A Case Study of the Background, Aspects, and Impacts of the Tehri Dam on the Economy, Ecology & Population of India

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ABSTRACT

t is well known that Dam projects have a very important role in utilizing water resources and thus play an essential part in the development of civilization. This paper discusses one such dam in great detail. The Tehri Dam is the highest dam in India and the third largest in the Himalayan region. The dam is within a controversial arena for a long time. Just like there are two sides to a coin, the Tehri Dam also has its own share of pros and cons which are frequently debated upon. The dam fulfilled not only the energy and water requirements of only the Garhwal region but benefitted the rest of the nation as well. On the other hand, its construction also had drastic impacts on the environment and society which cannot be ignored. This paper includes the background of the Tehri Dam, and its positive and negative aspects, with a major focus on its impacts. It further discusses the chemical aspects of materials employed in the construction of the dam which is often neglected but, is very important from the environmental perspective.

Keywords: Hydropower, Environment, Tehri Garhwal, Uttarakhand, Dams

1. Introduction

Dams and multi-purpose river projects are considered as a symbol of development of the country, which is though, not completely wrong as these dams play an important role in irrigation projects, generation of electricity, creating employment, providing water supply to the areas facing water scarcity etc.

Apart from so many uses dams in India are mostly surrounded with various controversies. An example of such a controversial dam is The Tehri Dam which faced several social and engineering challenges.

Tehri dam is one of the huge creations of 21st century, with a height of 260 meters (855feet). It is the 4th largest earth and rock filled dam in the world and tallest in India located on the Bhagirathi River near Tehri Garhwal district of Uttarakhand state. It is a primary dam of THDC India limited and a hydropower plant (Adhikari, 2009). The earth and rock filled dam is the one which is made up of compacted materials like (rock and clayey soil along with gravel) covered with layer of impermeable material (Baxter,1977).

The combination mixture of rock, clay and gravel had great influence in increasing the strength and stability of the dam as well as reduces the chances of cracks, scaling etc (Chen et al., 2018). The dam's reservoir is extending for over 44km in the Bhagirathi River valley and 25km over the Bhilganga river valley (sub-basin of Bhagirathi River) and is used for irrigation projects, municipal water supply and produces 1000 megawatts (1,300,000hp) of hydroelectricity (Adhikari, 2009).

Tehri Hydro Development Corporation (THDC) is a collaboration of the Government of India and the state government of Uttar Pradesh that was formed in 1988 for implementation of the Tehri dam project.

The Tehri dam project resulted in the establishment of the New Tehri town after the submergence of Old Tehri in the Garhwal hills for the rehabilitation of the people. However, Tehri Dam supported the economic growth of the country to a large extent but it also raised the concerns regarding the rights of local people which lead to civil protests like Anti-Tehri dam movement and the issues related to environment further contributed to the controversy.

The controversy of Tehri dam was based on the issues regarding (Asian Research Consortium, 2017) -

- i. The displacement and rehabilitation of thousands of people who became homeless and jobless.
- ii. Several towns submerged during the construction of dam which raised the questions that when and how they will bring their life back to the original track.
- iii. The high seismicity of the region raised the questions regarding the stability of the dam and safety of the local population.

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Basically, building a dam is a big factor in the development of a civilization as the area which gets filled with roads, houses, cities affects the river's flora and fauna as well as the level of water table (Chand, 2014). In short, building a dam is a severe threat to the environment and livelihood.

This thought raised the concerns of the people across the nation which lead to a conflict between development, environment and livelihood. Moreover, the local activists and environmentalists filed court cases against the construction of dam and THDC.

After a long wait finally in 2006 the construction of The Tehri Dam was completed. Since, the Tehri dam was formed there were drastic social, economic and cultural changes in the region and among the various local communities (Asian Research Consortium, 2017).

This article comprises a brief study of the historical, political as well as the geographical aspects of The Tehri Dam, its social, economic and ecological advantages, disadvantages and impacts. The main focus of the article is to analyze the impacts of the dam on the environment and livelihood with respect to future conditions in order to find out ways to deal with them within time.

2. Brief study of Tehri Dam

If we talk about the present situation of dam projects, then without any dilemma one can say that they play a very important role in utilizing water resources to a great extent, we simply can't count them as ordinary buildings because they are proven to be very useful (Chand, 2014). Hence, we can say that dams now play an essential part in the development of human civilization.

Although, dams have a number of advantages but it is also true that it holds a high possibility of causing great harm to the environment and livelihood (Chand, 2014). Therefore, it is important to do proper research and analysis before the implementation of the dam projects. Tehri dam is a massive and the most controversial multipurpose dam project till now, below is the flow chart (figure 1) showing a short glimpse of the brief study of the Tehri dam project.

2.1 Historical background

The Tehri Dam is located on the Bhagirathi river, a major tributary of Ganga river about 80 km upstream from Rishikesh, in the Garhwal district of Uttarakhand. Tehri dam is the third largest dam in the Himalayan region after Bhakra Nangal dam(1950) and Pong dam(1960) (Chand, 2014). The natural beauty of Uttarakhand state is well known for attracting tourists but its fragility often gives invitation to natural disasters like floods and landslides. The mountainous terrains are prone to earthquakes thats why one has to take due care about any kind of infrastructural development that takes place in Uttarakhand (Chand, 2014). Despite of these reasons and various controversies the proposal of Tehri dam project was passed and constructed successfully. To know the reason let's have a look over its past, the figure below shows the time line of the Tehri dam project (figure 2).

- i. The Tehri dam project was first introduced in 1941 and its preliminary investigation was conducted in the year 1961 (Adhikari, 2009).
- ii. In 1972 it was finally sanctioned by the Planning Commission. Based on the investigation of 1961 the project was planned and its architectural design was finalized with power generating capacity of 600MW.
- iii. In 1978 construction of the dam started but the issues related to environment, resettlement of people and even the ongoing social, administrative and environmental activities added in the delaying of the whole project (Adhikari, 2009).
- iv. In 1986 due to political changes in USSR, Russians terminate its support to the Tehri dam project. At last



Figure 1: This flow chart is a short glimpse about the study of Tehri dam project



Figure 2: Time line of the Tehri dam project

the Government of India took the full control of the dam project and again started the construction with its own technical and financial resources (Adhikari, 2009). Initially, the Irrigation Department of Uttar Pradesh took the lead role to implement the project as the circumstances changed because the project anticipated to provide additional irrigation in Uttar Pradesh.

- v. In 1988 Tehri Hydro Development Corporation (THDC) was formed, it was a joint undertaking of the Government of India and Government of Uttar Pradesh formed for further implementation and development of the Tehri dam project (Adhikari, 2009). It was decided that 75% of the funding will be provided by the Central Government and the rest 25% will be provided by the State Government in the hydropower component while the irrigation component was agreed to be financed by the Government of UP all alone.
- vi. In 1990 the project was revised from an original 600MW reservoir project to 2400MW multipurpose project to be developed in three stages at the time when the conditional clearance was given by the Ministry of Environment and Forest (Asian Research Consortium, 2017).

The first stage development was the Tehri dam and hydropower plant (1000MW) situated just downstream of the old Tehri town with a surface area of 42 square km at a full reservoir level of 830m and the second development was the Koteshwar Dam and a hydropower plant (400MW) being constructed about 22km downstream the main Tehri dam. The third stage development of THDC was Tehri Pump Storage Plant (1000MW) which aims to lift the water from lower Koteshwar dam to the upper Tehri dam mostly during the peak hours (Asian Research Consortium, 2017).

vii. In 2006 the construction of Tehri dam was completed, construction of the second part of project Koteshwar dam was completed in 2012 and in February 2016 the pumped storage house was criticized severely for commissioning (Asian Research Consortium, 2017).

This is all about the past of the Tehri multipurpose river project.

2.2 Political background

Tehri dam project had been in controversies since decades. At the time of construction of the dam it was a major topic of disputes between the locals, environmentalists, social workers and the Government (Asian Research Consortium, 2017).

The Tehri Bandh Virodhi Sangharsh Samiti (TBVSS), a committee for protest against the Tehri dam was formed on January 24,1978 under the presidentship of VD Saklani to raise the issues regarding rehabilitation, cost benefits and displacement as well as some important issues like democracy,social justice and sustainable development (Asian Research Consortium, 2017).

Along with TBVSS, the Vishwa Hindu Parishad (VHP) and the Chipko activist Sunderlal Bahuguna along with several others were also in the opposition of the dam (Kaushik, 2007). They all participated actively in this movement and worked together against the dam construction.

The TBVSS went to supreme court but the verdict was against the petition. After that when the Environmental Appraisal Committee (EAC) refused to give a clearance to the project the movement got further momentum. But at last, all efforts went in vain as the project did not stopped (Asian Research Consortium, 2017).

The motive of the movement was to establish the connections between ecological and social mythical value by using ecological politics that is by environmental campaigns, by giving cultural-religious references and by scientific study (Kaushik, 2007).

2.3 Geographical background

Located in a highly fragile zone the state of Uttarakhand did not favoured the formation of the Tehri Dam. The region experiences high magnitude earthquakes every year along with destruction of bridges, roads and other infrastructures during the monsoon season.

Thus, geographically the Tehri Dam paved way to many challenges and still faces a question on its geographical location.

3. Advantages of the Tehri Dam

This section deals with an elaborate research on how the Garhwal region as well as the rest of the nation was benefitted from the construction of the Tehri Hydro Power Complex, particularly in meeting the energy, irrigation and drinking water requirements.

- I. As per the data of 2018, the Tehri Hydro Power Complex added to 2400 MW of energy generating capacity. The Annual energy availability (Peaking) was 5220 MU while the additional generation in downstream projects was 200 MU (Panwar and Upreti, 2015) three 33 KV sub stations have been constructed and network of LT/HT transmission lines have been made to improve electricity distribution systems in rural areas nearby (Sandipa and Pandey, 2012).
- ii. The addition to irrigation was 2.70 lakh hectares and besides that, the stabilisation of existing irrigation was equal to 6.04 lakh hectares (Panwar and Upreti, 2015).
- iii. 300 Cusecs of drinking water for 40 Lac people in Delhi and 200 cusecs of drinking water for towns and villages of U.P. which will meet the requirements of 30 Lac people (Panwar and Upreti, 2015).
- iv. The Tehri Dam has helped in flood moderation too. Less flooding in the low-lying areas of states like Uttar Pradesh, Bihar, and West Bengal can be credited to the dam. Talking about profit, the dam brings Rs 2400 crores profit to the Central Government every year (Sharma, 2008).
- v. As per the data of 2022, the Tehri Hydro Power Complex added 2400 MW of energy generating capacity. The Annual energy availability was 5300 MU (in one cycle of PSP) and 6650 MU (in two cycles of PSP) (Naithani, 2022) while the additional generation in downstream projects was 200 MU.
- vi. The irrigation in command area was 8.74 Lac Ha. In Uttar Pradesh, the agricultural output was increased by INR 1600 Cr, annually (Naithani, 2022).

Apart from the above mentioned advantages, the construction of the dam led to the development of several other spheres of economy as well. It led to the integrated development of Garhwal region, which includes construction of a new hill station with all civic facilities and improvement in the sectors of health, education, tourism and environment conservation (Panwar and Upreti, 2015).

- i. Rishikesh Chamba New Tehri Town roads have been widened which has made communication easier and also reduced the total journey time. A good growth took place in the field of education as more degree colleges were constructed and efforts were made to accommodate more number of students (Sharma, 2008).
- ii. 75 bed hospital (with all modern medical facilities) were constructed at NTT and in addition to that, 5 Primary Health Centres with indoor treatment were constructed (at Project cost). Treated water is supplied to houses and a central sewerage treatment plant has

been constructed to maintain hygienic conditions (Sharma, 2008). Power is now easily available after the construction of the dam. So, more industries are growing coming in the New Tehri Town. NTT is also expected to become a major tourist destination in the near future. Water sports will be possible as well due to the creation of a lake by the impoundment of reservoir of the dam (Sharma, 2008).

4. Disadvantages of the Tehri Dam

Irrespective of its array of benefits, the Tehri dam has a significant share of disadvantages.

4.1 Displacement of people during construction

As the saying goes - "Older people prefer to stay in their homes as long as possible because it provides them with control over their lives; it enables them to keep their identity and well-being."

Resettlement disrupts the entire life of people. Involuntary, traumatic and delayed relocation, as well as denial of development opportunities for years and often decades, has characterized the resettlement process. Displacement mainly hits tribal and rural people who usually do not get the much-needed support from the government.

People have to leave their ancestral land and forests on which they depend for their livelihood. Many of them have no skills to take up another activity or pick up any occupation. Under the rural rehabilitation, affected families were categorized as 'fully affected 'or 'partially affected'. The families whose 50 percent or more land was acquired were treated as fully affected. Those families whose less than 50 percent land was coming under submergence were categorized as ''partially affected''.

4.2 Emission of a high percentage of greenhouse gases

Reservoirs are a major source of global greenhouse gases, scientist says. The new research that methane accounted for 79 percent of carbon dioxide equivalent emission from reservoirs, while the other two greenhouse gases, carbon dioxide and nitrous oxide, accounted for 17 percent and 4 percent.

As the Tehri reservoir led to the submergence of the entire forest area of Old Tehri town, the submerged flora including the fauna underwent decomposition and this led to emission of greenhouse gases in the atmosphere. It thus proved to be a major contributor to the rising temperatures of the town during the summer months.

4.3 Disrupted the local ecosystem

The first major effect of a dam is to alter the pattern of disturbances that the plants and animals of a river have evolved for. Many aquatic animals coordinate their reproductive cycles with annual flood seasons. Every flood is valuable in that it takes away nutrients from the land and deposits them in the river, providing food for the stream's residents. Floods also provide shallow back water areas on vegetated and shaded riversides; the young ones of many animals depend on these back waters to protect them from large predators.

4.4 Changes in the temperature cycle

Temperature is another problem. Rivers tend to be fairly homogenous in temperature. Reservoirs, on the other hand, are layered. They are warm at the top and cold at the bottom. If water is released downstream, it is usually released from the bottom of the dam, which means the water in the river is now colder than it should be. Many macro invertebrates depend on a regular cycle of temperatures throughout the year. When we change that, we compromise their survival (www.thdc.co.in).

4.5 Waterlogging and salinity

Canals themselves can directly contribute to waterlogging. If not properly lined, or maintained, significant amount of water can seep out of canals and inundate the land around. Also, when subsidiary canals are not well maintained, when the release of water is not properly monitored, or when drainage is not assured, waterlogging occurs (www.thdc.co.in).

Water logging not only reduces the anticipated agricultural benefits from irrigation projects but sometimes reduces them to a level below those prior to irrigation. A well-known and documented case is that of the Tawa Dam located in the state of Madhya Pradesh (www.thdc.co.in).

Waterlogging indeed destroys the natural vegetation of the local region, damages houses, buildings and roads.

4.6 Impact on Human Health

There are various impacts of the construction of the Tehri Dam on human health of the native state of Uttarakhand and the adjoining states too. One of the biggest health issue is Malaria. Although many efforts are being made, National Malaria Eradication Program and Malaria Research Center has carried out detailed field investigation of the area to recommend some preventive steps in order to nullify the causes of the harmful diseases. Action-plan for preventive/mitigation measures are being implemented by the state government efficiently (Sharma, 2008). The Tehri Dam is within a controversial arena since long times. Its pros and cons are frequently debated whenever a natural calamity occurs in the state of Uttarakhand as much is accredited to the mega hydropower plants that are being constructed in this ecologically fragile zone without much debate and discussions.

5. Impacts of Tehri Dam

5.1 Positive aspect

5.1.1 National impact

For the state of Uttarakhand and for those who were in favour of constructing the dam 'its construction' is the

synonym for nation-building. As the dam was constructed on Ganga-Bhagirathi, it was looked upon as a symbol of unity, as we see people say often 'Bhagirathi binds the whole country together' or 'Ganga is not only a holy river, but is most important for national integrity and oneness of India'.

Some of the nation round ramifications that emerged due to the building up of the tehri dam are:

- 1. 2400 MW of electrical power that has led to industrial development in the northern region.
- ii. Development of pisciculture.
- iii. With the formation of lakes and reservoirs various types of fisheries and migratory birds has been noticed in the region.

5.1.2 Regional impact

i. Electricity surge:

12% power generated by the hydroelectric project is being provided free to the state of Uttarakhand. About 2.7 lakh hectares of new area is being irrigated and an efficacious way of flood moderation during the monsoon season is being achieved through the storage of excess water in the dam.

ii. Water quality enhancement:

The water quality of the reservoir has not been affected as per data given by the monitory stations. A mathematical model even concluded that the reservoir remains under dynamic circulation throughout the year and does not remain stagnant (Sandipa and Pandey, 2012). This prevents contamination and eutrophication of the water in the reservoir.

iii. Better human health investment:

Some dust pollution that was observed in the adjoining regions of the project site was mitigated through preventive measures taken by the state government. The rise in vector-borne diseases like malaria and dengue were also prevented through surveys under the National Malaria Eradication Programme (NMEP) and the Malaria Research Centre (MRC) (Sandipa and Pandey, 2012); during that time which helped the state government of Uttarakhand to carry out several field investigations and educate the local inhabitants about the protective measures against malaria and dengue.

iv. Better employment opportunities:

Many people were benefited in terms of employment as the project managers employed the local people as workforce. As tourism sector has also flourished in the state due to the reservoir of the dam, it proved to be a boon for the local handicrafts industry of the region. Some sectors of the economy of the state were impacted but the difference in related statistics was not much as predicted by the authorities. As the dam construction ended in the year 2006, Figure 3 gives a comparative analysis of the livelihood patterns of the villages of Uttarakhand before the year 2006 and in the year 2010 (www.uttarakhand-tourism.com).



Figure 3: A comparative analysis of livelihood patterns before 2006 and in the year 2010.

5.1.3 Tourism:

Although the construction of the dam has obstructed the natural flow of the river Ganga-Bhagirathi but its most profound and positive impact can be assessed through the large growth of the tourism sector in the state of Uttarakhand. The state government has developed the 44



Figure 4: The 44 square km reservoir created out of the dam (Picture taken by authors of the article).



Figure 5: Tourists enjoy boating in the Tehri Lake accompanied by traditional sweets of Uttarakhand like Arsa as shown above.

square km of the water body that was created during the dam building (figure 4).

A beautiful drive uphill through the pines gives an amazing experience to the visitor. The Tehri lake is facilitated with various facilities for the visitors. One can enjoy boating, canoeing, jet-skiing, and various other sports and activities here (figure 5).

Due to better connectivity of road it has emerged as a major tourist town which has indeed boosted the hospitality industry and has provided employment to local population.

5.1.4 Impact on neighbouring states:

Tehri Dam reservoir provides about 162 million gallons of drinking water every day to about 4 million people of Delhi as well as 3 million people of Uttar Pradesh (Sandipa and Pandey, 2012).

Better road network that was developed during construction of dam led to connectivity of other states with the state of Uttarakhand that has brought huge economic boost to the state as well as to the nation.

5.2 Negative aspect

5.2.1 Environmental and geographical impact:

A dam is an obstruction in the natural flow of water. It is basically a wall that converts a lotic river ecosystem into a lentic lake ecosystem (Sandipa and Pandey, 2012).

This causes some changes in the basic riverine ecosystem.

Due to Tehri Dam construction the state of Uttarakhand has also faced some negative impacts and the geography of the area still experiences problems during the monsoon season like frequent landslides, minor earthquakes etc. The hills that surround the reservoir are in a threat to get collapse on the reservoir and cause problem to the people living downstream (Sandipa and Pandey, 2012).

The most important aspect of environmental impact of Tehri Dam is the change in the amount of dissolved oxygen in the water. It has also impacted the migration of fishes during breeding season.

5.2.2 Social impact

The Tehri Dam construction has faced protests and praise both in equal magnitude. It has impacted the local population of Tehri to a very large extent.

Recently the controversial issue of the Mullaperiyar Dam, between the states of Tamil Nadu and Kerala was undergoing scrutiny. While Tamil Nadu elaborates it to be strong enough Kerala on the other hand insists for a new dam. Such invocations also erupted in those days when the Tehri Dam was being constructed.

In the year 1991 a 6.6 Richter scale reading earthquake in the Tehri district of Uttarakhand invoked strong protests against the dam. Many people with their leader, the Chipko Movement Man, Sunderlal Bahuguna sat on a fast unto death for 45 days but their appeals went unheard, soon the protest also dwindled. People had to face rehabilitation and loss of livelihood at the time of the project enactment.

People lost their inherited lands, their social lineages and their cultural identity. It has been a major concern that the impact was felt badly and most importantly on the women of Uttarakhand.

On the contrary people have also experienced the positive impact of the dam as it enabled better road networks and better connectivity to hospitals; for example, the time of travelling from the Tehri district to AIIMS Rishikesh has reduced considerably.

Many leaders like Sunderlal Bahuguna, V D Saklani stood up as the voice of the common people to protest against the dam. Few lines that display the plight of the people can be quoted as:

"Tehri bandh ki denei char: Atyachar, begharbar, bhrstachar, narsamhar (Sailani, 2000)."

("There are four gifts of Tehri Dam: Atrocities, displacement, corruption and genocide.")

5.2.3 Ecological impact

Statistics reveal that about 4193.813 hectares of forest cover was used up in the construction of the dam (Sandipa and Pandey, 2012). The most important point to be focussed upon is that dam construction affects the chemical, biological, and physical properties of the water that flows in its reservoir or downwards to the habitats. As per geologists and chemists, there occur alkali-aggregate reactions and sulphate reactions in the concrete of the dam which leads to development of production of coliform bacteria and other microbes in the dam waters leading to formation of a breeding ground for various diseases. The presence of Fe, Mn, SO_4 , NO_3 , and NO_2 in the dissolved solids in the water below the dam is a threat to terminal

diseases in children and elderly people (Khalaf Ahmed Albaggar, 2021). Thus, the need of the hour is to educate the construction suppliers to provide adequate buildings materials free from harmful chemicals and toxins, so that the life of the dependent population of the dam-waters, can be saved (Charlwood and Sims, 2016).

The flora and fauna that was affected due to the dam construction was however preserved and conserved at other locations.

6. Conclusion

Tehri Dam construction forced thousands of families out of their native homelands. Many elderly people, unwillingly had to leave their native home behind to which they were emotionally attached. These displaced elderly people reported a feeling of dissatisfaction in life along with feeling of lack of enjoyment and loneliness as compared to non-displacement elderly. Further large-scale studies on the psychological variables related to development induced displacement should be done to cater to the needs of those affected (Thawani, 2021). Thus, it is a lesson for mankind to use the resources of Earth judiciously as Mahatma Gandhi rightly said - "The Earth Has Enough for Everyone's Need, But Not Enough for Anyone's Greed."

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Figure 6: A diagram showing summary of all impacts of Tehri Dam discussed in this section.

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