Chapter 5

[Environment impact]

The State's policy on hydropower projects was silent on the vital issue of maintaining downstream flow in the diversion reach (the stretch of the river from the point of diversion into tunnel to the point where it is released back into its natural stream). The physical verification of four[20] out of five operational projects, showed that river-beds down stream had almost completely dried up, the water flow was down to a trickle, and extremely inadequate for the sustenance of ecology and nearby groundwater aquifers.

Given the current policy of the State Government of pursuing hydro-power projects indiscriminately, the potential cumulative effect of multiple run-of-river power projects can turn out to be environmentally damaging. Presently, 42 hydro-power projects are in operation, 203 are under construction or clearance stage, while several others are at the conceptual stage.

Negligence of environmental concerns was obvious as the muck generated from excavation and construction activities was being openly dumped into the rivers contributing to increase in the turbidity of water. The projects seemed oblivious of the fact that such gross negligence of environmental concerns lead to deterioration of water quality and adverse impact on the aquatic biota.

The plantation activity was highly deficient, as 38 per cent of projects reported hardly any plantation; posing severe hazards both for natural ecology and stabilization of hill slopes.

To ensure sustainable development and optimal use of natural resources, environmental considerations are required to be integrated in planning, designing and implementation of development projects.

Understanding the consequences of development and forecasting its impact on the basic life support system- land, water and air- is referred to as Environmental Impact Assessment (EIA). It also encompasses impacts on the ethnic diversity, socio-culture and socio-economic environment including displacement, resettlement and rehabilitation of human societies where development activities are undertaken. The objective of EIA is to foresee and address potential environmental problems/ concerns at an early stage of project planning and design.

5.1 Insufficient environmental clearances

Under the existing policy regime, hydropower projects with a capacity of more than 25 MW are referred to GoI for environmental clearance. Projects with a capacity of less than 25 MW, only need the consent of UEPPCB to establish and then to operate. The Board after inspection, issues a No Objection Certificate (NOC), valid for three years subject to following conditions:

- Monthly report regarding establishment of machinery, equipment, pollution control accessories and air pollution control facilities

[20] Rajwakti, Debal, Hanumanganga and Loharkhet.

at the project site shall be submitted to the Board.

- Hydel projects will not start generation unless the project is cleared by the Board in respect of water and air pollution.
- The project authorities shall ensure the minimum discharge of water to flow in the natural water course of the river in order to protect and preserve aquatic life.
- Project shall also obtain necessary clearances from the Forest Department, the Fisheries Department, Agriculture Department and other related departments.
- Provisions for proper muck disposal shall be made and adhered to.
- Prior permission for cutting down of trees, if necessary, will be obtained from concerned Divisional Forest Office.

Audit found that out of eight projects[21], forming part of the audit sample, which were under construction/operation, the consent to establish the projects from the Board was obtained only by five. Besides, consent to operate was only obtained by one project (Debal) even though four projects were operational. Thus 75 per cent of the projects were being operated without the consent of UEPPCB. It was also noticed that

- The Board failed to enforce key conditions mandatory for certification such as submission of monthly reports, proper muck disposal and ensuring a minimum downstream flow.
- No penal action was initiated against project developers who were operating without proper consent and were blatantly defying environmental provisos.
- No regular inspections were being carried by Board personnel except during the mandatory inspection required for issuance of NOC.

[21] Hanuman Ganga, Srinagar (GVK), Rajwakti, Debal, Birahiganga, Bhilangana-III, Agunda Thati & Loharkhet.

5.2 Impact

Hydro-power projects carry direct and indirect environmental impact on various environmental elements, mainly aquatic, terrestrial, geophysical and human, both during the construction and operational phase. The impact due to the construction of hydro-power projects commences right from the start of exploration activities, construction of adit tunnels, head race tunnels and approach roads and may continue up to the stage of commercial operation of the project. The nature and extent of impact however, varies at different stages of project development. The environment impact assessed during construction and operation phase, are categorized into three basic types as per details given in the chart.

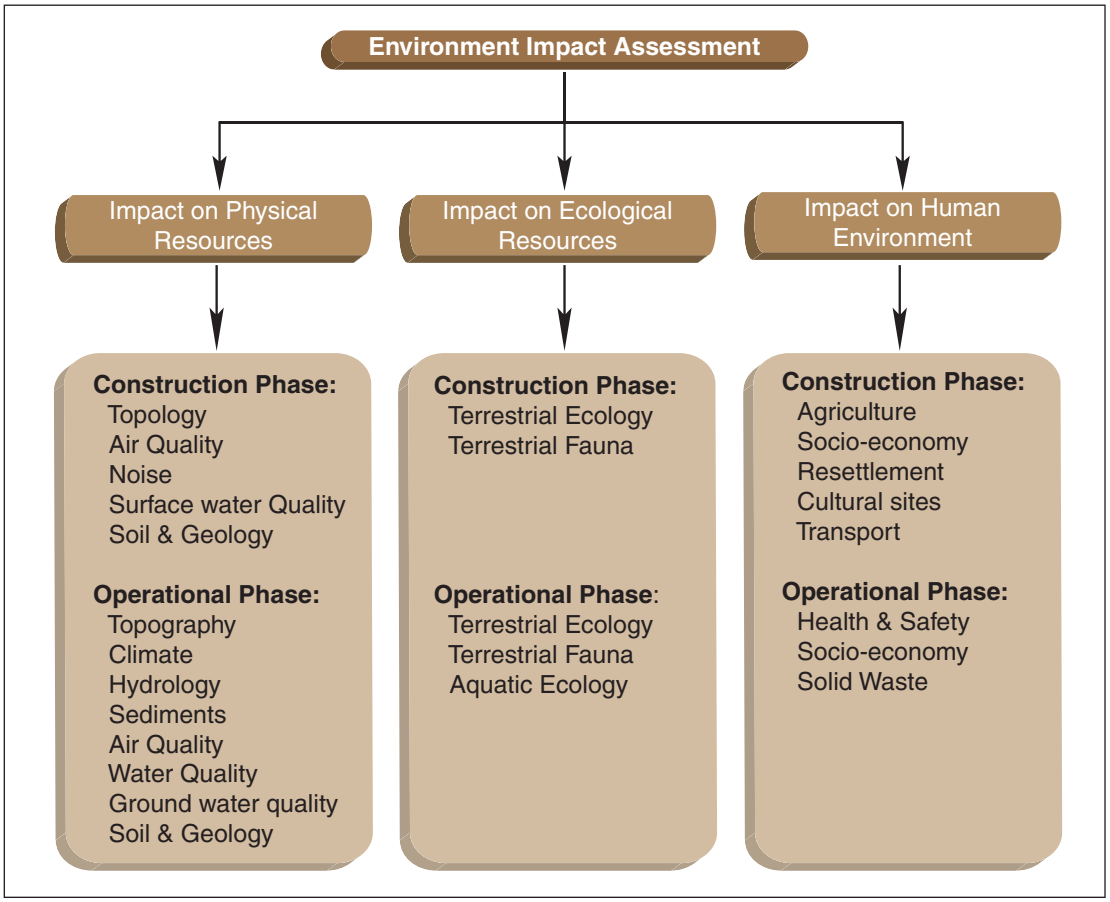
Based upon an evaluation of magnitudes of impacts of a project, an Environmental Management Plan (EMP) is formulated for each project, specifying protective and mitigation measures.

Audit analysis revealed that, the GMR project planned on river Alaknanda assessed the environmental impact through a detailed survey; EMP involving a financial outlay of Rs. 31.90 crore has been chalked out for preservation of natural ecosystems and mitigation of biotic and abiotic pressures.

5.3 Damaging impact on Aquatic Ecosystems

A run-of-river project involves diverting the river into a tunnel. The place from where the river is diverted into a tunnel, to the point where it is released back into its natural stream tends to have very little water, especially during the lean season. This alteration of the downstream flow inolves the following impact[22] with varying magnitude:

[22] http://www.sandrp.in/hydropower/crtlenv_issue



- Diversion of huge quantities of water by hydro power projects minimises water flow; even drying up the main river bed during lean season.
- Irrigation problems may arise for farming and cultivation which depend on river waters.
- Gangetic Rivers erode the bulk of their sediments from upstream areas in the Himalayas and deposit it in the alluvial plains which is critical for agriculture in the plains. Due to trapping of silt at barrage sites, the downstream areas will be deprived of huge amounts of sediment.
- Reduction in sediment load in the river can result in increased erosion of river-banks and beds. As the trapping of silt will considerably reduce the sediment supply in the river-waters, the river will behave as 'hungry waters' scouring sediments from riverbeds and river banks downstream to restore the natural sediment levels of the water.
- Stoppage of ground water recharge in the downstream regions.
- Salinity ingress due to stoppage of fresh water flow, which can not only spoil the existing groundwater quality in the region but can also affect the land near the river banks.
- Decreased volume of water is a cause of pollution of water streams because of low dilution. It carries potential for water-borne diseases.
- Destruction of riparian vegetation in and adverse effect on fisheries.

In addition, adverse impact on the water quality is also likely from inappropriate disposal of

muck[23], effluents from crushers and other sources and sewage from labour camps and colonies. The assorted waste going into the river channel contributes to the turbidity of water and also leads to deterioration of its water quality.

Therefore, muck needs to be dumped in an environmentally sound manner at pre-identified dumping sites. Also, in order to avoid any deterioration in water quality a proper sewage disposal system to check the discharge of waste into the river is essential. In the absence of such measures there is bound to be deterioration in water quality and consequent changes in the aquatic biota.

Audit noticed that adequate measures for proper muck disposal had neither been taken by the IPPs nor ensured by the department as elaborated under **para 5.3.3.**

5.3.1 Inadequate downstream flow

In order to maintain and sustain aquatic ecosystem in the downstream stretch of a river, sufficient amount of discharge during the lean period has to be ensured. However, audit analysis revealed that the policy on hydro-power projects is silent on this vital issue. Further, there is an absence of clear directions from the UEPPCB in the matter of downstream flows.

While computing the power potential of a project, sacrificial discharge of 10 per cent is taken into account, which is to be left untapped for fulfilling the requirements of maintaining downstream flows. Audit noticed that, this provision for sacrificial discharge taken for calculating the power potential of a project cannot be taken as constituting any binding commitment on the project developer for ensuring a minimum flow to this extent during the lean season.

For mitigating the downstream impacts, Himachal Pradesh has notified[24] (September 2008) a minimum flow of 15 per cent of the lean season, to be maintained by hydro-electric projects. However, no such norm has been stipulated by Uttarakhand.

The physical verification (during May 2009 to July 2009) at the project sites of all the four operational projects[25], falling in the audit sample, showed that river-beds down stream had almost completely dried up and the water flow was down to a trickle and extremely inadequate for the sustenance of ecology and nearby groundwater aquifers.

i. During interaction with the local residents of village situated in the vicinity of the Debal Hydro Power Project, it was informed (June 2009) that natural water resources used for drinking and irrigation purposes have depleted considerably because of diversion of river waters in the power tunnel. Audit also noticed that the issue has been brought to the notice of both the project developers as well as the concerned Government Departments, but the problems have remained unaddressed.

Debal - Downstream flow; Penstock is seen parallel

[23] The muck essentially comes from the road-building activity, tunneling and other excavation works.

[24] Applicable on upcoming hydro-power projects

[25] Rajwakti, Debal, Hanumanganga and Loharkhet

Rajwakti: Downstream flow of river Nandakini

Rajwakti: Defunct Hydram

ii. Due to diversion of the river course for the Rajwakti Hydro Project, 60 beneficiaries[26] were deprived of irrigation facilities as the hydram[27] constructed for the purpose became defunct. This was in contravention of the conditions of the IA, which clearly mentions that the IPP will be responsible for taking remedial measures to mitigate any adverse impact on existing facilities of irrigation or water supply.

iii. The residents of village Kail reported a threat to their lives due to the diversion of river Kail for the Debal hydro-power project. The natural water course which happened to be a safeguard from wild animals had dried up making the villagers and their livestock easy prey to wild animals from the nearby forest area.

iv. Due to trench type weir design of Loharkhet and Hanuman Ganga hydro-project the downstream flow got completely terminated during the lean season when the demand for water is at its peak as *discussed in Para 4.4.*

The State Government accepted the fact that at present there is no policy regarding maintaining of sacrificial discharge because the MoEF and CWC are yet to arrive at any decision regarding the same. However, any directions from these agencies for maintaining adequate down stream flow would be welcome and incorporated by designing appropriate policy.

5.3.2 Cumulative devastating effect

In an audit exercise undertaken to measure the impact of curtailed downstream flows, the diversion reach for all the 13 sampled run-of-river projects was calculated[28] based on the DPRs of respective projects. It is shown in the table 8.

Audit observed that, on an average 4.16 km of diversion reach is associated with one run-of-river project which appears to constitute an acceptable environmental impact. However, when combined with the diversion reach of other power projects on the same river the results could become environmentally unacceptable.

[26] From the villages of Tefina and Gwalla.

[27] Lift irrigation

[28] Diversion reach has been calculated by summing up the lengths of intake, desilting tank, penstock and tailrace; this would result in a conservative estimation of the diversion reach as the actual downstream river flow might cover a longer area.

Table : 8

SL. NO.	NAME OF PROJECT	DIVERSION REACH (IN KM)
1.	Rajwakti	2.56
2.	Debal	3.79
3.	Loharkhet	2.67
4.	Agunda Thati	2.11
5.	Birahiganga	1.67
6.	Kakora Gad	2.62
7.	Hanuman Ganga	1.86
8.	Melkhet	13.79
9.	Bhyunder Ganga	4.42
10.	Srinagar (GVK)	4.72
11.	Birahi Ganga-II	3.29
12.	Bhilangana III	4.77
13.	Alaknanda (GMR)	5.80

Source : Information extracted from DPRs

Table : 9

RIVER (INCLUDING TRIBUTARIES)	STATUS	HYDROPOWER PROJECTS		CUMULATIVE DIVERSION REACH (IN KM)
		NUMBER OF PROJECTS	COLLECTIVE CAPACITY (IN MW)	
Alaknanda	Operational	04	406.20	16.64
	Under construction	06	1643.00	24.96
	Planned	50	2843.63	208.00
	Total	**60**	**4892.83**	**249.60**
Bhagirathi	Operational	03	2394.00	12.48
	Under construction	08	1727.00	33.28
	Planned	16	494.75	66.56
	Total	**27**	**4615.75**	**112.32**
Yamuna	Operational	03	114.75	12.48
	Under construction	01	120.00	4.16
	Planned	18	1210.21	74.88
	Total	**22**	**1444.96**	**91.52**
Dhauliganga	Operational	01	280.00	4.16
	Under construction	00	--	--
	Planned	08	1282.00	33.28
	Total	**09**	**1562.00**	**37.44**
Mahakali	Operational	01	120.00	4.16
	Under construction	00	--	--
	Planned	11	1482.75	45.76
	Total	**12**	**1602.75**	**49.92**

Source : Information extracted from the records of UJVNL.

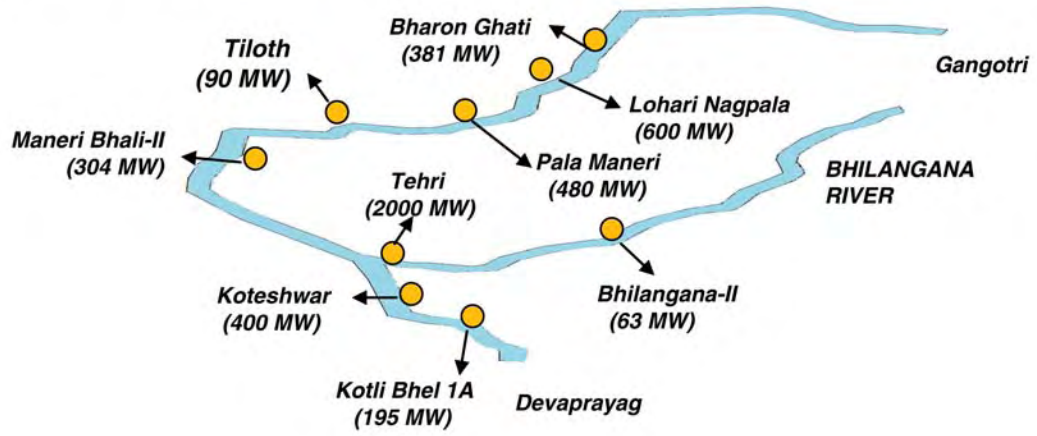
The cumulative diversion reaches for hydro-power projects being built/ planned on a particular river are tabulated in table 9, based on audit analysis, taking an average of 4.16 km per ROR project.

In audit; the case of Alaknanda river valley was analysed and is highlighted to provide an insight on the dimension of the problem arising out of the growing diversion reaches of such projects.

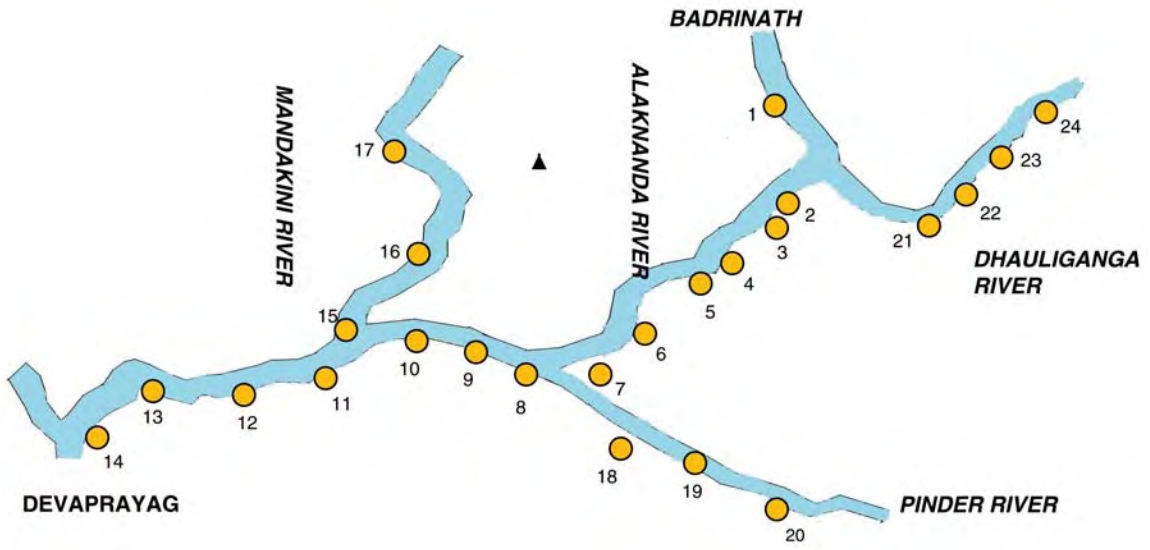
60 hydro projects, entailing a cumulative diversion reach of nearly 249.60 km, have either been built or are in the pipeline. If appropriate measures to ensure adequate downstream flow are not taken, it may cause a devastating effect on the region falling under the river valley.

The hydro-power projects, with capacity of above 25 MW planned in Bhagirathi & Alaknanda river valleys (*Appendix 1 & 2*) have been illustrated in the maps below:

Hydro-power projects (above 25 MW) planned in Bhagirathi river valley



Hydro-power projects (above 25 MW) planned in Alaknanda river valley



Alaknanda (300 MW)	Utyasu-IV (125 MW)	Rambara (76 MW)
Vishnuprayag (400 MW)	Utyasu-III (195 MW)	Bangasi (44 MW)
Tapovan Vishnugad (520 MW)	Utyasu-II (205 MW)	Ming Nalgaon (114 MW)
Vishnugad Pipalkoti (444 MW)	Utyasu-I (70 MW)	Devsari Dam (300 MW)
Bowala Nandprayag (300 MW)	Srinagar (330 MW)	Lata Tapovan (171 MW)
Nandprayag Langasu (141 MW)	Kotli Bhel IB (320 MW)	Tamaklata (280 MW)
Utyasu-VI (70 MW)	Singoli Bhatwari (99 MW)	Jelam Tamak (60 MW)
Utyasu-V (80 MW)	Phatabyung (76 MW)	Maleri Jelam (55 MW)

Given the current policy for vigorously pursuing hydro-power projects, the potential cumulative effect of multiple run-of-river power projects can become very significant. Presently, approximately 42 hydro-power projects are in operation and 203 more are under construction or in the clearance stage while several others are at the conceptual stage.

On being pointed out, the State Government was of the view that the quantum of water required for sustenance of aquatic life, flora and fauna is yet to be established.

5.3.3 Muck Disposal

The directions of the MoEF, GoI relating to muck disposal state that muck generated from excavation in course of construction activity, must be disposed in a planned manner so that it takes the least space, is not hazardous to the environment and does not contaminate any land or water source. With special reference to hilly areas, muck-disposal should be carried in such a way that usable terraces are developed with suitable retaining walls. The terraces should ultimately be covered with fertile soil and suitable plants.

i. The IA for hydro power projects also stipulates that suitable sites be identified for muck disposal. However, during physical inspection, Audit noticed that the Srinagar hydro-power project being built by GVK on river Alaknanda did not follow the GoI directions on muck disposal. In blatant violation of these directions, the muck was being dumped near the river banks. This led to increase in the turbidity of river water and shrinkage of the river catchment area. Stern resentment was noticed among the local residents of the affected areas.

Srinagar project on river Alaknanda - Muck disposal

ii. In Debal, the Chamoli Hydro Power Project which is in operation did not follow the norms of MoEF, GoI, regarding proper development of the Muck Disposal Site. The site should have been developed by making terraces and then covered with fertile soil and suitable plantation which was not done.

iii. In Rajwakti, the project authorities of Him Urja Hydro-power project could not show the disposal site, leaving the possibility of muck being dumped in the river Nandakini itself.

iv. The project authorities of Agunda Thati Hydro Power Project also, did not take steps for proper muck disposal. Even the protection wall of the power channel which would have stopped the muck from being dumped into river Balganga had not come up.

The above instances illustrate that negligence of environmental concerns was obvious as the muck generated from excavation and construction activities was being openly dumped into the rivers contributing to increase in the turbidity of water. The projects seemed oblivious of the fact that such gross negligence of environmental concerns lead to deterioration of water quality and adverse impact on the aquatic biota.

On being pointed out the State Government stated that defaulters have been issued warning and have been directed to meet the desired standards/ requirements.

However, the fact remains that the basic aim of muck management to protect the areas from soil erosion, encourage afforestation, ensure proper utilization of muck and the development of the areas in harmony with the landscape of the project area remained unfulfilled.

5.3.4 Establishment of Stone Crushers

During field inspection, it was found that stone crushers had been established within the project premises of two projects, namely Bhilangana-III and Srinagar. The conditions associated with the permission obtained from UEPPCB were thus not being followed by the project developers.

The establishment of the crushers was also a clear violation of the norms fixed by the State Mining Policy, wherein it has been prescribed that crushers should be installed at a minimum distance of 500 m from the river. However, no action was reported to have been taken either by the Board or by UJVNL in this matter.

Bhilangana-III : Stone crusher

Srinagar hydro project: Stone crusher

5.4 Impact on Terrestrial Ecosystems

Though run-of-river projects do not involve submergence of vast areas of land and vegetation yet, construction of project facilities, access roads to the project site, and transmission systems and lines would involve deforestation. There are thus risks of soil erosion, disruption to local flora and fauna and disturbance to hill slopes. However, these can be mitigated through afforestation.

5.4.1 Negligible afforestation

Afforestation is considered necessary

- To avoid soil erosion
- For rehabilitation of degraded forest areas

- For countering the effects of quarrying
- For habitat improvement and
- For structural stabilisation in landslide prone areas

The status of tree-plantation in the case of the four operational projects and four projects under construction which were part of the audit sample is tabulated in table 10.

Audit noticed that out of the eight projects, three reported zero achievement with regard to afforestation, while in one project the plantation rate was approximately half of the requirement. In the remaining four projects, afforestation requirements had been fully met. However, data pertaining to survival ratio was not made available by the concerned forest divisions.

Thus, the plantation activity was highly deficient, as 38 per cent of projects reported hardly any plantation; posing severe hazards both for natural ecology and stabilization of hill slopes.

On being pointed out, the State Department assured that the provisions regarding afforestation exist in the Catchment Area Treatment Plans of the Mega Projects and would be executed once the project become operational.

5.5 Geo-physical Impacts

The entire State of Uttarakhand is categorized as falling in Zone IV and V of the Earthquake Risk Map of India, as depicted in the diagram. The region has witnessed devastating earthquakes in 1720 (Kumaun Earthquake) and 1803 (Garhwal Earthquake). In the recent past earthquakes in Uttarkashi (1991) and Chamoli (1999) have been witnessed. Despite the threat of earthquakes looming large, hydro-power projects are in vogue in the State.

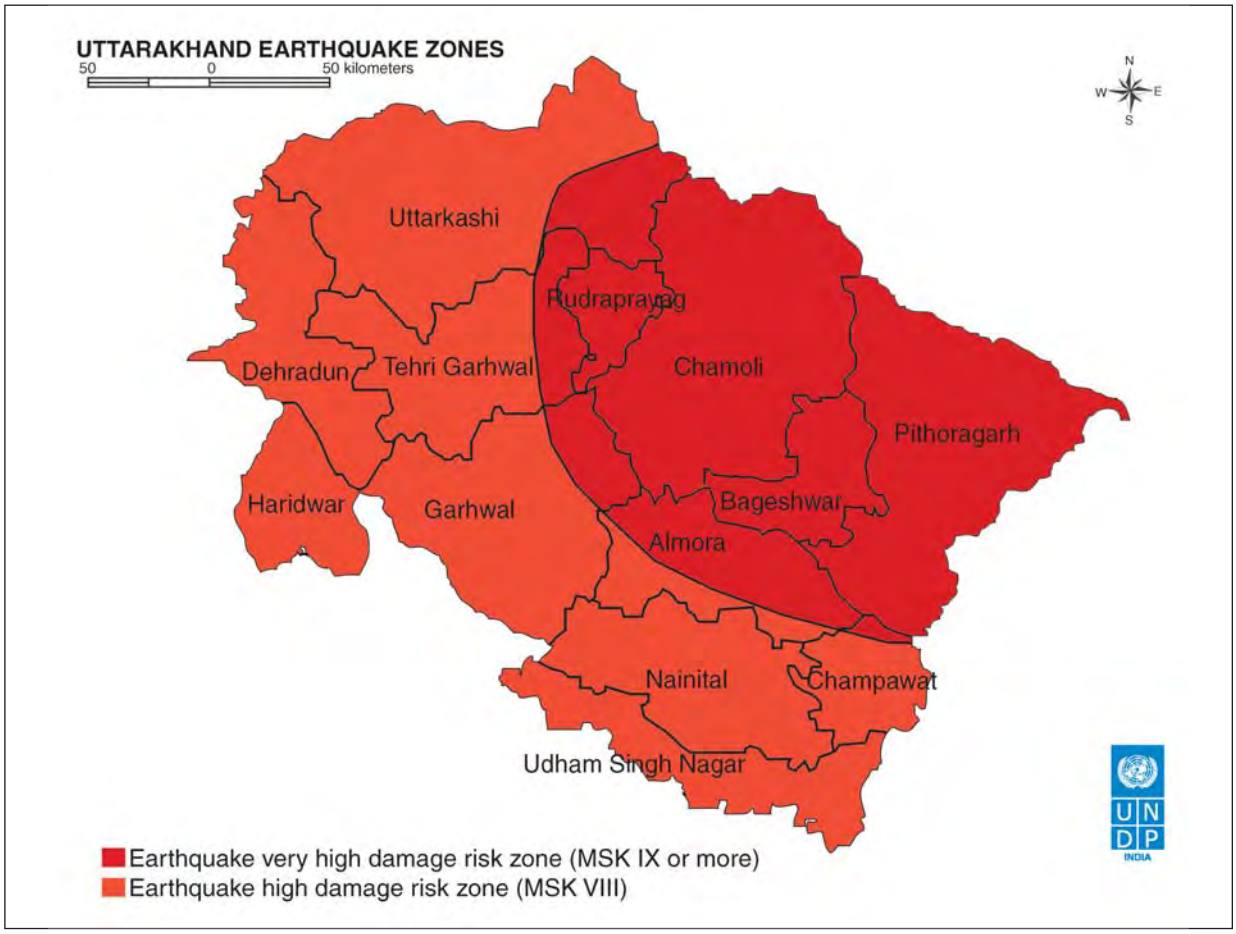
Audit analysis revealed that, negligence in applying appropriate construction norms and structuring the project without appropriate technical counter measures may expose projects to enhanced seismic vulnerability. Therefore, it is essential that earthquake safety measures are incorporated by adopting suitable seismic coefficient in the design for various structures forming part of the project.

While the mountains provide large amounts of water run-off for run-of-river projects from melting snow and glacier ice, glacier lakes can pose a significant hazard. Bursting of glacial lakes cause flashfloods with catastrophic consequences.

Table : 10

STAGE	NAME OF THE PROJECT	FOREST AREA (IN HECTARES)	NO. OF TREES CUT DOWN FOR SITE CLEARANCE	NO. OF TREES TO BE PLANTED	NO. OF TREES PLANTED
Operational	Rajwakti	3.834	Nil	15400	8470
	Debal	2.860	08	10400	Nil
	Hanuman Ganga	2.098	04	--	16000
	Loharkhet	2.876	53	11504	Nil
Under construction	Srinagar	NA	1739	115720	Nil
	Agunda Thati	2.332	117	9200	9200
	Birahi Ganga	4.658	98	28000	28000
	Bhilangana-III	8.330	47	19500	19500

Source: Information obtained from DFOs & project developers.



5.6 Safety measures

A scrutiny of the DPRs of the projects included in the audit sample revealed that geo-physical aspects were given due consideration while planning the projects. The details for the sampled projects are tabulated in table 11.

As is apparent from the above, safety measures adopted by the project developers vary greatly despite the projects being situated in the same seismic zone. Further, in the absence of adequate checks by either the Urja Cell or UJVNL, the implementation of the above mentioned measures can not be guaranteed.

5.7 Flash floods

Flash floods may occur due to cloud bursts, incessant heavy rains and bursting of glacial lakes. The adverse consequences of such floods are acute as they can not only damage the project structures but can cause loss of live in low-lying down stream areas. Civil construction in projects is required to factor in this natural threat. Also the bigger the project, the greater should be the efficacy of the preventive measures.

Audit scrutiny of project records revealed that no specific measures had been planned/ designed in any project to cope with the risk of flash floods. Information collected from project developers revealed that flash floods have occurred in the past as depicted in the table 12.

It is pertinent to mention here that the three projects mentioned above are of low capacity and thus do not carry as much risk for the local

Table : 11

STAGE	NAME OF THE PROJECT	SEISMICITY	MEASURES SUGGESTED IN DPRS
Operational	Rajwakti	Zone-V	Suitable plantation on slopes
	Debal	Zone-V	Incorporation of seismic factor during installation of project components
	Hanuman Ganga	Zone-IV	No specific measures
	Loharkhet	Zone-V	Removal of loose boulders, construction of retaining walls up-slope and down-slope, incorporation of seismic factor while designing engineering structures
Under construction	Srinagar (GVK)	Zone-IV	Copy of DPR not provided
	Agunda Thati	Zone-IV	Project has been located on stable geological strata; alignment of power channel and penstock has been planned in such a manner so as to avoid slip zone.
	Birahi Ganga	Zone-V	Intake structure, approach channel and tunnel have been constructed on stable rocks.
	Bhilangana-III	Zone-IV	Careful planning in setting up of project components
DPR approval stage	Bhyunder Ganga	Zone-V	Due investigation has been carried in the critical reaches to ensure long term stability
	Alaknanda (GMR)	Zone-V	Designing of tunnel section and other components is such to provide increased strength in zones of weakness
DPR preparation stage	Melkhet	Zone-V	--
	Kakoragad	Zone-IV	--
	Birahi Ganga - II	Zone-V	--

Source : Information extracted from DPRs of concerned projects.

Table: 12

NAME OF THE PROJECT	PERIOD	DISRUPTION
Rajwakti	September 2002	Damage to power channel; stoppage of power generation for 28 days
Hanuman Ganga	July 2005	Extensive damage to power house leading to temporary closure of project for four months involving energy loss worth Rs. 1.29 crore
Loharkhet	August 2008	Stoppage of power generation for 15 days

Source: Information provided by IPPs.

community. The consequences can be far worse had projects of high capacity been involved. In fact recently an incident where the coffer dam of the 330 MW Srinagar hydro-power project, had burst due to a flood like situation following incessant rains. This created considerable alarm in the downstream areas.

In conclusion, the above also shows inadequate construction practices being followed by project developers who failed to cater for such eventualities which are common place in the region. Additionally, it also highlights the ineffective monitoring by the GoU and the nodal agency as a result of which the slapdash approach of the project authorities towards project execution has gone on unchecked.

Recommendations

- The individual and cumulative impact on the downstream river flow should be seriously considered to ensure that the projects do not result in disastrous impact on the environment.
- The head pond, weir and intake associated with the diversion ought to be designed to minimize impacts, including those affecting aquatic life, sediment movement and flooding.
- Minimum flow in the diversion reach should be computed and prescribed taking into account the groundwater recharge potential of the river, irrigation, ecology and silt load factor.
- There is an urgent need for UEPPCB to strengthen its monitoring mechanism to ensure appropriate and timely action against projects that violate and are negligent of environmental concerns.
- In accordance with the GoI guidelines, an additional 1 per cent free power from the project may be provided and earmarked for Local Area Development Fund.