DRAFT PAPER

Integrated impact assessment of large hydropower projects in Sikkim, India

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Introduction

The energy sector is responsible for most of the emissions that have caused global temperatures to rise. However, modern energy is critical for the livelihoods and aspirations of a growing global population. India has seen a significant increase in non-fossil power plants over the past two decades, including hydropower which is considered as non-renewable energy.[1] The country plans to increase its non-fossil energy capacity to 500 GW by 2030, using solar, wind, biomass, nuclear and hydropower[2]. Large-scale renewable energy projects in India are expected to create job opportunities, address environmental challenges, and meet the country's electricity needs while reducing emissions. However, it is crucial to ensure that these 'mitigation' projects do not lead to land, social, and environmental conflicts as conventional power projects have in the past. This research aims to contribute to the discourse on the impacts of hydropower as large-scale climate change mitigation projects in the Himalayan region.

Motivation of study

The development of large hydropower plants in the Himalayas aims to leverage the huge hydro potential in the mountains to meet the growing energy demands, the need for economic development and efforts to transition to a low-carbon society. The Hydro Policy (2008) of India[3], makes it clear that climate change and reducing GHG emissions from coal-powered plants is one of the main reasons to increase the hydropower capacity of the country. Hydropower is termed as 'environmentally benign' with potential to open up avenues for development in remote and 'backward regions'. History and evidence have shown us that hydropower infrastructure can lead to several impacts socially and ecologically, and sometimes catastrophically. With a large number of hydropower projects coming up in the ecologically sensitive Himalayas, the co-benefits and tradeoffs need to be understood with adequate recommendations to reduce the latter.

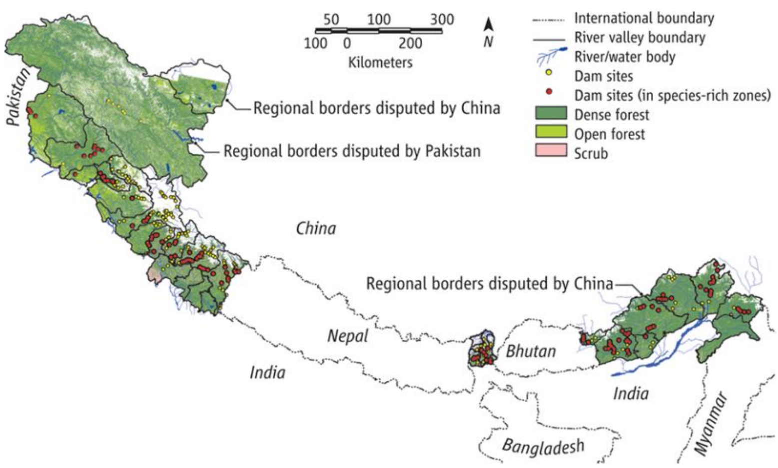

Figure 1: Distribution of proposed dams in the Himalayan states of India. Source: Grumbine and Pandit (2013)

Study Area

The culturally and ecologically diverse Eastern Himalayan region, considered climate-vulnerable, is currently also the target of ambitious hydropower projects. For the study, the Himalayan state of Sikkim has been chosen. Sikkim is state in India lying between 27° 04′ 46″ S to 28° 07′ 48″ N latitudes and 88° 00′ 58″ W and 88° 55′ 25″ E longitudes. Located in the eastern Himalayas, the total geographical area of the state is 7096 km^2 and is the second smallest state in India. It shares three international borders with Nepal to its West, China to its North and Bhutan to the East. It is connected to India with its southern borders shared with West Bengal. Teesta is the major river system in the State. Along its traverse from its origin to the plains, the river receives drainage from a number of tributaries on either side of its course. The Teesta basin extends from Sikkim to West Bengal and Bangladesh, joining the Arabian Sea.The State currently generates 2318 MW of power through hydropower.[4] About 90% of Sikkim's electricity supply is from hydropower, generated from the Teesta River making it one of the greenest states in India

The carrying capacity study[5] of the Teesta basin provides a comprehensive set of inventory and information with respect to the Teesta basin. From the perspective of this research, it highlights the carrying capacity potential of the bio-physical environment, the risks of construction of the project and most importantly, the concerns and expectations of the people of the basin area. The following table highlights the main socio-economic and environmental concerns.

Table 1: Prominent socio-economic and environmental concerns and expectations from a local perspective

Environmental	• Geological sensitivity o Landslides o Glacial floods o Earthquakes • Ecological sensitivity o Biodiversity conservation
Socio-economic	Expectations: • Improved infrastructure (roads + communication) • Access to energy • Improved healthcare • Education • Enhanced quality of Life Concerns: • Loss of livelihood • Displacement • Loss of cultural heritage and traditions • Influx of migrants

Conceptual framework

Rather than looking at the project in silos, we look at it from a systems viewpoint wherein each of these constituents interact with various others. Understanding the drivers behind energy infrastructure expansion, the various stakeholders involved and the impacts of the energy systems will provide an understanding of climate-energy-sustainable development interactions. The conceptual illustration of various drivers, initiatives, impacts and outcomes of an energy project is given in the figure below.

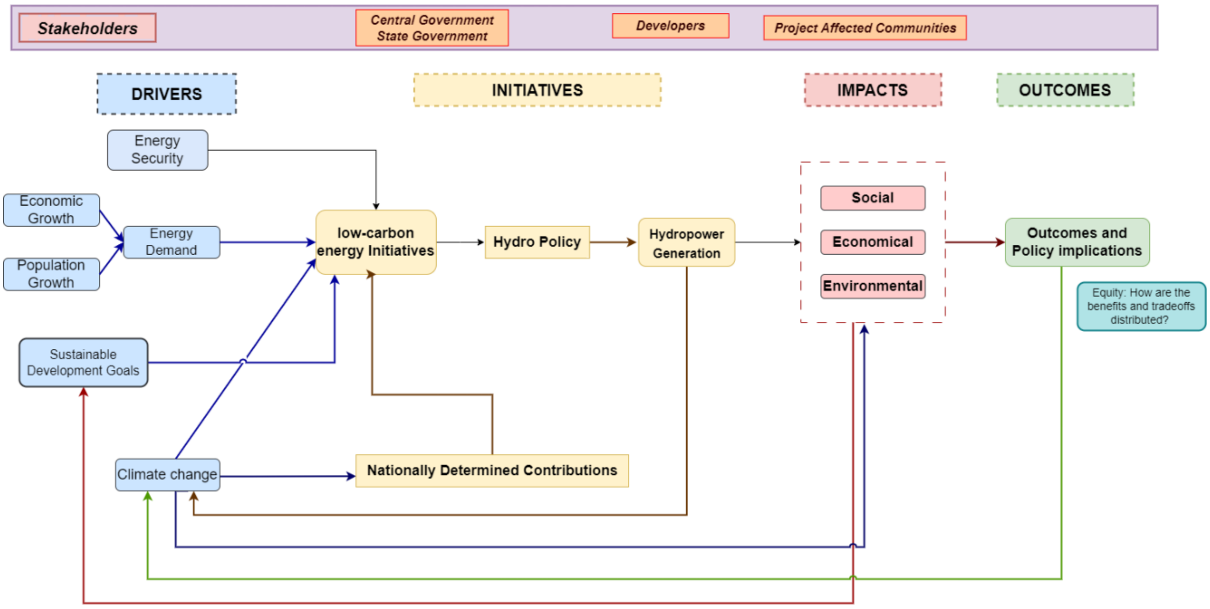

Figure 2: A conceptual illustration for understanding various drivers, impacts and outcomes of energy projects

Methodology

The framework used for analysis build on previous works[6,7] while additionally incorporating climate resilience as a new component, and includes indicators from both the socio-economic and environmental dimensions. It looks into the designed to be used for both hydropower and solar projects, and examines impacts from a spatial (local, regional, national), temporal (pre-construction, construction, operation) and value (costs and benefits) perspective. This enables a comprehensive impact assessment by evaluating each component for each dimension. The framework subdivides components into indicators for assessment.

Highlights from impact assessment studies

Hydropower development in Sikkim, India has been promoted as a solution to climate change and a means for economic growth. However, these interventions are often exclusionary, leading to conflicts with minority indigenous populations. The language of "remoteness" and "geological surprises" allows developers to shift responsibility away from themselves. Pre-construction, hydropower was promoted as "clean and sustainable" and a source of economic growth, but post-construction, it led to water insufficiency, drying up of springs, and lack of secure employment opportunities. Community perceptions on the impacts of hydropower development in rural Sikkim show that while employment benefits have helped, changes in land use and occupations may have adverse impacts on future livelihoods. Additionally, with climate change there are risks of hydrological disasters such as glacial lake outburst floods and landslide related disasters.

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