

The Development of Jamrani Multipurpose Project in India from a multilateral development bank perspective

Le développement du projet à usages multiples de Jamrani en Inde du point de vue d'une banque de développement

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Abstract. The State of Uttarakhand in India has been studying the Jamrani Multipurpose Project in the last 40 years. The government's feasibility study has been completed and all statutory clearances were obtained. It comprises the construction of a 150-meter-high roller compacted concrete dam across the Gola River, a 14-megawatt toe powerhouse, the expansion and modernization of irrigation canal systems and a drinking water component. The project benefits will include 117 million liters per day drinking water for Haldwani Town, increased water availability for 150,000 ha cultivable command area and annual energy generation of 63 gigawatt-hour as a by-product. The project is estimated to cost \$365 million and was proposed in 2019 for the Asian Development Bank's financial assistance. A memorandum of understanding was signed in 2018 between the states of Uttarakhand and Uttar Pradesh, defining how the cost and benefits will be shared. The paper will discuss the ADB project appraisal process and describe the steps being taken to confirm and enhance the project economic feasibility, improve the mitigation of environmental and social impacts and review and confirm the technical studies.

Résumé. Le projet à usages multiples de Jamrani est étudié par l'état de Uttarakhand en Inde depuis près de 40 ans. L'étude de faisabilité est achevée et toutes les autorisations ont été obtenues. Le projet consiste en un barrage BCR de 150m de haut sur la rivière Gola, une usine hydroélectrique de 14MW, l'expansion et la modernisation de canaux d'irrigation et une station d'eau potable. Les objectifs du projet sont d'augmenter l'apport en eau potable de 117 millions de litre par jour pour la ville de Haldwani et

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d'augmenter la disponibilité en eau pour 150 000 ha de zone de commande cultivable. La production d'énergie est un sous-produit. Le cout estimé du projet est de 365 MUSD. L'état de Uttarakhand a demandé en 2019 l'assistance de la Banque Asiatique de Développement pour son financement. Un mémorandum a été signé en 2018 entre les états de Uttarakhand et Uttar Pradesh, définissant comment les coûts et les bénéfices vont être partagés. Cet article va discuter de comment ADB procède avec l'évaluation de ce projet. Il va décrire les différentes étapes afin de confirmer ou améliorer la faisabilité économique, améliorer la mitigation des impacts environnementaux et sociaux et revoir et confirmer les études techniques.

1 Background

This article is being written to illustrate how the Asian Development Bank (ADB) processes in respect of dam projects are applied in one particular case and how they aim to result in improved outcomes. The final decision by ADB to finance or not this project will be only taken at the end of reviews and appraisal. For this project, initial appraisal has been delayed due to the coronavirus disease (COVID-19) pandemic.

1.1 Dams in India

According to the National Register of Large Dam (2019), there are 5,264 completed large dams* and another 437 under construction in India. The total storage capacity of these dams is more than 300 billion cubic meters (m³). The state governments, through their irrigation and water resources departments, have constructed and are maintaining most of these large dams. Some are also owned and operated by state public entities or the central government. These dams benefit millions of people who rely on their waters for livelihood. They play a key role in promoting rural development and food security but also in tackling climate change, building climate and disaster resilience, and enhancing environmental sustainability which are two of the seven operation priorities of the Strategy 2030 of ADB.

1.2 Dams and the Asian Development Bank

Dams continue to be one of the most controversial topics in the water sector but as a technology, they cannot be ignored. They continue to provide much needed services like water, electricity, agriculture, and flood management. However, the associated social and environmental impacts and governance issues need to be assessed together with other feasibility criteria prior to any financing decision. ADB recognizes the complex nature of issues surrounding dam projects and the opportunities and risks they present. In considering new projects, ADB looks at each proposal on its merits within the framework of ADB's policies.

ADB's environmental and social safeguards are a cornerstone of its support to inclusive economic growth and environmental sustainability in Asia and Pacific. In July 2009, ADB's Board of Directors approved the new Safeguard Policy Statement, 2009 (SPS) governing the environmental and social safeguards of ADB's operations. The objectives of the SPS are to

* Large dams definition has been revised by the ICOLD in 2018 (a dam with a height of 15m or greater from lowest foundation to crest or a dam between 5m and 15m impounding more than 3 million m³) but the register continues to follow the earlier definition.

avoid, or when avoidance is not possible, to minimize and mitigate adverse project impacts on the environment and affected people, and to help borrowers strengthen their safeguard systems and develop the capacity to manage environmental and social risks. The SPS applies to all ADB-financed projects. ADB's safeguard policy framework consists of three operational policies addressing the project potential impacts on the environment, the indigenous peoples, and involuntary resettlement. This policy framework requires all project risks to be evaluated and mitigated, including those related to dam safety, but does not prescribe specific standards.

In the past 10 years, ADB's involvement in financing dams mainly consisted of dam rehabilitation, the design and/or construction of run-of-river schemes and support for some large dams. About 17 large dams in Asia and the Pacific were studied and/or constructed under ADB's financing in the past decade. There were only two ADB-financed projects involving dams in India since 2010, one in Himachal Pradesh and one in Madhya Pradesh.

1.3 Need for Jamrani multipurpose project

Jamrani Multipurpose Project is physically located on the Gola River in the Nainital District of the State of Uttarakhand, in the North of India. Gola River is a flashy seasonal river which originates in the Kumaon Himalayas. It is fed largely by the runoff generated during the monsoon season. The lean season flow is not sufficient to meet the drinking water requirements of the Bhabar area in the Nainital District. The Bhabar belt has a limited ground water potential and the Gola River is the only available source of water for agricultural and industrial developments, in addition to fulfilling the needs of drinking water of the Haldwani town and surrounding rural population. The Town of Haldwani (400,000 inhabitants) is already relying heavily (almost 50%) on unsustainable ground water extraction. Water table has been depleted by more than 15 meters in the past 10 years. The current drinking water requirement is expected to more than double with population increase over the next 30 years (2051 projection: 1,070,000 inhabitants). Surface irrigation water is also very scarce during the dry season which also cause over extraction of ground water. As population and industrial activities increases, the creation of a storage project upstream of Haldwani town became more and more essential. Additional supply will also provide opportunity for increasing agriculture production in dry season while relieving pressure on ground water extraction.

2 History of the Jamrani Multipurpose Project

The first investigations and preliminary studies of the Jamrani Multipurpose project were initially carried out by the undivided State of Uttar Pradesh (now split in two states, Uttar Pradesh and Uttarakhand) during the 1970s. The project was sanctioned by the central government Planning Commission in 1975 for ₹61.25 crores (\$8.3 million current exchange rate). The original scope consisted of the following two main components:

- **Phase I:** diversion work consisting of the Gola barrage at Kathgodam increasing the capacity of Golawar right bank canal and Golapar left bank canal. It also includes the construction of new feeders, lining of guls (diversion channels), remodeling of existing canal systems and other head works, and construction of unlined channels.
- **Phase II:** storage project consisting of a rock fill dam with an upstream concrete membrane at Jamrani site located about 10 kilometers (km) upstream of Gola barrage with its appurtenant works.

Some of the diversion works, including the Gola barrage at Kathgodam, were taken up with government financing in 1977 as Phase I to divert additional rainy season flows of Gola River for *Kharif** irrigation. A modern and reliable diversion system with a gated barrage located 120 m downstream of the old weir was inaugurated on 2 October 1980 (Fig. 1). Water was fed into the newly constructed Golawar main canal with a design capacity of 22.12 cubic meters per second (m^3/s) and into Golapar main canal with a design capacity of 3 m^3/s .

The storage part of the project under Phase II could not be taken up due to internal disagreements regarding the dam type that was subsequently changed to concrete gravity dam. The revised project proposal was submitted to Central Water Commission (CWC) for review and approval in March 1983. An extensive investigation campaign was carried out at dam site to meet the design requirements and to satisfy the comments raised by various directorates of CWC. The project feasibility report and estimates were subsequently revised for a roller compacted concrete (RCC) dam type based on investigations carried out and on the suggestions of CWC. The detailed project report (DPR) was thereafter submitted to CWC by the Department of Irrigation (DOI) of Uttarakhand in 2005.

Additional technical studies were carried out to comply with the observations received from CWC, the Central Electricity Authority (CEA), the Geological Survey of India (GSI) and the Central Soil and Material Research Station (CSMRS). A revised DPR was submitted in 2019, 14 years after the previous version. The 2019 DPR aimed (i) to summarize the results of all previous and current field investigations and studies; (ii) to bring out an acceptable technical, environmental and social concept; (iii) to estimate with the project costs and benefits; and (iv) to develop the analyses required by CWC to confirm its economic and financial feasibility.

The Screening Committee of the Department of Economic Affairs approved the proposal of the State Government of Uttarakhand for posing the project for ADB consideration for financial assistance on 18 December 2019. The approved and estimated cost for the project is \$365 million, out of which ADB would finance 80% equivalent to \$292 million. ADB fielded a first consultation mission in February 2020 to undertake a review of the project components, due diligences undertaken by the State Government of Uttarakhand for project preparation and identification of next steps towards project consideration for ADB financing including additional studies and reviews. Specific focus was given to reviewing environmental impact assessment and economic analysis of the project and identifying what further steps are needed.

3 Main project components as per the latest feasibility

3.1 Jamrani Dam and appurtenant structures

The dam is designed as a 150 m high RCC gravity dam from the deepest foundation level located on the Gola River at Latitude $29^{\circ}16'15''\text{N}$ and Longitude $79^{\circ}36'36''\text{E}$. The dam crest is 480 m long located at el. 765.60 meter above sea level (masl) whereas the full supply level is at el. 762 masl. The catchment area at site is 450 square kilometers (km^2). The reservoir has a gross storage of 208.60 million m^3 , live storage of 142.72 million m^3 and dead storage of 65.88 million m^3 .

* *Kharif*: the wet season, which usually lasts from July until October. *Rabi*: the dry season, which starts in November ends in March of the following year.

The extensive investigations campaign carried out at dam site since 20 years include geological mapping of the dam and reservoir, 44 boreholes for a total of 3,408 m, 8 exploratory adits for a total of 278 m, water pressure tests in boreholes, grouting test, in-situ and laboratory tests on rock samples, construction material surveys, and seismicity surveys and studies. The foundation of the dam is principally made of sandstone with some intercalation of siltstone and shale bands (Fig. 1). Jamrani dam is located in a high seismic area and a peak ground acceleration of 0.23g has been considered in the DPR.

The average annual rainfall is estimated at 2,016 millimeters (mm). Flow data at Gola barrage, available for the period 1977 to 2006, was utilized for working out the flow series at Jamrani dam site. The average yields are 393.31 million m³ (50% dependable year) and 283.06 million m³ (75% dependable year). The probable maximum flood is estimated at 8,427 m³/s and the diversion flood at 500 m³/s corresponding to a non-monsoon flood of 25 years return period as per the Indian Standard. The sedimentation rate is estimated at 14.29 ha-m/100 km² per year.

All facilities for the flood control have been incorporated in the dam body (Fig. 2 and 3). The main spillway consists of four gated spillway openings, each 8 m wide by 12 m high. The sill of the main spillway is located at el. 716 masl. Two under sluices bays have been kept close to the power intake structure to keep this area free from sediments and to pass some portion of the design flood downstream. The under sluice arrangement consists of two bays, each 5 m wide by 7.5 m high. The crest level of under sluices bays have been kept at el. 701 masl, i.e. 11.80 m below the invert level of the power intake. The diversion river diversion (Fig. 3) consists of a 6.5 m diameter and 565 m long concrete lined horseshoe shaped diversion tunnel on the right bank, a 15 m high upstream cofferdam and a 7 m high downstream cofferdam.



Fig. 1. Left: Gola Barrage at Kathgodam – Right: Jamrani dam site – Left abutment view from the right bank (source: ADB).

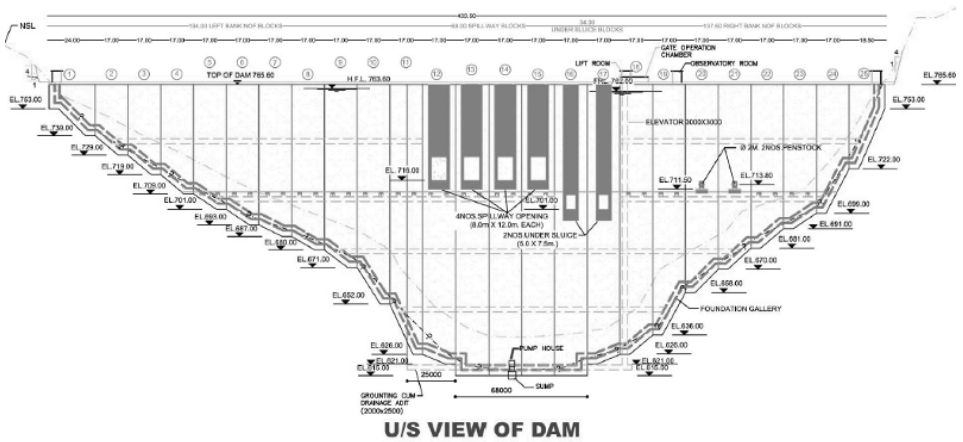


Fig. 2. Upstream view of the dam (source: DOI).

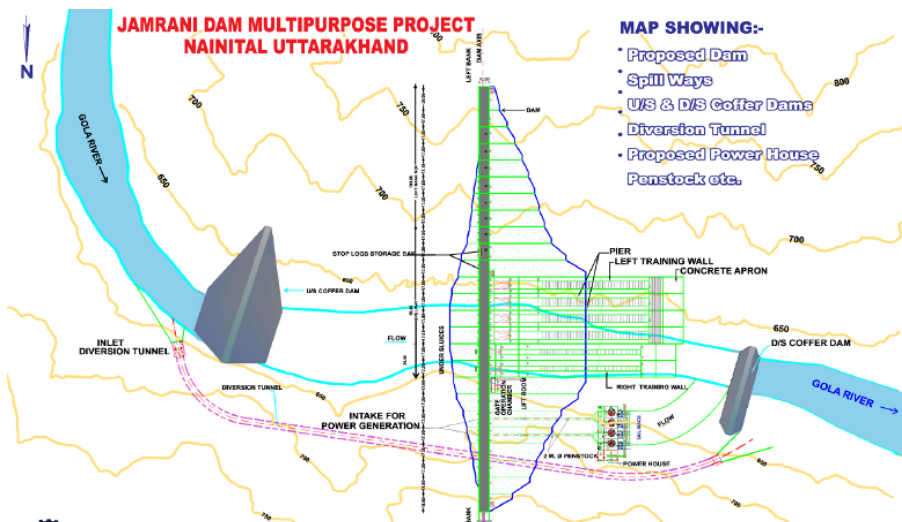


Fig. 3. General layout (source: DOI).

3.2 Irrigation systems

The project envisages to utilize the water resources potential of Gola River by constructing Jamrani dam for providing increased water availability for 150,027 ha cultivable command area (CCA) which includes 32,556 ha in Uttarakhand and 117,471 ha in Uttar Pradesh (Fig. 4).

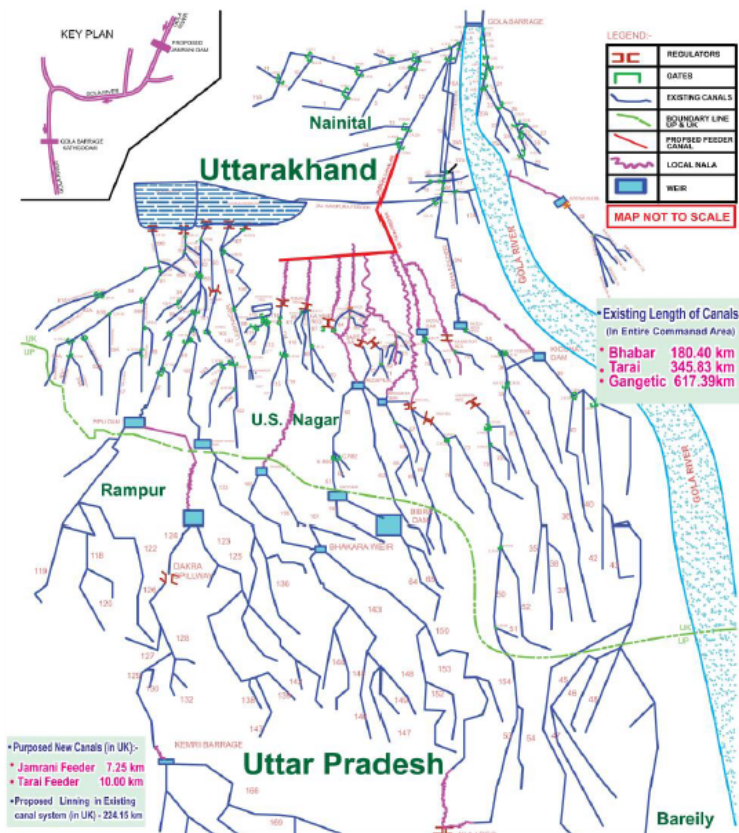


Fig. 4. Command area of the project (source: DOI).

3.3 Drinking Water

The project has been planned to augment the drinking water needs for the population of Haldwani currently facing water crisis during summer months. The works is estimated to cost ₹316.0 crores (about \$44 million). The main components are 20 km long and 900 mm diameter raw water gravity mains from the proposed Jamrani dam site to the 117 million liters per day (MLD) water treatment plant, connecting supply mains to existing overhead reservoirs and replacement and augmentation of the existing water supply system. The water demand has been computed based on the projected population considering 155 liters per capita per day (lpcd) for the urban and peri-urban areas and 78 lpcd for the rural areas. The pre-project demand of 30.67 million m³ is met when supplemented with tube-well extraction for 12.83 million m³. In the post project scenario, a storage of 42.70 million m³ has been kept for meeting the drinking water demand. The drinking water demand for estimated population of 1.07 million for the year 2051 would be 70.34 million m³ and would again needs to be supplemented from the aquifers.

3.4 Powerhouse

A small dam toe powerhouse with 14 megawatts (MW) installed capacity is also part of the project. The powerhouse consists of four 3.5 MW vertical francis turbines generating 63.4 gigawatt hours (GWh) on 75% dependable year. This power generation, even if a by-product

of the project, will help meet current gap in power demand and supply in the state as it is not a power surplus state. It is estimated to cost ₹81 crores (about \$11.2 million). The components include the construction of the intake and penstock inside the dam body, powerhouse civil works and switchyard complex along with tailrace canal, erection and commissioning of the electro-mechanical equipment and the power evacuation arrangement to Kathgodam Substation at 15 km.

3.5 Social and environmental studies

The project authorities assessed that as a result of the reservoir impounding, six villages (Tilwadi, Murkudia, Ganrad, Paniyabor, Udwa and Pastola) will be partially or fully submerged (Fig. 5) and a few physical cultural resources will fall under the submergence zone. About 401 ha of land will need to be acquired including 49.343 ha of private land and 307 families (426 adults above 18 years) would need to be resettled and rehabilitated. According to the government preliminary census, there are no indigenous tribal people in the project area. Yet 119 families part of vulnerable social groups have been identified and will be entitled to targeted social protection measures. During the ADB site visit held in February 2020, local communities expressed their interest to the project. The resettlement and rehabilitation plan is estimated to cost ₹ 24,301 lakhs (about \$35 million).

The project environmental impact assessment (EIA) was approved in December 2019 by the Ministry of Environment and Forest (MoEF). It is granted for a construction of the project within 10 years. The Uttarakhand State Forest Department has prepared a 10 year Wildlife Conservation Plan for the project in 2019 to be implemented by the Forest Department at an estimated cost of ₹19.70 crores already included in the project cost. The environmental flow from the proposed Jamrani dam has been calculated based on the water availability and as per Ministry of Water Resources, River Development and Ganga Rejuvenation (National Mission for Clean Ganga) Order dated 9 October 2018. This order specifies the minimum environmental flows to be maintained at different stretches in the Ganga river basin and downstream of existing, under-construction and future projects in order to protect the holy River Ganga.

Additional social and environmental aspects are described in section. 5.2 of the article.

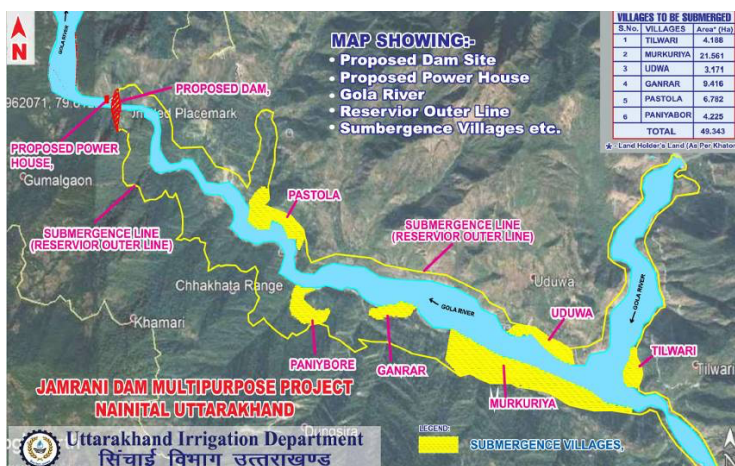


Fig. 5. Jamrani reservoir and submergence area (source: DOI).

3.6 Economics

A Benefit–Cost Ratio (BCR) of 1.09 was calculated in the DPR. On the basis that the BCR exceeds 1.0, the project was considered economically feasible by the government. However, the calculation has omitted the cost and benefits from drinking water and power and only considered cost and benefits from irrigated agriculture, which is mainly coming from increase cropping intensity, yield and change in cropping patterns. The dam cost has been split between the three subsectors and the BCR was calculated for irrigation only which considers 50% of the dam cost.

4 Inter-state and stakeholder’s involvement

4.1 Inter-state agreement

The MoU has been signed between the states of Uttar Pradesh and Uttarakhand, the two beneficiary states from the project, on 22 February 2018 for the construction of Jamrani Multipurpose Project. It envisages (i) provision for drinking water requirement to Uttarakhand, and (ii) meeting the existing irrigation demand of Uttar Pradesh and Uttarakhand. The MOU provided water sharing and prioritization including (i) first priority for drinking water requirement of 42.70 million m³ to Uttarakhand, (ii) second priority for meeting the existing irrigation demand of two systems of Uttar Pradesh (118 million m³ for Bareilly through Gola Barrage and irrigation to Rampur district through Haripura and Baur reservoirs), (iii) third priority for meeting the existing irrigation demand in Uttarakhand, and (iv) the water balance shall be distributed between Uttar Pradesh and Uttarakhand in the ratio of 57:43.

The sharing of cost between the two states will be as per the MoU signed between the two states in 2018. The project financing will be through the loan assistance borrowed by the Government of India and passed on to the State of Uttarakhand. The loan would be in 90:10 between the center and the state, as Uttarakhand is in the special category state, with an overall project financing in the ratio of center to state of 72:28. The sharing of cost between the two states is expected from the Uttarakhand State share of the investment program. Uttarakhand State expects Uttar Pradesh to reimburse their share. According to the interstate MoU, it amounts to 57% of the share of the dam costs allocated to the irrigation which was estimated to be ₹1,042 crores (50% of the dam cost) by the planning commission in 2015. Consequently, the State of Uttar Pradesh share recorded in the interstate MoU amounts to ₹594.38 crores (\$83 million) to be updated at project completion.

4.2 Implementation arrangements

As a multipurpose project and beside the inter-state agreement, it will also involve various stakeholders within the State Government of Uttarakhand and require adequate planning and coordination among them. The Department of Irrigation (DOI) will lead the project implementation. Three project implementation units (PIUs) are proposed for the separate components of irrigation, drinking water and power. The overall project coordination would remain with the PIU for dam and irrigation under DOI. The drinking water component PIU will be led by Jal Sansthan, State Government of Uttarakhand and the power component PIU by the Uttarakhand Jal Viduyut Nigam Ltd (UJVNL).

5 ADB due diligence for project development

ADB often provides technical assistance (TA) grants to help the government identify and prepare feasible projects. During the early stage of the TA, a scoping exercise—called an initial poverty and social analysis—is conducted to identify those people who may be beneficially or adversely affected. ADB usually hires consultants to work with government counterpart staff to undertake the project's feasibility study. If the feasibility study is already prepared by the government, like in the case for the Jamrani Multipurpose Project, ADB will recruit a team of consultants to conduct mandatory due diligences on several aspects (technical, economic and financial, social, environmental, climate change, etc.). Any gaps between policies and requirements from the government and ADB will need to be identified and addressed for ADB to be able to finance the project. The consultants work closely with the various stakeholders including the government, civil society, affected people, and other development agencies working in those sectors. The ADB fact-finding mission—in consultation with the government and other stakeholders—examines the project's technical, financial, economic, environmental, and management aspects and potential social impact. Detailed project risks and sensitivity analyses are carried out to assess viability of the proposed project. Loan terms and conditions for loan effectiveness are discussed to improve sector performance and address key policy issues.

5.1 Economic feasibility

A well-conducted economic analysis should show that (i) a project is in line with the development context of a borrowing country and ADB's country partnership strategy; (ii) there is strong rationale for the public sector and ADB to finance the project; and (iii) the selected project represents the most efficient or least-cost option among all the feasible alternatives for achieving the intended project benefits and, when benefit can be valued, it will generate a positive economic net present value (ENPV) using the minimum required economic internal rate of return (EIRR) as the discount rate, i.e. the project has an EIRR higher than the discount rate. The BCR analysis that were produced for project clearance by the government could not be used to justify the economic rationale of the project at this stage. ADB's 2017 Guidelines for the Economic Analysis of Projects require additional dimensions to be covered. Several methodological issues were identified, and some are discussed below.

- **Project scenarios.** An economic analysis that meets ADB requirements must have clearly defined with-project and without-project scenarios. The government analysis uses before and after project scenarios, which do not replicate the without-project scenario with future trends.
- **Discounted benefit cost analysis.** A comprehensive benefit–cost analysis is required to measure benefits and costs over some determined timeframe (i.e., 30–50 years) and discount the yearly values using ADB's recommended discount rate (9% for productivity enhancing projects). This allows derivation of the discounted decision-making criteria of EIR) and ENPV. Whilst a BCR is not used in ADB economic evaluations, it could be included however the appropriate calculation is dividing the discounted present value (PV) of benefits by the discounted PV of costs. ADB's newly adopted minimum required EIRR is 9%.*
- **Project costs** (in economic terms) are estimated for each year they will occur in a cash flow analysis instead of estimating an average annual value as it was done. Interest costs and depreciation are not included in an economic analysis as they are

* However, for social sector projects, selected poverty-targeting projects, and projects that primarily generate environmental benefits, the minimum required EIRR can be lowered to 6%.

financial values (they are transfer payments within the economy). Project costs should include all the civil works, operation and maintenance (O&M), resettlement costs, private capital investment (e.g., new canals, on-farm infrastructure).

- **Project benefits.** The project is complex and will require a multi-disciplinary approach to measuring the economic benefits. Some of the key sectors identified that will be affected by dam construction are irrigation, power/electricity, domestic water supply and tourism.
- **External costs.** An important component of the economic analysis will be to identify and value the external costs associated with construction and operation of the dam. There likely be a range of social and environmental externalities that will need to be accounted for and discussed in the project documents.

Appraisal of the likely economic feasibility of the project is critical before ADB can consider this project further. The State Government of Uttarakhand is therefore reviewing the economic analysis following ADB's guidelines with the help of an international economist recruited by ADB. The State Government of Uttarakhand will organize willingness to pay surveys to assess benefits from drinking and power components. They will also update the project cost in 2020 prices and provide updated data on without project cropping patterns and yields in both Uttarakhand and Uttar Pradesh command areas.

5.2 Environmental and social impact mitigation

5.2.1 Environment safeguards

The government EIA noted the possible but rare presence of endangered species in the project area including tigers, sloth bears, etc. However, the presence of these species in the reservoir area is not well documented. It is not known how many and how often or if they use any corridors. An unpublished research (2015) has however documented tigers and other endangered fauna in proximity of the proposed project area. To comply with the ADB's SPS environment safeguard requirement for biodiversity conservation and sustainable natural resource management, ADB suggested that, after an initial biodiversity risk screening, a wildlife survey using camera-trapping techniques will be undertaken to document possible wildlife corridors and assess the threats of the proposed project to such biodiversity. In case wildlife corridors in the dam/reservoir site are confirmed, specific measures will be considered in the EIA/environmental management plan (EMP) to ensure that suitable corridors can be maintained in the project area.

The environment clearance mentioned that the project falls under the Dudhwa-Lagga Tiger Corridor. However, it is located more than 100 km from the project site, so the state has approached MoEF for necessary rectification in the environment clearance. Similarly, the environment clearance mentions about the extent of eco-sensitive zone (ESZ) of Nandhaur Wildlife Sanctuary, which is located about 6 km from the project. The forest department has later on notified that the project falls outside the ESZ boundary.

The Baba Haidakhan Temples (Fig. 6) and its nearby cave are located below the proposed reservoir full supply level. They fall under the definition of physical cultural resources of the ADB's SPS. DOI proposed to rebuild an elevated constructed temple complex. Consultations with project affected people will be organised to arrive at a rehabilitation and resettlement plan in accordance with the prevailing act and ADB's SPS guidelines. A due diligence will also be performed to understand the overall benefits of the project and how these outweighs

the anticipated cultural heritage loss and meet other conditions of the ADB's SPS on physical cultural resources. The assessment of the physical cultural resources will be part of the EIA process.



Fig. 6. The Baba Haidakhan Temple (source: ADB).

5.2.2 Social Safeguards

The State Government of Uttarakhand is proceeding with implementation of the resettlement and rehabilitation (R&R) activities on a fast track mode. To ensure ADB financing can be considered, this needs to be done in compliance with ADB SPS. The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act (LARR), is an Act approved by the Indian Parliament in 2013 that regulates land acquisition and lays down the procedure and rules for granting compensation, rehabilitation and resettlement to the affected persons in India. This act is closely aligned with ADB's SPS 2009 except on one aspect. The SPS requires all displaced persons without titles to land or any recognizable legal rights to land to be eligible for resettlement assistance and compensation for loss of non-land assets. The LARR Act, however, applies only when land is being acquired and compensates only affected persons who lose legally held land or selected non-title holders who have resided on the acquired land for 3 years before the acquisition and whose primary source of livelihood is affected. ADB and the government have discussed the need to develop and agree on an entitlement matrix that will summarize the types of losses and the corresponding nature and scope of entitlements to address all social impacts.

5.3 Review and validation of the dam design criteria and options

Should the project be economically viable, ADB will finance a technical review of the dam feasibility by an independent panel of experts (PoE). The PoE would provide an in-depth review of the dam design with specific focus on safety, efficiency (particularly cost reductions) and sustainability prior to tendering. DOI envisages to tender the dam as an engineering, procurement and construction (EPC) contract. The principal activities of the PoE will be:

- To assess, investigate and report on selected topics on:
 - Potential risks and impacts of proposed designs, construction techniques and other related aspects including identifying the key gaps in information;
 - Opportunities to reduce costs or simplify designs while maintaining quality standards;
 - Key technical and contractual elements are being properly handled during the design and investigation periods before packages are tendered.

- To assess the results of field investigations and surveys and to draw attention to improvements needed and information gaps, if necessary.
- To conduct independent third-party reviews of the feasibility including in particular an assessment of the geological and geotechnical studies, hydrological studies, design parameters, interpretations of investigation and survey results, construction techniques, costs, construction schedule and other matters the PoE deems appropriate.
- To detect general problems and identify any other issues involved and to make recommendations on measures for improving designs, processes and practices, as appropriate.

5.4 Climate change

The climate risk management approach of ADB aims to reduce risks resulting from climate change to investment projects in Asia and the Pacific. ADB's framework identifies climate change risks to project performance in the early stages of project development, and incorporates adaptation measures in the design of projects at risk. ADB climate risk management framework comprises the following steps: (i) context-sensitive climate risk screening at the concept development stage to identify projects that may be at medium or high risk; (ii) climate change risk and vulnerability assessment (CRVA) during preparation of projects at risk; (iii) technical and economic evaluation of adaptation options; (iv) identification of adaptation options in project design; and (v) monitoring and reporting of the level of risk and climate-proofing measures.

For a project comprising a high dam, the preparation of a CRVA will be required. The goal of the CRVA is to characterize climate risks to the project by identifying both the nature and likely magnitude of climate change impacts on the project (flood increase, change in temperature, rain and inflows patterns, sedimentation, etc), and the specific features of the project that make it vulnerable to these impacts. A CRVA attempts to identify the underlying causes of a system's vulnerability to climate change. The CRVA process embodies the recognition that many of the future impacts of climate change are fundamentally uncertain and that project risk management procedures must be robust to a range of uncertainty. In addition, a CRVA seeks to ensure that adaptation measures are locally beneficial, sustainable, and economically efficient.

6 Challenges

6.1 Reconciliation of government design criteria and due diligence with ADB policies and due diligence requirements

While ADB has safeguard policies that govern all its projects, including hydropower projects, ADB does not prescribe specific design standards and policies for dam projects but in many cases, it follows international standards like ICOLD. Some countries like India have also their own standard codes for the design and analysis of civil engineering structures such as buildings, dams, roads, railways, and airports. ADB may accept such national standard if they are aligned with international best practices in term of safety, efficiency and sustainability. All the criteria should be reviewed and assessed, and additional studies might be carried out if required. Design criteria are not all technical and the political and local context can be clarified through dialogue with the Government and other stakeholders

6.2 Transboundary water sharing agreement between two states to be incorporated in the design

Support for the implementation and operationalization of the agreement between the States of Uttarakhand and Uttar Pradesh will be provided by ADB. If the project moves forward, ADB will help with the establishment of tools, like water flow measurement at different locations upstream and at the border, transparent system for sharing and reporting, capacity building of staff from both states, etc. to materialize the agreement and check its implementation over time to avoid any conflict between both states. ADB added value will be in bringing expertise and funding to support both states with water sharing.

7 Conclusion

The first step of ADB project appraisal consists in a preliminary economic analysis. Once the project is likely economic feasibility is confirmed, ADB will proceed further with the project preparation and assessment of other due diligences. An ADB reconnaissance mission will be fielded with an objective to reconfirm the project scope and agree on the final scope and term of reference of the project preparatory technical assistance that will undertake some of the tasks discussed in Section 5. Special focus will be given to the environmental and social impacts as well as the dam safety aspects.

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