



VIABILITY ANALYSIS OF SMALL HYDROELECTRIC POWER PROJECTS IN SAAL VALLEY IN RAVI BASIN OF CHAMBA DISTRICT IN NORTH WESTERN HIMALAYAS

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Abstract: Since time memorial man has been dependent on *Mother Nature* for his all sorts of needs. This dependency of human beings on natural resources is increasing day by day with the increase in population. This ever-growing assault on the limited resources is affecting the sustainability, especially the non-renewably energy resources. Conservation for sustainable future is need of the hour and led to the paradigm shift from the use of non-renewable energy resources to renewable energy resources. And use of water resources to meet out increasing energy requirement of any economy or society has increased to greater extent in past four decades and almost all rivers/rivulets in Himalayan region has been targeted and Ravi basin in Northern western Himalayas is not an expectation.

Ravi being one of the five perennial rivers of Himachal Pradesh, as per official records the hydropower generation potential capacity of this basin has been assessed 2301.5 MW and out of which 1038.5 MW potential has been commissioned so far by installing four major power projects. There are more than 100 mini and micro hydroelectric power projects are in different stages of their execution. In approximately 20 kms long Saal valley there are 8 mini power projects are in different stages of their execution. As per the version of PRIs these projects are expected to affect the lives of thousands of villagers negatively as well as the physical environment of the area. Because of opposition of people as well as in view of natural disasters the viability of such power projects in north west Himalayas is being questioned. The disturbances in the lives of thousands of people and fragile physical environment can be saved by using the Dr. Anil Joshi's model of converting water mills into electricity producing units.

Key words: Development; Natural Resources; Ravi Basin; Power Projects; Viability.

I. INTRODUCTION

Man being the finest creation of nature has basic right to live in such environment, in which he can lead a peaceful life with discipline, with a sense of duty to preserve and conserve the environment for the future generations by making effective planning in respect of air, water, land, hills, trees, plants and wild animal especially natural eco-system. Since time memorial he has totally been dependent on "*Mother Nature*" for his basic needs. Since ages, man has involved himself in making his life full of comforts. In search of better living style with the development of civilization, day back in 1672 Bon Guericke of Prussia¹ has invented first electric generator which produce static electricity and there are many others like; English physician William Gilbert, Ben Franklin, Italian physicist Alessandro Volta, Michael Faraday, American Thomas Edison, British scientist Joseph Swan, American inventor and industrialist George Westinghouse and Scottish inventor James Watt, Andre Ampere² are few to count who are fundamental in the invention of electricity. Right from that time till date the electricity has got the status of essential commodity of our routine life.

The potential capacity of hydropower generation in India is 1, 50, 000 MW³ out of which only 20 per cent has been tapped. In Himachal Pradesh, there are five natural drain systems in form of five river basins having 22000 MW potential capacity of hydro power generation⁴. Himachal Pradesh has completed 50 years of hydro-power generation on 23rd of October, 2014 and since 1964 state has progressed a lot, starting with mere two projects in 1960s today state has more than 400 projects of different power generation potential and are in different stages of their execution⁵. Focusing on three major basins (more than 70 % power generation potential), i.e., Ravi, Satluj and Beas the state is going to be *Electricity State of India*⁶.

3.1 Hydel Sector in Himachal Pradesh: As compared to other states of India, Himachal Pradesh is one the fastest growing state as it has maintained an above average economic growth over the last some decades⁷. The state mostly relies on four sources for the economic growth of the state; agriculture, tourism, cement and hydropower. Agriculture cannot expand as state has limited cultivable land, for tourism there are number of opportunities and government is doing its best to develop tourism, the remaining two sectors are based on natural wealth; i.e. availability of CaCO₃ and perennial sources of water, which is also available in abundance. Speaking particularly about the hydro power generation, the state has five perennial rivers and thousands of rivulets which are being targeted to make state an electricity state. These rivers and rivulets enable Himachal to sell electricity to neighboring states like; Delhi, Punjab, Haryana, Rajasthan etc. through grid-system⁸.

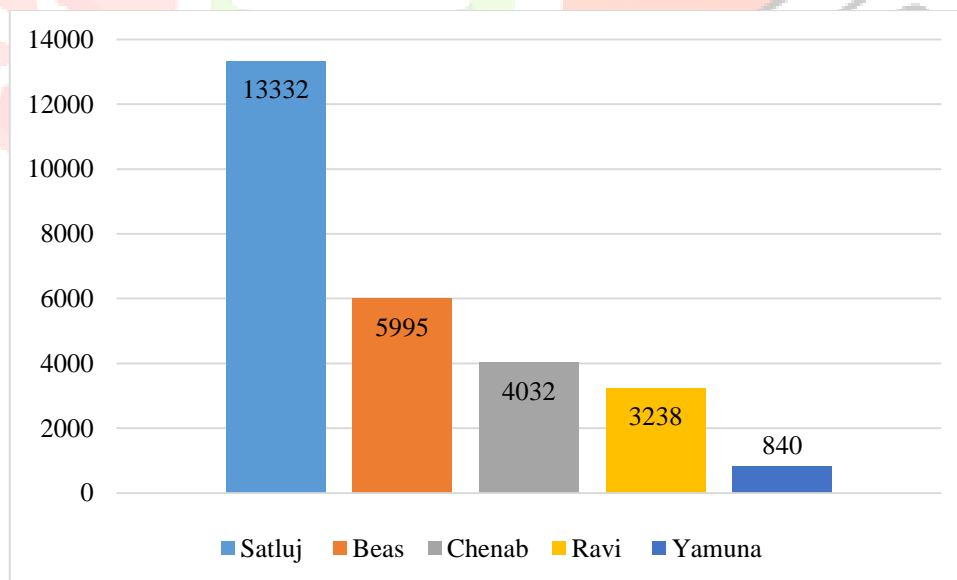
Himachal Pradesh being a hilly state is best suited for hydropower generation and presently it is estimated to produce 25.9 percent of India’s hydropower potential. Presently, state has an estimated to produce 27,437 MW of hydro power through the construction of various hydel projects on five river basins. Out of which 9,433 MW has already been commissioned and projects of 3,490 MW⁹. Basin wise detail of potential capacity is as follows:

Table:1
Showing Basin-wise Potential Capacity of Hydropower Generation

Sr. No.	Name of Basin	Potential Generation Capacity (in MW)
1.	Satluj	13,332=00
2.	Beas	05,995=00
3.	Chenab	04,032=00
4.	Ravi	03,238=00
5.	Yamuna	00,840=00
	Total	27,437=00

Source: Author’s compilation from different sources available on internet

Figure:1
Sowing Basin-wise Potential Generation Capacity Generation Capacity (in MW)



Source: Authors’ compilation from different sources available on internet

3.2 Hydroelectric Power Development in Peer Panjal and Dauladhar: Hydroelectric power developmental activities are in progress in the Peer Panjal ranges of young Himalayas, which are in formation stage, for the last forty years. Undoubtly, energy generation is the need of the hour and sine-que of any development, but on the other hand issues related to power generation are not being addressed properly. People as well as physical environment are being affected considerably, as whole human and physical dimension of such development is not been addressed properly which is creating many problems, which will increase with the coming up of these developmental activities in the region where such activities have been planned in particular and in whole state/country in general. Speaking specifically, in wake of climate change, which is almost reality now, mentioned areas are expected to affect the most¹⁰.

3.3 Power Projects in Ravi Basin: Specifically speaking about Ravi basin, this basin has about 40 small identifiable rivulets in the about 200 km length of water-shed of Ravi in India and as mentioned earlier, its potential power generation capacity has been assessed about more than 3238 MW of all rivulets and tributaries. Hydro power projects on Ravi has been started way back in 1980s with first project of NHPC i.e. Baira-suil power project of 198 MW. Then after in 1990s Chamera series of projects i.e. Chamera-I, II, III of 540, 300 and 231 MW respectively, Holi project of 5 MW, Bharmour power project of 70 MW is few to count which comes to the total 1344 MW. After exploiting Ravi 1344 MW, now state government has made target the tributaries of Ravi (small nallas and rivulets). In Chamba district, there are about 100 mini/small and micro power projects in different stage of their execution in Ravi basin. State Government has signed MoU with different executing agencies and is in different stages of their execution¹¹.

3.4 Present Status and Condition of Ravi: As mentioned earlier Ravi has been heavily targeted for hydropower generation since 1970s and at present there are 159 small/mini/micro power projects of different magnitude have been either installed or are in different stage of their execution. Presently 40.689 kms Ravi is in tunnel and not on its natural route and 36 kms in reservoirs of Chamera series of projects only¹². This diversion is shown in the following table:

Table:2
Showing the Present Status of Ravi after the Installation of Power Projects

Name of the Project	River/tributary	Year of Commission	Installation Capacity (in MW)	Diversion for HRTs (in kms)	Diversion for TRTs (in kms)	Reservoir (in KM approximately)	Total diversion (in kms)
Baira-suil	Baira-suil	1984	0198	07.063	0.048	00.500	07.111
Chamera-I	Ravi	1994	0540	06.400	2.004	29.000	08.404
Chamera-II	Ravi	2003	0300	07.083	3.046	02.500	10.129
Chamera-III	Ravi	2012	0231	15.093	---	04.500	15.093
		Total	1269	35.639	5.098	36.500	40.737

Authors' compilation from data available on NHPC website and different sources available on internet

Because of these projects, the physical health of river has affected badly which includes specifically, disappearance of river from its natural route and creation of reservoirs between hills of Dauladhar and Peer Panjal in north western Himalayas. Focusing particularly on dried patches of the river and rivulets in the whole basin of more than 40 kms because of four power projects is enough to question the viability of such developmental activities in the western Himalayas. Re-routing of river from its natural course have detrimental impacts on the ecology of the river and with the coming up of any such developmental project the viability is questioned.

Table: 3
Showing Small/Mini/micro Power Projects on Ravi Basin (Excluding Medium and Large Projects)

Sr. No.	Category of Project	No. of Projects	Installation Capacity (in MW)
1.	Project Allotted	117	372.55
2.	Other Projects	010	027.50
3.	Application filled	032	003.20
	Total	159	403.25

As shown in above table, presently there are 159 small/mini/micro power projects in different stage of their execution in Ravi basin. As per the notification of Ministry of New and Renewable Energy Govt. of India following is the categorization of power projects:

Source: Author's compilation from different sources available on internet

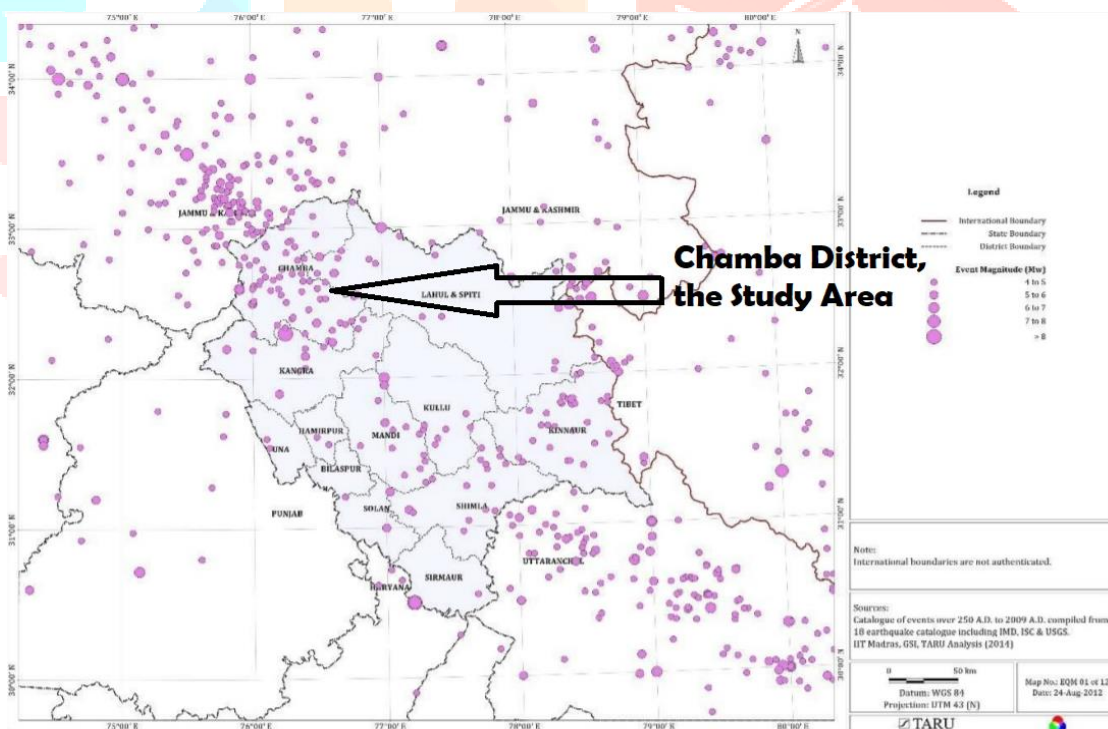
Table: 4
Showing Installation Category-wise Division of Power Projects

Category of Power Project	Power Generation Range
Pico	0 kW – 5 kW
Micro	5 kW – 100 kW
Mini	100 kW – 1 MW
Small	1 MW – 10 MW
Medium	10 MW – 100 MW
Large	100 MW+

Broadly, power projects can be divided in five categories; Pico, Micro, Mini, Small, Medium and Large. As shown in the table, it is the power generation range of any project which decide the category of that project¹³. As far as Ravi basin is concerned, all types of power projects have been either installed or in the process of installation. For this paper, power projects of small category have been considered in Saal valley in Ravi basin.

3.5 Unaddressed Issues: As far as human dimension is concerned, the affected people have not been rehabilitated they have to go in the court of law after sacrificing everything, once which was their own. In such type of developments, environmental, social, humanitarian and ecological aspects have always been ignored. And the other aspect i.e. effect on physical environment is concerned it is not being restored during the construction of project and after the project is over, it got very ugly shape as there is no mechanism to take care of dumping sites or disturbed physical environment. It has been observed during the study that schemes meant for the restoration like LADA (local area development agency) are being diverted to other parts of the district by considering other parts of district as local area as well as reforestation or complementary afforestation is being carried out on different locations may be far away from affected one.

Figure:2
Showing Main Earth Quake Events (250 AD- 2009 AD) and Hazard Map of Himachal Pradesh



Source: Disaster Management Cell, Department of Revenue, Govt. of Himachal Pradesh

Artificial lakes created because of installation of power projects (36 km) in Ravi basin on the rocks which are in formation stage and have no experience of load bearing, is question the viability of such developmental activities. Almost whole area of Chamba district falls in seismic zone V and in this zone disturbance in physical environment is not desirable particular the tunnelization of natural routes of the rivers and the reservoirization of the water on the rocks, which has no experience of bearing weight. The rocks may weaken which may have very serious consequences in seismicity prone area and is a challenge to the viability of power projects in Ravi basin. The situation become more complicated when power projects planned at minimum physical distance. As shown in the figure, this area falls highly prone to disaster particularly earthquake and many jolts have already been worn by this area, however whole state as well as adjoining states are also prone to earthquake, but installation of power project intensify and same is the case these power projects in Ravi basin which threat it's viability¹⁴.

3.6 Power Projects in Saal Valley: Nearby Chamba the historic Saal River, is one of the major tributaries of Ravi, flows in rain and snow fed hydrological homogenous region, area roughly defined between the elevations 1500 meter to 3000 meters. It is being exploited to the greater extend by disturbing the lives of the natives, environment, playing the sentiments of the people because of the fact that confluence point of Ravi and Saal river is known as **Ganga** for the poor people of the area, occupation (the area is known for growing seasonal as well as non- seasonal vegetables, which has checked the out village migration of the local youth); above all the fragile eco- system including flora and fauna of the area. The total length of the Saal River is 22 kilometers. On this river first power project of Chamba and second power project of Asia, after Darjling is functioning in the name of Bhuri Singh mini hydroelectric power project. Saho hydel electric power project of 5 MW is on the way of its completion, along with this, DPR of Hul hydel electric power project of 4.5 MW capacity has been submitted and environmental clearance has been sought at present, it is ready for installation, Saal HEP stage-II of 2.5 MW, Saho HEP stage –II of 3 MW, Hul HEP stage-II of 1.40 MW, Kiri HEP of 1MW are indifferent stages implementation¹⁵.

On the one hand whole saal valley is being develop from heritage tourism point of view because of many reasons. This valley has place in the folk-lore and folk-songs of Chamba and has attracted many scholars of different disciplines to document the rich multi-cultural features of this valley. Presently, many attractions have been developed and many initiatives have been taken by the tourism department of state government. People attracted to the beautiful land scape and perennial flow of one of the major tributaries of Ravi i.e. Saal.

On the other hand, the natural beauty of this valley is being disturbed by serials of power projects in the saal valley along with other rivulets of Ravi basin. The natural beauty of the main course of Ravi river has already been sacrificed/alterd by big power projects like; Chamera-I, Chamera-II and Chamera-III. During summer season main course of Ravi converts into a small nalla whereas it remained dried in the downstream of the dam, specifically from head race tunnel to tail race tunnel. To see the viability of micro power projects in such hills, a case study has been conducted and arrived at conclusion that such developmental projects are not viable in such areas and there are certain viable options are available and the advocacy of researcher is to opt these available options in place of installation of power projects.

I. RESEARCH METHODOLOGY

To see the viability of the small/mini and micro power projects either installed or yet to be installed, one of the tributaries (Saal) of Ravi basin has been undertaken for intensive research. The saal valley which is approximately more than 40 kms in length having four major small rivulets of Saal river, i.e. Hull, Batat, Kiri, Parotha and some more small rivulets are also there and contributing in the Saal valley water shed. All four major rivulets have been targeted for hydropower generation and also taken by researcher. For the study both primary as well as secondary sources of data have been use for this exploratory study. Semi-structured as well as open interview method have been used. Researcher directed met with respondents and recorded their response.

Mostly to check the technical viability of such power projects, all technical aspects have been checked and discussed with respondents, project officials, local administration, heads of villages and families. After having a thoughtful discussion with all, it was finally decided to conduct case-studies of the local stakeholders and record their response. After going through deepen through case-study, an attempt has been made to provide a sustainable, acceptable, workable and alternative.

IV. RESULTS AND DISCUSSION

After having thoughtful discussion with all stakeholder, it was decided to conduct case-study method. Technical it can be stated that power projects of any category are not desirable in seismic zone-V, where the possibility of earthquake remain highest, which can be proved on the basis of earlier earthquakes took place in the region. Technically, it is viable to install about 200 projects in one basin and chock almost all rivulets, even small rivulets as water coming from different small water-sheds cater the water need of Ravi and also maintain the eco-system of the river. The dry patches or the reservoirs are unusual phenomenon in the whole basin and the rocks in this zone has no experience of load bearing. In view of this, the viability of power projects is in question. For better understanding the case-study is being presented here:

Case Study

4.1 Why this is important to mention?:

Ravi River and its tributaries that give life to the people of Chamba district in Himachal Pradesh which is also known for its enchanting beauty. It is an area of dense forests, green peaks and valleys, snow tipped in the winter. In this basin three major power projects: Chamera-I, Chamera-II and Chamera-III. There are round hundred micro/mini hydroelectric projects in different stage of their execution. Speaking specifically, in Saal Valley in near Chamba town, Hul-I and Hul-II are two micro-hydroelectric projects still in the planning phase, much because they have encountered resistance from the inhabitants to be affected and focuses on the Hul-I project to better examine the situation.

Figure: 3
Showing Place from where Water is Proposed to be Diverted



Clicked by the Author

Cause of the Problem:

Hul-I is a micro-hydroelectric project, meaning it creates less than 5 MW of power and being constructed by diverting water from a small tributary i.e. Batat and Sillagharat nala. These canals will be 6 meters wide and 1 meter deep. With the use of dynamite and extensive human traffic during construction, they will cut into the Saal Valley surrounding the tributary, though undoubtedly micro hydro-electric projects are said to be less damaging to the environment as compare to thermal-electric projects because of many reasons. But the fact is these may still adversely affect the inhabitants, and have negative consequences on the surrounding environment.

4.2 Head Race Tunnel-main Cause of Concern:

The most damaging effect is the diversion of water will be in form of canal construction. Needless to say, this creates some serious issues for people who are living on both sides and existing rivulets are their lifeline and their livelihood options will vanish. The company has responded to this complaint by promising 15 percent of the water will remain in the river, which is mandatory as per the order of Hon'ble High court of Himachal Pradesh, but it has very bad history in the other executed projects in Ravi basin specifically and in whole state in general.

4.3 Impact on Lives and Livelihood: The impact on livelihood of the residents of this area will be huge as this project will divert the water of these rivulets and the vegetable growers and water millers will become unemployed. This project will affect villages of 2 panchayats, some 6,000 people directly or indirectly. Many families having fishing licenses as well as unlicensed rely on this tributary to sustain their families. Even more unlicensed families also rely on fishing for food. Possibly most adversely affected are the 26 traditional watermills in the area. Historically, watermills are being used to grind seasonal crops like; wheat, corn, etc. which is corner stone of local economy. If the flow of water in the rivulet stopped then water mills will be useless and closed which will snatch the livelihood of the miller particularly and affect the whole eco-system in general. This will directly affect the income for some 150 families. Not to mention the people who rely on the mills for grinding their grains will have to go elsewhere. Most will need to resort to electric grinding, which costs more. Watermills generally charge one kilo for every ten, while electric mills charge two. Moreover, a recent study has found that the grains crushed from the electric mills have a much lower



Figure: 4

Showing area Where Head Race Tunnel is Proposed (Clicked by Author)

nutritional value because of the excessive force used. Irrigation of agriculture around the tributary will also be affected. Without water from the river, irrigating the land will become extremely difficult, if not impossible.

4.4 Impact on Wild-life:

Hydro power generation consequentially prove disastrous for physical environment as well as wild-life of the area concerned. The wild-life lives in their natural habitat and never enter into the locality, but with coming up of hydro-projects, clearing forest to pave way for project, wildlife such as deer, bear, goat, tiger, monkeys etc. enter in the fields of farmers and destroy the crop and in some cases people stopped farming or shift to other crop. However, it can only be assumed that once the construction commences, the resulting disturbance will influence the wild animals as they are peace loving and cannot tolerate the noise of blasting and other activities and came out of their habitat and enter into the fields and sometimes houses. Deforestation and soil erosion in the catchment area of the project are even more devastating. Few forests have such a mixed vegetation of pine, oak, fruits, etc. The installation of power projects surely takes away natural beauty of the area.

4.5 Local Pain for National Gain:

Arundhati Roy in his work mentioned power projects are based on myth *Local Pain for National Gain*. Making the situation even more absurd is that the benefits of these power plants will not be going to the community suffering the consequences. Instead, the power is sold to private companies and distributed all over India for an incredible profit, none of which the locals will see. Amongst the leaders of the communities it is agreed that even if compensation was given, though it has not been, as of yet, it could never replace their livelihood. For this reason, the Gram Panchayat has set forth four resolutions to the central government denying the continuation of the project. However, all have been over turned. It seems the need for energy in the eyes of the government prevails over any consideration of the consequences it may have on the population it affects.

As a whole people of Chamba feels that they have already contributed to the development of nation with major energy projects and at least small rivulets should be spared for the sake of livelihood of the local people, otherwise they would be compelled to leave the area. They are of the view that they are not against development but if such developmental initiatives snatch their sources of livelihood then they have to think on the viability of such initiatives which are not viable as far as this micro power project is concerned. They are of the view it would be much rather to conserve the natural beauty of the area and community-based tourism could be an alternative source which is more viable and sustainable. The fundamental questions remained unanswered; like are natural resources the property of the local people? They simply believe the interests of India are better served by preserving its natural beauty instead of destroying it for energy purposes.

4.6 Hydrological Threats:

Saal river flows in snow and rain fed hydrological homogenous region and mostly depends on rain and snow for water. Because of drastic changes in climatic conditions of Ravi catchments areas whole area has experienced very less snow and rainfall during last ten years. In rainy season, whole rivulet experienced flood and damaged all flora of its catchments. There is no permanent or big glacier, but only seasonal snow, which is also decreasing per year. Blasting, five-kilometer-long open water channels and tunnels are not environmentally friendly, particularly, in seismic Zone-V such activities are not desirable and viable. The excess exploitation of this historical river may dry this river.

4.7 Human and Wild Life Encounter:

The beautiful 22-kilometer-long Saal valley may convert into dry valley; the scenic beauty may not be no more if the present situation persists. The lives of thousands of people, residing in this valley may be disturbed and even the lives of people of Chamba town may be questioned by not fulfilling the need of the potable water. The wild animals may have entered in the town because of blasting and extinction of flora of the area, as happened with Shakti Singh a resident of Surara Mohalla of Chamba town of dated May, 6, 2006 (as told by him to the researcher). These innocent wild animals may be shot down by the civilized people, because

the civilized people in the name of development have snatched the natural habitat of the wild animals. It is high time to think over such developmental policies, in which man, nature and natural creation of the God may live in harmonious environment.

4.8 Alternative to Small Power Projects

On the basis of this case study, it can be stated emphatically that there is another untouched and unexploited alternative which can easily replace the proposed power project and can save livelihood of the people of area as it is agricultural dominated having self-dependency and the carrier of “*Hatt and Gharat*” culture. This model will also resolute the hydrological threats which whole saal valley is facing every year as well as human and wild life encounter can be resolved very easily without disturbing their natural habitat. In the name of development, human beings have disturbed natural habitat of wild life and Saal valley is not an exception, this problem can also be solved easily with this model. According to Dr. Anil Joshi:

Dr. Anil Joshi Model

This model aims to produce electricity from water-mills along with doing other routine work without disturbing eco-system. According to a rough estimate made by HESCO there are nearly 50,000 water mills in the entire Himalayas region from the Northeastern states to J&K, which can produce 2500 MW, assuming each generates 5 KW, that is a cash generation of Rs. 1200 million per hour and gives direct employment to 1,50,000 people assuming three persons per water mill.



Figure: 5

Showing Inner side of Water mill, which can be Converted into Electricity Producing Unit (Clicked by Author)

According to Dr. Anil Joshi of HESCO a water mill can produce 5-10 KW power after slight modifications in the traditional water mills with little specifications with in the small expenditure of 35-45 thousand per water mill. There are 84 water mills in the basin of Saal River, which can be modernized and set an example for the whole district as well as for the state.

According to an estimate made by gram panchayat and Zila Parishad member that there are 49 functional water mills in Zadera nalla on which Hul HEP project is proposed to be installed and 35 water mills in Saho nalla which became Saal at Chaminu village.

The whole Saal region can be develop as *model from tourist point of view* along with *electricity generation* and *flour grinding* by providing direct employment to hundreds of local youths and will also preserve the *Pahari way of life* which *revolves around the water mills*, called as *Haat and Gharat Culture* of Hills. Above all, this can happen without disturbing the environment, ecosystem and over all the lives of people of the area which discussed earlier and responsible for physical, social, environment disturbances because of hydro power generation. Water mill cover and protected the cluster of trees which strengthen the soil and the problem of soil erosion of the Saal river can be solved and furthermore it will add to existing natural beauty of the area which attracts the tourists along with electricity generation. It needs only small technical intervention, which is not a big deal.

Solution: An Alternate

Adopting existing model of Dr. Anil Joshi, it can be stated that there are 84 water mills in saal valley, which can produce 420 KW power assuming 5 KW per water mill 420 units electricity can be generated per hour through which Rs. $420 \times 2.40 = 1008 = 00$ per hour can be earned, this amount goes to Rs. $24,192 = 00$ per day and Rs. $72,576 = 00$ per month and Rs. $8,70,912 = 00$ per year additional along with grinding. It will give direct employment to at least three persons per water mill ($84 \times 3 = 252$ persons) which directly give employment to 252 families and indirectly it increases manifolds.

This all can happen without disturbing anything. The conflict between development and the native people can be resolved easily. There will be no disturbance in the physical environment of the seismically sensitive zone-V, by adopting such type of approaches we can strengthen the physical environment and the possibility of the earthquakes in the region can be ruled out to a greater extent. The possibility of unrestness among the youth of the area can be ruled out easily by not snatching their traditional occupation of agriculture, which largely depends on the local kuhul (canal). The small patches of local varieties of trees around the water mills will increase the natural beauty of the area and invites tourists as well as researchers from far of places.

Conclusion: Today, we need to think again on the policies, which has been made for the hills because all the existing policies for the development of the hills are full of conflicts among the development and native people. We should think and make policies by taking local circumstances into consideration, so that this conflict can be resolved and the true fruits of development can be enjoyed. The feeling of insecurity among the local people of being disturbed by any developmental activities must not be there. If they disturbed by any developmental activity they must resettle in prior conditions, conducive for living, before starting developmental project. In the policies minimum disturbance to eco- system as well as to social system must be insured. For all that what we need, a strong political will and the will power of the local people, because it is the political will that may have brought any type of change in society and the political will can be implemented only through strong will power of the local people. *It is stated emphatically that everything can be generated but water cannot, if it disappears it cannot revive even by spending millions of rupees, so let us use it judiciously and sustainably because to date in spite of many scientific inventions the alternate of water has not invented and perhaps it may not in coming years!*

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