Land Use Policy 100 (2021) 105041

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Mitigation or Myth? Impacts of Hydropower Development and Compensatory Afforestation on forest ecosystems in the high Himalayas★

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ARTICLE INFO

Keywords:
Himalayan ecosystem
land use change
climate change mitigation
renewable energy
plantation
forest governance

ABSTRACT

Fragile ecosystems of the Himalayas have seen rampant land-use changes in recent times due to proliferation of hydropower development promoted as a climate change mitigation strategy for global energy transition. Further, in order to mitigate the loss of forest lands diverted for hydropower projects, countries like India have compensatory afforestation policies, which have meant more physical interference in natural landscapes, whose long-term consequences remain under-researched. This study conducted between 2012 and 2016 uses information from government data and ground research to examine the extent, nature and impact of forest diversion for hydropower projects in the remote, ecologically vulnerable Kinnaur Division of Himachal Pradesh in the Western Himalayas. It also studies the implementation of 'compensatory afforestation' undertaken as a 'mitigation' strategy as part of this forest diversion process. The study found that not only have construction activities for hydropower projects impacted existing land-use, disturbed forest biodiversity and fragmented the forest landscape, but the related compensatory afforestation plantations are also ridden with problems. These include abysmally low presence of surviving saplings (upto 10%) interspecies conflict, infringement on local land usage, and damage by wildfires and landslides. The study critically examines the role of state led institutions and global green growth policies in driving and legitimizing these developments in the name of 'mitigation', ultimately causing more harm to fragile local ecosystems and communities dependent on these.

1. Introduction

Himalayan ecosystems, recognised as diverse and fragile, have borne the brunt of extensive and rapid land use change with modern development (Batar et al., 2017; Malik et al., 2016). In recent years climatic hazards, such as landslides, floods and forest fires, have further destabilised mountain slopes and forest landscapes (Batar et al., 2017; Jamwal et al., 2019; Kuniyal et al., 2019; Sati, 2014). However, an unprecedented scale of land-use change in Himalayan river valleys is now clearly attributed to the proliferation of hydropower development, which has in turn unleashed a new set of challenges for the local terrestrial ecosystems over a short period of two decades (Grumbine & Pandit, 2013). Prominent among these challenges are deforestation, fragmentation, soil erosion and loss of forest biodiversity (Batar et al., 2017; Chawla et al., 2012). These are cause for serious concern for local communities, whose lives and livelihoods stand adversely affected by hydropower projects (Chandy et al., 2012; Diduck et al., 2013; Negi & Punetha, 2017).

State-led agencies in charge of environmental regulation and forest governance have failed to credibly assess the nature and magnitude of the impacts that a series of these projects are having on entire forest ecosystems (Agrawal et al., 2010; Panwar et al., 2010; Rajaram & Das, 2011). The process of diversion of forests, facilitated by the State Forest Department and various technical expert bodies constituted by the

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https://doi.org/10.1016/j.landusepol.2020.105041
Received 21 August 2019; Received in revised form 18 August 2020; Accepted 18 August 2020
Available online 6 September 2020

Ministry of Environment, Forests and Climate Change (MoEF & CC) under the provisions of the Forest Conservation Act, 1980 (FCA), does not effectively scrutinise forest loss as a result of development projects in general. This is evident in the track record of agencies on forest diversion proposals, clearing them with ease, hardly ever rejecting them (LIFE, 2019), and reducing the forest clearance process to a transactional formality (Narain, 2011). While environment impact assessment (EIA) studies are to be carried out under the Environment Protection Act (1986)[1] and appraised by other expert committees, these too have fallen short in regulating, monitoring and reviewing the impacts that ongoing hydropower development has had on the Himalayan forest-scape (Agrawal et al., 2010; Erlewein, 2013; Sagar, 2017).

Instead, forest governance policy and law have legitimised forest land diversion through its mitigatory scheme of 'compensatory afforestation' (Ghosh et al., 2019; K. B. Saxena, 2019). According to this policy, funds are collected from project proponents in lieu of forest diversion and are allocated for offsetting physical impacts and loss of forest ecosystems. This essentially comprises plantation activities carried out by the State Forest Department. Within the environmental governance framework, which has evolved and operates through an institutional consensus of the executive, judiciary and a majority of the scientific community, plantations are considered a panacea to 'irreversible' and 'complex' landscape changes (Bhatnagar, 2004; Kohli et al., 2011).

Both, contemporary hydropower development and compensatory afforestation, conceptualised as 'mitigation', are authored with the common assumption that environmental losses incurred as a result of a development in one area may be reversed or made-up for by alternative technological interventions or development in a different locale (Menon & Rai, 2019). Set firmly in the global neoliberal narrative of 'sustainable development' and 'green growth', these interventions are guided by the principle of valuation of ecosystem goods and services and their integration into markets through development as well as environmental policies (UNEP, 2011).

Post Rio and Kyoto, a shift to 'renewable energy' has been a central thrust of the dominant discourse on climate change mitigation and the fulcrum of the 'global energy transition' (REN21, 2017; Zarfl et al., 2014). In countries such as India and China, the Clean Development Mechanism (CDM) and foreign bank-led financing accelerated hydropower development in the Himalayas (Ahlers et al., 2015; Haya & Parekh, 2012). The Himalayan region became the prime location for hydropower development at the beginning of the liberalisation era in the 1990s, and to give an impetus to power generation, a potential of 150, 000 megawatt (MW) was planned to be tapped from this region alone (Dharmadhikary, 2008). These hydropower projects were mostly based on the 'run-of-the-river'[2] design and projected as the socially and ecologically friendly 'alternative', not just to coal-fired plants but also to the 'conventional' dams (Erlewein & Nüsser, 2011; Gibeau et al., 2017). 'Run-of-the-river' projects typically divert the river waters in high gradient mountainous zones, as against 'conventional' dams, which are reservoir-based storage projects involving large-scale impoundment of river water, and thus submergence of land and forests, causing relatively more displacement and greenhouse emissions (Abbasi & Abbasi, 2011; Anderson et al., 2006). However, the phrase 'run-of-the-river' gives the false impression that these projects are less damaging. These projects, of varying sizes and capacities,[3] also involve construction of dams and diversion of river waters through channels and underground tunnels (Egre & Milewski, 2002). Hydropower development in the Himalayas has involved construction of bumper-to-bumper projects in a cascade form on a single river basin for optimum utilisation of the energy potential (Abbasi & Abbasi, 2011; Erlewein, 2013). This has translated to recurrent diversion of the river, so much so that in various locations, the river has disappeared from the riverbed.

In the last decade, the 'clean energy' narrative behind the proliferation of hydropower development in the Himalayas has been challenged on grounds of adverse environmental impacts. The more visible transformations that have drawn attention include disruption of river flows (also known as environmental flows), forest loss, landslides and other hazards (Ahlers et al., 2015; Bhatt et al., 2012; Gibeau et al., 2017; Huber, 2019; Kuniyal et al., 2019). Existing GIS-based studies, mapping land use and land cover change due to hydropower projects in the Himalayan region, show significant physical landscape transformations (Batar et al., 2017; Jamwal et al., 2019; Kuniyal et al., 2019), indicating that the impact is not limited to riverine ecology.

In the Indian Himalayan regions where these developments are taking place, a majority of the land is legally classified as 'forest' and under the jurisdiction of the Forest Department, and its diversion for 'non-forest' activities attracts the provisions of the FCA. The enviro-legal mechanism of 'forest diversion' that enables these land use alterations thus comes into the picture. In the past three decades or so, several concepts, definitions and guidelines have been built into this legal framework by the Supreme Court, assisted by technical experts. Meant to regulate and conserve forests, this forest governance process legally institutionalised the 'payment for ecosystem services' model based on monetary valuation of forests lost to development projects. 'Forests' here are defined as the number of standing trees within it which are valuated, and the funds recovered from the promoters of the project can be used to raise plantations under legal measures like 'compensatory afforestation' (CAMPA).[4] This policy has been widely critiqued as reductionist, simplistic and a tool for further commoditization of forests (Ghosh et al., 2019; Seidler & Bawa, 2016). Plantations in India undertaken under this programme, by even conservation parameters, have shown no success (CAG, 2013), and it is believed to be greenwashing large-scale destruction of forest ecosystems (Brieger & Sauer, 2000; Ghosh et al., 2019). Moreover, plantations, undertaken as a method of ecological restoration, have been controversial, both for their effectiveness as well as for their impacts on ecosystems and the livelihoods of communities dependent on them (Valencia, 2019). Studies also question assumptions that there is uniformity in landscapes and forests lost in one place can be replaced with afforestation elsewhere (Bremer & Farley, 2010).

This paper, based on extensive field documentation in Kinnaur in the Western Himalayan Indian state of Himachal Pradesh, examines the impacts of rapid hydropower development in a short time-frame, focusing on forest land diversion. It documents the extent, nature and impact of this land-use change and then goes on to assess the efficacy and reality of what is promised as 'mitigation' of the damage to forest ecosystems.

In the following section we lay out the bio-physical, geographical and socio-legal background of the area where this study unfolds. Section

[1] The Environment Impact Assessment (EIA) Notification mandates that all development projects (including Hydropower Projects) seek Environment Clearance from the Union Ministry of Environment and Forests after an assessment called the EIA. However, the Environment Clearance process is separate from and runs parallel with the Forest Clearance process mentioned henceforth in the text. Further, the major allied activity of Hydropower projects, namely transmission lines, are exempt from seeking Environment Clearances.

[2] A run-of-the-river hydropower project uses the natural flow of the river, and enhances it further by diverting the river water into an underground diversion tunnel/channel. The water is carried to a distance using the sharp gradient, from where the water is dropped onto turbines in the power house (surface or underground) and then back into the river downstream. These projects use the advantage of the sites (with a strong head and flow) and thus avoid building huge impoundments, as done for conventional dams. https://www.renewableenergyworld.com/.

[3] Large projects (more than 100 MW); Medium (25 to 100 MW) and small (below 25 MW).

[4] Compensatory Afforestation Fund Management and Planning Authority Fund Act, 2013.

3 outlines the methods of gathering information. In section 4 we present our findings on forest land diversion as a result of hydropower development. The results of the assessment of compensatory afforestation activities and their efficacy are put forth in Section 5. In section 6 we discuss our findings, shedding light on the structural and institutional failures and their socio-political and economic underpinnings.

2. About the region

Kinnaur, a district[5] of Himachal Pradesh in the Western Himalayas, touching the international border of Tibet on its northeastern side, is spread over an area of 6401 sq. km. The Satluj is the main glacial river flowing through this district, with tributaries like Spiti and Baspa. The Zanskar, Great Himalaya and Dhauladhar mountain ranges run parallelly across Kinnaur with altitudes ranging from 2,320 meters to 6,816 meters. Variations in altitude, aspect and climatic zones (wet, dry and arid), contribute to the diverse natural vegetation ranging from subtropical pine forests to moist and dry temperate forests, from alpine Birch forests to alpine meadows, from cold desert vegetation in the arid zone to grasslands and scrublands (HPFD, 2000). These form critical habitats for different types of faunal species which also include endangered species like snow leopard *(Panthera uncia),* Himalayan Brown Bear *(Ursus arctos)* in three legally notified protected areas (Bhattacharya et al., 2019, 2020; Chandra et al., 2018). The natural vegetation comprises of forests, spread over 10.24% of the landscape, grasslands in 31.04%, scrublands over 2.95%, and 52% of total geographic area of Kinnaur is under bare rocky areas and cold desert (Chawla et al., 2012). A large part of the land has slopes of 30% to 80% gradient and is thus prone to severe erosion with few suitable zones for the establishment of vegetation (Uttam, 2014).

Deep dependence of local tribal inhabitants, the *Kinnauras*, on the limited land and forest resources for their day to day lives and livelihood needs is another characteristic feature. Land under cultivation constitutes a mere 1.35% of the total geographical area which indicates the scarce nature of its accessibility for human use, for the present and future. This also means that dependence on common lands (classified forest lands) is critical for local livelihoods and fulfillment of bonafide needs. Forests also hold socio-cultural and religious significance for the indigenous community of the region. In terms of legal classification 80% of the total geographical is under the jurisdiction of the Forest Department. While the ownership of this land is with the State, there are indigenous laws and state policy which grant rights and concessions of forest usage to local communities (Glover H, 1921). Further, these among other rights are enshrined in the Schedule V of the Indian constitution, giving them a special legal status.

The whole region is vulnerable to climatic disasters with high probability of cloudbursts, flash floods and landslides and is also seismically fragile (Kinnaur DDMA, 2009). Like the rest of the Himalayan region, here too, modern development has multiplied the anthropogenic pressures on the physical environment, biodiversity and other natural resources (Chawla et al., 2012; Malik et al., 2016). It is in this bio-physical and social context, characterized by multiple vulnerabilities, that we examine the role of forest diversion for hydropower development and so-called ecological restoration through the 'mitigation' policy of compensatory afforestation.

Of all the Himalayan states[6] in the Indian subcontinent, the pace and magnitude of hydropower development in Himachal Pradesh has been the highest (Standing Committee on Energy, 2019). The highest identified potential of hydropower amongst the 5 river basins of Himachal lies in the Satluj valley and if all planned projects materialize 22% of the river would be dammed and 72% flowing in tunnels. Kinnaur, located in the upper reaches of Satluj basin, is the state's hydropower hub with has 53 planned hydropower projects, of which 17 are large projects (above 25 MW). 15 projects of varying capacities, totaling to 3041 megawatt (MW), have already been commissioned (are operational) which is highest among all the districts in the state.

Further, in the entire state (Fig. 1) as well as Kinnaur region, forest land diversion undertaken for hydropower projects and transmission lines forms a large proportion (more than 90%) of all forest land diversion for any 'non-forest' activity. For every hectare of forest land diverted, double the area of 'degraded' lands have been used as sites for related 'compensatory afforestation' activities. The magnitude of land use change for all activities connected with hydropower projects (including compensatory afforestation) in Kinnaur, thus warrants urgent inquiry.

3. Methodology

A detailed secondary literature review was carried out during the study period of 4 years (2012 to 2016). Data of all forest clearances and compensatory afforestation activities including the extent of forest land diverted, specie wise trees felled, plantations carried out (numbers, species, funds expended) for the operational and under construction projects. This data was obtained through the Right to Information Act, 2005 (RTI), using the *File Inspection* route with the Forest Department. The names of plantation sites, area and the number of saplings planted, species-wise were collected through the plantation vouchers prepared by the Forest Department for each financial year (Table 1). Additionally, the Forest Clearance proposals and EIA reports of projects were also studied. Furthermore, the study relies on local dialogues and community interactions that have taken place since the year 2010 as part of the environmental justice work done by the authors in the region. These informal interactions were relied on to validate or question the secondary collected information.

A ground truthing exercise, as the primary method involving plot selection and sapling counts in plantation sites under Compensatory Afforestation (CA) and Catchment Area Treatment Plan (CAT),[7] was undertaken to assess their implementation and impacts. In order to physically assess the 'success' of plantations, a study of the survival rate of saplings planted as per the plantation record between 2003 and 2012 maintained by the Kinnaur Forest Division, was undertaken in the year 2014. Under the CA and CAT schemes, the work was spread over 222 plantation sites in 7 ranges of Kinnaur Forest Division. For this purpose, we randomly selected 22 plantation sites (proportional to 10% of the plantation carried out) representing four climatic zones: Wet zone – Bhabhanagar and Nichar; Dry and wet zone – Kilba; Dry zone – Kalpa and Dry, arid zone – Moorang, Pooh and Malling.

The selected sites were affixed with a weighted average calculated according to the total number of plantation sites and the total area under plantation in each zone (Table2). This was done separately for both CA and CAT plantations. Once the plantation sites were selected quadrats of 400 m^2 were marked randomly in 10% of the plot area following which the species-wise number of saplings were counted.

[5] The boundaries of Kinnaur Forest Division are coterminous with that of Kinnaur district.

[6] Thus far, potential generation of 150,000 MW of electricity has been identified in the states of Jammu &Kashmir, Himachal Pradesh, Uttarakhand, Arunachal Pradesh, Sikkim as per the 12[th] 5 year plan (erstwhile Planning Commission).

[7] CAT Plans are mandatory for hydro-projects with a capacity greater than 10 MW. The Environment Management Plan (EMP), of which CAT plans are but one part, encompasses a whole range of biological and civil engineering works. The activities are aimed at treating the degraded and potential areas with severe soil erosion in the catchment area of a project. CAT funds are also transferred to the Compensatory Afforestation Fund managed and implemented by the forest department.

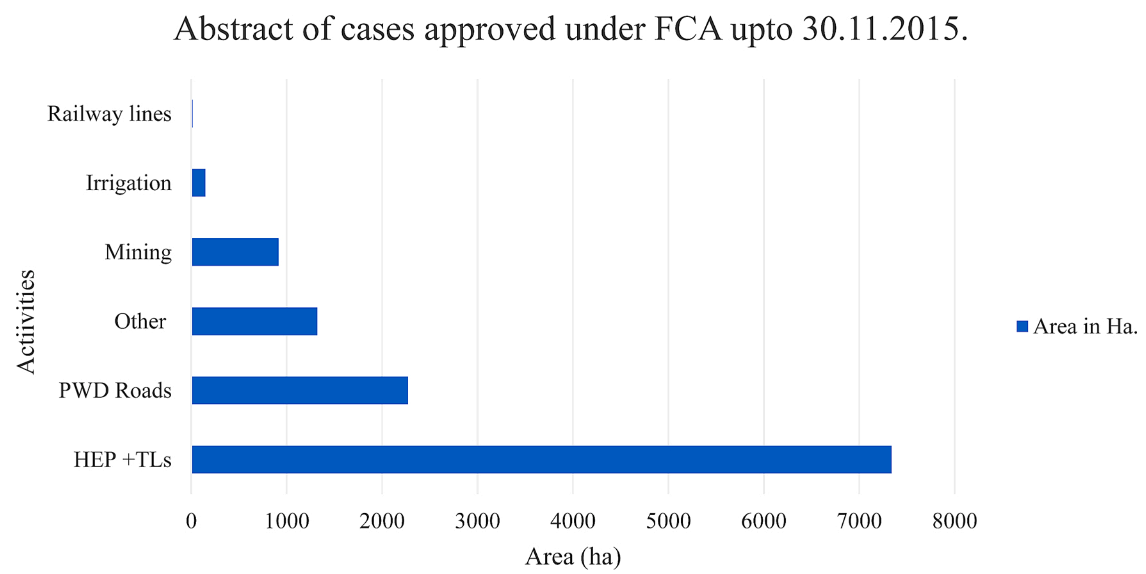

Fig. 1. Forest area diverted for various activities in Himachal Pradesh, India. (http://hpforest.nic.in/files/FCA_1.pdf).

Table 1
Plantations carried out under CA and CAT, Kinnaur Forest Division.

Scheme	No. of Plantations plots	Area (Ha)	Species planted	Saplings planted
CAT	178	808.60	25	**936,619**
CA	44	241.60	23	**282,240**
Total	222	1050.20		**1,222,159**

Table 2
Selection of plots and sampled area in Kinnaur Forest Division.

Zone	Range	Plantations plots (number)	Plantation area (ha)	Plantation plots selected from each zone	Sample area selected for counting saplings (hectare)
1	Bhabhanagar and Nichar	46	200.27	5	2.2
2	Kilba	54	268.67	5	2.56
3	Kalpa	68	364.26	7	3.76
4	Moorang	54	217.00	5	2.36
Total		**222**	**1050.20**	**22**	**10.88**

4. Forest Diversion: Extent, Nature and Impact

'Hydropower' is considered renewable because of the nature of its power source – water. However, this fails to take into account that this source is a part of a river basin environment that comprises land with forests, flora, fauna and people – all of which, in some form or another, are instrumentalized and disturbed by this development (Diduck et al., 2013; Jolli, 2017; Khare et al., 2017). The surface construction involved in these projects comprises construction of a high concrete gravity dam, approach roads, a power house, colony and labor camps, as well as a submergence area and the installation of towers for transmission lines (CEIA, 2014). The building of underground tunnels and powerhouses, also have repercussions on the surface (Attanayake & Waterman, 2006; R. K. Bhandari, 1987). For instance, the millions of tons of muck and debris extracted from the underground tunnels require a massive land area for dumping (A. Saxena, 2014; H. K. Sharma & Rana, 2014). Since land, officially classified as 'forest', occupies a large percentage of the landscape in Kinnaur, proliferation of hydropower/electric projects (HEP) and the allied Transmission Lines (TL) has obviously demanded the diversion of this land.

4.1. Land-use change

In Kinnaur, a total of 984 ha of forest land have been diverted for activities such as roads, defense services etc., out of which 867 ha of forest land has been transferred for 10 big projects, 12 small HEPs and 11 TLs, as of 2014, which is almost 90% of the total forest land diverted (RTI Information). 'Forest land', as explained in Section 2 does not necessarily translate to 'forests'. While the official figures for area under actual forests are varying, it is clear that forests (with cover) are present in approximately 10% of the total geographical area (SFR, 2015). These are found in a thin band (altitudinal range of 2130 to 3600 meters), along the both sides of Satluj river (HPFD, 2000). Much of what is classified forest land is naturally bereft of trees, under permanent pastures[8] and barren rocks located in the higher altitudes (P. D. Sharma & Minhas, 1993).

The lower altitudes, which are suitable for tree growth and thus essential for maintaining the ecological balance of the region are also highly contested areas for different human activities i.e. habitation, agriculture, basic infrastructure, as well as defense infrastructure (since this is a border district). Additionally, local communities hold 'rights and concessions' in the legally classified forests and pastures, for free grazing, timber for building at concession rates, collecting and selling minor forest produce and grass.[9] It is in this already contested area that the slew of construction activity for hydropower projects is on-going (Fig. 2).

This has brought the forests of the area under severe pressure due to change of land use and fencing of common lands for compensatory afforestation plantations. Diversion of forest land for purposes of agriculture (especially horticulture) as well as development of local infrastructure, both of which have benefitted local communities, has also

[8] This categorization is based on land use and is followed by the Revenue Department. Whereas the Forest Department Working plans only provide the legal categorization of Demarcated, Undemarcated Protected Forests, National Parks, Wild life Sanctuaries etc.

[9] Granted during the 1921 Forest settlement carried out by the British Empire to record rights of communities while demarcating forest land boundaries.

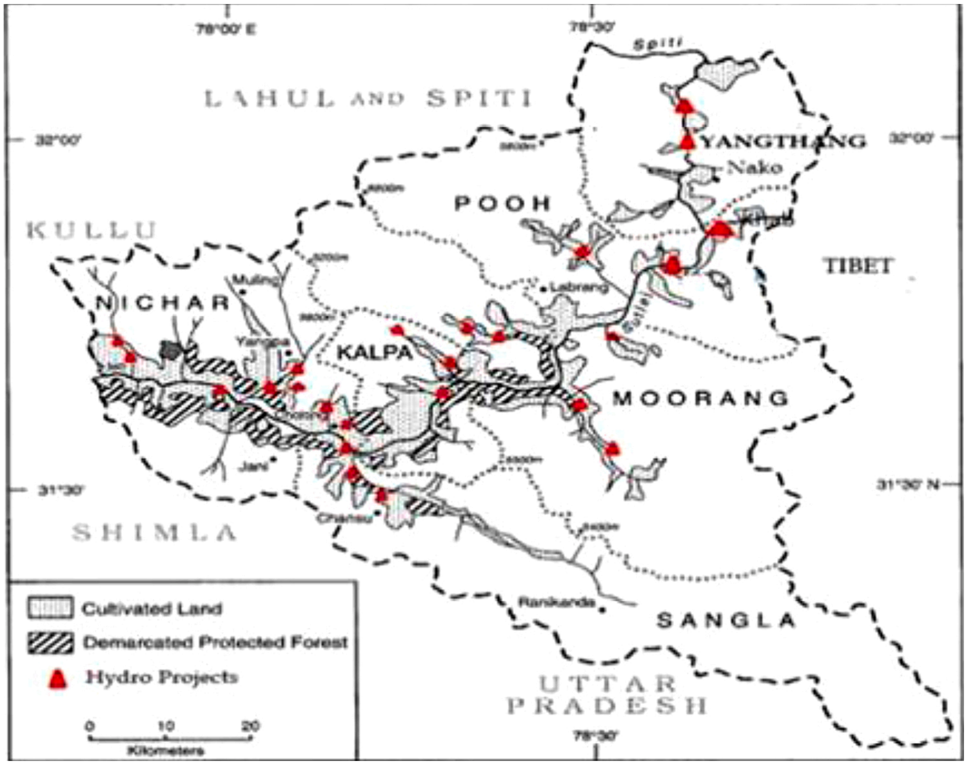

Fig. 2. Map of cultivated lands, DPFs and HEP sites in Kinnaur District.
(Source:Sharma, P. D., & Minhas, R. S. (1993). Land use and the biophysical environment of Kinnaur District, Himachal Pradesh, India. *Mountain Research & Development*, *13*(1), 41–60. https://doi.org/10.2307/3673643) (Adapted and modified).

contributed to the loss of forest cover. However, this has been to a lesser extent and spread over a longer period of time, compared to hydropower and transmission lines components, which have altered the landscape substantially and rapidly in a shorter period.

Fig. 3 gives an overview of the total area of forest land that has been diverted for HEPs, over a 31-year period following the enactment of the Forest (Conservation) Act, 1980 in Kinnaur. The trend shows that forest diversion picked up after the 1990s, and that from 2000 onwards, forest land has been diverted almost every year for HEPs and allied TLs up to 2012, after which there has been a decline in forest diversion. The peak period of forest diversion corresponds with the project proponents availing CDM benefits. 6 large hydro projects in the Satluj river basin made applications under this out of which 4 (Sorang, Karcham Wangtoo, Integrated Kashang and Tidong-I) are in Kinnaur district. The Integrated Kashang Project and Shongtong Karcham HEPs have availed loan facilities from the Asian Development Bank under the Himachal Pradesh Clean Energy Development Program (HERAC, 2011).

The assessment of land use data of 2001 and 2011 in 228 identified project-affected villages in the Satluj basin shows that in the Upper region of the river basin, where there are no hydro projects, there is a minor increase in forest, whereas the Middle region (from Khab to Nathpa) and in the Lower region (from Nathpa to Kol Dam) where projects have already been commissioned – forests have shrunk by 9.38% and 7.65%, respectively (CEIA, 2014). Another source of data on forest cover is the Indian State of Forest reports from 2001 to 2015, which indicates that there has been a 7.25% reduction in forest cover in Kinnaur District (SFR, 2001, 2015). This period was contemporaneous with the increase in hydropower development activities in the state.

Official data on 'forest land' diverted does not reveal the entire extent of the impacts of land-use change as these extend over a far larger area than the land that is diverted in the documents. Apart from the loss due to the officially permitted forest diversion, deforestation is caused due to landslides and illegal encroachment by project proponents (Jamwal et al., 2019). For instance, in several cases, locals reported dumping of muck on non-designated forest lands (Jamwal et al., 2019; Khare et al., 2017). These kind of changes to the forest environment are rarely recorded or accounted for. This was illustrated in case of Tidong-I project (Kumar & Shamet, 2016). Satellite images of Tidong-I project show the recession of forest cover, beginning in 2005 prior to construction, through 2012 when the project was under construction, and in 2014 when construction was reaching its conclusion. A Forest Department Damage report issued for this project reveals that "*an additional 4, 851 trees – of which 2,803 are Chilgoza Pines – have been demarcated by the Forest Department as, likely to be damaged during [the] execution of work (road to power house) in addition to the already sanctioned 1,261 trees ([of which] 786 [are] Chilgoza) in the Forest Clearance)*. The loss of forest cover was also amplified by the unprecedented rainfall in 2013 (Asher, 2015).

There are studies which show that the risk of landslide increases with the tunnelling in mountain areas as large amounts of water percolates into surfaces (Li et al., 2019). The use of dynamites for blasting through the surfaces and underground components of the projects disturb existing slopes and the fragile geology. These kinds of incidences are visible at other project sites Baspa-II, Karcham Wangtoo, Shongtong Karcham and Kashang-I (HERAC, 2019; Jamwal et al., 2019).

As project after project was constructed in this region, voices of dissent emerged from the inhabitants and impacted communities. Submission made to government agencies and courts significantly raise issues of deforestation; tunneling activity disturbing ground water spring discharge, leading to cracks in houses; landslides and dumping of muck on hill slopes hindering mobility, destroying apple orchards, grazing grounds and forests (Khanduri, 2014). These have been raised on official platforms like public consultations as part of the EIA process and also documented by expert committees set up by the government (Dogra, 2015). Non-compliance with the terms of the Scheduled Tribes and

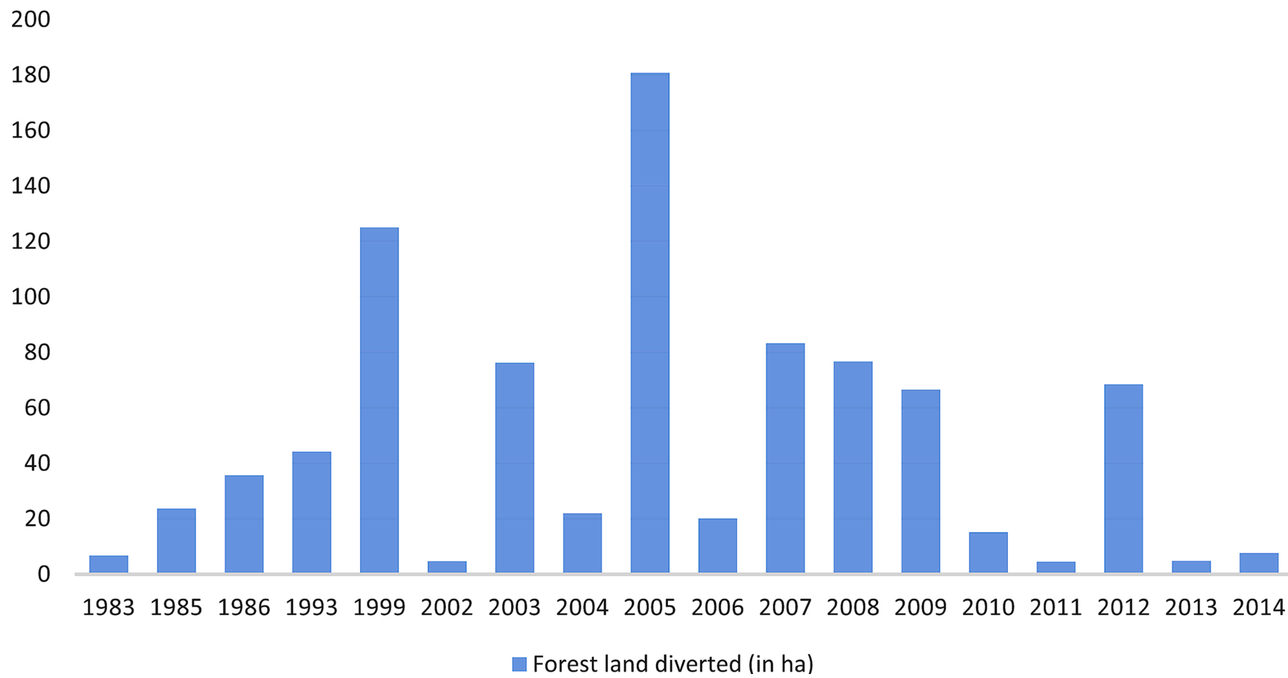

Fig. 3. Diversion of forest land over 31-year period, Kinnaur Forest Division (RTI Information).

Other Forest Dwellers (Recognition of Forest Rights) Act (FRA) 2006, which mandates consent from the impacted *Gram Sabhas*[10] that may have existing individual and community user rights on the forest land to be diverted, is the key legal contention in projects like Kashang Stage II and III (P. Bhandari & Mahar, 2016). FRA assumed significance in the Forest Clearance process as a formal condition only post 2009. Diversions prior to that period had no legal requirement for consent from the affected community under the FCA. However, being a Schedule V area meant that consent of *gram sabhas* for any development activity was mandatory under other legislations. "We believe that the Karchham Wangtoo project is illegal because atleast 2 village *gram sabhas* had not given their consent for the project" local leaders say.

4.2. Biodiversity loss: The case of an endangered species, the Chilgoza Pine (Pinus gerardiana)

The Forest diversion proposals are supposed to enumerate the species to be impacted as a result of the diversion and mention the presence of 'endangered, threatened and rare species', if any (Handbook of FCA, 1980; FCR, 2003 (Guidelines & Clarifications), 2019). This is the only biodiversity assessment carried out in the forest diversion process. The total diverted forest land in Kinnaur had 11,598 standing trees, belonging to 21 species – all of which had been cut down for the construction of these projects. Majority of the trees felled were coniferous, dominated by cedar *(Cedrus deodara)* (3612) and chilgoza pines (2,743). It appears that the enumeration is also focused on economically 'valuable' and timber species. Other species of trees, shrubs, herbs etc. are classified as 'inferior' referred to as *kokat* in local forest department terminology (HPFD, 2000) and find no mention, even though they may be valuable.

The Chilgoza or Neoza tree, impacted by these projects, is a rare and endangered species of evergreen pine that is indigenous to the western Himalayan region providing edible nuts. Shrinking Chigoza forests have been a cause for concern in this region (Kumar & Shamet, 2016). While its contribution to local income has decreased with apple and off-season vegetable cultivation, it still forms a substantial part of the economy in villages well-endowed with Chilgoza forests, with fewer orchards (Peltier & Dauffy, 2009).

There are 10 projects for which 415 hectares of forest land from the Chilgoza forest belt has, either been diverted or will be diverted, in the future.[11] There are currently 4 TLs passing through the Chilgoza forest belt. Six villages in Tinala Forest revealed that they had collectively lost 80% of their Chilgoza trees due to construction activities and debris dumping. Given these pressures and in the absence of opportunity for regeneration, through both natural and artificial means, this species stands under severe threat of extinction. (Malik et al., 2016). Natural regeneration of Chilgoza is difficult and even the Forest Department attempts at Chilgoza Pine plantations have met with failure and poor sapling survival rates. The seedling is very slow growing, attaining a height of just 22-25 cm in a 6- to 7-year period (Kumar & Shamet, 2016; Peltier & Dauffy, 2009).

4.3. Fragmentation of critical habitats

When the head of one project is the tail of another project, the whole basin is ultimately converted into a web of inter-connected roads and transmission lines, creating a massive fragmentation of the natural landscape. Forest diversion has taken place in small patches scattered over the length of the head race tunnel – from the dam (diversion structure) to the site of the power house. To gain access to different components of the project, a network of roads is constructed from the diversion structure to the access tunnels to muck dumping sites, to the de-silting chamber, stone crusher plant, store house, power house and finally, connecting to the project colony (CEIA, 2014). Similarly, patches of forest land are acquired for the erection of transmission towers through villages and mountain ridges.

This means a fragmentation of forests and habitats due to disruption

[10] A Gram Sabha is a village assembly consisting of all adult members of a village.

[11] Karcham-Wangtoo, Kashang-I, -II, -III and -IV, Ropa, Tidong-I, Shongtong-Karcham, Roura-II, Nesang, Jangi-Thopan-Powari and Nesang. Approximately 285 ha of forest land will be diverted for the 6 projects (Karcham-Wangtoo, Kashang stage-I and Stage-II and III, Tidong, for which forest diversion data is available).

of landscape connectivity and contiguity, provoking the dispersal of animals, and creating new edges that expose forests to exploitation and further degradation (Benítez-Malvido & Arroyo-Rodríguez, 2008; Saunders et al., 1991). A total of 13 hydropower projects fall within 10 km of the buffer zone of the Rupi-Bhaba Wildlife Sanctuary (WLS). Another 5 projects are in the area of the Lippa-Asrang WLS, while Baspa-II is a mere 6.5 km from the Rakcham-Chitkul WLS. All three WLSs are in the Greater Himalaya, where the winters are fairly severe and heavy snowfall is commonplace. During the winter months, wildlife tends to migrate to lower altitudes in search of food and water. It is in these lower areas that projects are springing up. Areas categorised as 'protected' and 'eco-sensitive zones' under law face stricter scrutiny of different government bodies in the process of forest diversion. However, in the case of Kashang II and III, the Forest Department while preparing its eco-sensitive zone proposal for the Lippa-Asrang WLS in the year 2015, excluded these critical habitat areas which are home to species like the Snow Leopard and Himalayan Brown Bear (Bhattacharya et al., 2019, 2020).

Forest diversion applications are submitted by the project proponents in a piece-meal manner, as seen in Kinnaur's case.[12] For instance, the Integrated Kashang Project involves four stages of construction and the project proponent applied separately for the forest diversion required for each stage. TLs, which plot a course along mountain ridges from the power stations of HEPs, are treated as a subsidiary activity and the Forest Clearance process is conducted separately from the main project application. In the case of 1000 MW KarchamWangtoo project, applications for the diversion of forest land were made on 5 separate occasions, not including the separate application for the project transmission lines. While 180 ha. of forest land were diverted for the main project activities, another 323 ha. of forest land was diverted for construction of the transmission line (with nearly 500 towers). Cumulatively, 503 hectares of forest land was diverted for the entire project in 4 separate forest divisions, with a total of 1,287 trees felled for the main project, and 3,924 felled for construction of the transmission lines.

5. Assessing 'plantations' under Compensatory Afforestation

The loss of forest and biodiversity on account of diversion of forest lands for construction of hydro projects is required by policy to be compensated by carrying out plantation activities. To check the effectiveness of plantation activities, a ground truthing study was carried out on 22 sites (Fig. 4). The total funds received by the Kinnaur Forest Division as part of the diversion of forest land for hydro-projects and transmission lines amounted to Rs. 111.50 million from 1980 to 2013. Of this around 50% was received for the trees to be cut down to carry out the project activities. As of 31st March, 2014, the total area of land demarcated for CA was 1,930 ha, in lieu of 984 ha of forest land diverted for non-forest activities, which includes roads, hydro-projects, transmission lines etc. Under CA, following the initial plantation there is a provision for the maintenance of planted trees over the next 7 years. From 2002 to 2013 the forest department has carried out plantation work in 44 sites in an area of 241.67 hectares (12% of the total plantation), for the forest land diverted for hydro-projects and transmission lines under CA. Between 2002 and 2014, of the Rs 1628.20 million collected under CAT plans' funds of Kinnaur's projects only 36% percent had been spent till 31st March, 2014. As part of the CAT plans along with other activities new plantations were carried out in an area of 808.60 hectares on 178 sites in KinnaurForest Division. This reveals the large amount of funding that the department is receiving in lieu of the diversion, slow implementation of these measures and the fact that they remain unreviewed while sanctioning newer proposals.

Our study ascertained that of the average number of total saplings reported under CA and CAT, only 10% of saplings were found in the plot, which is notably low (Table 3). This assessment was based on counting of saplings in sampled plots and matching the counts with the number of saplings reported (by the Forest Department) as planted in that plot. In three of the 22 sample plots, not a single sapling was found. In Demarcated Protected Forest (DPF) Manoti, an old barbed wire fence found in a few sections of the plot was the only proof of the plantation's existence. After thoroughly examining the whole plot, not a single planted sapling nor any sign of digging was found.

Plantations situated in mid and upper Kinnaur showed a very poor survival rate of approximately 3.6% in 4 plots, due to acute dry conditions and the absence of irrigation facilities – a state of affairs that is well-known to the Forest Department and has even been cited as a reason for the failure of plantations under the Desert Development Project.[13]

In the case of the Sangla Kanda site, the forest guard informed us that a fire had wiped out the whole plantation. This was also verified in the field. At plantations in Undemarcated Protected Forest (UF) Baspa, Landhar, Thong Shong Thikroo and Hurba, either landslides or avalanches had destroyed the plantations. The plot at Plingcha was full of stone boulders; there was hardly any space left for plantation while the Thach plot was located on a steep slope, and inaccessible for plantation activity. Over 50% plantation sites were in such terrain.

At UF Chango, C-233 and Thach, the plantations are located in areas used by locals for fodder/grass collection and for grazing. Locals do not want to convert these grasslands into plantations and so "uproot the saplings once they are planted by the Forest Department", the Beat Guard, Taranda acknowledged.

Plots in Manoti and Kutangenin already had a relatively large population of standing trees. Yet the Forest Department, planted exotics species like Ailanthus and Robinia here. Forest Department vouchers revealed that 1100 saplings per hectare were planted, which seemed impossible considering the geographical and physical limitations. In the case of the Baspa plot, saplings of Robinia (*Robinia pseudoacacia*) were found to be doing well, but according to the plantation voucher,[14] this species was not planted in the plot as part of the redressal scheme.

Forest department ground staff revealed that there are "hardly any sites which are suitable for plantations", but to fulfill the mandatory condition to mark the plantation sites for diversion of forest land and meet targets, "we have to put them on record and also carry out the activities wherever possible". A senior forest officer was in the know of poor survival rates as well as lack of suitable sites, and said that the Department has now decided to carry out plantations in other districts of Himachal Pradesh under CA in lieu of the forest land diverted in Kinnaur.

One of the starkest findings, was the discrepancy in the types of trees planted, when compared to the species of trees that were felled as part of the forest diversion. While the trees that were cut down were mostly of local and indigenous species, the plantations consist of a proportionately higher number of exotic species, such as Ailanthus and Robinia (Fig. 5). The prime reason for the same was the survivability of the species. The survival of Ailanthus is far better compared to any of the local species planted. Moreover, we observed that the survival and growth of Ailanthus and Robinia saplings is faster in comparison to local species, across all plantation sites (Fig. 6). The changing composition of the forest is posing a threat to the existence of native species, which now risk being overpowered by the new exotic species (Benesperi et al., 2012). Robinia is a particularly invasive species and many local farmers complained of it spreading to their farm lands. Known as black locust, this is a

[12] User Manual for User Agency on Procedure for Obtaining Forest Clearance, MoEFCC, forestsclearance.nic.in.

[13] Working Plan for the Forests of Kinnaur Forest Division, 1999-00 to 2014-15; Rajiv Kumar DFO-cum-WPO, Kinnaur.

[14] Plantation voucher is an official document which shows year wise data species wise planted saplings.

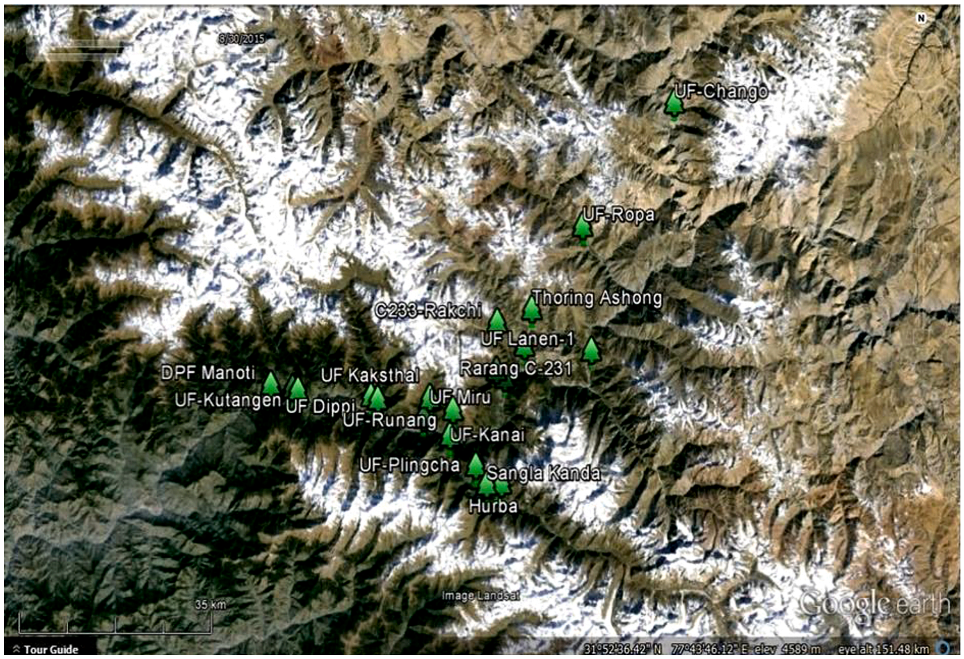

Fig. 4. Plantation sites selected for the study in Kinnaur Forest Division.

Table 3
Classification of plots according to survival rate (%) in Kinnaur Forest Division.

Saplings counted to planted as per records (%)	Plantation plots (number)	Ratio of plots
<10	11	50
10-20	5	23
20-30	3	14
30-40	1	5
40-50	1	5
>50	1	5

nitrogen-fixing, clonal tree species that aggressively invades open habitats and expands outside of plantations worldwide (Benesperi et al., 2012; von Holle et al., 2006).

6. Structural failures and Policy Pressures: A discussion

Loss of forest cover and critical biodiversity as well as fragmentation of ecologically sensitive forest areas, that our study provides evidence of, were expected given the magnitude and type of hydropower activity in the vulnerable Himalayas, as warned by Pandit et al (Grumbine & Pandit, 2013). The hydropower rush witnessed in Kinnaur is part of the larger global thrust towards 'renewable' and the national mission to raise hydroelectric capacities. The latter began with the opening of power production for the private sector in the early 1990s which brought investment in projects like Baspa and Karchham Wangtoo to Kinnaur. In the last two decades international financing of these projects (through CDM subsidies and foreign bank lending) specifically drove private as well as public players into the fray and in the Upper Satluj river basin at least 4 large projects received such support.

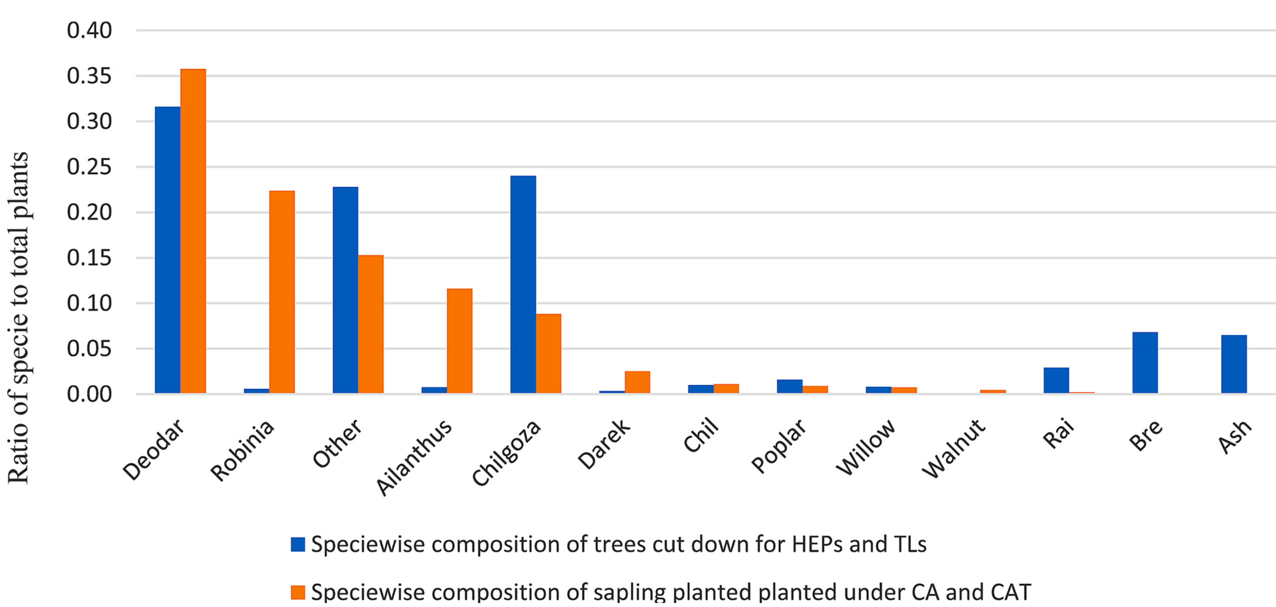

Fig. 5. Specie wise comparison of composition of saplings planted in lieu of trees cut down for HEPs and TLs in Kinnaur Forest Division.

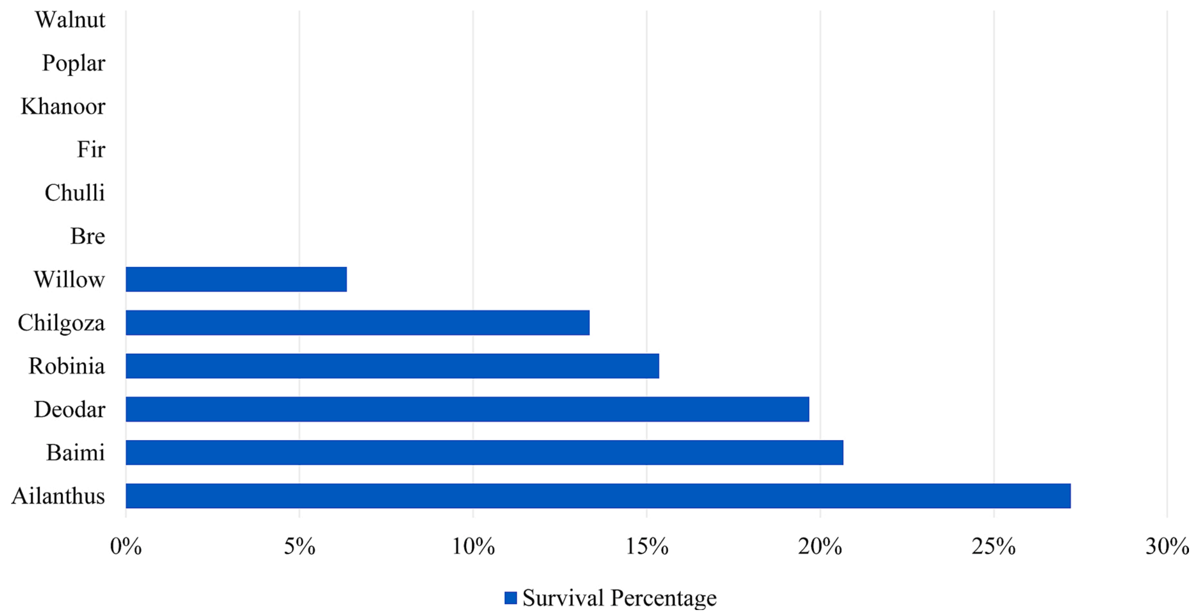

Fig. 6. Survival percentage in comparison to specie counted in the plots to the specie planted according to the Forest Department records in Kinnaur ForestDivision (.

The large-scale expansion of hydropower unleashed thereafter usurped substantial forest land, constituting 90% of all forest land diverted towards development work in the region. Forest land diversion for hydropower projects including the transmission lines component has been concentrated in the lower altitudes and valley areas with forest cover, cultivated lands and human habitations, throwing up various contestations in a vulnerable region like Kinnaur with scarce resources in a very short period of time.

On the other hand, plantation activities undertaken as 'compensatory afforestation' for forest land diversion and to offset ecosystem impacts, which are still unfolding and require more in-depth assessment, have not met planned targets and have seen poor survival rates. Our findings confirm the understanding that these plantations may be causing further negative impacts like interspecies conflict and encroachment on local forest access and use.

Examining the trajectory of hydropower activity, the forest land diversion process preceding compensatory afforestation-based mitigation in Kinnaur reveals that the emergent adversities are not despite, but rather due to the nature of the current institutional and policy framework around conservation and mitigation (Huber & Joshi, 2015).

Historically, 'forest governance' in India has been strictly the domain of the colonial Forest department which was set up to 'facilitate' commercial exploitation of forests through scientific management (forestry) borrowed from the West (Guha, 1983). Post India's independence, and especially 1970s onwards, 'Conservation', as practiced in the western world, was further institutionalised in the forest management regime through legislation like the FCA 1980. The 1980 law sought to regulate diversion of forests for 'non-forest' purposes. However, the commoditization of forests and their diversion for 'development' purposes under compulsions of neoliberal political economy, has continued under this forest 'management' and 'conservation' policy, sidelining ecological and social concerns (Gopalakrishnan, 2019; K. B. Saxena, 2019). The 'Forest Clearance' process, under the Forest Conservation Act 1980, obliges the involvement of the Forest Department in preparing the forest diversion proposal, and a body of technical experts assembled under the Forest Advisory Committee (FAC) under the Ministry of Environment, Forests and Climate Change (MoEF&CC), to scrutinize the proposal and give its recommendations. The provisions of this entire process are such that there is little scope to examine, holistically and in detail, the ecosystems impact of the diversion (Kohli et al., 2011; LIFE, 2019).

Significantly, our findings in case of forest diversions for HEPs and TLs highlight that forest land to be diverted is sought in parcels, not just for each individual project but also for different components of the same project. TLs, a critical allied activity, which this study shows entail substantial forest diversion, for instance, are treated as 'linear' projects under official guidelines exempt from some provisions and are also not scrutinised under the EIA process. This fragmented approach to acquiring and according clearance diminishes the sense of the cumulative damage, thereby ensuring that permission is given more readily by regulatory agencies. In several cases, like the Integrated Kashang Project, the FAC has approved clearance for diversion based on incomplete or partial information, paying attention to the impacts of only the part of the total forest land for whose diversion the permission is being sought.

Applications for forest diversion focus on enumeration of trees to be felled affording little consideration for the nature of the threatened forest itself. Even though names of 21 species were found amongst the total of 11, 589 trees officially felled within the area diverted in Kinnaur, these were amongst the well-known timber species. Species like Juniper *(Juniperus* spp.*)*, for instance, a shrub which is highly valued by the locals due to its use for spiritual purposes, is not found in this list. Even the impact on a rare and endangered species like Chilgoza Pine was denied by the forest department in case of forest diversion application for a proposed project site falling directly within the Chilgoza belt.

The forest diversion proposal apart from total forest area to be diverted, asks for the availability of area that would be brought under plantation as part of 'Compensatory Afforestation', considered as the most important condition for diversion. Additionally, a levy called the Net Present Value (NPV), collected through an arbitrary valuation of ecosystem services of the forest land to be diverted, is a mandatory condition to obtain a forest clearance and the same is to be deposited with the CAMPA fund (Temper & Martinez-Alier, 2013).

The only purpose of CA as defined under government guidelines is to "compensate the loss of 'land by land' and loss of 'trees by trees'". Additional information on CA is not sought by the FAC to examine the specific context or to tailor the mitigation measures for the specific needs of the region, local communities or ecosystem restoration (Ravi & Priyadarsanan, 2015). As was evident in Kinnaur, the plantations which were to be carried out on 'degraded' lands, have either been sited in natural forests, where community use has been impacted, or in completely unsuitable terrains, just to meet targets. The diverse yet peculiar bio-geographic and local conditions played a role determining the (lack of) implementation and 'success'. Thus, plantations have so far, only been undertaken over 12% of the planned area, and even these had a survival rate of less than 10%.

Further, plantations may be causing changes in the forest composition as non-native (exotic) and fast-growing species like Ailanthus and Robinia were introduced. The failure of Chilgoza regeneration attempted by the Forest Department, is but a small illustration of how natural ecosystems cannot be easily replicated. Studies have highlighted the detrimental consequences of carrying out afforestation in natural forests and natural non-forest land (Bremer & Farley, 2010; Kanongdate et al., 2012). Additionally, research also shows that such plantations may exacerbate environmental degradation in environmentally fragile areas because they ignore climate, pedological, hydrological, and landscape factors that would make a site unsuitable for afforestation (Cao, 2008).

The effectiveness or 'success' of CA is never monitored or reviewed which is why its failure is not subject of discussion for the agencies involved. Evidently the entire institutional set up is operating under pressure to fast track clearances given the demands and interests of the economic growth paradigm (Banerjee, 2015; Mandal, 2013). This is also the driver of violations in provisions of legislations like the FRA 2006, which mandate consent of affected communities for forest land diversion. Notably, in case of Kinnaur, non-compliance has been observed even after court directions and institutionalization of this provision in the Forest Conservation Rules of 2017 (Asher, 2019). Not just the forest land diversion, but even the transfer of forest land for 'compensatory afforestation' activities which affects community uses and rights, mandates consent under FRA, which is rarely ever sought (Ghosh et al., 2019; K. B. Saxena, 2019)

Growing local opposition to these projects has been driven by the ecological and socio-economic impacts mentioned in the study (Asher, 2019; Baruah, 2016; Sati, 2014; Vibha Arora, 2007). The official enviro-legal impact assessment process has failed in engaging with the full nature of impacts and responding to the issues raised during official public consultation processes. Even the 'Cumulative Environment Assessment' study conducted for the Satluj river to assess the basin wide impacts of all existing and planned hydropower activity, has not incorporated the environmental concerns and demands of affected people and environmentalists in the final decision giving a go-ahead to 148 projects.[15] Huber and Joshi in their various works examining hazardous hydropower infrastructure in the Eastern Himalayas from the political ecology lens have significantly highlighted how neglect of various environmental risks facilitates further wielding of economic benefits by political and corporate powers, while accelerating marginalization of already vulnerable groups (Huber & Joshi, 2015).

The policy moves in 2019 to declare all projects above 25 MW as 'renewable' to enable them to avail financial incentives[16] indicates the renewed efforts are underway in India to revive the hydropower sector, which has seen a slump in the last 5 years. On the other hand, introduction of the Compensatory Afforestation Management and Protection Act 2016[17] has further empowered State Forest Departments to carry out plantation activities by providing them access to the funds collected under the NPV mechanism as a part of the forest diversion process. This implies continued pressures on natural resources and ecosystems in the future.

7. Conclusion

Our study, based on ground research carried, provides evidence to suggest that both hydropower projects as well as compensatory afforestation plantations, carried out in lieu of the forest land diverted for these projects, in the name of 'mitigation' have altered land-use and are negatively impacting forest ecosystems. This notion of 'mitigation', propelled by the global 'green' growth narrative and implemented through top-down domestic governance processes rooted in the colonial past, relies on the fallacy that ecological damages in one region can be simply compensated by repair measures in another and needs to be confronted urgently.

Whereas, the call of the hour is a detailed, independent and multi-disciplinary inquiry into the eco-systems alteration due to hydropower projects, especially in the fragile Himalayas, while their further expansion is put on hold. All planning, impact assessment and decision-making processes need to be contextualised in local ecologies and democratised through involvement of local communities who inhabit these ecosystems (Tal, 2009). This calls for a systemic breaking away from economic and political pressures of the current development model and global climate politics, both of which are dictating the agenda of hydropower proliferation and financialisation of forests, the costs of which are being transferred to vulnerable ecosystems and people dependent on them.

Acknowledgements

The authors would like to thank the following people: Duleep Matthai Nature Conservation Trust, India for their financial support. Prerna Nair, Independent Research Associate and Sumit Mahar, photographer-activist for field research support. Field Staff of Forest Division Kinnaur for local logistical support. Neeraj Mahar, Research Scholar for editorial comments. The reviewers of this paper for their valuable inputs. Most importantly we thank the communities of Kinnaur, especially the pro-active members of Him Lok Jagriti Manch for their constant guidance and support.

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[15] Minutes of the 29th meeting of the Expert Appraisal Committee (Ministry of Environment Forests and Climate Change) for River Valley and Hydroelectric Projects held on 05th December, 2019 in New Delhi.

[16] "Cabinet approves Measures to promote Hydro Power Sector", March 07, 2019, Press Release of PIB, Government of India, https://pib.gov.in/Pressreleaseshare.aspx?PRID=1567817.

[17] This has paved the way for utilisation of more than Rs 66,000 crore afforestation funds. Before this afforestation was being carried out at a much smaller scale. The rules have been critiqued extensively for diluting the rights of forest dwellers on forest land. http://www.mondaq.com/india/x/737054/Climate+Change/Unlocking+the+Compensatory+Afforestation+Fund+for+Maximum+Benefit.

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