



## ENVIRONMENTAL AND SOCIOECONOMIC IMPACT OF KOL DAM HYDROPOWER PROJECT: A CASE STUDY OF TATTAPANI, DISTRICT MANDI, HIMACHAL PRADESH

**Dr. Pankaj Gupta<sup>1</sup>, Yogesh Mehta<sup>2</sup> and Amit Chanjta<sup>3</sup>**

<sup>1</sup> Course Coordinator, School of Environmental Studies, Department of Interdisciplinary Studies, Himachal Pradesh University, Summer Hill, Shimla-171005 Email: [pankajgupta08091975@gmail.com](mailto:pankajgupta08091975@gmail.com) (Corresponding Author)

<sup>2</sup> Project Fellow, Department of Interdisciplinary Studies, Himachal Pradesh University, Summer Hill, Shimla-171005

<sup>3</sup> Project Fellow, Department of Interdisciplinary Studies, Himachal Pradesh University, Summer Hill, Shimla-171005

### Abstract

Dams and hydropower projects ensure water for irrigation in summers or dry months and confirm drinking water supply and promote fish farming; yet, there are certain negative impacts linked with hydropower projects, like the flooding of large areas, thereby destroying the habitats of animals and displacement of the large population causing emotional trauma. It has also resulted in the submergence of flora, which decays anaerobically producing greenhouse gases. Millions of people around the globe have been displaced by the setting up of dams. Though the technical parameters pertaining to the setting-up of hydropower projects are ensured, the environmental and social parameters are often ignored or overlooked and the local communities have to pay for this. This paper is based on the fieldwork carried out in Tattapani and adjacent villages, which have witnessed the impacts of the Kol Dam.

**Keywords:** Environmental impacts, dams, hydropower projects, biodiversity loss, displacement, rehabilitation and resettlement

### INTRODUCTION

Though dams provide 20 percent of the world's electric power, these have always been in debate and controversy. There are more than fifty-seven thousand large dams worldwide, out of which China, the US, and India has the largest number of dams. Hydropower is a renewable energy source, which does not emit any pollutants. The use of hydropower for generating electricity started in the late 19th century. Cragside in Northumberland was the first house that was powered by electricity, and in 1879 Niagara Fall was the first place where a hydroelectric power plant was built on a commercial scale. However, the setting up of hydropower projects has both environmental and socioeconomic implications. Cernea (1997) described the social impacts of dam construction including population displacement and resettlement. He explained the lessons learned from the displacement of people, besides other social impacts of dam. Cernea (2000) summarized nine social risks of project development, viz. landlessness, joblessness, homelessness, marginalization, food insecurity, and growing morbidity, loss of access to common property resources, education loss, and social disarticulation. While talking about the positive and negative implications of hydropower projects, Koontza (2003) pointed out that hydropower generation requires moving water to work. Tilt, *et al.* (2009) concluded that the social impacts of dams are stronger on women, children, and poor families. Chandy *et al.* (2012) examined the community's perceptions of the environmental and socioeconomic impacts of hydropower projects in Sikkim. While benefits, such as employment have increased, changes in land use and livelihood are adverse impacts. Pandit and Grumbine (2012) studied the impact of hydropower projects in three major river basins, i.e. Ganga, Indus, and the Brahmaputra of the Indian Himalaya. They concluded that

nearly 90 percent of Himalayan valleys have been affected by the construction of dams and 27 percent of dams have affected dense forests. They proposed the SAR model which states that by 2025, deforestation and destruction due to dam construction would result in the extinction of twenty-two angiosperm, and seven vertebrate taxa and reduce tree species richness by 35 percent, tree density by 42 percent, and tree basal cover by 30 percent in dense forests. The environmental impacts of dams can be long-term or short-term and can be climatic, hydraulic, biologic, social, cultural, archaeological, etc. Paul *et al.* (2013) described the massive environmental impacts due to the construction of mega-dams including the disturbing ecological balance. Punetha (2017) highlighted the negative impacts associated with hydropower on Bhagirathi river valleys, such as decreased flora, fauna, agriculture, the flow of a river, and the aesthetic beauty of the valley, and increased water pollution, river bed quarrying for sand/stone and social-evils. These studies indicate that power projects have both positive and negative impacts and need to be managed to ensure sustainable development, which is the need of the hour.

## MATERIAL AND METHODS

For studying the impacts of Kol dam hydroelectric power project on Tattapani and adjacent villages, both primary and secondary data were collected from different sources. The research is descriptive and has been accomplished both quantitatively and qualitatively. For the accomplishment of the objectives, both primary and secondary data were collected using various tools. Primary data was gathered by using specially designed tools, like the interview method, Focused Group Discussions, field observation, etc. The study was carried out in Tattapani and adjacent panchayats which fall in the Project Affected Area, located in tehsil Karsog of district Mandi. Both males and females of different social groups were involved and their views were recorded. The focused group discussion covers the followings topics:

1. Awareness of people about the surrounding environment.
2. Environmental impact of Kol Dam as on forest, land, air environment.
3. Impact of setting –up of Kol Dam on the social environment
4. Issues pertaining to compensation, and infrastructure facilities.
5. Problems faced by the local people due to the setting of the dam.

The secondary data was collected from relevant published and unpublished literature gathered from different sources including national and international journals, books, and reports. The data collected has been analyzed with the help of computer-aided software. Diagrams and photographs have been used to interpret the results. Before undertaking data analysis, the collected data, which was scattered and unorganized, was organized suitably. Analytical tools have been used to interpret the data.

## RESULTS AND DISCUSSION

### Study Area

Tattapani is located in tehsil Karsog of Mandi district at a distance of 52 km from Shimla. It is situated on the right bank of river Satluj at an altitude of 2,230 ft. above sea level. Tattapani is located deep in the Satluj basin where during summers, the sun hits fiercely and the heat is exhausting, the nights and days are hot. But the vegetation and river have a pacifying effect and are conducive to the communities living in the basin. Due to altitudinal variation, the vegetation types in the entire basin range from tropical to alpine. Since Tattapani is located in a river valley with the most fertile and farmable agricultural lands, that permits the cultivation of a variety of crops and vegetables. The people cultivate rice, maize, sesame, barley, wheat, peas, mustard, potatoes, and other seasonal vegetables.

Though the panchayat is situated on the foothills and there is no dense forest nearby, still there is rich floral and faunal diversity. Plants provide food, medicines, fodder and forage, fuel wood, flowers for celebrations, raw materials for agricultural tools, timber for construction, and many more useful items. People in the project-affected area depend on agriculture and forest resources. They collect medicinal plants, fodder, fuel wood, and timber wood from nearby areas. People also use plants for treating various diseases and are dependent on surrounding plant resources for a very long time. The floral diversity of the study area includes *Achyranthes aspera*, *Adhatoda vasica*, *Aegle marmelos*, *Agave Americana*, *Bauhinia verigata*, *Bauhinia vahlii*, *Berberis aristata*,

*Butea monosperma, Calotropis gigantea, Cannabis sativa, Celtis australis, Dalbergia sisso, Datura metel, Emblica officinalis, Eucalyptus globulus, Ficus auriculate, Ficus bengalensis, Ficus religiosa, Grewia oppositifolia, Grewia oppositifolia, Indigofera gerrardiana, Juglans regia, Mangifera indica, Morus alba, Murraea koenigii, Pistacia intergerrima, Prinsepia utilis, Prunus cerasoides, Quercus leucotrichophora, Robinia pseudoacacia, Sapindus mukorossi, Tinospora cordifolia, Vitex negundo, Zanthoxylum armatum, Zizyphus jujube*, etc. The people use various locally available plants as fuel wood and fodder. Fuel wood utilization is comparatively more and the local flora is under pressure. The area has a rich biodiversity with eco-cultural connotations. Most plants have multiple uses such as edible, ornamental, fencing, thatching, and sheltering besides magico-religious purposes. A number of wild plants are used on festive and religious occasions. The fauna of the area can be categorized into two groups: domesticated and wild. The domesticated animals of the area are cows, goats, buffaloes, dogs, cats, and bulls. The wild animals/birds spotted in the area are the pigeon, parrots, sparrows, wild goose, red junglefowl, vulture, crow, common quail, grey francolin, etc.; mammals, such as monkey, langur leopard, goral, wild cat, hare/rabbit, barking deer, sambhar, snakes, frogs, and lizards.

### **Issue of concern linked with project**

There were many critical issues regarding the project, for instance:

- Land acquisition
- Danger to the existence of religious site "Tattapani"
- Displacement
- Financial distress
- Threat to local culture
- Submergence of sacred hot springs
- Court decision (failure of environmental justice)
- Insufficient compensation

**Shops/ Commercial establishments in the village:** There are approximately 10-15 shops in Tattapani, but there are no industrial units in the village and surrounding area.

**Economic activities:** Village's economy mostly depends on agriculture as every household has its own land and many people are employed in the government sector as well. The land is mostly used for agricultural, horticultural activities, and vegetable cultivation. Rabi and Kharif crops are grown according to the seasons. Rabi cropping includes the cultivation of wheat, pulses, mustard, linseed, etc. Kharif crop includes cultivation of maize, groundnut, rice, and millet. There is no landlessness in the village. The average land holding size of people is between five to eight Bighas.

**Sources of Irrigation:** The entire land is irrigated. Irrigation is done by *khul* as there is no lift irrigation, though people also depend on rainfall also.

**Source of drinking water:** *Baudi*, tap water, and hand-pump are local sources of drinking water.

**Access to forest resources:** Forest is used mainly for gathering fuel-wood, fodder, other forest products, etc. The forest is closed from time to time by villagers to avoid over-exploitation. Current rates for agricultural land vary from one area to another. The government rate of land in Thalli is approximately Rs. 8 Lakh/Bigha (1 Bigha= 20 Bishwa). The coming up of the project has affected the land.

**Project Description:** Kol dam build across the Sutlej River in Bilaspur district of Himachal Pradesh is used for hydroelectric power generation by NTPC with 800 MW power stations. Kol dam is an embankment dam. It is one of the top tallest dams in India with a height of 167 meters. Kol Dam Hydropower Project is an embankment dam on the Sutlej River near Barmana on the Chandigarh-Manali Highway (NH-21) at the border of Bilaspur and Mandi districts. The total capacity of the project is 800 MW and works started in 2004. Considering the high silt content of River Sutlej, the life of the reservoir is expected to be 30 years. The incomplete impoundment of water in the reservoir started in December 2013. Kol Dam Hydropower Project was planned to export energy to Delhi, Haryana, Punjab, Rajasthan, Uttar Pradesh, Jammu & Kashmir, and

Chandigarh, besides feeding the state grid as well. Tattapani and other hamlets like Thalli, Shakara, Seoni, Shakrori, and Sarsour have sacrificed their biodiversity and natural and cultural resources to the Kol Dam activities.

#### A. ENVIRONMENTAL IMPACTS

Dams have been the focus of many deliberations linked with environmental and sociocultural issues. Big dams have had substantial negative impacts on cultural heritage through the submergence and degradation of archaeological structures. In many cases, no actions are taken to curtail or lessen the loss of cultural and archaeological resources. Affected communities constantly raise the issues but in vain.

#### **Loss of Hot Water Sulphur Spring**

Having sacred and religio-cultural connotations, Tattapani, famous for its hot water springs with a temple of Jamdagni Rishi, has lost the precious hot water Jacuzzis and linked ritualistic performances with the coming up of 800 MW Kol Dam. Heated by geothermal power, the hot water oozes from the earth's crust on the bank of River Satluj and merges with the river water. These water pools contain dissolved chemicals and minerals which exhibit curative properties and offer a soothing therapeutic bath. For eternity, people have reaped the benefits of hot water springs, which ease muscular pains, dissolve kidney stones, and cure high blood pressure, and many skin problems. Apart from their healing properties, the thermal springs act as tourist destinations ventured by gazillions to witness these prodigies. Himachal is blessed to have many natural hot water springs, the important being Vashisht, Kheerganga, Manikaran, and Kalath in district Kullu, Tattapani in district Mandi, Tatwani in Kangra, and Thopan in Kinnaur.

Not only Tattapani but many adjacent villages and small hamlets by the riverside have been affected by the dam. There are myths and legends linked with Tattapani. It is believed that the ancient Rishi Jamdagni meditated on the banks of the River Satluj. According to a legend, King Sahasrabahu of Bhajji estate once attacked Rishi Jamadagni, the father of Lord Parashuram. At that time Lord Parashuram was bathing in the hot water springs of *Manikarna*. When he came to know about the assault, he reached Tattapani and squeezed his *dhoti* and wherever its water splashed, the hot water springs emerged.

Tattapani is known for *Tula daan*, which is one of the important rituals suggested for those getting rid of health problems, or planetary influences. During this ritual, the person for whom it is performed sits on one side of a beam balance and grains, sugar, ghee, precious metals, etc are kept on the other side. The weighed food grains and valuables are then offered to a *brahmin*. This ritual is usually performed on the banks of a holy river after a holy dip in its water. Though the government has been making consistent efforts to continue and restore back the age-old tradition, the natural Jacuzzis, which have been lost to the man-made reservoir, cannot be brought back.

People have experienced drastic changes in the local weather, which is slowly affecting their agriculture. The freezing dawns and dusks with misty winters are attributed to the reservoir for it surges the moisture level. The increasing attention toward the environment resulted in creating a difference among the planners, engineers, and society who are against dams. Conversely, it becomes inevitable to build dams to enhance the prosperity of a nation by realizing the socio-economic and technological developments.

Thus, living cultural, social, and ecological values must be taken into account in the planning of the studies based on the new understanding. With the passage of time, the water resource planners gave importance to ecological problems in their plans. The planners must be activist and permissive in assessing the critical needs. This novelty is essential for alternatives, for instance designing less water demand, and inspiring solutions which are not operational in flood control.

Construction of the Kol dam, which started in 2003, got delayed due to various environmental and geological difficulties which increased the cost of construction. Commissioning of the project was initially scheduled for 2009 but was rescheduled to 2015. The NTPC has recognized postponements to geological issues, including seepage which was later resolved besides the issues of oustees who were not contented with the rehabilitation and compensation and in turn, stopped the work. In December 2013 the impoundment of water in reservoirs started. The plant was planned to supply energy to the states of Delhi, Haryana, Punjab, Rajasthan, Uttar Pradesh, Jammu & Kashmir, and Chandigarh, besides serving the state grid also.

Climate change, change in rainfall patterns, loss of landscapes and aesthetic degradation are the main environmental impacts. Water quality impacts (Physico-chemical, biological), potential risk of floods, etc. are other probable impacts in the future.

### **Biodiversity Loss**

Loss of tree species due to submergence has a serious impact on the local biodiversity.

### **Impact on Agriculture**

Loss of agricultural land as many people lost their agriculture fields during the submergence.

In order to assess the people's perceptions about the Kol dams, a discussion was conducted. Human activities have amplified the water turbidity because of dam construction;

- The water regime has changed, unpredicted floods may occur and therefore vegetation and natural structures on the riverbanks are likely to be impacted in the future as well;
- Eleven families of Tattapani and more than fifty families of adjacent villages were displaced;
- Meagre compensation to the people;
- No additional space is provided for livestock rearing, hence, there is a loss of the additional source of income;
- People faced financial limitations for building new houses
- For elevating their standard of living, people bought cars, orchards, houses, etc. Some of them have misutilized the compensation money, which has increased the consumption of drugs among villagers and the incidence of domestic violence.
- The water level of the reservoir was pre-determined but it went beyond that after the commissioning of the project. Ten to eleven houses experienced water seepage problems and cracks on the walls. Many animals die because of no fence around the reservoir. Though the level of the reservoir never crossed the danger level if it goes up then it may cause flash floods or threaten the nearby land lying including agricultural land, residential area, forests, and public infrastructure like hospitals, colleges, etc.
- The water was not released instantaneously but gradually. The submergence of hot springs occurs concurrently with the formation of reservoirs. The people realized that if they won't have taken the compensation, then the hot springs could have been saved.
- The people faced emotional trauma due to the submergence of ancestral lands as their sentiments were attached to the land. They only realized the loss after the submergence of the hot springs of '*Tattapani*'.

Change in the air moisture content, air temperature, and air movements, besides topographical changes caused by the still water, has been noticed. This has affected the land use and cropping pattern of the area together with the loss of flora and fauna. Kol Dam has considerably affected the sociocultural and economic mosaic, mostly by enforcing people to migrate, thus, affecting them depressingly.

Similarly, the biological life of the river has undergone change both in the reservoir and downstream. The components of the biosystem that are disturbed due to the Kol dam are the watered parts on the river bank. During the filling of the dam, while the land remained underwater the land area has decreased; but, the water-land boundary has extended. Thus, plant, animal, or human settlements have undergone a change. Forests and agricultural areas got submerged in water. The area may turn to marshy land depending on the soil structure.

While discussing the general perception and awareness about the project, it was found that the local villagers have raised the issue of insufficient compensation assured to the affected families. There has been significant land acquisition and displacement.

### **B. SOCIOECONOMIC IMPACTS**

There was a loss of land in the village. Submergence of land resulted in the loss of different trees (fodder, timber, fuel wood, and fruits). The construction of the dam resulted in the loss of assets. This might have a serious impact on local biodiversity and the lifestyle of project-affected families. Some forest land also got

submerged due to project activities. Due to this, there was a huge loss of grazing grounds, a shortage of fuel wood, fodder, and medicinal plants for villagers.

### **Loss of residential/commercial structures**

There was a loss of houses, lands, cremation ground, crops, etc.

### **Protected areas near village**

There is no national park around the village; however, the forest land has submerged and the coming up of the project has affected Tattapani, the sacred site.

### **Rehabilitation & Resettlement**

The land was acquired for the project under Section 4, 17; but the compensation was not given appropriately. Job for one person per family was promised but not fulfilled.

As per the MoU signed, one percent of revenue in cash was to be given to the people but till now it has been not paid. MoU was signed without proper rehabilitation and Rs. 15,000 was given as one-time compensation. Rs. 60,000 was given as a rehabilitation package. Goodwill package was given according to the occupation of an individual.

The displaced people have been given plots in Sunni for setting up a new colony, which still lacks a new hospital, park, proper sewerage, etc.; but after the construction of projects, the cost of land and standard of living has improved and increasing cash flow has improved the economy.

During the fieldwork, an effort was made to undertake the biodiversity mapping to include flora and fauna, and medicinal herbs. While documenting floral wealth, it was observed that most of the plants found in and around have multipurpose uses. Some of these plants are lost with the progression of the Kol dam. The villagers especially the women folk expressed their deep concerns regarding changing scenario of village life, a decline of centuries-old culture, and the price that a peaceful society has to pay for the Kol dam. Despite the efforts of local people and NGOs the matter was overlooked or was ignored by the government and has not grasped the seriousness. The prevailing situation clearly suggests the fault of the project implementing agency in handling the situation.

People have lost their ancestral land. There is seepage of water in the houses due to reservoir water. There is a threat of water-borne diseases and wild animals to people living near the river. Seepage of water in houses resulted in cracks. No fencing has been done on the banks of the River. The road on the bank of the river is under threat. An old resident revealed:

Tattapani, which derived its name from the hot sulphur water springs, will never be seen again as the banks of the river got submerged Kol Dam reservoir. The bridal paths and cremation grounds located on the banks have been ruined. Evenings and mornings have become colder, with mercury dipping by 4 to 5 degrees Celsius with dense fog during winters. The drop-in temperature and fog are due to the reservoir as it increases the humidity.

Another added:

With the submergence of River banks, those earning a living by delivering sand have been rendered unemployed. Many people used to extract sand from the river bed, but no longer now. The place was also a major tourist attraction due to the hot water springs but now the government will have to introduce alternate activities to provide livelihood opportunities to the local residents.

According to a local resident:

The National Thermal Power Corporation gave funds to PWD to reconstruct the hot water Sulphur springs but these will be manmade while the natural springs which were part of the cultural legacy are lost forever. The backwaters of the 37-km dam extend right up to Lunsu village near Chabba powerhouse. The river banks, which used to be busy with spiritual activity in January, have disappeared. January 2015 witnessed the last 'Makar Sankranti' before the submergence of water in the reservoir.

The construction of dams is one of the man-made reasons requiring the rehabilitation of communities. More than fifty families have been displaced under the Kol Dam Rehabilitation Plan, which disrupted their entire life. Unintentional, upsetting, and delayed repositioning, as well as the defiance of development prospects for years and decades, has illustrated the resettlement process.

## Loss of Cultural Heritage

The backwaters of the reservoir have extended up to Lunsu village near the Chabba powerhouse, thus affecting the biodiversity and cultural heritage of the entire stretch. Locals say that the amenities, like, small shrines, sacred trees, and cremation grounds located on the river banks have submerged. In the want of government or common land, these facilities are expecting reinstitution. The temple of Rishi Jamadagni, which was once thronged by thousands of pilgrims, the sacred *peepal* tree by the riverside, which used to answer the prayers of its adherents, the school that edified progenies and the tourism guesthouse that satisfied the aspirations of vacationers, have now faded into oblivion. A worth visiting cave at Sarsour, which was a few kilometers from Tattapani, has also submerged. Being an ancient religious site, the cave was dedicated to Lord Shiv. The natural cave at a depth of thirty feet had more than a hundred *Lingas* or the '*Ganas*' of Lord Shiv. Despite its religious significance, it offered a place for nature's admirers, where people have witnessed the stalactites and stalagmites. It remained an ideal spot for fishing and swimming. But the backwaters of the reservoir have taken away this spot from pilgrims and tourists. The river banks of Tattapani, which once thrilled with the euphoria of festivity on *Makar Sankranti* and *Baisakhi*, have lost their charisma. The *Uttarayan* movement of the Sun starts from *Makar Sankranti* and it is believed that taking a dip in a holy river and making donations on this occasion relieves a person from all sins. But such holy dips will not be possible now.

## Psychological Trauma

Advancing age increases the attachment to a place and to the social and physical milieu. The majority of the elderly expressed to remain independent, till the time permitted and wanted to live in the ancestral land amidst their family and relatives. But people in Tattapani and surrounding villages had to leave the ancestral land and natural resources on which they remained dependent for their sustenance. All those who were displaced were fully aware that there was no chance of returning back to their ancestral homes. Thus, displacement due to natural or man-made circumstances has always been upsetting. The submergence of river banks has affected the livelihood of those earning on vending sand. The people displaced due to dams had to face considerable economic, cultural and psychological shock.

Although environmental issues are taken into consideration, the potential cultural heritage impacts of developmental projects are overlooked in the planning process. River valleys have nurtured many ancient civilizations, the significance of which must be realized while planning a developmental activity. Cultural heritage comprises traditional practices, resources of people, and their material expressions in the forms of sacred elements of natural sites, or artifacts and buildings. It is important that when the cultural assets have a spiritual or religious significance, all activities must be deliberated beforehand with the consent of the nearby communities. Furthermore, the evaluations must culminate in a mitigation plan to address the cultural heritage issues recognized through conservation, relocation, and documentation.

Studies on outcomes of dams include ecological, biological, geophysical, political, and socio-economic assessments and among these, ecological impacts are most important. The impacts of hydropower projects become a matter of incongruity. Environment Impact Assessment is the process of examining and handling the expected and inadvertent consequences on the environment of planned interventions to bring about a sustainable and justifiable biophysical and human environment (Vanclay, 2002). By identifying the probable impacts of large projects, organizations can make better resolutions. The dams and hydropower projects that are at different phases of construction and commissioning in Himachal have raised several alarming issues with unanswered inquiries. In the last few years, the social and environmental concerns related to dams in the mountainous regions have caught the attention of ecologists and social activists. These impacts are linked with modifications in the social, physical, and biological environment, which manifest in form of vegetation loss, topographical disturbances, changes in water bodies, involuntary resettlement, health problems, and transformation of cultural values.

People in the study area pointed out certain issues of concern with the regard to the execution of the Kol dam, which is in harmony with the observations made by Lepcha (2013) wherein the researcher proposed that the indigenous ecological knowledge system of communities must be taken into consideration during the project planning, construction, and operation. The project implementing agency has not taken into account the involvement and participation of the local community, which has increased the conflict between people and the project implementing agency. Likewise, the stakeholders in Sikkim also reported that they were not involved

directly in the planning process for hydropower. Thus, several conflicting issues, for example, impacts on water sources, a decline in agriculture productivity, deteriorating environmental conditions, land acquisition, and lack of proper rehabilitation and resettlement of project-affected population, etc. remained unaddressed. The project activities increased damage and cracks in the private land, houses, and fading of local culture. The people's perceptions of environmental and socio-economic impacts due to Kol dam identified mixed opinions of people. People in the study area reported the appearance of cracks in houses; submergence of land and loss of biodiversity, which bear a resemblance to the observation made by Punetha and Negi (2017), who revealed the negative impacts of projects, decrease in biodiversity, agriculture, the flow of the river, increase in water pollution, river bed quarrying for sand/stone, increased incidence of social evils as the more common negative impacts and among the positive impacts improved standard of living, road connectivity, means of transport, public facilities, etc. were common. In order to overcome the situation, they suggested multi-disciplinary scientific studies involving people's participation in planning and decision-making so as to make these projects sustainable.

Except for a few implications that the project has had on the local environment and ecology, as pointed out by the respondents the project implementing agency has made efforts to check the likely impacts projected in the EIA and complied with many issues raised during the public hearing. The technical, socio-economic, and environmental issues were given due attention. On the contrary, Panwar, *et al.* 2010 pointed out that all hydroelectric projects in the Chamba district were given consideration regarding technical design and economic issues but negligible attention was given to social and environmental issues, which are more important in the context of the remote and earthquake sensitive zone of Chamba district.

Besides environmental impacts, the setting-up of dams leads to the submergence of floristic diversity, and the falling of trees leads to loss of biodiversity. Panwar, *et al.* 2010 pointed out that a total of 165 plant species found in the submergence zone were used by the project-affected population for fuelwood, fodder, wild edibles, etc. Such circumstances not only lead to biodiversity loss but affect the dependence of people on the forest resources, which calls for a biodiversity management plan incorporating socio-economic considerations.

The welfare of local people must be taken into consideration during the planning and must adopt a model so that the impacts and effects of developmental activities can be abridged. To maximize the positive impacts and mitigate the negative environmental, and socioeconomic impacts, the sustainability of water-based projects is essential. Lata *et al.* (2013), while talking about the impact of Sorang HEP, Kinnaur stated that socio-economic and cultural impacts of hydropower projects and environmental changes are rooted in the complex interactivity between social and biophysical environments. Man is a vital component of the environment and likely an agent for ecological change. Thus, environmental change if any is deeply entwined with momentous change that occurs within society.

Of the various impacts of dams, the one linked with the loss of agricultural land or impact on agricultural produce has serious implications. The loss of agricultural land can be compensated, but the reduced agricultural productivity needs scientific validation. Though people have lost agricultural land in Kol Dam, for which they have been compensated; however, the other issues linked with agriculture and livestock rearing must be taken up earnestly. Katoch *et al.* (2016) studied the impacts of Nathpa Jhakri hydroelectric power project on-farm production systems, income, and livelihood status in Kinnaur and Shimla districts of Himachal Pradesh and stated the traditional cropping pattern has given way to the commercial agriculture in the region, which needs to be analyzed in the light of scientific explanation. The study has analyzed the impacts of the Kol dam in the light of people's perceptions. Thus, in the era of capitalization of river water for power generation, collaborative and planned approaches must be taken into consideration, mainly in the context of Himachal.

## CONCLUSION

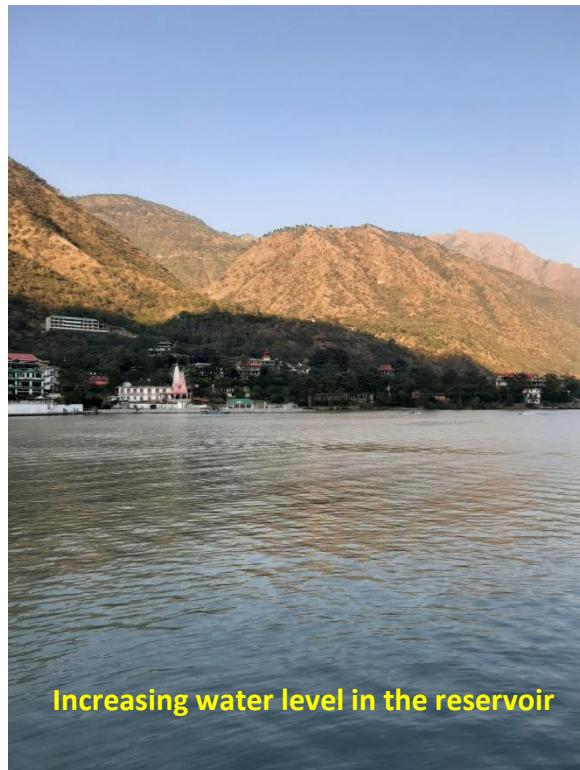
Mountain hamlets are tranquil and mystic, they are the most pictographic sites that one could visit on earth, with nature's charms, and sources of freshwater that fulfill the everyday requirements of the masses. Tattapani will never be the same again as the river banks have been water-logged by the reservoir of Kol Dam. The progression of Kol Dam has brought about significant changes in the biodiversity, hydrology of rivers, and mountain ecosystem, with an accumulation of silt and debris on the banks of the river Satluj which are likely to impact the ecological balance of the area in the future as well. Construction of dams and hydropower projects

around the globe have shown that these activities result in a large-scale restructuring of soil and water which have not only affected the river beds and slopes on both sides of the river but the habitats, livelihoods, biodiversity downstream of the dam.

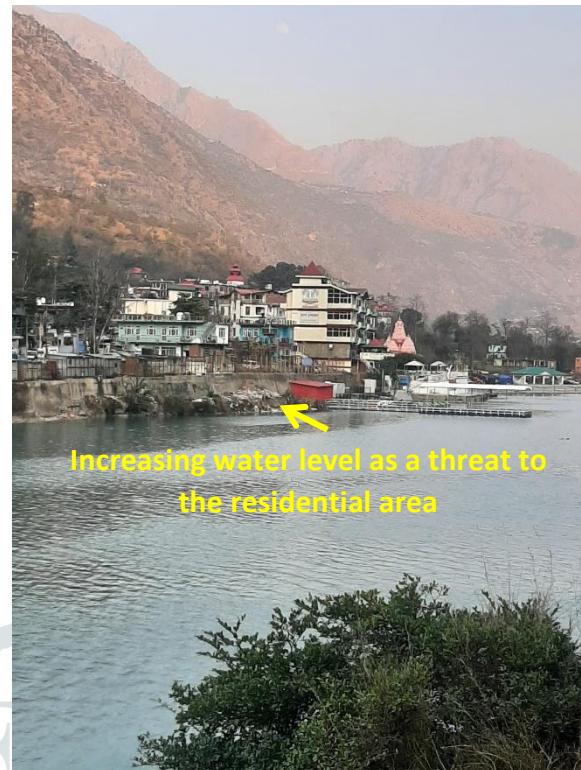
## REFERENCES

- Cerneia, M. M. (1997). Hydropower dams and social impacts: A sociological perspective. Social assessment series. Paper No. 16. Social development paper- environmentally and socially sustainable development.
- Cerneia, M. M. (2000). Risks, safeguards and reconstruction: A model for population displacement and resettlement. *Economic and Political Weekly*; 3659-3678.
- Chandy, T., Keenan, R. J., Petheram, R. J. and Shepherd, P. (2012). Impacts of hydropower development on rural livelihood sustainability in Sikkim, India: community perception. *Mountain research and development*; 32(2), 117-125.
- Katoch, A., Guleria J. S. and Kumar, A. (2016). Impact of Nathpa Jhakri hydroelectric power project on farm production systems, income and livelihood status in Kinnaur and Shimla districts of Himachal Pradesh. *Himachal Journal of Agricultural Research*; 42(1): 55-64.
- Koontza, R. (2015). What's good and what's bad about hydropower. <https://www.kidsdiscover.com/teacher-resources/whats-good-and-whats-bad-about-hydropower/>
- Lata, R., Rishi, M. S., Kochhar, N. and Sharma, R. (2013). Socio-economic impacts of Sorang hydroelectric power project in District Kinnaur, Himachal Pradesh, India. *Journal of Environment and Earth Science*; 3(3).
- Lepcha, T. (2013) Hydropower project on the Teesta River: Movement against mega dams in Sikkim In *Dialogue on Water Conflicts in India*, Pune.
- Negi, G. C. S. and Punetha, D. (2017). People's perception on impacts of hydro-power projects in Bhagirathi river valley, India. *Environmental Monitoring and Assessment*: 189:138.
- Pandit, M. K. and Grumbine, R. E. (2012). Potential effects of ongoing and proposed hydropower development on terrestrial biological diversity in the India Himalaya; 1-11.
- Panwar, S., Agrawal, D. K. and Negi, G. C. S. (2010). Impact assessment of a hydroelectric project on the flora in the Western Himalayan region based on vegetation analysis and socio-economic studies. *Journal of Environmental Planning and Management*; 53 (7).
- Paul, S., Singh, H. B. and Hazarika, R. (2013). Environmental impacts in the construction of dams. *International journal of innovative research and development*; 2(11):
- Punetha, (2017). People's perception on impacts of hydro-power project in Bhagirathi river valley, India. Springer International Publisher Switzerland
- Sharma, H. K. and Rana, P. K. (2014). Assessing the Impact of Hydroelectric Project construction on the Rivers of District Chamba of Himachal Pradesh in the Northwest Himalaya, India. *International Research Journal of Social Sciences*; 3(2): 21-25.
- Tilt, B., Braun, Y., and He, D. (2009). Social impacts of large dam projects: A comparison of international case studies and implications for best practice. *Journal of environmental management*; 90: S249-S257.
- Vanclay, F. (2002). Social Impact Assessment. *Encyclopedia of Global Environ. Change*; 4: 387-393.





Increasing water level in the reservoir



Increasing water level as a threat to the residential area



Increasing water level as a threat to the newly constructed bridge at Tattapani