A Study of Reservoir Volume and Its Inundated RMs of Budhi Gandaki Hydropower Project with Respect to Dam Height Variation

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Abstract

Water resources are the most important natural resources as they are renewable natural resources and also abundantly available in the context of our country. It has huge number of large rivers and streams which has got very high potential of generating hydroelectricity. Construction of any civil engineering structure is not only fully about the design on which it based on but also the impact it does to the surrounding of it. Huge civil engineering structure like Budhi Gandaki hydropower project is a proper demand for the country like ours. Budhi Gandaki Hydropower project site is west of Kathmandu having E576261 and N3079050. The project has the huge potential of generating about 1200 MW which is obtained by constructing a high rise dam height of 263m. In "A Study of Reservoir Volume and Its Inundated RMs of Budhi Gandaki Hydropower Project with Respect to Dam Height Variation", the analysis was done with the help GIS to find out various inundation nature of the reservoir at dam height variation and even DEM of the Nepal was used to find the catchment area, inundation area, inundation volume and affected RMs of the project.

Keywords : *Budhi Gandaki, Hydropower*

I. Introduction

Nepal is situated between latitudes of 26° 22' to 30°27' north and between longitudes of 80° 04' to 88° 12' east [1] bordering India on east, west and southern side and Tibetan region of China. The east west highway of the country is about 800 km, roughly parallel to Himalayan axis, and the average

north-south width is 140 km. The rivers/streams of Nepal flow through the entire mountain chain of Himalaya. Approximately 6000 rivers and rivulets [5], about 45000 km in length with total drainage area of 194,471 km^2 [6] flow through Nepal, of which 76% is contained within Nepal [2]. Sum of these rivers and streams constitute the majors river basins like koshi in the east; Gandaki, Bagmati, Kamala, Budhi Gandaki in the middle andarnali, Rapti and Mahakali in the west join Ganga River system draining the southern slope of Himalaya. Most of the major perennial rivers and sum of these tributaries originate in the high altitude in snow and glaciers while others have springs as antecedent and have cut deep gorges at their catchments areas lay on the northern slope of Central Himalya i.e. Gandak, Koshi, Karnali and Mahakali. The unique topographic features of Nepal are one of the two main reasons that make country so rich with water power resources.

Nepal's rivers are very steep. The average bed slope for the main rivers varies from 0.6% to 6.8% and for the small rivers from 1.0% to 12.4% [3]. Although Nepal is rich in water resources, the proper utilization of hydropower potential is below par. In Nepal, electricity is available to limited percentage of people in urban and semi urban areas. Hence most Nepalese living in villages use firewood for their energy requirements. utilizing woods for fire, construction of homes and other purposes are the major causes of deforestation and environmental degradation. On the other hand, the growing industrial sector needs reliable energy supply, which can only be fulfilled by hydropower in a country like Nepal.

A. Purpose of Research

Nepal has a huge potential of generating electricity. In spite of that, Nepal is still lacking power; as a result Nepal is still buying electricity from India to fulfill its need. Although Nepal has developed its first hydropower project about a century ago, the development pace of its hydropower development is not as it was expected and needed. Because of that, severe load shedding is unavoidable and becomes a part of Nepalese people.

There are various reasons which reflect the purpose of this research and they are as follows:

- Impacts of inundation in this area are essential element to be studied so as to get the proper view of the project.
- To know the reservoir volume and it's inundated RMs due to dam height variation.
- To prepare inundation map and catchment delineation

Recent advances in computer technology have offered many benefits to field of water resources especially due to emerging of geographic information system (GIS). GIS in conjunction with hydropower model can be used in a variety of hydrologic application like delineating the drainage pattern in a watershed. Especially in Hydropower sector the fewer example of GIS application has been used. The main basis of study is the couple the GIS with the modelling tool to assess the hydropower potential of the river reach.

II. Description of Study Basin

Budhi Gandaki Hydropower Project is a storage type project located in Central/Western Development Region on the Budhi Gandaki River of Nepal. This project was identified during the Gandaki Basin Study in late 70's [4]. In 1984, a prefeasibility study of the project was prepared. The prefeasibility study of the project has recommended 600 MW capacity plant with Full Supply Level 520 masl [4]

Fig.1 View of Budhi Gandaki River

A Location and Accessibility

The project lies in Gorkha and Dhading districts in Western/ Central Development Region of Nepal. The project site is accessible through Benighat on Prithvi Highway (Kathmandu - Pokhara). From Benighat, a pedestrian suspension bridge can be used to cross the Trishuli River and access the Dam and Powerhouse site both of which are at a distance of about 2 km from the road head. The Budhi Gandaki Hydropwer Project dam is located at the cross-junction of Ghyalchok RM of Gorkha District and Salang RM of Dhading District demarcated by Budhi Gandaki River whereas powerhouse is located on the left bank of the River on Salang RM at Kelleri village.

Fig. 2 Location of budhi gandaki hydropower project

Narayangaht and Pokhara are about 69 km and 123 km respectively to the south west and west of the Dam site. The right abutment of the Dam locates on the fair weather Benighat – Arughat road approximately 3 km from the Prithivi Highway. A two lane motorable bridge across Trishuli River connects Benight –Arughat Road with the Prithivi Highway.

III. Methodology

A. Study approach and process

Budhi Gandaki Hydropower is the most prestige project of Nepal. The location of our site is Benighat, Dhading and the geographic location of the site is E576261 and N3079050. [4] We in the process wanted to analysis the reservoir volume and its inundation area due to the dam height variation.

As it says, the reservoir has the capacity of producing 1200MW [4] power but we also wanted to confirm that the reservoir runs all day or variate in time as the demand on wet and dry season. We went to the office of Budhi Gandaki Hydropower project situated on Benighat and interviewed the employee. Data regarding the land accusation process were collected on the office as well. Various help of secondary data were taken and reports from various agencies are used to get to the conclusion.

B. Data Collection

The field visit was conducted on Budhi Gandaki Hydropower dam. The vicinity at the Budhi Gandaki Hydropower dam upstream was the area of study focusing the different features within the area. For Primary Data collection, the use of GPS Device was used for taking the coordinates at various points. Digital Elevation Model (DEM) and the land-use map have been used for the study as the secondary data collection. The team also collected information regarding the project from different agencies and organization.

C. Data Analysis

The details of different points and features around the DAM site were taken by using the GPS Device. ESRI GIS 10.4 was used for the analysis i.e. simulation and estimation modelling of the submerged area on the catchment on various elevation of the Budhi Gandaki Hydropower Dam. GIS is one of the most powerful mapping software with features such as estimation and modelling and above all, integration of the database to the digital map. And also for the easy accessibility of the software we used GIS as the major tool for analysis.

Fig. 3 Site visit and use of gps for data collection

The location of the possible households was obtained with the help of GPS and so does the location of the dam site. The analysis was done with the help GIS to find out various inundation nature of the reservoir at dam height variation. And even DEM of the Nepal was used to find the catchment area, inundation area, inundation volume and affected RMs of the project.

IV. Result and Discussion

With all the analysis, we can conclude that for every variation of dam height the changes happen on inundation area, inundation volume and on affected RMs from the inundation. As more the height more the values of the respective above features and vice versa.

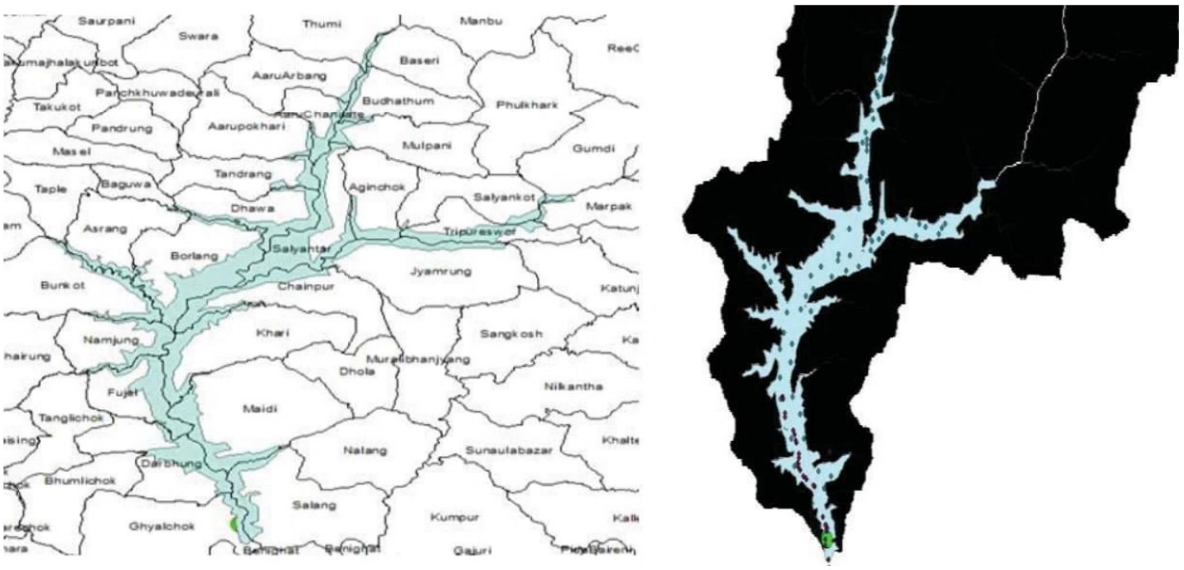

Fig. 4 Effected RMs at 263 m dam height

Inundated area = 96046032.537 m^2
Reservoir volume = 833726757704 m^3

Effected Project RMs of Gorkha district are Ghyalchok, Bhumlichok, Phujel, Namjung, Bungkot, Asrang, Borlang, Dhawa, Tandrang, Aarupokhari, Aaru Chanaute, Aaru Arbang and Thumi; and Salang, Maidi, Khari, Chainpur, Jyamrung, Marpak, Salyankot, Tripureswor, Aginchok, Salyanta, Mulpani, Budhathum and Baseri are RMs of Dhading district.

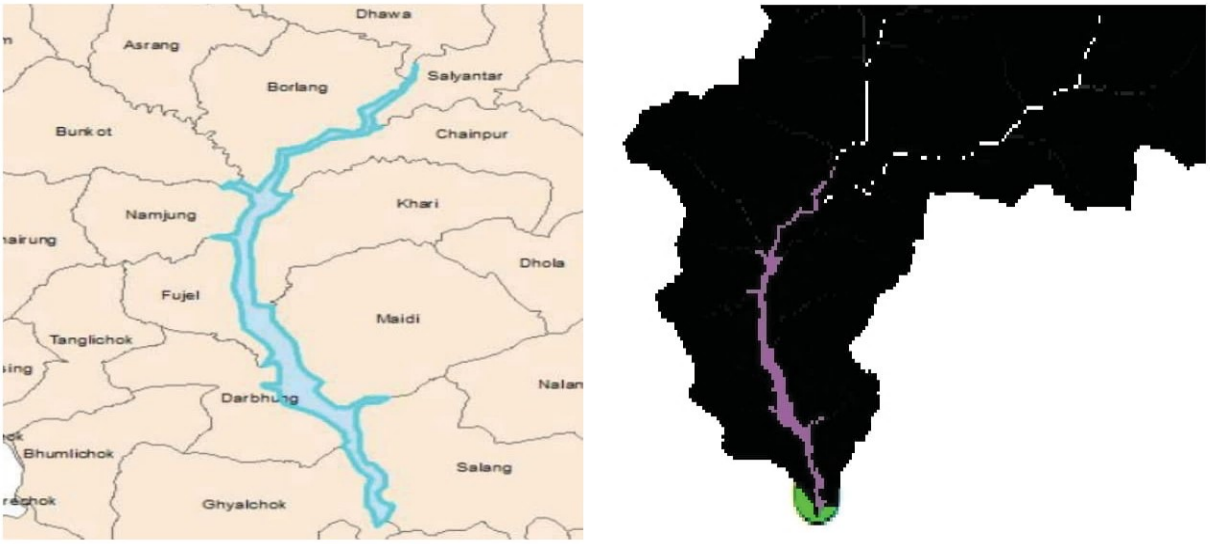

Fig. 5 Effected RMs at 100m dam height

Inundated Area = 13334782.55 m^2
Reservoir Volume= 1087927616.04 m^3

Effected RMs of Gorkha district are Ghyalchowk, Darbung, Fujel, Namjung, Bunkot and Borlang; and Salang, Maidi, Khari, Chainpur and Salyantar are RMs of Dhading district.

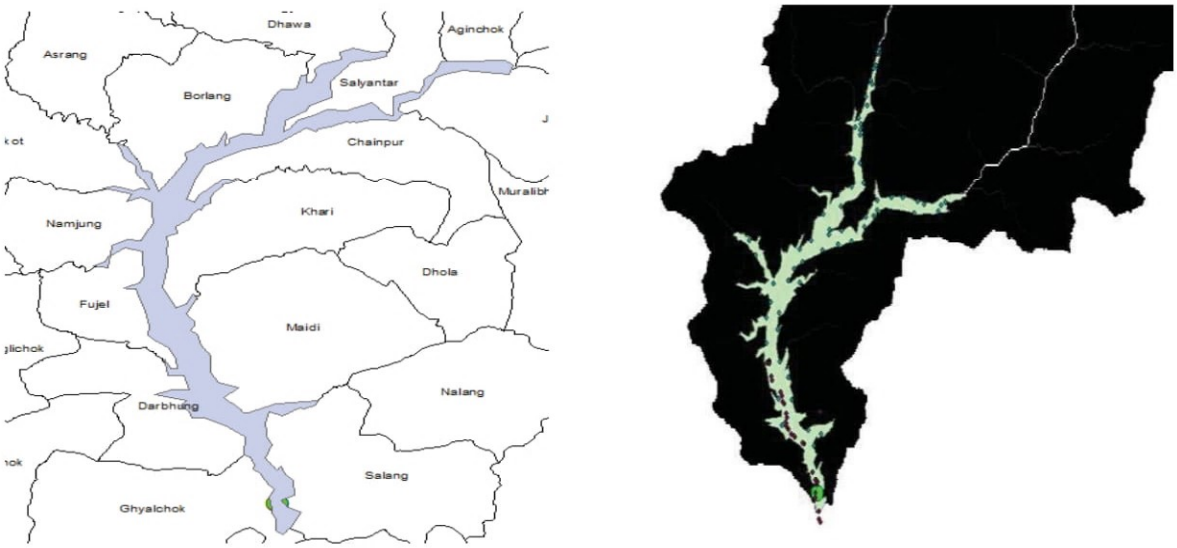

Fig. 6 Effected RMs at 150m dam height

Inundated Area Covered: 47247949.378 m^2
Reservoir Volume: 190691348720.68 m^3

Effected RMs of Gorkha district are Ghyalchowk, Darbung, Fujel, Namjung, Bunkot, Borlang, Dhawa and Salang, Maidi, Khari, Chainpur, Salyantar and Jyamrung are RMs of Dhading district.

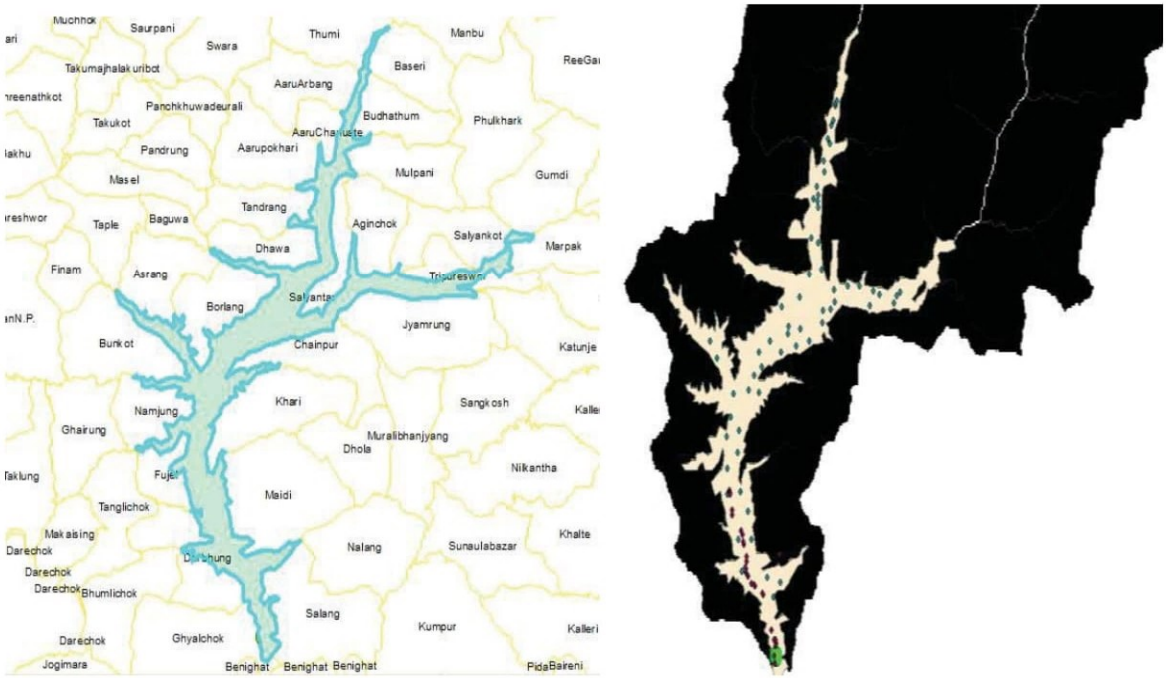

Fig. 7 Effected RMs at 250m dam height

Inundated Area: 87009816.85 m^2
Reservoir Volume: 680622061175.36 m^3

Effected RMs of Gorkha district are Ghyalchok, Bhumlichok, Phujel, Namjung, Bungkot, Asrang, Borlang, Dhawa, Tandrang, Aarupokhari, Aaru Chanaute, Aaru Arbang and Thumi; and Salang, Maidi, Khari, Chainpur, Jyamrung, Marpak, Salyankot, Tripureswor, Aginchok, Salyantar, Mulpani, Budhathum and Baseri RMs of Dhading district.

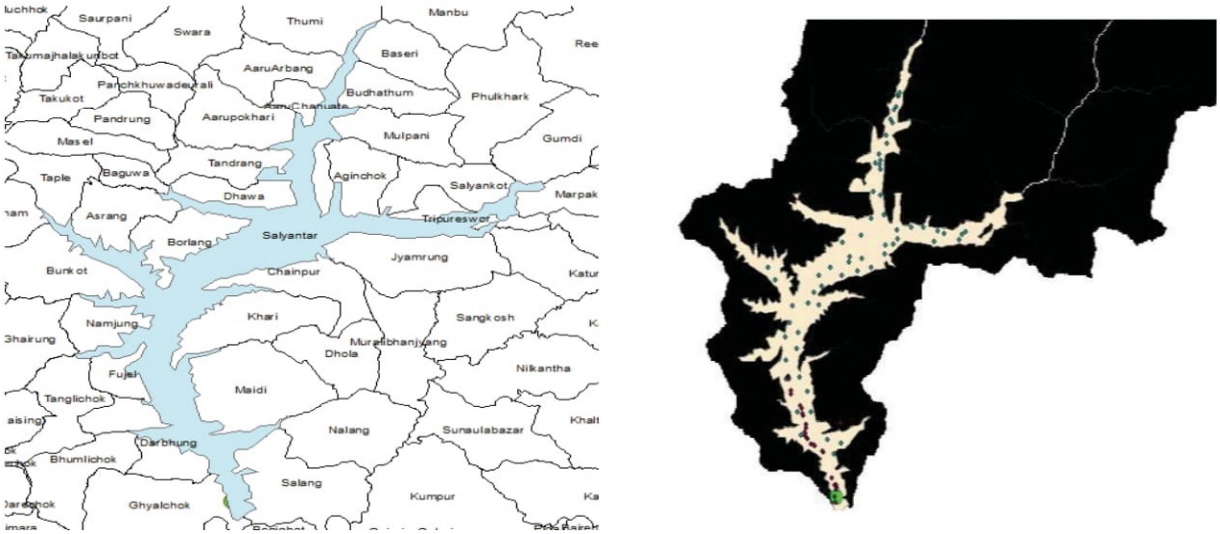

Fig. 8 Effected RMs at 300m dam height

Inundated Area: 119103476.69 m^2
Reservoir Volume: 1297882734045.05 m^3

Effected RMs of Gorkha district are Ghyalchok, Bhumlichok, Phujel, Namjung, Bungkot, Asrang, Borlang, Dhawa, Tandrang, Aarupokhari, Aaru Chanaute, Aaru Arbang, Thumi, Finam, Baguwa and Salang, Maidi, Khari, Chainpur, Jyamrung, Marpak, Salyankot, Tripureswor, Aginchok, Salyantar, Mulpani, Budhathum, Baseri and Nalang RMs of Dhading district.

TABLE 1

TOTAL AFFECTED RMs AND HOUSEHOLDS WITH RESPECT TO DAM HEIGHT VARIATION

Dam height	Gorkha		Dhading	
	RM	Household	RM	Household
100	6	1754	5	2492
150	7	2245	6	2773
250	13	3821	13	4296
263	14	3831	13	4296
300	15	5081	14	7031

TABLE 2

COVERAGE OF THE AREA BY THE CHANGE IN ELEVATION OF THE DAM

SN	Height of dam(m)	Area (m^2)	Volume(m^3)
1	100	13334782.55	1087927616.04
2	150	47247949.38	190691348720.68
3	250	87009816.85	680622061175.36
4	263	96046032.54	833726757704.00
5	300	119103476.69	1297882734045.05

V. Conclusion

With all the results and analysis, we conclude that variation of dam height changes inundation area, inundation volume and affected RMs. With the construction of the project various impacts will be developed in a positive and negative way. We can surely say that every measure is taken to make sure the negative impacts are minimized such as

compensation and relocation plan are in the way of implementation. Most of the people are happy that the country is developing and building the biggest project till date but some people are not due to lack of timely implementation of decision regarding relocation and compensation. The inundation of the reservoir affects the livelihood of the people and affects them mentally and challenges them on the future prospect of their lives. The demonstration of reservoir volume and its inundation area with variation of the dam height help to manage relocation of affected people of the project.

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