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Hydraulic Redesign and Analysis of Kotmara Dam: Kas River Basin

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Abstract - *Geographical Information System (GIS) is an effective tool top performs many operations such as digitization, delineation of streams in watershed. This tool can be efficiently used to carry out hydrological analysis and hence used for sustainable watershed management projects such as redesign of the dam or reservoir planning. In this process, the watershed of the Kas river was delineated and discharge estimation was carried out using toposheet from survey of India (scale 1:50000) and satellite based remote sensing digital elevation model (DEM). GIS tool (QGIS) was used to performed Morphomatric analysis for the above to derive the stream characteristics and stream orders. Using Strange's table, the yield of runoff from the catchment was estimated. This is useful to find out the actual storage available at the study site. So that we can analyze whether the existing dam reservoir is sufficient or not. And can give the best measures such as hydraulic redesign of the existing Kotmara dam.*

***Key Words*: River Kas, Delineation, QGIS, yield of runoff, rainfall, hydraulic design**

1. INTRODUCTION

The availability of fresh water is limited resource and needs sustainable management of this resource. Given the varied bio-climatic zones, rain fall patterns vary and each geographic area receives a certain mean annual rainfall. However, in certain areas with changing water demand, there is an apparent sense inadequate rainfall over the years and hence overall yield resulting of the precipitation. One such case is applicable for the upstream catchment of small river Kas that originates in Bota Village in Ahmednagar district of Maharashtra. There is a small dam named as Kotmara constructed on river Kas with 7899.463 Ha catchment area.

The main objective of this dam is to be providing the water supply to the agriculture and domestic purpose to the nearby villages. With changing agriculture practices and increase in population in nearby villages., water demand has increased that was often pushed for the need to draw water from other watersheds. Consequently, the nearby villages in the existing dam are fed with water drawn from river Kas through human made channels and closed conduits.

According to the survey and observation the area has quite good rainfall pattern (25mm); so there may be a scope to increase the water storage of the dam. In this backdrop it becomes pertinent to access the potential yield of runoff from rainfall in catchment. This can be achieved by delineating the watershed and analyze the stream network appropriate methods that is by manually using toposheet or through software using Digital Elevation Model. On the basis of runoff results we can find the either new site for dam or redesign the hydraulic dimension of the dam.

The Geographical Information System is an effective tool to perform various operations such as digitalization, delineation of stream of a watershed and carry out a variety of spatial analysis. The tool can be efficiently used to carry out hydrological analysis and hence used for sustainable watershed management projects.

Thus, this study aims to delineate the River Kas watershed and estimate the potential discharge from runoff in the catchment using QGIS software and manual drawing methods. In the next stage design the gravity dam and comparison is to be done.

QGIS (Previously known as Quantum Geographical Information System) is a cross platform free and open source desktop geographic information system application that provides data viewing, editing and analysis. The application is available from http://qgis.org/. QGIS allows users to create maps with many layers using different map projections. Maps can assemble in different formats and for different uses. QGIS allows maps to be composed of raster or vector layers. Typical of this kind of software's, the vector data is stored as point, line or polygon features. Different

kinds of raster images are supported and the software cans geo-referenced images.

1.1 STUDY AREA

Fig No.1: Google Earth View of Dam

1.2 OBJECTIVES

1. To calculate the actual geometric, hydrological and cost related data for existing dam.
2. To find out the catchment area for river Kas basin by toposheet and Digital Elevation Model (DEM).
3. To design the earthen dam on the basis of data collected.
4. To compare redesign parameters with respect to existing structure.
5. To suggest improvement measures to exiting dam

2. PROBLEM STATEMENT

The rainfall occurring in existing catchment area of the dam is heavy, whereas the storage capacity of the dam is not sufficient to store all the water available in the catchment area.

3. METHODOLOGY

3.1Data collection: we visited irrigation department at Sangamner taluka and collected existing dam details.
3.2 Rain fall assessment: from collected last five years rainfall data average annual rainfall was calculated.
3.3 Catchment area delineations: catchment area delineation was done by two methods that are by toposheet and by using QGIS software.
3.4 Redesign of dam: from data collection, rain fall assessment and catchment area delineation. It is observed that there is need of redesigning of dam.
3.5 Suggestions: After identifying causes of accidents on those black spots remedial measures will be suggested.

4. RESULT AND CONCLUSION

4.1 The catchment area obtained:
The catchment area calculated by the software is 4.43% more than the catchment area calculated by manual toposheet method. QGIS software use good and accurate results than the manual method which is open source software available worldwide.

Catchment area by toposheet method(sq km)	Catchment area by QGIS software method (sq km)	% of increase in area
80.952	84.7	4.43

4.2 Factor of safety for various cases:
We have started to increase the height of the dam by 3 meter then by 5 meter than existing condition of the dam. And the factor of safety obtained for these conditions are greater than minimum limit 1.35 for downstream side and 1.5 for upstream side which states that the dam is safe for respective scenarios.

No.	Height of Dam	Trial no. 1	Trial no. 2	Trial no. 3	Remark
1	29.10M				SAFE
	Upstream Dam	2.04	1.98	1.90	SAFE
	Downstream side	1.59	1.67	1.79	SAFE
2	32M				
	Upstream side	2.1	2.3	2.5	SAFE
	Downstream side	1.648	1.749	1.81	SAFE
3	34M				
	Upstream side	2.1	2.15	2.1	SAFE
	Downstream side	2.01	2.3	2.36	SAFE

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