Water Resource Potentials and Management in the Pindar Basin of Uttaranchal Himalaya, India

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Introduction

Water is the most underutilized, at the same time most abundant resource of Himalaya. It is estimated that about 11,00,000 million cubic meter water flows every year down the Himalaya offering a potentiality of generating electricity to the tune of 28,000 MW and making as much as 247,000 million cubic meters water available for irrigation in the Indo-gangetic plains. Despite of a surplus of water resource and hydropower, scarcity of this resource in the form of short supply of drinking water, predominance of rain-fed farming and low level of electrification are common in many areas. Flow of water as a result of high slope gradient and velocity provide immense scope for power generation and improving upon the efficiency of agricultural systems in the region.

The Pindar basin has the great potential of having huge reservoir of freshwater as a form of glaciers, rivers, streams and natural springs. These sources of water are perennial in nature. But the utilization of water is not proper because the rivers and their tributaries flow in the valley regions while agricultural fields and human settlements are located on the mid slopes, where the possibility of water supply from the valley regions are just negligible. Furthermore, fragility of terrain does not permit for any activities related with ample water supply. The populace of the region depends on the natural springs of water for their drinking water need, which are insufficient. As a result of this, many pockets of the entire region pass through water crises during the summer.

Study area

The Pindar Basin comprising of 1826.0 km^2 area extends from 30^o N to 30^o 18'N latitude and 79^o 13' E to 80^o E longitude. It represents the eastern part of the Garhwal Himalaya with height ranging between 800 m and 6800 m. River Pindar originates from the 'Pindari glacier' in district Almora (32 km) and flowing an approximate 124 km with its numerous tributaries, confluences into the Alaknanda River at Karanprayag in Chamoli district. The watersheds of the Ram Ganga in the south, the Saryu in the east, the Nandakini in the north and the Alaknanda in the northwest delimit it and giving it a distinct socio-geographical identity (Figure 1).

Water Resource Potential in the Pindar Basin

Unlike the other parts of Himalayas, the Pindar basin has the great potential of having huge perennial reservoir of water. The main river Pindar along with its numerous tributaries constitutes one of the major sub-systems of the Ganges, while the entire basin is fragile and prone to landslide mostly during the rainy season, when all the rivers and small streams flow above the danger marks. The rainwater run-off to the plains along with river water and due to poor management of water, water crises prevail everywhere in the basin. There is a slogan in local language "*Pahado ka pani aur Jawani dono medan mein bah gayi*", which means that the water and youth of the region drained to the plains.

However, the entire study area has the privilege to manage the water resources for the development of the region. The landscape of the valleys, on the other hand, permits for construction of micro-hydro power projects, which will lead for proper water supply and generation of electricity. Already, there are several micro-hydro power projects existing. While handling these activities related with hydropower project, we have to be very cautious because of the instability and fragility of the slope. Macro hydropower project cannot be sustained. Slope failure and mass movement of the upper surface of the land and complete movement of hill slope further aggravated the situation and as a result of this, water management through construction of macro hydropower projects is irrelevant.

In the entire course of the Pindar River, there are several ideal places (Figure 1), where installation of micro-hydropower projects is feasible. More prominently, generation of electricity for the development of the region is inevitable. The construction of motorable roads is not fit for the region. Already existed, the roads along the streams are more prone for soil erosion, landslide and mass movement. Ropeways, of course, are best suited with the landscape of the basin. Micro-hydropower project will supply electricity for the ropeways. It will definitely lead a way for transportation facilities, on the one hand and will reduce the ecological imbalance in this ecologically fragile mountain terrain, on the other.

Major Rivers and Their Tributaries

The main rivers are Pindar, Kail and their numerous tributaries, which are perennial. The details of the rivers and tributaries are given below:

The Pindar River

River Pindar originates from the 'Pindari glacier' in district Almora (32 km) and flowing an approximate 124 km with its numerous tributaries, confluences into the Alaknanda River at Karanprayag in Chamoli district. It flows through the narrow valleys, except some places where it makes wide terraces. There are many gorges in the course of the river, which are very ideal for construction of micro-hydropower projects. During the summer, when glaciers are melting in the high reaches of the Himalaya, the water level

of the river accedes. Similarly, during the rainy season, the water level crosses the danger marks, because the entire basin receives heavy downpour during the four months of the said season. The water of the river is completely unutilized yet, although, efforts are on full swing for utilization of river water for irrigation and electricity generation through installation of micro-hydropower projects.

The Kail Ganga

It is a major tributary of the Pindar River. Originates from the Sail Samunder glacier, it confluences with the Pindar near Deval. It flows from the high slope and deep gorges having total length of about 48 km. The government of Uttaranchal has already stalled the micro-hydropower projects on the course of the river.

The Pranmati Garh (Stream)

Pranmati makes a big watershed and this whole area is known as Sol-Dungri region. The total length of the stream is about 18 km. There are many ideal sites for generating electricity. With the help of Govind Ballabh Pant Institute of Himalayan environment and Development, electricity is generating in many places on the course of the river, which is providing electricity for ropeways in this watershed. Around sixteen villages are drawn in this basin.

The Ming Gadhera

Gadhera/Garh is synonymous for stream. Ming Gadhera receives its origin from the slope of Khankharakhet, first flows through steep slope, then through wide and stretch valley and before meeting with the Pindar in Ming Gadhera service center, it makes narrow valley. Almost in the middle of the stream slope gradient is low that’s why the water of the stream can be taken for irrigation purposes in a sustainable manner.

The Kaver Gadhera

This stream gets its origin from the bottom of Kanpurgarhi (2800 m) flows with gentle to steep slopes and merge with the Pindar River in Narainbagar service center. The total length of the stream is approx. 17 km. It receives numerous sub tributaries from its catchments. It becomes violent during the rainy seasons.

The Ata Garh

It is biggest tributaries of the Pindar basin after Kail Ganga and makes the watershed with Ramganga. It originates from the northeastern slope of Diwalikhal, flowing about 19 km and with deep valley, finally confluences with the Pindar in Simli service center.

Table: 1 Major rivers and their tributaries

S. No.	Name of River/Tributaries	Length (km)	Number of Villages in the watershed
1.	Pindar River	124	739
2.	Kail Ganga	48	42
3.	Pranmati Garh	18	16
4.	Ming Gadhera	9	22
5.	Kaver Gadhera	17	19
6.	Ata Garh	19	23

Sources of data: Primary data

Traditional Watermills (Gharats) System

Watermills, locally known as gharats, are the major traditional system for making wheat floor. These gharats are either seasonal or operating throughout the year. Seasonal gharats are operated during the rainy season when water level accedes in the stream. Although, these streams are perennial in nature, yet during the summer, level of water goes below the required amount. These are mostly found in the higher reaches, while in the low-lying areas, the gharats are operated throughout the year. Gharats are the source of livelihood for the people, who are engaged with this practice. Still, most of the places in the highlands, this system is prevailing, while, due to wheat floor industries flourishing everywhere, particularly in the valley region, the emergence of gharats is getting down.

Traditionally operated gharats can be modified in a form of hydropower plants in the entire basin, particularly in the small streams, which can serve the villages of the catchments for power supply. This system will reduce the heavy wealth expenditure for supplying electricity for the remote areas from the long distance plants. The impacts of the gharat system would on economic development; employment and reducing degradation of environment are as follows:

1. Reducing plan outlay because, this system requires low monetary input and the community people themselves can do this and become self-reliant.
2. Reducing unemployment because more people will involve with this entrepreneur.
3. Reducing environmental degradation through conserving the areas where the electric line will be imposed.

The basin has many ideal locations for installation of improved gharats in throughout the course of the rivers. There are numerous micro-drainage basins. These are Pranmati drainage basin, Ming Gadhera drainage basin, Kaver Gadhera drainage basin, Atagarh drainage basin and many more, where electricity can be generated at the local level. Already, there are many gharats existed in the entire basin. The author hase visited many places and observed that the capacity of the gharats can be increased for ample electricity generation.

Conclusion

Management of water resource in the mountain areas is a crucial issue because of the terrain, fragility of land landmasses and heavy inputs of money, which does not permit for construction of the dams, macro or meso. Most of the activities related with generation of electricity and construction of dams during the winder due to low level of water, disrupted during the rainy season because of the high water level, sometime above the danger marks. The whole constructions have been seen swept away during the rainy season in many times. The velocity of water remains high due to high slope gradient and high amount of water almost in throughout the year. It is therefore, suggested that micro-level hydropower plants may be more successful, which can supply the electricity to the small clusters of villages. Even, the micro-drainage basin can be divided into the sub divisions for the convenience of the installation of power plants. Traditional management of water resource as a form of *gharat* (water mills) and *gools* (small canals) did not involve any advance technology, while they are more suited for generation of electricity and are adaptable in this fragile land. Throughout the basin, several ideal locations are existed where micro dams can be constructed. The most important point in support of the construction of big dams is that the villages are fragmented and sparse settlements are seen everywhere, therefore, construction of micro-level hydropower plants are economically viable and environmentally sound.

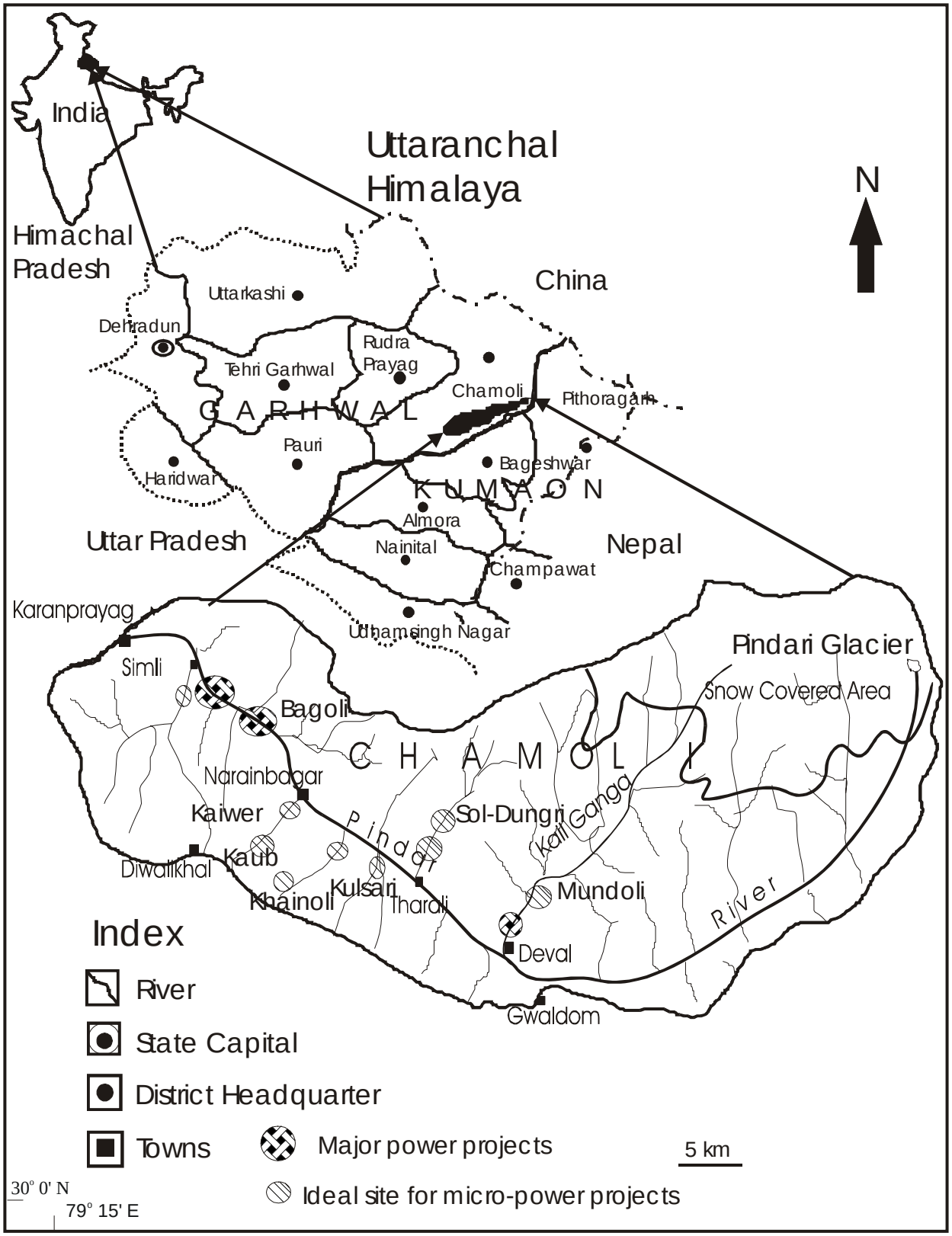

Figure 1 Location map of the Pindar River and ideal site of micro hydropower projects