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Hydro power generation: A case study of Sonbeel

Nandita Dutta[1], K Dutta Choudhury[2], M. Dutta Choudhury[3], S S Nath[4]
[1]*Department of Commerce, N C College, Badarpur, Karimganj, Assam,*
[2]*Department of Mathematics, Assam University, Silchar*
[3]*Department of Life Science & Bio-informatics, Assam University, Silchar*
[4]*Department of CIL, Assam University, Silchar*

Abstract- Sonbeel is the 2nd largest fresh water lake in Asia. Every year, the whole beel becomes full of water during rainy season and in winter the beel dries up. Sonbeel is connected to two major rivers of the valley namely Singhla and kochua. Shingla River is the only major inlet which is originated in Mizoram and finishes its course at the Southern end of Son beel. The outlet is Kachua River which originates from Northern part of the beel and touches Ratakandi, an another beel on the Northern part of the beel, connected to Kushiara River flowing along with Northern boundary of Karimganj district. Son beel is a natural basin situated between Singla and Kachua River. During dry season, water flows in the rivers are very lean and during the rainy season the flows are very high. Water is one of most valuable resources, and hydropower makes use of this renewable treasure. Here in this paper, an attempt has been made to explain Hydropower generation by using the water content of Sonbeel
Keywords: Flow duration curve, Sonbeel, Storage, River, hydropower plant

I. INTRODUCTION

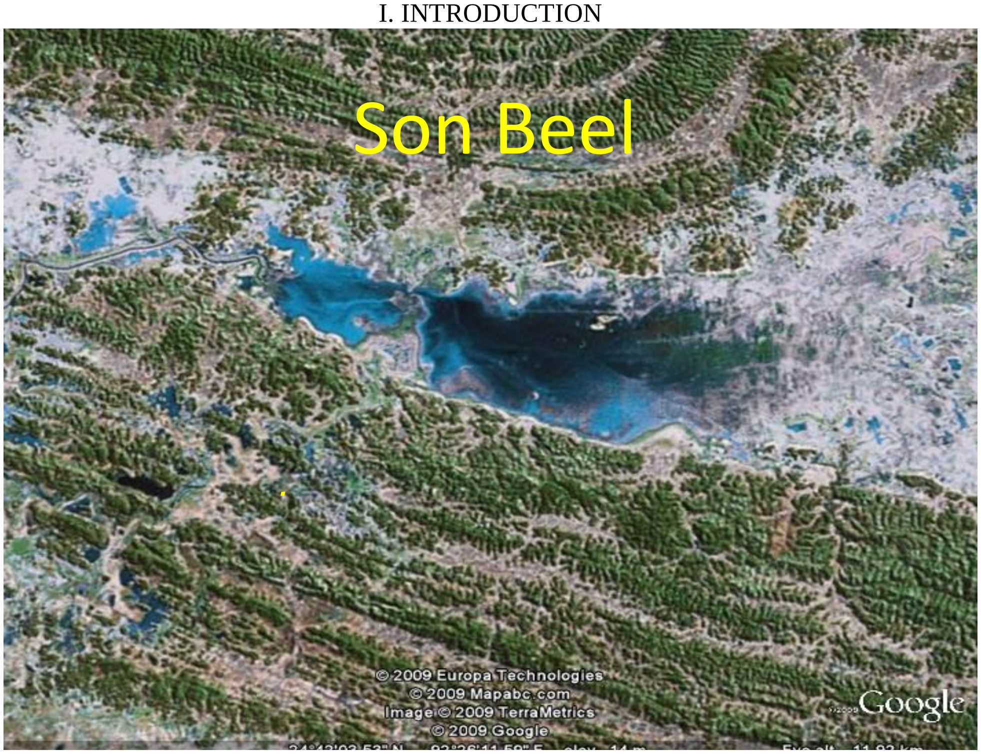

Fig 1. Satellite picture of Sonbeel

The study area (24030'-240 45" N latitude and 920 15'-920 30' E Longitude) which is the largest oxbow lake (Wetland) of Asia. Son beel- the largest fresh water lake in the state of Assam. Son beel falls under Barak Valley climatic zone which is tropical, warm and humid. Sonbeel which is located in the northern half of Karimganj district thus falls under rainfall zone 300-400 mm .Son beel is said to cover an area of approximately 30,000 bighas of land having length 12 .7km and average breadth 3.5 km. Almost 50,000 people's livelihood is directly or indirectly related to the production of the Son beel. Major production of the beel is the fish which is one of the main sources fishes in Southern Assam. In addition to that the beel produces large amount 'Buro' rice. [3]

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Hydropower is a very clean source of energy, which does not consume but only use the water and again make it available for other uses. [1-2]. In Sonbeel uninterrupted and regular electric power supply is not available due to which people suffer throughout the year and as a result there is no development in industrialization, agriculture etc. However if hydro power generation be possible in this region, it can significantly contribute to rural electrification, industrialization, agriculture along with multiple co-benefits including water storage for drinking and irrigation, drought- preparedness, flood control protection, aquaculture and recreational opportunities.

II. MECHANISM OF HYDROPOWER GENERATION

Available flow is the major input parameter that is responsible for the amount of energy that can be produced by an HPP [4]. To generate electricity, water must be in motion. When the water is falling by the force of gravity, its potential energy converts into kinetic energy. This kinetic energy of the flowing water turns blades or vanes in a hydraulic turbine; the form of energy is changed to mechanical energy. The turbine turns the generator which then converts this mechanical energy into electrical energy. Thus, basic requirement of a hydroelectric power station is a reservoir where large quantity of water is stored during rainy season and used during the dry season with an inlet and outlet. [12-13]

Some of the components of hydroelectric power plants and their functions are shown below: Ref [5-6]

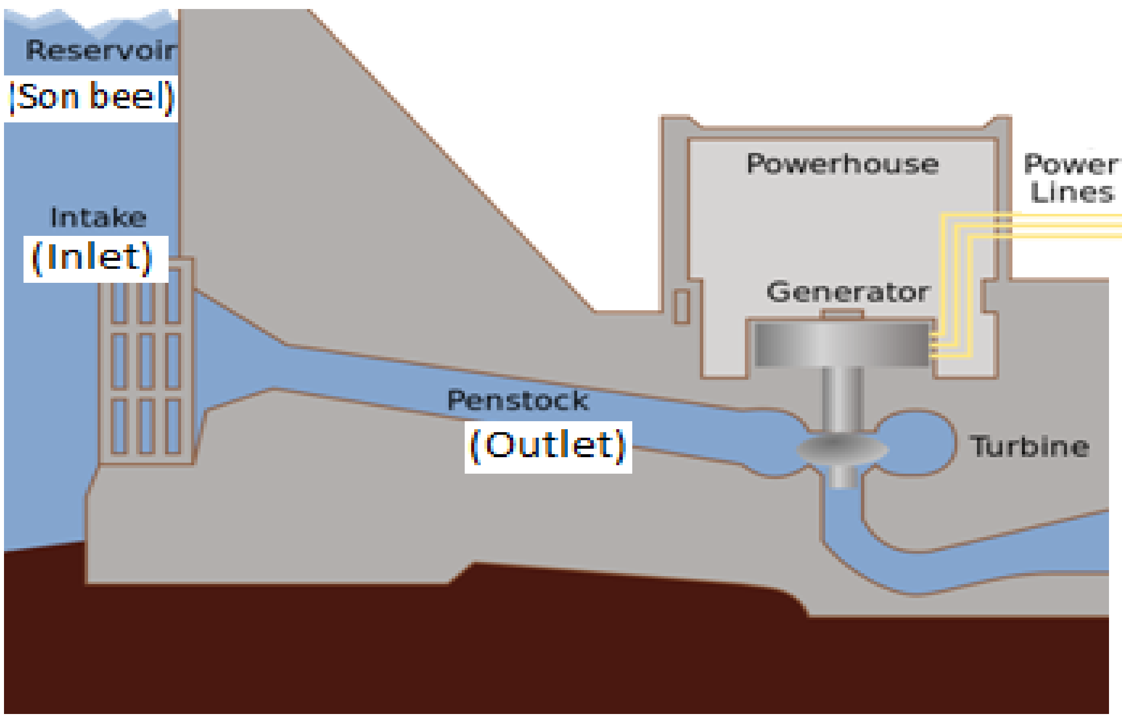

Fig 2

2.1. Reservoir

The purpose of reservoir is to store the water during rainy season and supply the same during dry season. This is in simple, water storage area.

The water flowing Intake or Controls Gate:

These are called inlet gates because water enters the power generation unit through these gates. When the control gates are opened the water flows due to gravity through the penstock (outlet) and towards the turbines through the gates possesses potential as well as kinetic energy. Intake structures are usually the most maintenance-intensive components of hydropower schemes.

2.2. Penstock (Outlet)

Penstock is commonly called outlet. The outlet works is used as the penstock for power plants. The penstock is the long pipe that carries the water flowing from the reservoir towards the power generation unit, comprised of the turbines and generator. The water in the penstock possesses kinetic energy due to its motion and potential energy due to its height. The total amount of power generated depends on the height of the water and the amount of water flowing through the penstock. The choice of outlet of a storage power plant is based on hydrological characteristics.

2.3 Power House:

The purpose of the power house is to support and house the hydraulic and electrical equipment. A power house consists of two main parts, a sub-structure to support the hydraulic and electrical equipment and a superstructure to house and protect this equipment. The superstructure of most power plants is the buildings that house all the operating equipment. This paper shows role of water as an energy resource and to utilize water resources in Sonbeel for maximum benefit. It is also attempted to calculate generation of hydro power in Sonbeel with the help of Flow duration curve Ref [7-8]

2.4 Power calculation:

To calculate power generation (e.g. Hydropower) various mathematical tools have been adopted by Researches. In the present work, due to certain advantages over the other techniques e.g. Simplicity FDC has been adopted. It is also attempted to calculate generation of hydro power in Sonbeel with the help of Flow duration curve

Flow Duration Curve:

Month	Average discharge (m3/s)
January	12.31
February	10.63
March	12 .38
April	16.80
May	35.13
June	90.28
July	172.95
August	185.71
September	131.42
October	60.11
November	27.25
December	18.18

The flow duration curve is a plot of discharge versus percentage of time for which the discharge is available. It is obtained from hydrograph data. The flow or discharge can be expressed as cubic meters per second, per week or other unit of time. If the head at which the flow is available is known, the discharge can be calculated in terms of the Kilowatts power (p). The flow duration curve becomes the load duration curve for Hydro electric plant and thus it is possible to know the total power available at the site. The maximum and minimum conditions of flow can also be obtained by the FDC where minimum flow conditions decide the maximum capacity of plant that can be improved by increasing the storage capacity [6]. Fig3 shows average discharge in Sonbeel.

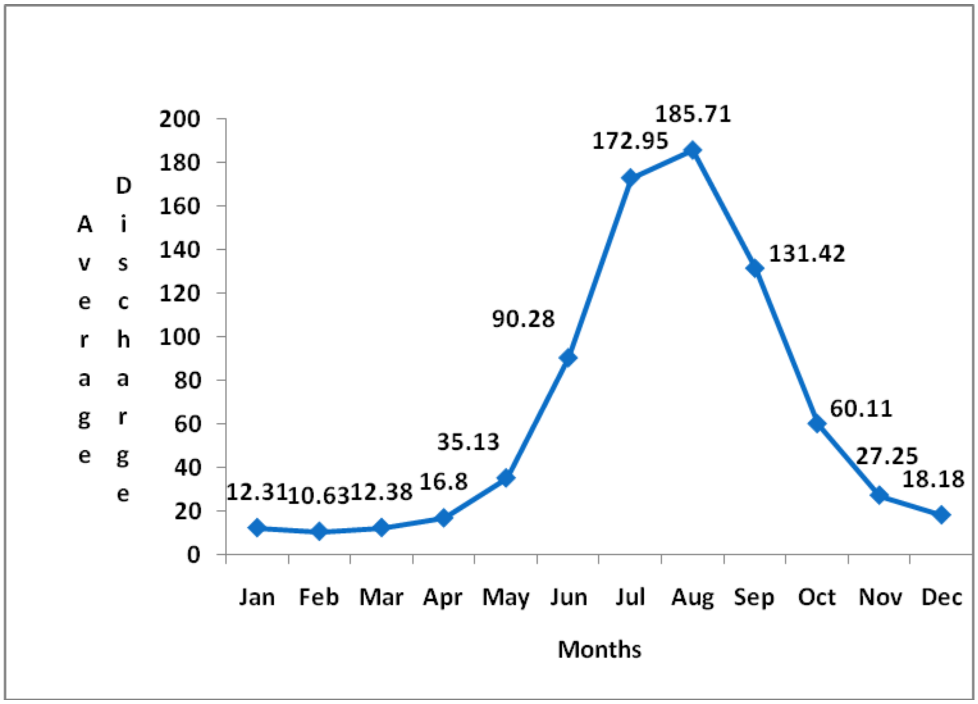

Fig: 3 Plot between average discharge and month

2.5 Power and energy

Power is the rate of producing energy. Power is measured in Watts (W) or kilowatts (kW).The maximum hydropower output is mainly dependent on how much head and water flow is available. In hydroelectric power and potential energy of water is utilized to generate electricity [9-10]. Power is proportional to the product of head and flow rate. The general expression for any Hydro power Generation is:

$$P = m \times g \times H_{net} \times \eta$$

Where

P = the power measured in Watts (W)

η = the overall efficiency of power plant

g = the acceleration due to gravity [9.81 m/s²]

$H_{net} =$ The net head [m]. This is the gross head physically measured at the site, less head losses. To keep things simple head losses can be assumed to be 10%, so

$H_{net} = H_{gross} \times 0.9$

m = the mass flow rate in kg/s (numerically the same as the flow rate in litres /second because litre of water weighs 1 kgs.)

The expression clearly shows that the total power that can be generated from the hydroelectric power plants depends on two major factors

a. The flow rate of water or volume of flow of water and height or head of water.

b. More the volume of water and more the head of water more is the power produced in the hydroelectric power plant.

The metric prefixes are given

1 Watt [W] = 1 Watt

1 Kilowatt [kW] = 1,000 Watt

1 Megawatt [MW] = 1,000,000 Watt

1 Gig watt [GW] = 1,000,000,000 Watt

III. EFFICIENCY

Turbine efficiency ratings are important to compare different turbine types and their performance under conditions of reduced flow. Hydro power efficiency includes the efficiency of the turbine, generator, and transformer.
Generally, in a hydropower system the different parameters of following efficiency are available [5].
Turbine efficiency= 85-95%
Transformer efficiency = 95-100%
Generator efficiency= 95-100%
Therefore in the present investigation, we have considered the parameters of following efficiency
Turbine efficiency= 89%
Transformer efficiency = 99%
Generator efficiency=98%
The overall Hydropower efficiency in Sonbeel [10] would be

$$\eta_{overall} = \eta_{Turbine} * \eta_{Generator} * \eta_{Transformer}$$

(η is the product of all of the component efficiencies)

$$\times 0.98 \times 0.99 = 0$$

= 0.89 .86 = 86%

Head:
Head is a very important parameter for a Hydro Power calculation Head is the change in water levels between the hydro intake and the hydro discharge point. Higher the head, greater is the water pressure across the hydro turbine resulting in more power, generated. Fig 4 shows the plot between head Vs time in month in sonbeel [11].

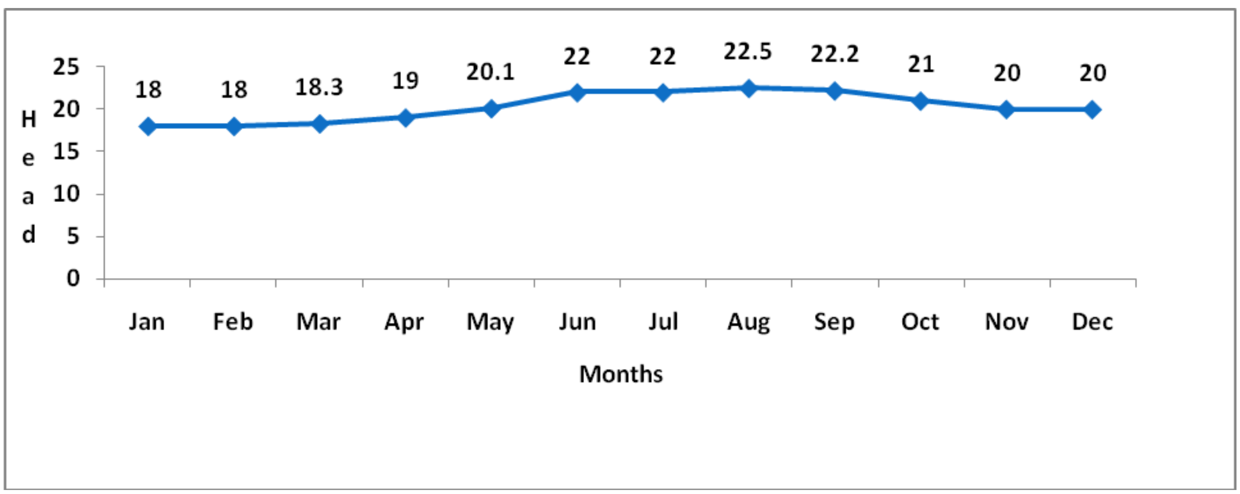

Fig: 4. Plot between head Vs month in sonbeel

Table1 shows the Power calculated with 5 year mean monthly averages values of outlet flow rate, head in Sonbeel

Table1: Power calculated with 5 year mean monthly averages values of outlet flow rate, head in Sonbeel

Month	Outlet flow rate(l/s) (1m3=1000l/s)	Head	Efficiency (%)	Power (K.W)
January	12310	18	86	1869.38
February	10630	18.	86	1614.26
March	12380	18.3	86	1911.35
April	16800	19	86	2692.96
May	35130	20.1	86	5957.19
June	90280	22	86	16756.44
July	172950	22	86	32100.42
August	185710	22.5	86	35252.12
September	131420	22.2	86	24613.98
October	60110	21	86	10649.60

November	27250	20	86	4597.95
December	18180	20	86	3067.55

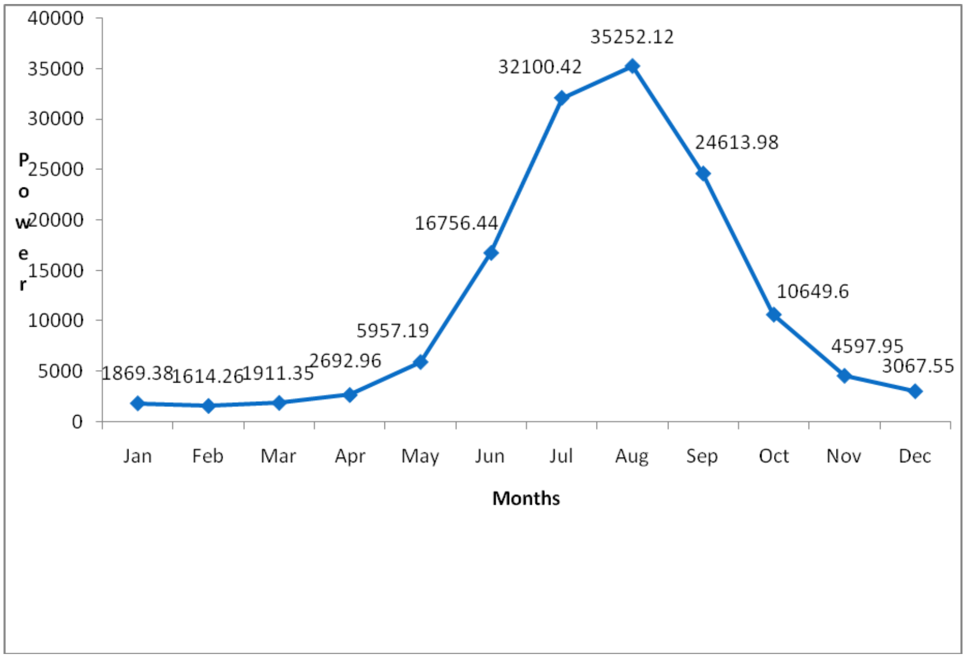

Fig 4 stands for plot between power and month.

IV. CONCLUSION

By considering the present condition of sonbeel and standard efficiency of power plant, the available hydropower generated ranges from ~ 16 KW to ~ 35 KW. However, the generated power may be enhanced to some more extent by digging the beel, inlet and out let.

V. REFERENCE

[1] Barrows, H. K., (1943), Water power engineering: 3d ed., New York, McGraw-Hill Book Co., p.791
[2] Bartle, A. (Ed.), (2010) Hydropower & Dams World Atlas & Industry Guide, Surrey, UK, Aqua Media International, . http://www.hydropower-dams.com/industryguide.
[3] Dutta, N.and Dutta choudhury, K. (2017), an attempt has been made to review the inventory models for decision making in water control management. ISOR Journal of Mathematics, 13(1), *16*-21.
[4] Singh, V Kumar. , Singh, N., Kushwaha C . And D. (2015) An Overview of Hydro-electric Power Plant.ISST Journal of Mechanical Engineering, Vol. 6 No. 1, (January - June), p.p. 59-62
[5] Power Resources Office Jul (2005). U.S Department of the Interior. Bureau of Reclamation. Hydro electric power.
[6] Pravin karki, Senior Hydro power Specialist, SASDE, World Bank, April 23 (2014) Thailand .A brief introduction to small Hydropower.
[7] Beard, L. R., (1943), Statistical analysis in hydrology: Am. Soc. Civil Engineers Trans., v. 108, p. 1110-1160
[8] Searcy, J.K [1969] Flow-Duration Curves, Manual of Hydrology: Part 2. Low-Flow Techniques U.S. GOVERNMENT PRINTING OFFICE WASHINGTON: O - 353-858
[9] PPC S.A., "Achelous River: Kastraki Hydroelectric Power Plant."
[10] Bosona T. G., and Gebresenbet, G. June (2010), "Modeling hydropower plant system to improve its reservoir operation." Swedish University of Agricultural Sciences, International Journal of Water Resources and Environmental Engineering Vol. 2(4), pp. 87-94.
[11] Phuyal, T.P., and Shrestha, M,(2006) Small Hydropower and Headwork's Modeling. Himalayan Small Hydropower Summit (October 12-13,), Dehradun.
[12] Okonkwo G.N and Ezeonu S.O. March (2012) .Scholarly Journal of Engineering Research Vol. 1(1), pp. 11-15.
[13] IFC International Finance Corporation, World Bank Group. Hydroelectric Power .A Guide for Developers and Investors.