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Short Communication

Hydro-Agriculture Prototype: Multiple Use of Water Resource In Nepal

Abhinav Gauli*, Shivesh Shrestha and Sujal Lama

Nightingale International Secondary School, Kupondole, Lalitpur, Nepal

***Corresponding author:** Abhinav Gauli, Nightingale International Secondary School, Kupondole, Lalitpur, Nepal

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Abstract

Nepal is rich in fresh water with more than 6,000 rivers, including that originated from the Himalaya. Being rich in water resources, it has the potential of producing more than 83,000 MW of energy. However, currently Nepal has only harnessed 1.2 % of its capacity. Besides, a Kulekhani (60 MW) all other hydropower plants in Nepal are of run of river type. Such plants are being exclusively used for producing electricity and undermining its potential of multiple use. We developed a prototype to demonstrate the multiple use of water resources. Our research methodology was based on extensive literature review and expert consultations. We found that Nepal has the potential for using hydropower plants in multiple ways. Its dam can be used for recreational activities, such as boating and swimming, and income generation activities like fish farming. Likewise, the most important secondary use of hydropower plant is irrigation. Although, Nepal has agricultural-based economy almost 70% agricultural lands are unirrigated. Hence, water from hydropower can be used for irrigation that increases agriculture production and productivity, contributing to food security. Likewise, the water can also be transferred to villages and cities for drinking purpose. The produced electricity can be used for modernizing agriculture practice. For instance, use of infrared red and blue lights inside the greenhouse to increase the production by increasing rate of photosynthesis. Hence, the multiple use of hydropower will contribute to local and national economy. In addition, it contributes to Goal 1 (No poverty), 2 (Zero hunger), and 7 (Affordable and clean energy) of Sustainable Development Goal (SDG). We suggest that policymakers and government of Nepal should implement this prototype for optimum use of water resource in Nepal.

Keyword: Hydro-agriculture; Green energy; Sustainable development; Hydroelectricity; Multiple use of hydropower

Introduction

Hydropower is an energy derived from converting the mechanical energy of the fast running water into electrical energy, and it can be harnessed for useful purposes. It was back in 1849 when British-American engineer James Francis developed the first modern water turbine in the late 19th century, hydropower became one of the sources of generating electricity [1]. Since then, hydroelectricity has become the biggest alternative source of energy. Nepal being second richest country in water resources has a capacity to produce 83,000 Mega Watt (MW) of hydroelectricity [2]. Although it has a history of more than a century in producing hydroelectricity, so far it is able to produce only 1,006 MW of electricity. Moreover, except Kulekhani hydropower all other hydropower plants are run-of-river type. They are exclusively used for generating electricity. There are limited recreational activities like boating and fish farming in Kulekhani; however, the water is still not being used for irrigation.

Nepal has 41,210 sq. km of agriculture which is 28.75% of the total land area. Nepal is an agricultural country having 66 percent people directly engaged in farming [3]. Farming is subsistent in nature and crop is mostly integrated with livestock. Despite being rich in water resources, one of the major problems of agriculture sector in Nepal is lack of proper irrigation system. Almost 70% irrigation land is rain fed; hence, agriculture production is low [4]. In order to boost the agricultural production, irrigation is very important, and this can be done channelizing stored water in dams constructed for hydropower plants to agriculture fields. With this concept, we developed a Hydro-agriculture Prototype for maximizing the use of the water resources. We believe our

prototype would be a useful guidance to policy makers and developers in Nepal for taking optimum benefits from the available water resources. In addition, our prototype introduces different modern technologies that increase productivity of agriculture.

Methodology

The hydro plant model was produced with extensive literature review and expert consultations. The major literature includes published scientific publications [1]. It also follows the checklist for consultation that includes engineers, geologists, policy makers and development workers. Once the information was accumulated a prototype was developed by using locally available materials, such as plywood, pipes, dynamos and bottle caps. The prototype was widely presented in the national and international young scientist forum and awarded.

Description of the Prototype

The prototype has water reservoir at the higher level. The water from the reservoir is brought to the powerhouse at the lower level. The powerhouse consists of dynamo for producing electricity. The reservoir and powerhouse are connected by penstock pipe, through which water from reservoir flows to the dynamo in the powerhouse. The vertical distance between water reservoir and dynamo in the powerhouse is called head. The amount of electricity produced directly depends on the head and discharge of water flowing through the penstock. The sketch of the hydro-power plant is shown in (Figure 1).

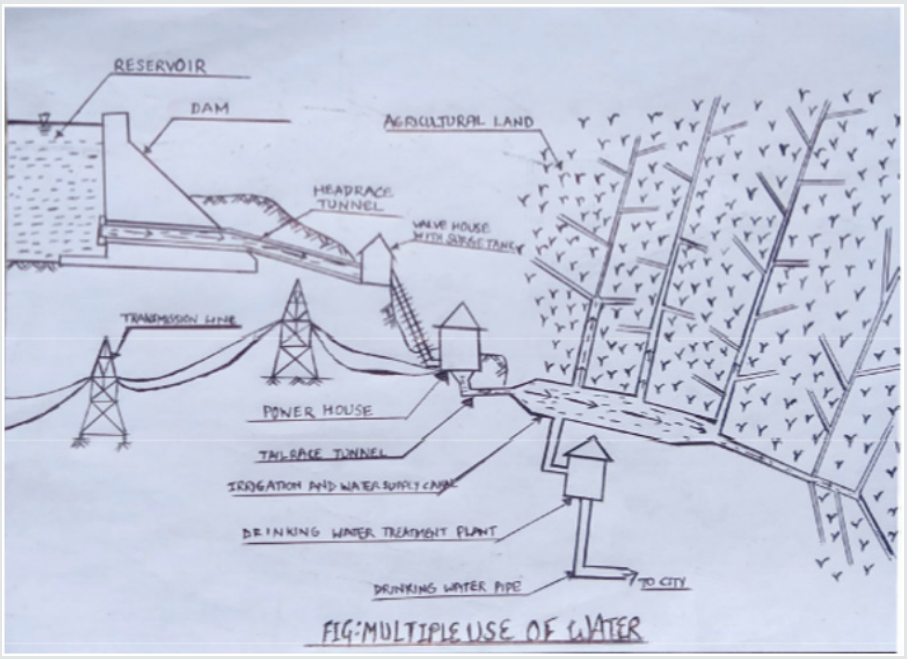

Figure 1: Sketch of hydro-power plant.

Result and Discussion

Hydropower is not only used for the energy it has a multiple use. It also supports in the local and national economy of country. It is the source of green economy and a renewable resource which is ever lasting. Following are the multiple use of the hydropower plant.

Producing Electricity

The first and foremost use of hydropower plant is to generate electricity. The produced electricity can be used locally or can be connected to the central grid for transferring to distant places. When the hydropower plant is of small capacity, the produced electricity is consumed locally, whereas big plant transfer to distant places. The produced electricity is used in houses, offices, industries and farming. As the produced energy is clean, it does not leave any CO_2 footprint, which is also claimed by the research carried out by [5].

Irrigation and Drinking

Another major use of hydropower plant is to link it with irrigation system and irrigate agriculture lands. As almost 70% land in Nepal is rain fed, production is uncertain [6]. When there is good monsoon rain there is good rice production that increases the country's Gross Domestic Product (GDP) and vice versa when poor monsoon [7] studied in Nepal and [8] studied in Ganges-Brahmaputra Basin of India regarding the rainfall variation. However, almost all hydropower plants in Nepal are only producing electricity. The water coming out from the outlet after producing electricity is again going to river. If the hydropower plants are designed, wherever possible, integrating irrigation system, it can increase the production and productivity of agriculture. As a result, food insecurity situation of the county can be minimized. For instance, Nepal is importing rice of value NRs 2.66 billion from

India [9]. The increased production and productivity can surely substitute the import of rice.

Recreation and Income Generation Activities

Reservoir of the hydropower can be used for recreational activities, such as boating and fishing. The hydropower company can collaborate with local community and promote such activities. This will be helpful for improving local economy and build ownership of the hydropower company among the local communities [10]. In addition, local communities can do fish farming in the reservoir [11].

Supplemental Lighting to Increase Crop Production

Supplemental lighting is often used to maintain year-round production and product quality [12]. Among the different spectra, blue and red lights increase the photosynthesis in plants. The produced electricity from hydropower can be used to produce such lights in greenhouse system. This will increase the productivity of the crops [12].

Conclusion

Our prototype shows the possibility of using water resources in multiple ways. The prototype is not only useful for Nepal, but it has global application. It contributes to achieving Sustainable Development Goals, particularly eliminating poverty (Goal 1), zero hunger (Goal 2), and affordable and clean energy (Goal 7). We recommend that our policy makers and development workers promote this multiple use of water resources for sustainable and environmentally friendly development.

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