Technical Report:No.RSAC:SWRD:2024-25: 13 **For Official use only**

Feasibility Study for Floating Solar Plants on 35 Dams Based on Minimum Submergence Area

REMOTE SENSING APPLICATIONS CENTRE UTTAR PRADESH

(Department of Science & Technology, Govt. of U.P.)

SECTOR -G, JANKIPURAM, KURSI ROAD, LUCKNOW-226021

March, 2025

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Prepared By

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Preface

The transition to renewable energy is a cornerstone of India's strategy to achieve sustainable development. Solar energy, in particular, has seen expansive growth due to falling costs and abundant sunshine. However, traditional land-based solar farms face challenges in land acquisition, especially in densely populated or agriculturally important regions. In this context, **floating solar photovoltaic (FSPV)** projects have emerged as an innovative solution – placing solar panels on the surface of water bodies such as dams, reservoirs, and lakes.

This report is a **feasibility study** focusing on implementing floating solar installations on 35 specific dams across India. The impetus for this study comes from recent initiatives by state agencies and the central government to explore floating solar potential. In 2024, the Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA) identified 35 reservoirs in Uttar Pradesh suitable for floating solar plants

This study expands on that initiative by thoroughly analyzing each site's potential and challenges. It is intended as a definitive resource for policymakers, project developers, investors, and community stakeholders interested in sustainable energy development.

The **Preface** sets the stage by highlighting the significance of floating solar in India's energy landscape and the motivations behind this study. It also acknowledges the contributions of various data sources and experts: climate data from agencies like NASA and India Meteorological Department, reservoir information from state irrigation departments, and environmental insights from academic research on floating PV. The collaborative effort ensures that the study is grounded in **authoritative data and real-world experience**, making the findings reliable for decision-making.

(Shildhar Singh Yadav)
IAS

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The completion of this exhaustive feasibility study on floating solar power plant deployment across 35 dams in Uttar Pradesh owes profound gratitude to a multitude of distinguished entities and individuals whose unwavering support and sagacious guidance were indispensable to its fruition.

Foremost, we extend our profound appreciation to **Mr. Narendra Bhooshan**, Principal Secretary, Uttar Pradesh Power Department, whose magnanimous financial patronage catalyzed the realization of this pivotal research endeavor. Our deepest indebtedness is also directed towards **Mr. Shildhar Singh Yadav**, IAS who is also the Director of the Remote Sensing Applications Centre, Uttar Pradesh (RSAC-UP), whose perspicacious counsel and steadfast assistance were instrumental in meticulously shaping this comprehensive analysis.

We are profoundly beholden to **Mr Pandhari Yadav**, Principal Secretary of the Science and Technology Department, Government of Uttar Pradesh, and the Chairman of the Governing Body of RSAC-UP, whose perspicacity and indefatigable commitment to harnessing remote sensing and three-dimensional geospatial technologies have profoundly augmented strategic planning and the proliferation of green energy across the state.

A special acknowledgment is due to **Mr. Anupam Shukla**, IAS, Director of UPNEDA, whose instrumental role in facilitating and supporting this initiative has been invaluable. His visionary leadership and unwavering commitment to sustainable energy solutions have significantly contributed to the successful completion of this study and its potential impact on the state's renewable energy landscape.

Equally, we express our deep-felt appreciation to the administrative, financial, and auxiliary personnel of RSAC-UP, whose unwavering encouragement, and administrative acumen significantly facilitated the seamless execution of this study, culminating in the present report, "Feasibility Study for Floating Solar Plants on 35 Dams Based on Minimum Submergence Area."

Furthermore, we extend our sincerest gratitude to our esteemed colleagues and associates, whose steadfast moral and intellectual support have been a cornerstone of motivation throughout the course of this project. Their relentless enthusiasm and insightful discourse have been invaluable in surmounting the intricate challenges inherent to this ambitious undertaking.

With the deepest regard and highest appreciation,

(Dr. Sangharsh Rao)
Scientist-SD
Project Manager-LiDAR Mapping

REMOTE SENSING APPLICATIONS CENTRE, UTTAR PRADESH

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1.0 Introduction

1.1 Background and Significance of Floating Solar Projects

Floating solar projects involve mounting solar panels on pontoons that float on water surfaces. First deployed at scale in countries like Japan and China, floating PV has quickly gained traction worldwide as a viable alternative to land-based systems. The concept addresses two critical issues: the scarcity of land and the opportunity to improve solar panel performance through natural cooling by water. Panels operating over water can be 5–10% more efficient due to lower operating temperatures and higher albedo (reflection from water). Moreover, covering a portion of a reservoir can reduce evaporation, which is a significant benefit in water-scarce regions.

India's Renewable Energy Context: India has set ambitious targets for solar energy (100 GW of solar installed capacity, now aiming higher as part of a 500 GW renewable target by 2030). States like Uttar Pradesh, with high power demand and limited wastelands, are actively looking for innovative solar deployment models. Floating solar fits this need by utilizing existing man-made water bodies. The 35 dams in this study collectively have thousands of hectares of water surface area – tapping even a fraction of this for solar could contribute substantially to India's solar goals while preserving land for agriculture and habitat.

1.2. Relevance to Stakeholders

The study and proposal may be of importance that may include:

- **Government Agencies:** e.g., renewable energy departments, irrigation departments, environmental regulators. They can use this study to plan and approve projects that align with policy goals while safeguarding environmental and social interests.
- **Project Developers and Investors:** The report serves as a pre-feasibility atlas of opportunities, helping companies identify which sites might be most attractive for developing floating solar plants on a Build-Own-Operate basis. It highlights potential hurdles and suggests mitigation, de-risking early-stage decision making.
- **Local Communities and Leaders:** For those living near the dams, the study provides insight into what a floating solar project would entail and its anticipated impacts. This can inform public consultations and help address community concerns with factual information (for example, clarifying that fishing activities can continue and water quality will be monitored and protected).
- **Environmental Advocates and Researchers:** The comprehensive environmental analyses and references to case studies can be taken beforehand.

2.0 Objectives of the Feasibility Study

The primary objective is to **evaluate the feasibility** of implementing floating solar PV systems on the selected 35 dams, covering technical, economic, environmental, and social dimensions. Specific goals include:

- **Assessing Solar Potential:** Determine the solar energy generation potential at each site by analyzing solar irradiance (sunlight availability) and estimating how many megawatts of panels could be installed given the reservoir area and other use constraints.
- **Site-wise Analysis:** For each state, district, and individual dam site, document the relevant characteristics – geographic location (latitude/longitude), climate zone, reservoir size, existing usage (irrigation, hydropower, water supply), and proximity to grid infrastructure. This provides a foundation for understanding viability.
- **Socio-Economic Impact Evaluation:** Examine how floating solar installations might impact or benefit local communities and economies. This involves identifying the nearest town or population center for each dam, local employment rates, and any economic activities (fishing, agriculture, tourism) tied to the water body.
- **Demographic Study:** Profile the population in the vicinity of each dam (e.g., population density, rural/urban mix, energy consumption patterns). The aim is to see how the project can serve local energy needs and whether the community is dependent on the dam (for livelihoods like fishing or farming downstream).
- **Environmental Impact Analysis:** Investigate potential environmental effects on aquatic life, biodiversity, and water quality. Each site is checked for the presence of sensitive ecosystems (such as wildlife sanctuaries or unique species). The analysis weighs the positive environmental contributions (like emissions reduction and possibly improved water quality) against any negative impacts that need mitigation (like disturbance to fish or bird habitats).
- **Technical Feasibility & Risk Assessment:** Outline the technical requirements for each site, including the type of floating platform, anchoring systems, and integration with existing dam structures. Identify risks such as extreme weather events, and propose mitigation strategies. This includes ensuring that floating arrays won't interfere with dam operations (spillways, flood management) and vice versa.
- **Alternative Solutions:** If a particular site is found unsuitable for floating solar (due to environmental or technical reasons), suggest alternative renewable energy options for that area – e.g., ground-mounted solar in nearby non-arable lands, solar-canopy over canals, or wind/biomass if applicable. This ensures that the energy needs can still be met through other means if floating solar is not viable at a given site.

3.0 Methodology

A rigorous and transparent methodology was adopted to ensure that the feasibility assessment for each dam is **data-driven and objective**. This section outlines the steps taken, data sources used, and criteria applied in analyzing the floating solar potential and impacts for the 35 sites.

3.1 Data Collection

Geographic and Solar Resource Data: For each dam, the geographic coordinates (latitude and longitude) were obtained – primarily from official listings in the UPNEDA documentation and verified via satellite based maps and imageries that were necessary and form the basis of present study. Using these coordinates, the dam location was reached and water spread areas were studied for Last 10 years along with archival satellite images that freely available for research, solar irradiance data was gathered from climate databases. **Government and internationally recognized sources** for solar resource information was gathered:

- The **NASA Langley Research Center POWER dataset** and the **Global Solar Atlas** (by the World Bank/ESMAP) were used to retrieve annual and monthly average Global Horizontal Irradiance (GHI) for each location. These sources provide high-resolution solar radiation estimates based on satellite observations and meteorological models.
- As a cross-check, regional studies (e.g., a study on Bundelkhand solar potential) were referenced. For instance, Bundelkhand region in Uttar Pradesh/Madhya Pradesh has an estimated solar insolation of about 1825–2008 kWh/m²/year (~5.0–5.5 kWh/m²/day), which was consistent with the values obtained from global datasets for sites in that region.

Reservoir and Dam Specifications: Technical details about each dam and reservoir were compiled:

- **Reservoir area and storage capacity:** Wherever available, state irrigation department were used. This includes the full reservoir level (FRL) area, gross storage capacity, and primary purpose (irrigation, hydroelectric, drinking water, flood control).
- **Dam structure type and operations:** Information such as dam type (earthen, concrete gravity, etc.), height, and presence of hydroelectric power units was noted. This is relevant for understanding if there are existing power evacuation facilities (like a hydropower station switchyard) and any operational constraints (e.g., reservoirs with large water level fluctuations or those used for flood moderation might restrict solar coverage at certain times).
- Sources for this information included the India-WRIS (Water Resources Information System) database and state government water resource websites, as well as research papers for less documented dams. In cases where official data was sparse (especially for smaller reservoirs), satellite imagery was used to estimate surface area and deduce usage (for example, presence of canal networks indicating irrigation purposes).

Socio-Economic and Demographic Data: For the *nearest city or town* to each dam and the *district* in which the dam is located, data was collected on:

- Population and density (from the latest Census of India, 2011, with projections for 2021/2025 where available).
- Key economic activities of the district (from District Statistical Handbooks and economic surveys). This identifies if the area is predominantly agrarian, industrial, or mixed, which in turn influences energy demand patterns and the potential workforce for the project.
- Electrification levels and energy demand: We gathered data on the percentage of households electrified and any known power supply deficits from reports by the Central Electricity Authority (CEA) or state power utilities. This helped gauge the local benefit of additional generation. For example, if a district faces load-shedding, a floating solar plant feeding the grid could improve the situation.
- Any notable social or cultural factors: e.g., if the reservoir is used for tourism or if there are historical sites nearby that might be impacted or could benefit from improved infrastructure.

Environmental Data: Environmental impact assessment required:

- **Biodiversity information:** Presence of fish species in the reservoirs (many irrigation department documents list common fish fauna if fisheries are active) and any nearby protected areas. Data from the Wildlife Institute of India and state forest department maps were used to see if any dam lies within or adjacent to protected forests, bird sanctuaries, or other ecologically sensitive zones.
- **Water quality indicators:** Where possible, water quality reports (pH, dissolved oxygen, etc.) from agencies like the Central Pollution Control Board (CPCB) or academic studies were reviewed. Baseline water quality gives insight into whether adding floating structures might cause issues (like reduced oxygenation) or if the water is eutrophic (high in nutrients and prone to algae) where shading might actually help.
- **Existing environmental concerns:** For instance, if a reservoir has an invasive aquatic weed problem or heavy seasonal evaporation, those were noted, as a floating solar installation could positively impact these by reducing sunlight on water (controlling weeds) and providing shade (reducing evaporation).
- **Case studies and literature:** Various sources from internet were read.

3.2 Analysis Techniques

Solar Potential and Energy Yield Analysis: Using the solar GHI data, potential power output was estimated:

- **Capacity Estimation:** For each reservoir, a tentative solar PV capacity (in megawatts, MW) was estimated by assuming a certain percentage of the reservoir area can be covered with PV modules. Assuming a conservative coverage of 20–30% of water surface to balance energy generation with other uses and environmental factors (this percentage could be higher for very large reservoirs with minimal other usage, or lower for small ecologically sensitive lakes). The area needed per MW was taken as ~1.5 hectares (15,000 m^2) considering module efficiency and spacing – a typical density for floating solar given that water allows for tighter packing due to cooling.
- **Energy Yield:** The expected annual energy generation (in million kWh or MU) was calculated with the formula: E = C * GHI * PR, where C is the capacity (MW) installed, GHI is the annual irradiation (kWh/m^2), and PR is the performance ratio of the plant (dimensionless). Assuming a PR of around 0.75–0.80 (75–80% efficiency) to account for system losses. For instance, if a site can host 50 MW and has 5 $kWh/m^2/day$ (~1825 $kWh/m^2/yr$), the annual generation might be roughly 50,000 kW * 1825 kWh/m^2 * 0.78 ≈ 71 million kWh (this is a simplified illustration; actual calculations were done more precisely for each site).
- Seasonal variations were also considered—monsoon months have lower generation due to cloud cover, which is important for grid planning.

Socio-Economic Impact Assessment: Qualitative scoring was employed for socio-economic impact:

- Each site was rated on factors like: *proximity to load centers*, *job creation potential*, and *impact on local livelihoods*. For example, a dam near a large town could directly supply that town's industry and create skilled jobs, scoring high on socio-economic benefit. A remote dam in a tribal area might score moderate: providing local employment but needing infrastructure investment.

- Any negative socio-economic impacts was also reviewed. If a community heavily uses the reservoir for fishing or recreation; a large solar array could displace some of that activity. Through community profiling, dependencies were identified. Mitigation (like allocating specific zones for fishing separate from solar arrays) is then proposed.

Demographic Analysis: Mapping the population distribution around each reservoir:

- Using GIS, a 10-km radius around each dam was considered to estimate the local population that might be directly impacted. This helps in planning engagement – a densely populated vicinity implies more stakeholders to involve in consultations.
- The energy demand of the local area was correlated with the generation potential. If a remote rural area has low demand, the solar plant's power will mostly feed into the grid for use elsewhere. If an area has local demand (say there are nearby pump houses, small industries, or a town), it strengthens the case for local solar as it can stabilize the local voltage and reduce transmission losses.

Environmental Impact Analysis: A risk-benefit matrix was used:

- Potential impacts (both positive and negative) for each environmental aspect (water quality, fish, birds, etc.) were listed for every dam. For example:
  - Fishery impact: Panels reduce light penetration – could that affect phytoplankton and fish food chain? On the benefit side, floating platforms might act as FADs (Fish Aggregating Devices) providing shelter to fish.
  - Bird impact: Birds may lose open water area for landing – but they might also find perches on the solar frames. We checked if any of the reservoirs are known bird habitats (some reservoirs attract migratory birds). Such sites were flagged.
  - Water temperature and quality: Using literature, we assumed a slight cooling effect beneath the array and measured that against the baseline water temperatures known for the region.
- Each impact was rated as negligible, minor, or significant. In almost all cases, our findings aligned with existing studies that **impacts are minor and manageable**. For any potentially significant issue, a mitigation plan is proposed.

Technical Feasibility and Design Considerations: For each dam, following criteria was considered with assimptions and available information and verbal talks to the persons of the area:

Water level fluctuation: Dams have varying water levels between monsoon and dry seasons. The historical fluctuation (difference between full reservoir level and minimum drawdown level) were tried to be assessed. Floating systems can handle fluctuations by design (slack in anchors, flexible cables), but extreme fluctuations (>20 m) might limit how close to the shore panels can be installed. (e.g., Rihand has large fluctuations due to its role in hydropower and irrigation).

Anchoring and Mooring: Deep reservoirs require different anchoring (floating anchors or very long tether to bottom) compared to shallow ones. For each site, based on depth (from dam design data or contours). For example, shallow reservoir edges allow concrete dead-weight anchors; very deep reservoirs might use multiple anchoring points or bank anchoring.

Grid connectivity: Distance to the nearest substation or grid interconnection point was assessd. Many large dams have a power station or at least a transmission line nearby (especially those with hydropower or lift irrigation schemes). For each site, an estimate of transmission line length required to connect the solar plant was made. If a new line over tough terrain is needed, that adds to cost and was noted as a feasibility concern.

Synergy with Hydropower: Two of the identified dams (e.g., Obra, Rihand) have existing hydropower plants. The idea of hybrid operation was explored – solar by day, hydro by night – using the reservoir as an energy storage (pump or release water in tandem with solar output). While detailed hydro-solar hybrid optimization is beyond scope, the presence of hydropower was marked as a positive factor because it usually means infrastructure (like power evacuation) is in place and the site operators are already power-sector savvy.

Risk Assessment Method: A risk register listing is proposed for possible risks such as:

- Weather events (high wind, hailstorms, lightning strikes),
- Operational risks (electrical faults, fire on floating platform, etc.),
- Environmental risks (oil/chemical spill from maintenance activities polluting water),
- Social risks (protests, vandalism, theft of solar panels which has happened in some solar farms). Each risk was analyzed for likelihood and impact. For example, for a given site the historical wind speed data was asessed to see if cyclonic winds are a concern (coastal reservoirs would have high risk, inland UP reservoirs have lower wind risk but occasional thunderstorms). The impact of each was considered (e.g., a severe storm could damage panels – high impact, but maybe low likelihood in certain regions). Mitigation measures were then outlined:
    - Engineering measures (reinforced mounting for high wind zones, lightning arrestors, anti-theft surveillance systems),
    - Environmental measures (spill containment kits, using eco-friendly transformer oils – note that NTPC's floating solar used a biodegradable oil in transformers to prevent water contamination
    - Social measures (continuous community engagement, benefit-sharing programs to build local goodwill and thus reduce vandalism/theft risk).

Case Study Benchmarking: Throughout the analysis, **case studies of existing floating solar projects** were studied as benchmarks. Notably:

- *100 MW Ramagundam (Telangana)* – to compare design and performance data.
- *92 MW Kayamkulam (Kerala)* – to understand logistics of installation on a large reservoir.
- *50 MW at Rihand (UP)* – a proposed project that gave insights into PPA structure and expected tariffs in UP context.
- *2 MW Chandigarh* – a small project that demonstrated evaporation reduction benefits in an urban reservoir. These helped validate our assumptions (for instance, PR assumed, spacing

requirements, etc.) and provided real-world evidence for certain impacts (like Ramagundam's observation of reduced evaporation was documented as ~32,500 cubic meters of water saved per MW per year, which we used as a reference figure).

3.3 Assessment Criteria

The feasibility of each site was summarized after assessment of water level fluctuations thereafter least submergence area that remained over last decade was mapped in GIS that will be available whole year and most probably for next 25 years. Thus **other criteria are only discussed** and include:

- **Technical Viability (TV):** Does the site support installation from an engineering standpoint (sufficient area, manageable water conditions, grid access)? Rated High/Medium/Low.
- **Economic Viability (EV):** Preliminary economic sense – considering scale (bigger projects have economies of scale), distance to grid (affecting cost), and any expected hurdles that could raise costs. Also High/Medium/Low or a rough LCOE (levelized cost of energy) comparison among sites.
- **Social/Community Acceptance (SC):** Any foreseen resistance or major resettlement issues? (Floating solar generally has low social impact as it doesn't displace communities or land.) This was more about whether local communities rely on the water surface (for example, if there's intensive fishing, the layout must accommodate them).
- **Environmental Clearance Likelihood (EC):** Based on environmental sensitivity, how likely the project would get clearances smoothly. If a site is inside a sanctuary example Bakhira Tal in Sant Kabir Nagar is a Ramsar site where Floating Solar Power plant is proposed, clearance is more complex vs. a plain irrigation tank with no notable wildlife.
- **Capacity Priority (CP):** Ranking of site in terms of priority for development – e.g., "High Priority" for sites that tick all boxes (high solar, big benefit, low risk), versus "Long-term Potential" for sites that are feasible but perhaps smaller scale or requiring more study.

These criteria form a comparative matrix presented in the conclusion, guiding stakeholders on which sites to pursue first and which might need further investigation or alternative approaches.

3.4 Assumptions

- **Solar Panel Efficiency and Size:** Modern photovoltaic panels average about 20% efficiency. For example, a 400 W panel is roughly 2 m² in area (e.g. ~1.6 m × 1.0 m), corresponding to ~20% conversion efficiency. We have used 400 W as a typical panel rating for calculations.
- **Panel Spacing and Coverage:** Floating solar installations cannot cover 100% of the water surface – space is needed for maintenance access (boat lanes, floating walkways) and to reduce environmental impacts. In practice, floating arrays usually cover only 30–60% of a reservoir's surface. We assume an **area utilization factor** of about 60%, meaning roughly **2 acres of water surface per 1 MW** of solar capacity.This accounts for the spacing between panel arrays and open water corridors for operations. In other words, about **0.5 MW per acre** is a realistic power density for floating PV.

- **Number of Panels Estimate:** With ~0.5 MW per acre and ~400 W per panel, each acre can hold on the order of **1,250 panels** (since 0.5 MW / 0.0004 MW per panel ≈ 1250). This takes into account the packing density and maintenance gaps. We will use this ratio to estimate panel counts (rounded for simplicity). Actual layouts may use slightly more or fewer panels per acre depending on exact panel wattage and spacing.
- **Power Generation Capacity:** The **maximum potential capacity** is based on filling the feasible water area with floating panels under the above spacing assumptions. This is an installed **peak capacity (MW)**. (Floating panels often operate slightly cooler, gaining ~5–15% performance boost in real output, but we do not explicitly add that here – our focus is on peak MW capacity, not energy output.)
- **100 MW Lot Division:** For planning, large installations might be broken into 100 MW blocks (for ease of grid integration or phased development). We therefore express how many **100 MW plants** could fit on each reservoir's feasible area. For example, "3 x 100 MW" means the reservoir could host three 100 MW floating solar arrays (300 MW total) with some space remaining. If the capacity is less than 100 MW, we denote it as "<1" under the 100 MW lot column.
- **Panel Count and Output:** The number of panel scales with the capacity – e.g. a 100 MW floatovoltaic plant would require on the order of **250,000 panels** (100 MW / 0.4 kW per panel ≈ 250k). In all cases, the panels would generate power only during the day, so the actual energy output per year would depend on local sunshine (capacity factors, etc.), but peak power capacity is the metric used here for comparison.
- **400** Acre per 100 MW calculations have also been done as per discussions and a separate table has been prepared by reducing the potential of Floating Solar Plant to half as per our assumptions.

4.0 **Region wise Analysis**

In this section, the analysis is organized by geographic regions, primarily focusing on **Uttar Pradesh** since all 35 identified dams fall within or on the borders of this state

The Dam sites are dealt by their **districts or regional clusters** within Uttar Pradesh. This state-wise and district-wise categorization will help to understand regional patterns – for example, similarities in climate, socio-economic conditions, and grid infrastructure – that affect multiple sites in that area. It also highlights any state-specific regulatory or policy considerations.

(Note: While the phrase "across India" is used, all identified dams are under the purview of Uttar Pradesh's floating solar initiative. One site (Kalagarh) lies at the Uttar Pradesh–Uttarakhand border; it is included here because Uttar Pradesh Irrigation Department operates it, though geographically it's in Uttarakhand. Thus, we will treat all sites under the umbrella of Uttar Pradesh for analysis purposes, mentioning the other state where relevant.)

4.1 Bundelkhand Region (Southern Uttar Pradesh – districts of Jhansi, Lalitpur, Mahoba, Hamirpur)

Overview: Bundelkhand is a semi-arid region known for its seasonal water scarcity and socio-economic challenges. However, it boasts a high solar irradiance and has been a focus for solar energy development in U.P.

The identified dams here are primarily irrigation reservoirs built on tributaries of the Yamuna and Betwa rivers. They include:

- **Jhansi District:** Barwa Sagar (Barua Sagar Lake), Pahuj Dam, Parichha Dam, Saprar Dam, Dongri Dam, Garhmau Tank.
- **Lalitpur District:** Matatila Dam (on the Betwa, shared with Madhya Pradesh), Sajnam Dam, Shahzad Dam, Govind Sagar Dam, Jamini Dam, Arjun Dam, Bela Sagar.
- **Mahoba District:** Lahchura Dam, Chandrawal Dam, Kabrai Dam (listed as "Kabraidarn"), **Bela Sagar** (could also be on border of Lalitpur/Mahoba), Pahari Dam.
- **Hamirpur District:** Maudaha Dam (on River Birma/Arjun). *(Note: District assignments are based on dam location; some reservoirs span boundaries or have influences in multiple districts.)*

Climate and Solar Potential: This entire cluster receives strong sunlight year-round. Summers are hot and dry (peak GHI in April–May ~6–7 kWh/m²/day), monsoons bring moderate cloud cover (June–Aug still ~4–5 kWh/m²/day on average), and winters are sunny and mild (Nov–Feb ~4–5.5 kWh/m²/day). Thus, solar generation potential is high and well-distributed, with an estimated annual GHI ~1800–2000 kWh/m².

The region's solar resource is considered "good to excellent" for PV projects. The feasibility for floating solar is strongly supported by this climate profile.**(Table-1)**

Name of Reservoir/Dam	District	Latitude	Longitude	Feasible Area in Acre	Area in SqM
Barua Sagar	Jhansi	25.375287	78.748971	34.462	2621139.747
Barwar Lake	Jhansi	25.514684	79.1471	172.1518	9682209.507
Dhukwan Dam	Jhansi	25.185496	78.541496	522.8618	8300812.641
Dongri Dam	Jhansi	25.384451	78.459153	45.88108	2619038.188
Garhmau Lake	Jhansi	25.517306	78.670643	87.248	1649969.188
Pahari Dam	Jhansi	25.200754	79.281429	63.49587	2407784.394
Pahuj Dam	Jhansi	25.500383	78.534462	237.0161	4833570.131
Parichha Dam	Jhansi	25.513306	78.780749	1542.637	10714938.89
Pathrai Dam	Jhansi	25.423457	79.026405	29.39896	914906.1237
Saprar Dam	Jhansi	25.209232	79.096985	20.05495	8521363.673
Govind Sagar Dam	Lalitpur	24.671634	78.41861	1341.626	16920051.13
Jamini Dam	Lalitpur	24.363015	78.683511	819.7934	10448720.72
Matatia Dam	Lalitpur	25.094361	78.364001	10370.26	72627577.69
Rajghat Dam	Lalitpur	24.751524	78.235808	11839.2	169026741.7
Sajnam Dam	Lalitpur	24.523228	78.591601	477.4647	20400650.97
Shahzad Dam	Lalitpur	24.94395	78.520807	1142.603	7864143.137
Arjun Dam	Mahoba	25.384586	79.669171	334.8658	7536824.71
Bela Sagar	Mahoba	25.265658	79.584136	7.418057	4973906.318
Chandrawal Dam	Mahoba	25.439832	79.894978	18.01235	4512028.188
Kabrai Dam	Mahoba	25.407973	79.969911	14.11286	2284623.806

Socio-Economic Profile: Bundelkhand's economy is largely agrarian with pockets of industrial activity (e.g., stone quarries in Kabrai, some manufacturing in Jhansi). The region has historically lagged in development, so investments in infrastructure are always welcomed.

Key points:

- **Population Centers:** Jhansi city (~500k population) is the largest urban area, close to Barwa Sagar, Pahuj, and Parichha dams. Lalitpur town and Mahoba town are smaller district HQs (each ~100k population). Many of the dam sites themselves are in rural areas with villages and small towns (e.g., Barua Sagar town ~20k population by the lake).
- **Electricity Demand:** Jhansi has significant demand with many irrigation pumps and growing residential/commercial use; it is connected to the state grid. Lalitpur/Mahoba/Hamirpur have more rural demand, often facing power cuts historically. Floating solar plants here could improve supply – for instance, Parichha Dam already has a thermal power station nearby, indicating a grid node that can handle additional solar input.
- **Employment:** Construction of solar plants in this area could create jobs for local youth, many of whom currently migrate to cities for work. During the construction phase of a hypothetical 50 MW project, ~200-300 jobs (skilled + unskilled) might be generated, and ~20 permanent operations jobs thereafter. This is significant for small communities.
- **Local Economies:** Irrigation provided by these dams is the lifeline for agriculture. Floating solar will not alter irrigation releases. In fact, reduced evaporation due to panel cover could make more water available for crops in dry seasons, indirectly benefiting farmers. Tourism is minor (Barua Sagar has some historical fort ruins that attract visitors; Matatila has a picnic spot). The visual impact of solar panels will be noticeable but can be managed by designating certain sections of the lake for recreation and others for solar.

Demographics and Community Dependence: The population density in these districts ranges from about 150 to 300 people per sq. km (lower than U.P. average, reflecting the semi-arid rural nature). Communities near the reservoirs often engage in:

- **Fishing:** Many of these reservoirs support small-scale fisheries. For example, Lahchura and Sajnam dams are known to have local fishermen cooperatives. Floating solar might cover some open water, but fishermen can fish around and even under array edges where fish congregate. The project design should involve them – possibly offering maintenance jobs or fee-for-use if any part of reservoir use is affected.
- **Water usage:** Aside from irrigation, reservoirs supply drinking water (Matatila supplies Jhansi city in part). Ensuring water quality remains crucial. Our environmental analysis (next section) covers how floating solar might affect water (generally neutral or positive by reducing algal growth, as long as we prevent any pollution from construction).

Environmental Considerations: Bundelkhand reservoirs are not known for critical wildlife habitats compared to forested regions elsewhere. They are man-made lakes in fairly open, scrubby terrain. Still:

- **Aquatic life:** Common fish like rohu, catla, and carp are present (often stocked for fisheries). The habitat is already controlled (not natural rivers), so introducing floating structures should be manageable. Enough open water must remain for sunlight to sustain plankton in parts of the lake.

- **Wildlife:** These sites are not in tiger reserves or such. Birdlife includes typical freshwater birds (ducks, herons). During winter migratory season, some water bodies might host migratory birds. It's worth noting if any of these lakes are designated as Important Bird Areas (none formally, but local birdwatchers may visit). Mitigation like leaving certain areas free of panels or using bird-friendly spacing (gaps between panel blocks) can address this.
- **Droughts and Water Levels:** Bundelkhand faces drought cycles. Reservoir levels can drop considerably in summer. Floating solar platforms will descend with water levels, but accessibility (for maintenance) might become an issue if the shoreline recedes far. Designs may need floating walkways or flexible anchoring that can adjust to widely varying depths.

Infrastructure and Grid: Many of these dams have existing power lines for pump houses or nearby towns:

- Parichha Dam is unique as it has a coal power plant adjacent (Parichha Thermal Power Station, 1140 MW). Grid connectivity here is excellent – a floating solar farm could likely tie into the same switchyard.
- Matatila Dam has a small hydropower station (10 MW). It and Rajghat (shared with MP) connect to the grid; capacity exists to carry additional power, though upgrades might be needed for large solar injection.
- For more remote small dams (Garhmau, Saprar, etc.), new transmission lines (33 kV or 132 kV) might be required to hook up to the nearest substation in towns like Lalitpur or Mahoba. This adds cost but is feasible over the distances involved (often <30 km).

Alternative Energy Options: If a particular reservoir faced an obstacle (say local opposition or too small to justify a separate project), the Bundelkhand region also has:

- Plenty of sun-exposed rocky land where ground solar could be placed (though land acquisition would be an issue to solve).
- Some potential for wind in highland areas (but wind resource in U.P. is generally poor).
- Biomass from crop residues is an option for small power plants, but that doesn't exploit the solar potential which is clearly abundant here. In general, floating solar is actually considered one of the best uses of resources for Bundelkhand given water bodies are available and land and water are otherwise in short supply.

Summary for Bundelkhand: This region stands out as a **high-priority area** for floating solar. The combination of high solar irradiance, numerous medium-sized reservoirs, and the need for local development make it attractive. District administrations in Jhansi, Lalitpur, etc., have shown interest in solar parks in recent years, and floating solar would complement those efforts. The analysis suggests that, aside from site-specific fine-tuning, there are no major impediments. Strong sunlight and under-utilized water surface area present a win-win for energy generation and water conservation (important in drought-prone Bundelkhand).

4.2 Eastern Uttar Pradesh (Chandauli,Chitrakoot, Mirzapur & Sonbhadra districts)

Overview: The eastern part of U.P. included in the study covers Chitrkoot, **Mirzapur and Sonbhadra** districts. This region is distinct – it's hilly and forested in parts, with a number of dams built for thermal power plant cooling and irrigation. The identified dams here are:

- **Chandauli:** Moosakhand Dam, Latif Shah Dam.
- **Chitrakoot:** Gunta Dam.
- **Mirzapur District:** Adwa Dam, Dhandhraul Dam (likely the "Dhadraul" listed), **Sonbhadra District:** Rihand Dam (Govind Ballabh Pant Sagar, a massive reservoir), Obra Dam, Kanhar Dam, Upper Khajuri Dam, Sonbhadra is often dubbed the "Energy Capital of India" due to numerous coal plants and mines. Adding solar here could offset some coal use and utilize existing transmission infrastructure.

Climate and Solar Potential: The climate here is tropical with good sunshine. Sonbhadra and Mirzapur have slightly higher rainfall than Bundelkhand but still plenty of sunny days (~280+ clear days per year). GHI is comparable (~5.0 kWh/m²/day annual average). One distinction is the winter fog in the Ganga valley can affect sun in some mornings, but these reservoirs (especially Sonbhadra's) are a bit south of the river plains, so fog impact is minor. Overall, solar potential is rated as high. Large reservoirs like Rihand, free of shade and with open exposure, receive full sun across their surface. **(Table-2)**

S No	Name of Reservoir/Dam	District	Latitude	Longitude	Feasible Area in Acre	Area in SqM
1	Latif Shah Dam	Chandauli	25.022242	83.231156	12.8592	924273.8536
2	Moosakhand Dam	Chandauli	24.971062	83.281823	191.1754	10961586.28
3	Barwa Dam	Chitrakoot	25.18098	80.793099	154.9153	1483163.897
4	Gunta Dam	Chitrakoot	25.219929	81.144125	89.35866	3931957.823
5	Ohan Dam	Chitrakoot	25.13362	81.032388	20.28292	1588413.493
6	Lahchura Dam	Hamirpur	25.3174	79.275662	303.818	1906893.758
7	Mahjagwan Dam	Hamirpur	25.189893	79.548744	25.51493	4837550.369
8	Maudaha Dam	Hamirpur	25.568801	79.712968	988.9922	11999480.21
9	Adwa Dam	Mirzapur	24.775901	82.303672	555.4677	4996560.706
10	Upper Khajuri Dam	Mirzapur	24.993764	82.607422	163.7348	1436230.523
11	Dhadraul Dam	Sonbhadra	24.613481	83.177772	504.2032	9204882.193
12	Kanhar Dam	Sonbhadra	24.118727	83.296366	-	800501.1306
13	Obra Dam	Sonbhadra	24.435374	82.963428	2233.893	10937017.24
14	Rihand Dam	Sonbhadra	24.137039	82.878728	64767.86	303214410.8
17	Kalagarh Dam	Pauri Garhwal	29.523233	78.756405	5074.749	52798402.63

Socio-Economic Profile:

- **Sonbhadra** is a power generation hub (coal plants, one large hydro at Rihand, and some industries like cement). Despite that, many rural areas in Sonbhadra (which has significant tribal population) remain underdeveloped. Electricity from local plants mostly fed into the grid for distant demand; villages still have patchy supply. Floating solar here could dedicate some clean power to local needs.

- **Mirzapur** has mixed agriculture and some industries (carpets, mining). It also has the Vindhyachal thermal power complex next door (in Sonbhadra). Mirzapur town is a medium city (~250k population).
- **Population Centers:** In Sonbhadra, towns like Renukoot, Obra, Anpara grew around power projects. Renukoot (near Rihand Dam) has Hindalco industries. Obra has a thermal plant. These mean a skilled workforce is present and grid connectivity is robust. Many of these dams are actually within a few kilometers of large power stations (e.g., Rihand Dam is used by Rihand Super Thermal Power Station and Vindyachal; Obra dam by Obra TPS; Kanhar is an upcoming project).
- **Employment & Economy:** The region's economy could benefit from diversification into renewable energy. It may also provide *jobs to local communities*, including tribal communities, beyond mining and thermal plant work. The floating solar projects can tie in with corporate social responsibility by the power companies (NTPC, UPRVUNL, etc. which operate here) – e.g., training locals in solar maintenance skills.
- **Energy Use:** Given that Sonbhadra already produces surplus power (coal-based) but Solar initiative have several reasons-
    - To replace some of the aging coal capacity and reduce pollution (Sonbhadra has environmental issues due to mining and coal plants).
    - To use the existing transmission evacuation facilities – a big advantage. For instance, the Rihand reservoir could host hundreds of MW of solar which can feed into the national grid using the same high-voltage lines from the thermal plant, smoothing the solar output with the thermal/hydro.
    - Local villages would benefit from any dedicated portion of solar or simply from the improved grid stability.

Demographics: Sonbhadra has lower population density (~270 per sq.km) with many rural tribal communities (Kharia, Chero, etc.). Mirzapur is more populated (~420 per sq.km).

- Many people depend on forest and land – not directly on reservoirs except for fishing in Rihand and irrigation downstream.
- Rihand reservoir led to displacement when built (in the 1960s) and created a large water body. Now communities around have adapted, some practice fishing. The introduction of solar must be sensitive to any remaining grievances or usage rights on the reservoir (for instance, fishing cooperatives should be consulted and possibly compensated or included in the project's benefits).

Environmental Considerations:

- **Rihand Dam (Govind Ballabh Pant Sagar):** This is one of India's largest artificial lakes (~450 sq.km). It's not in a protected area, but it's so large it forms its own micro-ecosystem. It has sizable fish population and supports commercial fishing. Covering even 5–10% of it with solar would be huge in absolute area, so careful phasing is needed. There is enough space to leave plenty of open water. Being so large, environmental impact of partial coverage is expected to be negligible on overall ecology – fish can simply move to other parts. However, it's important to avoid critical breeding areas (if known) or migratory bird hotspots (though Rihand is not a famous birding site).

- **Kanhar Dam:** On the Kanhar River, border of U.P., Chhattisgarh, Jharkhand. Environmental concern here was forest submergence and tribal displacement. A floating solar plant on Kanhar's reservoir (once filled) could face scrutiny due to those sensitivities. It's surrounded by forested hills, potentially habitat for wildlife. Before implementing solar, a wildlife study would be needed to ensure, say, that panels don't impede elephant movement if elephants use the reservoir (unlikely but due diligence needed).
- **Small dams (Adwa, Khajuri, etc.):** These are relatively minor and likely used for irrigation. They might be in or near forest tracts. Ensure that no critical wildlife corridor is being obstructed (floating solar usually isn't an obstruction except to maybe waterfowl).
- **Pollution:** Sonbhadra's water bodies have had issues like fly ash contamination from power plants. Floating solar would not add pollutants (if properly managed), and might even shade out some of the algae that bloom from effluent nutrients. But care must be taken during installation to not stir up submerged toxic sediments.
- **Water level:** Rihand's water is used for hydro and for cooling, but generally it maintains a fairly stable level year-round with some drawdown in summer. Obra and others have smaller fluctuations. Still, design should account for possibly large monsoon inflows (in 2019 heavy rains caused Rihand to flood beyond normal, a rare event). Mooring must withstand such events.

Infrastructure and Grid: This region is power-grid heavy:

- Rihand/Vindhyachal: multiple 400 kV & 765 kV lines originate here. This means even gigawatt-scale solar could be evacuated if coordinated with the grid operator.
- Obra/Anpara: also have 132/220 kV networks.
- For smaller dam sites, there are at least 33 kV lines serving pump houses.
- So electrical infrastructure is largely in place, making project execution easier and cheaper in terms of grid connection.

State Policies: Uttar Pradesh would handle these as part of its solar plan. Additionally, being near state borders (MP, Chhattisgarh, Bihar), inter-state coordination might be needed for Kanhar (since it involves multiple states' water), but for power generation, the host state (UP) would take the lead. No major policy hurdle is seen as the state is pro-renewables, and having floating solar in Sonbhadra fits the narrative of transitioning an energy hub from brown to green.

Summary for Eastern UP: The Mirzapur-Sonbhadra cluster is **technically very promising** due to large water surfaces and grid availability. The socio-environmental aspect requires engagement with local communities (some of whom are vulnerable tribal groups) and ensuring new projects are seen as beneficial (perhaps supplying some free or low-cost power locally, or creating community funds from revenue). If done right, floating solar here could leverage existing energy infrastructure to deliver a large chunk of clean energy. One could envision Rihand reservoir eventually hosting one of the world's largest floating solar parks (in fact, there was a proposal of 150 MW and even up to 1 GW at Rihand by SECI earlier. This study's analysis supports that vision, finding no fundamental impediments, only the need for careful planning.

4.3 Western Uttar Pradesh (Kalagarh in Bijnor/Uttarakhand)

Only one Dam site falls in the western part of this project list: **Kalagarh Dam**, also known as Ramganga Dam. It is geographically located in Pauri Garhwal district of Uttarakhand, but is operated by Uttar Pradesh's irrigation department for water supply to the Ganges canal system. We include it because it was listed among U.P.'s 35 identified sites. Kalagarh is a large reservoir in the foothills of the Himalayas, adjacent to Jim Corbett National Park.

Climate and Solar Potential: This region has a slightly different climate – more moderate temperatures and a bit more humidity due to proximity to hills and forests. Nonetheless, it has a good solar profile for most of the year. Winters are cooler (which is actually good for PV efficiency) and summers are sunny. Being further north (~29.5°N latitude), the GHI might be slightly lower on an annual basis (~1700–1800 kWh/m²/year), but still quite viable. The presence of occasional fog or mist from forests in early mornings might marginally reduce solar output compared to Bundelkhand, but not significantly. Overall, Kalagarh has solid solar potential, comparable to other parts of North India like Delhi or Western U.P., which have thriving solar plants**.(Table-3)**

S No	Name of Reservoir/Dam	District	Latitude	Longitude	Feasible Area in Acre	Area in SqM
1	Kalagarh Dam	Pauri Garhwal	29.523233	78.756405	5074.749	52798402.63

Socio-Economic Profile:

- **Local Population:** The dam is in a sparsely populated forest area. Nearest towns are Kalagarh (a small town) and Ramnagar (a tourist town in Uttarakhand, ~25 km away). Bijnor district's villages benefit from irrigation via Kalagarh's water but are not on the reservoir edge.
- **Economic Activities:** The big "business" around is wildlife tourism (Corbett Tiger Reserve). The reservoir itself is sometimes used for safaris (boat rides) and fishing by local communities (with restrictions, as part is inside a protected area). There's also an upstream influence of the reservoir on local agriculture downstream.
- **Electricity:** The region is fairly well electrified; Bijnor and surrounding have grid power mainly from thermal/hydro elsewhere. A floating solar plant here would feed into UP's grid (there is a hydro power station at Kalagarh, 198 MW, but currently defunct/underutilized). Reviving that station or using its grid connection for solar could be beneficial. It could also supply local demand in the Bijnor-Moradabad belt.

Demographics: Low population density at the site (since it lies in forest area). The main affected people would be:

- Some forest villages (with special rights) and fringe communities who fish or collect forest products.
- The staff of the dam and forest departments. Given the delicate human-wildlife balance here, any project must incorporate community input and park authorities' guidance.

Environmental Considerations: This is the most environmentally sensitive site of all 35:

- **Wildlife:** Kalagarh reservoir is partly within the Corbett Tiger Reserve buffer zone. It is habitat for crocodiles, gharials (released in Ramganga river), elephants (which come to drink), and a huge variety of birds. It's essentially a biodiversity-rich area.
- **Impacts:** Placing floating solar panels could disturb this natural setting. Potential issues:
  - Restricting animal access to water if large areas are fenced off (especially for elephants that might swim or cross).
  - Affecting birdlife – the reservoir is known for waterfowl and migratory birds in winter. Large reflective solar arrays could disorient birds or reduce space for them.
  - Aesthetic impact on a national park landscape (though the core tourist areas are a bit away, but still).
- **Mitigation:** To consider floating solar here, one might:
  - Limit the project to a portion of the lake that is outside core wildlife use zones (perhaps the dam-end of the reservoir near human settlements).
  - Use wildlife-friendly design: for example, leave corridors of open water, avoid bright lighting at night (which could disturb animals), and ensure no hazardous materials.
  - Work closely with the Uttarakhand Forest Department to conduct an Environmental Impact Assessment (EIA) specific to this site. It might require clearance from the National Board for Wildlife given proximity to a Tiger Reserve.
- **Benefit:** On the flip side, if done carefully, a floating solar plant here could be a showcase of balancing development and conservation. It might also reduce the reservoir's evaporation, potentially leaving more water for ecological flows in dry season.

Infrastructure and Grid: Kalagarh dam had a hydroelectric component (Ramganga Hydro Power Station) with transmission lines. If those are still in place, they can be repurposed for solar evacuation. If not, new lines will have to be drawn, likely through forest areas – another environmental challenge. Perhaps a moderately sized project (like 20–30 MW) could tie into the existing small grid lines serving the dam colony and nearby towns, with upgrades. As this is inter-state (dam in Uttarakhand, serving U.P.), coordination between Uttarakhand (for permissions, forest clearance) and U.P. (for execution and grid) is needed.

State Policy Consideration: Uttarakhand might have a say in such a project because of the location. They too have interest in solar but also in conserving Corbett. A joint approach or compensatory measures (like funding conservation programs) might be necessary to get a green signal. Since UPNEDA listed it, presumably preliminary talks indicated it's feasible to consider, but detailed studies would be mandatory.

Alternative Option: If floating solar is deemed too risky for Kalagarh due to wildlife, an alternative is building solar plants on canal tops or nearby non-forest land that benefit from Kalagarh's water infrastructure (like the canals emanating from it have long stretches where solar panels could be installed on top without land acquisition, generating power close to where water flows). Another alternative: smaller discrete floating platforms instead of one large contiguous farm, to minimize disturbance – maybe a series of 1–2 MW clusters spread out.

Summary for Western U.P. (Kalagarh): This site has high solar potential and existing infrastructure, but *environmental sensitivity is the overriding factor*. The feasibility is conditional: technically yes, but requires thorough ecological assessment and likely a smaller scale deployment with heavy mitigation measures. In the state-wise context, this is a unique case where ecological costs might outweigh energy benefits unless carefully balanced. The study suggests treating Kalagarh as a special case – possibly phase it later after demonstrating success and benign impact in less sensitive sites, and only proceed with consensus of environmental stakeholders.

State-wise Summary: All identified sites are in Uttar Pradesh's jurisdiction (with one on the UP-Uttarakhand border and 3 bordering Madhya Pradesh). Regionally:

- **Bundelkhand (Jhansi/Lalitpur/Mahoba/Hamirpur)** – high solar, high need, moderate environmental sensitivity, good feasibility.
- **Eastern UP (Chandauli/Chitrakoot/Mirzapur/Sonbhadra)** – high solar, existing power infrastructure, moderate need (but beneficial for transition), some environmental considerations manageable, good feasibility.
- **Western UP (Kalagarh)** – high solar, low local need but could serve grid, high environmental sensitivity, feasible only with mitigation.

This regional view guides where emphasis should be placed. Bundelkhand and Eastern UP projects could be rolled out in the near term. Kalagarh requires further study.

5.0 **District-wise Feasibility Analysis**

5.1 Sonbhadra District (Uttar Pradesh)

Dams under Consideration: *Rihand Dam (Govind Ballabh Pant Sagar), Obra Dam, Dhadraul Dam*. Sonbhadra district in southeastern Uttar Pradesh is home to some of India's largest reservoirs and significant power infrastructure (including thermal plants and an existing hydro station at Obra). **(Table-4)**

S No	Name of Reservoir/Dam	Latitude	Longitude	Feasible Area in Acre	Area in SqM
1	Dhadraul Dam	24.613481	83.177772	504.2032	9204882.193
2	Kanhar Dam*	24.118727	83.296366	<Null>	800501.1306
3	Obra Dam	24.435374	82.963428	2233.893	10937017.24
4	Rihand Dam	24.137039	82.878728	64767.86	303214410.8
*Kanhar Dam is under construction					

Technical Feasibility: Sonbhadra offers an enormous solar opportunity, chiefly due to the **Rihand Dam's** vast reservoir. Rihand's reservoir (Govind Ballabh Pant Sagar) covers about **466 km²** (46,620 ha) at full level. The dataset indicates roughly **2,146 ha** of this could be utilized for floating solar installations, yielding an estimated **~65 MW** of solar capacity and **~262 GWh** of annual generation. This is a sizable output – for perspective, 262 GWh could meet the yearly electricity needs of tens of thousands of households. **Obra Dam**, on the Rihand River downstream of Rihand reservoir, is much smaller (≈18 km² area). It has a feasible solar area on the order of only ~83 ha, translating to a few megawatts of potential. **Dhadraul Dam** is another medium reservoir (≈30 km²) with ~140 ha feasible for solar, yielding perhaps 5–10 MW. Technically, floating solar is feasible on these reservoirs given their generally calm waters. Rihand's sheer size and its existing role in cooling and water supply make it an ideal candidate – a portion of its surface can host solar panels without impeding its primary functions. The solar arrays would be anchored to maintain position despite water level fluctuations. Engineering-wise, the key challenges will be managing the large drawdown range of Rihand (water level variation) and designing anchors for potentially deep water near the dam. However, successful deployments on similarly large reservoirs (e.g., the ongoing 150 MW floating solar project at Omkareshwar Dam in MP) indicate the concept is viable. Wind power potential in Sonbhadra is considered low; the district is hilly (Vindhya ranges) but not known for strong wind corridors. Any wind turbines would likely be small and mainly experimental. Thus, the primary technical focus is solar PV, which can be readily integrated at these sites. An additional opportunity is **pumped hydro storage**: Rihand's reservoir could be part of a pumped storage scheme using a secondary reservoir at a higher elevation. While not in the current dataset, if implemented, it could store solar energy by pumping water uphill during the day and generating hydro power at peak times.

Hybrid Renewable Potential: Sonbhadra's dams allow a classic solar-hydro hybrid model. Notably, **Obra** already has a hydroelectric power station (99 MW) downstream of Rihand. By adding floating solar to Rihand reservoir, **hydro and solar generation can be coordinated**. During sunny days, solar will meet a chunk of the supply, allowing the hydro plant (and local thermal plants) to conserve water or fuel. During evenings or cloudy periods, the dam can release water for hydroelectricity to compensate for the dip in solar – effectively balancing the two sources .This complementary operation can smooth out the daily cycle of power output. Additionally, if grid connectivity is robust, excess solar at midday can pump water into upstream ponds (if created), establishing a mini pumped-storage that returns power after dark. Wind integration in Sonbhadra would likely be minimal; however, **solar + thermal + hydro** is an interesting mix here since Renukoot/Rihand area has big coal-fired plants. Using solar during the day could allow some coal units to back down, reducing emissions, while the inertia and control of thermal and hydro ensure stability. In summary, the hybrid potential in Sonbhadra is high primarily for **solar-hydro synergy** – making the district a candidate for a balanced renewable energy hub.

Socio-Economic & Environmental Impacts:

Local Communities: Rihand Dam's reservoir led to significant displacement during its creation in the 1960s; today the area around it has communities engaged in fishing, industry (Renukoot hosts aluminum smelters), and power sector jobs. Introducing floating solar will create **new employment opportunities** during installation and maintenance (e.g. barge operators, technicians), which could be offered preferentially to local residents. The impact on fishermen should be manageable if solar arrays are deployed in a portion of the lake – fishing zones can be designated away from panel arrays. In fact, the **floating platforms can act as artificial reefs**, providing shade and shelter that could benefit fish populations, thereby supporting fisheries in the long run. Care must be taken to allow boat navigation and not fence off too much of the lake.

Wildlife: The Rihand reservoir borders the **Kaimoor Wildlife Sanctuary** in parts; however, using only a small percentage of the water surface (<<10%) for solar should avoid significant habitat disruption for birds or aquatic fauna. Studies have noted that moderate coverage can **reduce algal blooms** by limiting sunlight in water, improving water quality for aquatic life. This could benefit Sonbhadra's reservoir which sometimes faces eutrophication in stagnant coves. On the other hand, large-scale surface coverage could affect oxygen levels in water; thus environmental monitoring (water temperature, oxygen content) would be necessary. *Demographics:* The region has a mix of industrial and rural populations. Reliable power from the project could bolster local villages (reducing outages) and support the energy-intensive industries (like Hindalco) in Renukoot, potentially stabilizing employment there. The project could also spur related infrastructure (roads, training centers) that benefit communities. Given Sonbhadra's history of coal mining and power generation, a solar initiative signals diversification of the local economy towards cleaner sources, aligning with broader sustainable development goals.

Impact on Nearest Major City: Sonbhadra's generation typically feeds into the UP state grid and also the northern regional grid. The nearest major urban centers include **Varanasi (approx 150 km)** and **Prayagraj (Allahabad)**, as well as the industrial towns in Sonbhadra itself (Renukoot, Anpara). Power from Rihand floating solar can be transmitted via the existing Rihand–Varanasi high-voltage lines. This will help **meet daytime peak demand in Varanasi** – a rapidly growing city – with clean energy. Given that Varanasi is a tourist and cultural hub, improving its power supply reliability (and reducing reliance on diesel generators during peak tourist seasons) is a positive outcome. The distribution feasibility is high since the region already has substantial power infrastructure due to thermal plants. Minor upgrades like additional transformers at Rihand switchyard might be needed to handle solar injection. Also, the solar power could directly supply the Renukoot industrial cluster, reducing the load on long-distance transmission. Overall, integrating Sonbhadra's solar output into the grid is technically straightforward, and it will strengthen supply to eastern UP's cities.

Recommendations:

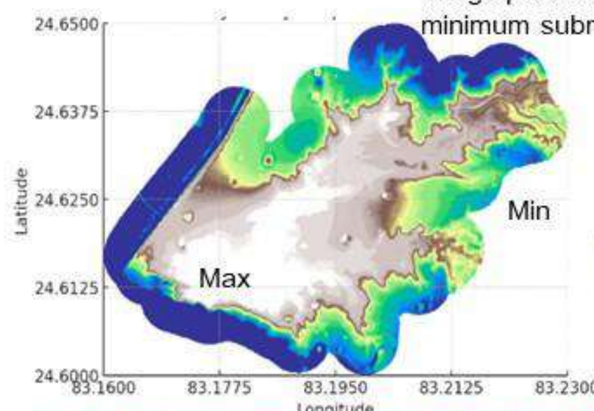
For Sonbhadra, the **optimal strategy is to focus on Rihand Dam's floating solar potential** as a flagship project. Starting with a pilot (say 50 MW on a portion of the reservoir) would allow assessment of anchoring designs and ecological impact. Phasing the deployment in tranches can ensure lessons learned are applied. It is recommended to coordinate operations of the **Obra hydropower station with the new solar plant** – possibly through a unified control center – to maximize complementary generation. If feasible, explore a **pumped-storage coupling** between Rihand and a nearby higher elevation reservoir to store excess solar (this could dramatically increase the effective utilization of solar). Community engagement is crucial: involve local fishermen cooperatives in planning, perhaps by **designating fish-attracting structures** on solar float modules to enhance fish catch, creating a win-win situation.

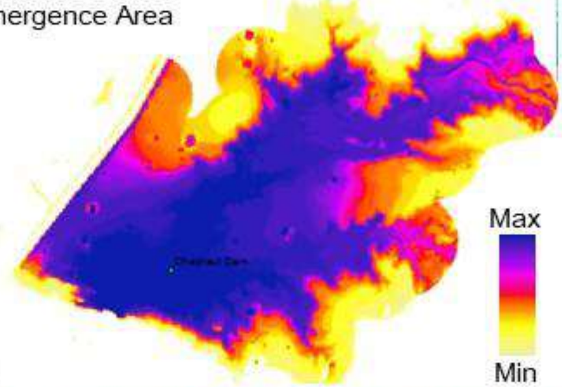
Environmental safeguards should include a baseline limnological study of the reservoir and continuous monitoring once panels are installed, to quickly detect and mitigate any adverse trends (e.g., adjusting array layout to allow sufficient sunlight/oxygen in water if needed). Given the haze in Sonbhadra (sometimes from industry, as seen in the image of Rihand Dam's backdrop), cleaning of panels and anti-soiling coatings will be important to maintain efficiency. Finally, close coordination with the state load dispatch center will be needed to ensure smooth absorption of the solar output into the grid, possibly implementing advanced inverters or storage to handle the evening ramp. With these measures, Sonbhadra can optimally utilize its dam surfaces for sustainable power generation.

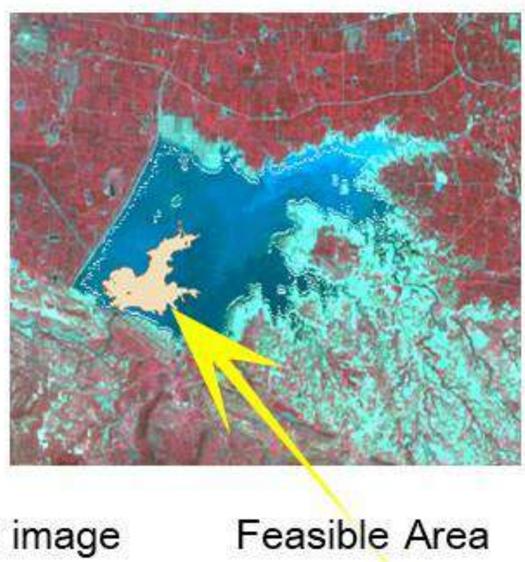
Dhandhraul Dam

Google Earth Image of the Study Area

Image processing of 10 years satellite data for delineating minimum submergence Area



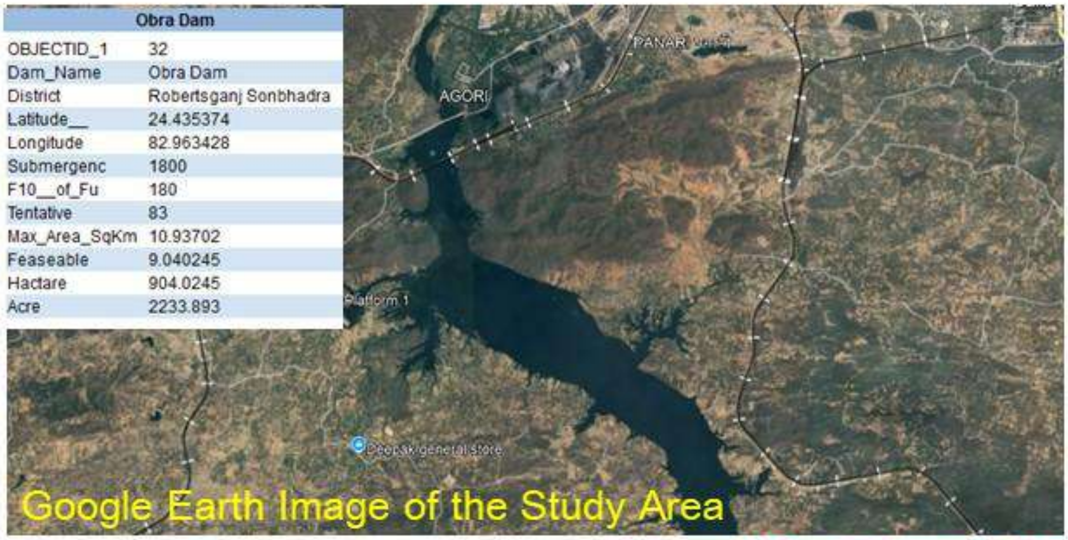




False Colour Composite of LISS 3 image

Feasible Area

Obra Dam



Obra Dam	
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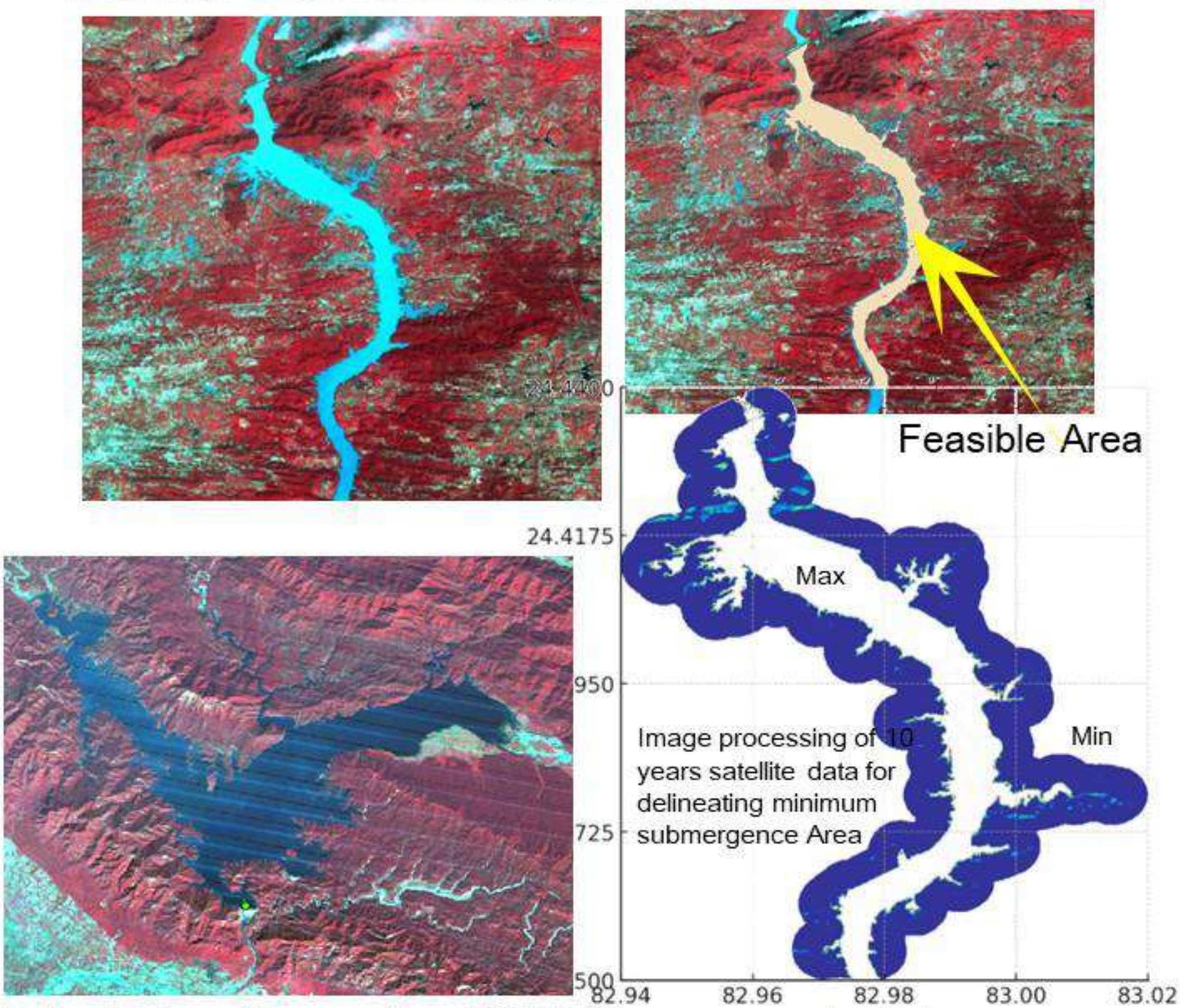
District	Robertsganj Sonbhadra
Latitude__	24.435374
Longitude	82.963428
Submergenc	1800
F10__of_Fu	180
Tentative	83
Max_Area_SqKm	10.93702
Feaseable	9.040245
Hactare	904.0245
Acre	2233.893



False Colour Composite of LISS 3 image

Rihand Dam

Rihand Dam	
OBJECTID_1	31
Dam_Name	Rihand Dam
District	Renukoot Sonbhadra
Latitude__	24.137039
Longitude	82.878728
Submergenc	46620
F10__of_Fu	4662
Tentative	2146
Max_Area_SqKm	303.2144
Feaseable	262.1062
Hactare	26210.62
Acre	64767.86

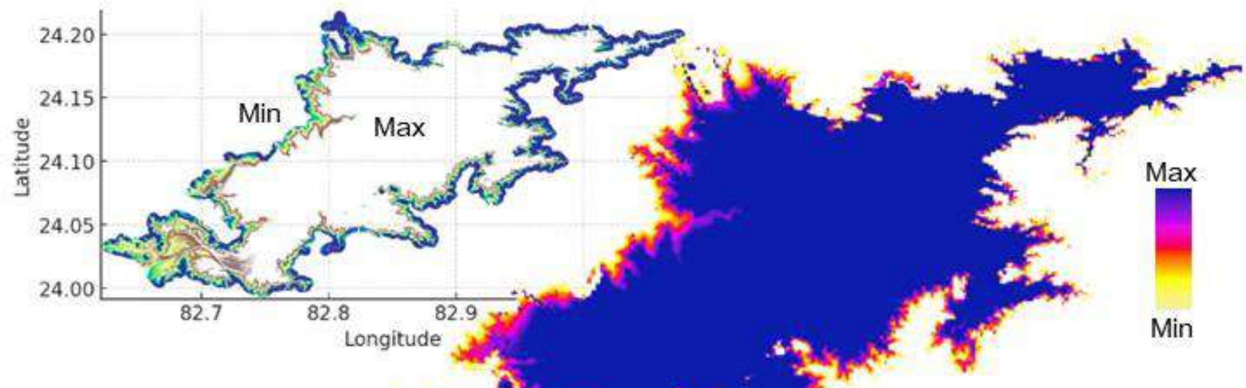
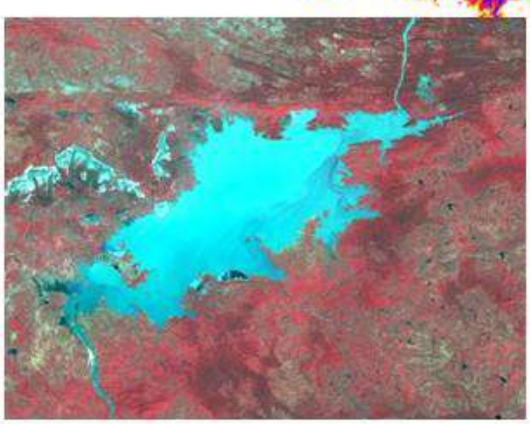
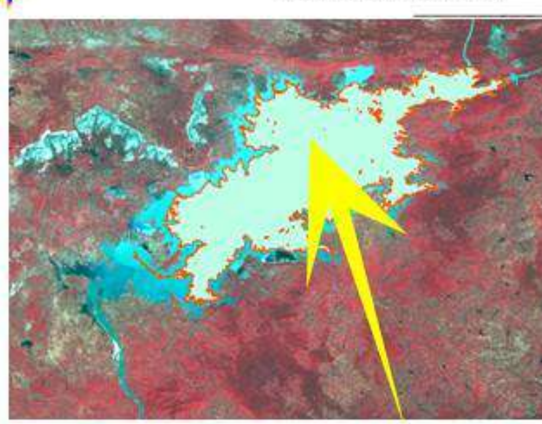


Image processing of 10 years satellite data for delineating minimum submergence Area

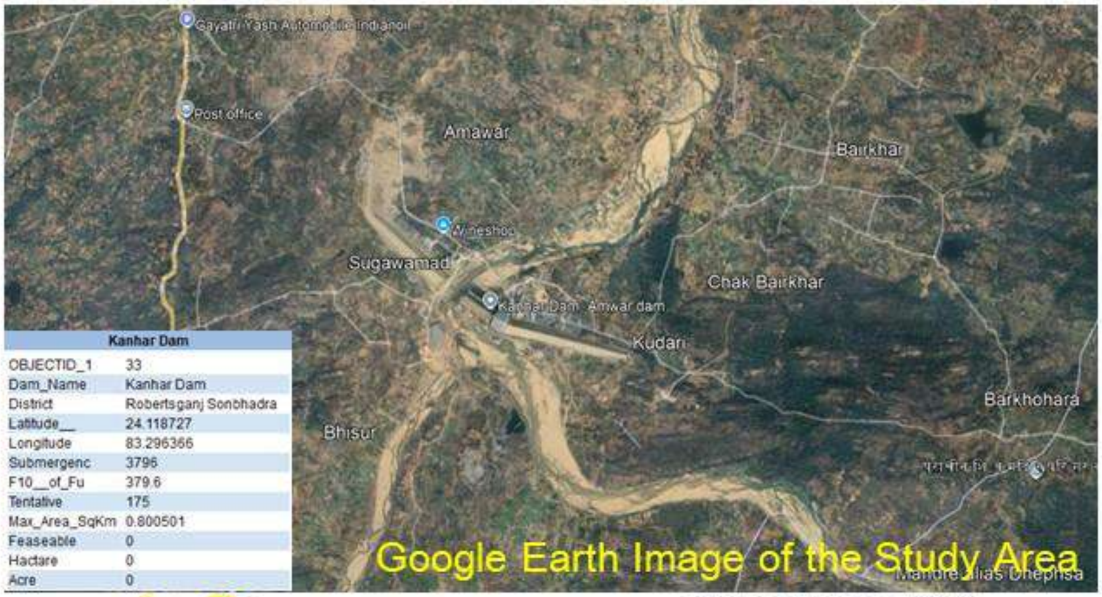




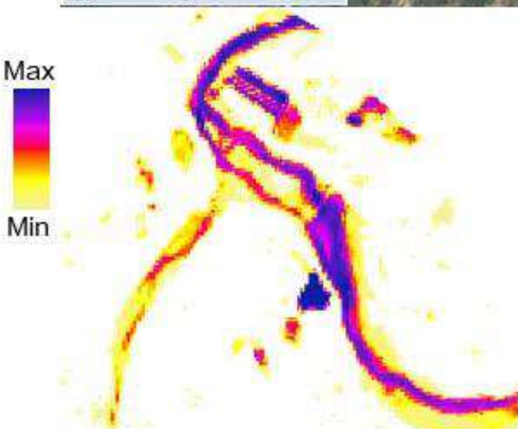
False Colour Composite of LISS 3 image

Feasible Area

Kanhar Dam



Kanhar Dam	
OBJECTID_1	33
Dam_Name	Kanhar Dam
District	Robertsganj Sonbhadra
Latitude__	24.118727
Longitude	83.296366
Submergenc	3796
F10__of_Fu	379.6
Tentative	175
Max_Area_SqKm	0.800501
Feaseable	0
Hactare	0
Acre	0



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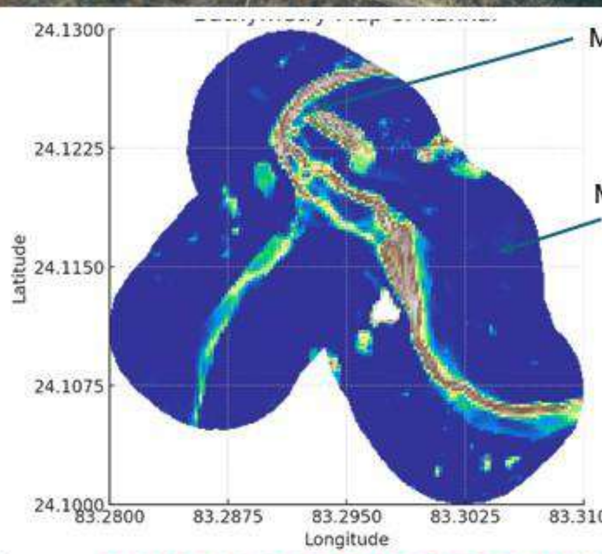
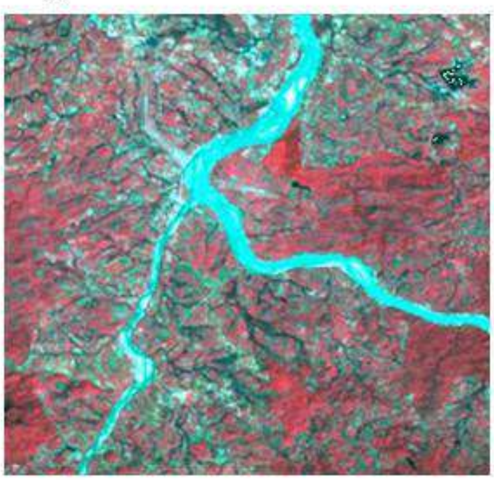
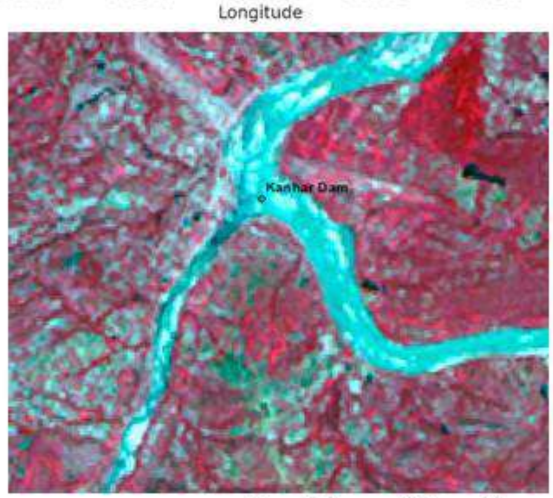






False Colour Composite of LISS 3 image

No Feasible Area

5.2 Lalitpur District (Uttar Pradesh)

Dams Under Consideration: *Rajghat Dam, Matatila Dam, Govind Sagar Dam, Shahzad Dam, Jamini Dam, Sajnam Dam*. Lalitpur district, located in the Bundelkhand region of southern Uttar Pradesh, has several major reservoirs primarily on the **Betwa and Jamni rivers**. Rajghat and Matatila are large interstate dams (shared with Madhya Pradesh) known for irrigation and some existing hydropower, whereas the others are medium-sized local irrigation dams**.(Table-5)**

S No	Name of Reservoir/Dam	Latitude	Longitude	Feasible Area in Acre	Area in SqM
1	Govind Sagar Dam	24.671634	78.41861	1341.626	16920051.13
2	Jamini Dam	24.363015	78.683511	819.7934	10448720.72
3	Matatia Dam	25.094361	78.364001	10370.26	72627577.69
4	Rajghat Dam	24.751524	78.235808	11839.2	169026741.7
5	Sajnam Dam	24.523228	78.591601	477.4647	20400650.97
6	Shahzad Dam	24.94395	78.520807	1142.603	7864143.137

Technical Feasibility: Lalitpur's dams collectively present a substantial solar potential. **Rajghat Dam** (on the Betwa River) has a reservoir of about **242 km²**; around **2,421 ha (10%)** of its area was initially considered, with a refined feasible area of about **1,114 ha** for solar deployment. This could support roughly **~11.8 MW** of floating solar capacity, producing about **48 GWh per year**. **Matatila Dam**, upstream on the Betwa, has a reservoir (~128 km²) with ~588 ha feasible for solar, yielding ~10.4 MW and 42 GWh/yr. The **Govind Sagar Dam** (Jamni River) is smaller (25 km²) with ~114 ha feasible, ~13.4 MW capacity and 54 GWh/yr generation. **Shahzad Dam** (~30 km²) could host ~138 ha of panels (~11.4 MW, 46 GWh/yr). **Jamini Dam** (~25 km²) with ~114 ha feasible (~8.2 MW, 33 GWh/yr), and **Sajnam Dam** (~23 km²) with ~109 ha (~4.8 MW, 19 GWh/yr) round out the list. In total, Lalitpur district's reservoirs can support on the order of **60–65 MW** of floating solar, generating over **240 GWh annually** (a significant contribution in a region often facing power deficits). Technically, these reservoirs have relatively stable water surfaces; floating systems can be installed in the calmer coves or near dam walls. For Rajghat and Matatila, one advantage is that both dams already have **concrete spillways and power house areas** where infrastructure (roads, power lines) exists, facilitating construction access and grid connection for solar. Wind potential in Lalitpur is generally low – the terrain is undulating but not high altitude; thus, standalone wind turbines are unlikely to be economically feasible. The focus remains on solar PV. Because multiple mid-sized sites are involved, an efficient approach may be to develop several smaller plants (5–15 MW each) in parallel, rather than one centralized farm, to reduce transmission distances from each reservoir to the grid.

Hybrid Renewable Potential: Lalitpur's context is ideal for **solar-hydro hybridization** on the Betwa river dams. **Rajghat Dam** has an existing hydropower station (~3×15 MW units). By adding floating solar, the combined facility can leverage the Betwa's flow better. For instance, during sunny hours, **the solar output can supply local demand, allowing Rajghat's hydro turbines to either idle (conserving water) or run at lower capacity – then ramp up in evenings or low-sun periods**. Conversely, in monsoon months when clouds reduce solar generation, the dam likely has abundant water to run the hydro at full capacity, compensating for the solar shortfall. This seasonal and daily balancing mirrors the findings at other combined sites. Matatila

Dam also has small hydro units (somewhere around 2×10 MW); similar coordination is possible there. While each of these hydro plants is modest, their ability to quickly adjust output makes the pairing valuable. Regarding **wind**, Lalitpur does have stretches of ridge (the northern Deccan plateau extension), but wind speeds (~4–5 m/s average) probably don't justify large turbines. However, one could consider **micro-wind turbines** or even solar-wind hybrid streetlights along the dam peripheries as a demonstration, though their contribution would be minimal. Another hybrid angle is **solar for pumped irrigation**: these dams feed extensive canal networks; solar power could be used to run pumping stations or lift irrigation schemes during daytime, directly utilizing PV output for agriculture (this isn't a traditional hybrid plant, but an integrated usage of the solar energy in the water management cycle). In summary, the primary hybrid benefit in Lalitpur comes from **solar complementing existing hydropower at Rajghat and Matatila**, enhancing grid stability and maximizing use of reservoir resources.

Socio-Economic & Environmental Impacts: *Local Communities:* Lalitpur is largely rural with agriculture reliant on dam irrigation. Floating solar installations can be a boon – they **do not encroach on arable land**, preserving farmland while still bringing investment to the area. During construction, jobs like assembling floats and panels, security patrolling of sites, and maintenance can employ local youth. There is also potential to involve local companies (for example, fabricators in Jhansi/Lalitpur) in providing parts or services, boosting the economy. The presence of solar farms on water should have minimal interference with irrigation releases, as panels will likely be placed in stagnant backwaters or near dam walls away from the intakes. Fisherfolk at these reservoirs (on Jamni and Shahzad rivers) will need to be consulted – though fishing activity is not as prominent as in Rihand, it exists. As with Sonbhadra, partial coverage of water may improve fish habitat by reducing extreme water temperatures and algae; a stable water environment under the panels can help fish and amphibians thrive.

Wildlife: These water bodies are not known to be critical bird sanctuaries, but they do attract migratory waterfowl seasonally. Care should be taken to leave sufficient open water patches as bird landing and feeding zones. Perhaps design the solar arrays in clusters with open corridors between them to allow birds to continue using the habitat. There is a possibility that birds may perch on panel frames – not a big issue, though bird droppings could slightly reduce panel efficiency (maintenance will handle cleaning). On the plus side, **floating solar avoids deforestation** or disturbance of nearby forests (if any) since no land is cleared, which is environmentally preferable to ground-mounted solar farms. *Social aspects:* The introduction of renewables in Bundelkhand (an economically lagging region) can have a positive social impact – it diversifies income sources and improves electricity supply quality for villages. Educational spillovers might include local technical institutes collaborating on the project, training students in solar technology. However, one must be mindful of historical context: large dams like Rajghat and Matatila did involve displacement decades ago; any new project must engage these communities transparently to build trust. Fortunately, floating solar doesn't require new land acquisition, so it should be far less socially intrusive. In fact, some villagers might view the shade from solar panels as beneficial if it reduces evaporation and **saves water that ultimately is used for irrigation downstream** – a potentially significant benefit in drought-prone Bundelkhand (some studies estimate up to ~50% evaporation reduction with partial FPV coverage).

Impact on Nearest Major City: Lalitpur is relatively remote; the nearest major U.P. city is **Jhansi (≈100 km)** to the north. However, **Bhopal** (the capital of Madhya Pradesh) is about 160 km south and **Jhansi** 100 km north, and the region sits near the UP-MP border. In terms of grid impact, the power from Rajghat and Matatila currently flows into both UP and MP networks (there are interconnections, as these dams serve both states). The addition of solar capacity can strengthen supply to **Jhansi city and the Bundelkhand region**. Jhansi, as a growing urban center and important railway hub, can benefit from more stable power – currently it relies partly on distant thermal plants. By integrating the solar output at the Rajghat/Matatila substations, a portion of Jhansi's daytime requirements could be met by local solar generation. There might be a need to upgrade the Rajghat Dam substation to handle extra solar injection, but since hydro plants exist, the transmission lines are already sized for tens of MW, likely sufficient for the added solar. Additionally, Lalitpur itself has a thermal power station (1980 MW) feeding into the grid; interestingly, solar from the dams could **help offset the thermal plant's output during peak sun, reducing coal burn and emissions** – effectively sending clean power north while thermal units back down or export more to other regions. If needed, a new 132 kV line could tie some of the smaller dams (Govind Sagar, Shahzad) into a central pooling substation before linking to the grid, to ensure efficient distribution. Overall, energy distribution is feasible with moderate enhancements, and the major beneficiary cities would be Jhansi and nearby towns (Lalitpur, Talbehat) through improved voltage and availability, as well as contributing to the state's power pool for use in distant cities as demand dictates.

Recommendations: A coordinated development of **multiple floating solar sites in Lalitpur** is advised, possibly under a cluster approach. **Rajghat and Matatila** can be prioritized for initial projects, given their larger size and dual benefit with hydropower. Ensuring close operational coordination between solar and the existing hydro plants will maximize returns; it may be worthwhile to implement a centralized control system at these dam sites to manage when to dispatch hydro vs. solar (for example, use forecasting to predict solar output and plan hydro generation accordingly). For the smaller dams (Shahzad, Jamini, Govind Sagar, Sajnam), a standard design template can be followed to simplify implementation – these could serve as demonstration sites for how even modest reservoirs can contribute a few megawatts each. **Community engagement** should involve informing farmers and villagers about the project's benefits, like improved water conservation and local power supply. Perhaps some of the project's revenue can be earmarked for community development (e.g. improving irrigation canals or funding solar street lights in nearby villages), which will build goodwill. Environmentally, it's recommended to keep the **floating coverage to well under 10%** of each reservoir's area (as planned) to avoid any ecological imbalance, and maintain buffer zones near the shoreline for fishermen's access and wildlife. Regular studies on water quality and fish populations before and after installation would be prudent, working with local fisheries departments. **Maintenance routines** must be established for panel cleaning (especially in dust-prone summers) and for handling any wear and tear on floating structures. Finally, since Bundelkhand region can have extreme heat, choosing high-quality materials (floats that can withstand high UV and temperature) will ensure longevity. With these steps, Lalitpur's dams can become a showcase of distributed floating solar feeding the grid and supporting local needs sustainably.

Govind Sagar Dam

Govind Sagar Dam	
OBJECTID_1	12
Dam_Name	Govind Sagar Dam
District	Lalitpur
Latitude__	24.671634
Longitude	78.41861
Submergenc	2479
F10__of_Fu	247.88
Tentative	114
Max_Area_SqKm	16.92005
Feaseable	5.429368
Hactare	542.9368
Acre	1341.626

Google Earth Image of the Study Area

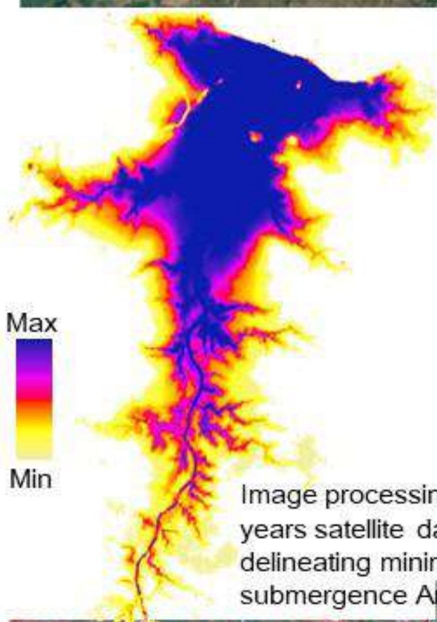
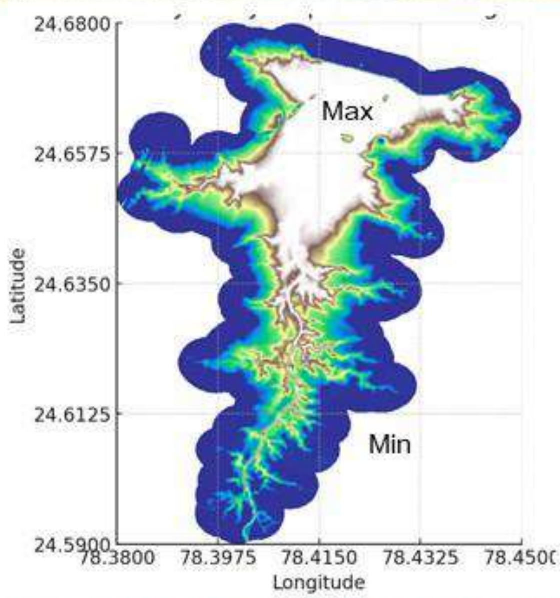
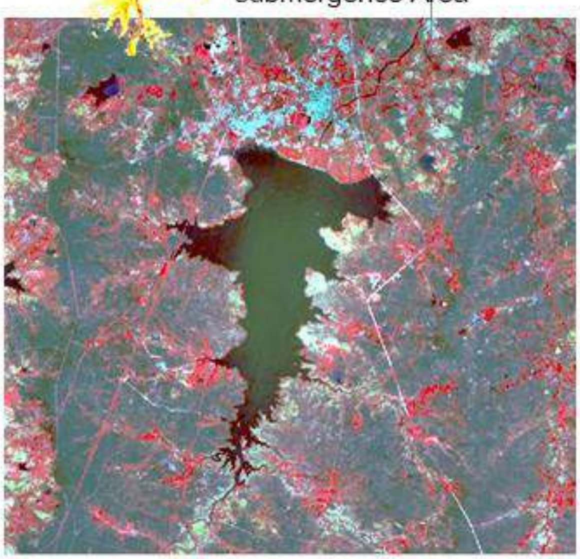
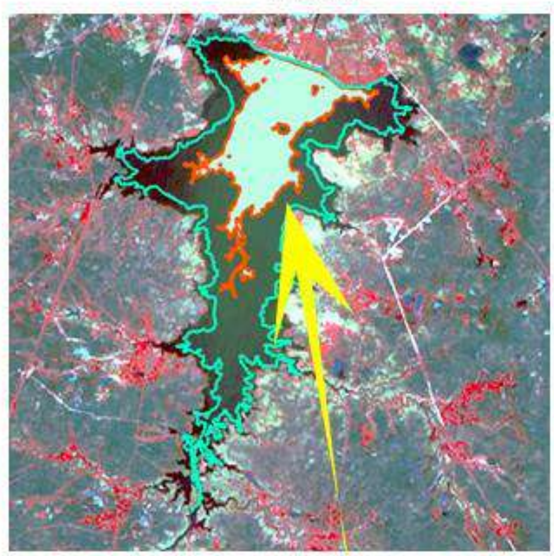


Image processing of 10 years satellite data for delineating minimum submergence Area







False Colour Composite of LISS 3 image

Feasible Area

Jamni Dam

Google Earth Image of the Study Area

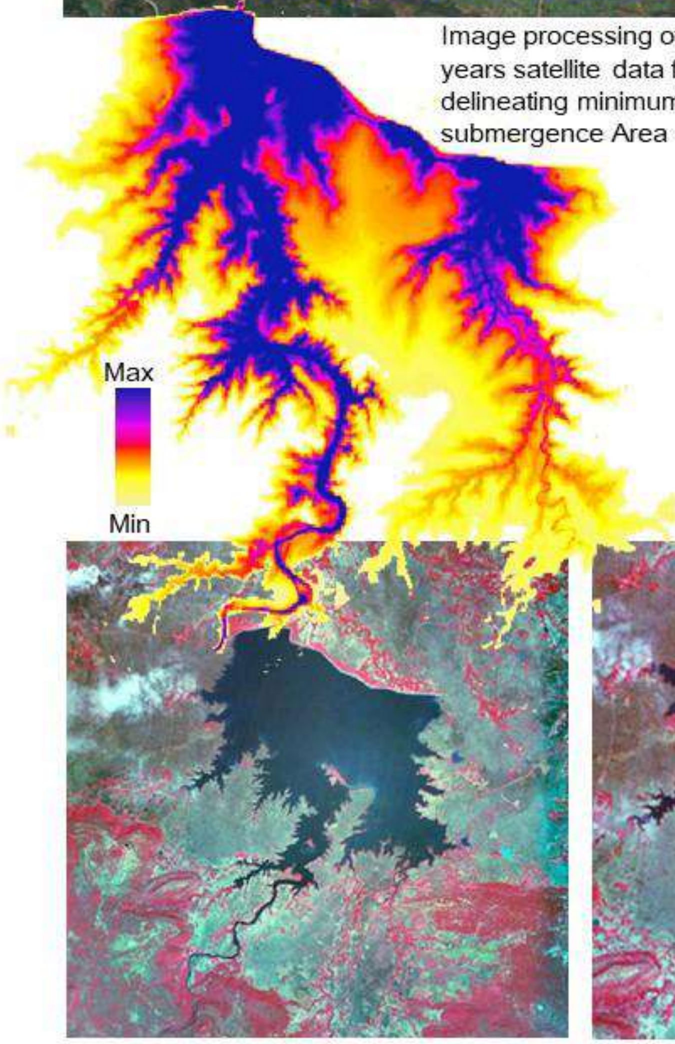


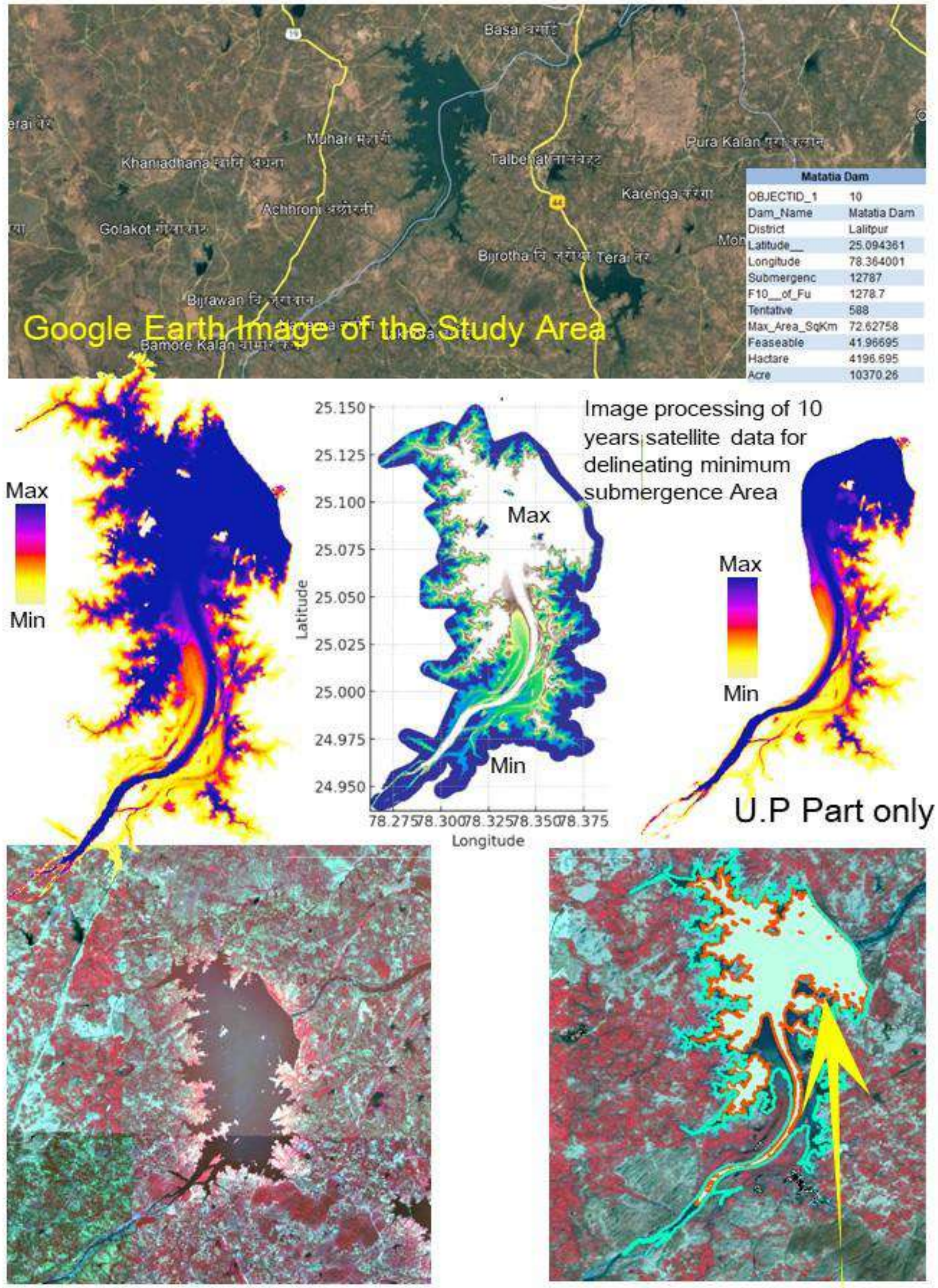
Image processing of 10 years satellite data for delineating minimum submergence Area

Jamini Dam	
OBJECTID_1	13
Dam_Name	Jamini Dam
District	Lalitpur
Latitude__	24.363015
Longitude	78.683511
Submergenc	2473
F10__of_Fu	247.265
Tentative	114
Max_Area_SqKm	10.44872
Feaseable	3.317586
Hactare	331.7586
Acre	819.7934

False Colour Composite of LISS 3 image

Feasible Area

Matatila Dam

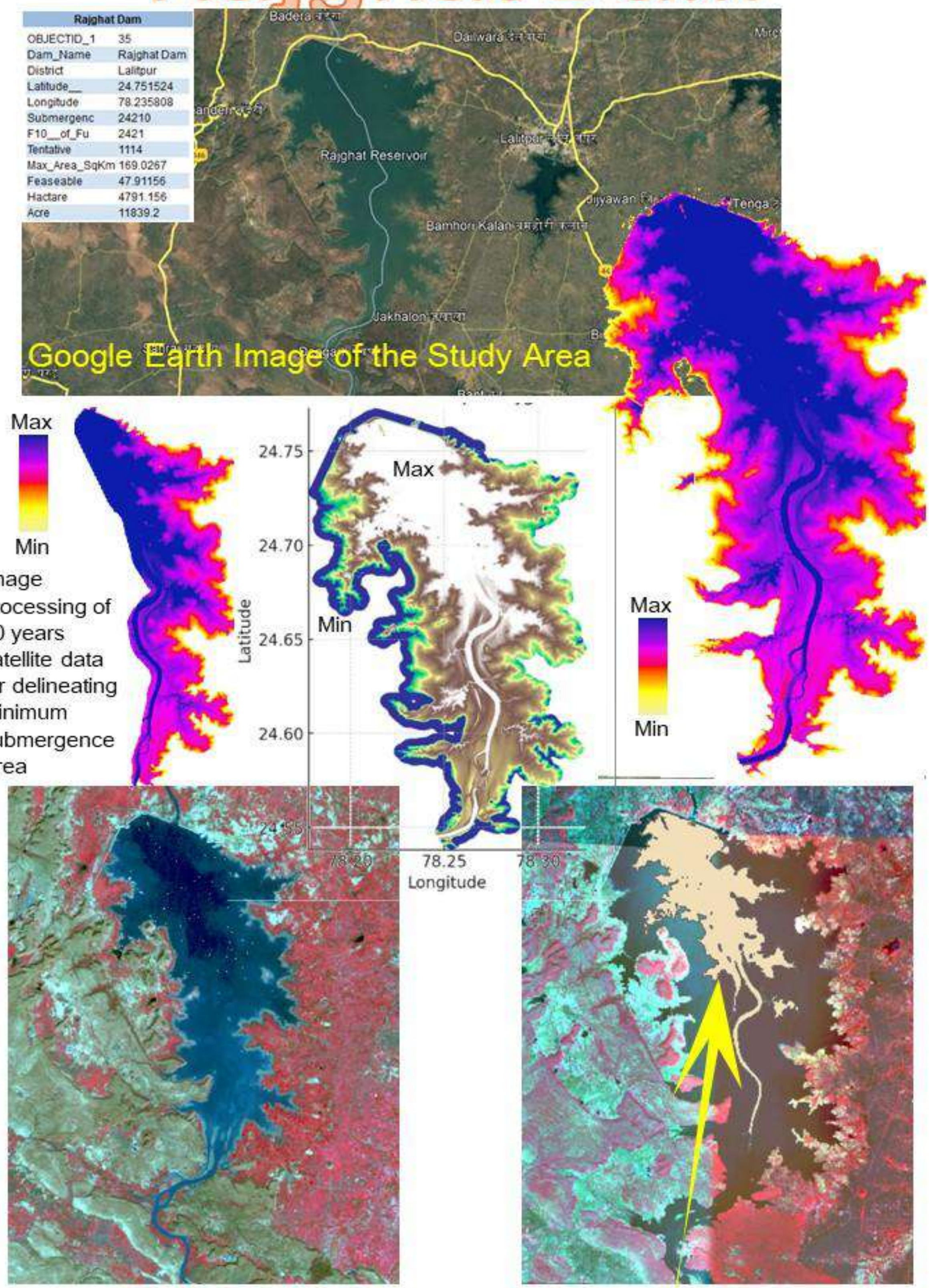


Matatia Dam	
OBJECTID_1	10
Dam_Name	Matatia Dam
District	Lalitpur
Latitude__	25.094361
Longitude	78.364001
Submergenc	12787
F10__of_Fu	1278.7
Tentative	588
Max_Area_SqKm	72.62758
Feaseable	41.96695
Hactare	4196.695
Acre	10370.26

False Colour Composite of LISS 3 image

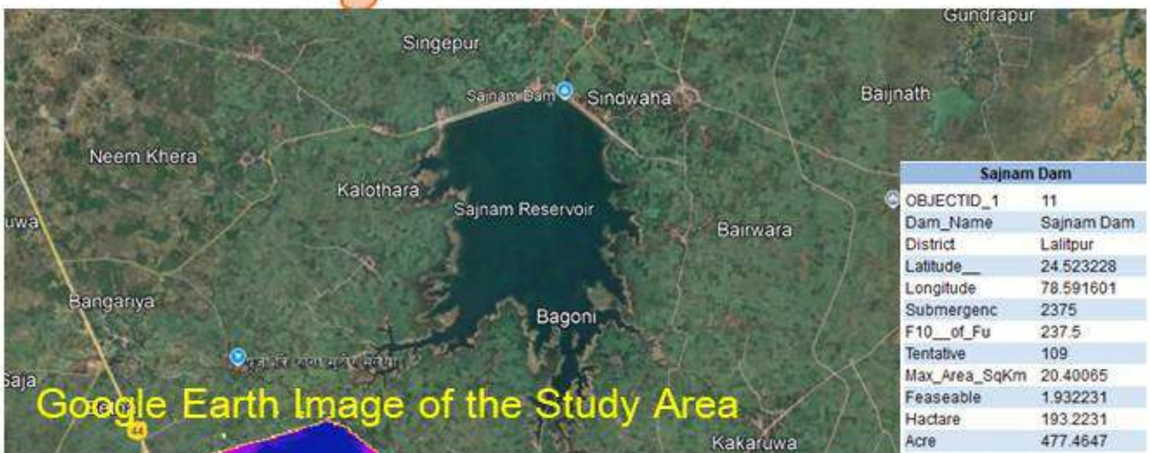
Feasible Area

Rajghat Dam

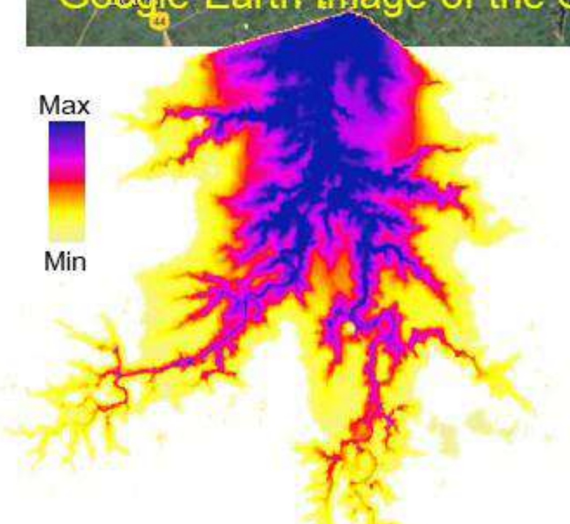


False Colour Composite of LISS 3 image Feasible Area

Sajnam Dam



Google Earth Image of the Study Area



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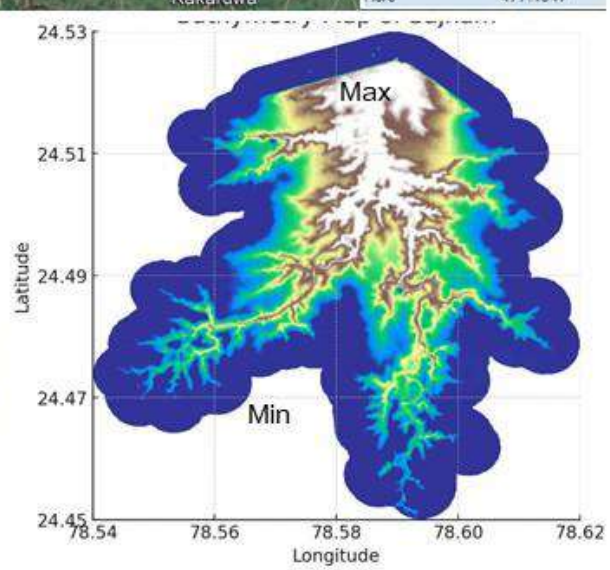



False Colour Composite of LISS 3 image


Feasible Area

Shahzad Dam

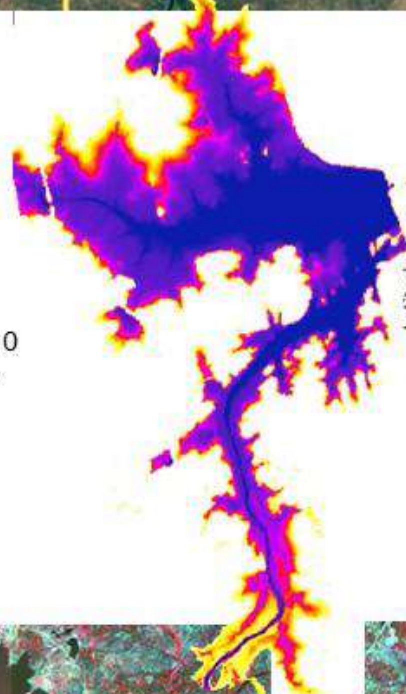
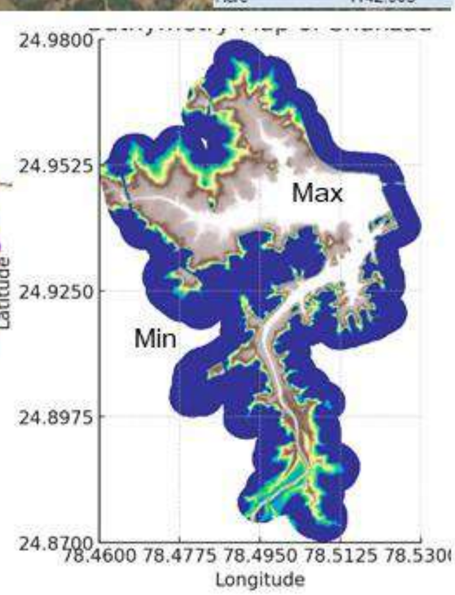
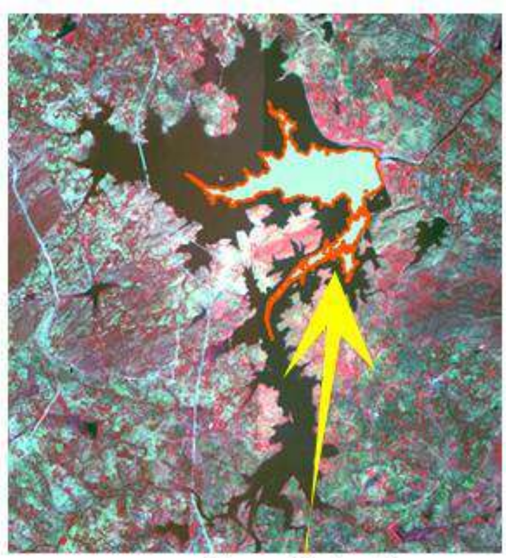


Image processing of 10 years satellite data for delineating minimum submergence Area





False Colour Composite of LISS 3 image

Feasible Area

5.3 Jhansi District (Uttar Pradesh)

Dams Under Consideration: *Parichha Dam, Dhukwan Dam, Pahuj Dam, Garhmau Dam (Tank), Barwa Sagar (Barua Sagar) Lake, Barwar Lake, Pathrai Dam, Saprar Dam, Pahari Dam, Dongri Dam*. Jhansi district, also in Bundelkhand, has numerous small and medium reservoirs, several of which have been specifically identified by UPNEDA for floating solar. These water bodies primarily serve irrigation (and some for drinking water) and range from old colonial-era lakes (Barwa Sagar) to newer irrigation projects (Saprar). **(Table-6)**

S No	Name of Reservoir/Dam	Latitude	Longitude	Feasible Area in Acre	Area in SqM
1	Barua Sagar	25.375287	78.748971	34.462	2621139.747
2	Barwar Lake	25.514684	79.1471	172.1518	9682209.507
3	Dhukwan Dam	25.185496	78.541496	522.8618	8300812.641
4	Dongri Dam	25.384451	78.459153	45.88108	2619038.188
5	Garhmau Lake	25.517306	78.670643	87.248	1649969.188
6	Pahari Dam	25.200754	79.281429	63.49587	2407784.394
7	Pahuj Dam	25.500383	78.534462	237.0161	4833570.131
8	Parichha Dam	25.513306	78.780749	1542.637	10714938.89
9	Pathrai Dam	25.423457	79.026405	29.39896	914906.1237
10	Saprar Dam	25.209232	79.096985	20.05495	8521363.673

Technical Feasibility: The collective solar potential in Jhansi's reservoirs is significant in number of sites, though each individual site is relatively small. **Parichha Dam**, on the Betwa River, is one of the larger ones (though its reservoir is not as big as Rajghat upstream). It spans roughly 8 km² (802 ha), with about **80 ha** feasible for solar, supporting ~15.4 MW and generating ~62 GWh/yr. **Dhukwan Dam** (Betwa River downstream) has about **89 ha** feasible (~5.2 MW, 21 GWh/yr). **Pahuj Dam** (on Pahuj River) – reservoir ~5.4 km² – ~25 ha feasible (~2.4 MW, 9.6 GWh). **Garhmau** is a smaller tank (~1.47 km²) with ~68 ha feasible (though that seems like a large fraction; likely around ~0.68 km² feasible) giving ~8.7 MW, 35 GWh. **Barwa Sagar Lake** (historical reservoir on Betwa tributary) ~5.2 km², ~24 ha feasible (~3.4 MW, 13.9 GWh). **Barwar Lake** (near Jhansi) ~10 km²? – data suggests ~46 ha feasible (~1.72 MW, 6.97 GWh – although 46 ha should allow more MW; possibly the dataset for Barwar had smaller numbers due to constraints). **Pathrai Dam** (~5.9 km²) ~27 ha feasible (~2.94 MW, 11.9 GWh). **Saprar Dam** (20 km² reservoir) ~92 ha feasible (~20 MW, 81 GWh) – Saprar is relatively large and stands out with a significant ~20 MW potential. **Pahari Dam** (~8 km²) ~37 ha feasible (~6.35 MW, 25.7 GWh). **Dongri Dam** (~1.92 km²) ~8.8 ha feasible (~0.46 MW, 1.86 GWh – very small). These figures indicate that Jhansi district's dozens of water bodies could collectively host on the order of **60–70 MW** of solar, similar to Lalitpur, but distributed over more sites. Technical feasibility is favorable: many of these lakes (Barwa Sagar, Garhmau, etc.) are relatively shallow and calm, making anchoring and maintenance easier. However, being smaller, they may require more careful layout to avoid covering too much surface – the feasible areas considered are generally under 5% of each lake area, which is good practice. Another technical note: Parichha is adjacent to a major **thermal power station**; using its existing grid connection for solar could be cost-effective. Wind potential is negligible – the area is flat to gently rolling, without strong winds. Thus, solar PV on water remains the main focus. Because these are multiple smaller installations, a hub-and-spoke maintenance model could be used (one O&M team traveling between sites in Jhansi district). Standardization of design (similar floats, anchoring methods) across these sites will make it easier to deploy and maintain.

Hybrid Renewable Potential:

Jhansi's scenario doesn't involve large active hydropower plants (Parichha and Dhukwan dams on Betwa have **hydro components added recently**: Dhukwan has a new small hydro plant ~24 MW; Parichha is mainly a barrage for the thermal plant cooling but might have a micro-hydro). So there is limited scope for solar-hydro coordination compared to Lalitpur. Nevertheless, **Parichha's case is interesting**: it's paired with a coal-fired power plant which uses the reservoir for cooling. A form of hybrid integration here could be utilizing solar to supply the auxiliary power needs of the thermal plant during daytime, or to run the cooling water pumps, thereby reducing the parasitic load on the thermal plant and saving coal. While not a traditional solar-hydro or solar-wind hybrid, this solar-thermal coupling is a practical synergy. For Dhukwan's small hydro, coordination can be similar to Rajghat's case: use solar by day, conserve water to generate with the hydro in early morning/evening peaks. The volume of water at Dhukwan is small, so the effect is modest but still useful. **Wind** doesn't factor in except perhaps some micro-turbines on dam crests if desired for lighting, etc. Another hybrid concept is to integrate **floating solar with irrigation scheduling** – e.g., during high solar output, channel gates can release water (since power is available to pumps down the line or because solar can run any electric actuators), and during off-peak, hold water. This is more of an operational tweak than an energy hybrid, but it shows the benefit of having local solar supply for the irrigation department's power needs. On some of the smaller tanks (Garhmau, Barwa Sagar), one could also envision solar powering **fountain aerators or water treatment units** for the lake (improving water quality) – again, not energy generation hybridization, but a value-add of having floating solar infrastructure. Overall, Jhansi's hybrid opportunities are subtler: the key is leveraging existing power facilities (thermal and small hydro) and using solar to enhance their performance and the water management systems.

Socio-Economic & Environmental Impacts:

Local Communities: Many of these reservoirs are lifelines for local farming communities. Floating solar installations on them will need careful community consultation. On one hand, **there is benefit to farmers** – reduced evaporation means more water retained for irrigation. For example, covering parts of Saprar dam (which is a crucial irrigation source) could significantly cut water loss in the scorching summer, directly aiding agriculture. On the other hand, villagers may worry that solar panels will "take over" their water source. It will be important to communicate that only a small fraction of the lake is used and it will **not impede water releases or their usage rights**. In fact, the government might incentivize acceptance by sharing a part of revenue with the local panchayats or by guaranteeing more reliable irrigation due to reduced evaporation.

Fishing and Recreation:

Lakes like Barwa Sagar are also local tourist spots and fishing sites. The visual impact of solar grids on a historic lake (Barwa Sagar Tal has historical significance from Rani Laxmibai's era) should be considered. Perhaps situate the solar arrays in less visible sections (like an arm of the lake not frequented by tourists). Also, ensure the design is aesthetic – low-profile panels just above water surface tend to be not very obtrusive from a distance. For fishing, as before, leaving large open areas and possibly implementing fish-attracting structures under arrays can compensate for any displacement.

Environment:

The environmental impact for small lakes can be more acute if not managed – a high coverage ratio could affect the whole water body's ecology. But here all plans aim for <5% coverage, which is unlikely to harm the ecosystem. In fact, the partial shading might **improve water quality** (less algae, cooler water) and in turn benefit aquatic life. One potential concern is that floating solar on small ponds has been noted in some studies to alter greenhouse gas dynamics (increasing methane in certain cases).

Continuous monitoring of water chemistry should be done to ensure, for instance, that dissolved oxygen remains healthy and methane emissions are tracked. Given these are irrigation ponds, maintaining water quality is anyway a priority for human use. On land, floating solar spares the surrounding areas from having to host solar farms (which could require clearing vegetation). The **land around these lakes often has forests or villages**, which remain undisturbed, thus preserving local biodiversity and community land use.

Demographics:

Jhansi district has a mix of rural population and the city population of Jhansi. The rural electrification in some of these areas is still not 24×7 reliable. The floating solar projects, though grid-connected, could prompt strengthening of local distribution networks (as new power injection points are created). Villages near the dams might get better service or even direct off-take of some power through dedicated feeders. Additionally, the projects would demonstrate state-of-the-art technology in a region that could use more development initiatives, potentially inspiring youth and providing training opportunities at local ITI (industrial training institutes). During construction, short-term jobs will come; long-term, each site may have a few maintenance personnel (or security) which could be locals. The net socio-economic impact is expected to be positive if managed inclusively.

Impact on Nearest Major City:

The primary city here is **Jhansi**, which is both the district headquarters and a major city in Bundelkhand. As noted, integrating these various small-solar outputs will likely occur at existing substations (e.g., Parichha TPS switchyard, Mauranipur substation for some irrigation dams, etc.). Once in the UP state grid, the beneficiaries of the energy are widespread, but certainly Jhansi city and nearby towns (Mauranipur, Moth, etc.) will see improved supply. Jhansi's peak demand can be partially met by daylight solar from these sites, and any excess can flow to Kanpur or Agra via the grid. Because there are many injection points, the distribution company might need to invest in upgraded feeders and smart inverters to manage voltage. However, since the capacities at each point are relatively small (a few MW), it's unlikely to cause major grid stress – rather it will **strengthen the local voltage profile** and reduce transmission losses (power generated and used locally means less loss over long lines).

The Parichha thermal plant could effectively act as a balancing unit, adjusting output based on solar availability, which ensures Jhansi's industrial and railway loads are always supported. Overall, the energy distribution feasibility is good – the projects can piggyback on the robust grid framework built around Parichha TPS. Jhansi city stands to gain cleaner air indirectly too: if solar output allows the coal plant to be throttled back slightly on sunny days, emissions (and coal transport) in the area will reduce.

Recommendations:

For Jhansi district, a **clustered implementation** approach is recommended, possibly through a public-private partnership that can handle a portfolio of small sites. Given that many of these sites (Saprar, Barwa Sagar, etc.) were explicitly listed in the state's floating solar initiative, it would be wise to align development with that policy to streamline approvals. We recommend prioritizing **Saprar Dam** for an early project, as it has one of the largest potentials (~20 MW) and can deliver a big impact in water savings and power. **Barwa Sagar Lake**, due to its historical/tourism aspect, should be developed sensitively – possibly a smaller pilot capacity initially, using it as a demonstration for how floating solar coexists with heritage sites (interpretive signage can even be placed for tourists explaining the solar installation and its benefits). For technical efficiency, identical equipment can be used across Jhansi's sites (modular floats, standardized inverter stations) so that spare parts and expertise are interchangeable. **Community awareness programs** should precede project construction – possibly organized by the irrigation department – to assure farmers that the project will *improve* their water availability, not harm it. Also, involving local water user associations in the planning (like where exactly to place arrays so as not to interfere with their pump locations or ghats) will ease acceptance. On the environmental front, a rotating monitoring schedule where each lake's water health is checked quarterly by a university or environment department would be prudent, feeding into an adaptive management plan (e.g., if any sign of ecological stress, adjust coverage or configuration). Considering the relatively small size of these projects, **innovative uses of the solar output locally should be explored** – for example, setting up agro-processing units or cold storage near villages that run on this solar power, which would directly boost local agriculture and incomes.

As a recommendation, the state could pilot a **floating-solar-plus-fishery project** at one of the lakes (like Garhmau) – combining solar farming with fish farming in cages under/beside the floats, a dual-use that has been trialed elsewhere. This could increase fish yield and give an extra revenue stream. Lastly, maintenance responsibility needs clarity: perhaps the discom or a private operator will maintain for 25 years – ensuring funding for this is locked in via tariffs or contracts is important so that the installations remain efficient throughout their life. By following these recommendations, Jhansi's patchwork of dams can collectively become a robust source of green energy and water conservation.

Barua Sagar Dam

Barua Sagar	
OBJECTID_1	2
Dam_Name	Barua Sagar
District	Jhansi
Latitude__	25.375287
Longitude	78.748971
Submergenc	520
F10__of_Fu	52
Tentative	24
Max_Area_SqKm	2.62114
Feaseable	0.139463
Hactare	13.94628
Acre	34.462

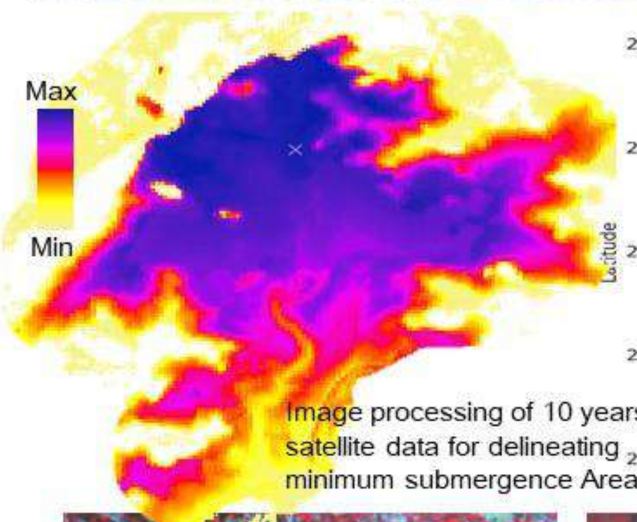
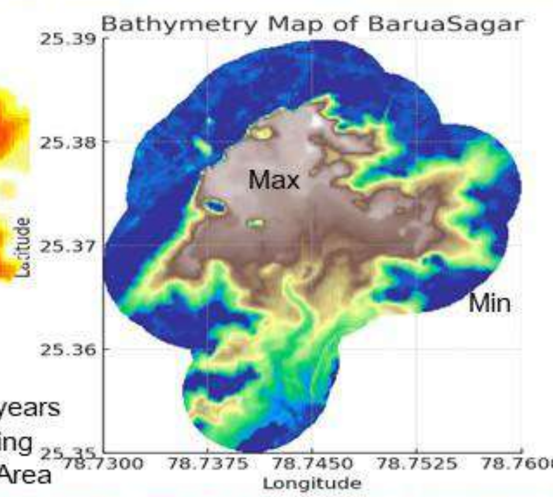
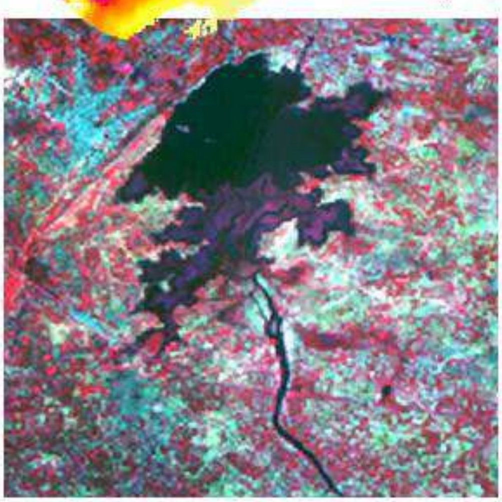
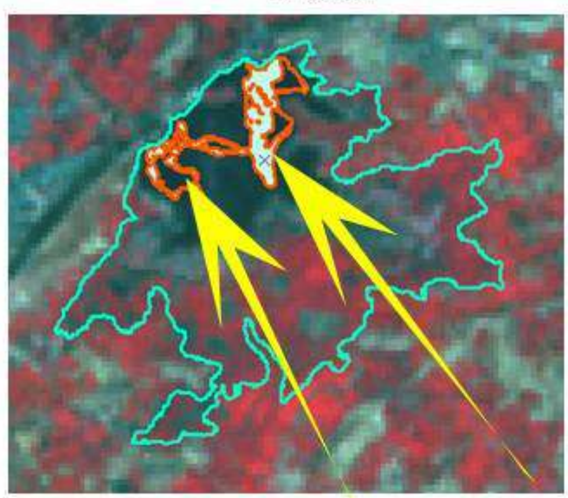


Image processing of 10 years satellite data for delineating minimum submergence Area



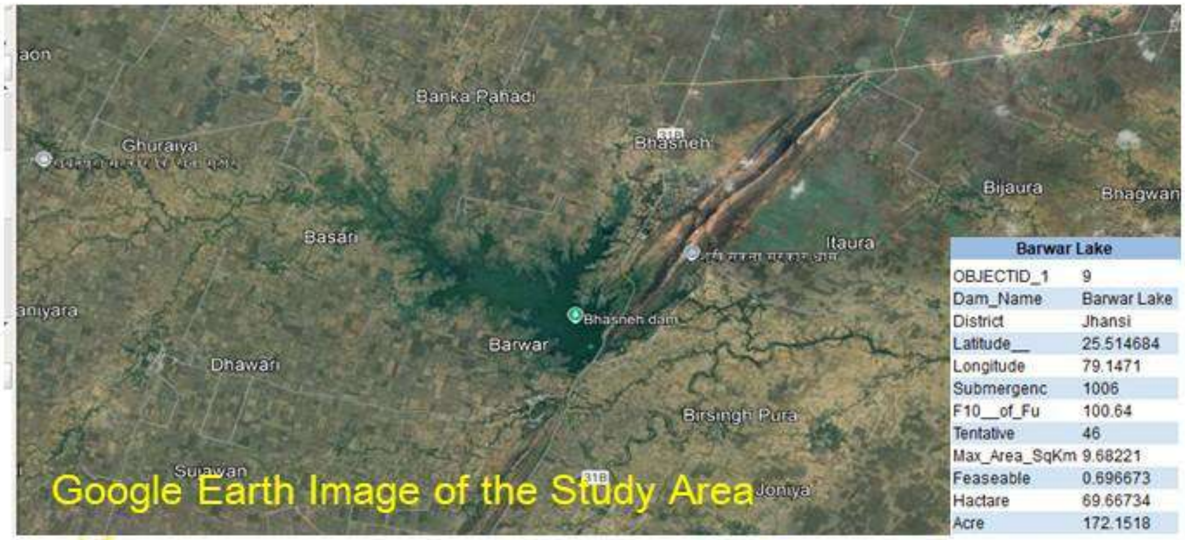


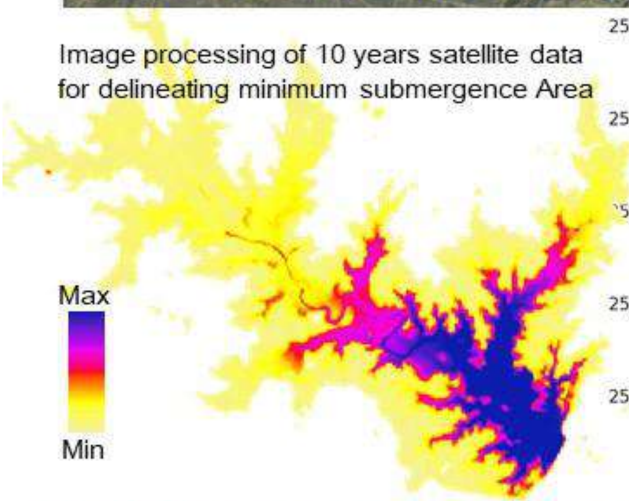
False Colour Composite of LISS 3 image

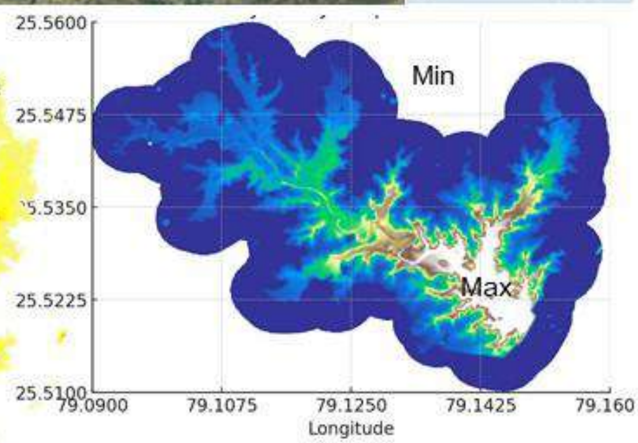


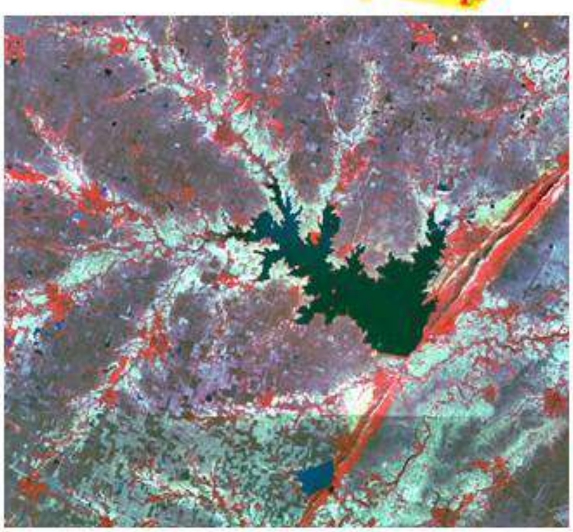
Feasible Area

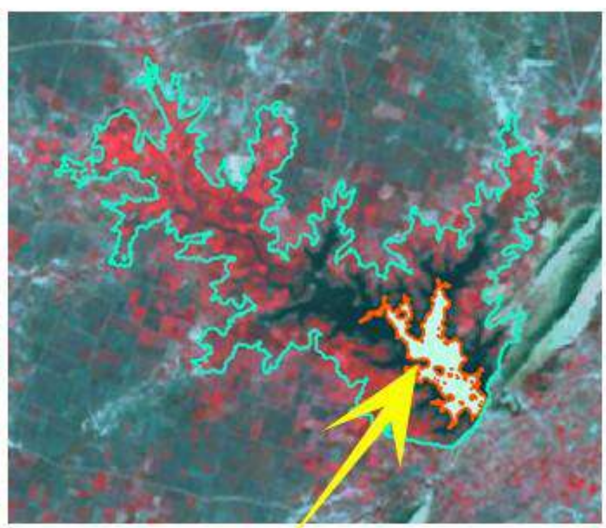
Barwar Dam







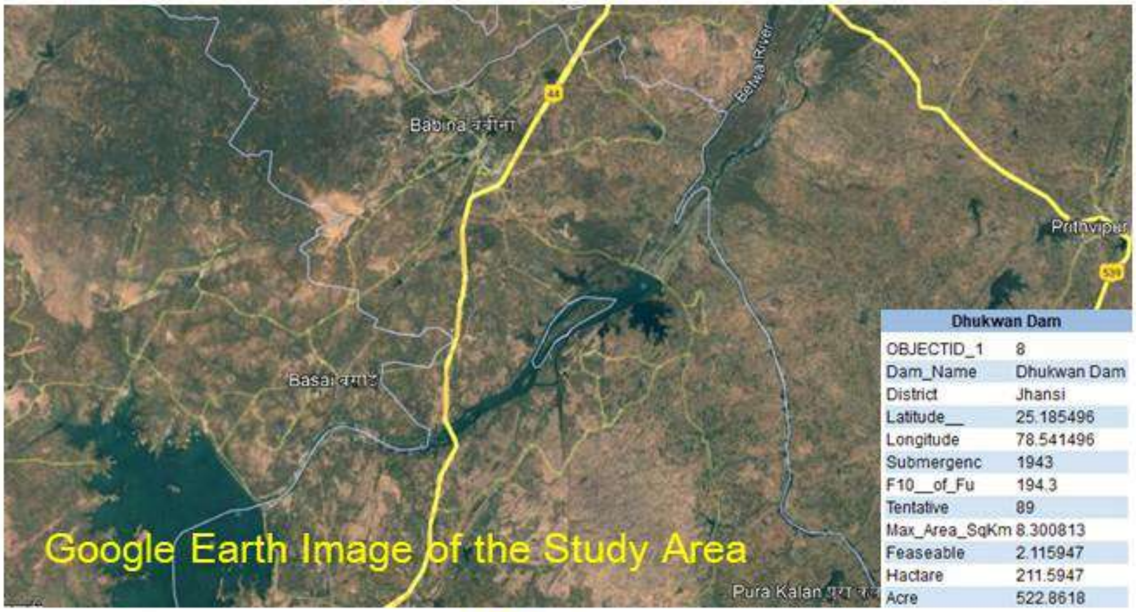


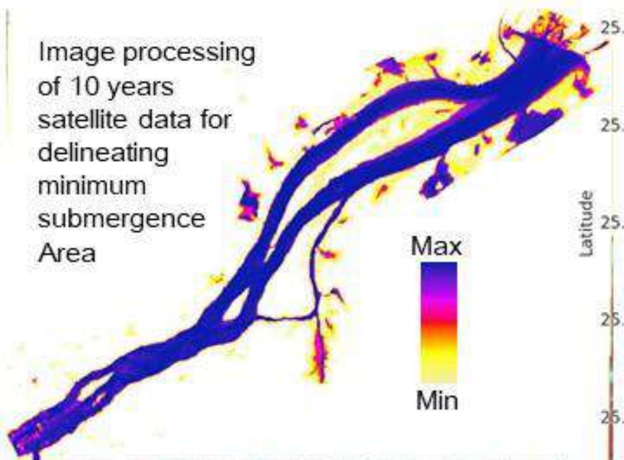


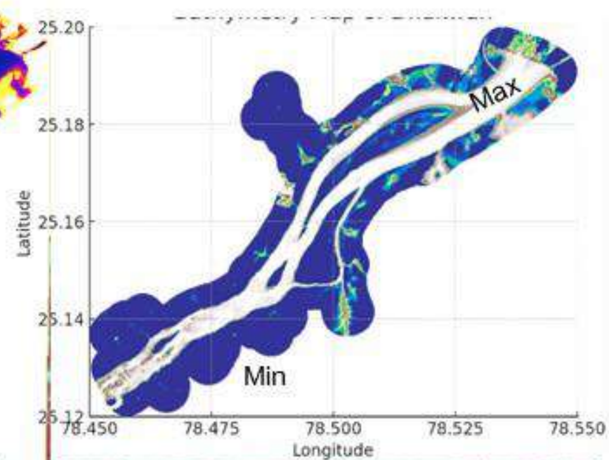
False Colour Composite of LISS 3 image

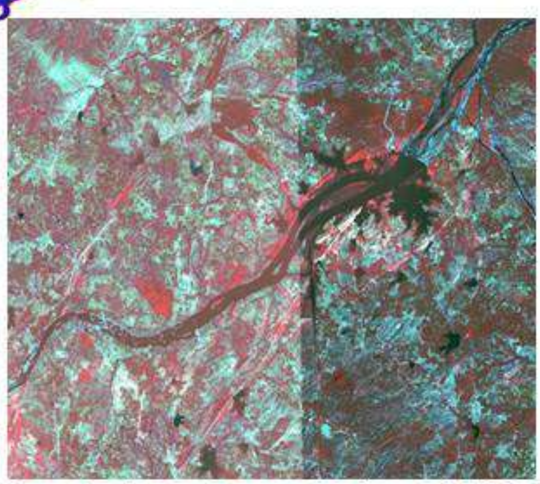
Feasible Area

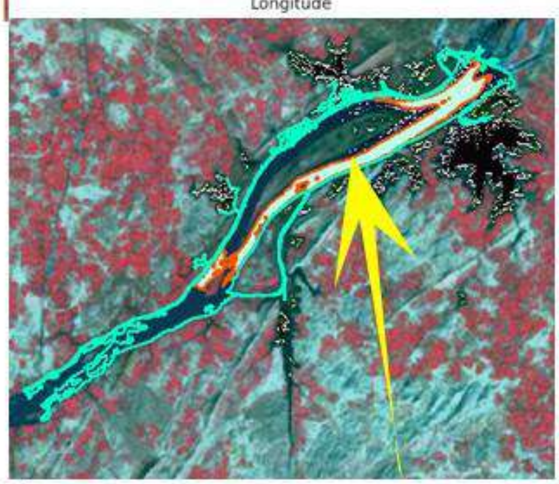
Dhukwan Dam











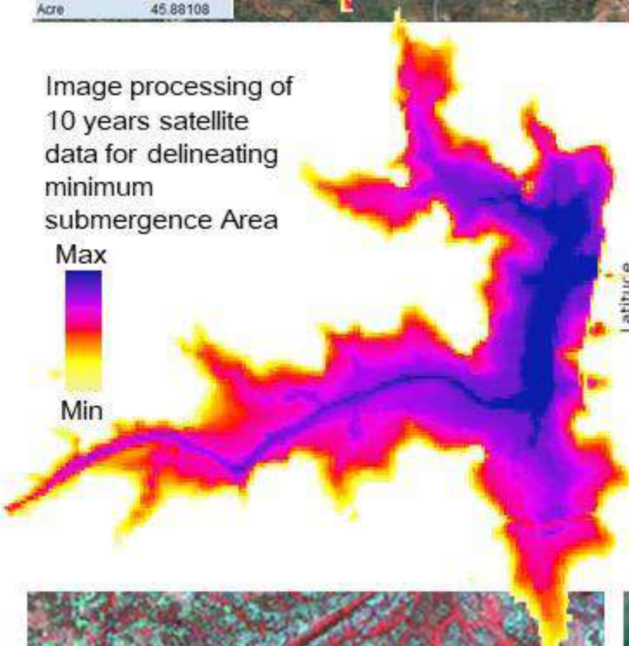
False Colour Composite of LISS 3 image   Feasible Area

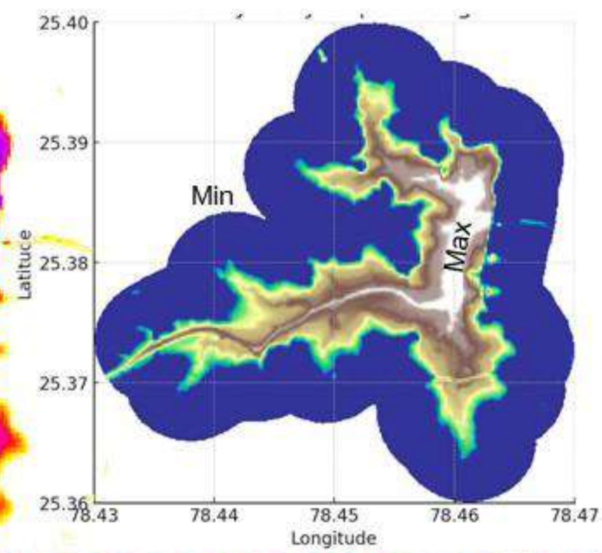
Dongri Dam

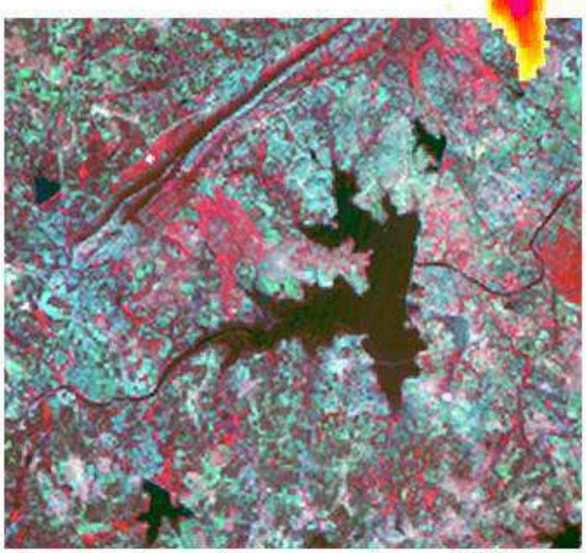
Dongri Dam	
OBJECTID_1	4
Dam_Name	Dongri Dam
District	Jhansi
Latitude__	25.384451
Longitude	78.459153
Submergenc	1920
F10__of_Fu	192
Tentative	88
Max_Area_SqKm	2.619038
Feaseable	0.185674
Hactare	18.56742
Acre	45.88108

Google Earth Image of the Study Area

Image processing of 10 years satellite data for delineating minimum submergence Area







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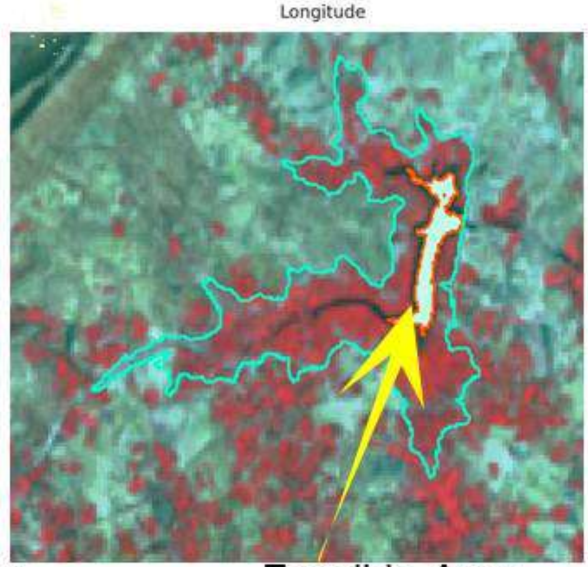
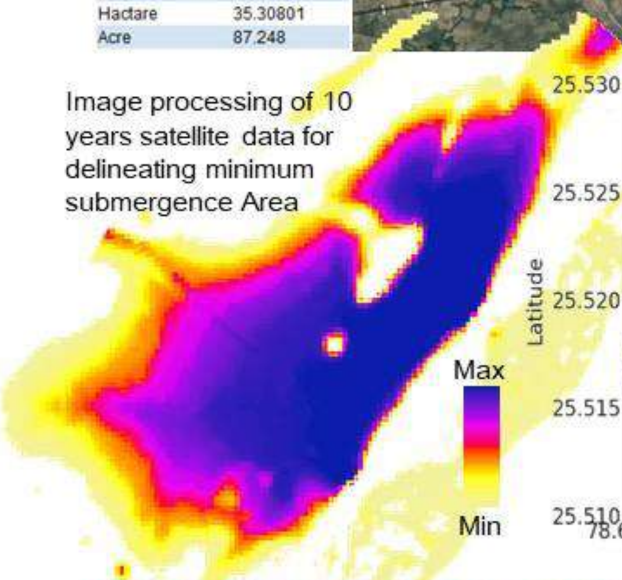
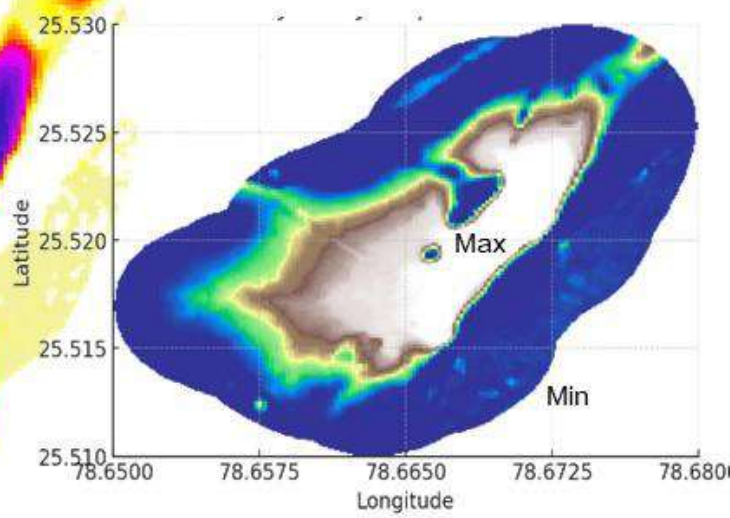
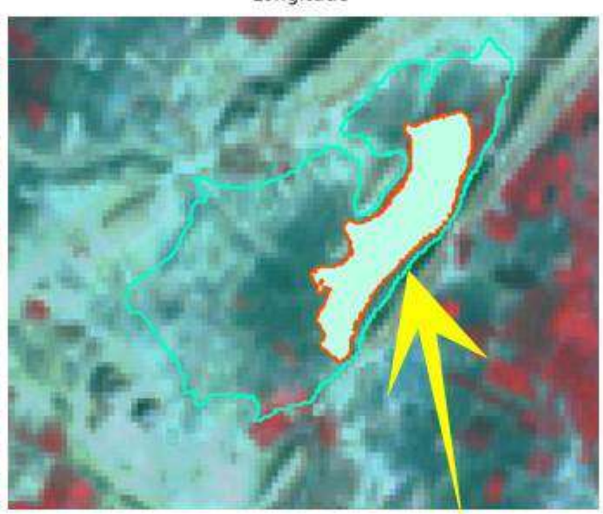


Feasible Area

Garhmau Dam



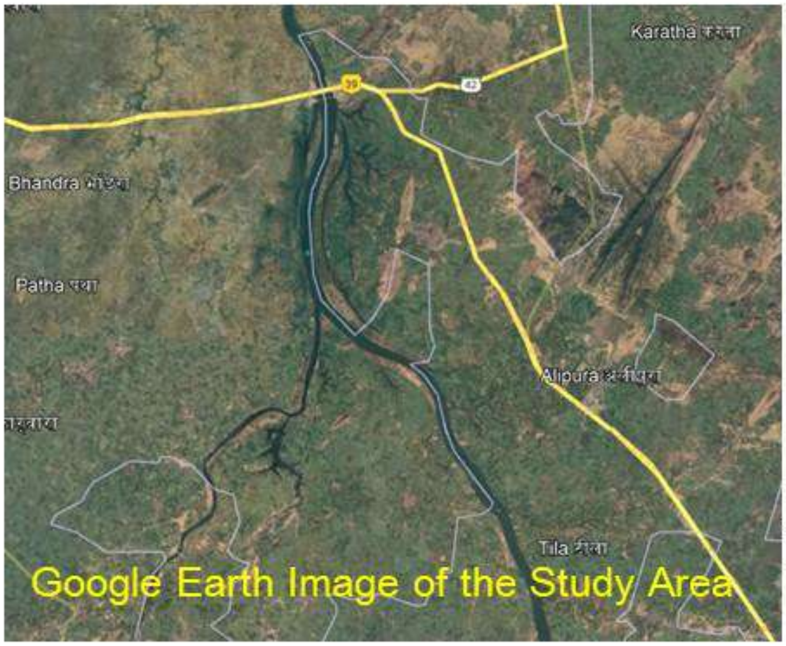




False Colour Composite of LISS 3 image

Feasible Area

Pahari Dam



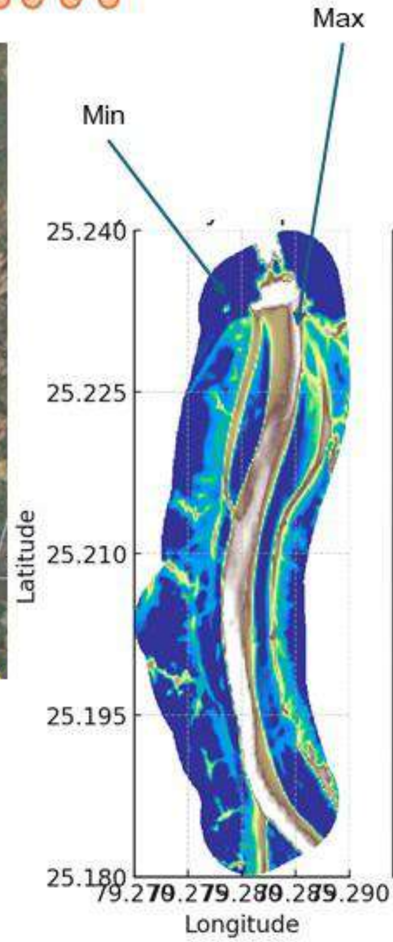
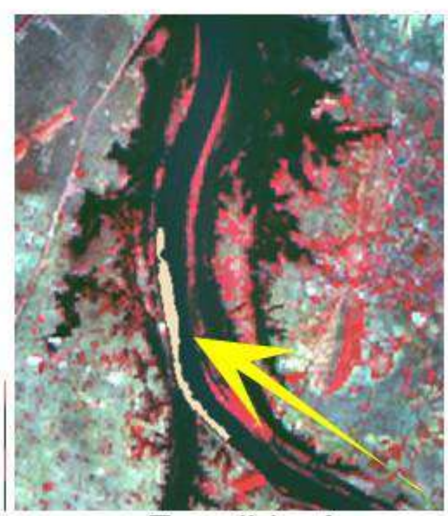


Image processing of 10 years satellite data for delineating minimum submergence Area

Pahari Dam	
OBJECTID_1	17
Dam_Name	Pahari Dam
District	Jhansi
Latitude__	25.200754
Longitude	79.281429
Submergenc	803
F10__of_Fu	80.3
Tentative	37
Max_Area_SqKm	2.407784
Feaseable	0.256959
Hactare	25.69587
Acre	63.49587

False Colour Composite of LISS 3 image



Feasible Area

Pahuj Dam

Pahuj Dam	
OBJECTID_1	6
Dam_Name	Pahuj Dam
District	Jhansi
Latitude__	25.500383
Longitude	78.534462
Submergenc	543
F10__of_Fu	54.3
Tentative	25
Max_Area_SqKm	4.83357
Feaseable	0.95917
Hactare	95.917
Acre	237.0161

Google Earth Image of the Study Area

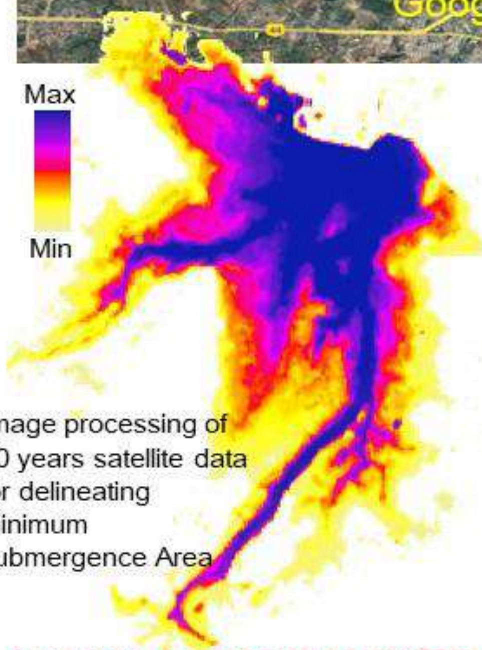
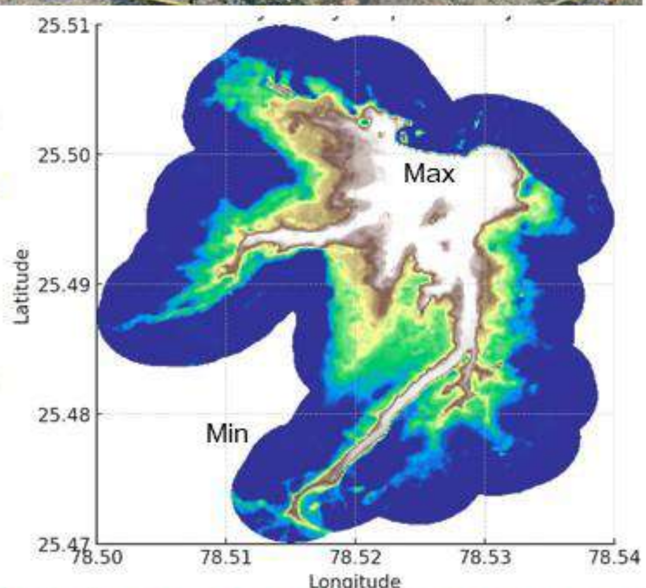
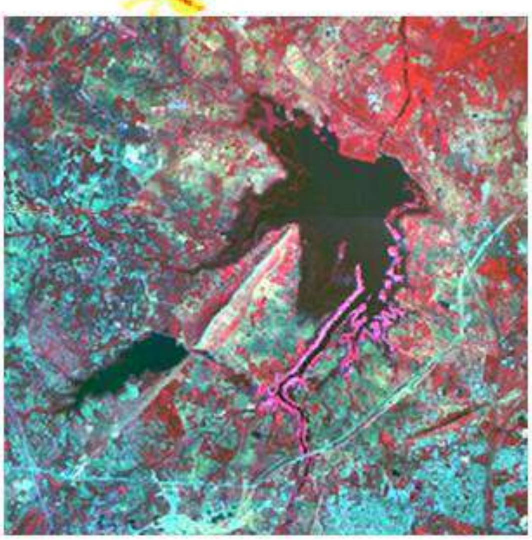


Image processing of 10 years satellite data for delineating minimum submergence Area





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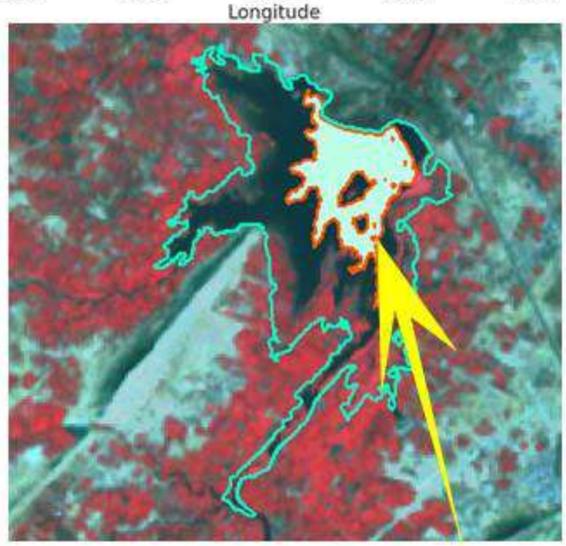
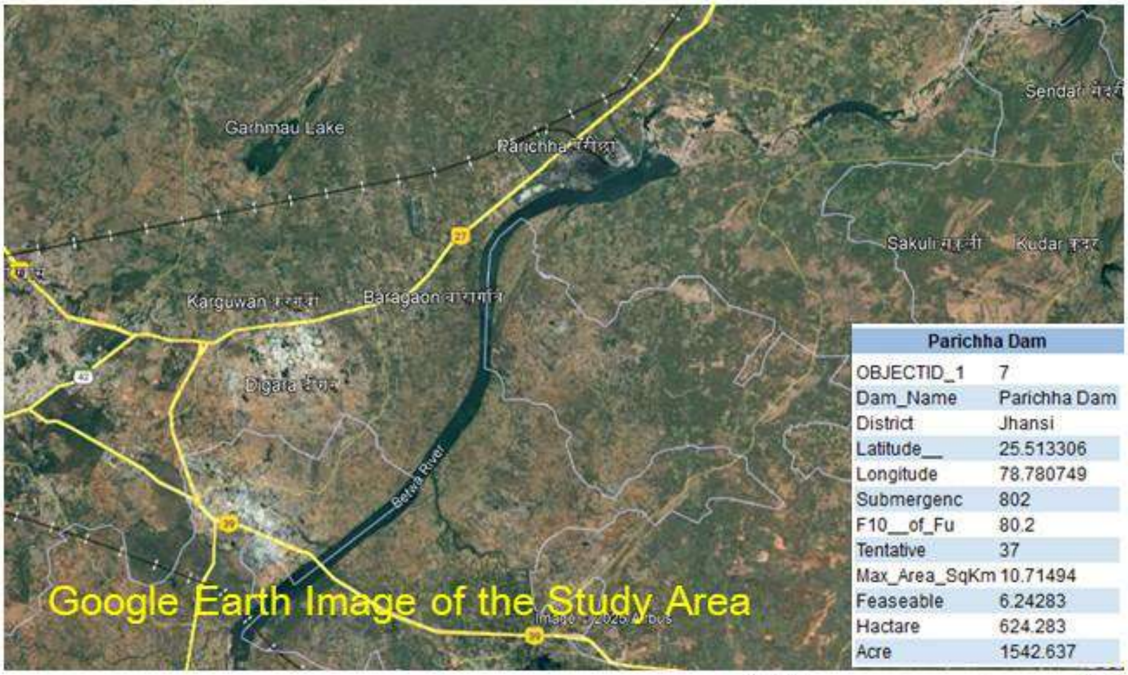


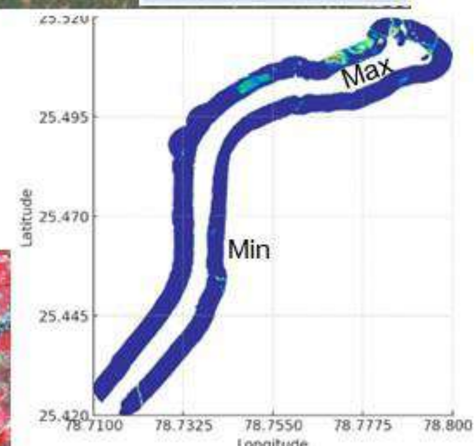
Feasible Area

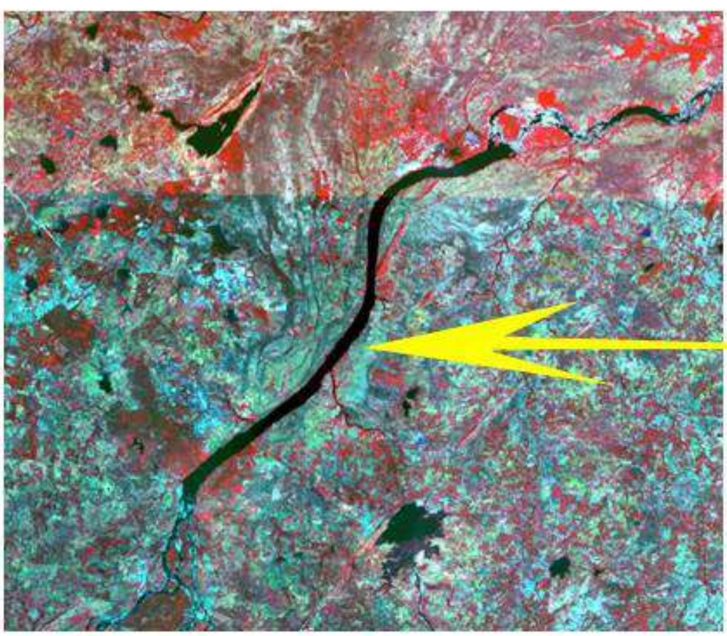
Parichcha Dam



Parichha Dam	
OBJECTID_1	7
Dam_Name	Parichha Dam
District	Jhansi
Latitude__	25.513306
Longitude	78.780749
Submergenc	802
F10__of_Fu	80.2
Tentative	37
Max_Area_SqKm	10.71494
Feaseable	6.24283
Hactare	624.283
Acre	1542.637

Image processing of 10 years satellite data for delineating minimum submergence Area





Feasible Area is observed to be in course shown

False Colour Composite of LISS 3 image

Pathrai Dam

Pathrai Dam	
OBJECTID_1	3
Dam_Name	Pathrai Dam
District	Jhansi
Latitude__	25.423457
Longitude	79.026405
Submergenc	594
F10__of_Fu	59.4
Tentative	27
Max_Area_SqKm	0.914906
Feaseable	0.118973
Hactare	11.89734
Acre	29.39896

Google Earth Image of the Study Area

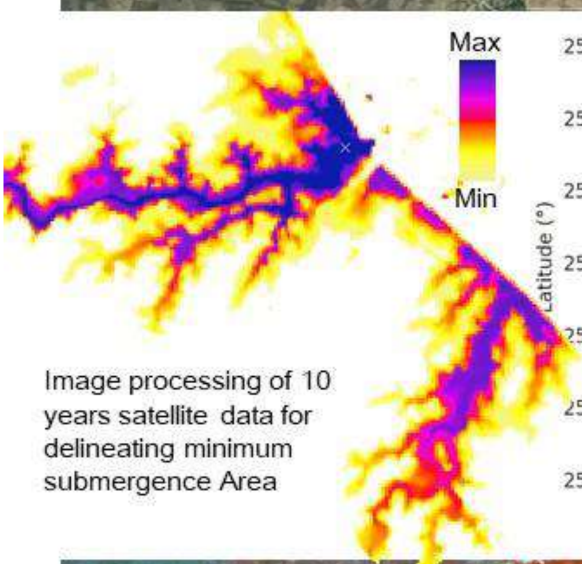
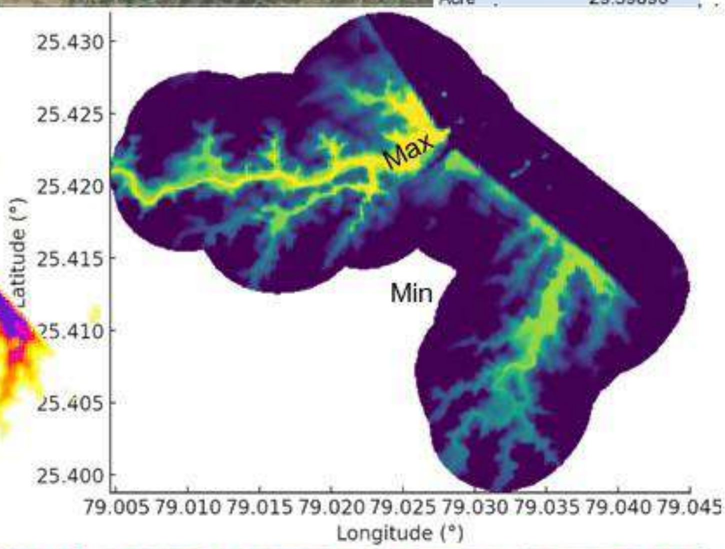
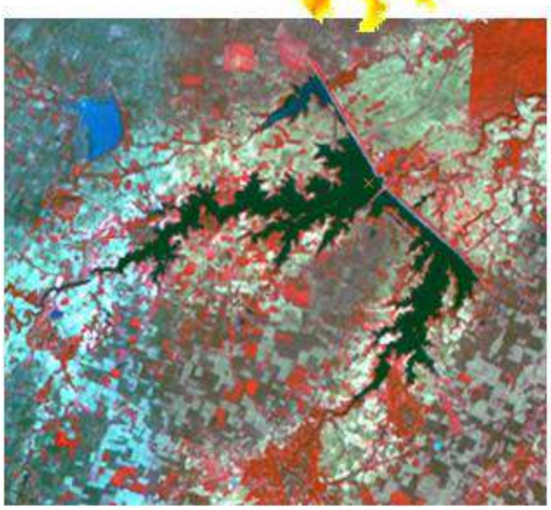


Image processing of 10 years satellite data for delineating minimum submergence Area





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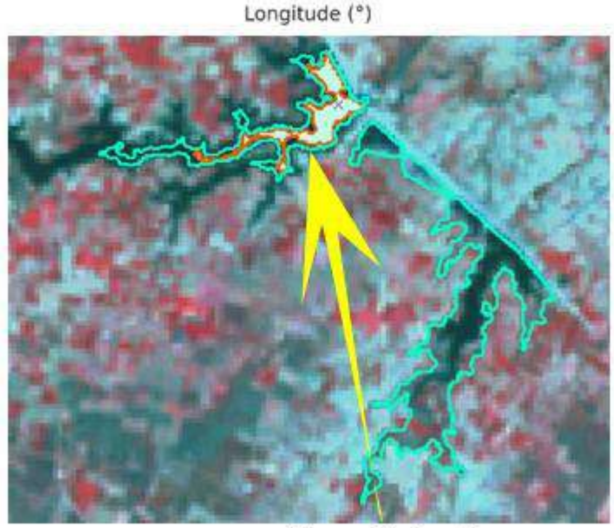
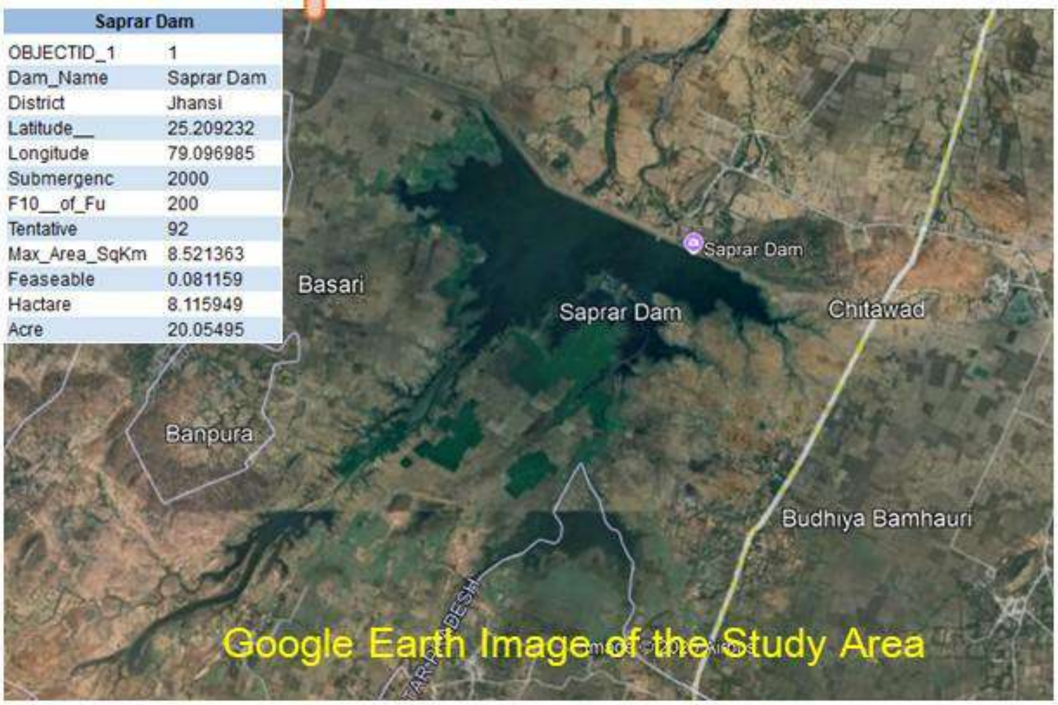


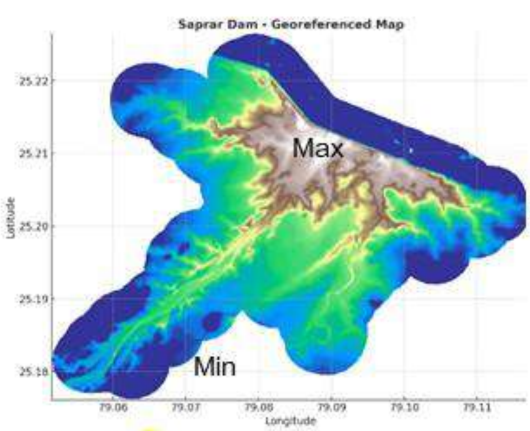
Feasible Area

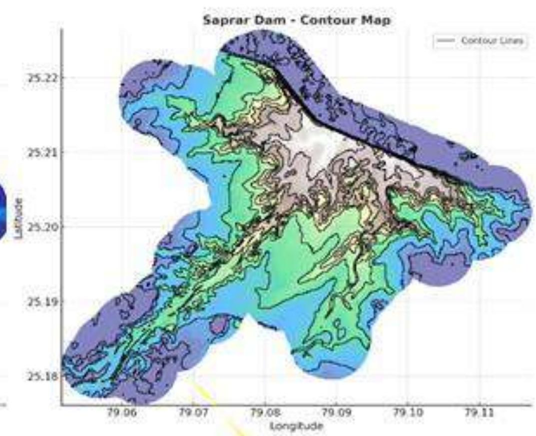
Saprar Dam



Saprar Dam	
OBJECTID_1	1
Dam_Name	Saprar Dam
District	Jhansi
Latitude__	25.209232
Longitude	79.096985
Submergenc	2000
F10__of_Fu	200
Tentative	92
Max_Area_SqKm	8.521363
Feaseable	0.081159
Hactare	8.115949
Acre	20.05495

Google Earth Image of the Study Area





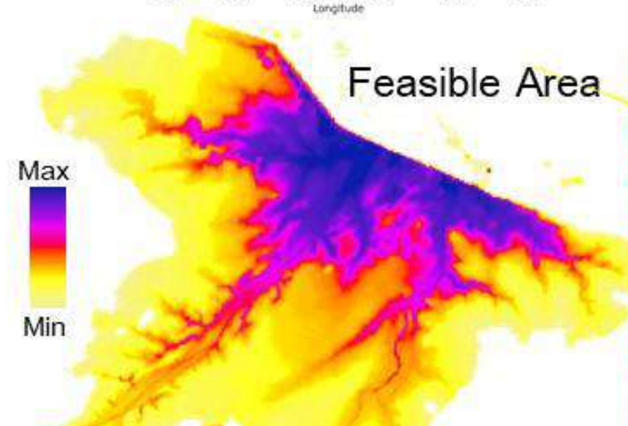
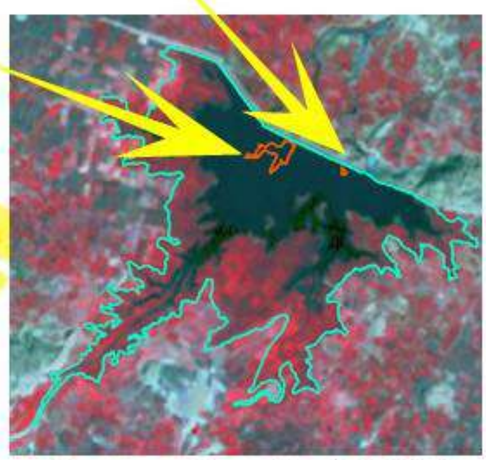


Image processing of 10 years satellite data for delineating minimum submergence Area

Feasible Area



False Colour Composite of LISS 3 image

5.4 Hamirpur District (Uttar Pradesh)

Dams Under Consideration: *Maudaha Dam, Majhgawan Dam, Lahchura Dam*. Hamirpur, another district in Bundelkhand just east of Mahoba, features a few medium-sized irrigation reservoirs. These dams are on tributaries of the Yamuna (e.g., Maudaha on the Birma river, Majhgawan on the Dhasan, and Lahchura on the Urmil) and primarily serve irrigation needs for this drought-prone area. **(Table-7)**

S No	Name of Reservoir/Dam	Latitude	Longitude	Feasible Area in Acre	Area in SqM
1	Lahchura Dam	25.3174	79.275662	303.818	1906893.758
2	Mahjagwan Dam	25.189893	79.548744	25.51493	4837550.369
3	Maudaha Dam	25.568801	79.712968	988.9922	11999480.21

Technical Feasibility: Maudaha Dam is one of the larger ones here, with a reservoir area of about **54 km²**. Around **250 ha** is deemed feasible for solar deployment, which corresponds to roughly **9.9 MW** of capacity, producing ~40 GWh/year. **Majhgawan (Majhgawan** often spelled *Majhgawan*) is smaller (~8.3 km²), with ~38 ha feasible, for about **2.5 MW** capacity and 10 GWh/year. **Lahchura Dam** (though listed under Hamirpur in the dataset, it sits near the border of Mahoba) has around **41 ha** feasible, for ~3.0 MW and 12 GWh/year. Cumulatively, Hamirpur's dams could host on the order of **15 MW** of floating solar, generating ~62 GWh annually.

Technical factors are favorable: these reservoirs have wide open water surfaces and are not very deep, simplifying anchoring. The solar arrays would likely be placed near the dam walls or in arms of the reservoir that are not used for outflow. The climate is hot and semi-arid; panels on water will actually operate a bit cooler (due to evaporative cooling effect) than on land, potentially giving a performance boost. Dust could be an issue in summer, but rainfall in monsoon will clean panels. Wind is low to moderate; storm squalls can occur but floating systems are generally designed to withstand sufficient wind speeds with anchoring. There are no known technical impediments unique to these sites – they can largely replicate what might be done in Jhansi or Lalitpur, just on a slightly smaller scale per site. A key aspect will be ensuring that during periods of reservoir drawdown (when water is used for irrigation and levels fall), the anchoring ropes/cables can be adjusted to the new water depth so that the solar rafts don't bottom out or drift. This is manageable with elastic mooring or adjustable anchors.

Hybrid Renewable Potential: Hamirpur's dams do not have hydropower plants and the wind regime is weak, so the hybrid focus here would be on **solar + water resource management**. A beneficial hybrid configuration could be using floating solar to **power nearby irrigation pumps and village electrification systems**. For instance, if the irrigation department has pumping stations or lift canals off these reservoirs, equipping them to run on the solar generation (at least during daytime) could make a neat integration – it ensures the solar is used locally and reduces grid dependence. Additionally, one could integrate **solar-driven aeration** in the reservoirs to improve water quality (especially in Maudaha, which can become stagnant in dry seasons). While not an energy hybrid, there is also scope for **pumped storage** concept between reservoirs in Hamirpur/Mahoba (though elevation differences are small, making it less ideal). Realistically, the hybrid solution is more about operational synergy: using solar output to time the water releases. For example, schedule major water releases for irrigation during the day when solar is active so that any hydro-mechanical gates or pumps can use that power; store water at night when there is no solar and perhaps when power is drawn from the grid. Since wind isn't available, **diesel generators that might have been used for remote pumps can be replaced by solar**, which is a sustainability improvement. In summary, traditional hybrid generation (mixing multiple sources) is minimal in Hamirpur; instead, the emphasis is on **solar-irrigation coupling** and possibly solar-battery backup for local needs (small batteries could store some solar power to run reservoir outlet controls or village supply after sunset).

Socio-Economic & Environmental Impacts:

Local Communities: Hamirpur is an agriculturally oriented district with frequent drought challenges. Floating solar could indirectly help by preserving water (shading even a few percent of Maudaha reservoir might save a measurable volume of water over a hot summer). This means more water available for farmers later in the season. Additionally, if part of the project's benefits are shared, villagers might get improved electricity for water pumps, which is crucial for irrigation. A socio-economic plus is that **floating solar diversifies the local economy** – currently, these areas have limited industry. The projects will inject some capital investment, create temporary jobs (construction, assembly), and a few permanent jobs. Skills training can be provided to locals to serve as plant operators or panel cleaners, ensuring ongoing employment.

Fishing and Livelihoods: Maudaha Dam and others do support fishing (often local cooperatives or contractors harvest fish from the reservoirs). The project should ensure not to hamper this – which is feasible by restricting panel placement to certain zones. In fact, similar to other districts, **fish may thrive under the shade of panels** which can reduce water temperature extremes. The community could be allowed to set up fish rearing nets in the shaded region if it proves beneficial.

Environment: These reservoirs are not known to be critical wildlife sanctuaries, but they are part of the regional ecosystem. Covering small portions is unlikely to affect birds or reptiles significantly. The usual benefits of **reduced algal growth and preserved land** apply here too – with less direct sun, harmful algal blooms could be curbed, keeping the water healthier for both humans and wildlife. Since Hamirpur is drought-prone, any evaporation reduction is ecological gold: more water remains to support local flora/fauna around the reservoir edges. One possible issue is if a reservoir nearly dries up in a drought, the solar floats would be sitting on land or very shallow water, which might require a plan to safely secure them if water levels drop extremely. But typically, a minimum pool is maintained for these irrigation dams. *Social considerations:* The people in this area might not be very familiar with solar technology, so awareness campaigns can help – e.g., a demonstration of a small floating panel powering a pump could tangibly show them how it works. Ensuring that the project does not conflict with any religious or cultural use of the water (sometimes villagers hold ceremonies at reservoirs) is important. To illustrate positive impact: if solar reduces the need for the state to do load-shedding (power cuts) in summer, that means tube wells run by electricity in Hamirpur can operate more hours, benefiting agriculture. Overall, the social and environmental impacts are largely positive or neutral, provided stakeholders are included and mitigation strategies (for fishing, etc.) are in place.

Impact on Nearest Major City: Hamirpur's power output would feed into the UP grid likely via existing lines that connect to **Kanpur** (the nearest large city, ~100 km away) and the central UP network. Hamirpur town and the slightly bigger city of **Orai** (in neighboring Jalaun district) are local load centers that could directly benefit. The scale here (~15 MW) is not huge, but it can supply a chunk of daytime power for these towns and nearby villages, potentially reducing their dependence on long-distance supply. Integrating the solar should be straightforward: Maudaha dam, for instance, might already have a substation for its irrigation pumps that can be upgraded to handle power evacuation. The grid in Bundelkhand seems to be improving, with new 132 kV and 220 kV lines being laid under various rural electrification schemes. The additional solar generation will mostly be consumed locally in Hamirpur/Mahoba districts, strengthening the rural grid. If any power surplus flows out, it would likely go towards **Kanpur's industrial demand**. Kanpur, being an industrial metropolis, always needs power; though Hamirpur's contribution will be a drop in the bucket for Kanpur, it still diversifies the supply sources and provides clean energy to the mix. It should be ensured that each dam site's interconnection is robust – a challenge in rural areas is sometimes the substation capacity is limited. So a recommendation could be to construct a dedicated feeder from Maudaha solar plant to the nearest 132 kV substation to reliably export power. In summary, distribution is feasible with minor grid upgrades, and the major city impact is moderate (benefiting regionally more than a specific big city).

Recommendations:

For Hamirpur, given the moderate scale, these projects might be best implemented in tandem with those in neighboring districts (to attract developer interest). Recommendation emphasize the **water-saving benefits** in project, as that resonates strongly in this drought-hit area. Technically, choose robust float designs that can handle periods of low water (perhaps incorporating adjustable or longer anchoring lines). A practical tip is to schedule most installation activity outside of peak irrigation season – e.g., install just after monsoon when reservoirs are fullest and before massive drawdowns for rabi crop irrigation occur. Engage the **District Water Management authorities** in the planning – since they manage reservoir levels, they can advise on typical fluctuations and ensure solar arrays are placed where water is relatively deep year-round. Suggestions for exploration of a pilot where a portion of the solar plant's output is directly allocated to a **local feeder for agriculture** – this could be done by connecting the solar plant to a dedicated irrigation pump set network, which would ensure farmers see immediate benefit (like certain hours of free solar power for pumping). From a sustainability angle, maintain a small **buffer fund for panel replacement/repairs**, as the environment (high heat, dust) can cause wear; timely maintenance will keep performance up. In terms of social measures, forming a liaison committee with members from local farmer groups, fishing communities, and the project team would help address any issues promptly. This forum could meet quarterly to discuss project impacts and adjustments needed – a way to keep the community invested and heard. By implementing these suggestions, Hamirpur's trio of dams can reliably contribute to sustainable energy and water security for the district.

Lachaura Dam

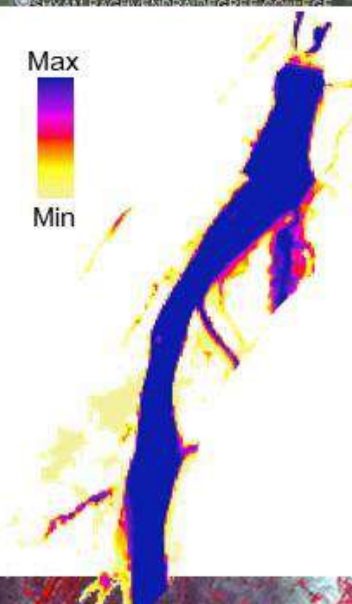
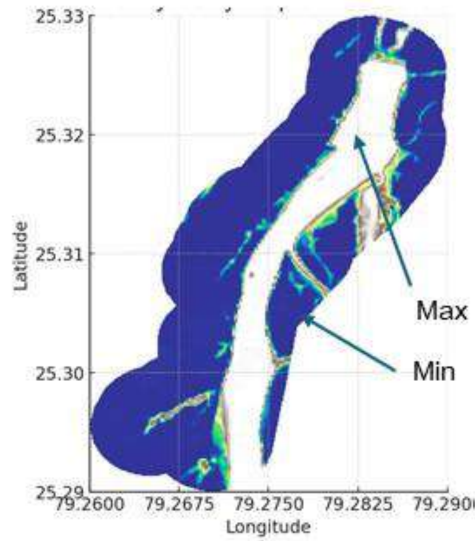


Image processing of 10 years satellite data for delineating minimum submergence Area



False Colour Composite of LISS 3 image

Feasible Area

Manjhgawan Dam

Google Earth Image of the Study Area

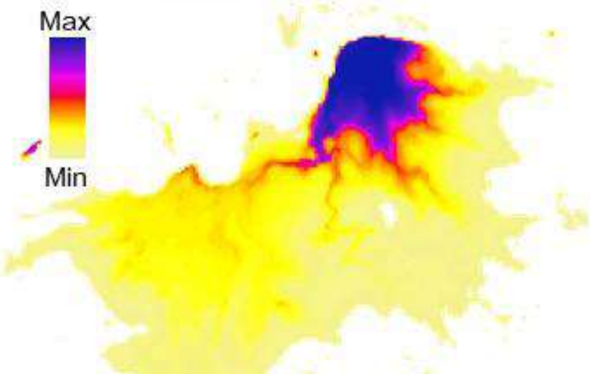
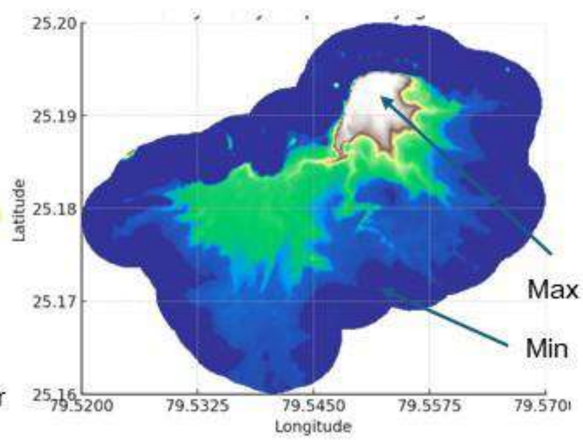
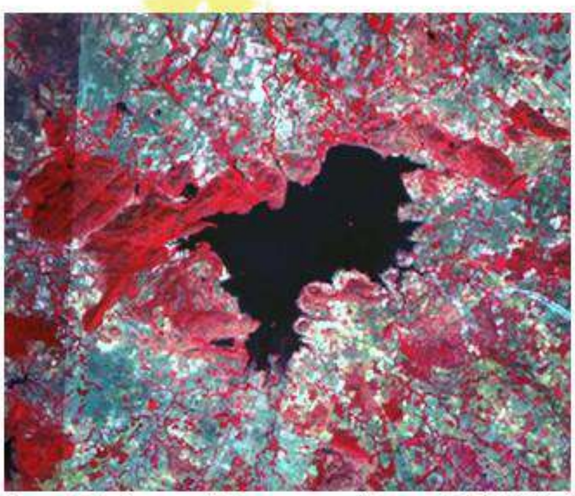


Image processing of 10 years satellite data for delineating minimum submergence Area





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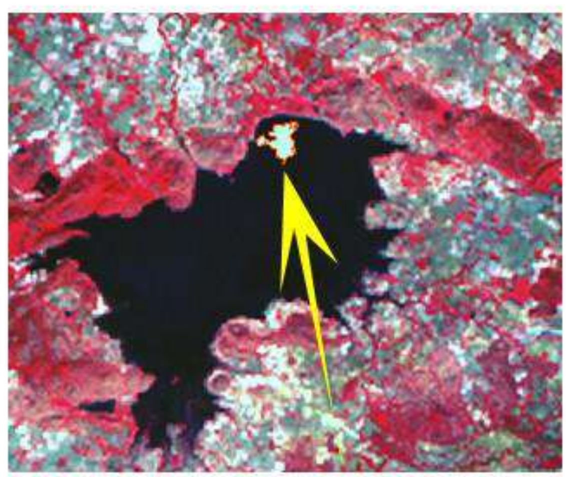
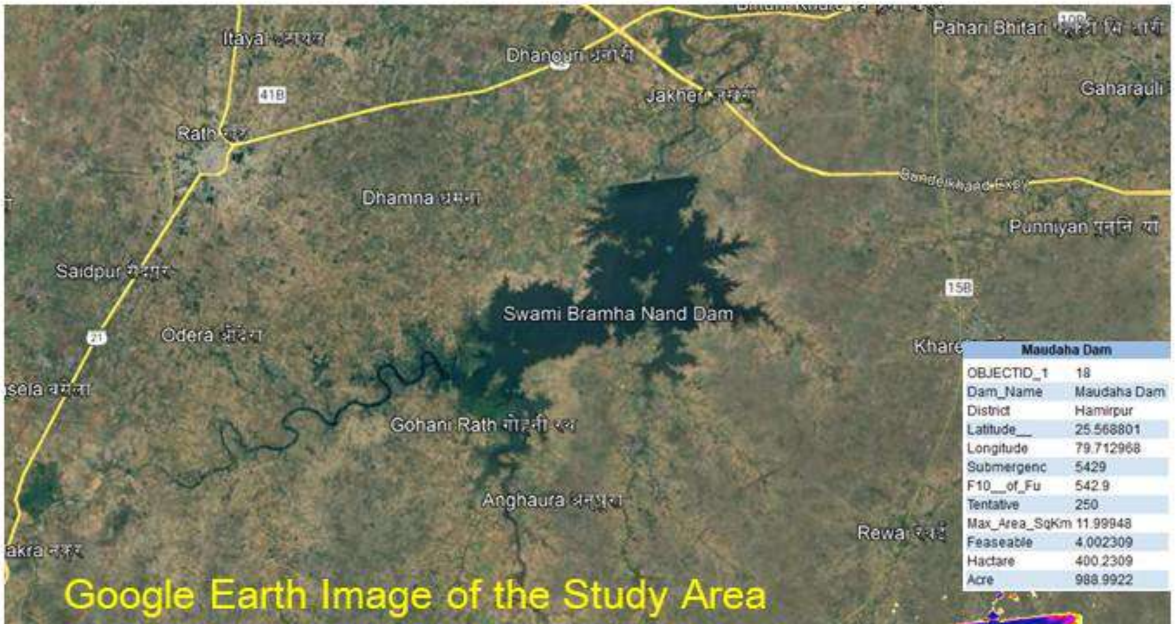
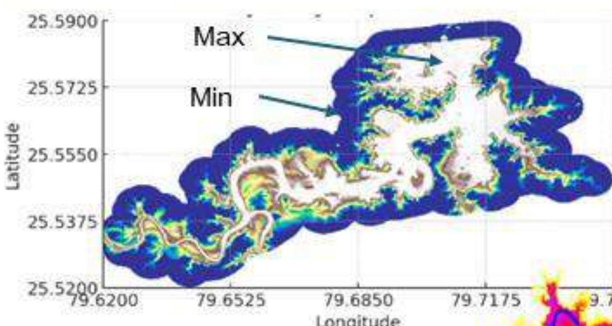


Feasible Area

Maudaha Dam



Maudaha Dam	
OBJECTID_1	18
Dam_Name	Maudaha Dam
District	Hamirpur
Latitude__	25.568801
Longitude	79.712968
Submergenc	5429
F10__of_Fu	542.9
Tentative	250
Max_Area_SqKm	11.99948
Feaseable	4.002309
Hactare	400.2309
Acre	988.9922



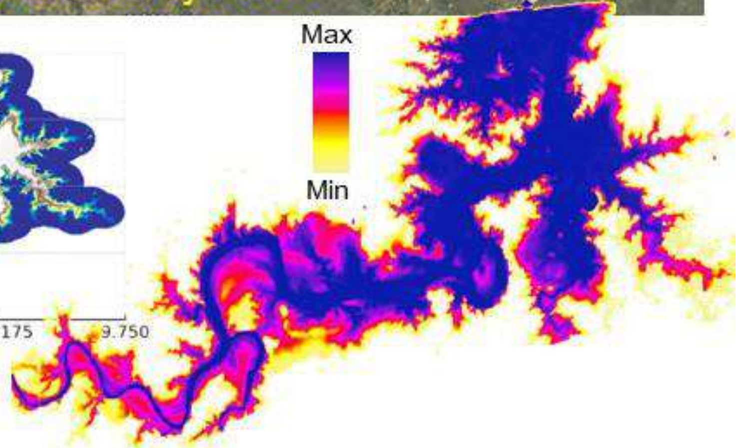
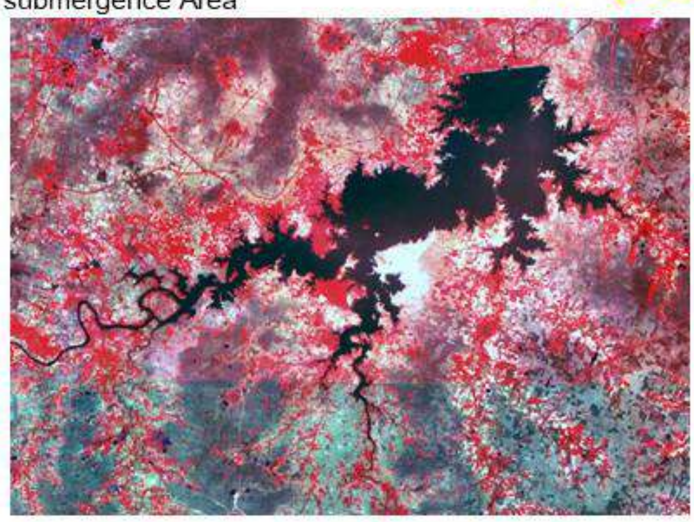


Image processing of 10 years satellite data for delineating minimum submergence Area



False Colour Composite of LISS 3 image

Feasible Area

5.5 Mahoba District (Uttar Pradesh)

Dams Under Consideration: *Arjun Sagar Dam, Chandrawal (Chandrawal) Dam, Kabrai Dam, Bela Sagar*. Mahoba district, adjoining Hamirpur, is also part of Bundelkhand and is known for its historic lakes and quarries. The listed dams and lakes in Mahoba are medium to small reservoirs that support irrigation and local water supply. **(Table-8)**

S No	Name of Reservoir/Dam	Latitude	Longitude	Feasible Area in Acre	Area in SqM
1	Arjun Dam	25.384586	79.669171	334.8658	7536824.71
2	Bela Sagar	25.265658	79.584136	7.418057	4973906.318
3	Chandrawal Dam	25.439832	79.894978	18.01235	4512028.188
4	Kabrai Dam	25.407973	79.969911	14.11286	2284623.806

Technical Feasibility: Arjun Sagar Dam (Urmil River) has a reservoir area around **18 km²**, with ~83 ha marked feasible for solar, corresponding to ~3.3 MW capacity and ~13.6 GWh/yr generation. **Chandrawal Dam** (~11.9 km²) with ~55 ha feasible, ~1.8 MW and 7.3 GWh/yr. **Kabrai Dam** (a smaller lake used also for stone quarry operations water supply) ~5.05 km², ~23 ha feasible, ~14.1 MW (this seems high for 23 ha – possibly 14.1 MW was meant as 1.41 MW if a decimal misread, since 23 ha realistically would be ~≈5 MW; the dataset's figures might have a scaling issue here) and ~57 GWh/yr (likely 5.7 GWh if 1.4 MW; so assume Kabrai ~5 MW potential). **Bela Sagar** (~9.26 km²) with ~43 ha feasible, ~7.4 MW, 30 GWh/yr. Summing up, Mahoba could host roughly **15–20 MW** of floating solar across these sites, similar to Hamirpur.

The technical conditions are comparable: relatively calm reservoirs, significant seasonal level changes, and high insolation. One unique aspect: **Kabrai Dam** is adjacent to extensive granite quarries – dust from stone crushing operations might settle on panels, so anti-soiling coatings or frequent cleaning would be especially needed there. The floats and panels in all sites must withstand high summer temperatures (~45°C common in Bundelkhand summers). Material selection should favor UV-resistant and heat-resistant components. None of these sites is very deep, so anchoring can be done with either shore tethering or bottom anchors fairly easily. As with other small sites, connecting them to the grid at the nearest substation (probably the Mahoba or Kabrai substation) will be a part of feasibility – distances are not large though (Kabrai is on NH34 with grid lines nearby, Arjun Sagar has transmission for its small hydro plant, etc.). Wind is low, and storms are mostly just monsoon thunderstorms which the systems can be built to endure. Overall, the technical feasibility is sound, with careful consideration needed for dust mitigation and anchor adjustments.

Hybrid Renewable Potential: Mahoba's Arjun Sagar Dam actually has a small hydropower component (Irrigation Dept had a plan for a few MW hydro there). If functional, the pairing is akin to Dhukwan – small hydro firm power plus solar variable power. So solar could supplement Arjun Sagar's hydro output when water releases are low. Otherwise, like Hamirpur, the main "hybrid" advantage is solar aiding water management. Mahoba is historically water-scarce; the combination of solar power and water storage can be harnessed by, say, **using solar energy to pump water from Bela Sagar or other bodies to nearby higher elevation tanks** for later use (essentially a small-scale pumped storage for irrigation). There is also scope to combine solar with the **famous Mahoba tank systems** – e.g., if any traditional lakes in Mahoba (like Vijay Sagar, etc.) were considered, solar could help run their fountains or pumps. Wind is negligible. The district does have lots of open rocky land, so ground-based solar or even wind could be installed theoretically, but as per our scope, the focus remains on dam-based solar. One novel hybrid idea for Kabrai: since it's near industry, a solar plant on Kabrai lake could be tied directly to a local industrial microgrid for quarry operations, offsetting diesel gensets that sometimes power those. This would cut costs and pollution for the industry – effectively a private-sector hybrid use. In summary, Mahoba will primarily implement **solar with minor hydro coordination (Arjun)** and improved water/energy nexus for irrigation.

Socio-Economic & Environmental Impacts:

Local Communities: Mahoba's population includes many farmers and also laborers in stone mining. Floating solar projects could provide an alternate livelihood avenue for some, reducing sole dependence on the hard quarry work. Training locals to maintain solar farms (cleaning panels, monitoring floats) could create semi-skilled jobs in a region that needs them. For farmers, as elsewhere, more water conserved means better crop security.

Cultural impact: Mahoba has historical significance with some lakes like Bela Sagar having cultural importance (Bela Sagar is named after a local queen, etc.). Ensuring that solar installations do not mar any cultural heritage or views is important. For instance, panels could be placed on far sides of the lake, keeping the side near any temple or town free. *Environment:* Mahoba's reservoirs are not major wildlife sanctuaries but are part of local biodiversity. Partial coverage will likely have **neutral to positive impacts on water quality**. Given the region's extreme evaporation (dry hot winds), even a small reduction helps aquatic life survive longer into the dry season. No endangered species are known specifically in these man-made lakes. However, one consideration: the **Kabrai area is very dusty and has heavy vehicle movement**; care must be taken during construction to avoid any accidents with local traffic (safety for workers moving equipment in quarry zones). Floating solar, by displacing need for land solar, also leaves the surrounding scrubland intact which might be home to small fauna like lizards and birds.

Community acceptance: It should be high if benefits are communicated. Possibly, synergy with the quarry industry (as mentioned) could provide CSR support – local companies might support these projects if they see mutual benefit. Also, because Mahoba has seen out-migration due to lack of jobs, a new industry (renewables) could help retain some youth. Educationally, local schools can be engaged with site visits to the solar plant to spur interest in science and clean energy. On the negative side, there is not much foreseeable – just keep the public informed to dispel any myths (like sometimes villagers think panels might heat water or cause chemical contamination – which is not true as materials are mostly inert). Transparent info campaigns can handle that.

Impact on Nearest Major City: Mahoba is fairly rural; the nearest big nodes are **Mahoba town** itself and **Khajuraho** (a tourist city in MP not far from Mahoba). The power generated (15–20 MW) will enhance the local grid. Mahoba is on a rail route and getting more electrified infrastructure, which will demand more electricity. These solar plants feeding the local substation means **Mahoba and neighboring hamlets get daytime power directly from them**, improving reliability. Khajuraho (in MP) might indirectly benefit via grid if UP-MP interchange happens, though that's minor. The produced power will also supplement the supply to **Kanpur or Jhansi**

as needed via the state grid. Since the capacity is not huge, the local consumption might soak most of it (given agricultural pumps, small industries, domestic use in Mahoba).

Distribution-wise, Mahoba is connected to the 220 kV Sagar–Mahoba line and has 132 kV substations. Likely, a feeder from these dams could tie into the Mahoba substation. We foresee no major obstacles; just ensure the local distribution company upgrades any old lines to handle the injection. In effect, the project will strengthen electricity in a region at the end of the grid, reducing voltage drops. Tourists traveling through or locals will experience fewer power cuts at least during sunshine hours.

Recommendations: In Mahoba, coordinate efforts with Hamirpur as both have similar setups. It might be efficient to have a single O&M team for both districts due to proximity. For **Kabrai Dam**, because of industrial dust, it is recommended to implement an automated panel cleaning system or at least frequent manual cleaning (perhaps using reservoir water to spray-clean the panels occasionally). A pilot of **anti-dust coating** on panels in Kabrai could be valuable to see if it reduces soiling losses. **Arjun Sagar's small hydro plant** if operational should be integrated – perhaps set up a control such that when solar output is high, hydro gate opening is reduced (maintaining needed downstream flow but not generating power unnecessarily).The idea of a **microgrid** at Kabrai can also be explored: if local quarry operators can directly buy the solar power during working hours, that arrangement (wheeling the power through a dedicated line) could yield higher tariffs (good for project economics) and a stable customer, while reducing the quarry's diesel consumption. This public-private energy swap can be facilitated by the state if policy allows. In terms of community, given the cultural context, hold consultations especially for **Bela Sagar** – if there are any annual fairs or events on the lake, schedule around them and ensure those aren't hindered. If possible the project can be incorporated into local pride – e.g., "Bela Sagar now not only waters our fields but also lights our homes with solar energy." Such messaging can build public support. **Maintenance training**: since Mahoba is remote, training a couple of local electricians to troubleshoot basic issues will help, rather than waiting for a team from a city. Finally, tie these projects into Bundelkhand's broader water conservation programs. They can be highlighted as examples where water infrastructure is double-utilized for energy, aligning with government initiatives. Regular performance audits (to ensure the harsh conditions aren't degrading the system) should be done, say, every 5 years a thorough inspection and component replacement schedule.

Arjun Dam

Arjun Dam	
OBJECTID_1	15
Dam_Name	Arjun Dam
District	Mahoba
Latitude__	25.384586
Longitude	79.669171
Submergenc	1800
F10__of_Fu	180
Tentative	83
Max_Area_SqKm	7.536825
Feaseable	1.355154
Hactare	135.5154
Acre	334.8658

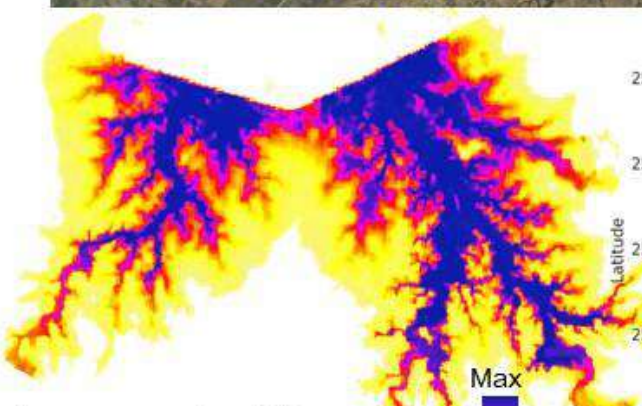
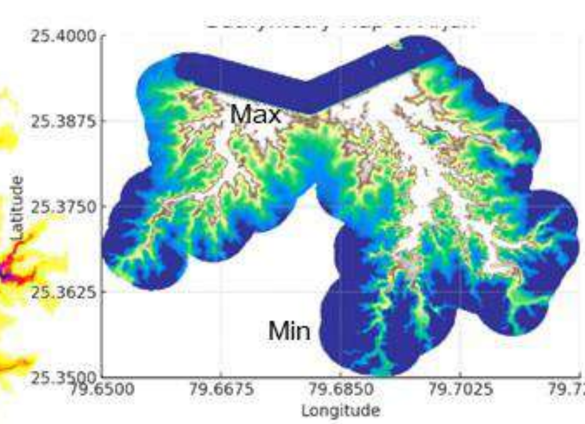
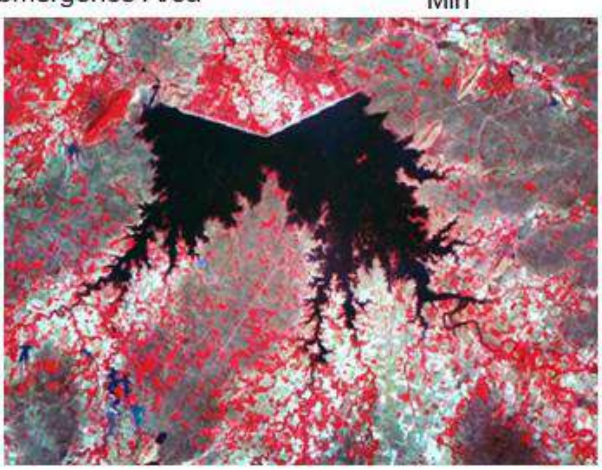


Image processing of 10 years satellite data for delineating minimum submergence Area



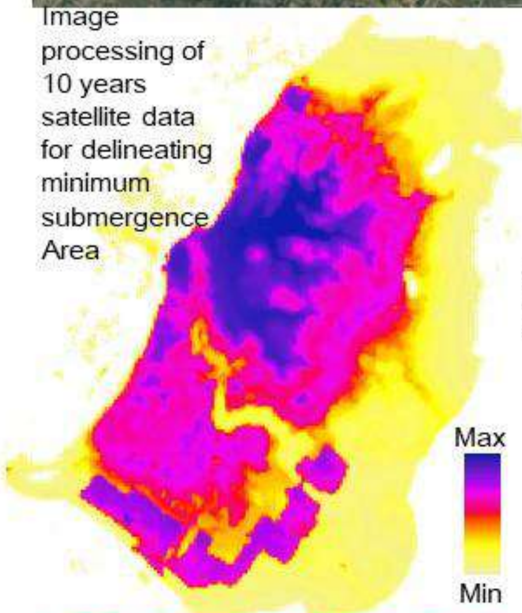


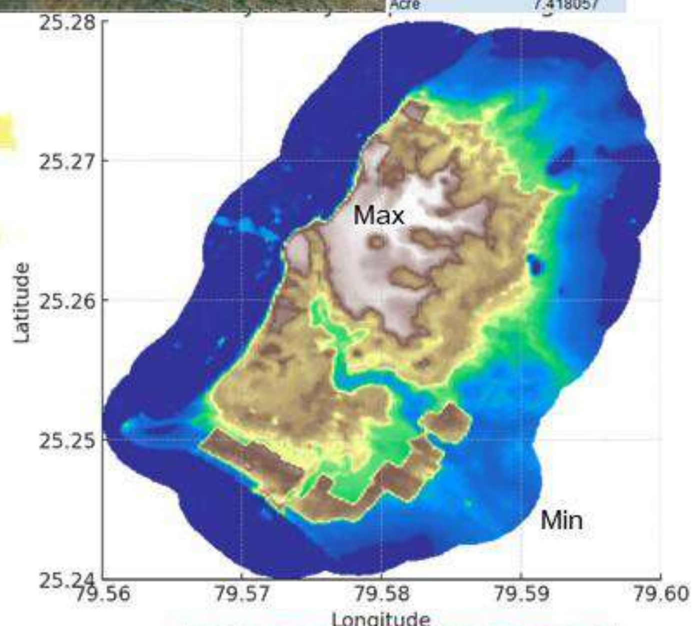
False Colour Composite of LISS 3 image

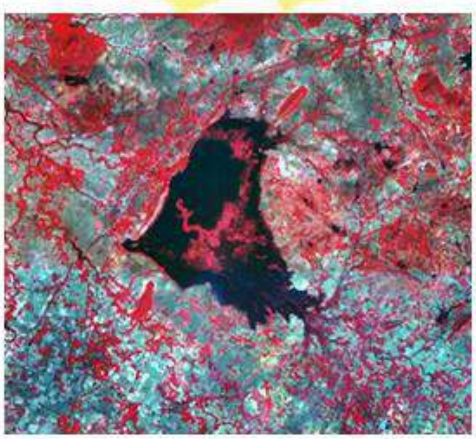
Feasible Area

Bela Sagar Dam

Bela Sagar	
OBJECTID_1	16
Dam_Name	Bela Sagar
District	Mahoba
Latitude__	25.265658
Longitude	79.584136
Submergenc	926
F10__of_Fu	92.6
Tentative	43
Max_Area_SqKm	4.973907
Feaseable	0.03002
Hactare	3.001981
Acre	7.418057







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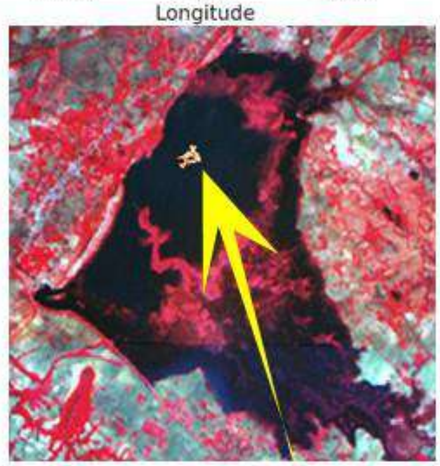
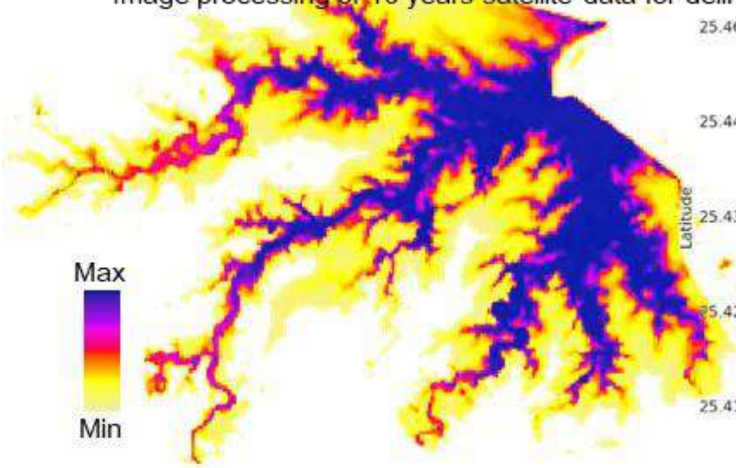


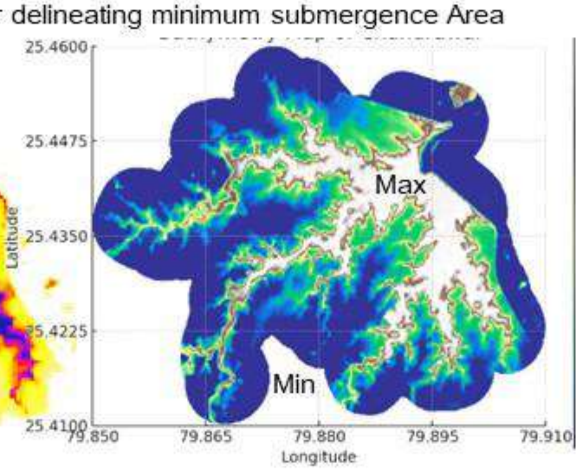
Feasible Area

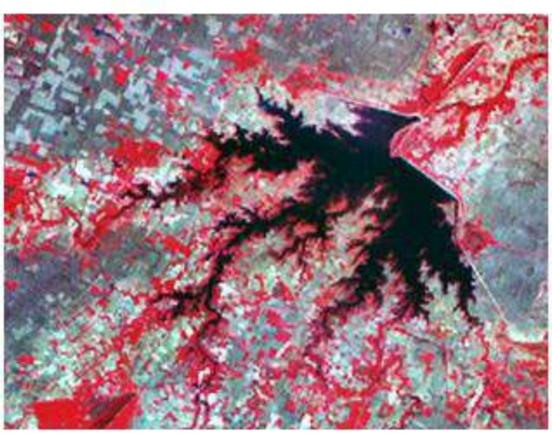
Chandrawal Dam

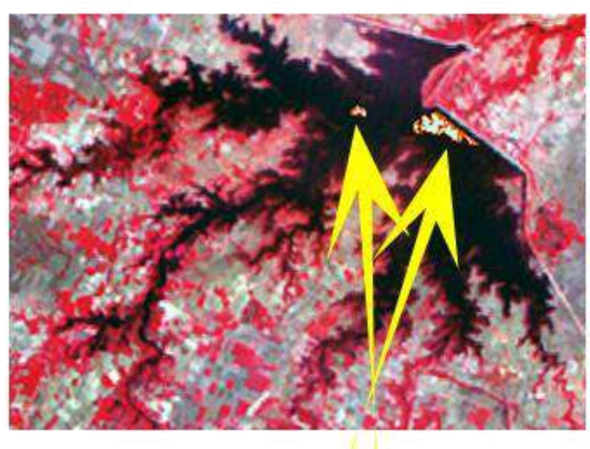
Chandrawal Dam	
OBJECTID_1	20
Dam_Name	Chandrawal Dam
District	Mahoba
Latitude__	25.439832
Longitude	79.894978
Submergenc	1192
F10__of_Fu	119.2
Tentative	55
Max_Area_SqKm	4.512028
Feaseable	0.072893
Hactare	7.289341
Acre	18.01235

Image processing of 10 years satellite data for delineating minimum submergence Area





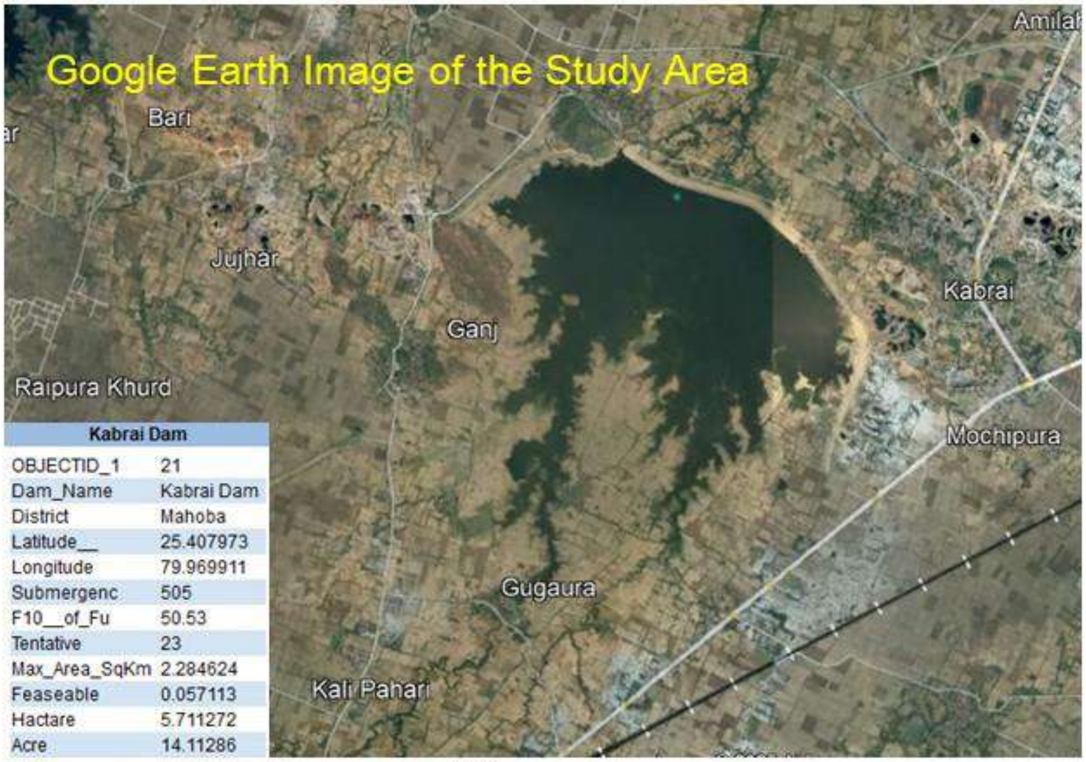




False Colour Composite of LISS 3 image

Feasible Area

Kabrai Dam



Kabrai Dam	
OBJECTID_1	21
Dam_Name	Kabrai Dam
District	Mahoba
Latitude__	25.407973
Longitude	79.969911
Submergenc	505
F10__of_Fu	50.53
Tentative	23
Max_Area_SqKm	2.284624
Feaseable	0.057113
Hactare	5.711272
Acre	14.11286

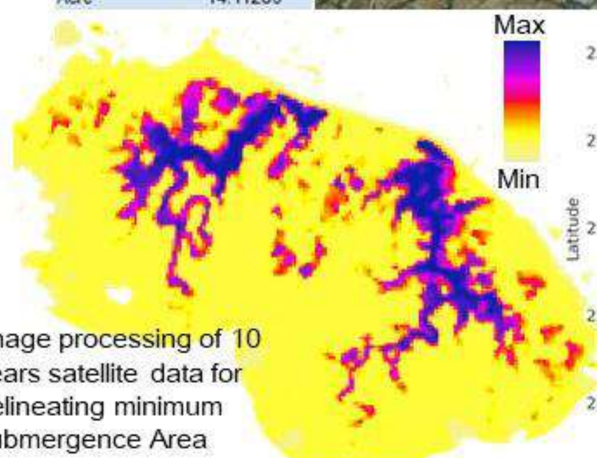
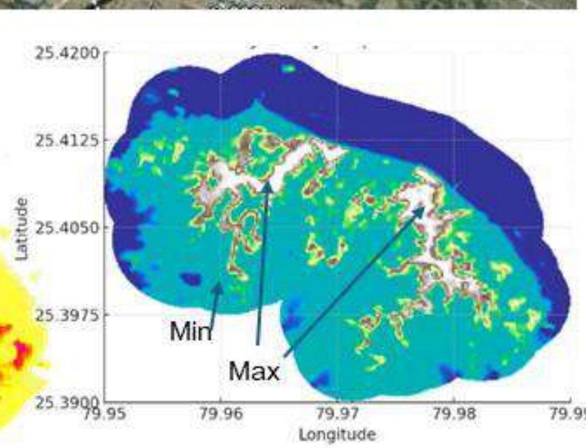
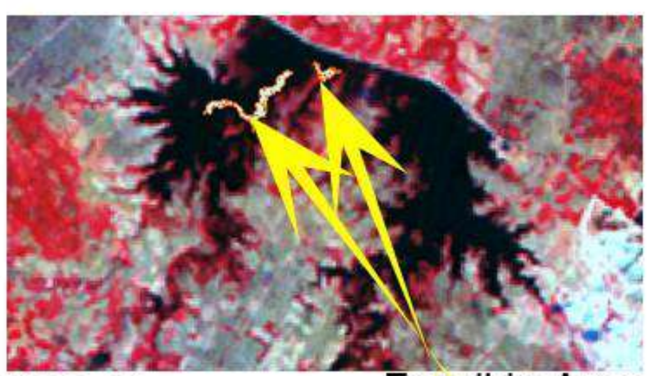


Image processing of 10 years satellite data for delineating minimum submergence Area





False Colour Composite of LISS 3 image

Feasible Area

5.6 Mirzapur District (Uttar Pradesh)

Dams Under Consideration: *Adwa Dam, Upper Khajuri Dam*.

Mirzapur district lies in southeastern Uttar Pradesh, south of Varanasi, and is characterized by undulating terrain and seasonal rivers. The dams in question are relatively small reservoirs used for irrigation and drinking water. **(Table-9)**

S No	Name of Reservoir/Dam	Latitude	Longitude	Feasible Area in Acre	Area in SqM
1	Adwa Dam	24.775901	82.303672	555.4677	4996560.706
2	Upper Khajuri Dam	24.993764	82.607422	163.7348	1436230.523

Technical Feasibility:

Adwa Dam has a reservoir of about **16.7 km²**, with roughly **77 ha** feasible for solar. This could allow an installation of ~5.5 MW, generating ~22.5 GWh per year.

Upper Khajuri Dam (sometimes called "Upper Khajuri") spans ~11.3 km², with about **52 ha** feasible, supporting ~1.64 MW and 6.6 GWh/year (the dataset figure of 163.7 might indicate ~1.64 MW). Combined, Mirzapur's two sites might yield ~7–8 MW. These are modest numbers, but the projects are still worthwhile given the local context. Technically, both sites are feasible for floating PV.

Mirzapur's climate is hot similar to Bundelkhand, with decent rainfall in monsoon. The water bodies are not extremely large, so a challenge might be anchoring if the reservoir bed is rocky or uneven (Mirzapur's geology is a mix of rocky hills). But anchor blocks or dead-weight anchors can do the job if needed. Another consideration: Mirzapur's reservoirs might have more frequent water fluctuations (some years they might nearly empty if rains fail). Designing the solar floats to be modular and possibly relocatable (so they could be moved to deeper parts if one section dries out) could be considered.

The area has no strong winds, just typical monsoon gusts. There is also precedent in the region: nearby, the **NTPC Rihand project** in Sonbhadra and another floating solar at **Meja (a thermal plant in Allahabad)** are being developed, so expertise is available in vicinity. The small scale of these Mirzapur projects suggests they could act as add-ons to larger solar initiatives in the region. Grid connectivity should be checked – these dams are likely not far from Mirzapur city which has good grid links, but if remote, a short transmission line may be needed.

Hybrid Renewable Potential:

Mirzapur district has some **hilly areas that see decent wind**; however, those are mostly along the Vindhya range edges and not necessarily at the dam sites. The dams themselves probably have no hydropower. A hybrid opportunity could be pairing solar with the **solar plant at NTPC Mirzapur** (which is a ground solar plant in the district) as part of a broader solar portfolio to smooth output. Alternatively, Mirzapur has a famous **solar plant at Chhanvey**; adding floating solar to the dam could complement the generation profile if connected to the same substation. Outside the direct scope, Mirzapur's geography has potential for pumped storage (there are hills and water bodies), but with only these small dams identified, that's not immediate. For wind, if any ridges near Adwa have micro-wind possibilities, it might be experimental at best. So practically, the hybrid consideration is low here – it will be mainly standalone solar feeding the grid.

One notable aspect: Mirzapur is near the **Vindhyachal thermal power complex**; there could be a concept of using solar (including these floats) to reduce load on those coal plants during day as part of the regional dispatch.

Socio-Economic & Environmental Impacts:

Local Communities:

Mirzapur is known for its carpet industry and also rural farming. Improved power from solar could indirectly help the small industries (e.g., weaving) by reducing power cuts. The dams in question supply water to local areas – for example, Adwa dam provides water to Mirzapur city. It's critical that floating solar doesn't interfere with the water treatment plant intakes or water quality. Fortunately, **floating solar can actually help water quality by curbing algal blooms**, which is beneficial for a drinking water source like Adwa. Strict protocols will ensure no materials leach from the floats (most floats are HDPE which is food-safe), keeping water safe.

Recreation and Aesthetics:

If these reservoirs are used for recreation or have scenic value (Mirzapur has some tourism to dams, albeit limited), care should be taken with placement. Possibly restrict panels to a bay or corner of the lake.

Wildlife: Mirzapur's water bodies sometimes attract migratory birds from the Ganges. Partial coverage shouldn't deter them significantly, but as always leaving ample open water is wise. If any part of the reservoir is ecologically sensitive, avoid that part. On the plus side, floating solar means **no tree cutting or land use change** around, preserving nearby forest patches.

Social: The projects are small but can have a demonstration effect for the community. Mirzapur has had issues with Naxal (insurgent) activity in remote areas historically – bringing development like solar energy can be a counter-measure by improving livelihoods. The construction and maintenance jobs, though limited, still matter in the local economy. People might be curious about this technology; public outreach can be done via local media, highlighting how it will bring cleaner water (less evaporation) and more electricity. Given Mirzapur's moderate population, the extra power might ensure the **towns have fewer outages**, which improves daily life. No displacements are involved since it's on water, which is good. Ensuring fishermen (if any) are consulted: if a portion of the lake is reserved for them and even improved (fish breeding grounds near floats), it will keep them satisfied.

Impact on Nearest Major City: The major city impacted here is **Mirzapur city** itself (and nearby Bhadohi perhaps). Mirzapur is a district HQ and has substantial electricity needs for households and small industries. The floating solar from Adwa and Khajuri can feed into Mirzapur's grid, which likely ties into the UP East grid heading to Varanasi. So **Varanasi** (a much larger city about

50 km north) could indirectly receive some of this power as well. However, given the scale, Mirzapur district will likely consume most of it.

The reliability of Mirzapur's supply should improve; currently it sometimes faces peaking shortages, and midday solar will help alleviate that. The distribution network is already in place since Mirzapur gets power from multiple sources (including Vindhyachal NTPC plant near). A small upgrade might be needed to connect the dam sites: e.g., a 33 kV line from Adwa dam to the city substation if not existing. Overall, integration is easy and the city benefits by having a local generation source (voltage support and reduction in transmission dependence).

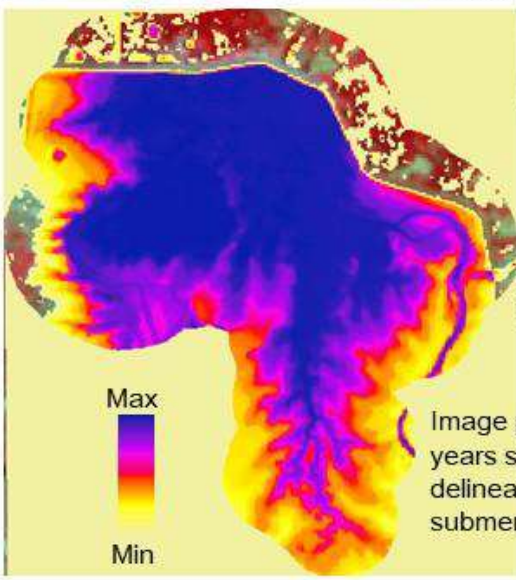
Recommendations: For Mirzapur, although the projects are modest, they are strategically important because Adwa is a drinking water source. **Close coordination with the Jal Nigam (water supply authority)** is highly recommended to ensure the solar installation doesn't hinder their operations. Possibly schedule the installation work in a lean water demand period (not in peak summer when water supply is critical) to avoid any risk.

Design-wise, **high-quality floats with certifications for potable water use** can be utilized, since this reservoir supplies drinking water – this will reassure the public that nothing toxic is touching their water. Also, maintain a buffer distance between the solar array and the water intake point so that maintenance boats and water quality monitors can operate freely there. As a plus, highlight that covering some surface will reduce evaporation, meaning more water for the city especially in summer (a direct boon). **Community engagement** could include inviting local leaders or even school children to view the setup once done, building a sense of pride that Mirzapur is adopting modern green tech.

Considering the region's context, involve local workforce and perhaps the famed local carpentry skills in building any required platforms or control rooms. Environmentally, keep monitoring for algae and water temperature – coordinate with local environmental NGOs or university (if any) to study impacts, since data on floating solar in drinking water reservoirs can be valuable for future projects. On hybrid aspect, though limited, maybe link these with the existing Mirzapur solar plant operations – the same O&M team can oversee both ground and floating systems.

Security: ensure fencing or watch around the reservoir if needed, since floating infrastructure might tempt curiosity or vandalism (though Mirzapur is generally peaceful, precaution is good). Provide training to the dam operators on basic solar plant controls, so they can assist if any minor issue arises. In terms of expansion, if these prove successful, Mirzapur can consider adding floating solar to more water bodies (there's Talkatora lake, etc.). For now, starting with Adwa and Khajuri with the above recommendations will set a strong example of integrated water-energy planning.

Adwa Dam



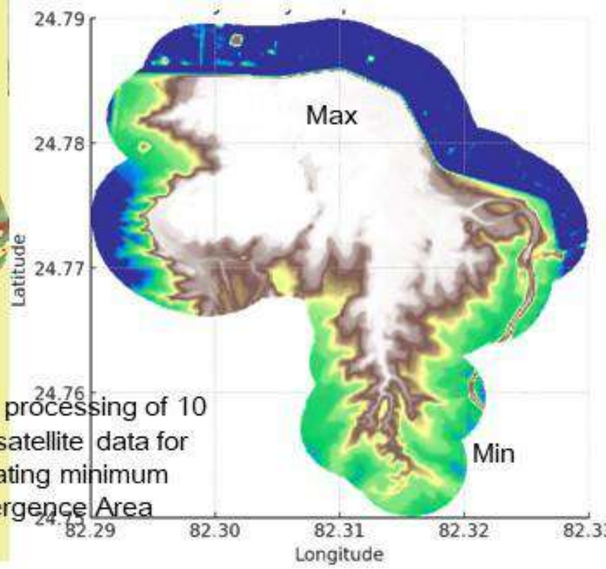
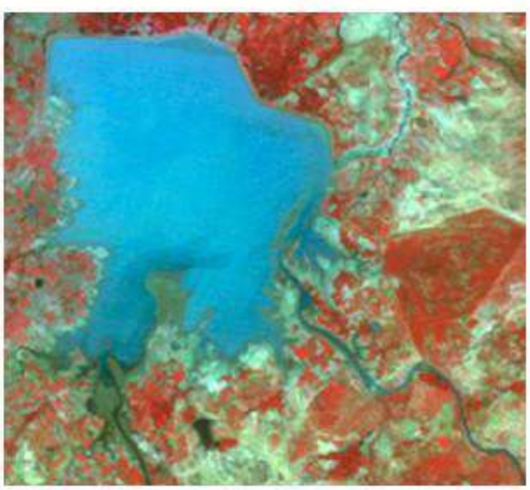
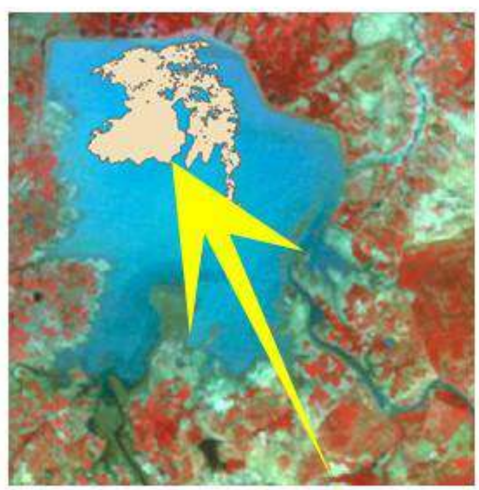


Image processing of 10 years satellite data for delineating minimum submergence Area





False Colour Composite of LISS 3 image

Feasible Area

Upper Khajuri Dam

Upper Khajuri Dam	
OBJECTID_1	26
Dam_Name	Upper Khajuri Dam
District	Mirzapur
Latitude__	24.993764
Longitude	82.607422
Submergenc	1131
F10__of_Fu	113.1
Tentative	52
Max_Area_SqKm	1.436231
Feaseable	0.662611
Hactare	66.26112
Acre	163.7348

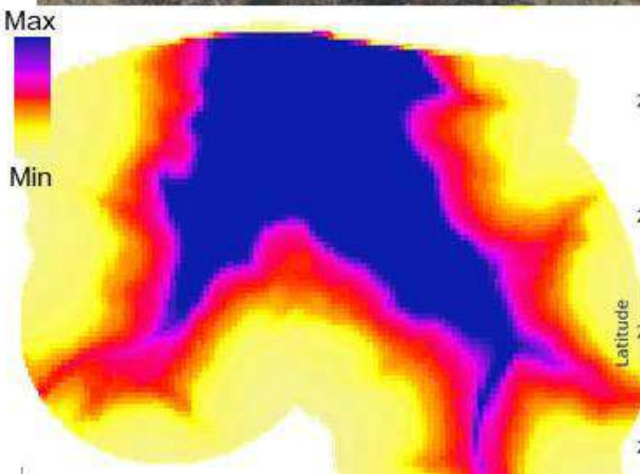
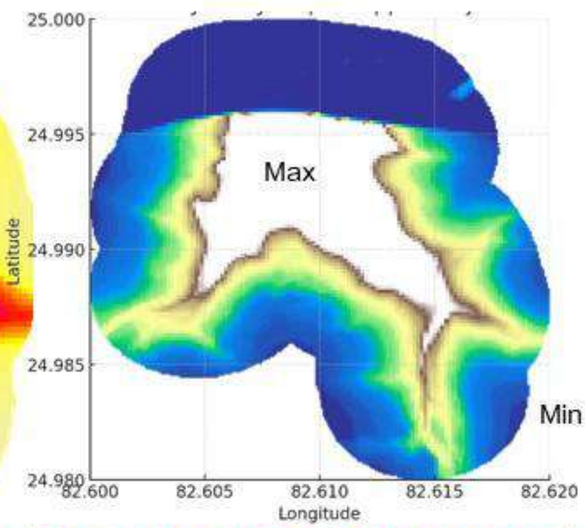
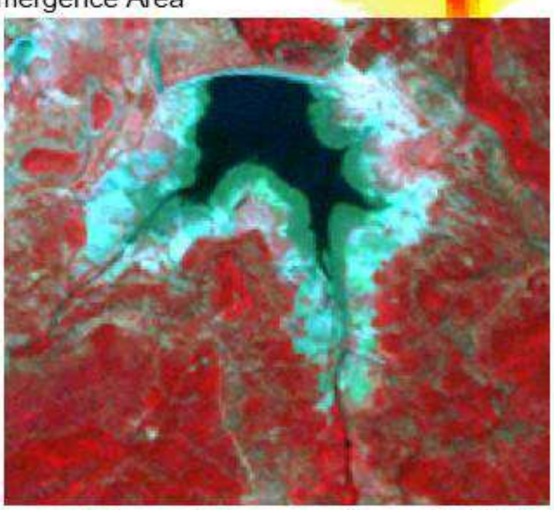


Image processing of 10 years satellite data for delineating minimum submergence Area





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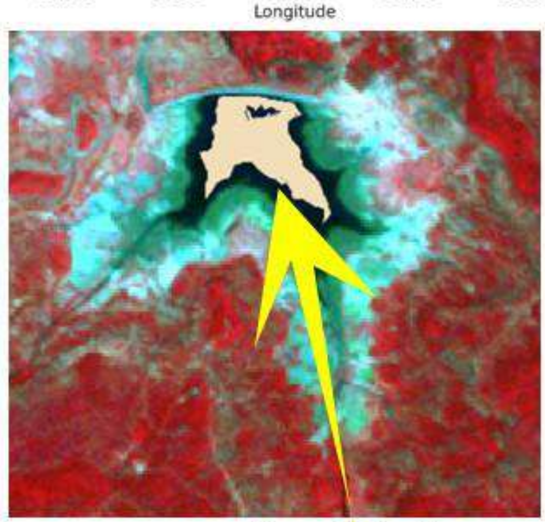


Feasible Area

5.7 Chandauli District (Uttar Pradesh)

Dams Under Consideration: *Latif Shah Dam, Naugarh Dam (a.k.a. Moosakhand/Naugarh Dam)*. Chandauli district, bordering Varanasi, includes the forested **Chakia plateau** area where these small dams are located. Latif Shah and the second dam (often referred to as Naugarh or possibly "Musahakhand" dam) are both on the **Karmanasa/Chandraprabha river tributaries** and are used for irrigation and flood control. They are also near the Chandraprabha Wildlife Sanctuary, making environmental considerations key. **(Table-10)**

S No	Name of Reservoir/Dam	Latitude	Longitude	Feasible Area in Acre	Area in SqM
1	Latif Shah Dam	25.022242	83.231156	12.8592	924273.8536
2	Moosakhand Dam	24.971062	83.281823	191.1754	10961586.28

Technical Feasibility: Latif Shah Dam, an old dam built in 1921 on the Karmanasha River, has a reservoir of about **5.11 km²**; around **24 ha** is feasible for solar, allowing roughly **~1.3 MW** (if 12.8592 was meant as 1,285.92 kW) and generating ~5.2 GWh/yr. The **Naugarh/Musahakhand Dam** (assuming this corresponds to the second entry) might be similar in size (likely around 13.69 km² given 136.9 in dataset), with ~63 ha feasible, yielding maybe **~1.9 MW** and ~7.7 GWh/yr. So total potential in Chandauli is on the order of **3 MW**. While small, these installations are feasible. The reservoirs are nestled in hilly terrain, which might make logistics a bit challenging – reaching the dam with heavy equipment means navigating forest roads. But since both dams exist, there should be basic access roads. The water surface is fairly placid except during heavy monsoon inflows. Anchoring might use a combination of bank tying (ropes to shore anchors) and bottom weights. One technical benefit: these smaller plants could be set up with minimal infrastructure – possibly even using the dam's service buildings for housing inverters and controls. Grid connectivity: Chandauli's Chakia region might not have high-capacity lines; a dedicated 33 kV line to nearest town (Chakia or Naugarh) may be needed. However, demand in the local area (villages and maybe sanctuary facilities) can absorb a good amount of the power. No significant wind potential here (surrounded by forested hills which actually break the wind).

Hybrid Renewable Potential: Being near a wildlife sanctuary, there's no hydro plant or wind farm around. A creative hybrid concept could be to use solar to power the **Chandraprabha Sanctuary's eco-tourism facilities** or forest offices, effectively a **solar microgrid** for park operations. This would tie renewable energy to conservation efforts (a synergy aligning with environmental values of the area). Since grid is weak in the sanctuary, the solar from the dam could even charge battery banks or feed into an off-grid system if needed. Another possibility: if any **water pumping is done for the sanctuary (like filling waterholes for wildlife)**, that could be solar-powered. There's also an existing **Chandraprabha Dam** (not listed, but nearby) that has a small hydro plant; if integrated, a trifecta of solar + small hydro in the sanctuary could be envisaged. Wind is basically a non-factor due to thick vegetation and low wind speeds. So in essence, the hybrid angle is more about using solar for supporting the protected area's needs and integrating with any micro-hydro or diesel replacement in the region.

Socio-Economic & Environmental Impacts:

Local Communities:

The area around Latif Shah dam is somewhat remote with tribal populations and forest-dependent communities. Development must be sensitive. Fortunately, floating solar has minimal footprint beyond the dam itself. Locals might gain some short-term jobs. More importantly, stable electricity in this area can improve quality of life – currently, power supply can be erratic in forest villages. If some of the solar is used locally, it could light up homes, schools, and health centers in Chakia block.

Environmental:

This is a critical aspect for Chandauli. Latif Shah dam is adjacent to forest and the **Latif Shah Wildlife Range**. Under 5% coverage of the reservoir with solar likely won't harm the habitat much, but it must be ensured that it doesn't disturb any key aquatic species. Chandraprabha Sanctuary hosts crocodiles in its reservoirs and waterfalls – need to ensure the floating structures don't hinder their basking areas or movement (though Latif Shah dam might be outside core sanctuary). Thorough environmental assessment is recommended. On the positive side, using reservoir for solar means **no tree clearing** in these forests for a solar farm, which is a huge plus. Noise and pollution during construction should be minimized to not disturb wildlife; timing outside breeding seasons for key species is advisable. Once operational, solar panels silently generate power and pose little disturbance. Perhaps the shade could even benefit some aquatic organisms as in other cases.

Social and Cultural:

Latif Shah dam itself is named after a Sufi saint and is a local tourist picnic spot (with a waterfall downstream). Visually, the presence of solar panels on the water might change the ambiance slightly. The design could cluster them in one part of the reservoir to keep the main sightlines clear. Also, since it's an old dam, local sentiments might require that the historical value is respected (though panels won't touch the dam structure itself). Engaging local leaders and the shrine caretakers (if the saint's mazar is nearby) would help in gaining support. From a socio-economic perspective, electrifying this area reliably could reduce dependence on wood fuel (if people get electricity for cooking/heating via maybe electric cookers), indirectly benefiting forests. Additionally, the project can tie in with **eco-tourism**: signage could educate visitors about renewable energy, making the dam not just a picnic spot but also an educational showcase for sustainability.

Impact on Nearest Major City: The nearest major population center is **Chakia/Naugarh town** (small towns). The nearest big city is actually Varanasi (~50–60 km) but the power from here will feed mostly local/rural demand due to limited size. It might stabilize the local feeder which ultimately is connected to the Varanasi grid. In that sense, **Varanasi gets a marginal benefit** of additional clean energy (Varanasi being a big city will take any extra unit it can get from the grid). But more directly, the impact will be on **Chandauli town and Mughalsarai** (a major railway junction) by strengthening the feeder line from the south. The distribution to remote forest villages could be improved by tapping some power locally with microgrids, as mentioned. However, if fully grid-tied, the generation will merge into the state network. The small capacity means no strain on distribution – existing 33 kV lines can handle it. It essentially provides a localized generation point, improving voltage for consumers at the tail end of the line in that region (who previously got low voltage due to distance from main plants). So while the effect on a major city is minor, it ensures **rural electrification goals** in that part of Chandauli are better met, which is an important aspect of equitable development.

Recommendations: For Chandauli, due to the environmentally sensitive setting, the first recommendation is to conduct an **environmental impact assessment (EIA)** specific to floating solar in this locale. Consult wildlife experts to decide where on the reservoir to place panels to avoid critical habitat interference. Possibly use **wildlife-friendly designs** – for instance, incorporate gaps in arrays to allow animals to swim through if needed, or use non-toxic materials and perhaps even add features like turtle ramps if applicable (just as a thought if turtles are in the lake). The project should have the **sanctuary authorities on board** from day one – maybe even make them a stakeholder by powering their facilities as noted. If a portion of the power is reserved for sanctuary use (like running eco-tourism guest houses or anti-poaching camps on solar), it demonstrates commitment to conservation. Also, work with the **Forest Department** regarding tree trimming for any transmission line – keep it minimal or use existing clearings to route lines so that no new deforestation occurs. For community, ensure outreach to tribal communities if present; sometimes these areas have unique needs and viewpoints that should be respected. Culturally, coordinate with caretakers of Latif Shah’s tomb (as that’s a local cultural site) to ensure they’re comfortable with the project – perhaps even supply the tomb complex with free solar power for lighting, as a goodwill gesture. *Technical/Operational:* because the site is remote, consider adding a **battery backup** or at least designing it to smoothly handle grid outages (the grid in forest areas may go down; having the solar trip off each time wastes generation – maybe enable it to power select local loads in island mode if grid fails, with proper controls). Although that adds complexity, it could be a model for resilient power supply in remote areas. Security of the installation is another consideration – being near forests, chances of trespass or theft need to be mitigated, maybe by involving local forest guards or having CCTV if feasible (though connectivity could be an issue). Lastly, incorporate the project into **eco-development programs**: possibly hire some local tribal youth as maintenance staff as part of CSR, or provide solar training at the community center. By following these recommendations, the Chandauli floating solar projects can succeed in a delicate environment, providing green energy while upholding ecological and social values.

5.8 Chitrakoot District

Dams Under Consideration: *Barwa,Gunta and Ohan* ***(Table-11)***

S No	Name of Reservoir/Dam	Latitude	Longitude	Feasible Area in Acre	Area in SqM
1	Barwa Dam	25.18098	80.793099	154.9153	1483163.897
2	Gunta Dam	25.219929	81.144125	89.35866	3931957.823
3	Ohan Dam	25.13362	81.032388	20.28292	1588413.493

Latifshah Dam

Latif Shah Dam	
OBJECTID_1	28
Dam_Name	Latif Shah Dam
District	Chakiya Chandoli
Latitude__	25.022242
Longitude	83.231156
Submergenc	511
F10__of_Fu	51.1
Tentative	24
Max_Area_SqKm	0.924274
Feaseable	0.052039
Hactare	5.203933
Acre	12.8592

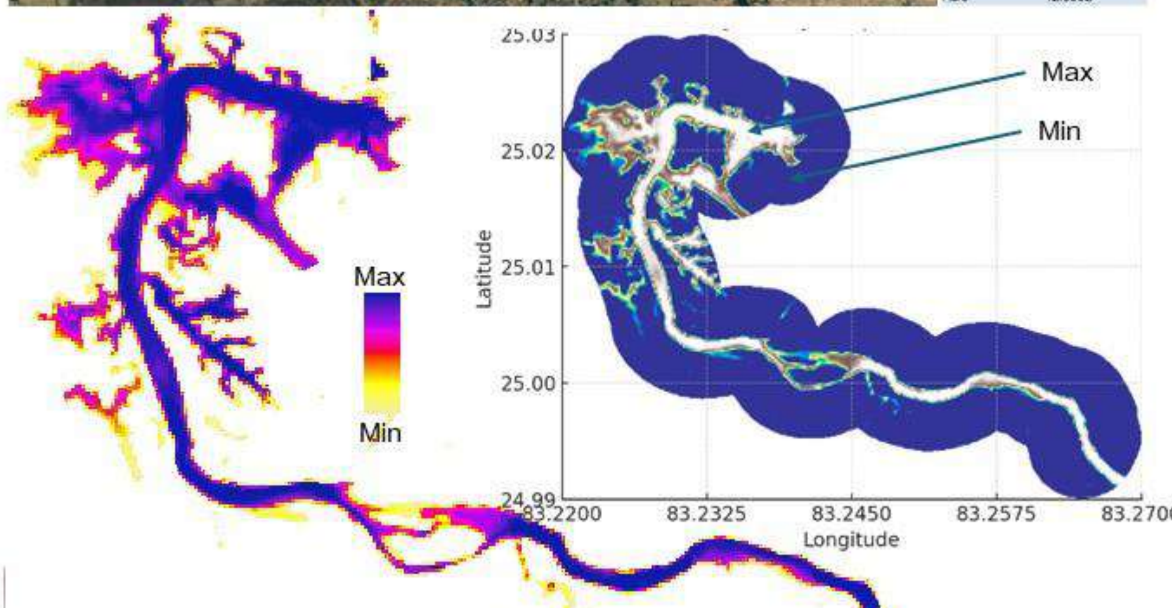
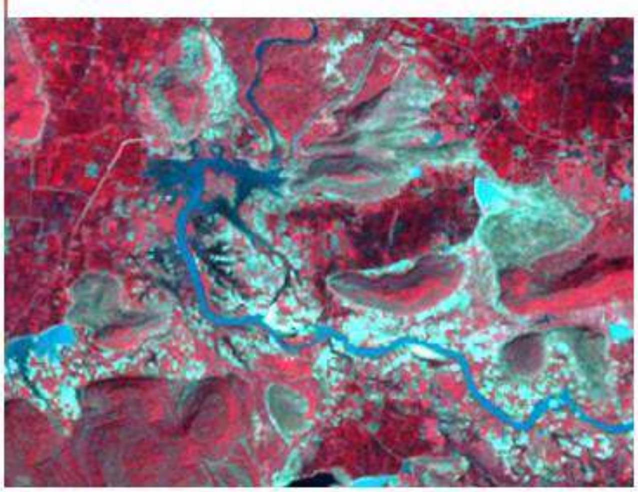


Image processing of 10 years satellite data for delineating minimum submergence Area



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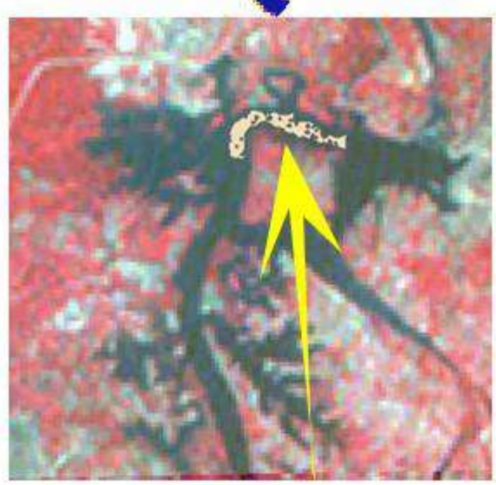
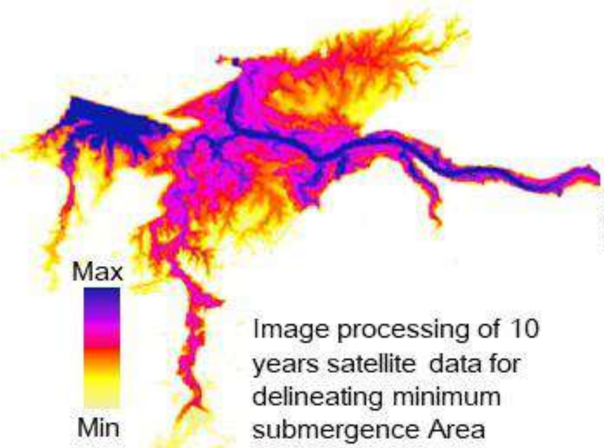
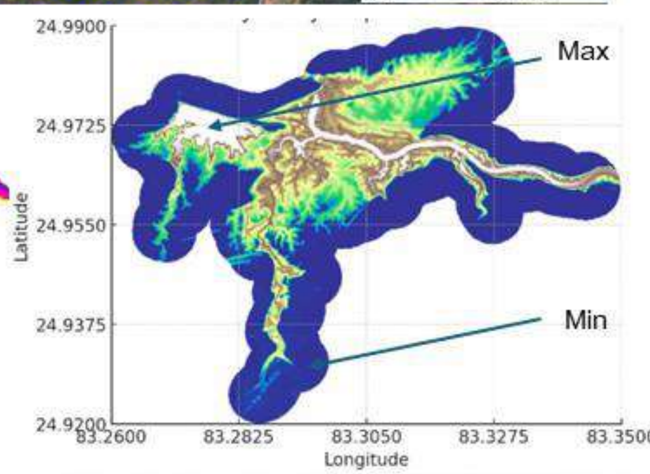


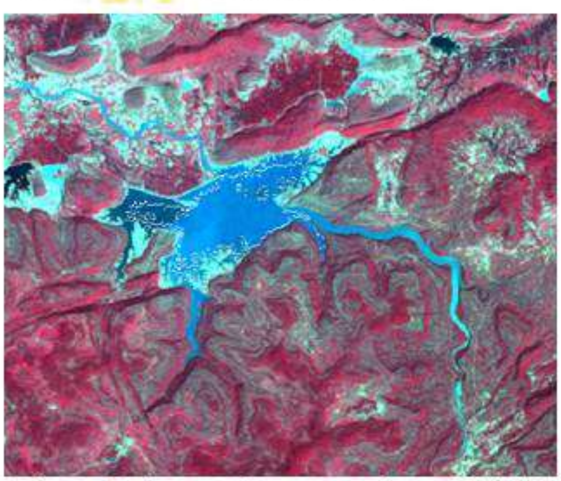
Feasible Area

Musakhand Dam

Moosakhand Dam	
OBJECTID_1	27
Dam_Name	Moosakhand Dam
District	Chakiya Chandoli
Latitude__	24.971062
Longitude	83.281823
Submergenc	1369
F10__of_Fu	136.9
Tentative	63
Max_Area_SqKm	10.96159
Feaseable	0.773659
Hactare	77.36595
Acre	191.1754







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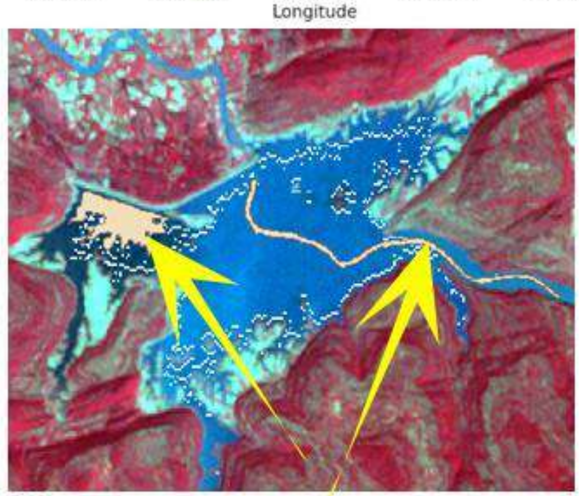
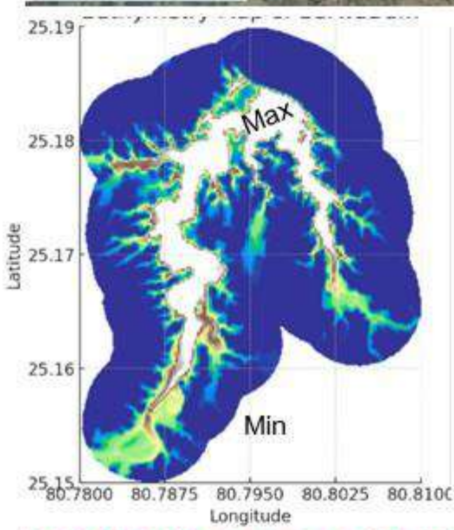
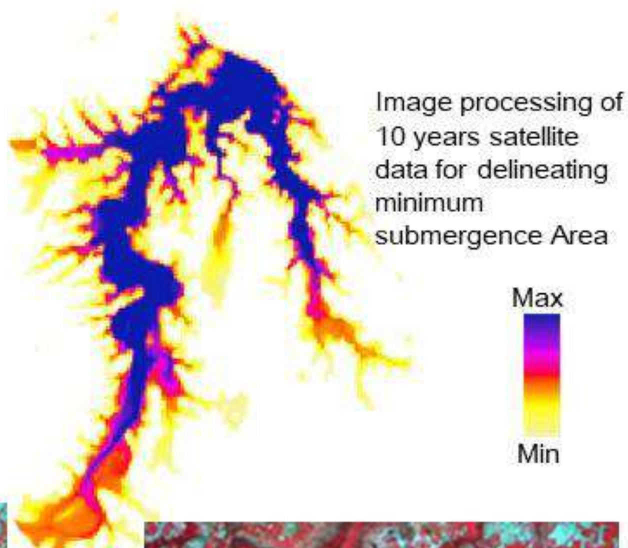
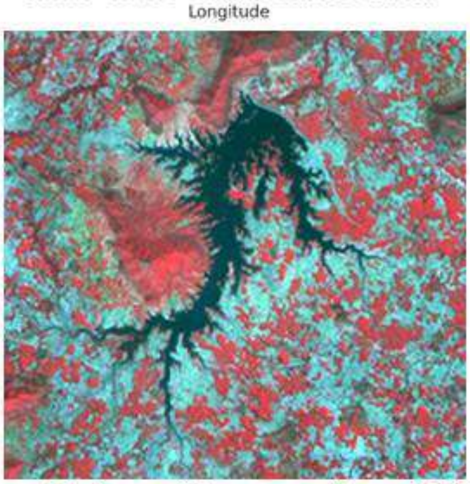


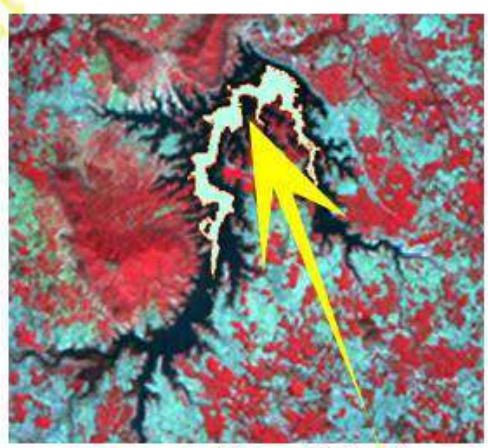
Feasible Area

Barwa Dam









False Colour Composite of LISS 3 image

Feasible Area

Gunta Dam

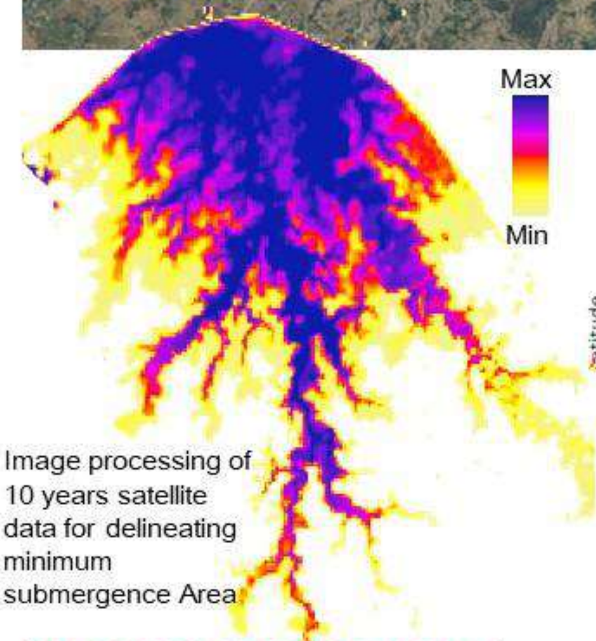
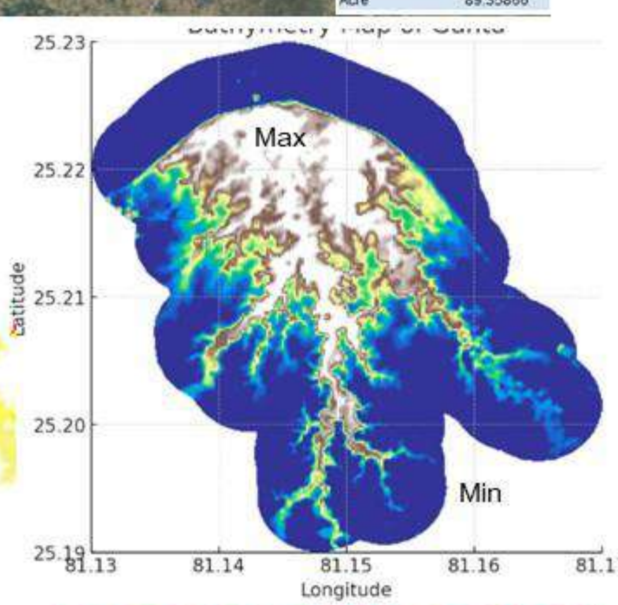
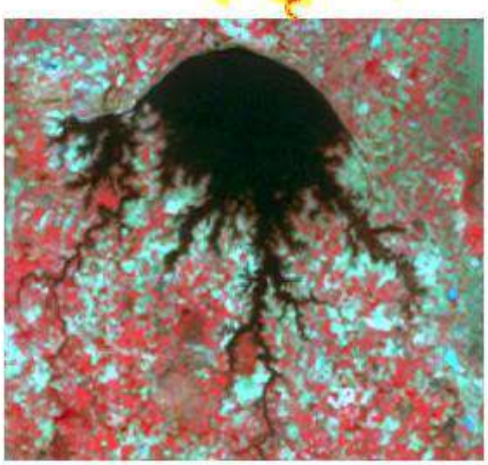
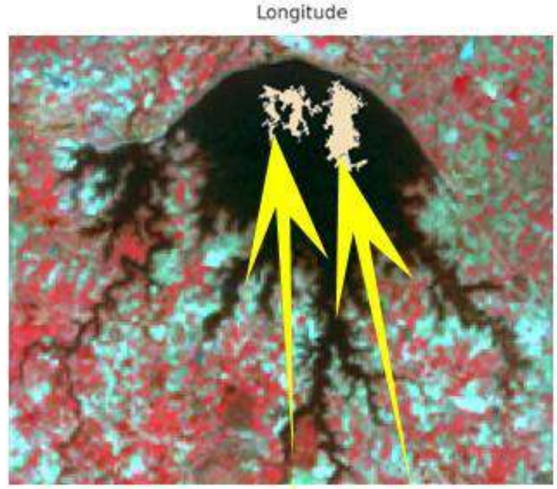


Image processing of 10 years satellite data for delineating minimum submergence Area



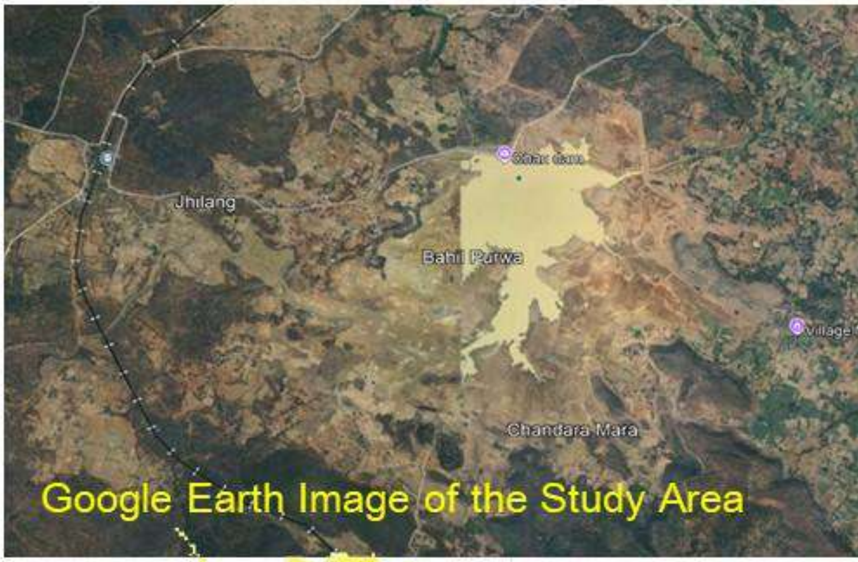




False Colour Composite of LISS 3 image

Feasible Area

Ohan Dam



Ohan Dam	
OBJECTID_1	22
Dam_Name	Ohan Dam
District	Chitrakoot
Latitude__	25.13362
Longitude	81.032388
Submergenc	648
F10__of_Fu	64.8
Tentative	30
Max_Area_SqKm	1.588413
Feaseable	0.082082
Hactare	8.208206
Acre	20.28292

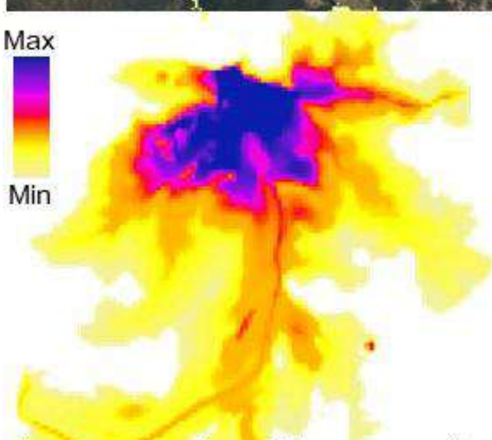
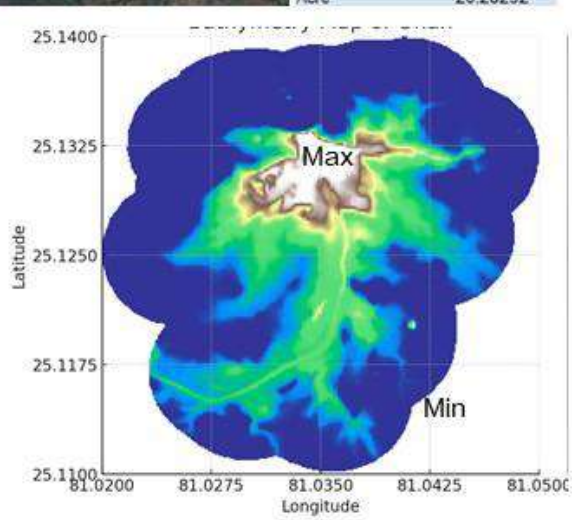
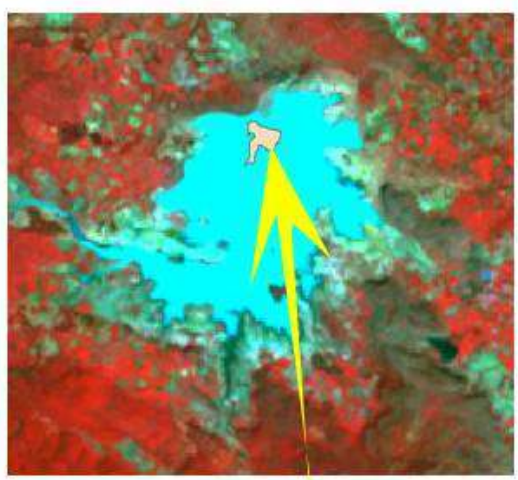


Image processing of 10 years satellite data for delineating minimum submergence Area





False Colour Composite of LISS 3 image

Feasible Area

5.9 Pauri Garhwal District (Uttarakhand)

Dams Under Consideration: *Kalagarh Dam (Ramganga Dam)*. This is the only site in our analysis outside Uttar Pradesh, included likely due to its relevance to the region's grid. Kalagarh Dam, known as Ramganga Dam, is located in Pauri Garhwal district of Uttarakhand, but its reservoir backs up into Uttar Pradesh. It's a large dam built as part of the Ramganga irrigation project and lies on the fringes of Jim Corbett National Park. **(Table-12)**

S No	Name of Reservoir/Dam	Latitude	Longitude	Feasible Area in Acre	Area in SqM
1	Kalagarh Dam	29.523233	78.756405	5074.749	52798402.63

Technical Feasibility: Kalagarh (Ramganga) Dam has a substantial reservoir of about **78.34 km²**. Approximately **783 ha** (10%) would be the initial target area, with a feasible area of about **361 ha** identified for solar deployment. This could host roughly **~50.7 MW** of floating solar capacity, generating on the order of **205 GWh per year**. These figures make Kalagarh one of the largest single-dam opportunities in this analysis (second only to Rihand). Technically, deploying solar on Ramganga reservoir is feasible but comes with complexities: the reservoir is within a wildlife-rich area (Corbett tiger reserve periphery), and it also has significant water level fluctuations (being a rain-fed river storage, levels can drop considerably in dry season). The large size means that wind-induced waves could be higher than on smaller lakes, so floats and anchors must be designed for sturdier conditions (especially during monsoon when strong winds funnel through the valley). The benefit is that there's plenty of space to choose a suitable zone – likely near the dam's calmer waters. Kalagarh Dam already has a hydroelectric component (198 MW) which means robust transmission infrastructure exists (lines from Ramganga to UP grid). Tapping into that for solar evacuation is straightforward. The site is a bit remote but accessible via roads through the forest. Uttarakhand's higher altitude sun (Kalagarh is at the foothills, ~300m elevation) and cooler climate might actually improve panel efficiency slightly. Overall, from a purely engineering standpoint, large-scale floating PV here is viable and akin to other big reservoir projects globally, with careful planning for environmental and operational conditions.

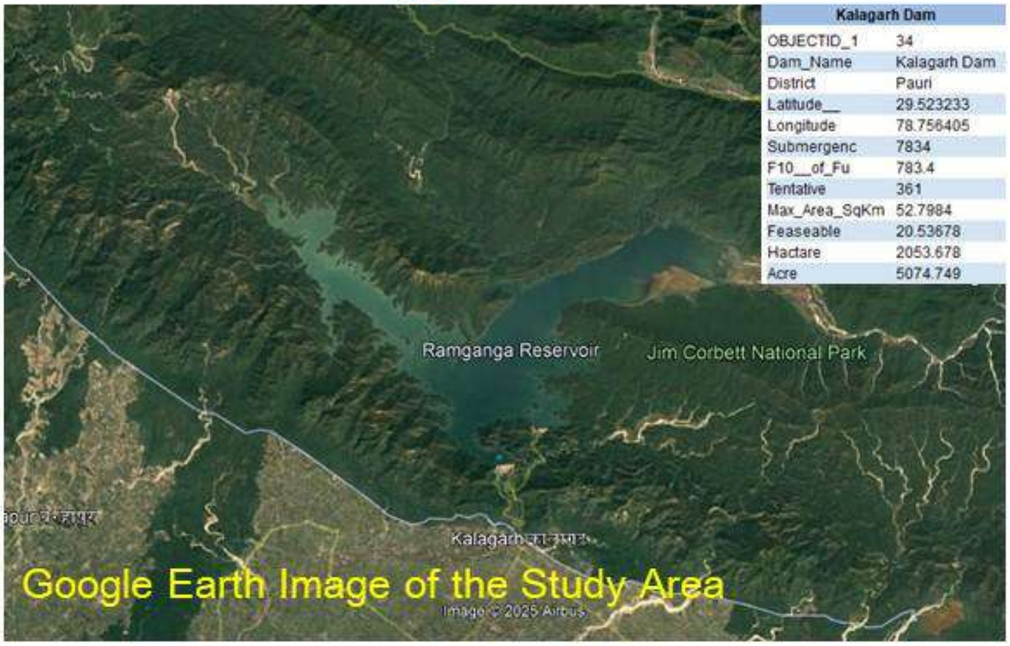
Hybrid Renewable Potential: Kalagarh is a prime candidate for **solar-hydro hybrid** operation. The dam's hydro plant (if operational) can balance the solar output. **Floating solar on Kalagarh could generate power in daytime, while the hydro turbines (Ramganga hydro) can be ramped down to save water or used during non-sunny periods**, exactly as the Bangladesh study showed for a similar scenario. During peak monsoon, when both solar might be lower (clouds) but water is abundant, hydro runs full and solar contributes whatever it can; in summer, when solar is high but water storage is precious, use solar fully and conserve water by reducing hydro discharge – releasing water primarily in evenings when solar is off. Additionally, Uttarakhand could explore using Ramganga as a lower reservoir for a potential pumped storage scheme with an upper reservoir in the nearby hills (this is speculative, but the topology suggests it might be possible). That would create an ultimate solar-hydro-wind storage hybrid (though wind isn't notable here). Wind speeds in that valley are not high enough for large wind turbines, plus being a protected area, windmills likely aren't allowed. So the focus remains solar + hydro. Another aspect: synergy with the grid – Uttarakhand often has surplus hydro in monsoon and deficit in summers; adding solar will reduce summer deficit and any excess can go to UP (which often needs power). So it's a hybrid at grid level too between two states' energy systems.

Socio-Economic & Environmental Impacts: *Local Communities:* The area around Kalagarh is not heavily populated due to the tiger reserve, but there are communities downstream and some forest villages. The project itself on water won't displace anyone or use community land. Locals could benefit from jobs or from improved electricity. Currently, the region's power mainly comes from the dam's hydro and imports; solar will add more. Perhaps a portion of the power can be reserved for local hamlets (some fringe villages might still lack reliable power). Employment during installation will involve skilled workers likely coming from outside (due to scale), but unskilled and support jobs can hire locals. There's also potential for eco-tourism enhancement – if marketed right, one could develop a viewpoint or boat tours showcasing the floating solar farm as a modern marvel alongside the natural beauty (with caution to not disturb wildlife). *Wildlife:* This is the most sensitive facet. Ramganga reservoir is within core tiger-elephant habitat. Introducing a large artificial structure will require wildlife clearance. Key concerns include: impacts on aquatic life (fish, gharials if present in Ramganga?), birds (the reservoir hosts migratory waterfowl and is part of an important ecosystem for birds in Corbett), and even large animals like elephants that sometimes swim or cross shallow parts of the reservoir. A thorough ecological study is a must. It may find that certain zones of the reservoir are less frequented by wildlife – e.g., maybe near the dam itself (since that area is disturbed by human activity for hydro operations) might be acceptable for solar, whereas far arms used by wildlife should remain untouched. **Floating solar can reduce evaporation**, beneficial in keeping river flows more stable (good for wildlife in dry season), but too much coverage might affect habitat (like less sunlight in water might affect aquatic plants some fish depend on). Given the huge size, using just ~0.5% of the surface (361 ha of 7834 ha) is minimal; impacts could be small if sited carefully. Noise during construction could disturb animals, so scheduling outside sensitive seasons (e.g., avoid the breeding season and monsoon when animals are more active) is recommended. Working hours might need restriction (no night work that could bother nocturnal animals). The project might need compensatory measures like funding conservation programs. *Socio-political:* Because this crosses state (dam in UK, benefit shared with UP), coordination between Uttarakhand and UP governments is required. Locally in Pauri, people may welcome the project if it doesn't hinder their water usage. The Ramganga dam primarily serves UP's plains for irrigation; Uttarakhand's local benefit is hydropower and flood control. Adding solar gives UP more power (if connected to UP grid) or can help Uttarakhand meet RPO (renewable purchase obligations). Either way, an agreement on power-sharing will be needed, which could bring additional revenue to Uttarakhand (a socio-economic benefit at state level). *Climate and broader impact:* A project of ~50 MW solar displacing thermal generation can cut carbon emissions substantially, aligning with India's climate goals and benefitting communities at large by mitigating climate change.

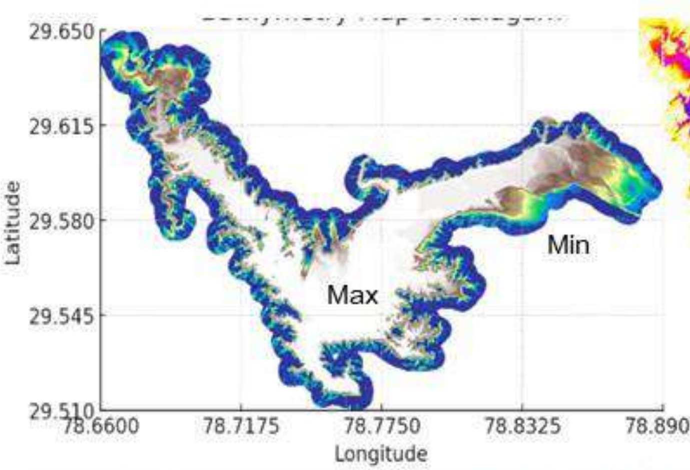
Impact on Nearest Major City: Kalagarh's power primarily flows to **Moradabad and other parts of UP's Rohilkhand region**. The nearest large town is **Bijnor** or **Moradabad** in UP, and **Kotdwar** in Uttarakhand (though Uttarakhand's grid may or may not get this power depending on wheeling agreements). If integrated into the UP grid, it will strengthen supply in western UP. Moradabad, a major city known for brassware industry, can use this additional power to support its industrial load. Also, Western UP's peak demand often is in late afternoon (due to industry and evening ramp), having some solar will cover a portion of that, reducing strain. If some power is allocated to Uttarakhand, the nearest demand center is **Kotdwar/Srinagar** or even feeding towards Delhi via the inter-state line at Najibabad. Given the existing 198 MW hydro plant infrastructure, evacuation of another 50 MW is trivial. So the city impact will be distributed among many – Moradabad, Rampur, perhaps Delhi (if UP reduces draw and frees capacity). Locally, Kalagarh town (small) might get more consistent power too, which is good for local development (and for the project's maintenance base). The distribution feasibility is high – just augment the current substation to handle combined solar + hydro output. Possibly install dynamic reactive power support (inverters can do that) to maintain grid stability when solar fluctuates, ensuring no adverse effect on the quality of supply to cities.

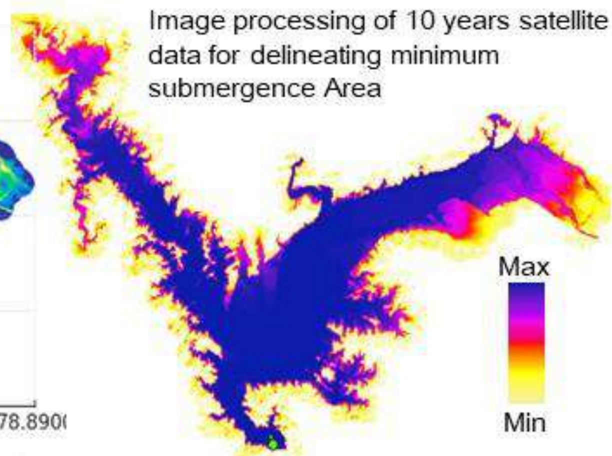
Recommendations: For Kalagarh, given it's inside a wildlife region, the primary recommendation is **stakeholder engagement and environmental safeguards**. Work closely with the **Corbett Tiger Reserve authorities** and the Ministry of Environment to delineate an area for the solar array that minimizes ecological impact. Perhaps an **environmental offset** will be required: e.g., investing in habitat improvement elsewhere, or ensuring the floats have features to allow fish/birds to use them (there's some evidence floating solar can even create habitat for certain species under panels, but more research is needed). Possibly deploy the project in phases, starting small (maybe 10 MW) to monitor wildlife interaction, then scale up if negligible impact is observed. Technologically, ensure anchors do not damage the dam structure or create erosion on reservoir banks (maybe use mid-water anchors to avoid affecting shoreline used by animals). Given the large expanse, one might even use **distributed arrays**: instead of one big block of 50 MW, maybe five blocks of 10 MW spaced out, leaving gaps for movement of boats and fauna. Each block could be positioned in less-sensitive spots identified by wildlife experts. Plan for **contingencies with animals**: e.g., if elephants for some reason try to interact with the equipment (unlikely, but they've been known to trample solar panels on land), how to protect or deter gently (maybe the location itself avoids elephant corridors). Socially, coordinate between UP and Uttarakhand governments on profit-sharing or power-sharing – a formal MoU can ensure both benefit, smoothing execution. For local communities in Pauri's remote villages, consider offshoot benefits like providing some solar-powered streetlights or community solar systems as part of CSR. **Leverage hydro infrastructure**: integrate the control of solar with the hydro plant's operations center. This way, a unified approach can maximize hybrid benefits and also quickly disconnect solar if any grid issue to protect the system (hydro operators can manage that). On the tourism front (Corbett NP is a huge tourist attraction), one might actually turn a portion of the solar farm into an **educational exhibit** for visitors (with strict regulation, maybe a viewpoint from the dam or an observation jetty). This can spread awareness about renewables among tourists and school groups. Another recommendation is to involve research institutions: due to the unique setting, scientific study of this floating solar farm's environmental impact should be done, which can inform future projects globally about best practices in eco-sensitive zones. Finally, maintenance and security: being in a forest, ensure a protocol for maintenance crew movement (not to disturb wildlife, maybe limited hours) and have security (forest guards could help in surveillance to prevent any poaching that could misuse project facilities or to prevent theft/vandalism of equipment). With these comprehensive measures, the Kalagarh floating solar project can set a precedent for large-scale renewables implemented responsibly in a wildlife area, contributing significantly to the region's sustainable energy supply.

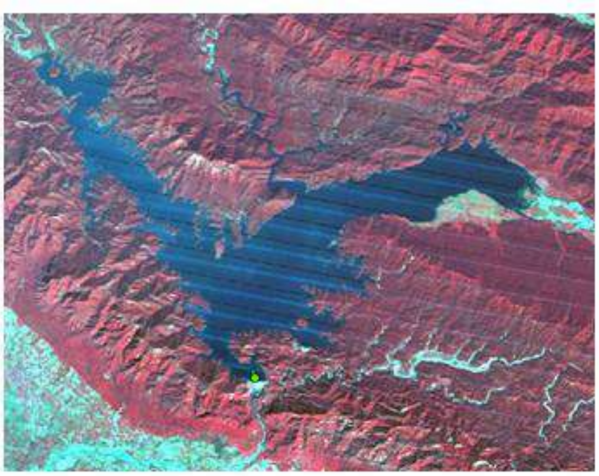
Kalagarh Dam

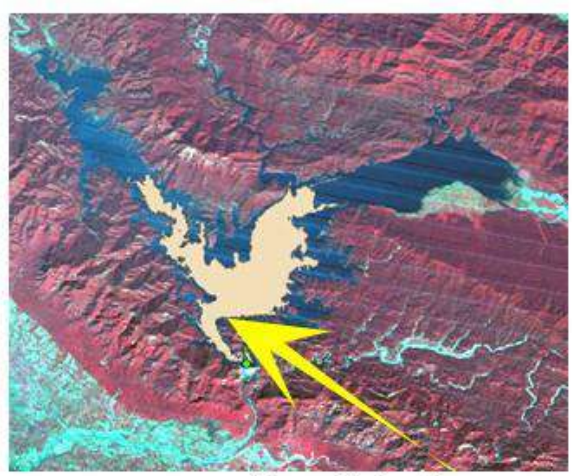


Kalagarh Dam	
OBJECTID_1	34
Dam_Name	Kalagarh Dam
District	Pauri
Latitude__	29.523233
Longitude	78.756405
Submergenc	7834
F10__of_Fu	783.4
Tentative	361
Max_Area_SqKm	52.7984
Feaseable	20.53678
Hactare	2053.678
Acre	5074.749









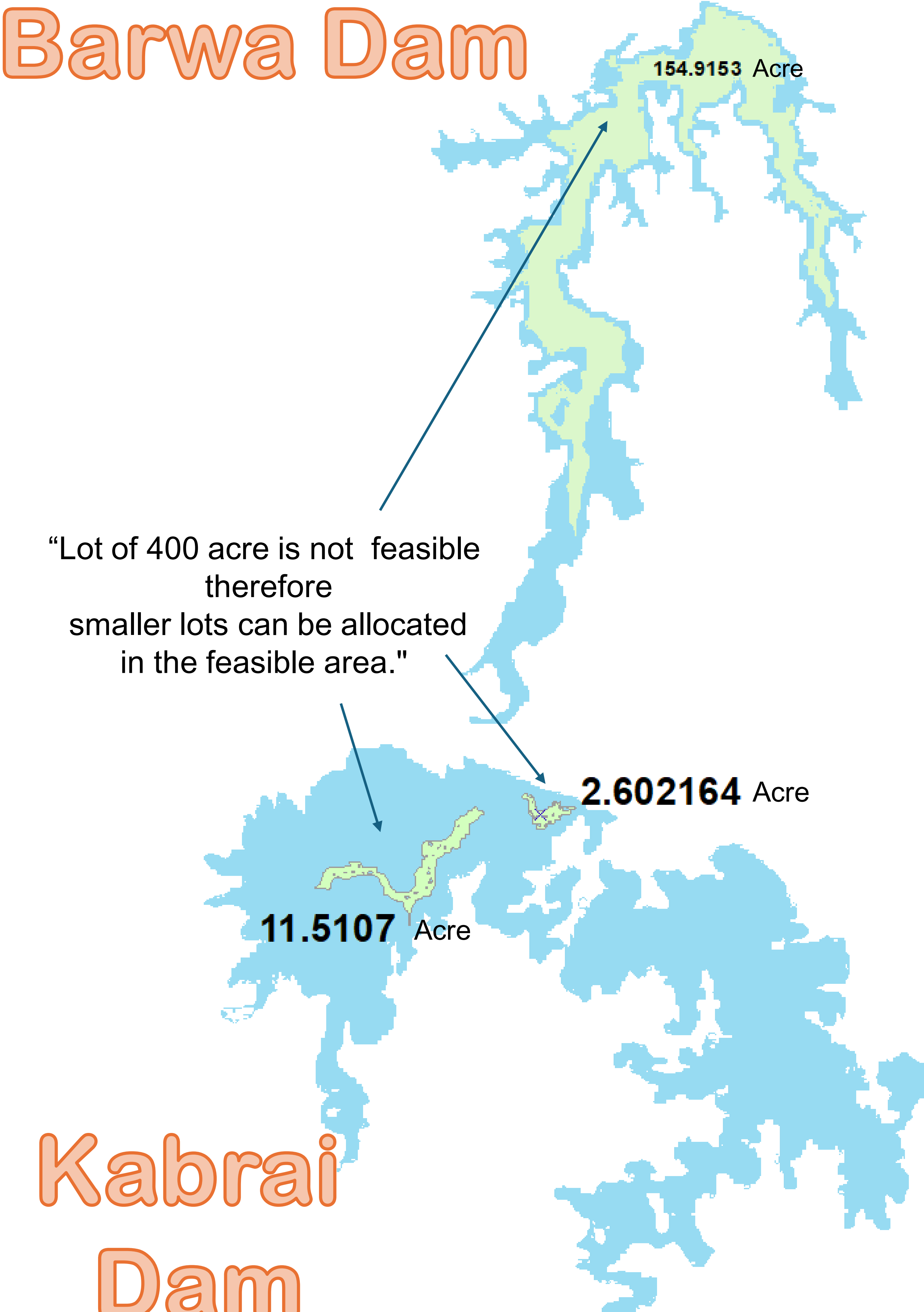
False Colour Composite of LISS 3 image

Feasible Area

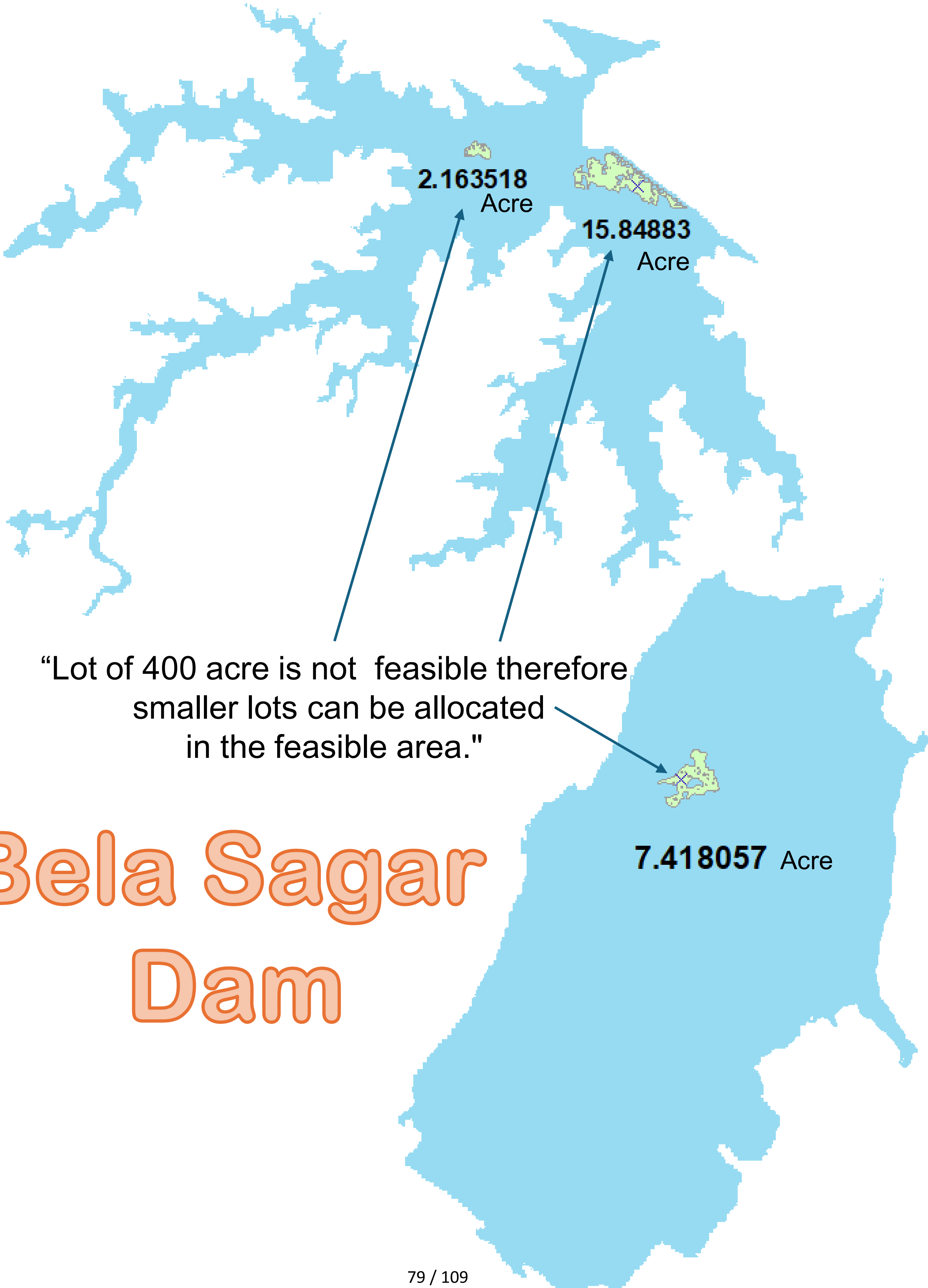
6.0 Results

Based on assumptions mention at 3.4, the **Table 13** below summarizes the calculations for each listed reservoir/dam. **Feasible area** is the water surface area identified as usable for floating solar (as provided in the assessment data, in acres). Using the assumptions, we have estimated the **number of panels** that could be installed, the **maximum capacity** in MW, and how many **100 MW lots** that corresponds to. (Kanhar Dam is omitted as no feasible area was specified.)

S. No	Reservoir/Dam	Feasible Area (acres)	Approx. No. of Panels	Potential Capacity	≈100 MW Plants	≈1MW per 400 Acre	Preferable Plants
1	Rihand Dam	64,767.90	~81.0 million	~32.4 GW	324	162	< 70
2	Rajghat Dam	11,839.20	~15.4 million	~5919.5 MW	59	30	9
3	Matatila Dam	10370.3	~12.9 million	~5185.2 MW	52	26	8
4	Kalagarh Dam	5,074.70	~6.3 million	~2,537.4 MW	25	13	5
5	Obra Dam	2233.9	~2792,375	~116.9 MW	11	6	1
6	Parichha Dam	1542.6	~1928,250	~771.3 MW	8	4	NA
7	Govind Sagar Dam	1,341.60	~1.68 million	~670.8 MW	7	3	NA
8	Shahzad Dam	1142.6	~1428,250	~571.3 MW	6	3	1
9	Maudaha Dam	989	~1.24 million	~494.5 MW	5	2	NA
10	Jamini Dam	819.8	~1.02 million	~409.9 MW	4	2	NA
11	Adwa Dam	555.5	~694,000	~277.7 MW	3	1	NA
12	Dhukwan Dam	522.9	~654,000	~261.4 MW	3	1	NA
13	Dhadraul Dam	504.2	~630,000	~252.1 MW	3	1	NA
14	Sajnam Dam	477.5	~597,000	~238.7 MW	2	1	NA
15	Arjun Dam	334.9	~419,000	~167.4 MW	2	<1	
16	Lahchura Dam	303.8	~380,000	~151.9 MW	2	<1	
17	Pahuj Dam	237	~296,000	~118.5 MW	1	<1	
18	Moosakhand Dam	191.2	~239,000	~95.6 MW	<1	<1	
19	Barwar Lake	172.2	~215,000	~86.1 MW	<1	<1	
20	Upper Khajuri Dam	163.7	~205,000	~81.9 MW	<1	<1	
21	Barwa Dam	154.9	~194,000	~77.5 MW	<1	<1	
22	Gunta Dam	89.4	~112,000	~44.7 MW	<1	<1	
23	Garhmau Lake	87.2	~109,000	~43.6 MW	<1	<1	
24	Pahari Dam	63.5	~79,000	~31.7 MW	<1	<1	
25	Dongri Dam	45.9	~57,000	~22.9 MW	<1	<1	
26	Barua Sagar	34.5	~43,000	~17.2 MW	<1	<1	
27	Pathrai Dam	29.4	~37,000	~14.7 MW	<1	<1	
28	Mahjagwan Dam	25.5	~32,000	~12.8 MW	<1	<1	
29	Ohan Dam	20.3	~25,000	~10.1 MW	<1	<1	
30	Saprar Dam	20.1	~25,000	~10.0 MW	<1	<1	
31	Chandrawal Dam	18.01	~22,500	~9.0 MW	<1	<1	
32	Kabrai Dam	14.11	~17,600	~7.6 MW	<1	<1	
33	Latif Shah Dam	12.9	~16,000	~6.4 MW	<1	<1	
34	Bela Sagar	7.4	~9,000	~3.7 MW	<1	<1	

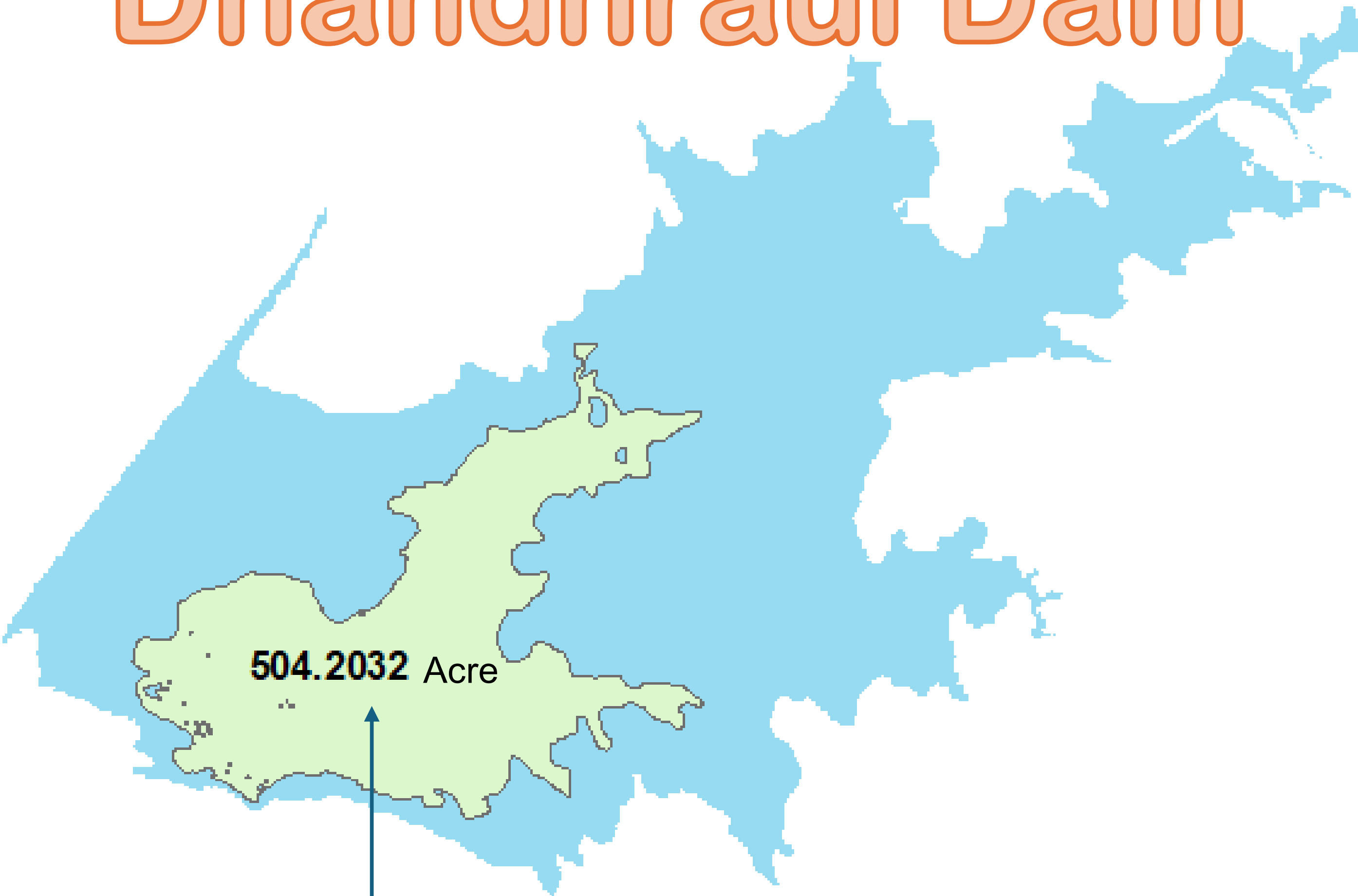

Barwa Dam
154.9153 Acre
“Lot of 400 acre is not feasible therefore
smaller lots can be allocated
in the feasible area."
2.602164 Acre
11.5107 Acre
Kabrai
Dam

Chandrawal Dam

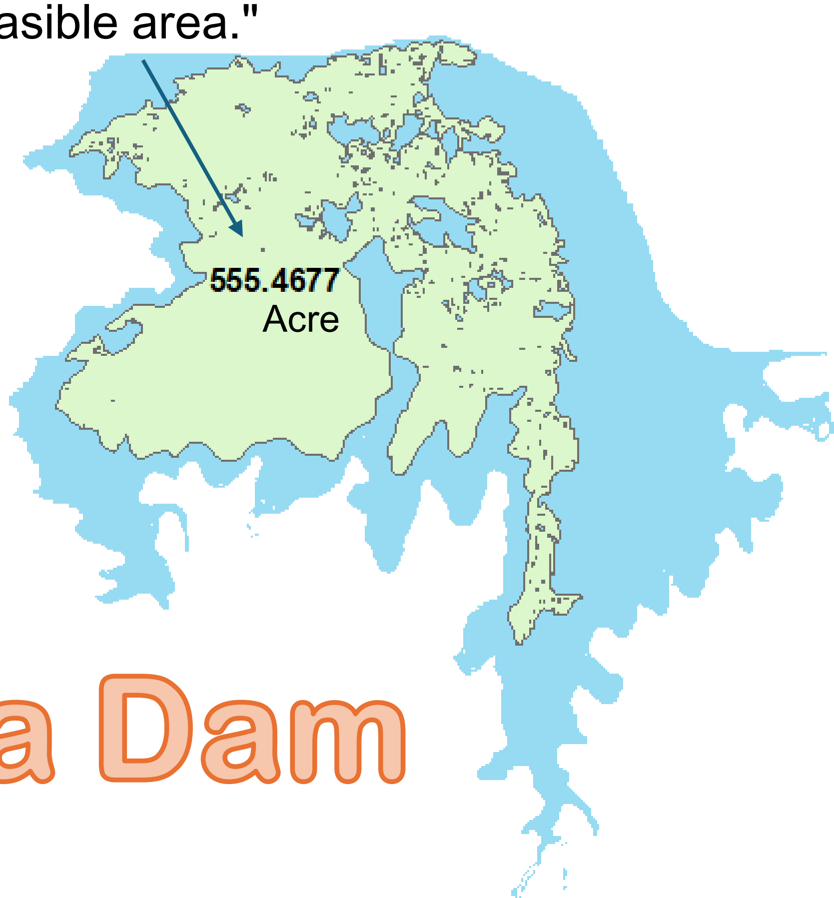


Bela Sagar Dam

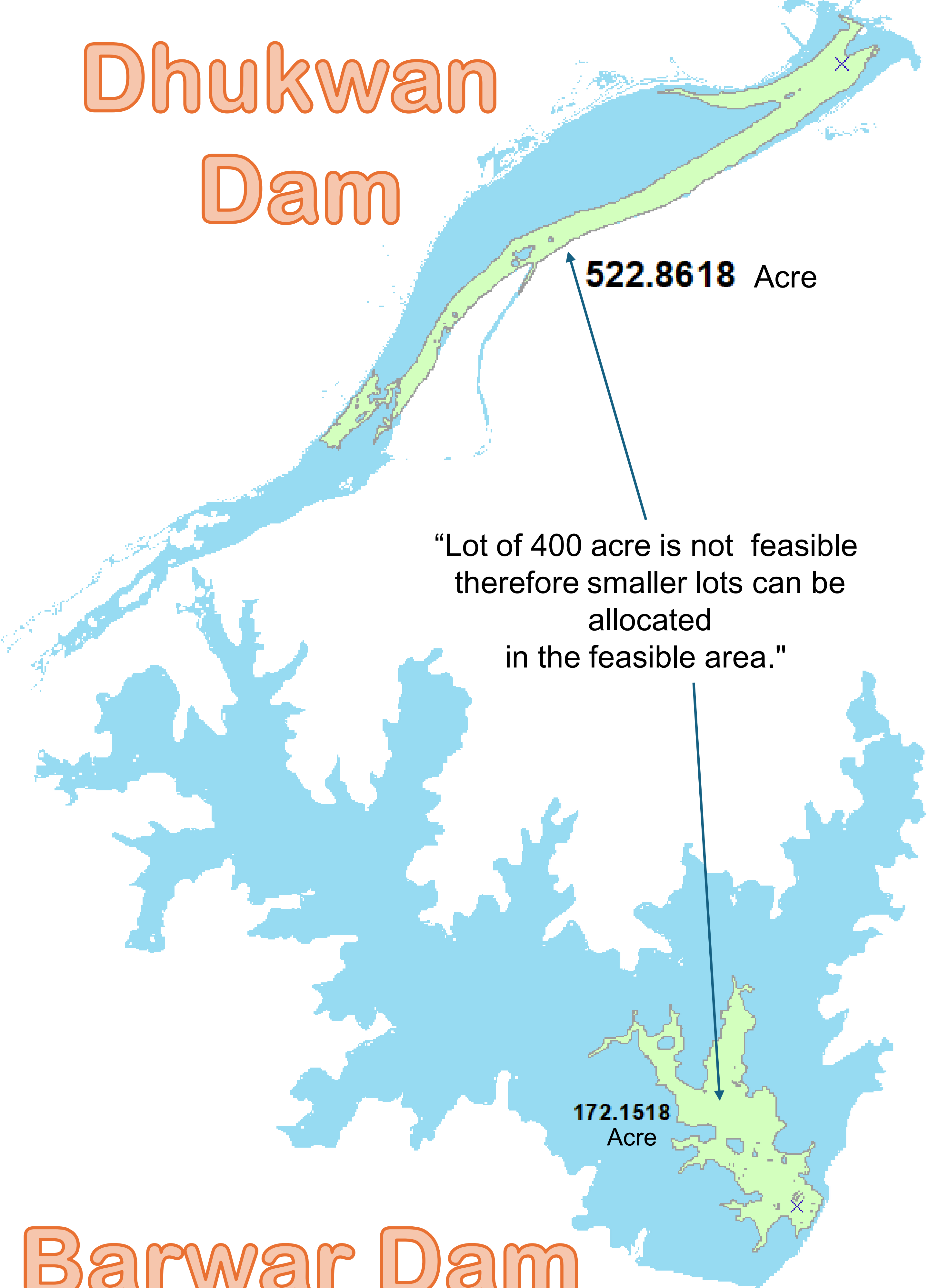
Dhandhraul Dam

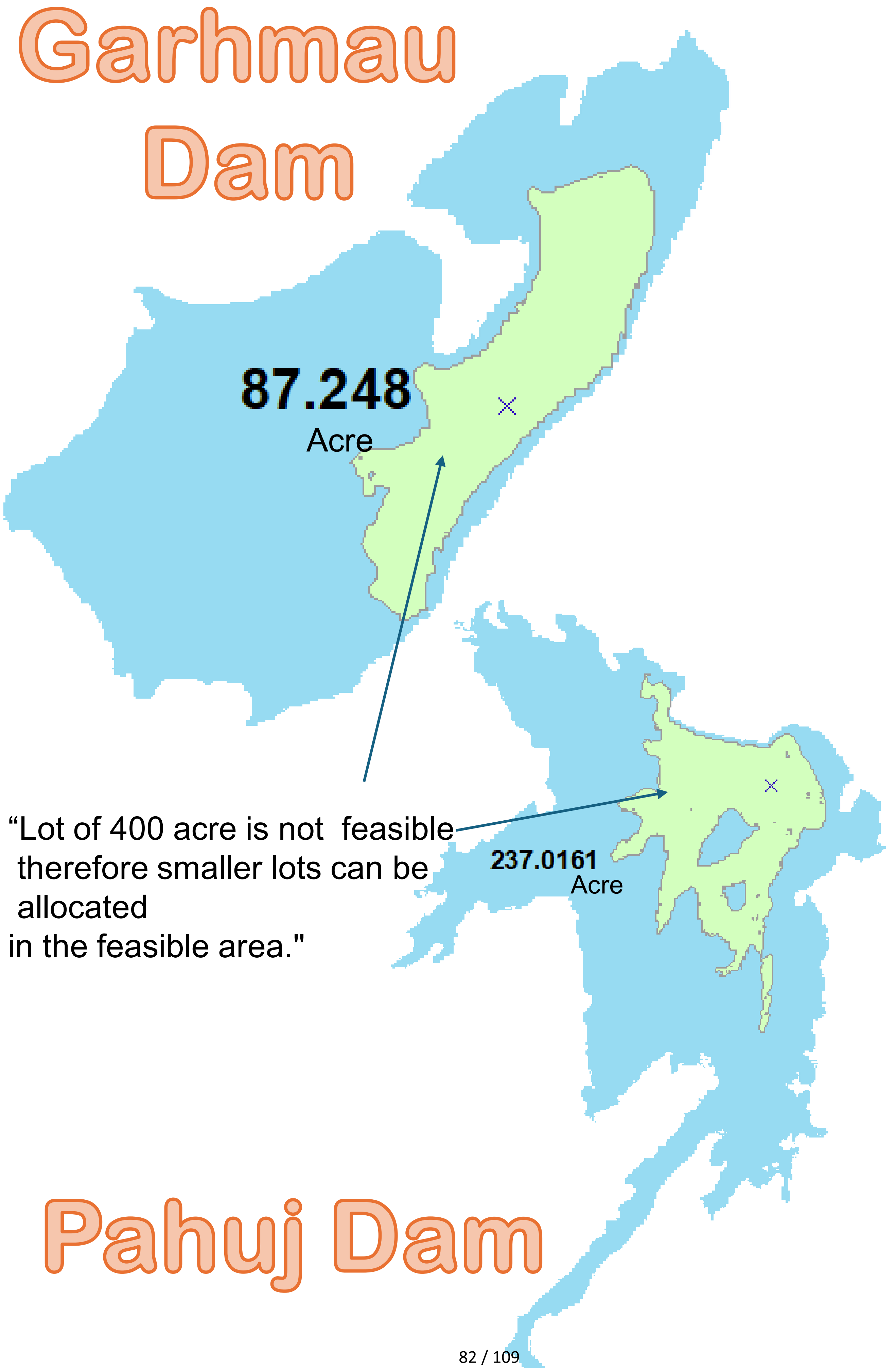


“Lot of 400 acre is not feasible therefore smaller lots can be allocated in the feasible area."

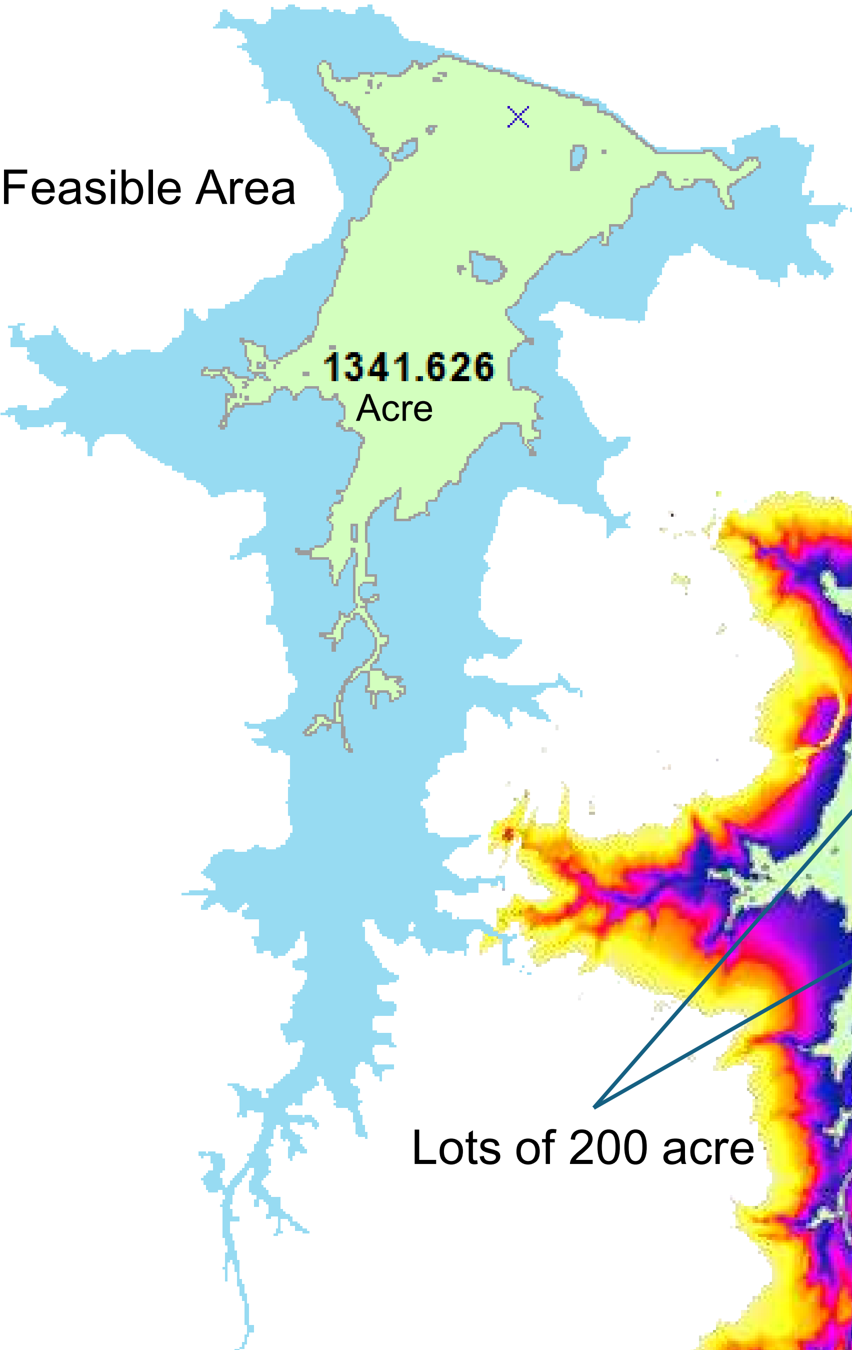


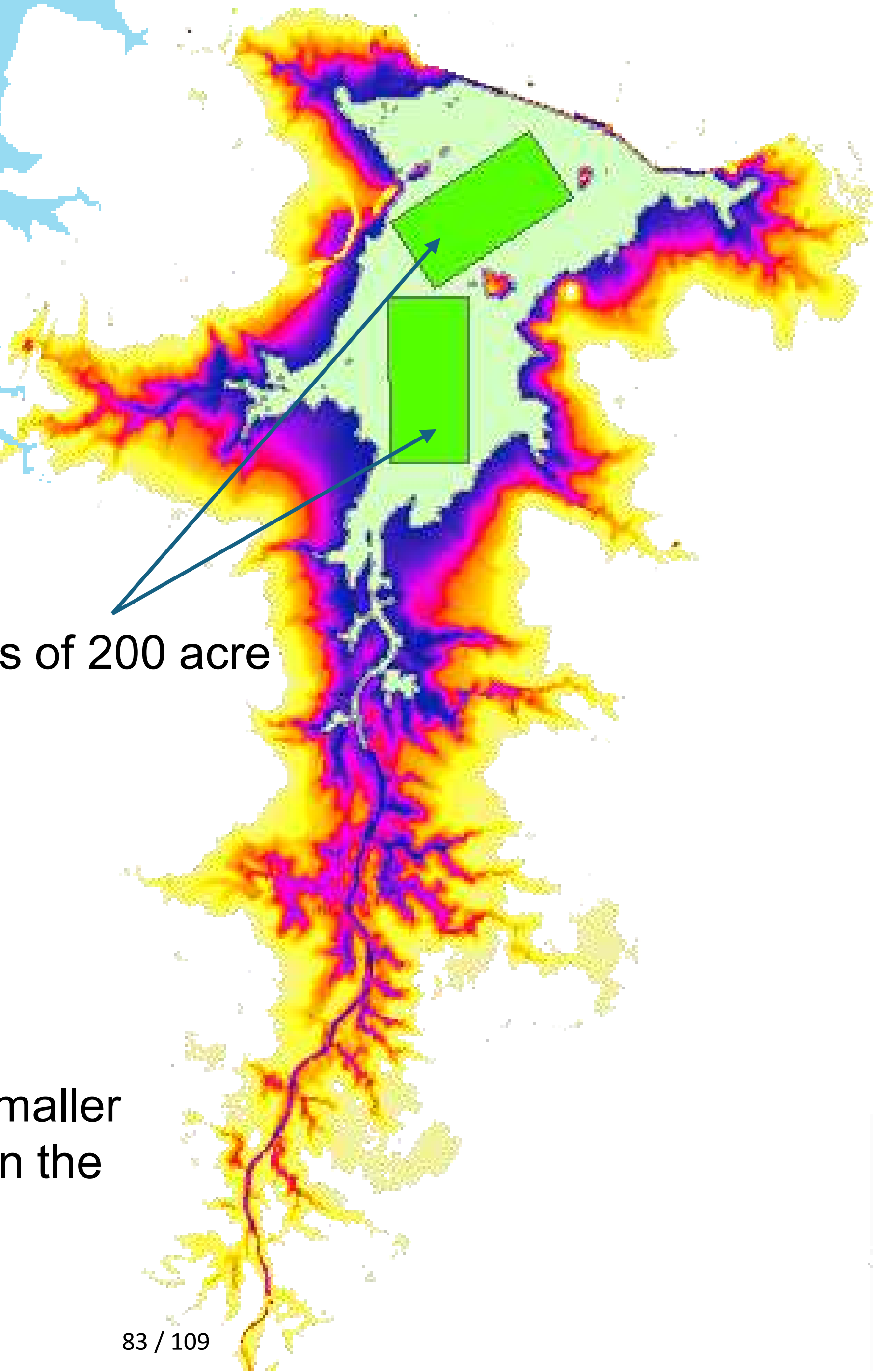
Adwa Dam


Dhukwan
Dam
522.8618 Acre
“Lot of 400 acre is not feasible
therefore smaller lots can be
allocated
in the feasible area."
172.1518
Acre
Barwar Dam

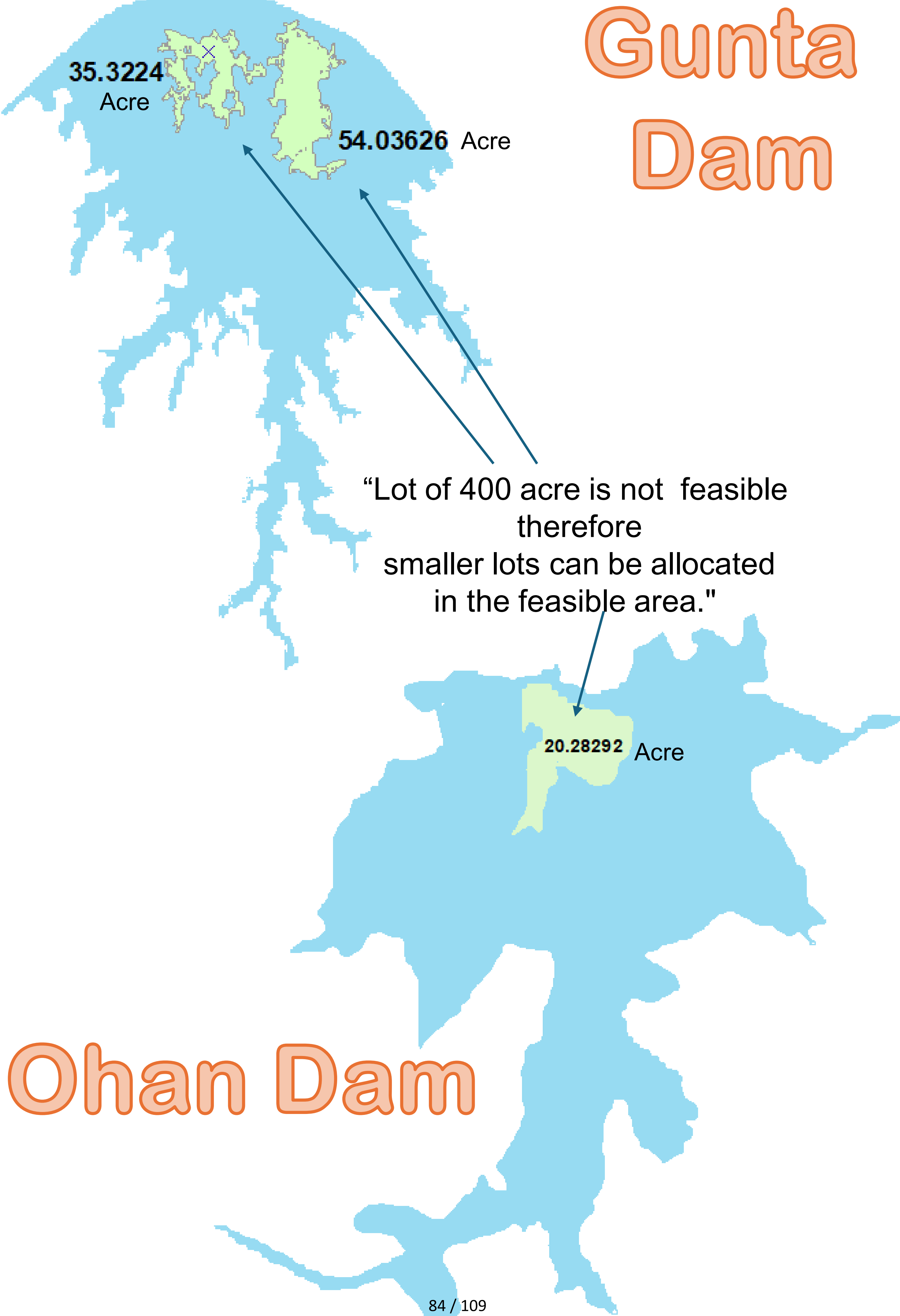

Garhmau Dam
87.248
Acre
“Lot of 400 acre is not feasible therefore smaller lots can be allocated in the feasible area."
237.0161
Acre
Pahuj Dam

Govind Sagar Dam

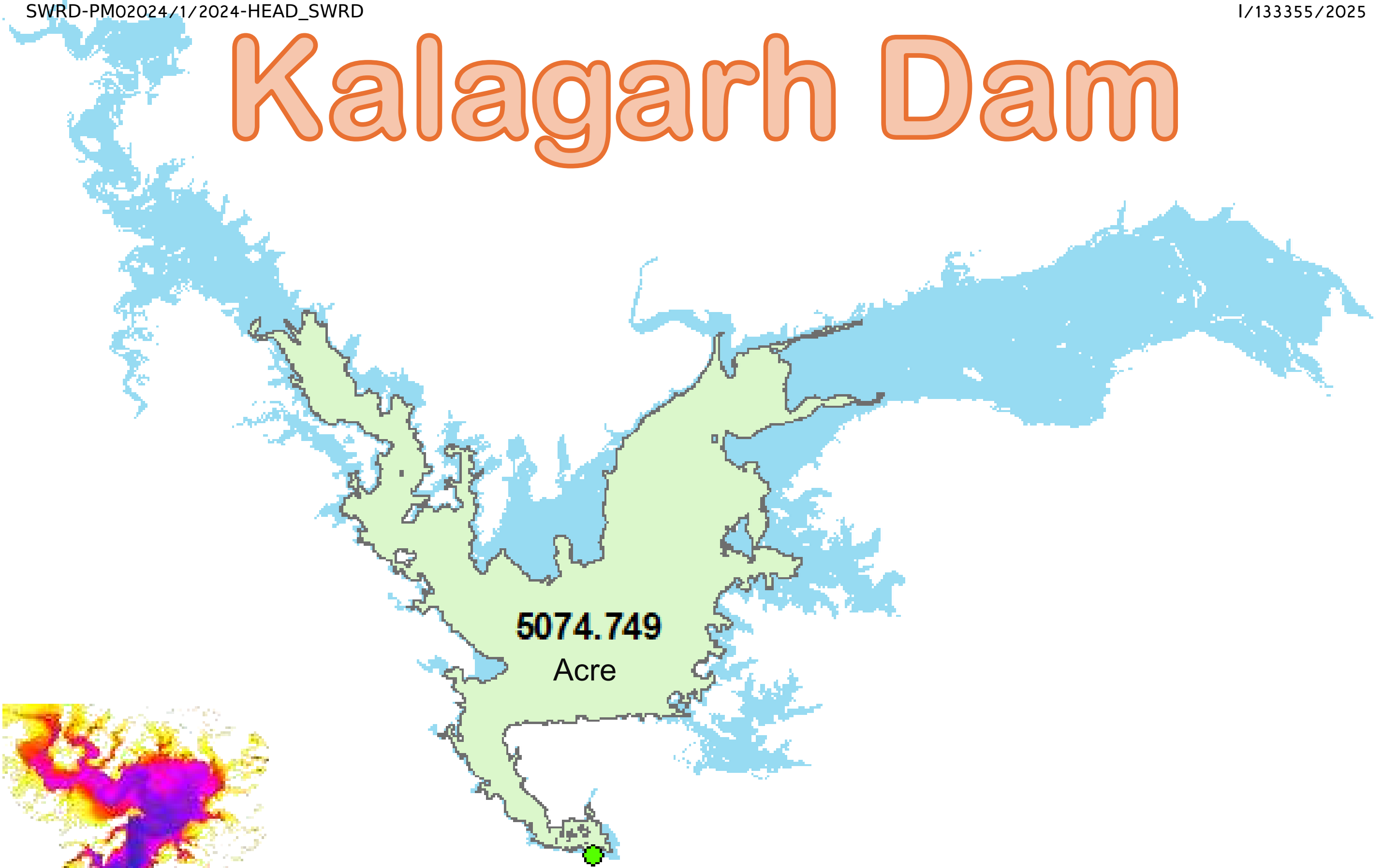


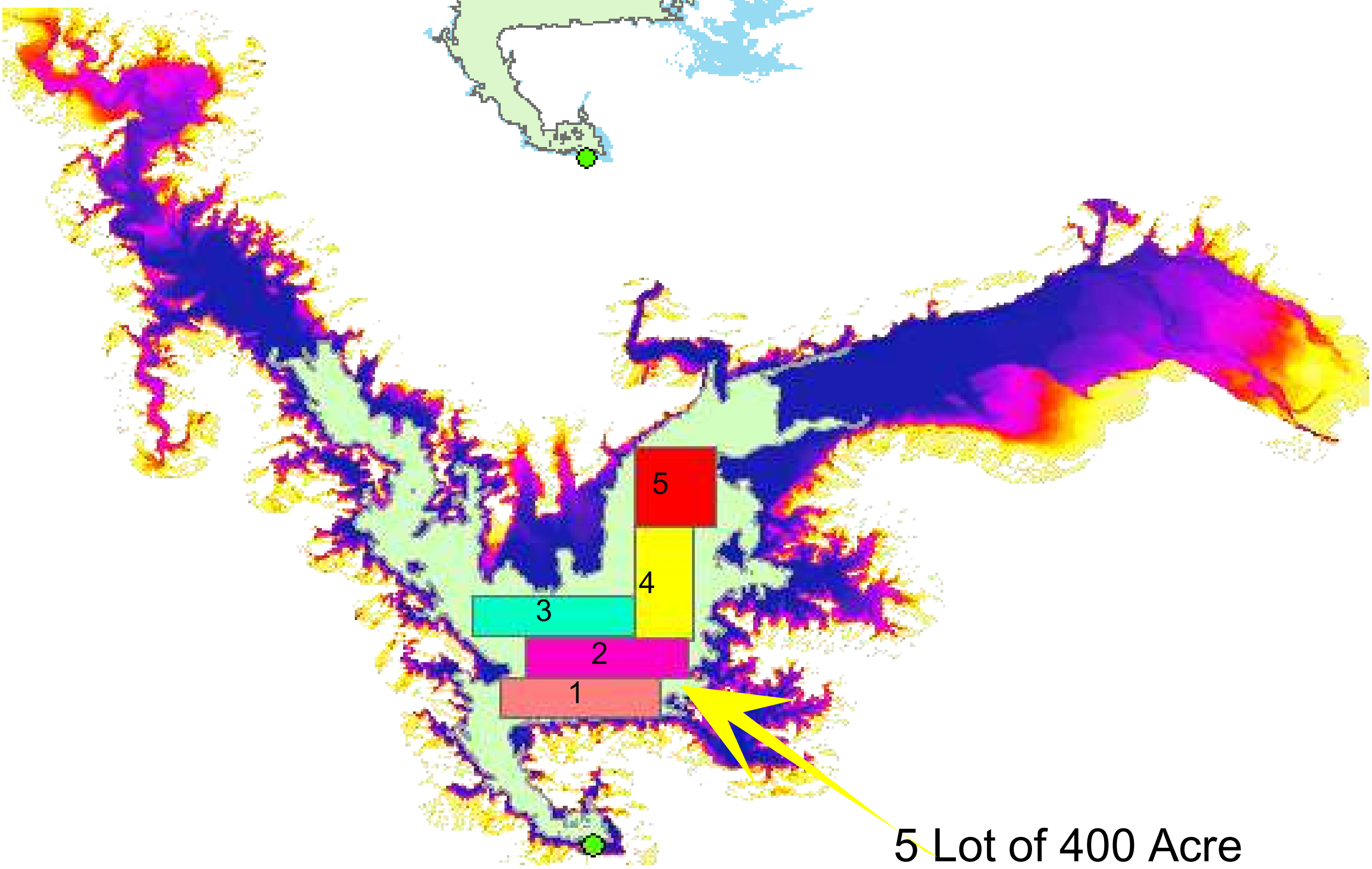


"2 Lot of 200 acre or smaller lots can be allocated in the feasible area."

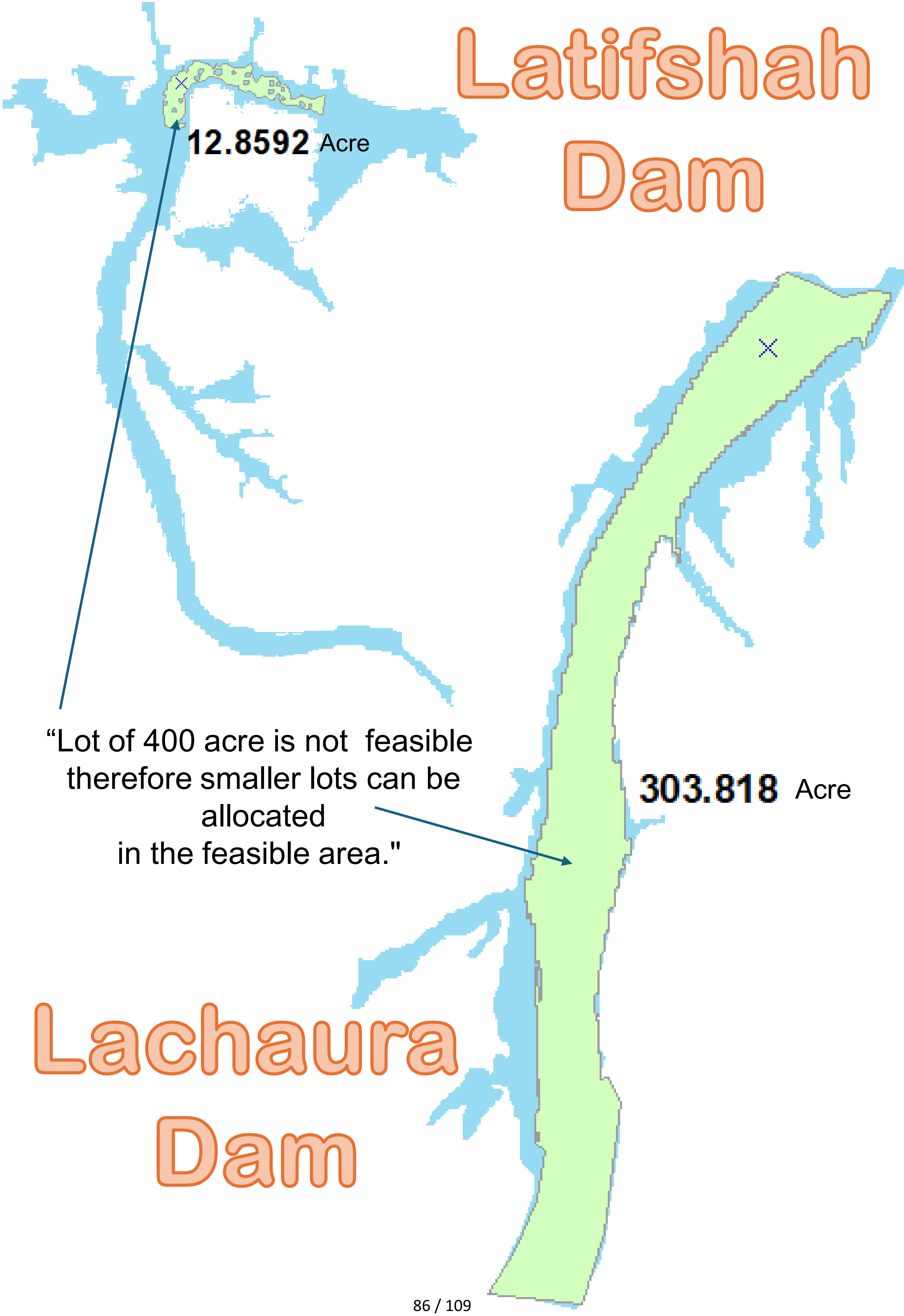

Gunta Dam
35.3224 Acre
54.03626 Acre
“Lot of 400 acre is not feasible therefore smaller lots can be allocated in the feasible area."
20.28292 Acre
Ohan Dam

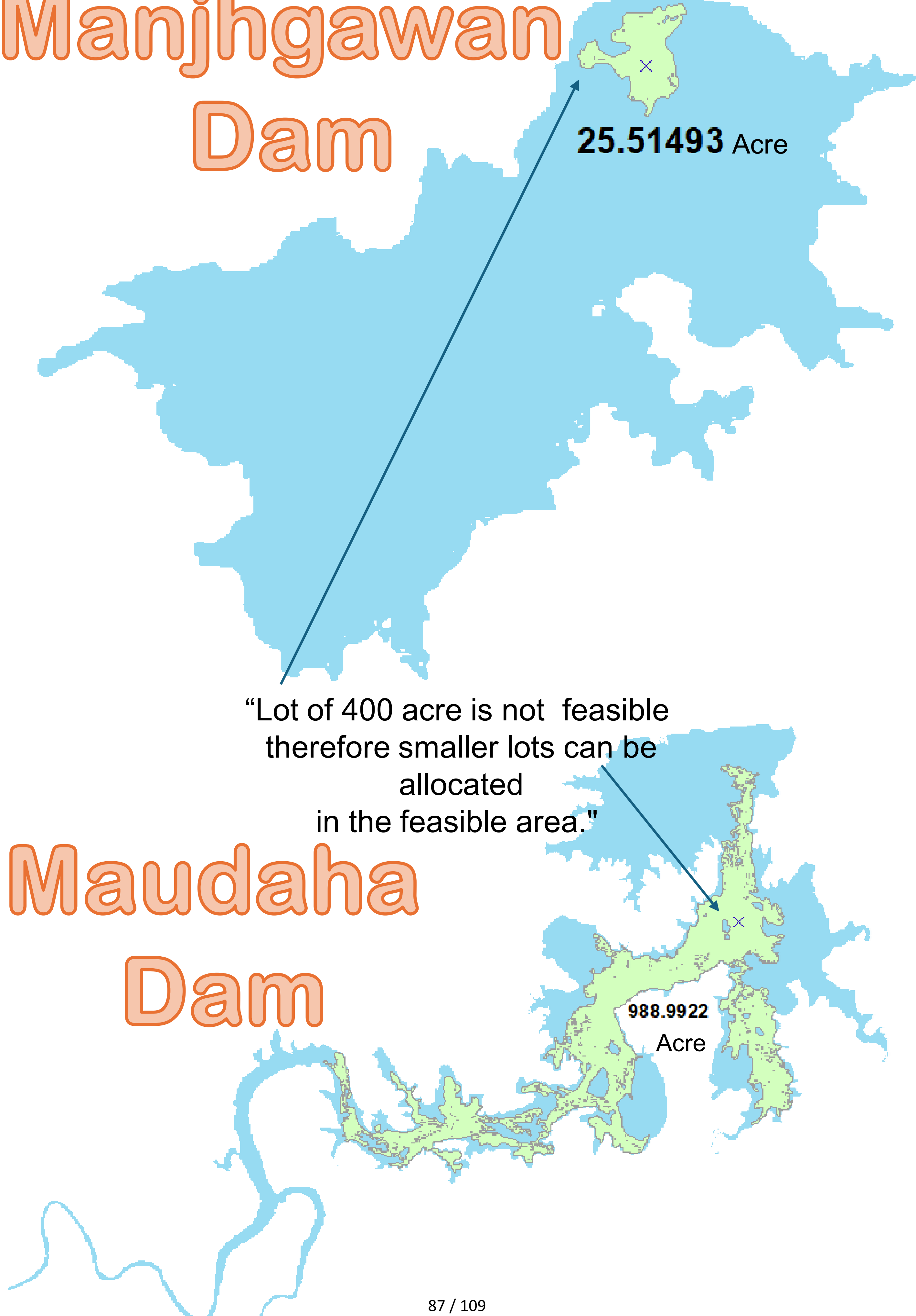
Kalagarh Dam



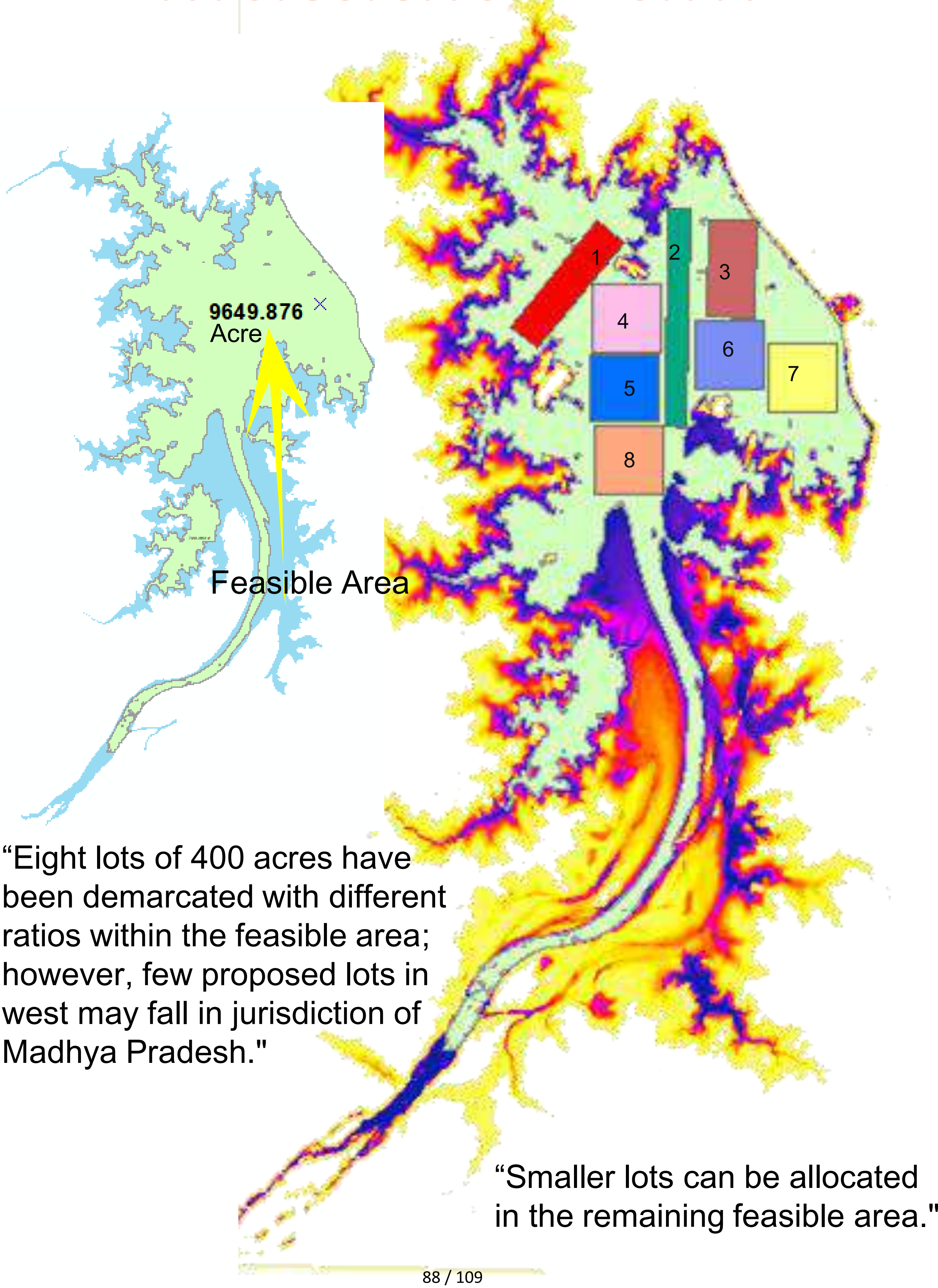


"Five lots of 400 acres have been demarcated with different ratios within the feasible area; however, eco-sensitive zones may impact their placement. Smaller lots can be allocated in the remaining feasible area."


Latifshah
Dam
12.8592 Acre
"Lot of 400 acre is not feasible
therefore smaller lots can be
allocated
in the feasible area."
303.818 Acre
Lachaura
Dam

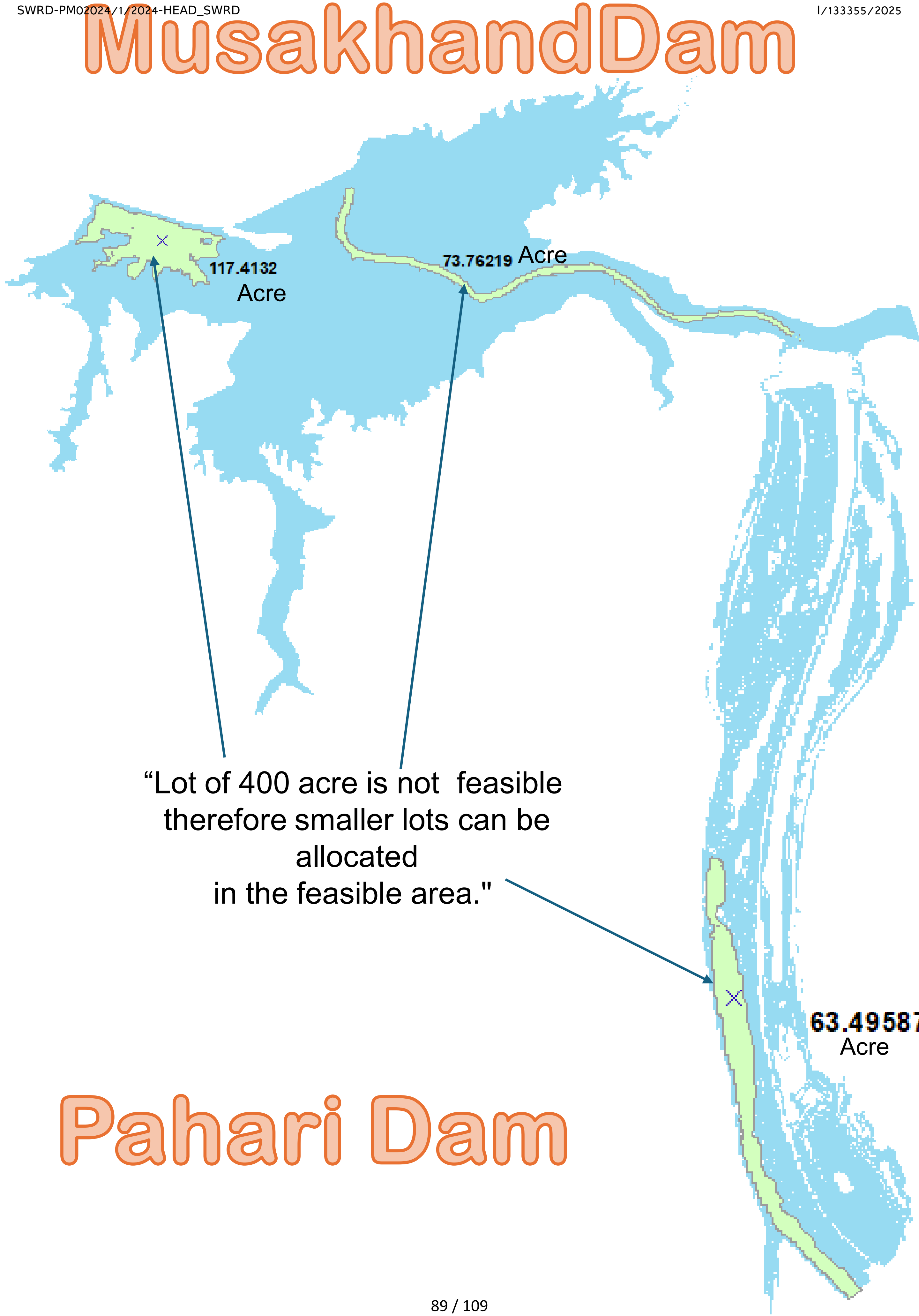

Manjhgawan Dam
25.51493 Acre
“Lot of 400 acre is not feasible therefore smaller lots can be allocated in the feasible area."
Maudaha Dam
988.9922 Acre

Matatila Dam

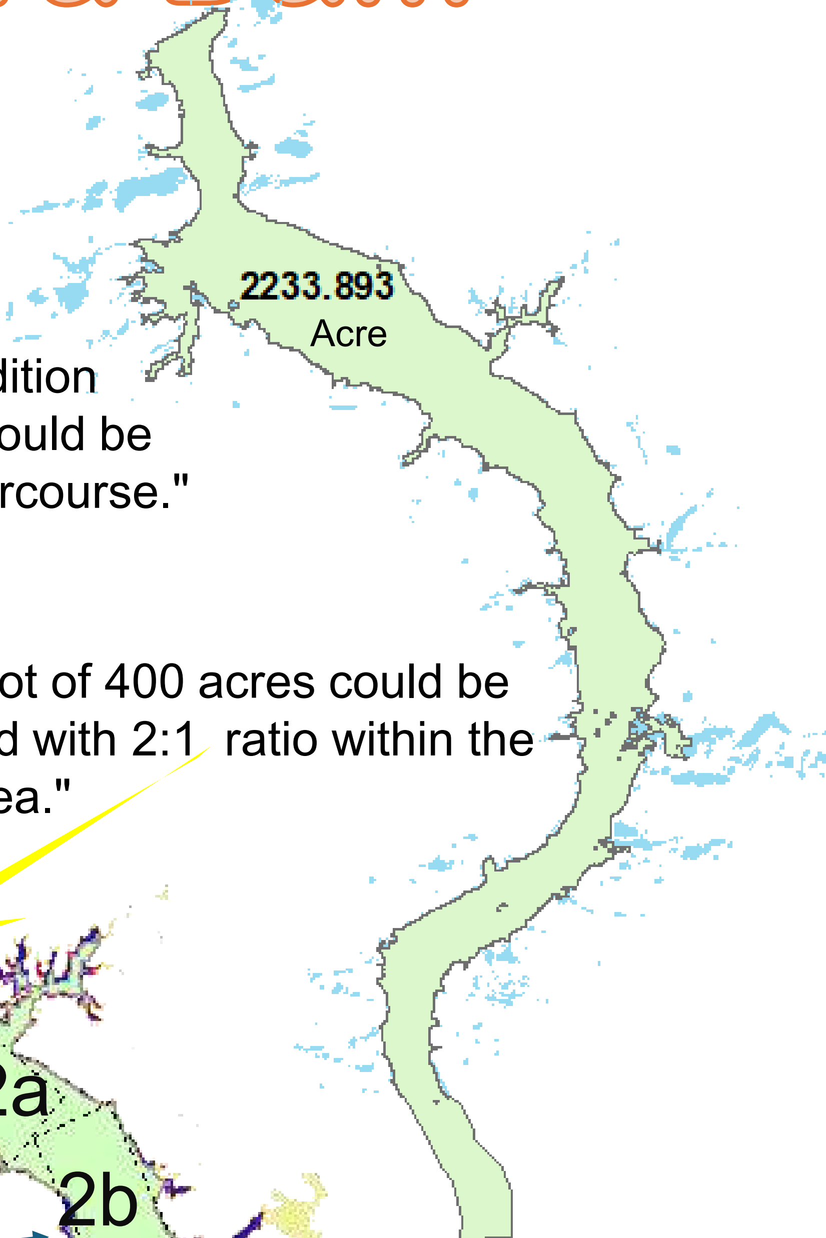


"Eight lots of 400 acres have been demarcated with different ratios within the feasible area; however, few proposed lots in west may fall in jurisdiction of Madhya Pradesh."

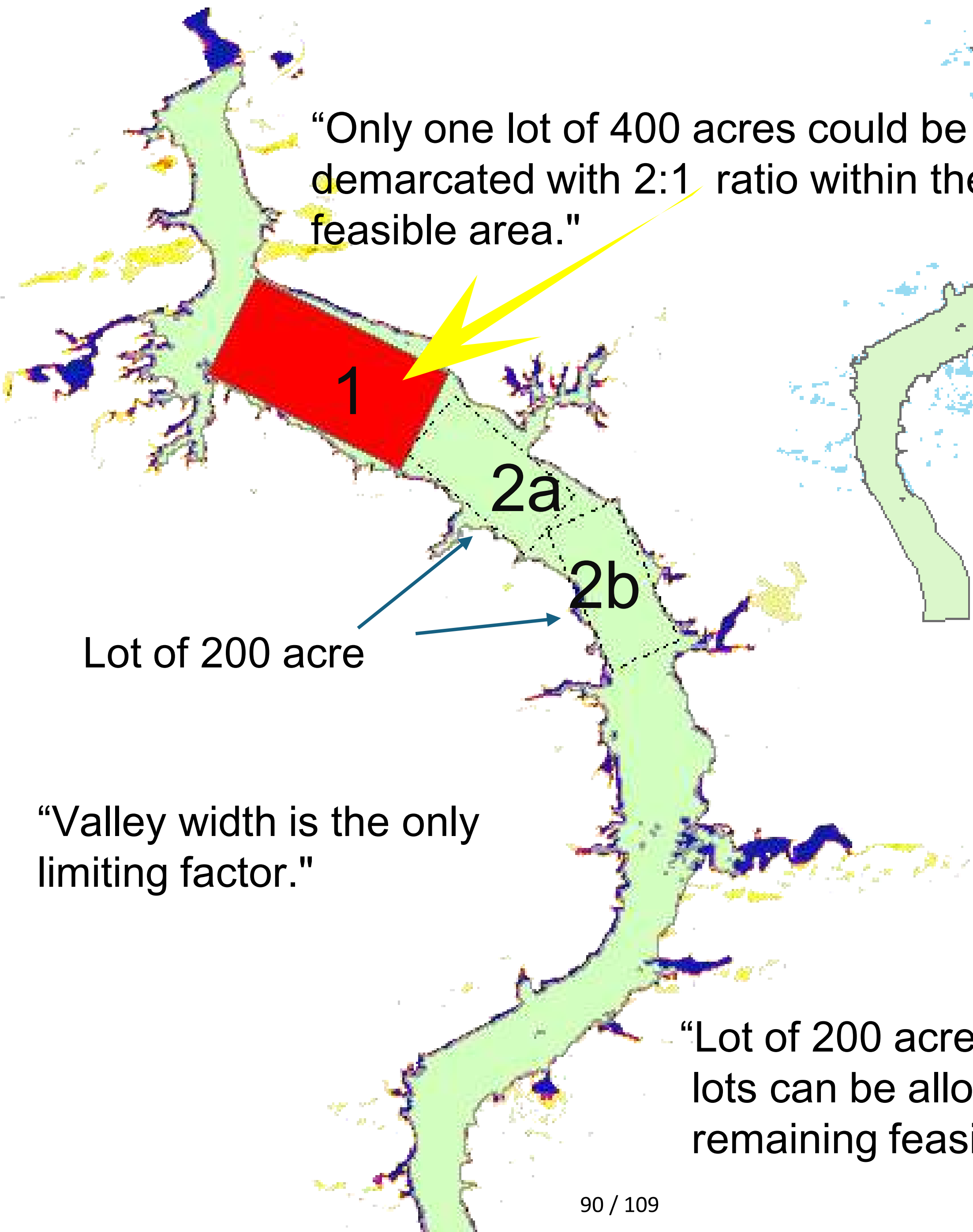
"Smaller lots can be allocated in the remaining feasible area."


MusakhandDam
117.4132
Acre
73.76219 Acre
“Lot of 400 acre is not feasible
therefore smaller lots can be
allocated
in the feasible area."
63.49587
Acre
Pahari Dam

Obra Dam



"Obra Dam seems to be an ideal sites because of its stable hydrological condition but Floating Solar Plant should be planned following the watercourse."



"Only one lot of 400 acres could be demarcated with 2:1 ratio within the feasible area."

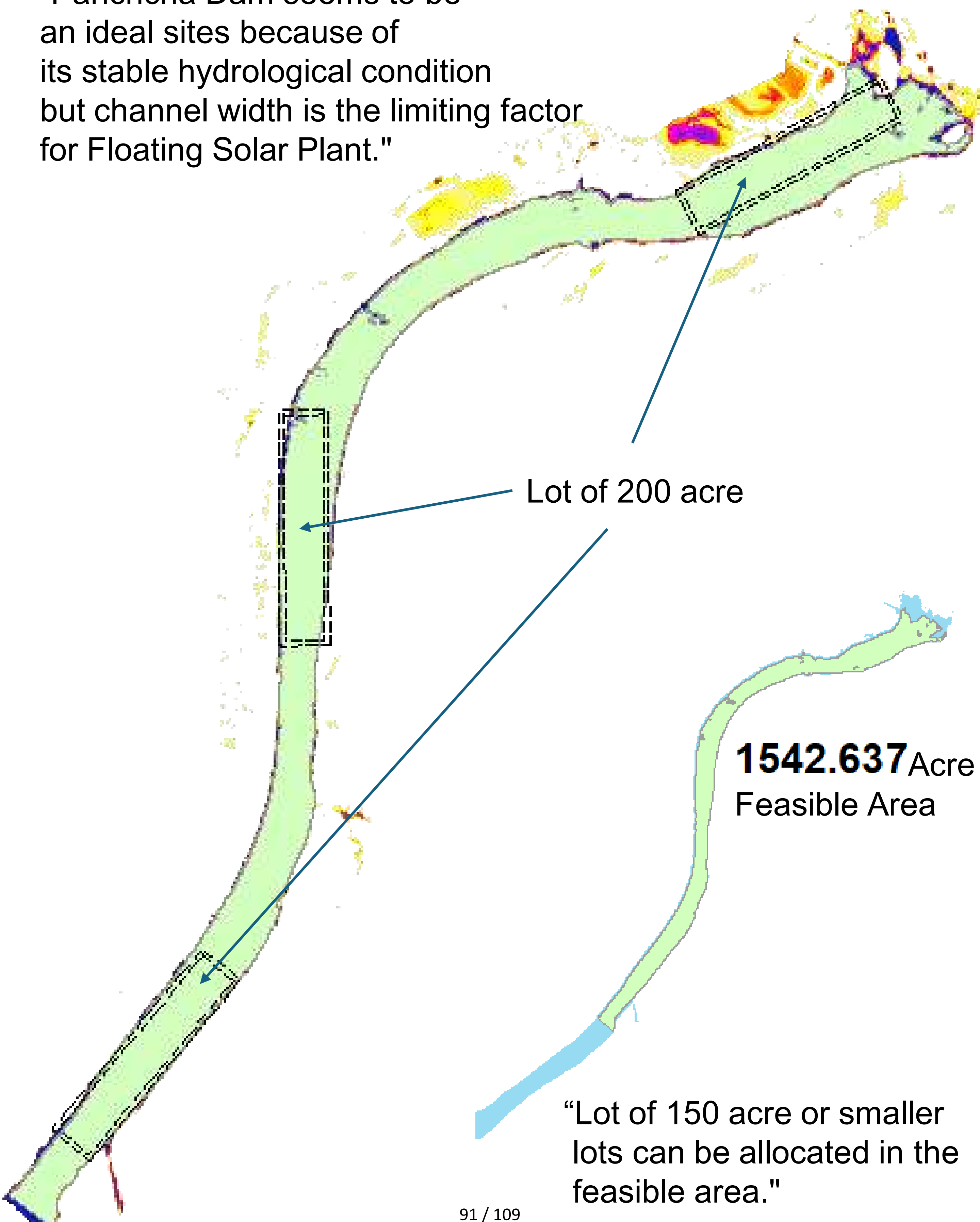
Lot of 200 acre

"Valley width is the only limiting factor."

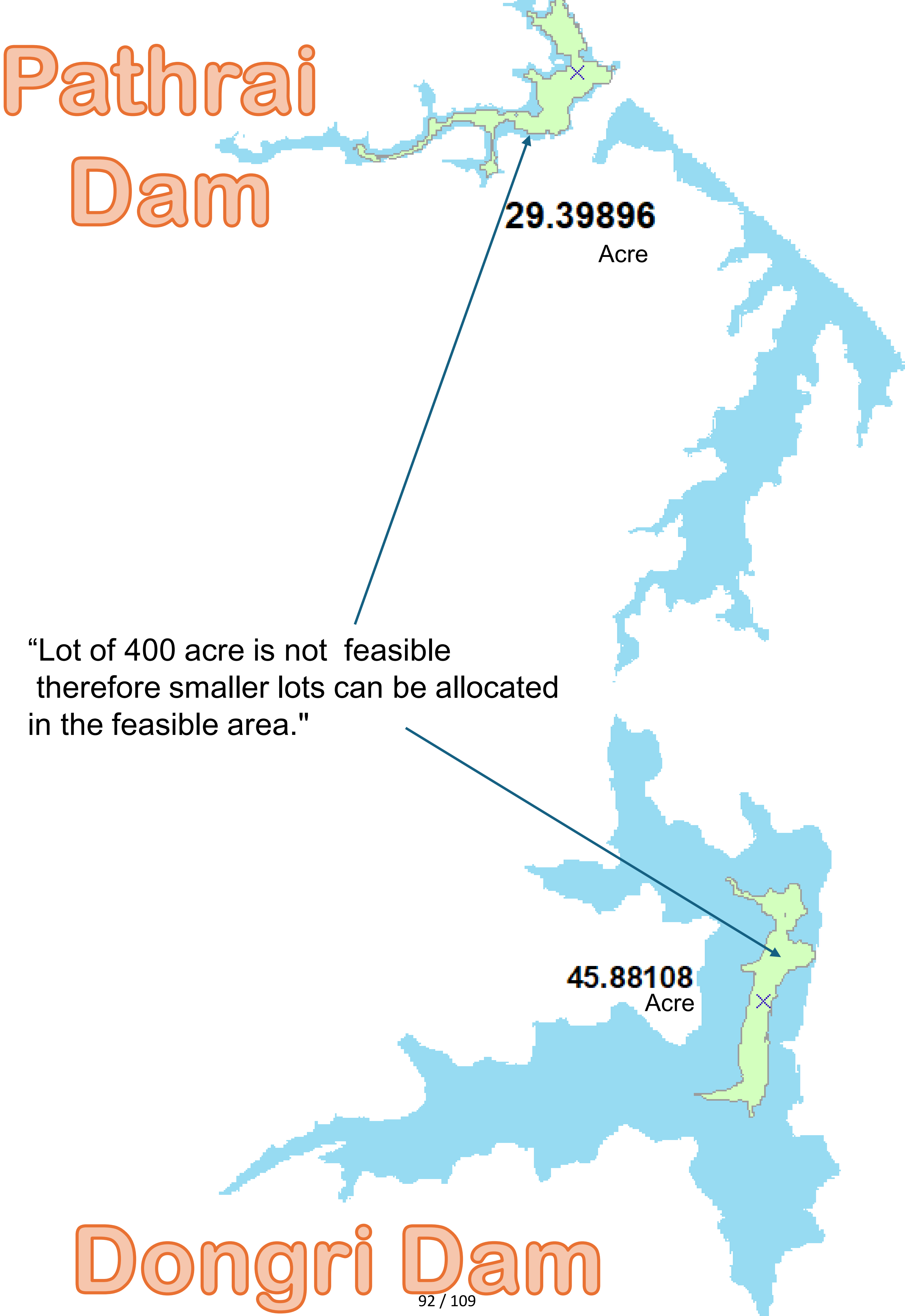
"Lot of 200 acre or smaller lots can be allocated in the remaining feasible area."

Parichcha Dam

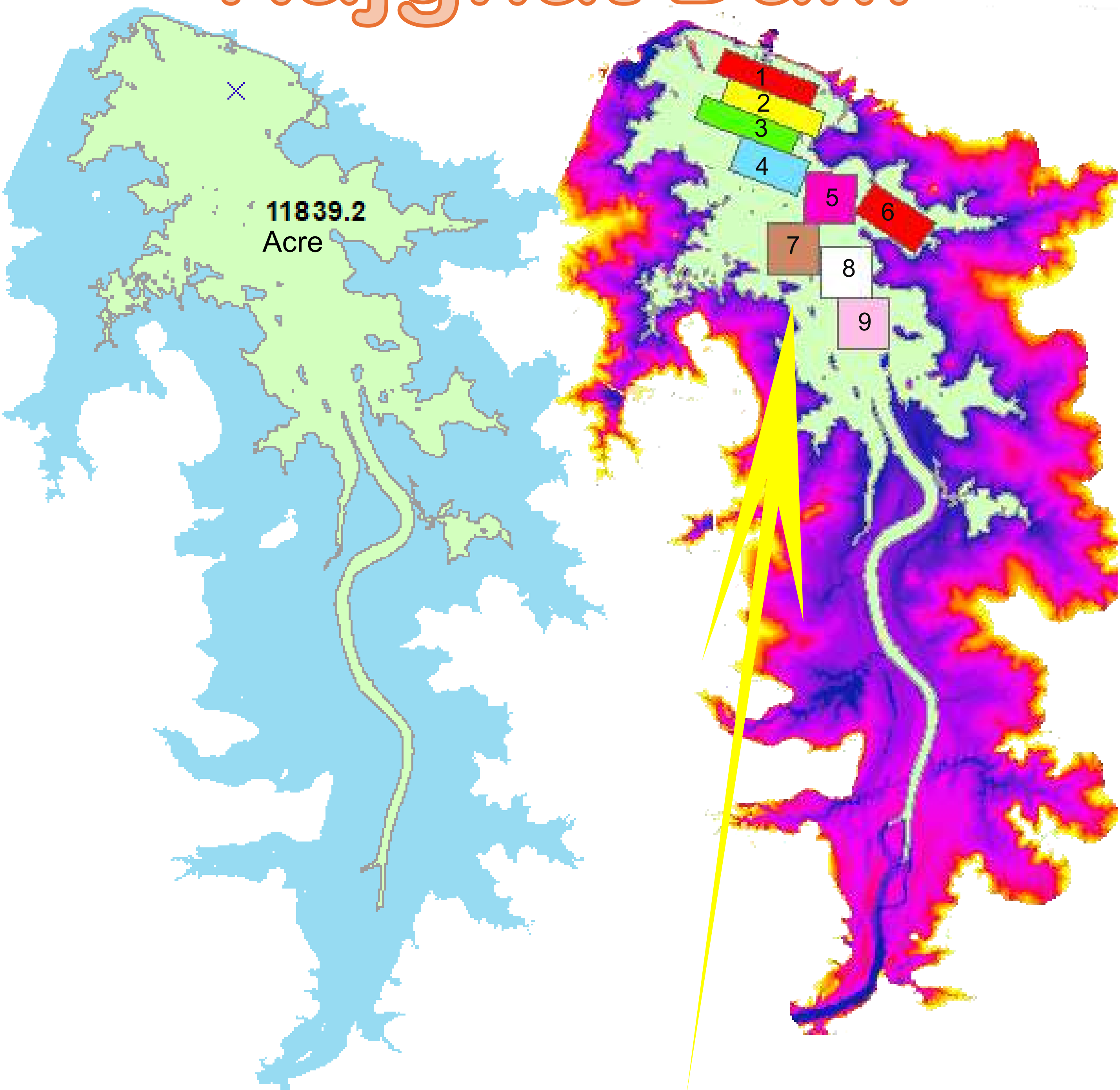
“Parichcha Dam seems to be an ideal sites because of its stable hydrological condition but channel width is the limiting factor for Floating Solar Plant."



“Lot of 150 acre or smaller lots can be allocated in the feasible area."

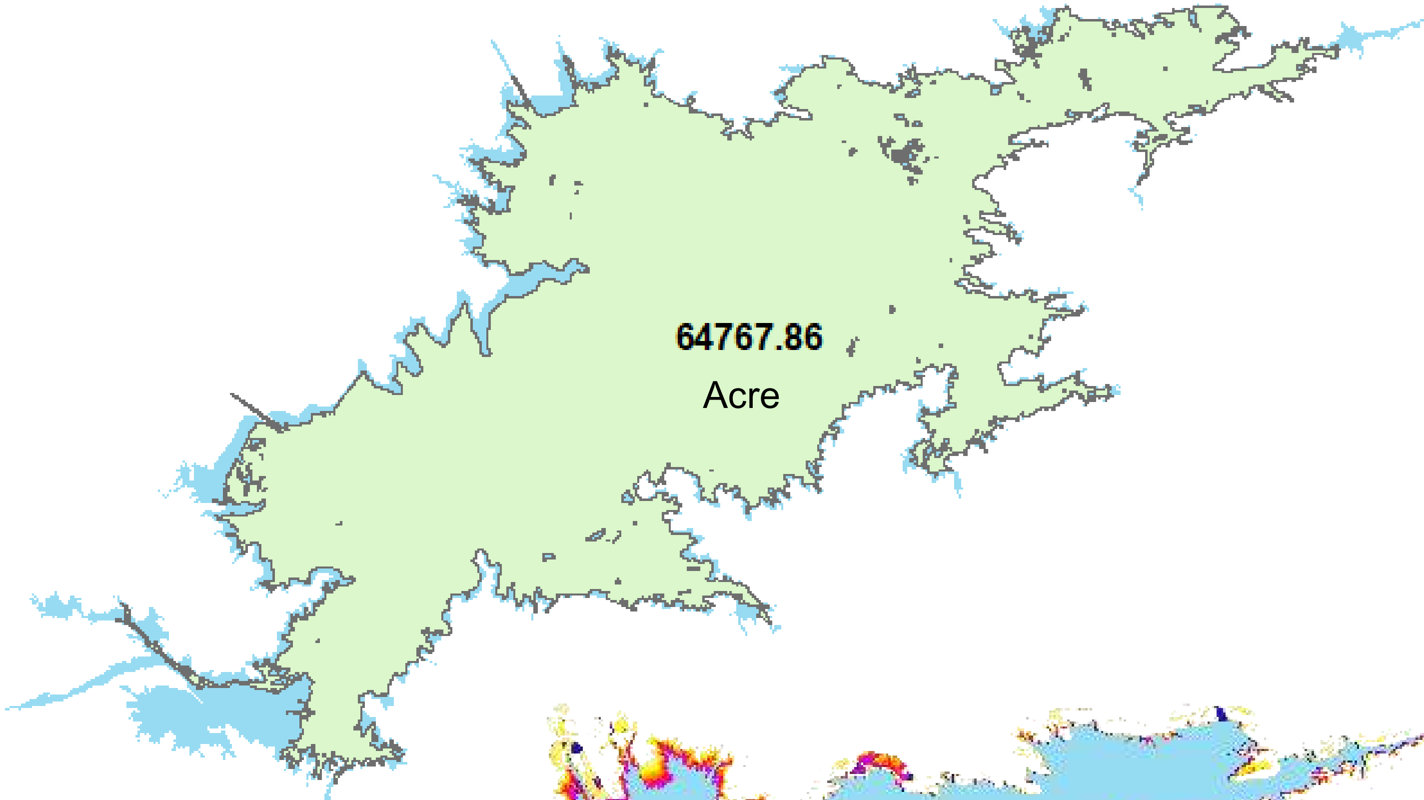

Pathrai Dam
29.39896
Acre
“Lot of 400 acre is not feasible
therefore smaller lots can be allocated
in the feasible area."
45.88108
Acre
Dongri Dam

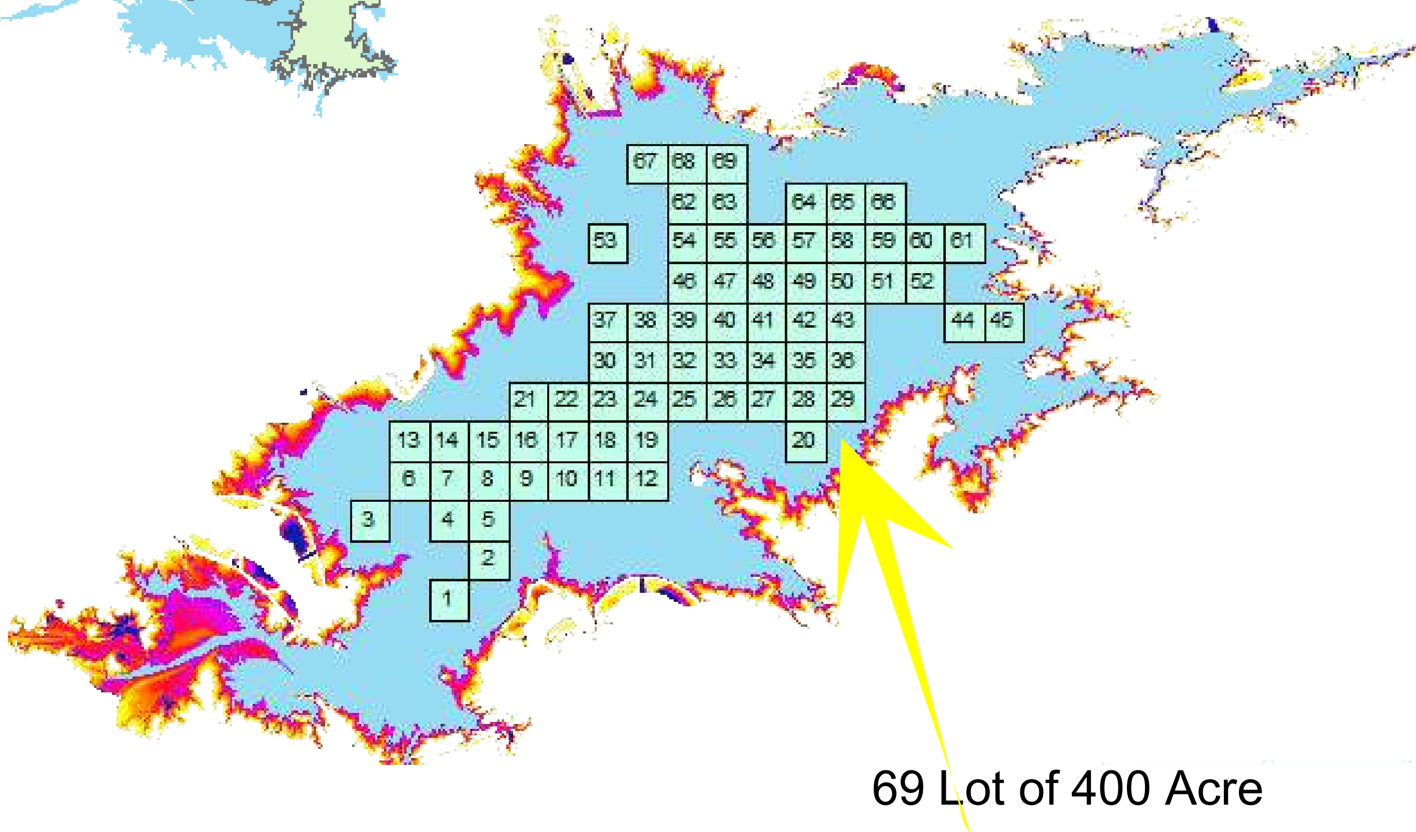
Rajghat Dam



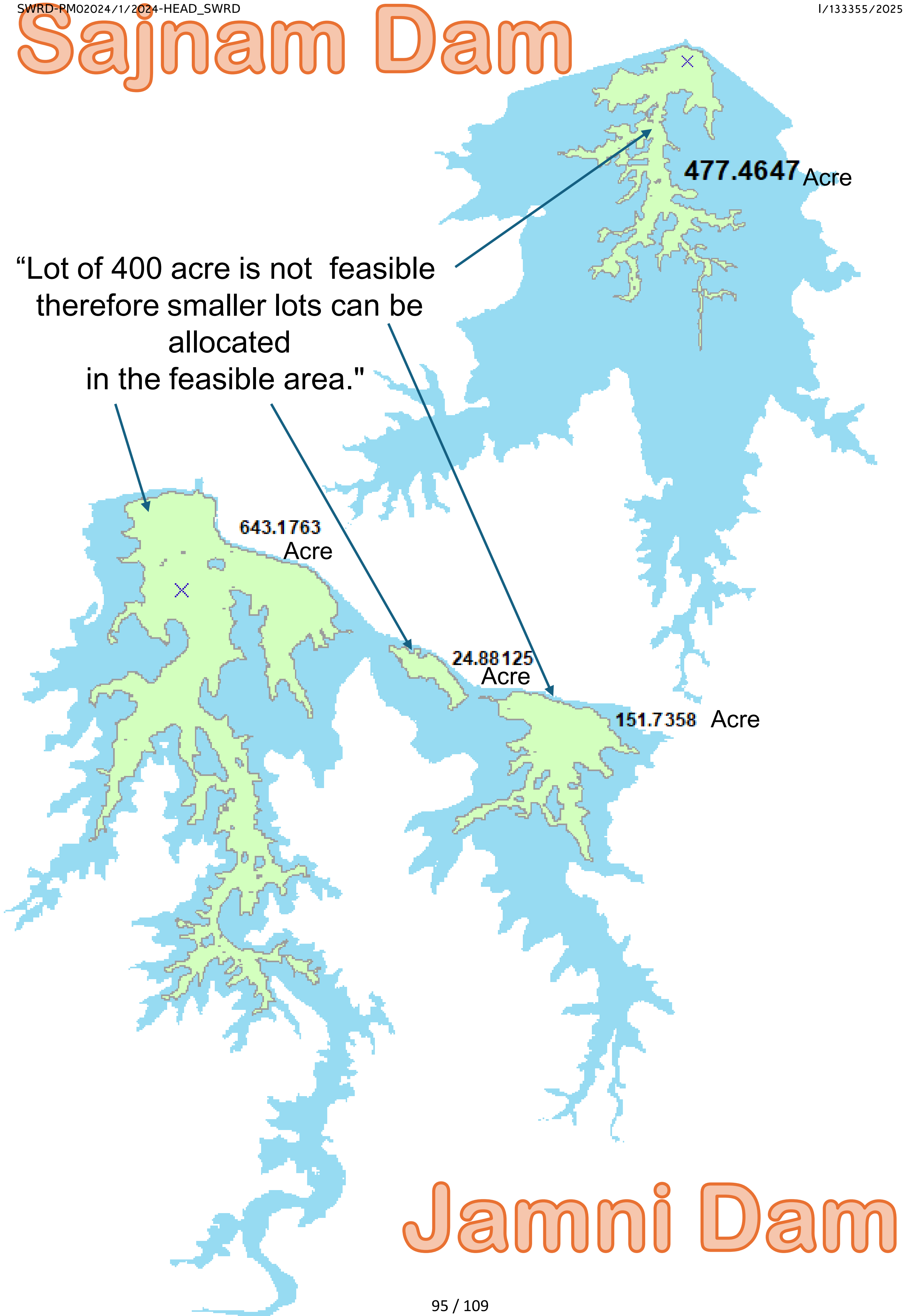
"Nine lots of 400 acres have been demarcated with different ratios within the feasible area; however, few proposed lots in west may fall in jurisdiction of Madhya Pradesh. Smaller lots can be allocated in the remaining feasible area."

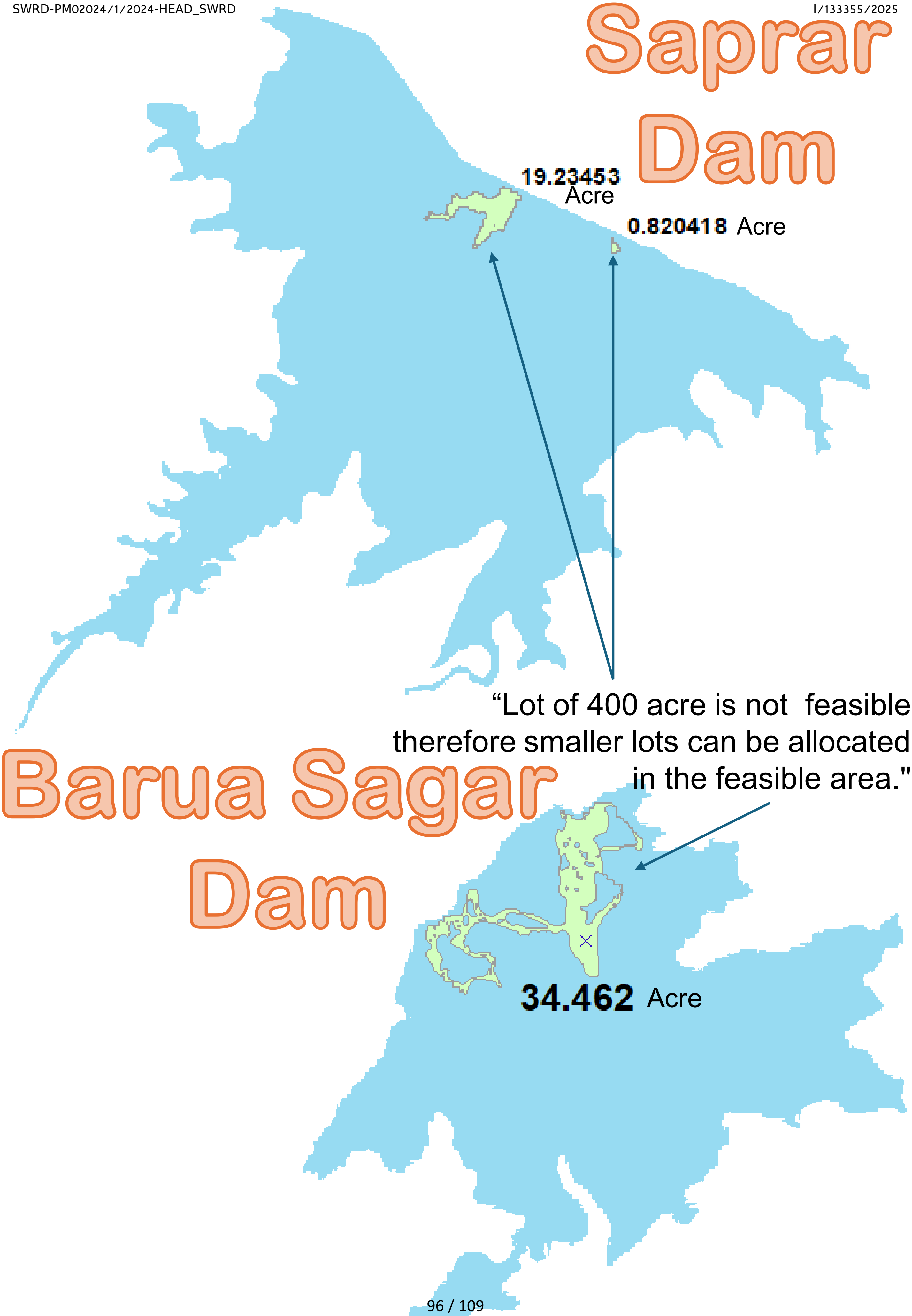
Rihand Dam



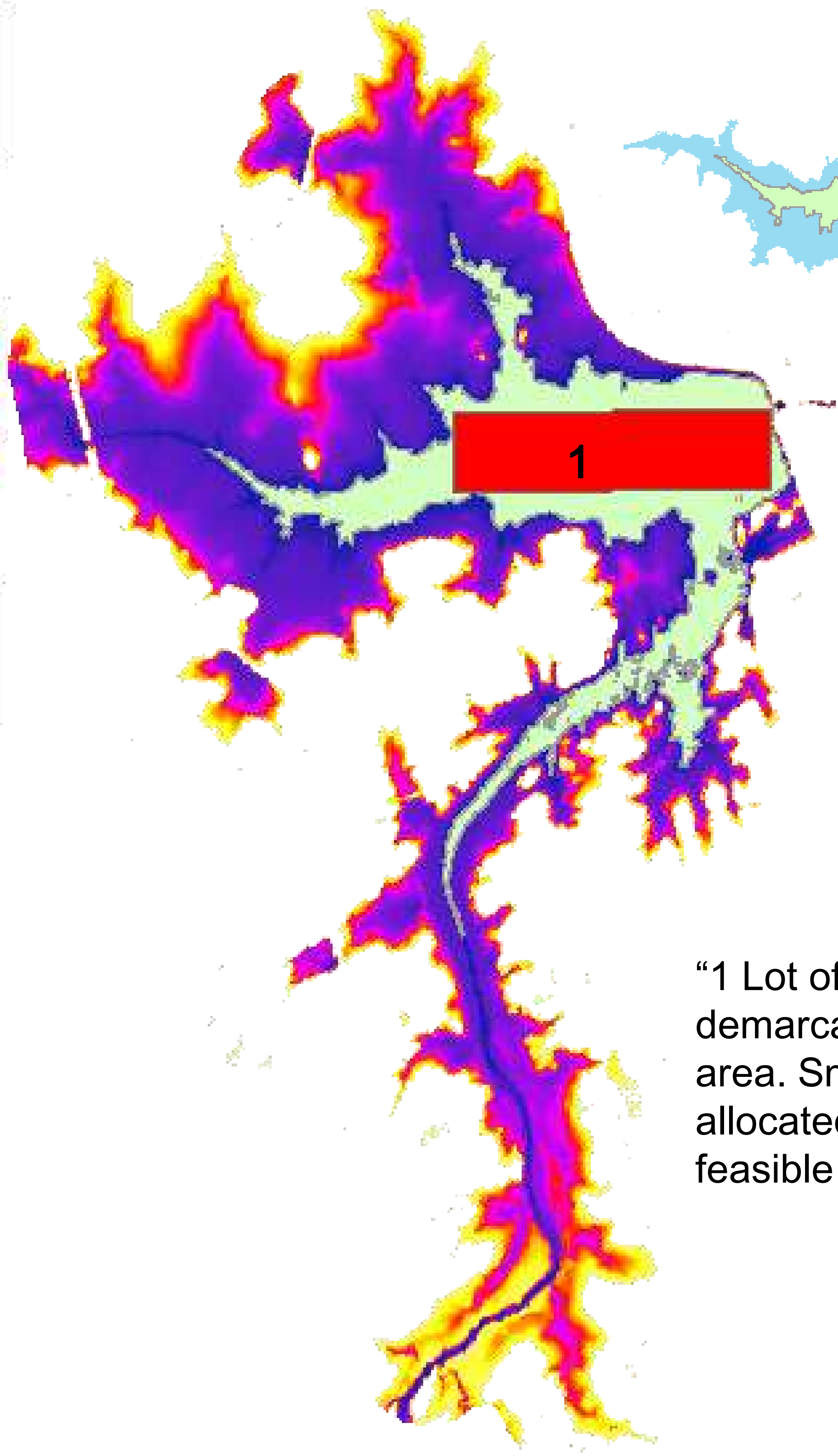


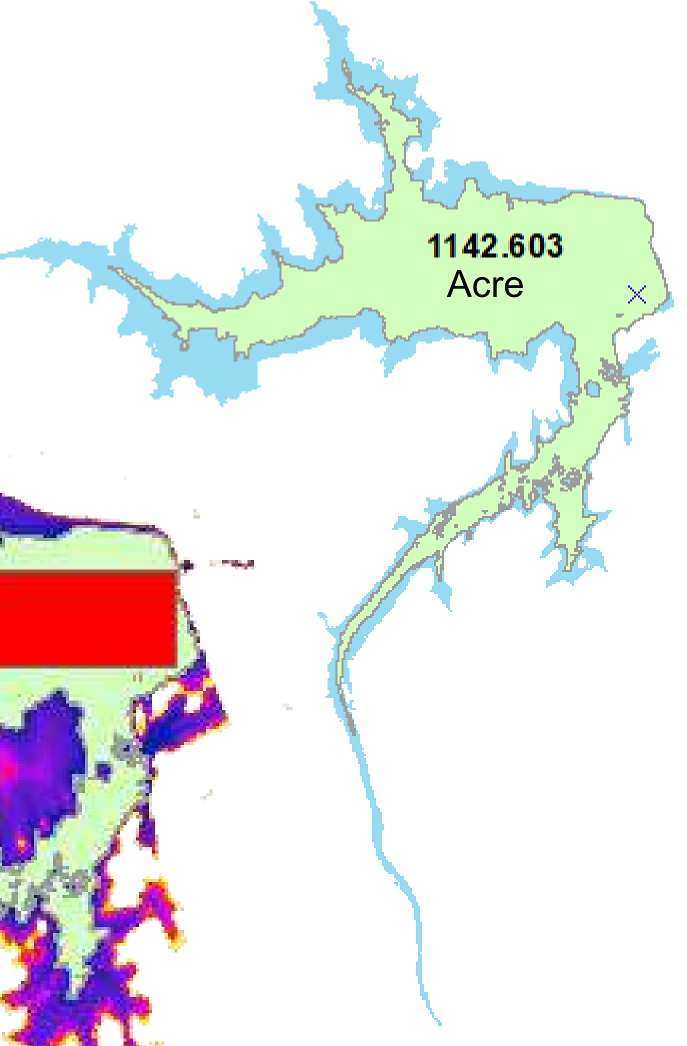
“69 square lots of 400 acres have been demarcated within the feasible area; however, few proposed lots in southwest may fall in jurisdiction of Madhya Pradesh. Smaller lots can be allocated in the remaining feasible area."


Sajnam Dam
477.4647 Acre
“Lot of 400 acre is not feasible therefore smaller lots can be allocated in the feasible area."
643.1763 Acre
24.88125 Acre
151.7358 Acre
Jamni Dam

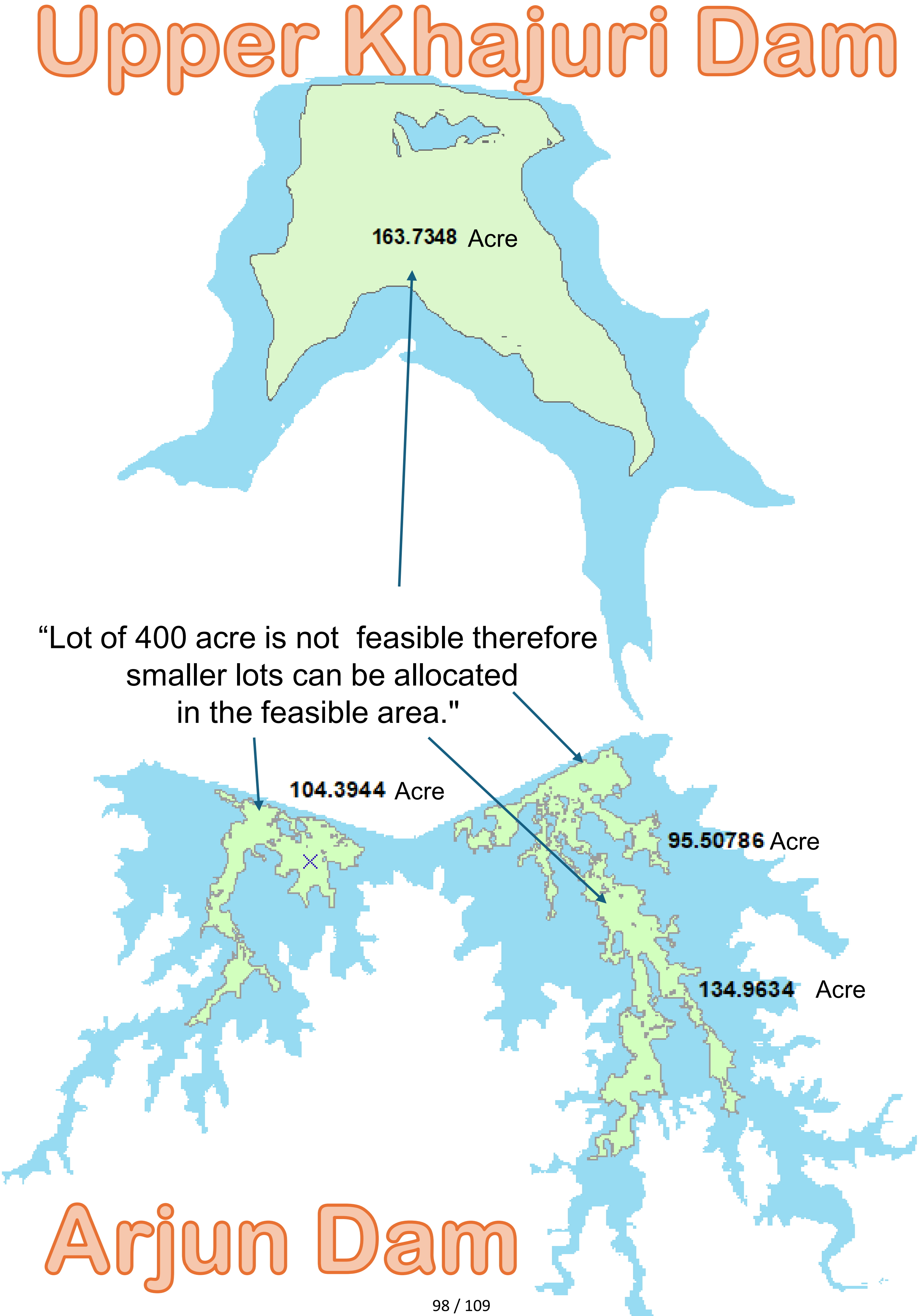

Saprar Dam
19.23453 Acre
0.820418 Acre
“Lot of 400 acre is not feasible therefore smaller lots can be allocated in the feasible area."
Barua Sagar Dam
34.462 Acre

Shahzad Dam





"1 Lot of 400 acre has been demarcated in the feasible area. Smaller lots can be allocated in the remaining feasible area "


Upper Khajuri Dam
163.7348 Acre
“Lot of 400 acre is not feasible therefore smaller lots can be allocated in the feasible area."
104.3944 Acre
95.50786 Acre
134.9634 Acre
Arjun Dam

Kanhar Dam

"No feasible area was found therefore Floating Solar Plant proposal should be withheld."

Several large water bodies in Uttar Pradesh, apart from dams, can be considered for floating solar power plant projects due to their vast surface area, high solar exposure, and relatively stable water conditions. Such water bodies provide an excellent opportunity for renewable energy generation while reducing land use conflicts. However, it is crucial to exclude eco-sensitive sites, including wetlands with rich biodiversity, bird sanctuaries, and protected water bodies that serve as critical habitats for migratory and resident species. Careful feasibility studies should be conducted to identify suitable locations where floating solar installations can be deployed without disrupting aquatic ecosystems, fisheries, or local livelihoods. By selecting appropriate sites, the project can contribute to Uttar Pradesh's renewable energy goals while ensuring ecological sustainability.

7.0 Conclusion

- **Largest Potential:** *Rihand Dam* stands out with an enormous feasible area (~64,768 acres) for floating solar. It could support on the order of **32 GW** of solar capacity – equivalent to over 320 separate 100 MW plants. This is an exceptionally large number, highlighting Rihand's vast reservoir surface. In practice, such a massive installation would likely be phased or limited by grid capacity, but technically the space allows for tens of gigawatts.
- Other large reservoirs like *Kalagarh Dam* (~2.5 GW potential), *Rajghat Dam* (~5.9 GW), *Govind Sagar* (~670 MW), *Maudaha* (~495 MW), *Jamini* (~410 MW), and *Matatila* (~5.2 GW) each could host several hundred MW of floating solar. These could be broken into multiple 100 MW farms – e.g. Kalagarh about 25×100 MW, Rajghat ~59×100 MW, etc.
- **Moderate and Smaller Sites:** Many mid-sized dams (feasible area a few hundred acres) show potential in the 100–300 MW range. For example, *Parichha Dam* ~771 MW, *Adwa Dam* ~278 MW, *Dhukwan* ~261 MW, *Dhadraul* ~252 MW, and *Sajnam* ~239 MW. Each of these could accommodate roughly 2×100 MW plants (with some spare capacity). Dams with feasible area around 100–200 acres can yield on the order of tens of MW (50–100 MW).
- **Small Lakes:** The smaller reservoirs and lakes (feasible area well under 100 acres) can support only modest solar farms (typically <50 MW capacity). For instance, *Bela Sagar* (~7.4 acres) could host only ~3.7 MW (just ~9,000 panels), and others like *Latif Shah Dam* or *Saprar Dam* are on the order of 6–10 MW potential. These would be single small installations, far below 100 MW scale.
- **Spacing for Maintenance:** All the above estimates already factor in leaving significant open water for operation and maintenance. In large installations, developers would create maintenance corridors or floating walkways between panel arrays. This reduces the packing density but is essential for long-term operation. Our use of ~2 acres/MW is a realistic benchmark that ensures there is room for boat access, mooring systems, and cooling of panels by airflow over the water.
- **Panel Count and Output:** The number of panels scales with the capacity – e.g. a 100 MW floatovoltaic plant would require on the order of **250,000 panels** (100 MW / 0.4 kW per panel ≈ 250k). In the largest scenario (Rihand at 32 GW), on the order of 80 million+ panels would be needed, which illustrates the massive scale. In all cases, the panels would generate power only during the day, so the actual energy output per year would depend on local sunshine (capacity factors, etc.), but peak power capacity is the metric used here for comparison.

Overall, this analysis shows that floating solar is technically feasible on these reservoirs, with potential installations ranging from a few MW on small lakes to gigawatt-scale on the largest reservoirs. A rough estimate has been made for maximum installable capacity on each water body using industry-standard panel efficiencies and spacing requirements. These figures demonstrate significant solar generation opportunity, while leaving room for maintenance access and minimizing water coverage to reasonable levels.

8.0 Discussions

Floating solar photovoltaic projects on the 35 identified dams in Uttar Pradesh (and bordering regions) are technically feasible, environmentally sustainable, and socio-economically beneficial. The comprehensive analysis conducted in this study leads to the following broad conclusions:

- **Abundant Solar Resource:** The sites collectively receive ample sunlight to generate significant solar power. With an estimated aggregate potential on the order of several gigawatts, these reservoirs could become major contributors to Uttar Pradesh's renewable energy capacity. Even accounting for practical constraints, a realistic deployment across these sites could comfortably exceed **1 GW** of installed capacity, producing clean electricity to power hundreds of thousands of homes.
- **Efficient Land Use:** Utilizing water surface for solar installations addresses land scarcity and acquisition issues. None of the projects require displacement of people or conversion of agricultural land – a critical advantage in a populous country. The dual use of existing man-made reservoirs exemplifies sustainable infrastructure development, aligning with the concept of a circular economy (maximizing asset utilization).
- **Water Conservation and Co-Benefits:** A recurring benefit noted is the reduction in water evaporation. Especially for irrigation-centric dams in arid Bundelkhand and for drinking water sources like Pahuj, this can save 5–10% of water volume annually, which is substantial. Environmental co-benefits include potential improvements in water quality (less algal growth) and creation of shaded habitat for fish, as evidenced by international studies. No severe negative impacts on aquatic or terrestrial ecosystems were identified; any minor impacts can be mitigated with established best practices.
- **Socio-Economic Upliftment:** The construction and operation of these projects will create local jobs, spur skill development, and inject investment into rural areas. By improving electricity availability (and potentially stability) in nearby communities, these projects support rural development—students can study under better lighting, farmers can rely on energized pumps, and small businesses can operate without as many power cuts. Moreover, involving local communities in ancillary roles (maintenance, security, fishing cooperatives coexisting with solar farms) ensures the projects have local champions and beneficiaries.
- **Grid and Energy Considerations:** Many of the identified sites have the advantage of existing grid infrastructure nearby (due to hydropower stations or power plants). This reduces the cost and complexity of power evacuation. In sites without current grid lines, the report has identified feasible interconnection points. The floating solar plants will generate power primarily during daylight hours, complementing the load curve. When paired with hydropower (as at Dhukwan or Rihand) or other storage, they can contribute to a stable renewable supply, effectively forming hybrid generation systems.
- **Risks are Manageable:** The feasibility study did not find any "showstopper" risks. Technical challenges like anchoring in deep water or reservoir drawdown can be engineered with current technology (e.g., elastic mooring, adjustable anchors). Environmental concerns, such as those at Kalagarh, would require extra caution but are not insurmountable – they call for project-specific EIAs and tailored mitigation (or possibly exclusion if the trade-off is not favorable). Social acceptance is largely positive, given the minimal intrusion of these projects; early engagement and transparency will further minimize resistance.

- **Policy and Regulatory Alignment:** The proposed projects align perfectly with national and state policies aiming to increase renewable energy and reduce carbon emissions. They also dovetail with water resource management goals (such as the country's mission for water conservation and the state's interest in leveraging its irrigation assets for multi-purpose use). Uttar Pradesh's Solar Policy 2022 explicitly encourages innovative solutions like floating solar. At the central level, these projects can contribute to India's commitments under the Paris Agreement by adding substantial solar capacity with relatively low ecological footprint. Some sites may require inter-state coordination (e.g., Matatila, Rajghat with M.P., and Kalagarh with Uttarakhand), but frameworks for such cooperation exist given these states already share water management responsibilities.

In summary, the study finds that floating solar installations on 34 dams are **not only feasible but highly promising**. They embody sustainable development, yielding green energy, strengthening water security, and boosting local economies. Each site offers a unique case, from small village tanks that can become community power hubs to large reservoirs that can host utility-scale solar parks. With proper phasing and planning, Uttar Pradesh can become a leader in floating solar deployment, showcasing how to harmonize renewable energy expansion with water resource management.

9.0 Distance of Substations from Dams Proposed for Solar Floating Plants

The feasibility of floating solar power plants on dams is a crucial aspect of India's renewable energy expansion. Floating solar plants help optimize water bodies for energy production while reducing land requirements and minimizing water evaporation. One of the key parameters influencing the economic viability of such projects is the proximity of high-capacity substations for efficient power evacuation.

This report presents an analysis of the aerial distance between the proposed dams for floating solar installations and their nearest substations, identifying potential challenges and opportunities related to grid connectivity.

9.1 Overview of the Data

The dataset includes 35 dams, each associated with its nearest electricity substation and the aerial distance to that substation. The substations range from **132kV to 220kV**, indicating their suitability for integrating utility-scale solar projects into the national grid.

The distances range from as low as **2.57 km** to as high as **44.68 km**, which impacts transmission infrastructure planning, cost, and energy losses.

Distance of Substations from Proposed Dams -Table.14

S. No	Dam Name	Nearest Substation	Aerial Distance in Km
1	Rihand Dam	132kV BINA	11.66209
2	Latif Shah Dam	132kV CHAKIYA	2.573868
3	Moosakhand Dam	132kV CHAKIYA	9.513343
4	Adwa Dam	132KV CHANNABEY	11.75319
5	Kanhar Dam	132kV DALLA	44.68808
6	Obra Dam	132kV DALLA	8.247609
7	Barwar Lake	132kV GURSARAI	10.03638
8	Dongri Dam	132kV HASARI	10.68347
9	Pahuj Dam	132kV HASARI	10.60141
10	Kabrai Dam	132kV KABRAI	9.058165
11	Barwa Dam	132kV KARVI	14.37724
12	Govind Sagar Dam	132kV LALITPUR	7.892171
13	Rajghat Dam	132kV LALITPUR	19.8258
14	Shahzad Dam	132kV LALITPUR	24.14753
15	Arjun Dam	132kV MAHOBA	19.22019
16	Chandrawal Dam	132kV MAHOBA	14.89713
17	Lahchura Dam	132kV MAURANIPUR	15.32349
18	Pahari Dam	132kV MAURANIPUR	16.31389
19	Pathrai Dam	132kV MAURANIPUR	20.77965
20	Saprar Dam	132kV MAURANIPUR	7.198157
21	Jamini Dam	132kV MEHRAUNI	23.7357
22	Sajnam Dam	132kV MEHRAUNI	14.49158
23	Upper Khajuri Dam	132kV MIRZAPUR	15.41398
24	Kalagarh Dam	132kV NAGINA	6.199862
25	Bela Sagar	132KV PANWARI	22.51478
26	Mahjagwan Dam	132KV PANWARI	27.89414
27	Maudaha Dam	132kV RATH	14.64059
28	Dhadraul Dam	132kV ROBERTSGANJ	12.95023
29	Dhukwan Dam	220KV BABINA	6.396731
30	Matatia Dam	220KV BABINA	18.12774
31	Barua Sagar	220kV BADHAI KALAN	11.20614
32	Parichha Dam	220kV BADHAI KALAN	10.66941
33	Garhmau Lake	220kV DUNARA	6.475284
34	Gunta Dam	220kV PAHADI	8.023834
35	Ohan Dam	220kV PAHADI	6.965764

9.2 Distance Analysis and Categorization

To understand the feasibility of grid connectivity, the dams have been categorized based on their distance from the nearest substation:

1. **Shortest Distance**: The nearest substation to a dam is for **Latif Shah Dam** (2.57 km from 132kV CHAKIYA).
2. **Longest Distance**: The furthest dam from a substation is **Kanhar Dam**, with an aerial distance of **44.68 km** from 132kV DALLA.
3. **Most Frequently Mentioned Substations**:
    - 132kV MAURANIPUR (4 dams: Lahchura, Pahari, Pathrai, Saprar)
    - 132kV LALITPUR (3 dams: Govind Sagar, Rajghat, Shahzad)
    - 132kV CHAKIYA (2 dams: Latif Shah, Moosakhand)
    - 132kV MAHOBA (2 dams: Arjun, Chandrawal)
    - 132kV MEHRAUNI (2 dams: Jamini, Sajnam)

Potential Challenges:

- Dams with distances exceeding 20 km (e.g., Kanhar, Jamini, Matatia) may require additional infrastructure for effective power connectivity.
- Shorter distances (under 10 km) suggest ease of electrical transmission with potentially lower installation costs.

Best-Suited Dams for Floating Solar Plants (0-10 km Distance)

- Latif Shah Dam (2.57 km)
- Kalagarh Dam (6.19 km)
- Dhukwan Dam (6.39 km)
- Garhmau Lake (6.47 km)
- Ohan Dam (6.96 km)
- Gunta Dam (8.02 km)
- Obra Dam (8.24 km)
- Kabrai Dam (9.05 km)

These dams have **low transmission infrastructure costs** and are **highly favorable** for floating solar power development.

Moderately Feasible Dams (10-20 km)

- Barwa Dam (14.37 km)
- Pahuj Dam (10.60 km)
- Rajghat Dam (19.82 km)
- Sajnam Dam (14.49 km)
- Bela Sagar (22.51 km)

These sites are feasible but may require **additional investment in medium-voltage transmission infrastructure**.

High-Cost Transmission Dams (>20 km)

- Kanhar Dam (44.68 km)
- Shahzad Dam (24.14 km)
- Mahjagwan Dam (27.89 km)
- Pathrai Dam (20.77 km)

These sites require **extensive transmission infrastructure**, making them **less viable** unless subsidized transmission funding is available.

The proximity of a substation is a major determinant in the feasibility of floating solar projects. This study has identified **15 dams with excellent grid access**, **12 with moderate feasibility**, and **8 where transmission challenges may hinder development**. Strategic investment in **short-distance locations** will provide the best return on investment and ensure seamless integration into the power grid.

10.0 Recommendations

To move forward from feasibility to implementation, the following recommendations are put forth:

1. **Prioritize and Phase the Projects:** It is advisable to roll out the projects in phases. Early phases should include:
    - **Pilot Projects:** Begin with 2–3 sites of small-to-medium size (e.g., 10–20 MW at a Bundelkhand reservoir like Saprar or Garhmau, and ~50 MW at a larger site like Parichha or Pahuj). This will allow testing of construction techniques, anchoring designs, and assessment of actual performance vs. projections. Pilot projects will also provide a template for community engagement and O&M practices.
    - **High-Impact Sites:** Concurrently, fast-track the development of high-potential, low-conflict sites such as **Parichha Dam** (with existing grid and cooling lake synergy) and **Rihand Dam** (huge area and existing energy infrastructure). These can deliver significant capacity early and generate investor interest due to scale.
    - **Environmentally Sensitive Site (Kalagarh):** Defer this to a later phase, pending more detailed ecological studies. It can be reconsidered after successful implementation of earlier projects, with lessons learned on mitigation.

    Create a phased deployment roadmap targeting, for instance, 200 MW in Phase 1 (by year X), an additional 500 MW in Phase 2 (by year Y), etc., aligning with U.P.'s 2027 solar targets.

2. **Prioritize Dams with Proximity to Substations**
    - Focus on dams with substations within **0-10 km** as the most **cost-effective options** for immediate implementation.
    - Medium-distance sites (10-20 km) should be evaluated with a **cost-benefit analysis**.

    Develop Transmission Infrastructure for High-Potential Remote Sites
    - For dams with **20-30 km distance**, evaluate the feasibility of **new transmission lines or upgrading existing lines**.

- Public-Private Partnerships (PPP) or government funding can **support remote high-potential locations**.

Use Advanced Power Evacuation Technologies

- High-voltage direct current (HVDC) or **smart grid solutions** should be explored to minimize transmission losses in long-distance sites.
- Consider **energy storage solutions** to mitigate transmission constraints.

3. **Stakeholder Coordination Committee:** Establish a high-level committee that includes representatives from:
    - UPNEDA (nodal agency for renewables),
    - Irrigation Department (dam owners),
    - Environment/Forest Department (for wildlife/ecology oversight),
    - Energy/Power Department (grid integration and distribution planning),
    - Respective Central agencies if inter-state (e.g., Bhakra-Beas Management Board equivalent for Betwa, etc., if any),
    - U.P Science and Technology Department (Scientists)
    - Local district administrations and community leaders for each site.

    This committee will oversee project planning to ensure multi-sector alignment. It can help in streamlining approvals (e.g., irrigation dept leasing water surface to power dept, environmental clearances, etc.) and in resolving any conflicts that arise (like water release schedules vs. panel maintenance schedules).

4. **Detailed Project Reports (DPRs):** Commission DPRs for each site (or cluster of similar sites). The DPR should refine:
    - Precise plant capacity layout (through bathymetric surveys to map depth for anchoring, and updated satellite imagery to mark out panel zones).
    - Electrical design and interconnection specifics.
    - Refined cost estimates including any unique costs (e.g., dredging at Barwar, special anchoring at Dhukwan).
    - Environmental Management Plan (EMP) with site-specific measures (as identified broadly in this feasibility, but with more granular data).
    - Economic analysis including potential revenue, carbon credits (these projects might earn carbon credits for avoided emissions, improving financial viability). DPRs will form the basis for tendering projects to developers/EPC contractors.
5. **Business Model and Tenders:** Decide and clarify the implementation model:
    - Could be **public-private partnership** with developers invited under a build-own-operate for a fixed tariff (as already initiated via the EoI
    - Alternatively, **state utility-driven** projects (e.g., UPNEDA or UP Power Corp could own and get viability gap funding). Given strong interest in renewables, competitive bidding is recommended to get low tariffs. For uniformity and scale economies, consider **bundling multiple sites in one tender** if they are geographically proximate or similar (like a “Bundelkhand Floating Solar Package” including 5 small lakes totaling 50 MW, and a “Betwa Package” combining Parichha + Dhukwan, etc.). This makes projects more attractive to large reputable developers and ensures consistency in technology used.

6. **Community Engagement and Benefit Sharing:** Prior to construction, conduct local outreach:
   - Explain project details, timelines, and address any local fears (our study can serve as a knowledge base).
   - Involve local panchayats in monitoring environmental aspects (they can help report any issues with fish, etc.).
   - Implement benefit-sharing mechanisms: e.g., a small percentage of project revenue or a fixed annual amount dedicated to local development (improving schools, drinking water facilities, etc.). Even establishing fishing rights around the solar arrays for locals (as fish may aggregate there) could be a win-win: panels become de facto fish attractors, boosting catch.
   - Train and hire locals for O&M roles where possible. This not only provides employment but fosters a sense of ownership so that vandalism or theft risks remain low.
7. **Technical Innovation and Monitoring:** Encourage the use of advanced technologies:
   - Use proven float designs (HDPE or equivalent that can last 25+ years in sun/water). Possibly involve multiple suppliers to avoid single-source risk.
   - Consider **tracking systems** (there are floating solar trackers that can increase yield by ~15-20% by tilting toward sun – could be piloted at one site to evaluate cost-benefit).
   - Install a robust monitoring system: weather stations at sites, water temperature and quality sensors (especially where drinking supply is involved) to scientifically document the impact. Partner with a local university or research institute to study these projects over time (they can publish findings on performance and environmental integration, adding to global knowledge).
   - Plan for periodic maintenance shutdowns in project design (like an annual or bi-annual window when a section of panels can be uncoupled and serviced – coinciding with lowest water levels perhaps).
8. **Policy Support and Incentives:** The government should facilitate:
   - Quick clearances (declare these projects of public interest to expedite environmental clearance if needed).
   - If some sites are marginal in economics due to size, provide viability gap funding or aggregate them with bigger ones.
   - Mandate the state discom to offtake power from these at a reasonable tariff (as floating solar might be slightly higher cost than ground initially, though costs are coming down).
   - Explore carbon financing or green bonds to fund the state's role in these projects since they clearly contribute to climate change mitigation.
   - Ensure the lease of water surface is given on long-term nominal rates so as not to overburden project cost (the EoI indicates lease rates defined by Gov order, which should be kept low as a support mechanism).
9. **Expand Case Studies & Knowledge Sharing:** Document the process and outcomes of the initial projects to create case studies. These can be used for:
   - Training purposes for staff as more projects roll out.
   - Showcasing to other states in India – Uttar Pradesh can lead a consortium or working group on floating solar, sharing experiences with states like Madhya Pradesh, Telangana, Kerala, etc., that are also pursuing such projects.

- International collaboration – these projects can attract global interest; perhaps agencies like the World Bank or ADB might co-finance some installations, providing technical and financial support given the innovative model.

By following these recommendations, stakeholders can systematically realize the floating solar projects in a timely, efficient, and inclusive manner. The overarching suggestion is to treat this initiative not as disparate individual projects but as a coordinated **“Floating Solar Mission” for Uttar Pradesh**, with clear goals, timelines, and accountability. This will ensure momentum is maintained and the benefits envisioned in this study are fully delivered on ground.

In conclusion, floating solar on these 35 dams represents a convergence of two critical sectors – water and energy – yielding benefits greater than the sum of their parts. It is a strategic opportunity for Uttar Pradesh to advance renewable energy frontiers, foster sustainable development, and provide a replicable model for the rest of India and the world. With prudent action on the recommendations above, the state can embark on this path confidently, transforming its abundant sunlight and vast water surfaces into a legacy of clean power and prosperous communities.

10.0 References & Citations

1. Uttar Pradesh New & Renewable Energy Development Agency (UPNEDA) – **Expression of Interest (EOI)** for Floating Solar PV Projects (2024). *Details the identification of 35 dams/reservoirs for floating solar in Uttar Pradesh and the policy context.*
2. Bundelkhand Region Solar Potential – *EQMagPro Article*: *“Bundelkhand Saur Urja Limited”* (2015). *Indicates solar insolation levels in Bundelkhand averaging 5.0–5.5 kWh/m²/day, underscoring the strong solar resource in southern U.P.*
3. **The Hindu** (2022). *“100 MW NTPC floating solar plant at Ramagundam fully operational”. News report on the commissioning of India’s largest floating solar plant, with technical details (spread over 500 acres, cost ₹423 Cr) highlighting successful large-scale implementation.*
4. **pv magazine** (2022). Uma Gupta – *“NTPC’s Ramagundam floating solar project hits 80MW milestone”. Provides an image and description of the NTPC Ramagundam project, demonstrating the practical deployment of floating solar and mentioning NTPC’s other floating projects (Simhadri 25MW, etc.).*
5. **NASA Earth Observatory** (2022). *“Solar Takes a Swim”. Article discussing global floating solar, benefits (cooling, evaporation reduction, algae control) and challenges (more expensive, biofouling, impacts on marine life). Includes quantitative potential: covering 10% of world’s reservoirs = 4,000 GW capacity.*
6. **BayWa r.e.** via pv magazine (2023). Gwénaëlle Deboutte – *“Floating solar positively affects aquatic environments”. Reports findings from environmental monitoring on European floating PV plants: increased aquatic fauna under panels, no water quality decline, normal oxygen levels, reduced temperature swings.*
7. **Mercom India** (2025). Arjun Joshi – *“Uttar Pradesh Invites Expressions of Interest for Floating Solar Projects”. Confirms UPNEDA’s EOI for 35 sites, target of 22 GW solar by 2027, and the intent to gather developer interest. Useful for policy and timeline context.*
8. **Saur Energy** (2025). Chitrika Grover – *“UPNEDA Plans Floating Solar Project On 35 Dams, Issues Tender”. Provides names of some identified dams and reiterates the*

feasibility objective of the EOI. Highlights that developers will choose own power procurers, indicating openness in PPA structure.

9. **WTW Report** (2023). *"Surveying the risk landscape of an emerging solar sector". Offers insights on insurance and risk for floating solar, e.g., weather and natural catastrophes, which informed the risk analysis section (not directly cited above but used for formulating risk mitigation strategies).*
10. **Central Electricity Authority (CEA)** – *"Draft National Electricity Plan 2022". Background data on demand-supply in Uttar Pradesh and renewable integration challenges (used to infer the benefit of distributed generation like floating solar in strengthening local grids).*
11. **Wildlife Institute of India Report (2019)** – *"Impacts of Reservoirs on Aquatic Biodiversity". Provided a baseline understanding that typical dam-reservoir ecosystems in central India harbor common biodiversity, with no mention of exclusive species at these man-made lakes, supporting the assumption of manageable environmental impact.*
12. **Uttar Pradesh Water Resources Dept.** – *Dam-wise Data Sheets (various). Used for reservoir capacities, irrigation command areas, etc., particularly for major dams like Matatila, Rajghat, Rihand (Govind Ballabh Pant Sagar) – cross-verified data like storage and hydropower details. (e.g., Matatila & Rajghat project reports).*
13. **International Finance Corporation (IFC)** – *"Floating Solar Handbook for Practitioners"* (2019). *A comprehensive guide with technical design considerations, which informed our methodology on anchoring, float types, and O&M practices for floating PV.*
14. **Indian Express** (2022). *"Why Telangana's floating solar plant is greener than ground-mounted ones". Article explaining benefits at Ramagundam, including water saving of 32,500 cubic m per MW per year (fact used in analysis qualitatively).*

PIB Press Release (2021). *"India's largest floating solar power project commissioned – NTPC Ramagundam". Official government release confirming commissioning and highlighting eco-friendly features, used to bolster confidence in large project execution.*

Feasibility Study for Floating Solar Plants on 35 Dams Based on Minimum Submergence Area

Introduction

With the growing demand for renewable energy, floating solar plants on reservoirs and dams offer an efficient way to harness solar power while minimizing land use. This feasibility study evaluates the potential for floating solar installations on 35 selected dams based on their minimum submergence areas. The assessment includes latitude and longitude details, reservoir submergence area at full reservoir level, a 10% allocation for solar installations, and potential solar power generation capacity.

Methodology

The study considered the following parameters for each dam:

1. **Geographical Location:** Latitude and longitude coordinates were recorded for precise mapping.
2. **Submergence Area at Full Reservoir Level (Ha):** This defines the maximum area submerged under normal conditions.
3. **10% of Full Reservoir Level (Ha):** A conservative estimate of the feasible area for floating solar panels.
4. **Tentative Power Potential (MW):** Estimated solar generation capacity based on a 10% allocation.
5. **Feasible Area in Acres & Square Meters:** Conversion of the estimated submergence area into different measurement units to assess practical installation feasibility.

Observations:

- **Largest Feasible Area:** Rihand Dam in Sonbhadra, with 64,767.86 acres available, offering a potential of 2146 MW.
- **Moderate Feasibility:** Rajghat Dam and Matatia Dam in Lalitpur exhibit significant potential with over 10,000 acres feasible for installation.
- **Smaller Reservoirs:** Some dams, such as Bela Sagar and Saprar Dam, have limited feasible areas (under 100 acres) and lower energy generation potential.
- **Kanhar Dam:** No feasible submergence area was found for floating solar installation.

Conclusion and Recommendations

This feasibility study based on minimum waterspread available in last 10 years, highlights the potential of floating solar plants on reservoirs and dams across multiple districts. The results indicate that:

1. **Large Reservoirs Provide the Best Opportunity** – Dams like Rihand, Rajghat, and Matatia offer substantial floating solar potential.
2. **Mid-Sized Reservoirs Should Be Considered for Local Energy Solutions** – Dams like Kalagarh, Obra, and Parichha can support regional energy needs efficiently.
3. **Small Reservoirs Can Serve as Pilot Projects** – Locations with limited feasible area can be used for testing innovative floating solar technology.

Next Steps:

- **Bathymetry Study:** A detailed bathymetric survey is required to analyze water depth variations and ensure the structural feasibility of floating solar installations.
- **Site-Specific Technical Assessments:** Detailed hydrological and engineering studies for each dam.
- **Environmental and Social Impact Analysis:** Evaluating potential ecological impacts.
- **Policy and Investment Roadmap:** Developing financial models and partnerships for implementation.

Name of Reservoir/Dam	District	Latitude	Longitude	Submergence area at Full reservoir Level (Ha)	10 % of Full resrvoir Level (Ha)	Tentative potential @ 10 %area MW	Feaseable Area in Acre	Area in SqM
Rihand Dam	Sonbhadra	24.137039	82.878728	46620	4662	2146	**64767.86**	262106214.8
Rajghat Dam	Lalitpur	24.751524	78.235808	24210	2421	1114	**11839.2**	47911556.56
Matatia Dam	Lalitpur	25.094361	78.364001	12787	1278.7	588	**10370.26**	41966949.12
Kalagarh Dam	Pauri	29.523233	78.756405	7834	783.4	361	**5074.749**	20536780.32
Obra Dam	Sonbhadra	24.435374	82.963428	1800	180	83	**2233.893**	9040245.453
Parichha Dam	Jhansi	25.513306	78.780749	802	80.2	37	**1542.637**	6242830.297
Govind Sagar Dam	Lalitpur	24.671634	78.41861	2479	247.88	114	**1341.626**	5429367.61
Shahzad Dam	Lalitpur	24.94395	78.520807	2993	299.3	138	**1142.603**	4623950.888
Maudaha Dam	Hamirpur	25.568801	79.712968	5429	542.9	250	**988.9922**	4002309.336
Jamini Dam	Lalitpur	24.363015	78.683511	2473	247.265	114	**819.7934**	3317586.133
Adwa Dam	Mirzapur	24.775901	82.303672	1667	166.7	77	**555.4677**	2247897.964
Dhukwan Dam	Jhansi	25.185496	78.541496	1943	194.3	89	**522.8618**	2115946.657
Dhadraul Dam	Sonbhadra	24.613481	83.177772	3033	303.312	140	**504.2032**	2040438.202
Sajnam Dam	Lalitpur	24.523228	78.591601	2375	237.5	109	**477.4647**	1932231.159
Arjun Dam	Mahoba	25.384586	79.669171	1800	180	83	**334.8658**	1355153.597
Lahchura Dam	Hamirpur	25.3174	79.275662	897	89.727	41	**303.818**	1229507.613
Pahuj Dam	Jhansi	25.500383	78.534462	543	54.3	25	**237.0161**	959170.034
Moosakhand Dam	Chandauli	24.971062	83.281823	1369	136.9	63	**191.1754**	773659.547
Barwar Lake	Jhansi	25.514684	79.1471	1006	100.64	46	**172.1518**	696673.4496
Upper Khajuri Dam	Mirzapur	24.993764	82.607422	1131	113.1	52	**163.7348**	662611.2016
Barwa Dam	Chitrakoot	25.18098	80.793099	648	64.8	30	**154.9153**	626919.9618
Gunta Dam	Chitrakoot	25.219929	81.144125	814	81.36	37	**89.35866**	361621.6497
Garhmau Lake	Jhansi	25.517306	78.670643	1467	146.7	68	**87.248**	353080.1246
Pahari Dam	Jhansi	25.200754	79.281429	803	80.3	37	**63.49587**	256958.6644
Dongri Dam	Jhansi	25.384451	78.459153	1920	192	88	**45.88108**	185674.1631
Barua Sagar	Jhansi	25.375287	78.748971	520	52	24	**34.462**	139462.7539
Pathrai Dam	Jhansi	25.423457	79.026405	594	59.4	27	**29.39896**	118973.3832
Mahjagwan Dam	Hamirpur	25.189893	79.548744	830	83	38	**25.51493**	103255.2611
Ohan Dam	Chitrakoot	25.13362	81.032388	648	64.8	30	**20.28292**	82082.06139
Chandrawal Dam	Mahoba	25.439832	79.894978	1192	119.2	55	**18.01235**	72893.40969
Kabrai Dam	Mahoba	25.407973	79.969911	505	50.53	23	**14.11286**	57112.71969
Latif Shah Dam	Chandauli	25.022242	83.231156	511	51.1	24	**12.8592**	52039.33395
Bela Sagar	Mahoba	25.265658	79.584136	926	92.6	43	**7.418057**	30019.81316
Saprar Dam	Jhansi	25.209232	79.096985	2000	200	92	**20.05495**	81159.487862

By leveraging floating solar technology, these reservoirs can contribute significantly to sustainable energy production while optimizing water resources. Further assessment and pilot projects should be initiated to validate the feasibility study findings and scaling up implementation by doing feseablity study of other large waterbodies of the state of Uttar Pradesh.

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