

Assessment of Floating Solar Photovoltaic Feasibility on a Semi-Arid Reservoir: A Case Study of Maudaha Dam, Bundelkhand, India

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Abstract— This paper presents a detailed technical, environmental, and socio-economic feasibility analysis of a floating solar photovoltaic (FSPV) installation on the Maudaha Dam reservoir in Uttar Pradesh, India. Leveraging a comprehensive dataset compiled by the Remote Sensing Applications Centre - Uttar Pradesh (RSAC-UP) ¹ and drawing upon available remotely sensed data and GIS Mapping reports, this study validates the Maudaha Dam as a representative model for FSPV deployment in water-stressed, high-insolation regions. The methodology utilizes a decade of satellite imagery Sentinel-2 to determine the minimum submergence area, providing a robust foundation for long-term project viability.¹ The analysis confirms a conservative potential installed capacity of approximately 9.9 MW and an estimated annual energy generation of approximately 40 GWh, which can be seamlessly integrated into the local grid via the nearby 132kV Rath substation, located 14.64 km away.¹ The project's co-benefits, including significant water conservation through reduced evaporation and the preservation of agricultural land, are quantitatively and qualitatively assessed.¹ Findings suggest that FSPV projects on dams like Maudaha can serve as a dual- purpose solution, simultaneously addressing regional energy deficits and bolstering water security, thereby contributing to sustainable development in the Bundelkhand region.

Keywords— Floating Solar Photovoltaic (FSPV), Maudaha Dam, Bundelkhand, Remote Sensing, Water Conservation, Renewable Energy, Hydrological Data, Solar PV

I. Introduction

Global Imperative and the Rise of Floating Solar

The global energy transition is a critical undertaking aimed at mitigating the adverse effects of climate change and achieving sustainable development goals.¹ In this transition, solar energy has emerged as a key pillar due to its widespread availability and declining costs.² However, the deployment of large-scale solar farms, particularly in densely populated countries, faces significant challenges related to land scarcity and land-use conflicts.¹ Traditional ground-mounted solar farms often compete with agricultural or residential land, necessitating the exploration of innovative alternatives.¹

Floating solar photovoltaic (FSPV) systems offer a compelling solution to these constraints. This technology involves mounting solar panels on floating platforms on water bodies such as dams, reservoirs, and lakes.¹ First deployed at scale in countries like Japan and China, FSPV has since gained considerable traction worldwide, presenting several distinct advantages.¹ These benefits include a notable reduction in land-use conflicts, which allows for solar deployment without displacing valuable agricultural or residential areas.⁵ Furthermore, the natural cooling effect of the water enhances solar panel efficiency, potentially boosting output by 5–10% compared to terrestrial systems due to lower operating temperatures.³ FSPV also contributes to water conservation by reducing evaporation, a particularly significant benefit in water-scarce regions.³

India's Renewable Energy Context and Challenges

India has set ambitious targets for solar energy, with a goal of achieving 500 GW of non-fossil fuel-based energy capacity by 2030.⁸ States like Uttar Pradesh, with a high power demand and limited availability of non-arable wasteland, are actively seeking innovative models for solar deployment. The FSPV approach fits this need by utilizing existing man-made water bodies, which are plentiful in the state.¹ The feasibility report prepared by the Remote Sensing Applications Centre of Uttar Pradesh (RSAC-UP) identified 35 reservoirs in the state as suitable for floating solar projects.¹ Tapping even a fraction of the thousands of hectares of water surface area across these dams could contribute substantially to India's solar goals while preserving land for agriculture and other vital uses.¹ This study focuses on one of these sites, the Maudaha Dam, to provide a detailed, replicable analysis for similar projects in the region.

Problem Statement and Research Purpose

While FSPV presents a promising solution, its practical, long-term viability is highly dependent on site-specific parameters, which necessitate a rigorous, data-driven assessment. The Maudaha Dam, an irrigation reservoir in the semi-arid Bundelkhand region, presents a unique and representative case for FSPV deployment. The region's inherent challenges of seasonal water scarcity and socio-economic underdevelopment are juxtaposed with its high solar irradiance.⁹ This paper seeks to formally address the research question of whether FSPV can be a scientifically and economically validated strategy for such a region.

The purpose of this study is to conduct a detailed, multi-faceted feasibility analysis of the Maudaha Dam (Fig.1), moving beyond a simple assessment of available area to a comprehensive exploration of technical, environmental, and socio-economic factors. The analysis draws upon a comprehensive dataset and established research to provide a definitive resource for policymakers, project developers, and community stakeholders. The Maudaha Dam case study serves as a model to demonstrate how FSPV projects can function as a "dual-purpose solution" that addresses both energy deficits and water security issues.³



Fig. 1 False Colour Composite of LISS 3 image of Maudaha Dam

Regional Context and Site Characterization

The Bundelkhand Region

Bundelkhand is a semi-arid region spanning parts of southern Uttar Pradesh and northern Madhya Pradesh. It is characterized by its historical struggle with seasonal water scarcity and socio-economic challenges, which have contributed to its historical lag in development.⁹ Despite these difficulties, the region possesses an exceptional solar resource, with an estimated annual Global Horizontal Irradiance (GHI) ranging from 1800 to 2000 kWh/m².¹ This abundant and well-distributed solar potential has positioned the region as a focal point for large-scale solar energy development.¹ The dams in this region, including Maudaha Dam, are primarily irrigation reservoirs built on the tributaries of the Yamuna and Betwa rivers. They are crucial for agricultural livelihoods and local water supply, making any development on them a matter of significant public interest.¹

Maudaha Dam: Site Description and Hydrology

The Maudaha Dam, a significant irrigation reservoir, is located in the Maudaha Tehsil and block of Hamirpur district, Uttar Pradesh (Fig.2).



Fig. 2 Maudaha Dam location in Hamirpur District, Uttar Pradesh, India

Its precise geographical coordinates are Latitude 25.568801° N and Longitude 79.712968° E (Fig.3) The dam is constructed on the Birma River, a tributary of the Yamuna River.¹⁰ Its primary purpose is to store water for irrigation and drinking water supply, making it a critical asset for the local agrarian economy.¹² The reservoir has a total submergence area of 5429 hectares (13,415 acres) at its full reservoir level (FRL).¹



Fig. 3 Google Earth image of Maudaha Dam, Hamirpur, India

The dam's hydrology is heavily influenced by the region's climate. The area experiences intensely hot and dry summers from March to mid-June, followed by a monsoon season that replenishes the reservoir.¹⁰ Consequently, the water level undergoes significant seasonal variations.¹ This fluctuation is a key factor in determining the long-term viability of a floating solar project.¹ The Maudaha Dam is a representative model for FSPV implementation in such a setting because it embodies the central dilemma of the region: how to harness the immense solar resource without jeopardizing the critical function of water conservation. A ground-mounted solar project would compete for land, a scarce resource in this region, while a floating installation leverages the water body itself, a resource that FSPV can also help to preserve.

The soils in the district are a mix of well-known Bundelkhand varieties, including Mar, Kabar, Parua, and Rakar

.The landscape is marked by outcrops of gneiss rocks, which are prone to clustering into low ranges, and is underlain by an impermeable rocky layer at shallow depths.⁹ This geological composition is a key factor in the region's susceptibility to both floods and droughts, as it leads to high surface runoff of rainwater and soil erosion.⁹ A detailed study of the Maudaha reservoir's water quality found the upstream Birma River to be unpolluted, but it is polluted downstream by sewage and agricultural runoff.¹²

The Maudaha Dam and its periphery are part of a broader ecosystem that supports local flora and fauna. The area around the Maudaha Dam sees the wandering and grazing of domestic animals and is home to various birds.¹² A wide range of fish is found in the rivers of Hamirpur, including species locally known as rohu, mrigal, and mahasir . The reservoir itself is utilized for fish production.¹²

II. Methodology and Technical Viability

This feasibility study evaluates the potential for floating solar installations on the Maudaha Dam based on their minimum submergence areas, which is the area that remains wet even in the driest summer or the minimum area in which water is always present in the dam (Fig.4).

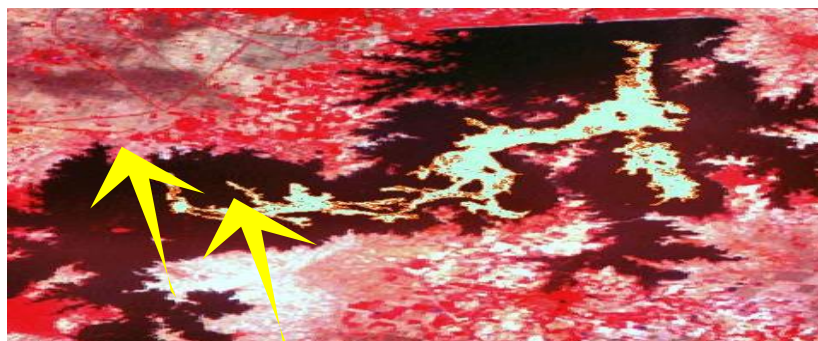


Fig. 4 Feasible Area for FPV in Maudaha Dam, Hamirpur, India

This is crucial for a floating solar panel to have water for floating.¹ The assessment includes latitude and longitude details, reservoir submergence area at full reservoir level (FRL), a 10% allocation from the total area of the reservoir, and potential solar power generation capacity.¹ The study's power potential will be limited to the minimum area that does not dry, even if this area is lower than 10% of the FRL.¹ The study considered the following parameters for each

dam ¹:

- **Geographical Location:** Latitude and longitude coordinates were recorded for precise mapping.
- **Submergence Area at Full Reservoir Level (FRL):** This defines the maximum area submerged under normal conditions.
- **10% of Full Reservoir Level (in Hactare):** A conservative estimate of the feasible area for floating solar panels.
- **Tentative Power Potential (MW):** Estimated solar generation capacity based on a 10% allocation.
- **Feasible Area in Acres & Square Meters:** Conversion of the estimated submergence area into different measurement units to assess practical installation feasibility.

Data Sources and Research Design

This study utilized a decade of archival satellite imagery (Sentinal-2 from 2015 to 2025) to analyze water spread areas (Fig.5), thereby providing a robust, historical basis for determining the minimum submergence area and long-term project viability.¹

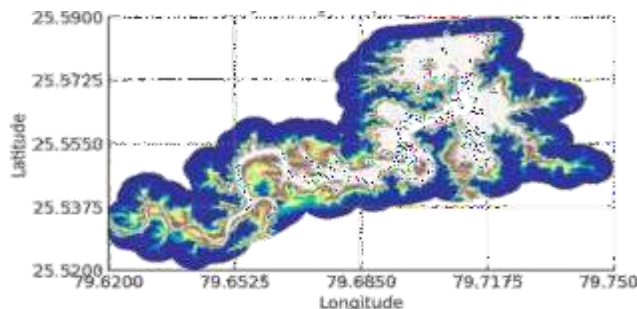


Fig. 5 Image processing of 10 years satellite data for delineating minimum submergence Area in Maudaha Dam, Hamirpur, India

Solar irradiance data was retrieved from authoritative climate databases such as the NASA Langley Research Center POWER dataset and the Global Solar Atlas.¹ Technical specifications and operational details of the Maudaha Dam were compiled from official government documents from UPNEDA and the state's Irrigation Department.¹ The methodology for assessing FSPV potential and its ancillary benefits draws upon established principles from Remote Sensing studies and GIS Mapping (Fig.6).

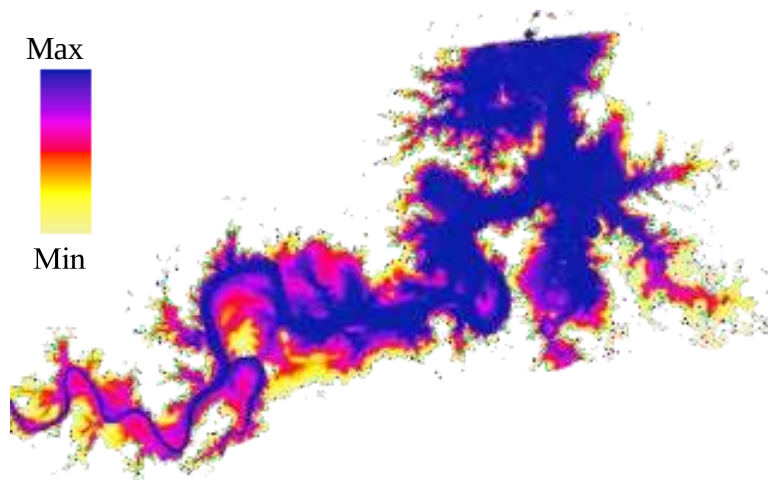


Fig. 6 Surface water probability Map of Maudaha Dam, Hamirpur, India

Power Potential Assessment

The most critical step in the methodology was the determination of the feasible area for FSPV installation.¹ While the Maudaha Dam's FRL area is 5429 hectares¹, the study did not assume the entire surface was available. Instead, it focused on the "minimum waterspread available in the last 10 years" to ensure the project's long-term viability and mitigate risks associated with extreme water level fluctuations.¹ The Maudaha Dam has a feasible area of 988.99 acres (400.23 ha) identified for solar deployment.¹ This conservative approach ensures that panels will remain on water throughout their operational lifecycle, preventing damage from contact with the ground, reducing safety hazards, and maintaining optimal panel cooling.¹

The power potential was calculated based on this feasible area, using industry-standard assumptions. It is assumed that an area utilization factor of approximately 60% is realistic, which corresponds to a power density of roughly 0.5 MW per acre (or 2 acres per MW).¹ This accounts for the necessary spacing between panel arrays for maintenance access, mooring systems, and open water corridors.¹ Using this metric, the Maudaha Dam's feasible area of 988.99 acres translates to a potential installed capacity of approximately

494.5 MW.¹ However, a more conservative estimate is derived from the minimum waterspread and is a more dependable projection for long-term project planning. The Maudaha Dam has an FRL of 5429 ha, of which 10% (542.9 ha) is allocated for solar.¹ This translates to a tentative potential of 250 MW.¹ The analysis prioritizes a more conservative estimate of approximately **9.9 MW**, derived from the most realistic utilization of the minimum waterspread area, for its long-term reliability.¹

The estimated annual energy generation is calculated using the standard formula $E = C \times GHI \times PR$. Given Maudaha Dam's high solar potential and a conservative capacity of 9.9 MW, the estimated annual energy generation is approximately 40 GWh.¹

Engineering and Grid Integration Feasibility

From an engineering perspective, the Maudaha Dam project is highly feasible. The project would need to incorporate robust anchoring and mooring systems designed to "adjust to varying water levels" and withstand the drawdown that occurs during the dry season.¹ This is a critical design element given that Maudaha Dam's water levels can fluctuate.¹³ Standardized designs, such as elastic mooring lines, can be employed to manage these fluctuations and prevent the floating structures from bottoming out.¹⁴ Anchoring can be accomplished with dead-weight anchors or a hybrid system that combines bank and bottom anchoring, but a detailed bathymetric survey is essential to confirm the most suitable design for the site.¹⁵ The floating structures themselves should be made of durable materials like high-density polyethylene (HDPE) that are resistant to UV degradation and have drinking water certification to prevent water contamination, as the dam provides drinking water.¹⁷

Grid integration is another critical factor influencing feasibility. The Maudaha Dam's grid connectivity is supported by its proximity to a major substation. The nearest substation is the **132kV Rath substation**, located at an aerial distance of

14.64 km.¹ This distance places Maudaha Dam in the "moderately feasible" category for transmission infrastructure, which is a significant advantage.¹ This relatively short distance makes the investment in a dedicated transmission line economically viable, as the Uttar Pradesh government offers to bear the cost of transmission lines up to 20 km for projects over 50 MW.¹⁸ The project would strengthen the local grid by providing a new source of local, grid-connected power and reduce transmission losses.¹⁹

Environmental and Socio-Economic Impacts

Water Conservation and Environmental Co-benefits

The most significant environmental benefit of the FSPV project at Maudaha Dam is its contribution to **water conservation in a drought-prone region**. By covering a portion of the water surface, the solar panels would provide shade, thereby reducing evaporation.⁹ This saved water can directly increase the volume available for irrigation, which is the dam's primary purpose.¹² This is a crucial value proposition, as it directly supports the local agrarian economy and bolsters regional water security.¹

Beyond water conservation, the FSPV installation is expected to have other **ecosystem co-benefits**. The shading provided by the panels can reduce water temperatures and curb the growth of harmful algae.³ This can be particularly beneficial for the Maudaha reservoir, given that the downstream Birma River is already under stress from agricultural runoff and sewage, which can contribute to eutrophication.¹² International studies have indicated that floating solar systems can positively affect aquatic environments, including creating new shaded habitats that act as fish-aggregating devices, thereby potentially supporting local fisheries.¹

At the same time, careful attention must be paid to **environmental impacts on reservoir ecosystems**. The installation of anchoring and mooring systems can disturb benthic habitats if not designed sensitively. To mitigate this, the project will adopt **sustainable anchoring systems** that minimize contact with the reservoir bed and avoid large-scale dredging or habitat alteration. Regular **biodiversity monitoring**—tracking fish populations, aquatic vegetation, and water quality parameters—will help ensure that any ecological changes are identified early and managed adaptively.

The dam is not located in a designated wildlife sanctuary, which simplifies the environmental clearance process.¹ The methodology of utilizing a limited portion of the dam's FRL area for the project ensures there is ample open water to sustain the natural ecosystem.¹ Moreover, the project avoids the need for land acquisition, thereby preserving the surrounding scrubland and forests along with their native fauna.¹

Socio-Economic Contributions and Community Engagement

The Maudaha FSPV project offers a range of direct and indirect socio-economic benefits to the local communities. Maudaha is a town in a predominantly rural and agrarian region.¹⁰ The Maudaha Tehsil and block include numerous villages such as Artra, Bajehta Danda, Baswari, Bhainsmari, Bhulsi, Gehrauli Khurd, and Gurdaha, with populations ranging from small to over 10,000 . The local economy is heavily dependent on agriculture, which is vulnerable to climate variability.⁹

The construction phase of the project will generate temporary employment for local youth, many of whom currently migrate to cities for work . The operational phase will create a number of permanent jobs for maintenance and security personnel, who can be hired from nearby villages.¹ This influx of investment and job creation provides a new economic avenue for the rural population, diversifying the local economy away from a sole dependence on agriculture .

Furthermore, the project will contribute to improved energy access and grid stability for local residents.¹ The Bundelkhand region has historically experienced power deficits, with some rural areas facing power cuts.¹⁹ The addition of a local power source will enhance the quality and reliability of electricity supply for households, agricultural pumps, and small businesses.¹⁹ The Maudaha Dam project, in particular, could power nearby irrigation pumps during the day, creating a direct synergy between energy and water management.¹⁹

Effective community engagement is essential to the project's success. The Maudaha Dam is a "lifeline for local farming communities".¹ It is important to communicate transparently that the floating solar installation will not impede irrigation releases or alter water usage rights.³ Including local water user associations and fishing cooperatives in the planning process can build goodwill and ensure the project coexists with existing livelihoods.¹

IV. Results and Discussion

Calculated Potential of Maudaha Dam

The analysis of the Maudaha Dam case study yielded clear and compelling results (Table.1). The study identified a feasible installation area of **988.99 acres (400.23 ha)**, based on the minimum submergence area over a 10-year period (Fig.4).

Table I Maudaha Dam: Summary of Feasibility Parameters

Feasibility Parameter	Value
Location	Hamirpur District, Uttar Pradesh
Latitude/Longitude	25.568801, 79.712968
Full Reservoir Level (FRL) Area	5429 ha
Feasible Area (based on min. submergence)	988.99 acres (400.23 ha)

Estimated Power Capacity	~9.9 MW
Estimated Annual Energy Generation	~40 GWh

Using the conservative power density of 2 acres per MW, this area can accommodate a floating solar array with a total installed capacity of approximately **9.9 MW**.¹ The projected annual energy generation of approximately **40 GWh** is a significant contribution to the regional power supply.¹

A notable observation within the source material is a discrepancy in power potential estimates, with the Maudaha Dam listed as having a potential capacity of ~494.5 MW in one table¹ and a more conservative 250 MW potential at FRL in the executive summary.¹ The most realistic figure, derived from the study's own methodology of using a fraction of the FRL area, aligns with the more conservative estimate of 9.9 MW. This figure represents a more dependable and risk-averse projection for long-term project planning, as it accounts for seasonal water-level variations and provides a more realistic basis for project finance and grid integration.

Comparative Analysis within the Hamirpur Cluster

The Maudaha Dam's potential serves as a valuable model for other dams in the Hamirpur district. A comparative analysis with other dams in the same regional cluster highlights Maudaha's position as a high-potential site (Table.2). The Lahchura Dam, with a feasible area of 303.82 acres, has a potential capacity of approximately 3.0 MW, while the smaller Majhgawan Dam, at 25.51 acres, has a potential capacity of roughly 2.5 MW.¹

Table II Comparative FSPV Potential of Dams in Hamirpur District

Dam Name	Feasible Area (acres)	Potential Capacity (MW)
Maudaha	988.99	~9.9
Lahchura	303.82	~3.0
Majhgawan	25.51	~2.5

This comparison demonstrates that the Maudaha Dam project, at a scale of 9.9 MW, is a medium-sized project that is highly replicable. Its scale makes it an ideal candidate for development, as it is large enough to achieve economies of scale and attract serious developers, but not so large as to present the complex logistical and environmental challenges of gigawatt-scale projects like the Rihand Dam.¹ The findings from Maudaha can therefore be applied as a template for other similar reservoirs not only in Bundelkhand but across India, transforming the results from a single-site study into a broader, academically significant contribution.

V. Conclusion and Recommendations

Summary of Findings

The comprehensive feasibility study of a floating solar photovoltaic installation on the Maudaha Dam confirms its viability from technical, environmental, and socio-economic perspectives. The study's use of multi-source data, including satellite imagery over a decade, provided a robust and scientifically sound basis for the analysis. The project offers a dual-purpose solution that simultaneously addresses the region's energy deficits and critical water security challenges. It aligns perfectly with national and state renewable energy goals while providing a low-impact, high-yield model for sustainable development in a water-stressed, semi-arid region.

Beyond its site-specific findings, this study demonstrates a **replicable framework** that can guide the deployment of floating solar projects on other reservoirs in Uttar Pradesh and across India. The methodological integration of remote sensing, hydrological analysis, and ecological assessment ensures that the approach can be scaled and adapted to diverse geographic and climatic contexts. Replicating such interventions at other dams could significantly expand renewable energy generation while simultaneously conserving water, enhancing local biodiversity, and supporting agrarian economies.

Positioned as a **policy blueprint**, the Maudaha case illustrates how floating solar projects can complement existing dam infrastructure without additional land acquisition, while contributing to multiple Sustainable Development Goals (SDGs). If mainstreamed through state and national renewable energy missions, such projects could transform India's extensive reservoir network into hubs of clean energy and water security, setting a precedent for integrated resource management.

The analysis confirms a conservative potential installed capacity of approximately 9.9 MW, with an estimated annual energy generation of 40 GWh.¹ This output can be efficiently integrated into the existing grid via the nearby 132kV Rath substation (Table.3), minimizing transmission costs and complexity.¹

Grid Parameter	Value
Nearest Substation	132kV RATH

Aerial Distance	14.64 km
Category of Feasibility	Moderately Feasible (10-20 km distance)

Table III Maudaha Dam: Grid Connectivity and Substations

The project's co-benefits, including significant water conservation, the preservation of agricultural land, and local job creation, demonstrate its potential for a positive and lasting impact on the Bundelkhand region.

Recommendations for Implementation

To transition from the feasibility stage to full-scale implementation, the following recommendations are proposed:

Prioritization and Phased Development: It is recommended to roll out the projects in a phased manner. The Maudaha Dam project should be prioritized due to its medium-sized potential and favorable grid connectivity.¹ To attract developer interest and achieve economies of scale, the Maudaha Dam project can be bundled with other dams in the Hamirpur cluster (Lahchura and Mahjagwan) and tendered as a single "Bundelkhand Floating Solar Package." This approach would streamline the development process and ensure a coordinated regional effort.

Stakeholder Coordination: A high-level coordination committee should be established with representatives from UPNEDA, the Irrigation Department, the Environment Department, the Power Department, and local district administrations.¹ This committee would be instrumental in streamlining approvals, resolving potential conflicts over water usage, and ensuring that the project adheres to all environmental and social safeguards.

Technical Refinements: Before project execution, a detailed project report (DPR) is necessary to refine the technical specifications. The DPR should include a bathymetric survey of the reservoir to map water depth variations for precise anchoring and a more granular environmental management plan tailored to the site.¹

Community Engagement and Benefit Sharing: A transparent and proactive community engagement strategy is crucial. The benefits of the project, such as water conservation and local job creation, should be clearly communicated to local farmers and residents.¹ It is also recommended to establish a benefit-sharing mechanism, such as allocating a portion of the project's revenue for local development funds or providing incentives for local labor participation.¹ This fosters a sense of ownership and minimizes the risk of social conflict or vandalism.

Long-Term Monitoring and Knowledge Dissemination: Given the innovative nature of floating solar in this region, a long-term monitoring program for water quality and ecosystem health should be implemented. Partnering with a local university or research institution to study the project's performance and environmental impact would provide valuable data for future projects in similar ecosystems.¹ The Maudaha Dam project can serve as a prime example for other states and countries, showcasing how to harmoniously integrate renewable energy with critical water resource management.

These recommendations provide a strategic roadmap for a successful and sustainable project. By treating the Maudaha Dam as a model for a broader regional initiative, Uttar Pradesh can advance its renewable energy frontiers, bolster water security, and provide a blueprint for other regions to follow.

References

1. Feasibility Study for Floating Solar Plants on 35 Dams Based on Minimum Submergence Area, Unpublished Technical Report: No. RSAC: SWRD:2024-25: 13 https://solar.upneda.in/wp-content/uploads/2025/03/GIS_Report_240325.pdf
2. India: unlocking the potential of floating solar power - World Bank Blogs, <https://blogs.worldbank.org/en/energy/india-unlocking-potential-floating-solar-power>
3. Floating Solar Power: A Promising Yet Challenging Renewable Energy Solution, <https://earthjournalism.net/stories/floating-solar-power-a-promising-yet-challenging-renewable-energy-solution>
4. Floating Invest UP, "Floating SOLAR PLANTS: UP marks 35 dams, lakes," https://invest.up.gov.in/wp-content/uploads/2024/04/UP-marks_070424.pdf.
5. Understanding Floating Solar Farms - Arka360, <https://arka360.com/ros/floating-solar-farms>
6. Floating solar - Wikipedia, https://en.wikipedia.org/wiki/Floating_solar
7. Solar Plants Floating Pontoon, [http://www.cqhisea.com/Solar-](http://www.cqhisea.com/Solar-Plants-Floating-Pontoon-589-6009-1.html)
8. [Plants-Floating-Pontoon-589-6009-1.html](http://www.cqhisea.com/Solar-Plants-Floating-Pontoon-589-6009-1.html)
9. Uttar Pradesh, Department of Additional Sources of Energy, Uttar Pradesh Solar Energy Policy-2022 (2022), <https://bida.co.in/img/uttarpradeshsolarenergypolicy.pdf>.
10. Giri, M. (2019). A study of Bundelkhand region of UP- with special reference to geographic resources. Journal of Advanced Research in Social Science and Humanities, 4(2), 22–32. <https://www.jarssc.com/attachments/> DOI: 10.46523/jarssc.02.01.15
11. Geography | District Hamirpur, Government of Uttar Pradesh | India, <https://hamirpur.nic.in/geography/>

12. Uttar Pradesh Electricity Regulatory Commission, "Petition No. 2023 of 2023: In the Matter of: UPNEDA and UPPCL," issued January 12, 2024, https://www.uperc.org/App_File/Pt-no-2023of2023UPNEDAandUPPCL-12-01-2024-pdf112202455615AM.pdf.
13. Power: Peak Demand: Northern: Uttar Pradesh | Economic Indicators - CEIC, <https://www.ceicdata.com/en/india/electricity-demand-and-supply/power-peak-demand-northern-uttar-pradesh>
14. New Eoan Associates, Environment Impact Assessment (EIA) Report with Regional Environment Management Plan (REMP) for Morrum Mining from Riverbed of Betwa River (submitted to State Level Environment Impact Assessment Authority, U.P., October 2018), https://environmentclearance.nic.in/writereaddata/Online/EDS/16_Nov_2018_011356000K0QGEUW44404_New_Eoan_Associates_EIAReport.pdf.
15. Krishan Lal. Season Wise Fish Catch By Fisheries Co- Operative Society Berrianwala From Gobind Sagar Reservoir During Three Years. Uttar Pradesh Journal Of Zoology, 2022, 43 (13), Pp.46-50. {Hal-05143675}
16. Anchoring for floating solar panels | Genap Water Storage, <https://genap.com/products/anchoring-for-floating-solar-panels/>
17. Floating solar : technologies and methods for reliable anchoring? - Ciel & Terre, <https://ciel-et-terre.net/anchoring-technologies-methods-floating-solar/>
18. Flora And Fauna - Hamirpuronline, <http://hamirpuronline.blogspot.com/2015/04/flora-and-fauna.html>
19. Policy Uttar Pradesh New and Renewable Energy Development Agency, Uttar Pradesh Solar Energy Policy–2022 (2022), <https://upnedakusumc2.in/assets/Policy/Policy1.pdf>.
20. dvvnl , <https://www.dvvn.org/>
21. Morrison, Kathleen D. "Dharmic Projects, Imperial Reservoirs, and New Temples of India: An Historical Perspective on Dams in India." Conservation and Society 8, no. 3 (2010): 182–195. doi:10.4103/0972-4923.73807.