REDVET - Revista electrónica de Veterinaria - ISSN 1695-7504
Vol 25, No. 1 (2024)
http://www.veterinaria.org
Article Received: 20/09/2024 Revised: 22/09/2024 Accepted: 22/10/2024

Dams And Development- An Understanding Of Geologic, Socio-Economic And Environmental Impacts

Anjali Kumari[1], Prem Kumar[2], Harshulika[3], Arbin Kr. Thakur[4*], Jaya Rai[5]

[1*]Department of Political Science, University of Delhi, New Delhi, India, 110007.
[2]Department of Geology, University of Delhi, India, 110007.
[3]Ministry of Environment, Forest and Climate Change, New Delhi -110003.
[4]Department of Environmental Studies, Zakir Husain Delhi College (Evening), University of Delhi, India, 110002.
[5]Department of Geology, Ram Lal Anand College, University of Delhi, New Delhi, India, 110021.

***Corresponding Author:** Arbin Kr. Thakur
*****Email- arbin@zhe.du.ac.in

ABSTRACT
Over 40 million people are said to have been relocated in India over the course of the previous 60 years due to the construction of 4,300 major dams. India currently has a serious water scarcity that affects domestic, industrial, and agricultural use. This is mostly the result of inadequate storage and ineffective water management. Recent patterns in decreased reservoir capacity seem to be a result of social and environmental opposition to developments as well as the necessity to restrict resettlement. In the light of advancement, there are numerous adverse social and environmental impacts being imposed on the habitants of the river basins. However, the regulatory authorities are enhancing the procedures to ensure that environmental and social repercussions are appropriately reviewed and controlled while being created to promote growth in order to ensure that the lessons of the past are learned and mistakes are avoided, or at least reduced.
It is presumable that development at the national level affects project planning and practices through the creation of laws and policies, but it is individual projects where laws and policies actually take effect, where actual changes to higher social and environmental standards become evident, and possibly where these changes have cascading effects. Two policy areas will be examined for norm evolution and implementation: firstly, the use of environmental impact assessment along with the socio-economic effects on the lives of the people as a tool for planning and making decisions on dams; and secondly, the analysis of the resettlement policies such as the National Rehabilitation policy of 2007.

KEYWORDS: Development, Policy, Environmental Impacts, Resettlement, Social Impacts

INTRODUCTION:

The benefits generated from dams have been enormous and have played a key role in the development of humanity (Asmal, 2000). Due to the wide spectrum of pertinent issues, whether they be social, environmental, economic, or political in character, they have nevertheless sparked ferocious discussions and the arguments are immensely complex. Equity, governance, justice, and power challenges, which are at the root of many of humanity's insurmountable problems, are at the center of the discussion. (Schulz & Adams, 2019). To address these concerns, mechanisms like Environmental Impact Assessments (EIA) and Social Impact Assessments (SIA) have been developed. EIAs evaluate the potential environmental risks and effects of dam projects, while SIAs focus on the social consequences, including displacement and the well-being of affected communities. In developing nations, where major dams are viewed as symbols of modern development, EIAs and SIAs are critical in balancing the pursuit of progress with the protection of human rights and the environment (Tullos et. al., 2009; WCD report, 2000).
In an effort to advance their countries, developing nations have constructed numerous major dams in the belief that they represent modern development and provide solutions to issues like food scarcity, agricultural irrigation, and energy demand. Massive nations like China, India, Brazil, and certain African governments appear to be competing for the construction of large dams. However, in many instances, securing those benefits has come at an undesirable and frequently unneeded cost, particularly in terms of social and environmental issues, with the relocation of people (Hartje & Horstmann, 1999).
Since its independence, India has conducted numerous experiments in an effort to become a self-sufficient nation. With the adoption of policies for planned development, policymakers made the exploitation of the nation's water resources for irrigation and the production and distribution of electricity a top priority (Asmal, 2000). Large dams gradually replaced earlier systems that relied on diversion or run-of-the-river plans. Mega-dams were potent symbols of the recovery and renewal of the battered economies of long-repressed post-colonial countries due to their visibility, scale, and sweep. They reaped immediate benefits by providing water to power the green revolution, which was thought to be the key to turning India into a food basket from a food aid basket (Schulz & Adams, 2019).
Along with per capita income and average life expectancy, intra-national inequality has also significantly risen slowly. India is currently making progress toward becoming one of the most industrialized nations with one of the fastest

expanding economies despite the need to address all these concerns (Hartje & Horstmann, 1999). It is building an increasing number of so-called enormous multi-utility dams to meet its historically high demand for water and energy. Large-scale forced evictions of populations, especially vulnerable groups, continue to be a common practice during dam building (Schulz & Adams, 2019).

OBJECTIVES

This article aims to investigate India's potential for dam development by examining the policy discourse surrounding dams, displacement, and rehabilitation policies. A central focus is on understanding the extent to which dam construction in India has led to the marginalization of certain communities due to inadequate compensation and the impact on local livelihoods. The study also aims to develop a brief understanding about the major thematic areas affected by the development of dams. The study explores the development debate within India, particularly the state's role in addressing the challenges of development-induced displacement, and assesses how national resettlement policies have attempted to balance the goals of economic development with the rights and well-being of displaced populations.

Importance of Dams:

The construction of dams has significantly improved the living conditions of billions of people worldwide, according to a report by the United States Committee on Large Dams (USCOLD). Dams provide recreational amenities, industrial water supply, food production through irrigation, electricity and power production, flood control, and the production of drinkable water. The World Bank report highlights the importance of rivers in the world's largest river basins and settlements, highlighting the need for water for their way of life. (Altinbliek, 2002)

Hydropower was the primary reason for most significant dams being constructed, with hundreds of sizable dams in operation by 1900. The World commission on Dams (WCD) states that hydropower currently supplies 19% of the world's electricity and is used in more than 150 nations. More than half of the world's nations rely on hydropower to meet their electrical needs. (Kumar et. al., 2021; Altinbliek, 2002)

Hydropower has numerous advantages, including flood prevention, flow regulation, diverse uses, and the avoidance of fossil fuels. Governments and utilities in developing nations often prefer hydro-generated electricity over fossil fuel-based electricity, and countries with complex maintenance and operational logistics may benefit from the relatively cheap maintenance costs and ease of operation associated with hydro projects. (Sharma and Kakoty, 2004)

The debate centered on the development of dams and balancing its impacts

The development of large dams has been central to India's efforts to manage water resources and generate hydroelectric power, as outlined in policies such as the National Water Policy and the National Hydro Power Policy (M DV, V.M. Salgaocar College of Law). Through these initiatives, the Indian government has aimed to balance economic growth with resource management, commissioning various boards and committees like the Water Board and the Inter-State Water Commission (Hazarika, 2020).

However, the construction of dams has sparked significant debate over development-induced displacement and its socio-economic impacts. Large-scale dam projects have displaced millions, often the rural poor, such as landless laborers and small farmers, with 40% of the displaced being tribal people and 20% Dalits. The forced relocation of these communities has disrupted traditional livelihoods, cultural identities, and social networks, leading to criticism of India's development model, which has been described as uneven, unjust, and focused on capital accumulation (M DV, V.M. Salgaocar College of Law).

Scholars like Vandana Shiva have critiqued this postcolonial development approach, arguing that it prioritizes commercial interests over sustainable resource management, exacerbating poverty and displacement. Ramachandra Guha has called for a return to community-based environmental management and the protection of common property resources, emphasizing the need to integrate environmental sustainability with development (Hazarika, 2020).

Environmental impacts of dam construction are also significant. Dams alter river ecosystems, affecting the biological, chemical, and physical characteristics of rivers and adjacent habitats. This leads to habitat loss, species extinction, and the proliferation of invasive species, which threaten native aquatic life. The creation of large reservoirs disrupts natural water flow, affecting both aquatic organisms and terrestrial vegetation. Additionally, dams can lead to natural disasters, such as earthquakes, and can create international tensions over water resources (Kumar et. al., 2021; Altinbliek, 2002).

Despite modern engineering efforts to mitigate risks, the displacement and environmental degradation caused by large dams remain pressing ethical concerns. Affected communities often receive inadequate compensation, and their displacement is often managed without adherence to strict regulatory frameworks. The challenge lies in balancing the benefits of dam construction for economic development with the need to protect the rights and livelihoods of displaced communities and preserve environmental integrity (World Commission on Dams, 2000).

Thematic areas affected by development of Dam

Geological and bio-physical Aspects

The biophysical systems encountering the dam development are altered to great extent (Tullos et. al., 2009). This alteration is expressed in form of fragmenting the river system and modifying the hydrograph of the river along with significant

changes in the river basin (Kotchen et. al., 2006). Such major and primary effects include changes in river bed morphology, enhanced sediment load, soil quality, water quality, biodiversity composition of the river basin, modified aquatic habitat and proliferated invasion of exotic species (Tullos et. al., 2009; Yang et. al., 2006; Mumba and Thompson, 2005; Kingsford, 2000; Lerer and Scudder, 1999). These changes result in fluctuating viability of the aquatic biota and elevated disease burden on the downstream inhabiting human population (Lerer and Scudder, 1999). Numerous studies have pointed towards the declining livelihood generation and threat to food security of the indigenous population resulting mainly due to habitat fragmentation and increased threat to aquatic biota (Beck et. al., 2012; Duckworth et al. 2001; Baran et al. 2007; Woodruff 2010; Baird and Meach2005). The most adverse effect of damming a river is the conversion of lotic ecosystem to lentic ecosystem (McCartney M. 2009). Additionally, the altered hydrology of the river basin playing crucial role in maintaining the ecosystem services affects the agricultural productivity to greater extent (Beck et. al., 2012; Shoemaker et al. 2001).

The most obvious impact of dam construction in a river catchment is the changes undergone by the hydrologic regime and sedimentation patterns of the basin. The reduced flow rates result in augmented sedimentation resulting in the changes in the river course, incision rates and physiographic features of the river (St Louis ei al, 2000). The regulated flow in the downstream area not only controls the flow regime but also affects the flood peaks and overbanking flood in the low-lying area (McCartney M. 2009). In addition to the fluctuation in the flow regime, dams also affect the thermal regime of the river sections. Usually under the influence of the ambient meteorological conditions, the water in a river section holds a uniform temperature through turbulent mixing. However, due to prevailed long-term storage in the reservoir, the water undergoes thermal stratification which allows heat storage resulting in production of short term non-natural thermal fluctuation and thermal out phasing (McCartney M. 2009). These bio-physcial factors collectively affect the water chemistry due to prominent fluctuations in the bio-geochemical cycle and nutrient influx. Such changes can even result in eutrophication, bio-magnifications and bio-accumulations of numerous chemical elements and compounds in the food chain (Kumar et. al., 2021; McCartney M. 2009; Chapman, 1996; Zakova et al., 1993). Such biochemical factors have serious implications for the population depending on the aquatic resources for diet intake ((Bodaly et al, 1984).

Socio-economic Aspects

Dams being an important developmental tool, impart substantial intentional and unintentional socio-economic impacts on the human communities. The socio-economic impacts on the society include numerous parameters like migration, cultural changes, resettlement and shifted household structure, changes in employment opportunities, fluctuating community integrity, shifting utilization of land and water resources and adversely affected psycho-social well-being of the displaced population (Brown et. al., 2009; Egre and Senecal, 2003; Bartolome et al., 2000; Lerer and Scudder, 1999; Fuggle and Smith, 2000; World Commission on Dams, 2000). Since these effects are long lasting, irreversible and spatially significant it's really imperative to manage and mitigate these adverse socio-economic impacts (Tullos et al., 2009; World Commission on Dams, 2000).

Large dam development has been a major cause of displacement in India, forcibly relocating millions and disrupting their livelihoods. Despite this, state administrations remain largely indifferent to addressing the underlying issues faced by the displaced. As a result, many internally displaced persons in India can be seen as refugees from an unacknowledged crisis. The majority of the displaced are impoverished rural populations, including landless laborers and small-scale farmers, often referred to as "Gandhi's last man." Notably, over 40% of the displaced are tribal individuals, who constitute 8.08% of India's population and 20% are Dalits (M DV, V.M. Salgaocar College of Law).

Since the 1950s, large-scale land acquisitions for projects in irrigation, power, steel, and heavy industries have occurred without adequate legal frameworks to address the rehabilitation and resettlement needs of the displaced. This gap prompted the Indian government to develop the National Policy for Rehabilitation and Resettlement in 2007, replacing the inadequate 2003 policy, following prolonged advocacy by people's organizations and environmental groups (World Commission on Dams, 2000)

The **National Rehabilitation and Resettlement Policy of 2007** was introduced to minimize displacement caused by development projects, emphasizing careful site selection and comprehensive assessments by state governments prior to project approval. This marked a significant shift from earlier policies, which inadequately addressed displacement issues. A notable feature of the 2007 policy is the requirement for social impact assessments, a demand long championed by civil society but absent from previous drafts (Sharma and Kakoty, 2004; Biswas and Tortajada, 2001)

The policy is grounded in principles of participation, consistent income generation, and improving the quality of life for displaced populations. It requires the development of resettlement plans in consultation with local institutions and advocates for providing affected individuals with shares in the project as compensation, thus ensuring their stake in its success.

Despite these positive measures, the policy's provisions are not mandatory, often phrased with terms like "may" and "to the degree practicable," allowing considerable discretion to project developers and the government. While this flexibility might be intended to accommodate various scenarios, historical evidence suggests it is often used to the detriment of displaced communities. Additionally, the policy lacks detailed guidelines on conducting social impact assessments, such

as the methodology, responsible parties, timing, and their impact on decision-making processes (Sharma and Kakoty, 2004; Biswas and Tortajada, 2001).

Despite the Indian government's rejection of the WCD report, many of its recommendations have been integrated into national policy, successfully balancing various interests. This has resulted in flexible implementation of favorable provisions by project developers and governmental entities, leaving some issues unresolved (Chaudhory, 2010).

The Land Acquisition, Rehabilitation, and Resettlement (LARR) Act, 2013, enacted in August 2013, represents a comprehensive approach to land acquisition, including explicit provisions for rehabilitation and resettlement. The Act defines "public purpose" for land acquisition and mandates a thorough rehabilitation package for tenants and landless individuals who lose their livelihoods. It ensures access to safe drinking water, roads, health centers, parks, and schools. Additionally, the Act emphasizes the role of the gram Sabha, requiring government consultation. Compliance with other legislation, such as the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, the Panchayat (Extension to the Scheduled Areas) Act (PESA), 1996, and the Land Transfer Regulations in Schedule V (Tribal) Areas, is also required (M DV, V.M. Salgaocar College of Law).

Geo-political Aspects

The water-energy nexus has been since always interlinked with geo-political aspects specially in terms of security, resource utilization and distribution accounting to the ultimate development within different states as well as nations (Scott et. al., 2011; Siddiqi and Anadon, 2011). The geo-political issues associated with dam construction are mostly centered around unequal distribution of benefits and costs, public participation, trans-boundary concerns and governance issues (Tullos et al., 2009; Scudder, 2005; Bocking, 1998). Unequal consideration of geo-political factors often leads to arise of numerous transborder hydro-political problems (Tullos et al., 2009). The main geopolitical aspects affected by dam construction involve an assemblage of numerous factors like downstream population, downstream irrigation, political boundaries, political participation, domestic governance, existing dams and socio-economic impacts on the non-constituents (Brown et. al., 2009).

The resource utilization and distribution is not just as local levels but it’s of national and international importance when it comes to regulating a utility for development purpose and in such cases the administrative boundaries are more important to be considered rather than the physical boundaries of the particular resource (Scott et. al., 2011). In such geo-political resource utilization scenario, the decision making at national level extends beyond mere management to policy setting considering the importance of national sovereignty. Erstwhile the decision making globally is a function of the United Nations along with the crucial conviction of various national governances (Scott et. al., 2011). The policy making related to dam construction and developmental issues include a complex array of government, policy institutions, corporate entities, NGOs, advocacy groups and public participations. Thus, it’s really imperative to plan the dam development projects considering various geo-political aspects like global finance, human rights and environmental sustainability (McDonald et al. 2009).

Sustainable Development Aspects

Dam development is integral to sustainable development, serving key functions in water management, energy production, agricultural productivity, and flood control. However, these benefits must be weighed against significant environmental, social, and economic challenges to ensure long-term sustainability (WCD report, 2000). Hydropower, a significant advantage of dam development, offers a renewable and low-carbon energy source, contributing to energy security and reducing reliance on fossil fuels (Moore et al. 2010; Ma¨kinen and Khan 2010; St. Louis et al. 2000). This aligns with global climate change mitigation efforts by lowering greenhouse gas emissions. Nonetheless, the sustainability of hydropower projects depends on addressing their environmental and social impacts, including ecosystem disruption, community displacement, and changes to downstream water availability (Anderson et al. 2008; Garrett 2010).

Environmental and social sustainability are keys in dam development. Dams play a crucial role in water distribution, agricultural production and management by regulating water flow, storing water for periods of scarcity, and ensuring a stable supply for domestic, agricultural, and industrial use (Kumar et. al., 2021; Beck et. al., 2012). However, sustainable water management requires careful planning to avoid issues like waterlogging, salinization, and the disruption of natural water cycles, while ensuring equitable access to water resources for all communities, including marginalized groups (McDonald et al. 2009).

Sustainable dam development requires a comprehensive approach that integrates environmental, social, and economic factors. By balancing the benefits of water management, energy production, agriculture, and flood control with the need to protect ecosystems and communities, dam projects can effectively contribute to sustainable development goals. Continuous monitoring, adaptive management, and inclusive decision-making are critical to achieving sustainable outcomes (Beck et. al., 2012; Anderson et al. 2008).

EIA and SIA overview for development of dams

Dams are important contributory elements in human development considering matching the desired quality life and addressing the needs of rising global population (Tullos et. al., 2009; WCD report, 2000). However, effective management of freshwater is one of the key human endeavors which require proper environmental and social impact assessment.

REDVET - Revista electrónica de Veterinaria - ISSN 1695-7504
Vol 25, No. 1 (2024)
http://www.veterinaria.org
Article Received: 20/09/2024 Revised: 22/09/2024 Accepted: 22/10/2024

Environmental management including proper impact assessment is a prerequisite requirement for binding with the specific social and environmental commitments arising due to the ongoing developmental activities (McCartney M. 2009). During the earlier stages of development, in absence of proper defined methodologies and transparent guidelines of EIA and SIA most of the hydroelectric projects have gained the limelight of controversies (Rana et. al., 2007). However, during the later stages, EIA has helped to establish a legal framework required essentially to assess and resolve the adverse effects of a dam project. Yet, due ineffective implementation of EIA practices the mitigation measures are not met properly. The major factors accounting to such legal incapabilities are lack of formal methodologies to involve different stakeholders and decision makers, absence of essential requirements required to identify project alternatives and inadequate provisions to ensure proper implementation of mitigation measures (Beck et. al., 2012; McDonald 2007; Boxer 2001).
However later induced intervention of public participation has led to partial improvement of provisions of EIA enabling the consideration of various minute and intricate details of the affected individuals (McDonald et al. 2009). SIA as an important part of policy evaluation and project planning in EIA has expanded the horizon of the social considerations while planning developmental projects (Burdge and Vanclay, 1996). Additionally, introduction of progressive governance policies and their implementation has led to significant safeguard of the interests of the local communities (Beck et. al., 2012). Likewise, the SIA interventions have really helped to pace up the implementation of developmental mitigatory measure in the direction of evaluation and understanding the impacts undergone by the society under the impression of developmental projects (Burdge and Vanclay, 1996). Despite the aforementioned advances, numerous conceptual, methodological and procedural gaps are still persistent in the actual on-ground scenario (Beck et. al., 2012; Burdge and Vanclay, 1996). Due to poor data collections, inadequate considerations and discrete identity of certain class, few sections of society are still deprived off from the basic allowances provided on account of development projects (Beck et. al., 2012; McDonald 2007; Rana et. al., 2007).

A WAY FORWARD:

In its development process, WCD discusses the advantages of dams to the countries; it has been a crucial way to address perceived needs for water, energy, and related services, as well as a strategic investment. The Development of dams brings us to a triangular linkage of development, people and environment. Development of dams is thought to provide numerous advantages, including the prevention of flooding, the growth of industry, the creation of jobs, and others. The socio-cultural costs of these large dams are likewise tracked by WCD. The WCD study discusses the difficulties faced by ousters, particularly during their resettlement, and specifically accuses political and institutional players of failing the ousters.
It is obvious that laws, regulations, plans, and most crucially, a political class that lacks commitment, ineffective administrations, and unsure project authorities have reduced the advantages of dams. If dams are seen of as signs of progress, then that development need to be able to make decisions, have choices, and furthermore, advance the common good. Future development results must be improved by taking a far broader approach to the proposed water and energy development projects, one that fully considers the advantages and drawbacks of major dam projects as well as all available alternatives.
It is crucial to design a strategy that will foster consensus around the decisions made, whether they are in favour of a dam or not, and to include fresh voices, perspectives, and criteria in the decision-making process in order to achieve this. This will have a profound impact on how decisions are made when building dams, which will alter thousands of lives. Making dams a development that is constructive and focused in this context is acceptable and crucial which includes public acceptance, a thorough assessment of all available options, sharing of benefits and recognition of entitlements and ensuring compliance are all necessary. However, we can conclude that decisions involved in development of dam carry valuable stakes which may lead to undesirable changes and irreversible societal as well as environmental shifts. The existing decision making and policy framing regarding dams is reliable on incomplete information and fragmented scientific methodologies including huge gap between theoretical considerations and real on ground scenarios. Thus, it's really imperative to develop a new integrative approach by proposing new tools, utilizing the existing knowledge, recording the new observations and addressing current gaps for the policy makers, resources managers and scientists to access and evaluate the costs and benefits that the community and ecosystems are bearing in the name of development through dams.

REFRENCES:

1. Altinbilek D. The role of dams in development. Water Sci Technol. 2002;45(8):169-180.
2. Anderson DH, et al. Proximate and distant visitors: differences in importance ratings of beneficial experiences. J Park Recreat Admin. 2008;26(4):47-65.
3. Asmal K. Introduction: World Commission on Dams report, dams and development. *Am U Int'l L Rev.* 2000;16:1411.
4. Baird IG, Meach M. Sesan River fisheries monitoring in Ratanakiri province, northeast Cambodia: before and after construction of the Yali Falls dam in the Central Highlands of Vietnam. Ban Lung, Cambodia: 3S Rivers Protection Network, GAPE; 2005.
5. Baran E, Jantunen T, Chong CK. Values of inland fisheries in the Mekong River Basin. Phnom Penh, Cambodia: WorldFish Center; 2007.
6. Bartolome LJ, et al. Displacement, resettlement, rehabilitation, reparation, and development: China report, World Commission on Dams Thematic Review 1.3. Cape Town: World Commission on Dams; 2000.

7. Beck MW, Claassen AH, Hundt PJ. Environmental and livelihood impacts of dams: common lessons across development gradients that challenge sustainability. Int J River Basin Manag. 2012;10(1):73-92.
8. Biswas AK, Tortajada C. Development and large dams: a global perspective. International Journal of Water Resources Development. 2001;17(1):9-21.
9. Bocking S. Dams & Development. International Development Studies Network. 1998. Accessed December 1, 2007.
10. Bodaly RA, Hecky RE, Fudge RJP. Increases in fish mercury levels in lakes flooded by the Churchill River diversion, northern Manitoba. Can J Fish Aquat Sci. 1984;41(4):682-691.
11. Boxer B. Contradictions and challenges in China's water policy development. Water Int. 2001;26(3):335-341.
12. Brown PH, Tullos D, Tilt B, Magee D, Wolf AT. Modeling the costs and benefits of dam construction from a multidisciplinary perspective. J Environ Manage. 2009;90
13. Burdge RJ, Vanclay F. Social impact assessment: a contribution to the state of the art series. Impact Assess. 1996;14(1):59-86.
14. Cakmak C. The role of dams in development. 2001.
15. Chapman MA. Human impacts on the Waikato river system, New Zealand. Cejournal. 1996;40(1-2):85-99.
16. Choudhury N. Sustainable dam development in India between global norms and local practices. Discussion Paper. 2010;(10/2010).
17. Duckworth JW, et al. A new species of wagtail from the Lower Mekong Basin. Bull Br Ornithol Club. 2001;121(3):152-182.
18. Dwivedi R. Resisting dams and 'development': contemporary significance of the campaign against the Narmada projects in India. Eur J Dev Res. 1998;10(2):135-183.
19. Egre D, Senecal P. Social impact assessments of large dams throughout the world: lessons learned over two decades. Impact Assess Proj Apprais. 2003;21(3):215-224.
20. Environmental management. National Rehabilitation and Resettlement Policy, 2007 – Environmental management.
21. Fuggle R, Smith WT. Large dams in water and energy resource development in The People's Republic of China, World Commission on Dams Country Review Paper. Cape Town: World Commission on Dams; 2000.
22. Garrett BL. Drowned memories: the submerged places of the Winnemem Wintu. Archaeologies. 2010;6(2):346-371.
23. Hartje V, Horstmann K. Dams and development co-operation: experiences and perspectives in German development co-operation with selected topics. Berlin, Dortmund; 1999.
24. Kingsford RT. Ecological impacts of dams, water diversions and river management on floodplain wetlands in Australia. Austral Ecol. 2000;25(2):109-127.
25. Kotchen MJ, Moore MR, Lupi F, Rutherford ES. Environmental constraints on hydropower: an ex post benefit-cost analysis of dam relicensing in Michigan. *Land Econ.* 2006;82(3):384-403.
26. Kumar P, Dubey CS, Kumar O, Shekhar S, Shukla DP, Ramanathan AL. Deciphering the role of meteorological parameters controlling the sediment load and water discharge in the Sutlej basin, Western Himalaya. J Environ Manage. 2021;298:113413.
27. Lerer LB, Scudder T. Health impacts of large dams. Environ Impact Assess Rev.1999;19(2):113-123.
28. Mäkinen K, Khan S. Policy considerations for greenhouse gas emissions from freshwater reservoirs. Water Altern. 2010;3(2):91-105.
29. McCartney M. Living with dams: managing the environmental impacts. Water Policy. 2009;11(S1):121-139.
30. McCartney MP, Sullivan C, Acreman MC, McAllister DE. Ecosystem impacts of large dams. Background paper, 2; 2001.
31. McDonald K, Bosshard P, Brewer N. Exporting dams: China's hydropower industry goes global. J Environ Manage. 2009;90(S3)
32. McDonald K. Damming China's grand canyon: pluralization without democratization in the Nu River Valley [dissertation]. University of California; 2007.
33. Moore D, Dore J, Gyawali D. Special issue: WCD+10: revisiting the large dam controversy. Water Altern. 2010;3(2):1-474.
34. Mumba M, Thompson JR. Hydrological and ecological impacts of dams on the Kafue Flats floodplain system, Southern Zambia. Phys Chem Earth. 2005;30:442-447.
35. Rana N, Sati SP, Sundriyal YP, Doval MM, Juyal N. Socio-economic and environmental implications of the hydroelectric projects in Uttarakhand Himalaya, India. J Mountain Sci. 2007;4:344-353.
36. Schulz C, Adams WM. Debating dams: the World Commission on Dams 20 years on. Wiley Interdiscip Rev Water. 2019;6(5).
37. Scott CA, Pierce SA, Pasqualetti MJ, Jones AL, Montz BE, Hoover JH. Policy and institutional dimensions of the water–energy nexus. Energy Policy. 2011;39(10):6622-6630.
38. Scudder T. The future of large dams: dealing with social, environmental, institutional and political costs. London: Earthscan; 2005.
39. Sengupta A. Dams and development: a controversy. Available at: SSRN 2124369; 2009.
40. Sharma SC, Kakoty N. Need for development of hydropower and dams in India highlighting the associated environmental issues. Water and Energy Abstracts. 2004;14(2):123.

41. Siddiqi A, Anadon LD. The water–energy nexus in Middle East and North Africa. Energy Policy. 2011. doi:10.1016/j.enpol.2011.04.023.
42. St Louis VL, Kelly CA, Duchemin E, Rudd JWM, Rosenberg DM. Reservoir surfaces as sources of greenhouse gases to the atmosphere: a global estimate. BioScience. 2000;50(9):766-775.
43. Tortajada C. Dams: an essential component of development. Journal of Hydrologic Engineering. 2015;20(1)
44. Tullos D, Tilt B, Liermann CR. Introduction to the special issue: Understanding and linking the biophysical, socioeconomic and geopolitical effects of dams. J Environ Manage. 2009;90
45. Woodruff DS. Biogeography and conservation in Southeast Asia: how 2.7 million years of repeated environmental fluctuations affect today's patterns and the future of the remaining refugial-phase biodiversity. Biodivers Conserv. 2010;19(4):919-941.
46. World Commission on Dams. Dams and Development: A New Framework for Decision-Making: The Report of the World Commission on Dams. Earthscan; 2000.
47. World Commission on Dams. Dams and development: a new framework for decision-making. London: Earthscan; 2000.
48. Yang Z, et al. Dam impacts on the Changjiang (Yangtze) river sediment discharge to the sea: the past 55 years and after the Three Gorges Dam. Water Resour Res. 2006;42.
49. Zakova Z, Berankova D, Kockova E, Kriz P, Mlejnkova H, Lind OT. Investigation of the development of biological and chemical conditions in the Vir reservoir 30 years after impoundment. Water Sci Technol. 1993;28:65-74.