the dam, preliminary investigation is carried out using topographic sheets and Google earth. Further to identify the suitable location, there are 36 possible location are considered to choose best location in terms of maximum

storage and minimum investment. For each location 0.5 meter interval capacity contours are generated in GIS platform using Digital Elevation Model (DEM) data. Finally location near Bylahalli towards the upstream of Railway Bridge is selected.

II. LITERATURE REVIEW

Adushandi and Alatawi (2015) carried out investigation to plane a dam near the tabuk city of Saudi Arabia. In the investigation, remote sensing and GIS tool was used, for the delineation of the watershed boundary Advanced Specborne Thermal Emission and Reflection Radiometer (ASTER) DEM was considered. There are six location are verified and estimated the runoff coefficient.

Awomeso, Ufoegbune (2009) have discussed the basic planning flaws and errors which include hydrologic, environmental and social factors. The authors carried out research on proper planning, design and monitoring of Nigerian dams, to prevent dam failure and reservoir siltation. They carried out a detailed comprehensive study of all old dams (i.e. $\geq$ 20 years).

Dorfeshan, Heidarnejad and others (2014) studied criteria such as Decline, hydraulic conductivity, effective porosity and foundation permeability and economic factors for selecting the dam site near Andika region of Iran. Out of 27 locations, 15 locations were considered for determining the final dam site. Arc GIS and geological maps prepared by NIOPDC, satellite images, Digital Elevation Map of the area, weather information and maps at scale of 1:25000 prepared by the Iranians National Cartographic Center (NCC) were used to select the dam site.

Xinyi Dai (2016) has discussed criteria for selection of dam site in Bortala, Northwest china. Dam site was selected based on Analytical Hierarchy process (AHP) using Geographic information system (GIS). This study considered Precipitation, slope, geological layer, soil type, land cover drainage, as criteria for dam site selection. Toposheet was generated and using this 8 highly suitable dam sites were proposed.

III. SOFTWARES AND INSTRUMENTS USED FOR THE PROJECT

3.1 Arc G.I.S.:

Geographic Information System (GIS) is map preparation software to represents the geographic information in different layer. It is used for creating and use of maps from different source of data, compiling geographic data, analyzing mapped information, sharing and discovering geographic information, using maps and geographic information in a range of applications, and managing geographic information in a database.

The system provides an infrastructure for making maps and geographic information available throughout an organization, across a community, and openly on the Web.

3.2 Google Earth:

Google Earth is a geobrowser that accesses satellite and aerial imagery, ocean bathymetry, and other geographic data over the internet to represent the Earth as a three-dimensional globe. Geobrowsers are alternatively known as virtual globes or Earth browsers. Google also refers to Google Earth as a "geographic browser." Other examples of geobrowsers are NASA's World Wind, ESRI's ArcGIS Explorer, GeoFusions's GeoPlayer, and EarthBrowser by Lunar Software. Google Earth is available on the web for free as well for purchase in more

advanced versions. While the free version offers numerous features that are useful in educational settings, the Pro version offers additional capabilities such as higher resolution printing and saving of images and the ability to open ESRI shapefiles. The free version of Google Earth as well as Pro are available through Google's Explore, Search, and Discover page.

3.3 Total Station:

A total station or TST (total station theodolite) is an electronic/optical instrument used in modern surveying and building construction. The total station is an electronic theodolite (transit) integrated with an electronic distance measurement (EDM) to read slope distances from the instrument to a particular point, and an on-board computer to collect data and perform advanced coordinate based calculations.

Robotic total stations allow the operator to control the instrument from a distance via remote control. This eliminates the need for an assistant staff member as the operator holds the reflector and controls the total station from the observed point.

IV. DESCRIPTION OF STUDY AREA

The proposed Check Dam site is located near Kandali village in Hassan District. It is located between 13^0 02' 04.41"North Latitude and 75^0 58'49.47" East Longitude. Dam site is located in Alur taluk of Hassan district. It is considered as one of the semiarid zone with mean annual rainfall about 1044.5 mm for the last hundred and eleven years, in that duration

The surrounding villages having a population of about 9000[Including Institutions and Factories near Thimmanahalli Industrial area].Agriculture is the main activity in the surrounding villages and also developed 59.25 acres of Industrial area.

Dam location is lies in the Yagachi River basin and is the only source of water for the area and hence check dam is proposed to construct near by the Bylahally, which located upstream of the railway bridge across the river Yagachi. The river Yagachi originates at Thotadappanagiri in the Western Ghats near the city of Chickmagaluru and riverflows through Belur Taluka of Hassan District, finally it confluences in the back water of Hemavathi reservoir. Yagachi river is the main tributary of the Hemavati River, further it is tributary of Cauvery river which is the one of the major river basin of India.

V.CRITERIA FOR SELECTION OF DAM SITE

Dam types can be classified in different categories according to the materials used in construction and how they withstand the thrust of water:

- Homogeneous drained earth fill dams, either zoned or with a man-made
- Impervious element;
- Gravity dams, whether concrete or RCC;
- Arch dams;
- Buttress or multiple arch dams (not dealt with here).

Fill dams are flexible structures while the other types are rigid.

5.1 Parameters for Dam site

The main parameters to be taken into account in choosing a dam site and typeare the following:

- Topography
- Geology and Foundation Conditions
- Availability of materials
- Spillway size and location
- Earthquake zone
- Height of the Dam
- Other factors such as cost of construction and maintenance, life of dam, aesthetics etc.

5.2 Conclusions on selecting a type of dam

The choice of a type of dam is imposed by natural conditions in many cases, with no need for in-depth investigations. For example, if the rock substratum is at a depth of more than 5 metres, the only reasonable alternative will be a fill dam, at least for any project less than 25 metres high. In some regions, the geological context is such that only one type of dam is usually built. In other cases, the choice of dam type will be a compromise between different aspects and types of foundation, availability of materials in the vicinity, hydrology - to arriveat the best option economically speaking. However, it is always an advantage to make a decision as quickly as possible, as a rule after the feasibility studies.

VI. DEMAND STUDY

The demand of water can be found on the basis of daily requirement of water by following categories

a) Domestic,

b) Institutional,

c) Industrial

d) Public,

e) Agricultural, and

f) Compensation of losses.

S. No.	Institutions	Liters per head per day
1.	Hospital (including laundry)	
	(a) No. of beds exceeding 100	450 (per bed)
	(b) No. of beds not exceeding 100	340 (per bed
2.	Hotels	180 (per bed)
3.	Hostels	135
4.	Nurses homes and medical quarters	135
5.	Boarding schools / colleges	135
6.	Restaurants	70 (per seat)
7.	Air ports and sea ports	10
8.	Junction Stations and intermediate stations where mail or express stoppage (both railways and bus stations) is provided	70
9.	Terminal station	45
10.	Intermediate stations (excluding mail and express stops)	45 (could be reduced to 25 where bathing facilities are not provided)
11.	Day schools/ colleges	45
12.	Offices	45
13.	Factories	45 (could be reduced to 25 where bathing facilities are not provided)
14.	Cinema, concert halls and theatres	15

Source: Manual on Water Supply and Treatment: III Edition (1999)

Table 1: Showing demand of water for various Institutions

Table 2: Showing demand of water for various industries

VII. HYDROLOGICAL AND GEOLOGICAL STUDY

After knowing the demand of water required for the area to be served, it is a must to know the quantity of storm water from the catchment area.

7.1 Quantity of storm water:

1. Rational Method

2. Empirical formulae method

In both the above methods, the quantity of storm water is considered as function of intensity of rainfall, coefficient of runoff and area of catchment.

7.1.1Rational method:

Storm water quantity can be estimated by rational method as below:

Storm water quantity, Q = C.I.A / 360

Where,

Q = Quantity of storm water, m3/sec

C = Coefficient of runoff

I = intensity of rainfall (mm/hour) for the duration equal to time of concentration, and

A = Drainage area in hectares

OR

Q=0.278C.I.A

Where, Q is m3/sec;

I is mm/hour, and A is area in square kilometre

7.1.2 Empirical Formulae:

Empirical formulae are used for determination of runoff from very large area. Various empirical relationships are developed based on the past observations on specific site conditions suiting a particular region. These empirical formulae can be used for prediction of storm water runoff for that particular catchment.

A] Burkli – Zeiglar formula

$$Q= \frac{C.I.A}{141.58}\sqrt[4]{S/A}$$

B] Mc Math formula (used in USA)

$$Q= \frac{C.I.A}{148.35}\sqrt[4]{S/A}$$

VIII. ENGINEERING SURVEY

The survey work includes:

- Reconnaissance of the sites & preliminary investigation.
- Selection of the Dam site.(Includes Capacity survey).
- Alignment of centre line of the proposed bund.
- Longitudinal & cross sections of the centre line.

} Area survey

8.1 Reconnaissance of the sites & preliminary investigation.

A reconnaissance survey is conducted to identify the location, observing for the following points.

using below steps(using GIS)

1. Selecting the catchment basin for the check Dam location to be constructed.
2. Selecting different check dam locations along the river stream.
3. Calculation of quantity of water for different locations.(Capacity survey)
4. Choosing the best site based on the quatity of water stored in that location, length of the bund, and Height of the check dam.

8.2.1 Catchment basin

The catchment basin is selected around the dam location using GIS software

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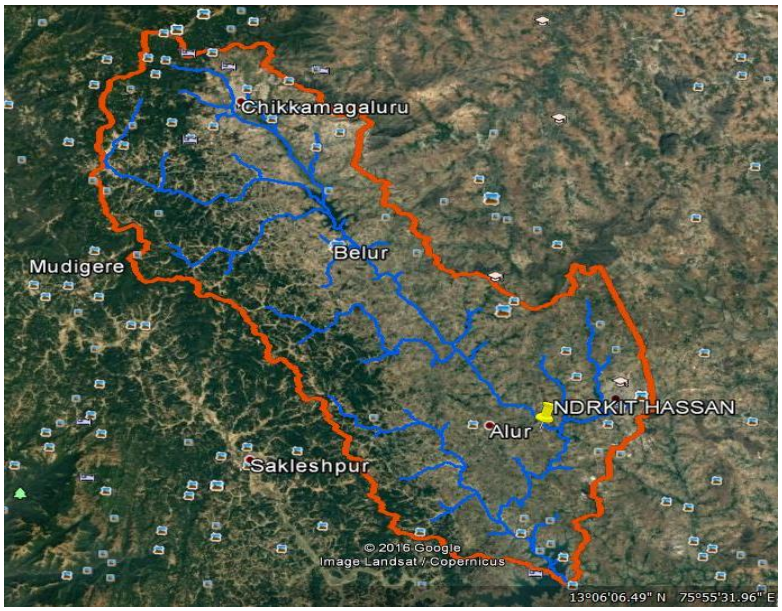

Fig 1: NDRKIT is marked with inYagachi river basin

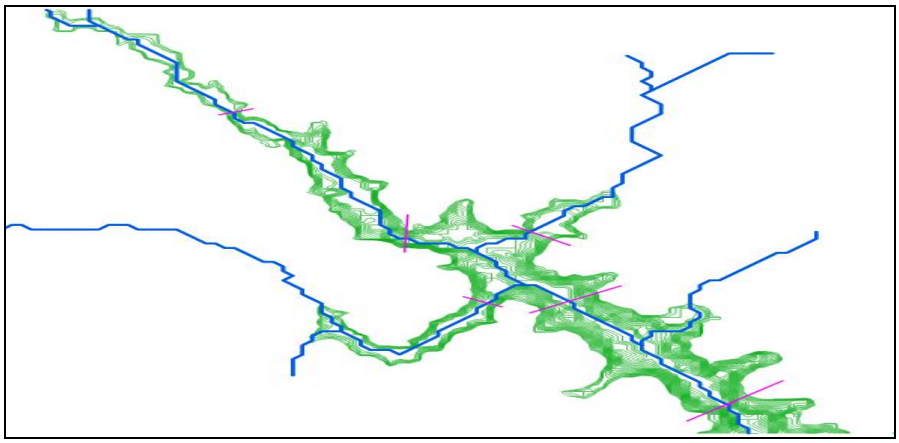

Fig 2: Contour map of the study area to estimate the capacity of different locations

- Different Bund locations are selected based on the contours patterns along the river stream (i.e. wherever we get valley locations)
- Pink coloured line indicates the different bund locations
- Green coloured lines are the contour lines
- Blue coloured line indicate the river path

8.2.2 Calculation of quantity of water or Capacity survey:

It is done by calculating the average area of contours and multiplying them with the contour intervals. Here in our case we have taken 0.5m contour interval.

The steps included are as follows:

- Generating the contours of 0.5 m intervals for the catchment areausing GIS software tools.
- Then the generated contours are then converted to Auto cad file extensions having same scale as in GIS.

- The different locations are selected based on ground profile i.e valley conditions by looking at the contour patterns.
- The first location is chosen and the area of each contour is calculated by using Auto cad.
- Then all the areas are tabulated in excel worksheet.
- Then the average areas are calculated.
- The average areas are multiplied with the successive contour intervals to get the volume of water for respective contour depths.
- The volume of water of the particular location is obtained by adding all the volumes.
- Similarly Volume of water or the Capacity of water for all the locations are calculated and Tabulated.
- Then the table containing capacity of water for all locations, Demand, their bund lengths and Heights.
- The dam site location is selected based on following points.
  - The site which gives minimum length of the Dam.
  - The location where Dam Height is minimum.
  - The location where storage capacity of the dam is more.
  - The location where the volume of earth material used for filling of the dam is less
- The field survey is conducted to get Longitudinal and cross sections of the check dam.

8.3 Area survey

After selecting the Dam site, next part of the work is to conduct the field survey to know the ground levels along the check dam. It includes taking the Reduced levels of the check dam along alignment of the dam at regular intervals i.e along the Longitudinal section as well as the cross sections of the dam

The longitudinal and cross section of the bund line were done using

- Total station
- Chain
- Tape
- Ranging rod
- Arrows

RL's at every 5 m interval, along the centre line of the bund is calculated to get the longitudinal section of the bund line. Cross sectional details across the centre line at 5 m interval is calculated for every 5m along the centre line is taken. The longitudinal section, cross sections & typical section of the bund are shown in the drawings.

The sectional details are required for earth work calculations. Slopes on upstream & downstream sides usually vary depending on the soil parameters.

IX. CONCLUSION

Water resource planning and Management nowadays gaining momentum because of shortage of water and increase in pollution of existing water. The present study enhanced the knowledge of small reservoir planning ,

it involved use of advanced tools like GIS for the Reservoir planning. Actual site selection for the dam, knowledge on Hydrological, Geological and Engineering survey is enhanced in the work.

Study reveals the availability of excess of water in the yagachi catchment and it can be utilized for further enhancement of the Industrial area and Residential colonies.

So use of GIS reduces human effort which would require for the preliminary work for the selection of Dam site. In GIS platform Toposheets, Digital Elevation Models are used to explore the topographical information with efficiency. Google earth is also one of the wonderful tool for the approximate verification of physical features on the ground in and around the dam location

X. ACKNOWLEDGEMENT

The satisfaction that accompanies the successful completion of any task would be incomplete without mentioning of the Person who made it possible.

I take privilege to thank our beloved Associate Professor **Mr. B. E. Yogendra**, MCE, HASSAN, for his kind encouragement and support throughout the project work.

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