SEA for hydropower development planning in Alaknanda and Bhagirathi basins, Uttarakhand State

INDIA

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SEA FOR HYDROPOWER DEVELOPMENT PLANNING IN ALAKNANDA AND BHAGIRATHI BASINS, UTTARAKHAND STATE

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Authorities	Planning agency of Uttarakhand State
Type of plan	Energy / hydropower development plan Uttarakhand State
Scope of SEA	All HPPs in two river basins in Uttarakhand State (~40% State hydropower potential)
Key SEA issues	Assessment of four scenarios of developing HPPs ranging from min. 2,308 to max 10,685 MW, based on cumulative assessment of ecological impacts and power production
Stakeholder engagement	Informing relevant authorities; MoEFCC, National Ganga River Basin, Planning agency of Uttarakhand; hydro development agencies, conservation community and religious leaders
Duration and year	12 months; 2013 - 2014
Influence of SEA	• Of the 39 planned HPPs (6001 MW) in total 24 of the ecologically most sensitive HPPs are stopped (2611 MW). • Environmental flow secured for sensitive sections of the river basin. • Policy adopted; E-flow for river basins (2018)
Link to SEA report	https://www.researchgate.net/publication/324471805_Assessment_of_Cumulative_Impacts_of_Hydroelectric_Projects_on_Aquatic_and_Terrestrial_Biodiversity_in_Alaknanada_and_Bhagirathi_Basins_Uttarakhand

1.1 INTRODUCTION

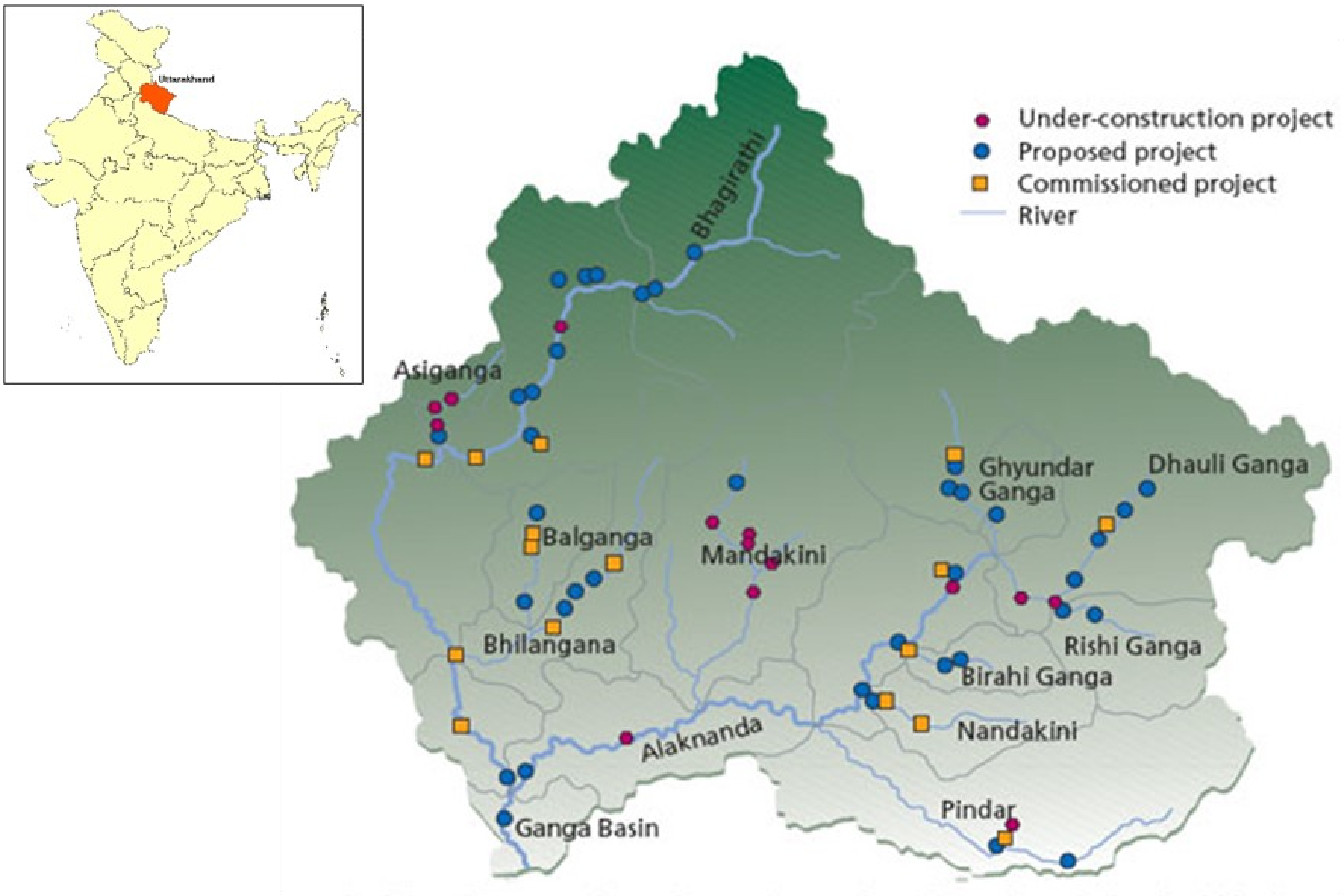
Energy Plan of the State of Uttarakhand

Himalaya, also known as the water tower of the earth (Valdiya, 1997; Bandhopadhya, 2013), provides water to a larger part of the Indian subcontinent. The State of Uttarakhand with 8.5 million inhabitants is one of the smaller states that form a part of the Indian Himalaya Region. This state uniquely endowed with glaciers and rain-fed monsoonal rivers, has a combined hydropower potential of 27,189 Megawatt (MW) in all the six river basins that include Alaknanda, Bhagirathi, Ganga sub-basin, Ramganga, Sharda and Yamuna (SANDRP, 2013). Against this projected potential, only about 3,598 MW equalling to about 14% has been utilized so far from all basins including in Alaknanda and Bhagirathi basins (Table 1). Since hydropower is one of the most important strategic assets of the state for the development of the economy (World Bank, 2011), the energy plans of the state are being developed to ensure that the State of Uttarakhand ultimately becomes the future energy state of India (Joshi, 2007). Based on the current energy plan of the state, as many as 70 hydropower projects are to be concentrated in Alaknanda and Bhagirathi river basins to utilise the combined hydropower potential of over 10,000 MW of these two basins. Among the various allotted hydropower projects in these two basins, 17 are commissioned hydropower projects with total installed capacity of

Table.1 Hydropower utilisation (MW) in Uttarakhand State

River basins Uttarakhand	Commissioned projects	Projects under construction	Projects planned	**Total Hydropower potential**
Alaknanda and Bhagirathi river basins	2,398	2,376	6,001	**10,775**
Other river basins	1,191	2,0	15,619	**16,812**
Total	**3,589**	**2,378.**	**21,620**	**27,587**

Figure 1. Hydropower projects in Alaknanda and Bhagirathi Basins within Uttarakhand state of India (Source Rajvanshi et al, 2012)



2,308 MW; 14 projects of 2,376 MW capacity are in the advanced stage of construction and 39 projects with installed capacity of 6,001 MW are proposed for construction in future (Figure 1).

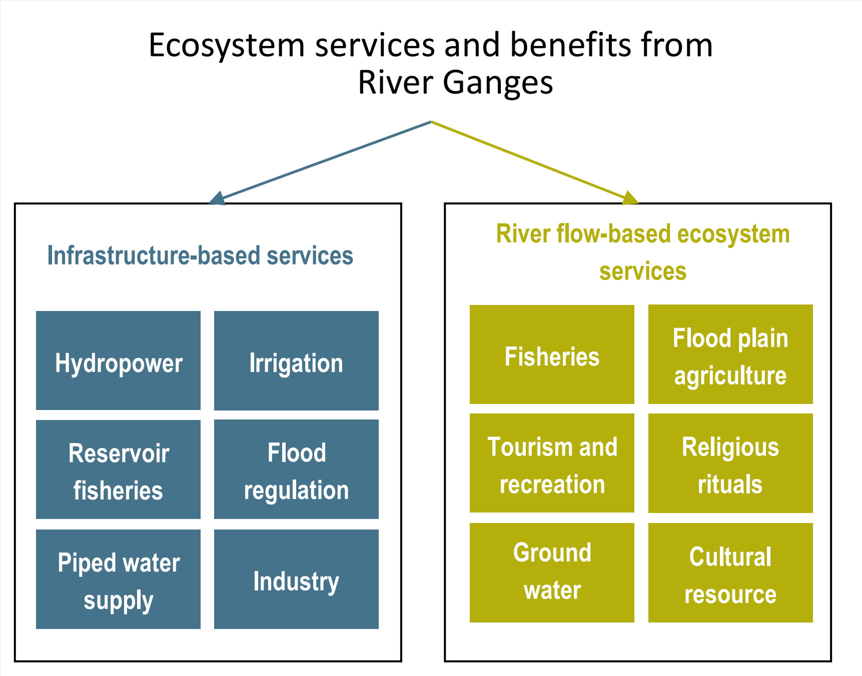
Environmental concerns associated with the implementation of the energy plan

These projects are planned on the two major headstreams, Bhagirathi and Alaknanda of the River Ganges. The River Ganges has not only been the cradle of the Indian civilisation but has commanded a great spiritual, cultural, economic and symbolic significance in Hinduism since times immemorial. It is revered as a Goddess, life giving and life sustaining succour for the environment, ecology and socio-economic wellbeing of the people of India. A large number of pilgrims assemble on the banks of the river and ponds to take holy dips (Kumar, 2009). For this purpose, certain minimum depths of flow and good water quality must be maintained, particularly during the lean season. Flowing through five major states of the country, (Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal) and due to the perennial nature of the river, the riverbanks have become locus points for many major cities, agriculture, intensive industries, leather tanneries and religious tourism. The Ganges is truly a lifeline of over 40% population of India because of the wide range of ecosystem services and benefits it provides see figure 2.

Concerns about the hydropower projects in the upper reaches of the Ganges have increased because of their future anticipated impacts that may threaten the status of the entire Ganges river system. This issue has become more serious given the listing of the Ganges among the world's ten most endangered rivers at risk based on the WWF'S global study (Wong et al. 2007). Furthermore, the dam-induced impacts of a reduced flow of the river would have major implications of its use for cultural and religious purposes by a large section of society.

From the biodiversity standpoint, Alaknanda and Bhagirathi Basins support rich biodiversity, both terrestrial and aquatic. Over 35 mammal, 350 bird and 1000 plant species have been reported in the sub-basins. Out of these, five species of mammals and five of birds, as well as 55 plant species are Rare,

Figure 2. Key ecosystems services and benefits of the River Ganges for people of India



Endangered or Threatened (RET). The forest types of these basins include Himalayan subtropical scrub at lower elevations, temperate broad-leaved forests in the middle elevations to subalpine oak and conifer forests at 'tree line' at the higher elevations. The courses of Bhagirathi and Alaknanda support several forest formations that are typically riverine in nature. These riparian areas play a critical role as corridors and migration pathways for several RET species of fauna including the Himalayan brown bear, Asiatic black bear, snow leopard, common leopard, Himalayan musk deer, Himalayan tahr, blue sheep and serow (Rajvanshi et al, 2012).

Of the 76 fish species found in the Alaknanda-Bhagirathi basins, threatened species including golden mahseer and snow trout, breed in this landscape and require the riverine habitats as well as the floodplains for their breeding.

Concerns are associated with land clearing and water withdrawals for meeting the state's energy and irrigation demands that may cause decimation of forested areas, alterations of river systems and receding wildlife habitats. These changes may ultimately become compounding factors for threatening resources that sustain biodiversity and socio-economic well-being of the people.

The State Government of Uttarakhand submitted proposals to the federal nodal agency, Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India, to grant environmental and forestry clearances for construction of various hydropower projects. The MoEFCC assigned to Wildlife Institute of India (WII) the task of executing environmental assessment studies of all the proposed projects to support informed decision making.

Focus of this case study

The conjunctive and competing uses of water resources of the Ganges are varied and involve use by a wide range of stakeholders. The conflicting goals of maximising water withdrawal (for meeting the demands for industries, irrigation, harnessing energy) and at the same time, maintaining the continuity of the river flow for conserving biodiversity and sustaining the cultural and religious services for people, pose a major challenge for managing the sustained use of the water resources of the Ganges. The challenges of maintaining the environmental flow become further compounded by the imbalance between water demand and seasonal availability. More than 80 % of the annual flow in the River Ganges occurs during the 4 monsoon months (June, July, August and September), resulting in widespread flooding. During the rest of the year, irrigation and power generation potential, and ecosystem services are affected because of water scarcity. The lean season flows can become significantly affected by the hydropower projects in the upper reaches of the Ganges[1]

The impact assessment study was premised on the assumption that the changes in the length of two free-flowing headstreams of the Ganges and the direct loss of terrestrial habitats would be the key factors leading to the aggregated impacts of multiple dams planned on Alaknanda and Bhagirathi rivers. These direct impacts

[1] According to the Brisbane Declaration (2007, p. 1), "environmental flows (EFs/e-flows) are the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and wellbeing that depend on these ecosystems"

may result in compounding effects on a range of receptors including- aquatic and terrestrial species and on the flow of ecosystem benefits for the range of stakeholders.

The aims of the impact assessment study were identified as follows:

- safeguard priority areas for conservation of terrestrial and aquatic biodiversity in the two basins;
- provide a 'risk forecast' of dams-induced changes in environmental flows at the basin level that may impair the longitudinal connectivity of riverine ecosystems supporting rare and endangered fish fauna;
- prioritise to what degree the aquatic and terrestrial biodiversity values and habitats should be protected and what ecosystem services would have to be maintained in the event all developments proceed as proposed in the state energy plan.

Therefore, four different scenarios depicting changes associated with different scales of hydropower development were generated. These scenarios helped capture the distinctions in the range of impacts on the river flow and biodiversity elements associated with different scales of development for decision-makers to identify. As a result, alternative energy plans were reviewed to identify that plan that can best help in aligning the goals of energy planning with those goals of biodiversity conservation and societal welfare.

This impact assessment study commands significant merit as the country's first-ever assessment of cumulative impacts of developments at a river basin level. It highlights 'the acceptable limits of change' for making strategic level decisions to regulate and realign actions associated with future developments that are part of the state energy plan.

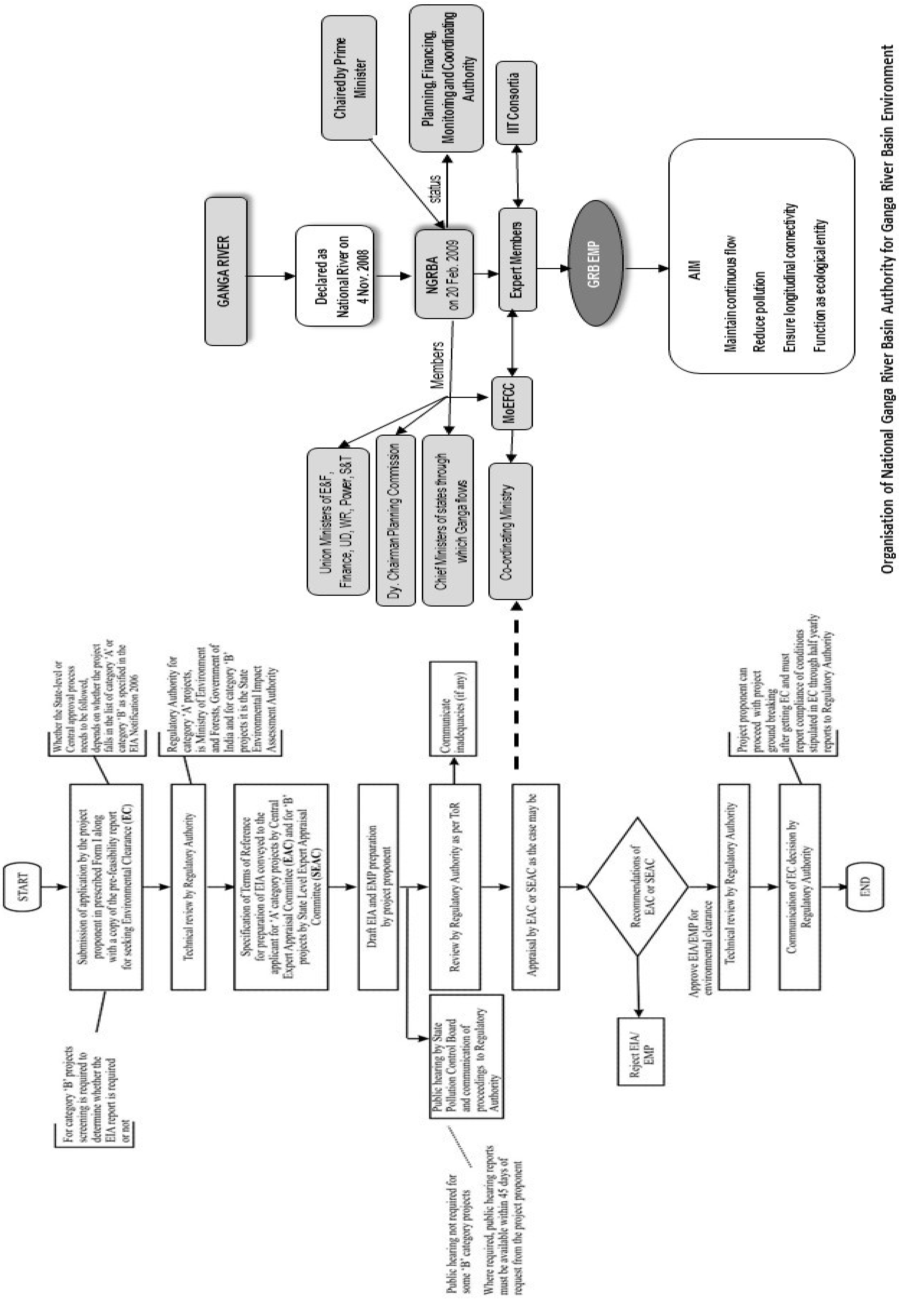
1.2 BACKGROUND: CONTEXT AND ISSUES

Governance situation; social and environmental setting

Triggered by the declaration of the River Ganges as a national river on 4 November 2008, the National Ganga River Basin Authority (NGBA) was constituted as empowered planning, financing, monitoring and coordinating body in 2009 to adopt a river basin approach for managing the environmental sustainability of the river. This apex level authority is chaired by the Prime Minister of India and has members represented by Union Ministers of 6 key ministries (Environment, Forest and Climate Change; Power; Finance; Water resources; Urban Development and Science and Technology) and the Chief Ministers 2016, this Authority renamed as National Council for River Ganga (Figure 3) has among other things, the overall responsibility for the superintendence of pollution prevention and rejuvenation of the River Ganga Basin.

India also has a well laid down legal and an institutional framework (MoEFCC, 1994; 2006) for conducting environmental impact assessment (EIA) of all individual projects. The Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India, is the nodal agency for grant of Environmental Clearance for all major projects defined under Category 'A' of the EIA Notification (MoEFCC, 2006). These two independent governance systems for decision-making and planning of development projects in general, and environmental management of the Ganga River Basin together established the clear need for conducting the environmental assessment of all 70 dams in different phase of development on the two headstreams of the Ganges in Uttarakhand.

Figure 3. Governance systems for decsion-making related to dams in Ganga basin, India



Apart from these regulatory bodies, governance system at the central and state levels and judiciary plays an important role in overseeing the implementation of constitutional provisions and procedures.

Nature of SEA, scope and influence

The timing of the study (ex-post and ex- ante), its scope to capture basin-wide impacts and the objectives to guide strategic planning of developments envisaged under the state's energy plan imposed the need to adopt an innovative and hybrid approach for this assessment.

The existing EIA process as defined under the legislative framework could not be applied to the series of projects planned on the upper reaches of the Ganges, as this would have failed in capturing the impacts of multiple dams that are invariably more complex and greater than the simple sum of their direct impacts. The project level EIAs would not have unscrambled the more specific impacts of multiple projects or those resulting from other indirect perturbations in a landscape (e.g. fragmentation of wildlife habitats or alteration of river morphology and longitudinal connectivity). The fact that some of the projects have already been commissioned, while others are in advanced stages of construction and more are planned in future, limited the scope for subjecting the partially implemented plan to an ex-ante Strategic Environmental Assessment.

A hybrid approach was therefore adopted consisting of Cumulative Environmental Impact Assessment (CEIA) and SEA. This involved a basin-wide assessment employing central properties of CEIA for determining incremental, spatial and temporal dimensions of impacts of past, present and future hydropower developments on terrestrial and aquatic biodiversity values. The results of CEIA/SEA can contribute to planning of energy projects in locations within the basin that are least disruptive to key ecological processes and operating them in ways that protect biodiversity and maintain key ecological services. CEIA/SEA can sign-post the requirements for more project specific EIA resulting in 'green decisions' which are more environmentally sustainable and more favourable for biodiversity conservation. This approach (Figure 4), therefore had significant departures from traditional approaches and also from the provisions under national legislations.

The approach adopted was also in sync with hybrid approaches to stream the benefits of SEA in other regions of Asia (Victor and Agamuthu, 2014). Bragagnolo and Geneletti, 2012 have also demonstrated SEA supporting better management of cumulative effects arising from local-level spatial planning decisions.

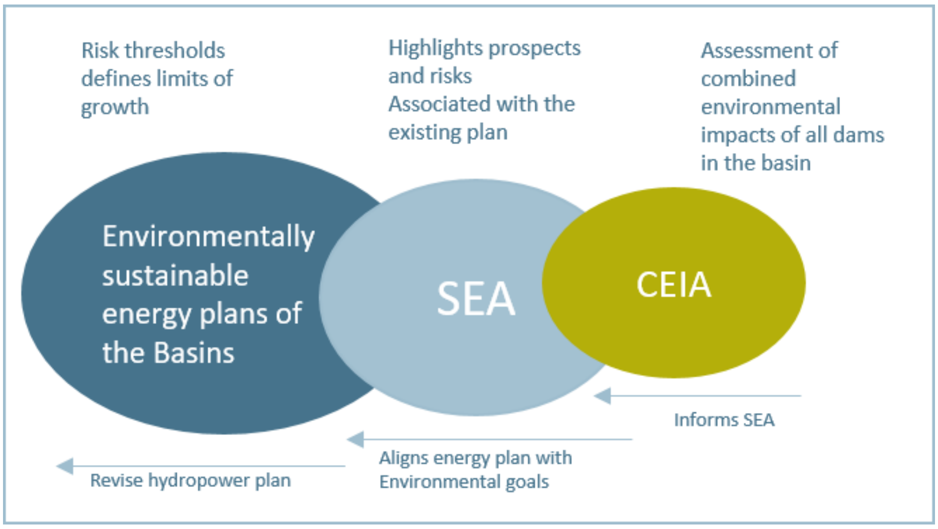
1.3 Approach and Methods Used

Selection of issues and indicators

A total of 18 sub-basins were delineated within the study area for assessing the cumulative impacts of all dams on targeted receptors. These include several RET species of mammals, birds and plants that have flagship values and keystone effects and are highly sensitive to changes in the habitat and intensity of disturbance in their habitats. Similarly, RET species of fishes were included to represent the aquatic system.

Scores were generated to reflect the relative biodiversity values of the sub-basin based on criteria such as richness and rarity of species that are well recognised for evaluating the significance of natural areas for conservation (Smith and Theberge, 1986). These scores were then converted into percentages

Figure 4. CEIA aided SEA approach adopted for the study



based on proportion of total RET species in the basin that were found in each of the sub-basins. This resulted in characterisation of biodiversity values as low, medium, high and very high.

Growing awareness of the relevance of flow regimes as a key factor shaping the ecology of rivers (Sparks 1995; Ward et al, 1999; Bunn and Arthington, 2002; Poff and Zimmerman 2010) and importance of natural riparian zones as important corridors for movements of animals in natural landscapes (Forman and Godron 1986; Malanson 1993) aided in the selection of stress indicators. Profiling of the impact on biodiversity values considered the following two most relevant and well-recognised criteria for evaluating stress factors:

I. River length affected (river dryness and submergence): The length of river that would be deprived of water because of the diversion through head/tailrace tunnel and the area lost to submergence.
II. Forest area loss: The location, extent and nature of forest area cleared and submerged due to hydroelectric projects construction and operation.

The scores were given for each of the two criteria (river length affected, forest land diverted for clearing and submergence) as the determinants of the changes in habitat size and quality and impacts of river flow on aquatic and terrestrial biodiversity at the sub-basin levels in each basin.

Impact analysis

The CEIA/SEA provided the context for a systematic examination of development choices for decisions based on the review of plan alternatives. Four scenarios were developed (Fig. 5) to explore various trajectories of change that may lead to a broadening range of plausible alternatives for securing and safeguarding priority biodiversity values.

- Scenario 1 (N=17): Exclusive impacts of only commissioned projects (N=17) to assess their influence on the true biodiversity baseline of the basins in the 'no dam' scenario.
- Scenario 2 (N=31): Assessment of the combined impacts of all commissioned projects (N=17) and those under different stages of construction (N = 14) on biodiversity values.
- Scenario 3 (N=70): Evaluating the cumulative effects of all projects including commissioned projects (N=17) those under progressive stages of construction (N=14) and those that are still in the form of proposals for consideration (N=39).
- Scenario 4 (N=39): Presenting the incremental impacts of the proposed projects by targeting only the proposed projects.

These scenarios provided a clear visualisation of the impacts based on inclusion and exclusion of past, present and future projects to profile impacts on biodiversity of the two basins. These scenarios highlighted the significant overlap in the spatial expansion of the critically important habitats of terrestrial and aquatic biodiversity with locations of existing and proposed hydropower projects in Alaknanda and Bhagirathi Basins.

Of the 39 planned projects (scenario 4), 24 planned projects have the potential to impact areas with high biodiversity values (both aquatic and terrestrial) and critically important habitats for RET (rare, endangered or threatened) and IWPA (Indian Wildlife Protection Act) protected species in different sub-basins in the two larger landscape units, the Alaknanda and Bhagirathi basins. One of the sub-basins harbours areas of outstanding universal values in the Nanda Devi UNESCO World Heritage Site.

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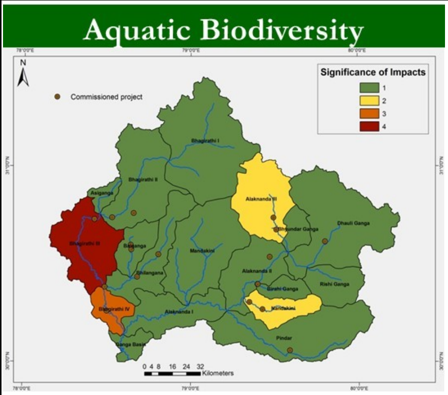
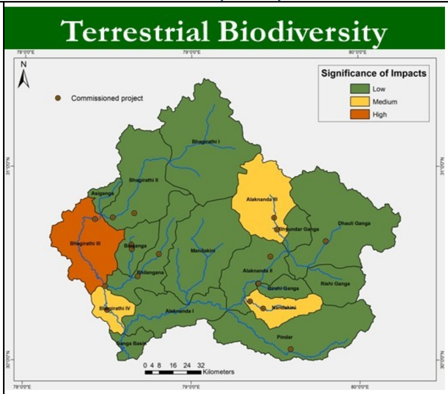
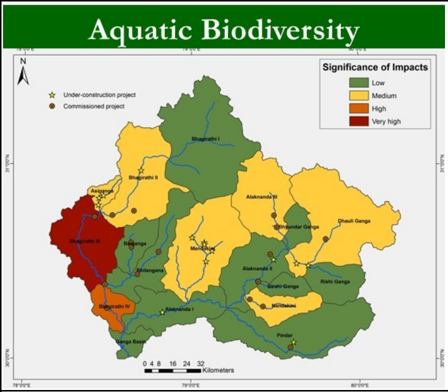
Figure 5. Four different scenarios to explore various trajectories of changes in impacts on biodiversity

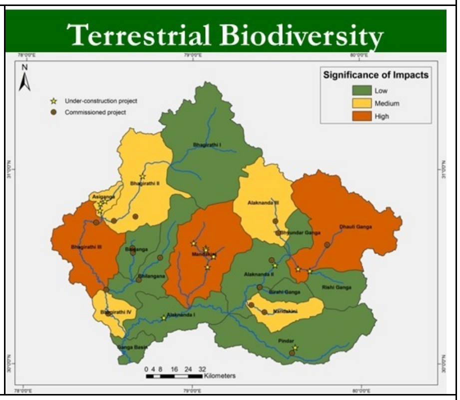
Scenario 1: Exclusive impacts of commissioned dams (N=17)



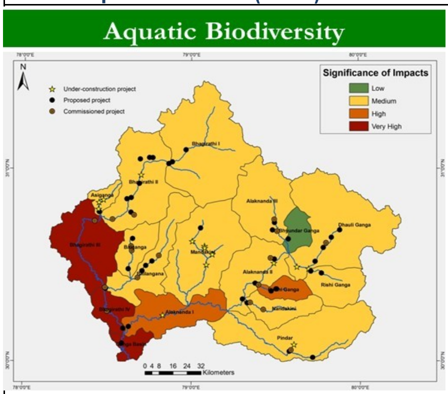


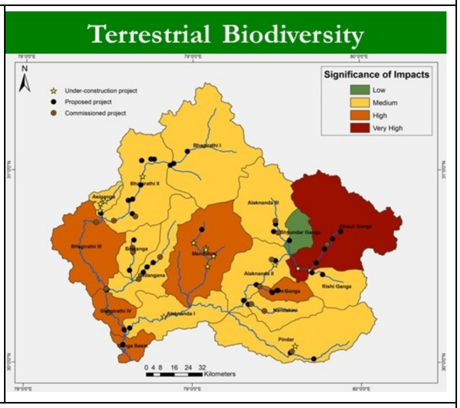
Scenario 2: Combined impacts of dams commissioned and under construction (N= 31)



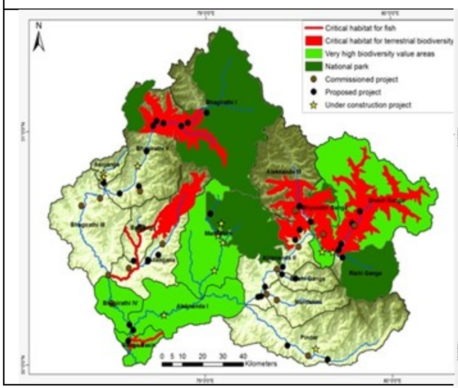


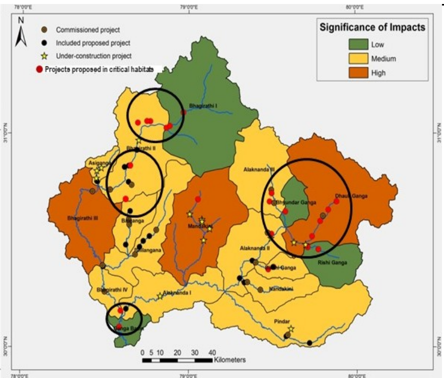
Scenario 3: Combined impacts of commissioned, under construction, planned dams (N=70)





Scenario 4: Incremental impacts of proposed dams (N=39)





SEA driven alternatives for energy planning

Based on the significance of existing and future impact potential of all dams, three alternatives for promoting development were presented for making decisions with respect to energy planning in the state. The analysis of scenarios provided the estimates of overall gains and losses for biodiversity and power production in the event of developments proceeding as planned or when regulated by proposing exclusion of some dams to optimise benefits for conservation and power development.

Figure 6. Alternatives for developments under the State Energy Plan

ALTERNATIVES ENERGY PLANS TO REVIEW THE SCALE OF IMPACTS		
Alternative 1 (= scenario 1) Proceed with commissioned projects only (N=17; 2308MW)	Alternative 2 (= scenario 2) Proceed with commissioned projects and those under construction (N=31; 4684 MW)	Alternative 3 Proceed with planned projects (N=15; 3390 M) ** Of the 39 projects planned (6001 MW – scenario 3 and 4) in total 24 projects are excluded (2611 MW)*
• Commissioned projects have already impacted the biodiversity • Prospects of conserving biodiversity likely to be further compromised by projects under construction Decline in population of Golden Mahaseer, an endangered fish in upstream stretches of Bhagirathi River has already occurred due to construction of a major reservoir based Tehri Dam	• 47% river stretch would be additionally affected by all projects under different phases of construction • 87% fish species would be affected by changes in the environmental flow of rivers already influenced by commissioned projects and by the development of dam in progress Diversion of 1700 ha of forest area for dams would lead to a loss of critical habitats of many RET species	• 37% reduction in river length would be affected • 21.71% decrease in the total forest land required (9494.68 ha) • 27% reduction in planned power generation capacity • Power deficit by improving the efficiency of existing projects can be effectively compensated Reduction in the transmission loss that currently accounts for 40% of total power generated could reduce the need for projects

Outcomes for decision-making

The projected changes in the reduction of the river flows in the different scenarios of dam construction yielded a hierarchy of more strategic decisions about river flow requirements and biodiversity issues linked to land diversion rather than a one-off decision based on piecemeal assessment that would have failed to consider the broader context of sustainable and equitable water allocation. The results of the simulation of the combined effects contributed to the following key strategic decisions in a transparent manner:

- Exclusion of 24 proposed projects (2611 MW) from the list of proposed future projects in Uttarakhand state's energy plan was recommended.
- The Government of India recognised the importance of protecting river ecosystems for conserving biodiversity through a shift in the existing water management policies (GoI, 2012) that were largely driven by concern of food security, livelihoods and economic growth. It was made implicit that such a shift in the policy for managing biodiversity would also help to maintain the cultural and religious services they provide for human well-being.
- A recommendation was made for retaining 21.8% of Mean Seasonal Runoff (MSR) in the golden mahseer and snow trout zones and 14.5 % of MSR for river stretches in the 'no fish zone'.

1.4 RESULTS AND OUTCOMES

Contribution to decision-making

These strategic decisions were documented and shared with MoEFCC, the key environmental regulator and with the National Ganga River Basin Authority (NGRBA). These SEA outcomes were also shared with a range of stakeholders including the hydro development agencies, Government of Uttarakhand as the planning agency, conservation community, and the religious leaders. The decision-making became more complex with developers aspiring to proceed as per the plan for harnessing energy; spiritual leader and conservation community bargaining for better management of environmental flows in the rivers and environmental regulators trying to achieve balance between conservation goals and economic benefits (Figure 7).

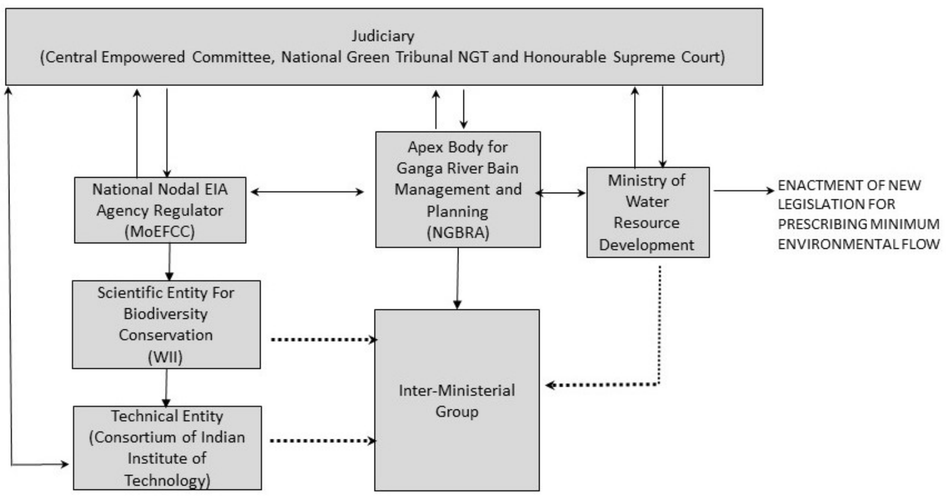


Figure 7. Complex Governance Mechanism for Decisions on Ganga River Valley Projects

Insufficient coordination among regulators and other key entities both laterally and vertically led to the delays in decisions favouring basin-wide management and planning of future hydropower developments in Uttarakhand. Consequently, the Central Empowered Committees (CEC) of the judicial regulator provided directives to the national level scientific and technological bodies (WII and Consortium of IITs) with support from the two governance systems to review the grant of moratoriums on future dams. The objectives of Hon'ble Supreme Court of India's directive were to review which future projects would significantly impact the ecologically sensitive habitats and impair the environmental flow regimes of the rivers especially during the lean season and how the technical and design consideration can improve the prospects for Ganga River Basin Management Planning (GRBMP) and for energy generation.

Contribution to policy and legislative reforms

While the dilemma and uncertainty delayed decision-making with respect to acceptable limits hydropower development, the outcomes of the scenario analysis already provided a strong argument for environmental flow considerations to be moved up in the decision hierarchy to policy and planning levels, if the concerns linked to changes in environmental flow are to be addressed at the project-level investments.

The Ministry of Water Resources, River Development and Ganga Rejuvenation (Government of India), which is represented on the NGRBA and the Inter-Ministerial Group responded to this urgency of moving environmental flow up in the decision hierarchy by enacting a new legislation (GoI, 2018) before the individual dams were approved for implementation as a part of the future programme. This notification stated 20%, 25% and 30% in the lean, non-monsoon and monsoon season respectively of e-flows are to be maintained in all the tributaries in the Upper Ganges Basin starting from the glaciers, finally meeting at Devprayag and in the main stem of the Ganges flowing through to the holy city of Haridwar. These stipulated e-flow levels are higher than those earlier recommended (AHEC, 20111; WWF, 2011) and also higher than the levels recommended in the CEIA study by WII (Rajvanshi et al. 2012). The GOI Notification (2018) also states:

"maintenance of uninterrupted flows along the entire length of the river would be ensured without altering the seasonal variations." The notification further states that "the existing projects, which currently do not meet the norms of these environmental flows, shall also have to comply and ensure that the requirements of stipulated environmental flow are met within a period of three years from the date of issue of this notification."

Major influence of outcomes

The e-flows notification provides the limits of the agreed environmental flows to be delivered through specific releases of water from the storages at the right times to mimic some of the natural patterns of flows. The regulation incorporates the larger policy provisions for maintaining the longitudinal connectivity and plan-level or project-level environmental flow.

With this recent regulation, India is among the few countries that are global leaders in developed (Australia, EU, and Florida in USA) and developing (South Africa and Tanzania) countries (Hirji and Davis, 2009) in integrating environmental flow provisions into their water resources policies.

This SEA study commands special interest because of the two key reforms that it could bring in influencing the decision-making at all levels from plans to the levels of individual projects. It created a strong ground for reorienting policies to upstream e-flow considerations in decisions on dams. The new legislation stepped up the decision-making process that was considerably delayed because of the conflicting interest of the key stakeholders. The new legislation could also directly influence the strategies to improve the energy plans at the basin level, which would finally influence the decision-making at the project level (Figure 8).

This case exemplifies that if hydropower planning is supported and driven by good governance and influenced by outcomes of appropriate assessments, development planning can be directed to deliver ecological, social and economic securities linked to power generation.

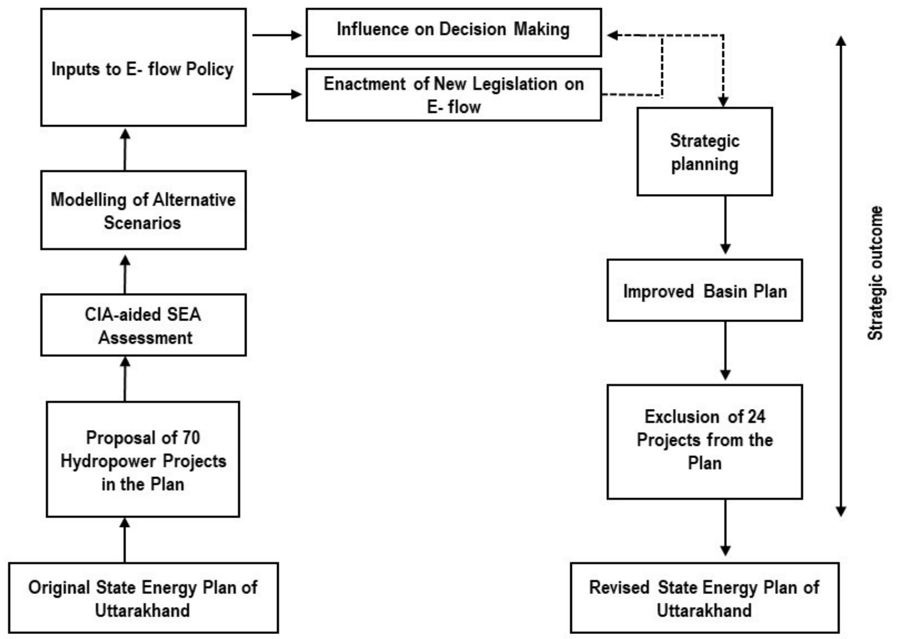


Figure 8. Hierarchy of outcomes influencing project-level planning

Another important insight gained from this case study is that India should proactively encourage SEA to become formally linked to the decision-making process rather than just serve as a voluntary conflict resolution tool. A well-designed institutional support and a major shift in policy is urgently needed to make SEA an effective approach for assisting with the implementation of policy and sector reforms that foster sustainable development.

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About the author

Asha Rajvanshi (PhD) has over three decades of professional standing as a teacher, trainer, EIA practitioner and the reviewer of EIAs on behalf of the federal Government of India. She has played the lead role in developing and encouraging mainstreaming tools for integrating biodiversity in impact assessment in India and the region. She has been also credited to promote Strategic Environmental Assessment (SEA); Cumulative Impact Assessment; sustainable land-use planning; Smart Green Infrastructure and mitigation planning for promoting wildlife friendly transportation projects. She has made significant contribution to Impact Assessment through her global level training initiatives, scholarly writings, academic mentoring of young researchers and publication of training manuals/best practice guides, which are being extensively used by students, researchers and IA practitioner's worldwide. She has created several knowledge products and learning platforms to promote EIA and SEA. Asha has provided professional support in EIA and SEA initiatives led by UNEP, the World Bank, IUCN, IAIA, CBD, GIZ, and ADB. She has served as one of the experts on the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), for the Regional/sub-regional assessments on biodiversity and ecosystem services for Asia and Pacific region. She is presently also the member of the IPBES Task Force for Capacity Building and Scoping expert for biodiversity and business assessments. Asha is a recipient of the prestigious Lifetime Achievement Award from IAIA for the year 2019.
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Colophon

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