

Hydropower Development in Jammu Division: A Comprehensive Study.

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Abstract

Hydropower is a consistent, eco-friendly, and long-lasting energy source, particularly in mountainous areas with lot of water. The Jammu Division is laying in the northern part of India has great ability for hydropower due to its hilly region, flowing rivers, and good weather conditions. This paper examines the growth, challenges, opportunities, and future possibilities of hydropower projects in the Jammu Division. It uses quantitative method and qualitative method, analysing primary data as well as secondary data from government reports, research papers, and hydropower development agencies. The study focuses on major hydropower projects, their impact on society and the economy, environmental issues, and policy challenges.

The analysis reveal that although the Jammu Division has ample hydropower capacity, and not fully utilized due to various challenges, like poor infrastructure, ecological concerns administrative delays, and local livelihood problems. The paper ends with suggestions for upgrading improving policies to make hydropower development more long-lasting in the region.

Keywords: Hydropower, eco-friendly, Jammu Division, Chenab Basin, Sustainable Development, Energy Policy.

1. Introduction

Hydropower is the oldest and most important sources of clean energy, playing an important role in meeting global energy demands. India, with its varied landscape, has a huge potential for hydropower, estimated to be around 150,000 MW. The Himalayan region contributes the largest share of this potential, thanks to its continuous rivers, steep slopes, and steady water flow.

The Jammu Division of Jammu & Kashmir, with its mountainous terrain, river valleys, and high-altitude areas, is known to have some of the greatest hydropower potential in India. A major share of this potential comes from the Chenab River Basin, which represent for around 60-65% of the region's total hydropower capacity.

1.1 Background of the Study

The Indian government has been concentrating on using clean and renewable energy sources to meet the increasing demand for electricity. Hydropower, which does not generate carbon, supports India's goals under the Paris Climate Agreement. In this intervention, the Jammu Division is especially important due to its natural river systems, including:

- The Chenab
- The Ravi
- The Tawi
- The Ujh
- The Ans River

Many hydropower projects, such as Baglihar, Dulhasti, Salal, Pakal Dul, Kiru, and Kwar, have been set up in the region, constructing it a key centre for energy production.

1.2 Research Gap

Where as hydropower projects are operational in Jammu Division, challenges related to land procurement, environmental impact, resettlement of affected population, forest clearance, coordination among departments, and disaster vulnerability remain significant. Many studies focus on individual hydropower projects, but comprehensive region-based studies are limited, creating a research gap.

1.3 Objectives of the Study

This research sets out to accomplish the following objectives:

1. Assess the current landscape of hydropower development in the Jammu Division mapping existing projects, capacity, and future potential.
2. Diagnose the principal obstacles that impede efficient hydropower deployment, encompassing technical, regulatory, financial, and infrastructure-related constraints.
3. Quantify and interpret the environmental and socio-economic ramifications of hydropower activities, including impacts on biodiversity, water quality, livelihoods, and local communities.
4. Propose actionable strategies for fostering sustainable hydropower growth that integrates environmental stewardship, social equity, and economic viability.

These aims collectively guide the study toward a holistic understanding of hydropower's role and prospects in the Jammu Division.

1.4 Significance of the Study

Jammu Division's abundant river systems and steep topography render it an exceptional candidate for large-scale hydropower development. This study systematically unpacks the region's technical, environmental, and socio-economic challenges and potentials, thereby offering several pivotal contributions:

1. Policy Guidance,

By identifying bottlenecks—such as permitting delays, water-sharing disputes, and grid integration constraints—policymakers can devise targeted reforms to streamline project approvals and secure cross-border water-sharing agreements.

2. Engineering Insight.

The analysis of site-specific hydrological regimes, sedimentation patterns, and geotechnical conditions informs the design of resilient turbines, spillways, and foundation systems, reducing capital and operational risks.

3. Environmental & Social Impact Planning.

Recognizing ecological sensitivities (e.g., fish migration corridors, downstream flow regimes) and community livelihoods, the study equips planners to incorporate mitigation measures and compensation schemes that align with sustainable development goals.

4. National Energy Security.

Positioning Jammu as a hydropower hub would diversify India's renewable mix, curtail reliance on fossil fuels, and create strategic reserves of clean energy—an essential step toward meeting Paris Agreement commitments.

5. Academic Advancement.

The research contributes novel data sets and modelling approaches to the limited body of literature on Himalayan hydropower, fostering future investigations into climate-adaptive water resource management.

In sum, this work serves as a decision-support tool that bridges scientific understanding with practical implementation, thereby catalyzing Jammu Division's transformation into a national leader in hydropower generation.

2. Literature Review

The development of hydropower has greatly attracted the research of its significance worldwide. Other researchers like Bhatia (2018) and Verma (2020) have discussed hydropower as an alternative source of power to fossil fuels that is sustainable.

2.1 Global Studies

Hydropower has significant role in the global transition towards sustainable energy. According to the **(IRENA, 2021) International Renewable Energy Agency**, hydropower contributes to **43% of the global renewable electricity generation**. This significant share shows the key importance of hydropower in the global energy mix, especially in nations working towards reduce their dependence on fossil fuels. Hydropower is acknowledge not only for its environmental gains but also for its ability to provide a stable and reliable source of energy. Its potential to help tackle climate change by reducing greenhouse gas emissions is widely acknowledged, making it a backbone of many nations' renewable energy strategies.

In this studies, **Kumar et al. (2019)** point out that mountainous areas are particularly best-suited for hydropower development. These locations boasting of steep slopes and lots of water provide a perfect location to produce stable and sustainable energy. It is observed that hydropower in these areas is a viable and sustainable solution, as well as a stable source of energy. The fact that water flows continuously and the rugged topography guarantees the ability to sustain hydropower as a source of energy even in the long run.

2.2 National Studies (India)

In India, hydro power plays a major role in the energy future of the country particularly as the country tries to diversify its energy base and minimise carbon emission.

Sharma and Singh (2020) review the reforms of the Indian hydropower sector and the requirement to accelerate the process of developing the projects, especially in the Himalayan region. In their research, they note that although the region has immense potential, the bureaucracy, environmental clearance delays, and lack of infrastructure have been major setbacks. The region of Himalayas with Jammu Division has the capacity to emerge as the powerhouse of renewable energy in India, and it is only possible to unlock this potential with the higher rate of development and reforming of the policy.

Moreover, the Himalayan hydropower projects are particularly significant to the attention due to the peculiarities of the region, which includes not only severe weather conditions but also the issues related to managing and processing disasters and environmental risks. Without addressing these issues, the hydropower projects in the region might be undermined in the long term.

Simultaneously, Joshi (2017) focuses on the hydropower station vulnerability to disasters in Uttarakhand, the geographically and climate-wise similar location to Jammu. The heavy incidence of natural phenomena like landslides, floods and earthquakes has been a significant threat to the safety and sustainability of hydropower generation facilities. These are vital lessons to be learned by Jammu Division which has such high terrain and monsoon rains which might present the same challenge to hydropower developments.

2.3 Regional Studies (J&K and Jammu Division)

Regional-level In the J&K, and specifically Jammu Division, a lot of focus has been given to the hydropower potential of the region. Kaul and Koul (2019) give a detailed discussion of Chenab Basin area, which is among the most likely areas in the development of hydropower in Jammu Division. In their work, they underline the fact that the Chenab River can become a important source of electricity production that can play the significant role in the energy demands of the region and Indian goals in terms of renewable energy. However, they also point out some of the difficulties that have slowed down the progress of hydropower projects such as the problems in environmental approvals and governance instability. Major infrastructure projects are concerned about such delays in the Jammu Division where there has always been a tense political environment.

Expanding further, **Thakur (2022)** examines the **socio-economic impact** of hydropower projects in the **Kishtwar district**, an area within Jammu Division with a rich hydropower potential. Thakur describe the **benefits** of hydropower projects, such as **employment creation**, economic development, and **upgraded infrastructure** in rural areas. On the other hand, the study also highlights the **displacement** and **resettlement issues** faced by local population. In several cases, large hydropower projects require the **submergence of land** and the **displacement of residents**, leading to protests and social unrest. While the benefits of electricity generation and employment are clear, the social costs, particularly for ecologically sensitive communities, often receive less attention.

2.4 Research Gap in Literature

Although there is a substantial amount of research on the environmental consequences of hydropower and studies focused on individual projects, there is a clear gap when it comes to comprehensive studies on hydropower development specifically in Jammu Division. The majority of research seems at the technical details or the local impacts of specific hydropower plants, but there is not much work that examining the whole area and its full hydropower potential. This study goal is to fill this gap by providing a more complete analysis that takes into account not just the technical aspects but also the economic, social, and environmental factors involved in hydropower development throughout the Jammu Division. By bridging this gap, the research seeks to provide actionable suggestion for decision makers, development organizations, and local communities, fostering more sustainable and inclusive approach to hydropower development in the region.

3. Research Methodology

The ongoing study is based on a mixture of two types of data: primary and secondary.

1. **Primary Data:** This includes original information obtained from both published and unpublished sources. The data was acquired through site visits to various hydropower projects in both the Jammu regions. Detailed discussions were conducted with officials involved in these projects to gather insights and suitable information.
2. **Secondary Data:** This data was gathered from a variety of journals, magazines, and economic reviews published within the Jammu and Kashmir region, providing background information and supporting the primary data.

The information taken from these sources has been carefully tabulated, analyzed, and interpreted to match with the objectives of the study.

3.3 Study Area

The Jammu Division has following districts:

Kishtwar ,Doda, Ramban, Jammu, Kathua, Reasi, Udhampur

These districts are lucky with a strong network of rivers and steep terrain, both of which are perfect for hydropower generation. The topography, combined with the availability of multiple rivers, provides significant opportunities for the development of hydropower projects.

3.4 Limitations

This study has a few limitations:

Limited Primary Data: The study was restricted by the availability of primary data from field visits, with some areas being less accessible for detailed surveys.

Government Data Changes: Government reports and energy data are subject to periodic revisions, which may result in inconsistencies or changes in the available data over time.

Restricted Access to Technical Information: Some technical details related to specific hydropower projects were not fully accessible due to confidentiality or security reasons.

4. Hydropower Potential & Development in Jammu Division

4.1 Major Rivers & Hydropower Potential

The Chenab Basin is the most important source for hydropower production in Jammu Division, due to its vast water flow and beneficial altitude. The primary rivers that contribute to the region's hydropower potential include:

Chenab River: The largest and most significant river for hydropower generation in Jammu Division.

Ravi River, Tawi River, Ujh River,

These rivers provide a regular supply of water, which is essential for hydropower development, making them central to any projected growth of the region's renewable energy capacity.

4.2 Major Operational Hydropower Projects

Project Name	Capacity	Status	Location
Salal HEP	690 MW	Operational	Reasi
Dulhasti HEP	390 MW	Operational	Kishtwar
Baglihar HEP Stage 1	450 MW x 2	Operational	Ramban
Chenani-I, II, III	62 MW	Operational	Udhampur
Sewa-II	120 MW	Operational	Kathu

4.3 Upcoming and Under-Constructions Projects

Project Name	Capacity	Status	Location
Pakal Dul	1000 MW	Under construction	Kishtwar
Kiru	624 MW	Under construction	Kishtwar
Kwar	540 MW	Ongoing	Kishtwar
Ratle	850 MW	Revived	Doda

These projects will significantly increase Jammu's energy contribution.

5. Environmental & Socio-Economic Impact

5.1 Socio-Economic Benefits

The development of hydropower projects in Jammu Division provides socio-economic benefits, including:

Job Creation: Hydropower projects generate employment possibilities, for skilled and unskilled labor, supporting to local employment rates.

Boost to Local Markets: The increase in the workforce and resources commonly leads to a growth in local businesses, such trades, shops, and services that meet the needs of the project and its workers.

Improved Road Connectivity: The building of hydropower plants usually needs better road framework which leads to enhance connectivity in far flung areas.

Infrastructure Development: The installation of these projects results in the improvement of local infrastructure, including better roads, schools, healthcare facilities, and public amenities.

Increased UT Revenue: The business activities by hydropower projects, such as taxes, royalties, and sales, contribute largely to the UT revenue, which can be reallocated in region.

5.2 Environmental Challenges:

Deforestation Caused by Dam Build-up: The building of dams frequently results in substantial forest loss, as trees are eliminated to make space for the reservoir. This loss of vegetation upsets native biodiversity and contributes to erosion of the soil.

Effect on Aquatic Habitats: Reservoirs establishment changed the natural flow of water, which also effect aquatic life. Such changes can lead to interruption within ecosystems, threatening species that rely on the original river system.

Alterations in Microclimate: Reservoirs can alter in local climates. This modification may shift the temperature, fluctuations in air moisture, and disturb the local weather condition, all of which can effect nearby communities and wildlife.

Heightened Risk of Landslides: The construction of dams can weaken the surrounding terrain, increasing the chance of landslides. The variations in land use and loss of vegetation can result in soil instability, raising the risk of landslides, mainly during time of intense rainfall.

Community Concerns:

Displacement of Local Communities: The development of major infrastructure, such as dams, frequently necessitates the relocation of adjacent populations. Families are displaced from their homes and must relocate to different regions, which can lead to considerable social and economic difficulties.

Loss of Agricultural Land: Flooding the land to create reservoirs results in the submersion of productive farming areas, leading to the loss of livelihoods for local agricultural workers. This decrease in land available for farming can have a serious effect on food production and local economic conditions.

Challenges in Rehabilitation: The process of resettling and supporting displaced individuals can be complicated and insufficient. Many affected communities find it challenging to obtain adequate assistance, resulting in obstacles to rebuilding their lives and sustaining their livelihoods in new areas.

Cultural Disruption in Isolated Regions: In remote or indigenous communities, the establishment of large-scale projects can interfere with cultural practices and traditional lifestyles. The relocation of these communities can lead to the dilution of distinctive cultural identities as individuals are forced to leave their ancestral territories.

5.3 Disaster Risks

The Himalayan area is susceptible to multiple natural threats, such as cloudbursts, flash floods, earthquakes, and Glacial Lake Outburst Floods (GLOFs). These dangers underscore the importance of careful planning in constructing hydropower infrastructure.

6. Results

Jammu Division holds significant untapped hydropower potential, with only 40-45% of its capacity currently being utilized, offering ample opportunities for development. Kishtwar district, individually, has the assets to become India's hydropower capital, offering a unique opportunity to transform the region into a major energy hub. However, the development of hydropower is restricted by bureaucratic delays, including lagging permit processes and institutional barriers, which result in uncertainty and impede project progress.

Additionally, local communities are often not adequately involved in the planning and implementation of these projects, leading to social resistance and missed opportunities for shared benefits. Despite these challenges, the economic prospects for expanding hydropower remain strong, as it offers potential for job creation, infrastructure development, and a sustainable energy future. With improved administrative processes and better community engagement, Jammu Division could unlock its full hydropower potential, driving both regional and national economic growth.

Conclusion

Hydropower development in Jammu Division holds immense promise for sustainable energy generation, economic growth, and regional development. However, realizing this potential demands a balanced approach that addresses environmental concerns, enhances community participation, and strengthens administrative coordination. The study concludes that with proper policy reforms, disaster-resilient infrastructure, and transparent rehabilitation mechanisms, the Jammu Division can emerge as a major hydropower hub in India.

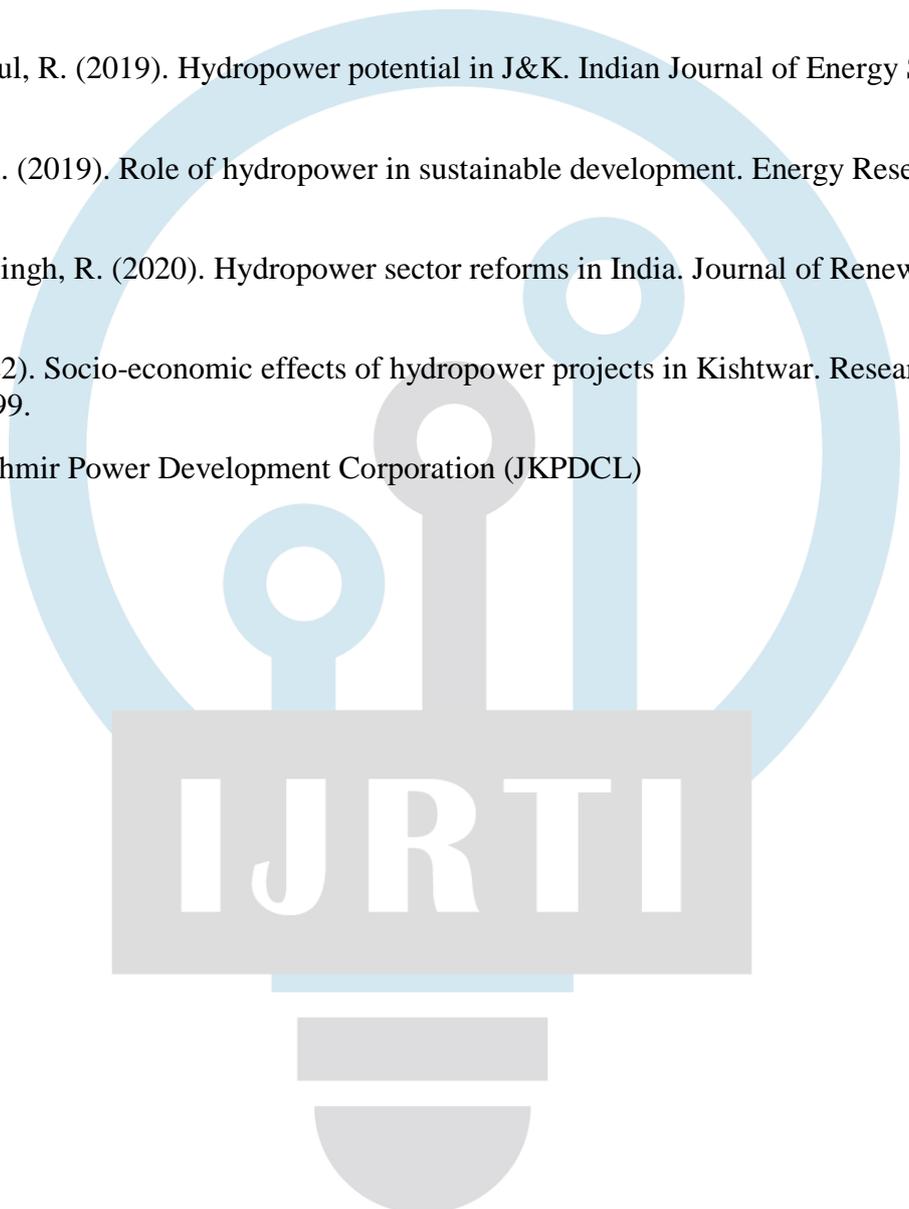
Policy Recommendations

Fast-track environmental clearances with scientific safeguards Enhance disaster prediction systems

Promote local employment in all project phases Introduce transparent rehabilitation policies Ensure inter-departmental coordination

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