

# CONTEMPORARY SOCIAL SCIENCES

PEER REVIEWED, INDEXED & REFEREED QUARTERLY INTERNATIONAL JOURNAL

ISSN 0302-9298

<https://www.jndmeerut.org>

[Vol. 34, No. 2 (April-June), 2025]

<https://doi.org/10.62047/CSS.2025.06.30.40>

## Systematic Review on Socio-economic and Environmental Impacts of Hydropower Projects: A Global and Indian Perspective

*Lakhvir Singh*

Assistant Professor, Department of Social Work Punjabi University, Patiala, Punjab (India) E-mail:<[sukhlakha@gmail.com](mailto:sukhlakha@gmail.com)>

### Abstract

*One of the most well-known renewable energy sources, hydropower is essential for lowering reliance on fossil fuels and slowing down global warming. But even though hydropower is renewable, its growth has always been linked to intricate and extensive socioeconomic and environmental effects. This systematic analysis looks at case studies from India and around the world, highlighting problems such community dislocation, environmental damage, difficulties with governance and participation, and the exclusion of underprivileged groups, particularly women and indigenous populations. The review also looks at other models and solutions that have been suggested, like micro- and small-scale hydropower projects. In order to provide a comparative viewpoint, theme analyses are presented after structured summary tables of pertinent studies. Finally, this review concludes with policy recommendations meant to guarantee equitable and sustainable hydropower development.*

### Keywords

Hydropower, Socio-economic, Environmental, Displacement and Energy.

**Research Foundation International, New Delhi**  
(Affiliated to UNO)

Editorial Office : D-59, Shastri Nagar, Meerut - 250 004 (INDIA)

Ph. : 0121-2763765, +91-9997771669, +91-9219658788

# 4

## **Systematic Review on Socio-economic and Environmental Impacts of Hydropower Projects: A Global and Indian Perspective**

### **1. Background**

Hydropower projects present serious socioeconomic and environmental issues, despite being hailed as a renewable energy source with the ability to boost the economy.<sup>1</sup> Dam development and related infrastructure have been widely linked to ecosystem damage and community displacement, especially among vulnerable groups like tribal tribes.

About 17-19% of the world's electricity is produced by hydropower, which is also a major part of renewable energy portfolios.<sup>2</sup> Thousands of megawatts of electricity are produced by large dams and hydroelectric reservoirs, which support industrialization, rural electrification, and economic expansion. However, there are significant ecological and socioeconomic costs associated with the development and maintenance of hydroelectric facilities.

Hydropower projects around the world, and especially in developing nations like India, have caused river ecosystems to be disrupted, biodiversity to be destroyed, and millions of people to be displaced. Furthermore, the negative effects of these projects are made worse by governance problems such poor rehabilitation of impacted areas, a lack of transparency, and insufficient public consultation.

For an in-depth understanding of the multifaceted effects of hydropower, this review methodically synthesizes the existing literature and arranges it into both Indian and international studies. This study uses comparative analysis to identify similarities and differences and suggest sustainable methods for developing hydropower.

### **2. Methodology**

The secondary data gathered from academic journals, government papers, environmental studies, and non-governmental organization (NGO) publications is analyzed methodically in this review.

## 2.1 Selection Criteria

- ▶ **Focus on Displacement and Rehabilitation:** Research examining the socioeconomic impacts of relocation brought on by hydropower projects.
- ▶ **Environmental Impact:** Studies describing how hydropower development affects biodiversity and the environment.
- ▶ **Governance and Public Participation:** Evaluations of governance frameworks and participatory methods.
- ▶ **Gender and Tribal Issues:** Research on the effects on under-represented populations, such as women and indigenous people.
- ▶ **Alternative Solutions:** Studies supporting small-scale and sustainable hydropower solutions.

In order to promote systematic analysis and comparative topic discussion, studies were divided into two categories: Indian and International.

## 3. International Studies on Hydropower Projects

### 3.1 Displacement and Resettlement Issues

Numerous international studies draw attention to the substantial human displacement brought on by hydropower developments. According to Menzes (1991), the main reasons why displacement is problematic are because it is often forced and infrequently receives just compensation.<sup>3</sup> In his 1995 analysis of China's Three Gorges Dam, Chau noted that more than a million people had been displaced and underlined the difficulties of relocation in impoverished areas. Concerns about displaced people frequently becoming poorer without proper compensation or rehabilitation were voiced by Michael, (1996).

The Impoverishment hazards and Reconstruction (IRR) model was first presented by Cernea (1996, 2003), and it outlined dangers such social dis-articulation, homelessness, and landlessness.<sup>4</sup> His approach highlights how crucial it is to address the cultural and social effects of resettlement in addition to the economic ones.<sup>5</sup>

### 3.2 Environmental Impacts and Economic Considerations

Degradation of the environment is another recurrent issue. In their analyses of hydropower projects in Brazil and Turkey,

respectively, Cummings (1995)<sup>6</sup> and Biro (1998) noted the loss of agricultural land and irreversible harm to ecosystems. According to Biro's analysis, many projects lost their economic viability when environmental costs were internalized.<sup>7</sup>

Silva (1990) looked at the wider environmental effects of Sri Lankan development, such as resource depletion and pollution associated with hydro projects.<sup>8</sup> Environmental Impact Assessments (EIA) are essential for methodically addressing these issues, according to Brismar (2003).<sup>9</sup>

### **3.3 Governance, Participation and Human Rights**

To reduce negative effects, international organizations such as the World Bank (1998)<sup>10</sup> and United Nations Environment Programme (UNEP/DDP) (2001) have acknowledged the importance of using participatory approaches in hydropower planning.<sup>11</sup> However, research by Sinclair (2003)<sup>12</sup> and Peterson (2001) revealed that social instability was frequently caused by insufficient public participation.

Human rights may be violated by development-induced relocation, particularly when disadvantaged groups are disproportionately affected, according to Robinson (2003). Schmoelling (2003) suggested actions to reduce environmental risks, such as waste management and the use of renewable energy.<sup>13</sup>

## **4. Indian Studies on Hydropower Projects**

### **4.1 Displacement and Socio-Economic Impacts**

Large-scale displacement has occurred in India as a result of the development of hydropower. Singh (1992)<sup>14</sup> and Mridula Singh (1992) talked on how current policies disregard women and landless people, making them susceptible to poverty after displacement. Roy (1987, 1999)<sup>15,16</sup> and Nehru (1958) criticized the propensity for massive dam construction and argued in favor of more manageable, neighborhood-friendly alternatives.<sup>17</sup>

A large number of hydroelectric projects are situated in Himachal Pradesh, where displaced inhabitants experience economic and social challenges, as demonstrated by studies like as those conducted by Advani (2009)<sup>18</sup> and Bala (2010).<sup>19</sup> Roy (1987) also emphasized health issues, such as the rise in vector-borne illnesses in areas impacted by dams.<sup>20</sup>

## **4.2 Environmental Concerns and Biodiversity Loss**

In river systems impacted by dams, Gaur (2007)<sup>21</sup> and Qureshi (2007) reported negative ecological effects, such as a decline in biodiversity and disturbance of aquatic life. Particular attention was drawn to the decline in fish populations in the Jhelum River and other rivers as a result of dam construction.<sup>22</sup>

Saxena (1994) highlighted the necessity for context-specific technological adaptation while pointing out the potential of small hydropower projects for sustainable rural development.<sup>23</sup> Given the high density of planned dams in areas like the Himalayas, Singh (2006) criticized the inadequate biodiversity assessment in Environmental Impact Assessments (EIA) and argued in favour of cumulative effects analysis.

## **4.3 Governance and Policy Shortcomings**

It has been discovered that institutional structures and government policies are insufficient to handle displacement. According to the Government of India (1984) and later research, land acquisition regulations prioritize monetary compensation over proper rehabilitation and resettlement. Affected populations are left vulnerable by the National Policy on Resettlement and Rehabilitation (2004)'s lack of legislative support.

Despite stipulations under the Panchayats (Extension to Scheduled Areas) Act, 1996, Soren (2006) talked about how tribal rights are being neglected in the development of hydropower.<sup>24</sup> The absence of significant public involvement in hydro project planning in India, especially in the Himalayan states of Himachal Pradesh and Uttarakhand, was highlighted by Diduck (2007)<sup>25</sup> and Sinclair & Diduck (2000).

# **5. Emerging Alternatives and Mitigation Approaches**

## **5.1 Small-Scale Hydropower and Community-based Models**

The potential of small and micro-hydropower projects as sustainable substitutes for major dams was examined by Mehra (2007)<sup>26</sup> and Sengupta (1987).<sup>27</sup> Though they still need careful planning, some projects are thought to be more socially and environmentally acceptable.

## **5.2 Integrating Environmental and Social Safeguards**

Important steps were emphasized, including the need for thorough Environmental Impact Assessments (EIA), inclusive

planning, and incorporating social safeguards. Diduck (2007)<sup>28</sup> and Sinclair (2003) focused on increasing public involvement,<sup>29</sup> although Biro (1998) promoted include environmental costs in evaluations of economic viability.<sup>30</sup>

### 6. Comparative Analysis of Hydropower Impact Studies: International vs. Indian Perspectives

Comparative Analysis of International vs. Indian Perspectives of Hydropower Impact Studies is depicted in the following table:

**Table-1: Comparative Analysis of International vs. Indian Perspectives of Hydropower Impact Studies**

Aspect	International Studies Findings	Indian Studies Findings	Comparative Analysis
Displacement and Rehabilitation	According to Menzes, Michael, and Chau, displacement is primarily involuntary, undercompensated, & causes socio-economic vulnerabilities.	Large-scale relocation with little to no resettlement; excluded are vulnerable populations such as landless workers (Singh, Bala, Roy).	Displacement with inadequate rehabilitation is evident in both situations. While international studies stress the effects of displacement on a broad scale, India places greater emphasis on tribal displacement.
Environmental Impact	Extensive environmental deterioration, encompassing pollution, biodiversity loss, and forest loss (Silva, Biro, Cummings).	Severe harm to aquatic ecosystems and biodiversity, as well as disturbances in river flow (Gaur, Qureshi).	Environmental deterioration is a widespread worry. International research emphasizes biodiversity loss and the wider landscape, while Indian studies concentrate on river ecosystems.
Public Participation and Governance	Lack of inclusive governance and frequent disregard for public consultation (Peterson, Sinclair).	Lack of transparency and inadequate public participation in project development (Diduck, Sinclair & Diduck).	Although a lack of public involvement is common around the world, Indian studies draw attention to additional problems with administrative and policy shortcomings in governance.

Gender and Tribal Issues	There are a few mentions of vulnerable groups; however gender and indigenous rights are not given as much attention (Cernea, Robinson).	Gender prejudice is widespread in resettlement, and women's and tribal rights are neglected (Mridula Singh, Soren).	While worldwide literature discusses vulnerable groups in general terms, Indian studies are unusual in that they focus on gender and tribal issues in particular.
Alternative Solutions	Better EIA is required, and renewable options are mentioned (Brismar, UNEP/DDP).	Encouragement of modest hydro projects as environmentally friendly substitutes (Saxena, Mehra).	Both promote different approaches. International research concentrate on improved EIA and public involvement, while Indian studies prioritize small-scale hydro.

## 7. Thematic Inferences and Comparative Analysis

### 7.1 Displacement and Rehabilitation

One of the most significant social effects of hydropower development is displacement. Studies conducted in India and abroad emphasize how involuntary displacement causes socio-economic vulnerabilities, the uprooting of entire communities, and the loss of livelihoods. Systemic exclusions in resettlement planning are shown by Indian research that goes deeper into the implications of caste, gender, and tribe. For example, Singh (1992) concentrates on the predicament of landless communities that do not receive formal compensation, while Mridula Singh (1992) highlights the unique vulnerability of women.

International studies like Menzes (1991) and Michael (1996), on the other hand, focus on more general economic displacement but provide little analysis that breaks down gender.

### 7.2 Environmental Impact

Environmental deterioration is still a global issue, and Indian and foreign experiences are very similar. Deforestation, biodiversity loss, and river system pollution are all included in international studies such as Silva (1990) and Biro (1998). These worries are supported by Indian studies like Gaur (2007) and Qureshi (2007), which highlight

the loss in fish populations and river ecosystems and how it affects livelihoods that depend on these resources.

### **7-3 Public Participation and Governance**

The problems of governance are universal. Diduck (2004) in India and Peterson and Sinclair (2003) worldwide both draw attention to the dearth of effective community involvement and participatory planning. Cases from India also highlight opacity, corruption, and institutional barriers that limit community involvement. Conflict and opposition to dam projects, like the Narmada Bachao Andolan, are frequently caused by this lack of transparency.

### **7-4 Gender and Tribal Issues**

Gender and tribal concerns are examined in greater detail and with greater depth in Indian studies. The systematic marginalization of women and indigenous groups, who have limited control over project design and relocation procedures, is revealed in works such as Mridula Singh (1992) and Soren (2009). Vulnerable groups are mentioned in international studies, such as Cernea (1997), but no focused analysis is offered, indicating a deficiency in intersectionality research worldwide.

### **7-5 Alternative Solutions**

The necessity for alternatives is acknowledged in both Indian and international literature. United Nations Environment Programme (UNEP) (2001) and Brismar (2003) promoted the use of non-dam renewable energy sources and strict EIAs. Small and micro-hydropower projects are emphasized by Indian academics such as Saxena (1994) and Mehra (2007) as less intrusive, community-managed solutions that can satisfy local energy demands without causing ecological harm or broad displacement.

## **8. Summing Up**

The literature emphasizes that although hydropower projects can make a large contribution to economic growth and energy generation, they also come with a high cost, which is mostly paid by natural ecosystems and vulnerable communities. Strong legislative frameworks that guarantee equitable restitution, efficient relocation, environmental protection, and sincere community involvement are desperately needed. While still providing for energy demands, a

move toward smaller, locally driven hydroelectric projects could lessen some of these negative effects.

## 9. Recommendations

Based on the findings of this systematic review on socio-economic and environmental impacts of hydropower projects, following recommendations have been made:

1. **Strengthen Resettlement Laws:** Implement inclusive policies for Tribes, gender-sensitive rehabilitation, and land-for-land compensation.
2. **Mandatory Environmental Assessments:** Make sure that thorough, open EIAs are conducted with active public involvement.
3. **Encourage Small/Micro Hydropower:** Provide assistance to locally run small-scale hydropower initiatives.
4. **Community Engagement:** Establish inclusive and open planning procedures

## Financial Support and Sponsorship

Nil .

## Conflicts of Interest

There are no conflicts of interest.

## References

1. World Development Report, *The State in a Changing World*, New York: Oxford University Press, 1997.
2. International Energy Agency. Hydropower Special Market Report: Analysis and Forecast to 2030. (2021). Retrieved on 03.05.2025 from <https://iea.blob.core.windows.net/assets/83ff8935-62dd-4150-80a8-/HydropowerSpecialMarketReport.pdf>
3. Menezes, "Compensation for Project and Displacement", *Economic and Political Weekly*, 26(3), 1991, 2465.
4. Cernea, M. M., "The Power of Synthesis", Orissa Resettlement and Rehabilitation Policy, Government of Orissa, 1999.
5. Cernea, M. M., "For a new economics of resettlement, A Sociological critique of the compensation principle", *International Social Science Journal*, 17, 2003, 1-27.
6. Cummings, B., "Dam the Rivers, Dam the People: Hydroelectric Development and Resistance in Amazonian Brazil", *Geo Journal* 35(2), 1995, 151-160.

7. Biro, K., "Valuation of the Environmental Impacts of the Kayraktepe Dam, Hydroelectric Project, Turkey: An Exercise in Contingent Valuation", *Ambio*, 27(3), 1998, 98-102.
8. Silva, D., "Destruction of Natural Resources and Conservation Efforts, Ecology and Landscape Management in Sri Lanka", *Proceedings of the International and Interdisciplinary Symposium*, Colombo, Sri Lanka, 1990, 231-235.
9. Brismar, A., *Environmental Consideration in the Planning of Large Dam Projects*, Ph.D. Thesis, Sweden: Linköping University, 2003.
10. World Bank, *Global Organizations to Expand Cooperation on Green Growth for Development*, World Bank, 1998.
11. UNEP/DDP, Resource to the Final Report, Norwegian Ministry of Foreign Affairs. Retrieved December 16, 2024. <http://www.unep.org/dams/documents>
12. Sinclair, J., "Assessing the Impacts of Micro Hydro Development in the Kullu District, Himachal Pradesh, India", *Mountain Research and Development*, International Mountain Society, 23(1), 2003, 11-13.
13. Schmoelling, J., "Management of integrated Pollution Control Concerning Air, Water Pollution Waste Management, S. P. Dasgupta (ed.), *Environmental Issues of 21<sup>st</sup> Century*, New Delhi: Mittal Publications, 2003.
14. Singh, M., *Displacement by Sardar Sarovar and Tehri: A Comparative Study of Two Dams*, New Delhi: MARG, 1992.
15. Roy, S., *Tehri Dam*, Uttarakhand: Society for participatory Research in India, 1987.
16. Roy, A., *The Greater Common Good*, Bombay: India Book Distributors Ltd., 1999.
17. Nehru, J., "Modern Temples of India", *Selected Speeches of Nehru*, New Delhi: Ministry of Information and Broadcasting, Government of India, 1958.
18. Advani, M., *Urbanization, Displacement and Rehabilitation*, New Delhi: Rawat Publication, 2009.
19. Bala, R., "Under the Shadow of Development", *MP Journal of Social Science*, 15 (1), 2010, 87-96.
20. Roy, S., *Tehri Dam*, Uttarakhand: Society for Participatory Research in India, 1987.
21. Gaur, R., "Biodiversity and River Valley Projects in Uttarakhand", *Proceedings of the National Academy of Sciences, India, Section-B, Biological Sciences*, 77(3), 2007, 253-262.
22. Qreshi, T., "Effect of lower Jhelum hydroelectric power project on finfish diversity of river Jhelum, J & K", *Current World Environment*, Oriental Scientific Publishing Company, Bhopal, India, 2(1), 2007, 43-46.
23. Saxena, K., Kumar, Y., Rao, K.S., Sen, K.K., Rana, U., Majila, B.S., Pharswan, A., Singh, G.S. & Nehal, *Hydropower Management for*

- Sustainable Rural Development in Remote Unelectrified Zones of Himachal Pradesh*, Kosi, Almora: Himvikas Publication No. 7. G.B. Pant Institute of Himalayan Environment and Development, 1994.
24. Soren, Rajni, Refugee Watch Online. (2006). <http://refugeewatchonline.slogspot.com> (now moved to [refugeewatchonline.wordpress.com](http://refugeewatchonline.wordpress.com)).
  25. Diduck, A. and Hostetler, G., "Achieving Meaningful Public Participation in the Environmental Assessment of Hydro Development. Case Studies from Chamoli District, Uttarakhand, India", *Impact Assessment and Project Appraisal*, 25(3), 2007, 219-231.
  26. Mehra, T. and Rajasekhar, A., "Performance of Tawa Hydroelectric Power Plant, A Case Study", Paper presented at International Conference on Small Hydropower Projects, Sri Lanka, held on 22-24 October, 2007.
  27. Sengupta, D. P., "Mini and Micro Hydel Prospects in the Indian Himalaya. Himalayan Energy System", *HIM Gayanodaya Prakashan*, 1987, 154-159..
  28. Diduck, A. and Hostetler, G., "Achieving Meaningful Public Participation in the Environmental Assessment of Hydro Development. Case Studies from Chamoli District, Uttarakhand, India", *Impact Assessment and Project Appraisal*, 25(3), 2007, 219-231.
  29. Sinclair, J., "Assessing the Impacts of Micro Hydro Development in the Kullu District, Himachal Pradesh, India", *Mountain Research and Development*, International Mountain Society, 23(1), 2003, 11-13.
  30. Biro, Y. E. K., "Valuation of the Environmental Impacts of the Kayraktepe Dam, Hydroelectric Project, Turkey: An Exercise in Contingent Valuation", *Ambio*, 27(3), 1998, 224-229. ★