SITE SUITABILITY ASSESSMENT FOR CLOSED LOOP PUMPED STORAGE HYDROPOWER

KALVARAYAN HILLS,
TAMIL NADU

AUGUST 2024

PUMPED STORAGE HYDROPOWER

AurovilleConsulting

LiLa
Earth Intelligence for Climate Action

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ACKNOWLEDGEMENT

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PUMPED STORAGE HYDROPOWER

KEY FINDINGS

Total reservoir paring with technical capacity	**311**	pairs
1,500 GWh capacity pairings	**2**	pairs
500 GWh capacity pairings	**7**	pairs
150 GWh capacity pairings	**23**	pairs
50 GWh capacity pairings	49	pairs
15 GWh capacity pairings	81	pairs
5 GWh capacity pairings	82	pairs
2 GWh capacity pairings	67	pairs

TABLE OF CONTENTS

01 INTRODUCTION

The objective of this report is to identify potential off-river reservoirs that are suitable for pumped storage hydropower system in the Kalvarayan Hills.

1.1 RELEVANCE OF PSH

The evolving landscape of energy transition, characterized by the increasing presence of variable and intermittent renewable energy sources such as solar and wind, poses significant challenges for grid stability. To address these challenges, the integration of storage and ancillary services into the power system is imperative. Among the various storage technologies available, pumped storage hydropower (PSH) emerged as a clean, domestically available, and internationally accepted solution that has stood the test of time (Blakers et al., 2017).

1.2 GLOBAL STATUS OF PSH

The world added 50% more renewable capacity in 2023 than in 2022 and the next 5 years will see the fastest growth yet. China, Japan and United States are the leaders of this mature energy storage technology (IEA, 2024). PSH will be vital to facilitate the integration of the fast-growing renewables into the grid. The total installed capacity of pumped storage hydropower stood at around 160 GW in 2021 and is projected to rise to about 240 GW by 2030 (IHA, 2022). In India out of 4.76 GW of installed capacity, 3.36 GW capacity is working in pumping mode and about 44.50 GW including 34 GW off-river pumped storage hydro plants are under various stages of development (TERI, 2023).

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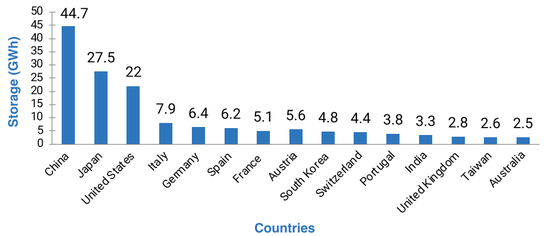


Figure 1: PSH installed across countries with large storage capacities (TERI, 2023)

1.3 BASIC PRINCIPLE

The PSH is a type of hydroelectric energy storage. It offers a unique solution for storing electricity generated from various sources such as solar, wind, and nuclear power. During such periods of surplus electricity, water is pumped from the lower reservoir to the upper reservoir, storing energy for later use. When the demand is high water moves down from the upper reservoir to the lower reservoir (discharge), passing through a turbine, generating power. PSH acts similarly to a giant battery because it can store power and then release it when needed (Department of Energy, 2023).

They operate by repeatedly cycling the same water between upper and lower reservoirs. This process allows PSH plants to efficiently balance electricity supply and demand, providing a reliable source of power. In recent years, there has been a surge in both commercial and technical interest in PSH systems.

This heightened attention is attributed to several factors, including directives aimed at expanding renewable energy sources, anticipated growth in electricity demand, and the imperative of ensuring the security of energy supply. PSH can efficiently supply both base load and peaking power which are crucial for meeting the dynamic energy needs of India (IEA, 2021). It utilises surplus grid power available from thermal power stations or other sources to pump up water from the lower to the upper reservoir and reproduces power during peak demand when there is scarcity of power.

In February 2023, the Ministry of Power released Draft Guidelines to Promote Development of Pump Storage Projects (MoP 2023). The document addresses financial mechanisms and policy changes to promote PSH development. The document proposes to introduce a financial value to the reliability and flexibility services that can be provided by PSH. Additionally, the Guidelines set out potential tax and land exemptions that may also help to improve the financial viability of pumped hydro projects

1.4 BENEFITS

PSH presents a multitude of benefits, including sustainable storage of the surplus electricity that is generated during peak hours of solar and wind utilisation of proven technology, promotion of local development, extended discharge durations, and high reliability. With a lifespan surpassing 40-50 years, PSH boasts a round-trip efficiency ranging from 70 % to 85 % and exhibits rapid response times typically within seconds or minutes. By storing considerable energy volumes, PSH emerges as a trustworthy and eco-friendly solution for energy storage needs. PSH offers multifaceted benefits in power grid management. Its high ramp rate makes it invaluable for peak shaving and load balancing, storing excess energy during off-peak hours and releasing it during high-demand periods. Additionally, PHES provides excellent frequency regulation by adjusting operation modes based on grid frequency, and it serves as a reliable spinning reserve with quick start capabilities, offering backup during sudden outages. Furthermore, PHES can facilitate black start services, energizing the grid in emergencies, and offers voltage control services by managing reactive power, thus enhancing overall grid stability and reliability (Lu et al., 2017; Blakers et al., 2017; NREL 2022; Stocks et al., 2020; Weber et al., 2024; Lu et al., 2018).

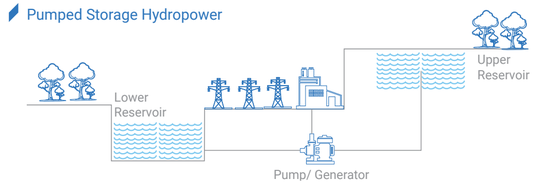
1.5 ENVIRONMENTAL IMPACTS

Closed loop or off-river PSH have far fewer environmental impacts in comparison to open loop systems. By not maintaining continuous connections to flowing bodies, they lessen surface water disturbances, benefiting aquatic ecosystems. The recharge of water in the reservoir occasionally ensures that groundwater extraction in closed-loop PSH operations has marginal disruption to nearby ecosystems and biodiversity by altering circulation patterns and chemistry. Above-ground reservoirs in closed-loop projects result in fewer ecological, visual, and cultural impacts compared to open-loop designs due to fewer siting constraints, and underground construction activities such as drilling and blasting (NREL, 2020; PNNL, 2020).

1.6 SCOPE OF THE REPORT

The objective of this report is to identify reservoirs suitable for developing pumped storage hydropower in the Kalvarayan Hills area of Kallakurichi District and to assess the extent to which these sites overlap with unused lands. Degraded lands can play a crucial role in advancing clean energy transitions and implementing climate adaptation and mitigation programs.

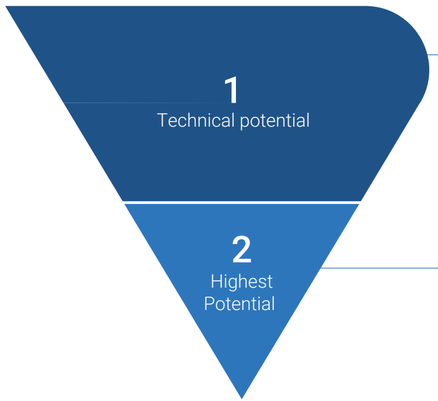
The use of geospatial data can create critical data-based insights that support decision-making by providing detailed information on exactly "where" (location) and "why" (attributes of the location) to implement PSH initiatives.



02 METHODOLOGY

EVALUATION STEPS

The site suitability assessment is undertaken in a 2-step filtration process to identify reservoirs that consecutively meet technical and highest potential criteria (refer to tables below).



Technical Potential: Potential reservoirs were identified using a digital elevation model (DEM). The DEM helps determine flow direction and finds flow accumulation, virtual streams and pour points. The potential reservoirs are all paired based on separation distance (head-to-distance ratio < 0.05), minimum reservoir capacity of 1 gigalitre, minimum head height of 100 m, slope greater than 3 %, dam wall below 150m and water-to-rock water ratio greater than 1.50.

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Highest Potential: The identified reservoir pairs are further analysed to assess the current land cover of the reservoir sites. Reservoirs with a significant percentage of unused land are considered to have the highest potential for development.

The following table summarises the criteria for technical potential in the 2-step filtration process for pumped storage hydropower. An initial requirement of a minimum head height, separation distance, head-to-distance ratio, slope, dam height, water-rock ratio, reservoir volume similarity, and a minimum reservoir capacity is required to detect the potential sites.

TECHNICAL POTENTIAL	
Criteria	
Minimum height (upper reservoir)	100
Head	>100 m
Minimum reservoir capacity	1 GL
Head/Distance	>0.05
Slope	>3 %
Volume similarity	90 %
Water rock ratio	1.50
Dam height	<150 m

HIGHEST POTENTIAL			
Criteria	**Low**	**Medium**	**High**
Unused land (for both reservoir)	0-20 %	21-40 %	41-60%

TECHNICAL POTENTIAL

The Digital Elevation Model (DEM) is used for the 3D representation of our area of interest. It determines the flow accumulation which represents the total amount of water flow that accumulates at a given point in a watershed and pour points which are outlets or drainage points in a watershed where water flows out of an area. A minimum height for the upper reservoir is required and the separation distance is defined as the ratio of head height to the distance between reservoir pairs. The head height is defined as the vertical distance between the upper and lower reservoirs. Additionally, the terrain's slope/inclination is an essential factor. The water-rock ratio, which must exceed 1.50, is the ratio of the volume of water to the volume of rock. Volume similarity refers to the degree of similarity in volume between paired reservoirs, requiring a 90% similarity.

The initial step involves identifying all potential reservoirs, followed by selecting the most suitable pairs based on the specified parameters. After the identification of all potential reservoir pairs, the most suited reservoir pairs that meet the criteria for technical potential are further assessed to determine the reservoirs that have the highest suitability for the construction of PSH. The evaluation of the highest potential reservoirs is based on the percentage of unused land within the reservoir area (Stocks et al., 2020; Weber et al., 2024; Lu et al., 2018).

HIGHEST POTENTIAL

Unused land is defined as land that has been unused throughout the year 2021 (in terms of cultivation/built-up/water/trees) and do not belong to any of the other categories and could be in barren condition sometimes. Identifying unused lands within the reservoir area provides a clear indication of the most suitable sites for reservoir construction, ensuring minimal impact on the existing land cover.

KEY TERMS: The following table provides further details on the key terms utilized for this land suitability assessment.

Term	Description
Accessibility	Refers to the roads and railway lines within the district.
Ancillary services	Capacity and energy services (e.g., non-spinning operating reserve, frequency support, voltage support) provided by power plants that are able to respond on short notice, such as hydropower plants, and are used to ensure stable electricity delivery and optimized grid reliability. Also called grid services.
Biodiversity	The variety of life in the world or in a particular habitat or ecosystem.
Built-up	Land covered by buildings. Buildings include both residential and industrial building.
Conveyance length to head height ratio	This ratio represents the length of the water conveyance system (such as penstocks or tunnels) compared to the height (head) of the system. A higher ratio typically implies a longer conveyance system relative to the elevation difference.
Cropland	The annual cropland produces a herbaceous cover and is sometimes combined with some tree or woody vegetation. Note that perennial woody crops will be classified as the appropriate tree cover or shrub land cover type. Greenhouses are considered as built-up.
Dam height	Dam height refers to the vertical dimension of the dam structure that creates the upper reservoir in a pumped storage hydropower system. This criterion specifies that potential PSH sites should have a significant dam height exceeding 100 meters, which is indicative of a large-scale infrastructure suitable for PSH operations (PSH searching GitHub).
Electricity generation	The amount of electricity a generator produces during a specific period of time.
Elevation	Elevation is often used as a criterion, which considers the height of the area of interest relative to the highest point of the watershed it is in. Ex: lands with elevation > 0.7 are lands that lie above 70% of the region's watershed elevation, and lands with elevation < 0.3 are lands that lie below 30% of the region's watershed elevation. Elevation of lands are also provided in terms of their height in meters from mean-sea-level.
Evacuation infrastructure	Includes transmission lines and substations. The nearest distance to either is considered.
Head (Head height)	The term "head" refers to the vertical distance (elevation) between the upper and lower reservoirs in a pumped storage hydropower system. The specified head range is between 200 meters and 750 meters. This indicates that potential PSH sites should have this difference in elevation between the upper and lower reservoirs (Stocks et al., 2020; Weber et al., 2024; Lu et al., 2018).
High potential	A sub-category of technical potential criteria that ensure the most preferable conditions based on the purpose of the evaluation. The criteria vary based on the type of assessment.
Hydropower	The harnessing of flowing water—using a dam or other type of diversion structure—to create energy that can be captured via a turbine to generate electricity. Also called hydroelectric power.
Land use	The LiLa algorithm identifies 6 categories of land use: unused/barren, sparse vegetation, cropland, tree cover, water and built-up. Land is recognized under each of these categories by the algorithm based on the pixel properties obtained through satellite imagery.
Load	The amount of electrical power delivered or required at any specific point or points on a system.
Load balancing	The use of various techniques by electrical power stations to store excess electrical power during low demand periods for release as demand rises.
Low potential	A sub-category of technical potential criteria. This is a minimum criterion.
Medium potential	A sub-category of technical potential criteria, satisfying a higher number of criteria than 'low'. The criteria vary based on the type of assessment.
Peaking	Operating mode in which power is produced only during periods of peak demand.
Power	The rate of production or consumption of energy; electric power is the rate at which electrical energy is transferred by an electric circuit.
Powerhouse	The structure that houses generators and turbines at a hydropower facility.

KEY TERMS: The following table provides further details on the key terms utilised for this land suitability assessment.

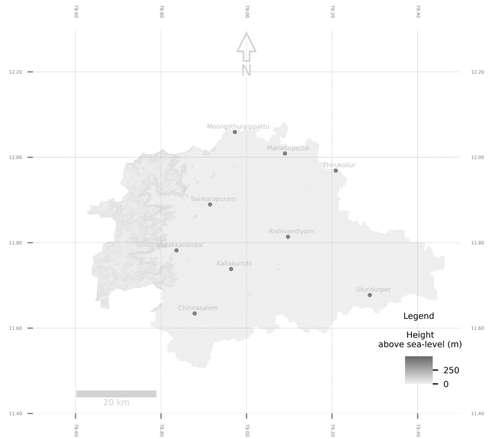
Protected areas/lands	These are areas allocated for reserve forests and other such classified lands.
Pumped storage hydropower (PSH):	Type of hydropower project where energy can be stored and generated by moving water between two reservoirs of differing elevations.
Ramp rate	Rate at which flows from the powerhouse into the tailwater and downstream into the natural waterway are increased or decreased.
Roads	Different types of pathways are recognized as roads, including highways, primary, secondary, tertiary and residential roads. The roads included in this analysis consider those sufficient to allow mini-trucks to pass.
Search radius	The search radius specifies the maximum distance within which potential PSH sites will be considered from a given location, typically based on geographic or topographic constraints. Suitable PSH sites should be located within a specified radius (2,200 meters to 8,250 meters) from a reference point, ensuring feasibility in terms of access and infrastructure development (Stocks et al., 2020; Weber et al., 2024; Lu et al., 2018).
Sparse Vegetation	Includes scrubs, grassland and sparse vegetation. Land covered with annual cropland that is sowed/planted and harvestable at least once within the 12 months after the sowing/ planting date.
Storage	The storing of water in a reservoir during periods of high inflow that can be used later to generate electricity.
Technical potential	A set of criteria that characterizes unused lands with a relatively good potential, in terms of social, economic and environmental factors. The criteria vary based on the type of assessment.
Transmission	Conveyance of electrical energy from generation facilities to local distribution systems.
Tree cover	This class includes any geographic area dominated by trees with a cover of 10% or more. Other land cover classes (shrubs and/or herbs in the understorey, built-up, permanent water bodies, ...) can be present below the canopy, even with a density higher than trees. Areas planted with trees for afforestation purposes and plantations (e.g. oil palm, olive trees) are included in this class. This class also includes tree covered areas seasonally or permanently flooded with fresh water.
Unused Lands	Lands that have been unused throughout the year (in terms of cultivation/built-up/water/trees) and does not belong to any of the other categories, and could be in barren condition sometimes.
Volume similarity	Volume similarity refers to the degree of similarity or closeness in terms of reservoir storage capacity between the upper and lower reservoirs. A volume similarity of 90% indicates that the upper and lower reservoirs should have reservoir capacities that are relatively close (minimum 90% similarity) to ensure efficient energy storage and discharge operations (Stocks et al., 2020; Weber et al., 2024; Lu et al., 2018).

KEY DATA LAYERS

The essential data layers for the entire district of Kallakurichi have been thoroughly analysed. Portions of the identified reservoir pairs extend beyond the boundaries of the Kalvarayan Hill Taluk, encroaching into adjacent taluks and, occasionally, into neighbouring districts

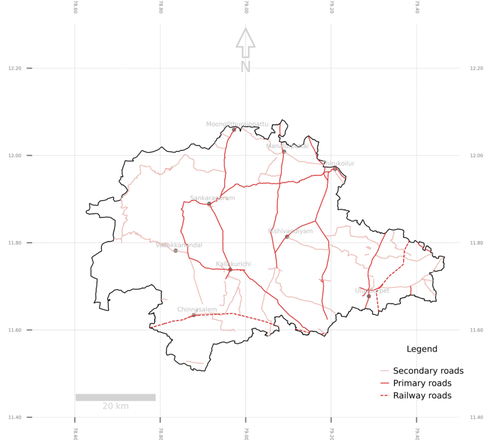
Slope

Slope tells us about the ideal sites for the development of PSH. Lands with a steeper slope will be suitable for the development of PSH.



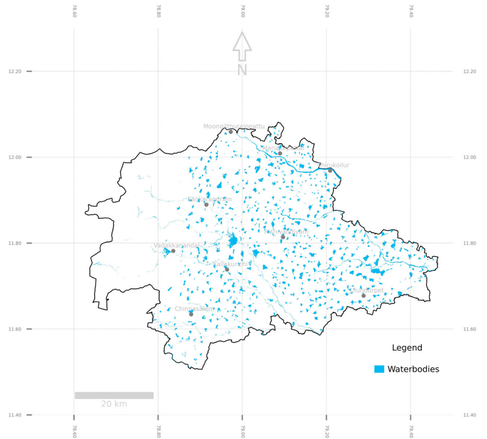
Accessibility

Vicinity to a road that can accommodate load carriers provides direct access to the site with the possibility of transporting equipment that might be necessary for the maintenance



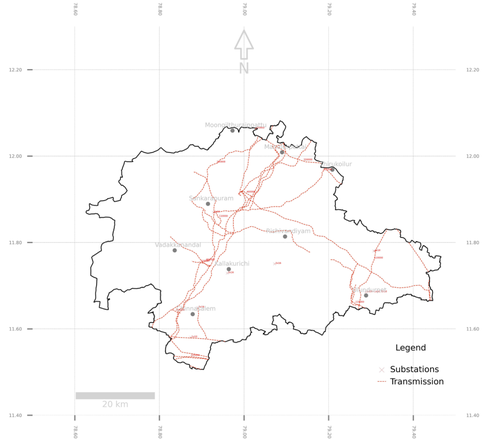
Waterbodies

Large water bodies, if available, could be utilised for recharge of the reservoir.



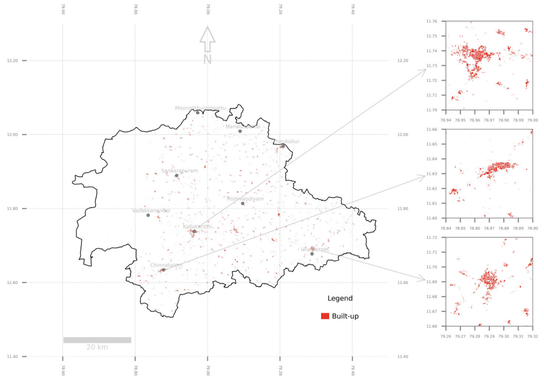
Power infrastructure

Substations are critical nodes in the power distribution sector and indicate development zones.



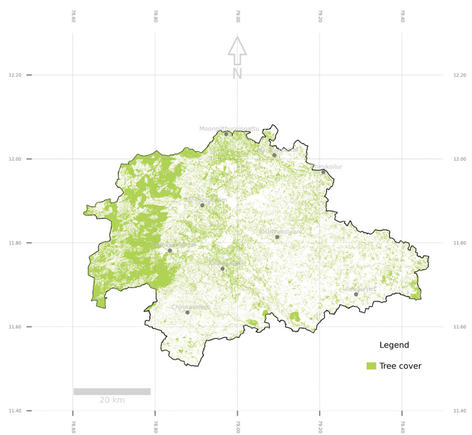
Built-up areas

To involve and develop local communities, their proximity to the potential lands for developing PSH plays a key role.



Tree cover

The existing tree cover can indicate areas which can be avoided. They also indicate dry and relatively suitable areas for developing PSH.



03 RESULTS

A total of 311 reservoir pairings that meet the technical criteria were identified, collectively representing a PSH capacity of 14,159 GWh. This cumulative PSH capacity includes overlapping reservoir pairs across different capacity ranges and does not reflect the achievable capacity potential, as certain sites have multiple pairing options and variable energy potential depending on the selected dam height.

Total pairings	311	nos
Total capacity	14,159	GWh

Profiling of reservoir pairs

The analysis conducted for all the reservoir pairs indicates the potential for developing an off-river pumped storage hydropower facility in the Kalvarayan Hills of Tamil Nadu. The list includes 7 different categories of capacities of reservoir pairs. The existing land use share and the unused lands were derived using remote sensing. Detailed tables with the analysis are given below.

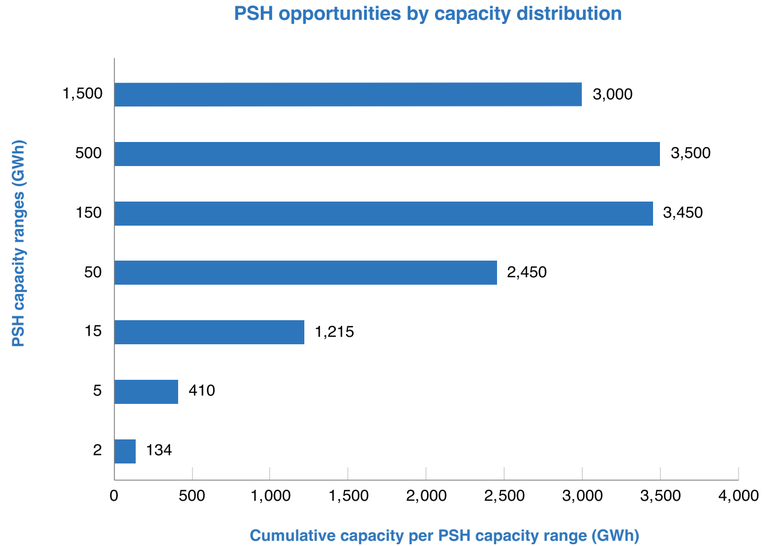
Note:

1. *The reservoirs that are unrated are classified as 'NA' in the land cover sections in the following tables.*
2. *The data used for the analysis had disparities. Some of those reservoirs have not been taken for analysis.*
3. *Reservoirs falling in the Kalvarayan Hill taluk have been analysed. The pairs of reservoirs that fall outside the administrative boundary have also been taken into consideration. Pairs that are completely outside the district boundary have not been analysed.*

Distribution of reservoir by capacity

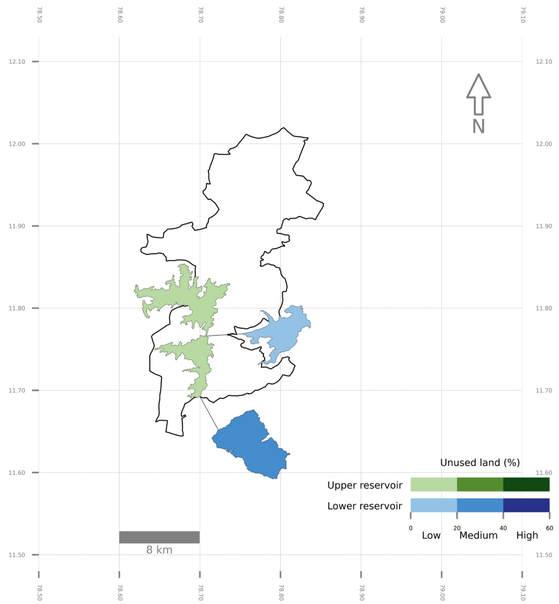
The algorithm developed by the ANU 100% Renewable Energy group identifies potentially feasible closed-loop pumped storage hydropower sites through the use of geographic information system (GIS) analysis. The global atlas is designed to detect reservoirs corresponding to the following energy capacities: 1500 GWh, 500 GWh, 150 GWh, 50 GWh, 15 GWh, 5 GWh, and 2 GWh. Additional parameters, such as reservoir volume and dam height, are kept variable to accommodate the specific capacity requirements of each category.

Distribution (GWh)	Pairings	Total Capacity (GWh)
1,500	**2**	**3,000**
500	**7**	**3,500**
150	**23**	**3,450**
50	49	2,450
15	81	1,215
5	82	410
2	67	134



1,500 GWh

A total number of 2 pairings with an energy capacity of 1500 GWh each, were identified. 2 upper reservoirs and 1 lower reservoir have low potential in terms of land use impact mitigation, these reservoir sites have a 0 to 20 percent of areas with an unused or barren land signature. Whereas 1 lower reservoir meets the medium potential criteria which would reduce the environmental impact on the region.

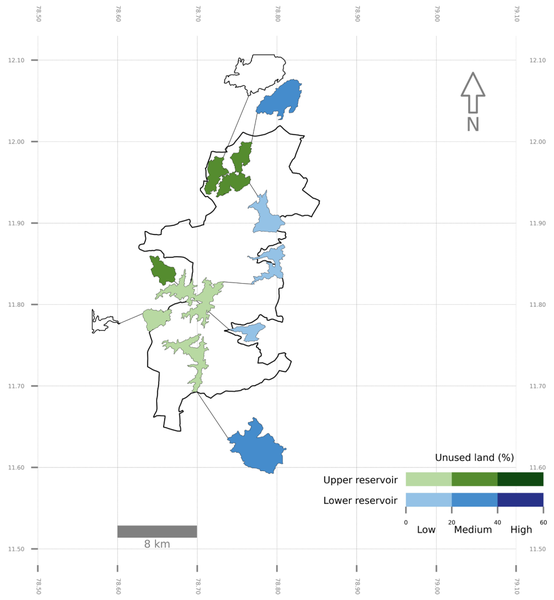


1,500 GWh

Pairings	Reservoirs	Location (long/lat)		Elevation (m)	Area (acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Water-bodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
1	Upper	78.71	11.72	671	5,538	521	1,381	5.14	11	22	18	47	2	0	0	12,682
	Lower	78.81	11.61	150	12,272	521	1,376		28	4	54	8	3	1	3	0
2	Upper	78.72	11.81	650	10,516	480	1,492	4.97	16	21	17	44	0	0	2	9,759
	Lower	78.84	11.78	170	6,834	480	1,498		8	5	26	52	8	0	1	823

500 GWh

7 pairs of reservoirs have a storage capacity of 500 GWh. 1 reservoir pair along with 3 upper reservoirs and 1 lower reservoir have medium potential in terms of land use mitigation. Land use assessment could not be undertaken for 2 lower reservoirs located in the north and west of the study area as the landcover details were not available beyond that extent. These 2 reservoirs are not coloured.



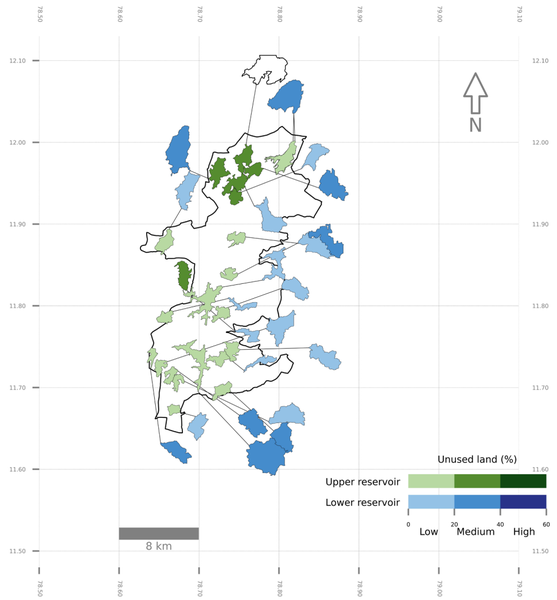
Note: Unrated reservoirs are not shaded.

500 GWh

Pairings	Reservoirs	Location (long/lat)		Elevation (m)	Area (acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
1	Upper	78.67	11.83	740	1,955	540	445	9.95	24	20	24	30	0	0	2	16,780
	Lower	78.79	11.77	200	1,389	540	444		5	7	12	76	0	0	0	6174
2	Upper	78.71	11.72	671	3,407	521	459	7.66	13	22	25	38	2	0	0	12,792
	Lower	78.81	11.61	150	7,577	521	457		31	4	50	7	5	1	2	0
3	Upper	78.73	11.97	722	2,155	512	469	9.15	30	18	23	29	0	0	0	15,423
	Lower	78.81	12.1	210	6,861	512	457		NA	NA	NA	NA	NA	NA	NA	14,946
4	Upper	78.77	11.95	670	2,134	470	512	1.91	31	18	12	37	2	0	1	12,471
	Lower	78.81	11.9	200	2,943	470	510		11	4	39	43	2	0	1	7,334
5	Upper	78.72	11.81	650	5,235	440	538	3.79	14	23	16	45	0	0	2	10,126
	Lower	78.81	11.83	210	2,297	440	545		5	7	12	74	2	0	0	2,955
6	Upper	78.77	11.98	650	1,689	440	546	4.06	32	14	17	33	0	0	4	12,627
	Lower	78.83	12.07	210	4,428	440	545		38	6	39	15	1	0	2	10,460
7	Upper	78.63	11.79	760	1,927	360	666	3.38	14	19	28	37	0	0	1	17,315
	Lower	78.54	11.78	400	979	360	666		NA	NA	NA	NA	NA	NA	NA	24,558

150 GWh

23 pairs of reservoirs that have a storage capacity of 150 GWh. The total storage is 3,450 GWh, with a few storages overlapping with one another. The topmost reservoir in the north of the study area is not coloured as the landcover details were not available for some parts of that reservoir. 2 pairs of reservoirs have medium potential for developing PSH as they have 20 to 40 per cent unused land. Overall, 6 upper reservoirs and 8 lower reservoirs have medium potential in terms of land use mitigation..



Note: Unrated reservoirs are not shaded.

150 GWh

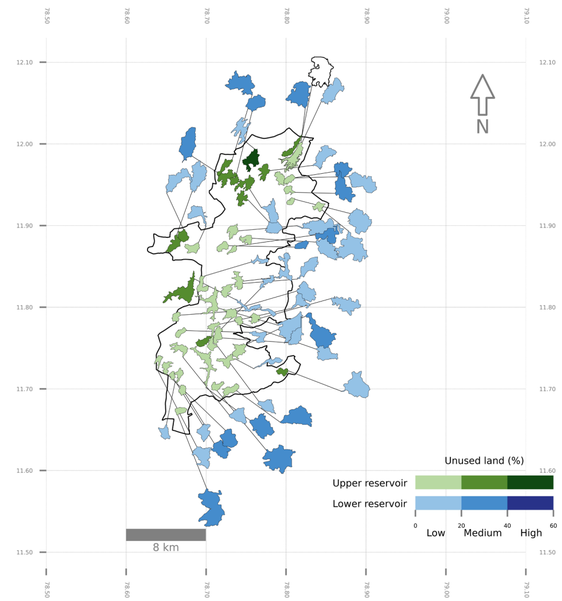
Pairings	Reservoirs	Location (long/lat)		Elevation (m)	Area (acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
1	Upper	78.68	11.71	942	510	792	91	12.76	10	29	10	52	0	0	0	15,208
	Lower	78.83	11.66	150	2,222	792	88		20	7	59	12	1	0	2	745
2	Upper	78.65	11.73	956	585	776	93	14.13	9	16	11	63	0	0	0	18,391
	Lower	78.82	11.79	180	2,135	776	91		10	5	36	42	7	0	0	2,075
3	Upper	78.67	11.72	860	586	690	105	10.27	7	15	15	62	0	0	0	16,596
	Lower	78.77	11.64	170	2,060	690	102		21	3	63	8	1	0	4	2,768
4	Upper	78.64	11.75	825	414	635	113	10	6	15	6	73	0	0	0	19,888
	Lower	78.68	11.61	190	1,465	635	112		23	6	54	15	0	0	1	10,141
5	Upper	78.74	11.83	730	630	560	129	10.95	17	30	14	37	0	0	2	8,805
	Lower	78.88	11.87	170	2,069	560	127		26	8	43	14	6	2	1	1,223
6	Upper	78.71	11.72	671	1,818	521	136	10.12	15	18	30	36	2	0	0	13,015
	Lower	78.81	11.61	150	4,503	521	134		32	4	49	7	6	1	2	0
7	Upper	78.66	11.67	720	444	510	142	2.16	9	24	6	61	0	0	0	13,487
	Lower	78.7	11.64	210	1,327	510	141		11	6	6	74	3	0	0	9,424
8	Upper	78.68	11.82	710	1,231	500	143	8.53	24	18	32	24	0	0	1	14,952
	Lower	78.78	11.77	210	759	500	144		5	8	11	76	0	0	0	7,280
9	Upper	78.74	11.8	671	738	491	147	7.77	9	35	9	45	0	0	2	9,707
	Lower	78.84	11.81	180	1,523	491	146		11	5	51	29	0	0	3	0
10	Upper	78.65	11.79	790	658	487	148	7.7	9	28	19	42	0	0	1	17,315
	Lower	78.77	11.8	303	582	487	148		0	0	0	100	0	0	0	5,845
11	Upper	78.75	11.75	630	911	480	150	9.37	9	21	12	56	0	0	0	10,445
	Lower	78.88	11.73	150	1,954	480	149		12	11	26	48	3	0	0	1,071
12	Upper	78.76	11.95	680	1,232	480	150	2.89	37	17	15	27	2	0	1	13,123
	Lower	78.81	11.9	200	2065	480	148		11	3	48	33	3	0	1	7,334
13	Upper	78.75	11.88	630	747	460	157	7.21	13	29	14	42	2	0	1	10,378
	Lower	78.86	11.86	170	1,936	460	154		17	7	49	20	5	1	1	2,751

150 GWh

Pairings	Reservoirs	Location (long/lat)		Elevation (m)	Area (acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
14	Upper	78.74	11.92	660	710	460	157	8.78	23	22	4	50	0	0	0	13,725
	Lower	78.86	11.99	200	1,413	460	156		18	4	44	32	0	0	1	3,433
15	Upper	78.77	11.98	650	1238	440	163	8.21	38	13	23	21	0	0	5	12,627
	Lower	78.81	12.1	210	3,705	440	163		NA	NA	NA	NA	NA	NA	NA	14,954
16	Upper	78.72	11.81	650	2113	440	162	5.52	13	25	15	44	0	0	3	10,474
	Lower	78.81	11.83	210	1,430	440	163		7	8	19	63	3	0	0	2955
17	Upper	78.73	11.97	722	1,439	412	174	2.82	28	17	23	32	0	0	0	15,455
	Lower	78.68	12.02	310	3,365	412	167		31	8	24	32	4	1	1	20,963
18	Upper	78.73	11.73	626	762	406	177	2.45	5	15	8	71	0	0	0	12,622
	Lower	78.79	11.74	220	648	406	177		1	2	1	94	1	0	0	8,393
19	Upper	78.77	11.96	581	792	401	180	8	31	15	16	37	0	0	1	10,958
	Lower	78.88	11.93	180	2273	401	178		24	10	38	26	0	0	1	1,083
20	Upper	78.74	11.7	550	842	400	180	7.98	10	38	4	48	0	0	0	10,091
	Lower	78.82	11.63	150	1,818	400	179		26	28	31	12	2	0	1	0
21	Upper	78.65	11.87	710	1087	359	200	3.26	18	27	22	32	0	0	2	18,492
	Lower	78.69	11.96	351	2023	359	200		17	3	13	65	1	0	0	19,128
22	Upper	78.82	11.99	550	1482	340	212	4.88	15	9	19	57	0	0	0	6,981
	Lower	78.83	12.07	210	3,242	340	211		40	6	40	11	1	0	1	10,460
23	Upper	78.82	12	502	1,568	292	246	3.83	13	9	18	61	0	0	0	7,011
	Lower	78.83	12.07	210	3,242	292	243		40	6	40	11	1	0	1	10,460

50 GWh

There is a single upper reservoir with the highest potential in terms of land use mitigation. Although numerous upper and lower reservoirs have medium and low potential. Overall, the category of 50 GWh can contribute to a total capacity of 2,450 GWh (with some overlaps) in the Kalvarayan Hill taluk.



Note: Unrated reservoirs are not shaded.

50 GWh

Pairings	Reservoirs	Location (long/lat)		Elevation (m)	Area (acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
1	Upper	78.66	11.72	970	152	790	31	10.35	5	12	10	70	0	0	0	17,459
	Lower	78.73	11.62	180	881	790	30		25	3	57	10	0	0	3	6,007
2	Upper	78.67	11.7	990	255	780	31	4.8	10	22	13	54	0	0	0	14,992
	Lower	78.7	11.64	210	615	780	30		13	8	5	67	7	0	0	9,561
3	Upper	78.65	11.73	956	322	776	31	10.99	10	15	11	63	0	0	0	18,641
	Lower	78.74	11.64	180	970	776	30		22	4	58	9	0	1	6	5,573
4	Upper	78.64	11.74	840	204	660	36	11.66	2	5	1	92	0	0	0	19,960
	Lower	78.7	11.6	180	1100	660	36		20	5	57	16	0	0	2	8,553
5	Upper	78.67	11.72	873	253	643	37	5.86	4	13	8	75	0	0	0	16,798
	Lower	78.65	11.64	230	420	643	37		2	0	1	90	8	0	0	14,467
6	Upper	78.81	11.93	783	174	623	39	7.83	9	8	5	77	0	0	0	7,999
	Lower	78.91	11.9	160	1668	623	37		8	5	50	26	7	1	2	0
7	Upper	78.67	11.77	830	251	620	39	8.53	2	17	11	70	0	0	0	16,949
	Lower	78.78	11.77	210	472	620	38		7	11	17	64	0	0	0	7,280
8	Upper	78.66	11.79	811	255	601	40	10.91	5	36	13	45	0	0	0	17,315
	Lower	78.79	11.79	210	196	601	40		1	0	0	98	1	0	0	4,769
9	Upper	78.73	11.88	780	338	580	42	8.97	10	23	28	37	0	0	2	12,460
	Lower	78.83	11.88	200	360	580	41		26	6	28	40	0	0	0	5,540
10	Upper	78.74	11.87	750	171	570	42	10.92	11	27	5	52	0	0	4	11,422
	Lower	78.86	11.88	180	1022	570	41		21	10	48	15	1	3	2	1,223
11	Upper	78.79	11.73	694	277	564	43	7.74	31	22	3	42	0	0	2	8,071
	Lower	78.9	11.69	130	1861	564	41		16	3	47	29	3	0	1	0
12	Upper	78.72	11.7	713	304	563	43	10.42	12	24	16	48	0	0	0	11,983
	Lower	78.81	11.61	150	2,403	563	43		29	3	54	7	5	0	2	0
13	Upper	78.74	11.79	720	231	560	43	10.66	11	23	4	63	0	0	0	9,230
	Lower	78.86	11.74	160	919	560	41		9	18	5	68	0	0	0	2,072

50 GWh

Pairings	Reservoirs	Location (long/lat)		Elevation (m)	Area (acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
14	Upper	78.66	11.67	720	276	550	44	10.79	12	28	10	50	0	0	0	13,762
	Lower	78.72	11.55	170	2,676	550	45		33	5	47	8	3	1	2	7713
15	Upper	78.69	11.75	711	380	531	45	10.55	23	24	39	15	0	0	0	14,017
	Lower	78.82	11.79	180	790	531	44		5	3	24	57	10	0	1	2465
16	Upper	78.71	11.75	710	330	530	45	9.29	14	24	23	36	0	0	2	13,774
	Lower	78.79	11.67	180	618	530	44		19	22	30	29	0	0	1	5,001
17	Upper	78.68	11.75	710	487	520	46	10.05	12	18	21	39	9	0	0	17,610
	Lower	78.75	11.66	190	751	520	46		10	5	36	45	0	0	4	6,137
18	Upper	78.71	11.78	700	278	520	46	10.03	12	24	9	51	0	0	3	12,348
	Lower	78.83	11.8	180	567	520	46		13	5	53	25	3	0	1	349
19	Upper	78.71	11.72	671	901	501	46	7.41	14	15	29	39	2	0	0	13,367
	Lower	78.77	11.64	170	1,541	501	47		20	3	63	8	2	0	3	2,817
20	Upper	78.75	11.82	710	491	500	48	4.29	18	20	21	38	0	0	3	8,783
	Lower	78.81	11.83	210	797	500	47		6	5	22	63	4	0	0	2,955
21	Upper	78.73	11.97	740	397	500	48	9.24	31	24	11	33	0	0	0	16,247
	Lower	78.76	12.08	240	1649	500	47		31	11	40	11	5	0	1	17,204
22	Upper	78.72	11.82	672	420	492	49	8.82	16	28	9	43	0	0	3	10,126
	Lower	78.84	11.86	180	878	492	47		14	11	47	23	2	0	2	2,570
23	Upper	78.74	11.8	671	442	491	49	8.75	9	36	9	44	0	0	2	9,707
	Lower	78.84	11.81	180	1,010	491	49		14	6	55	21	0	0	3	0
24	Upper	78.76	11.79	641	306	491	49	9.91	17	23	6	54	0	0	0	6,851
	Lower	78.89	11.8	150	1,279	491	46		6	7	44	40	0	1	3	1118
25	Upper	78.74	11.95	731	279	481	50	8.94	26	23	10	40	0	0	0	15,229
	Lower	78.77	12.06	250	937	481	49		39	7	37	16	0	0	1	14,979

50 GWh

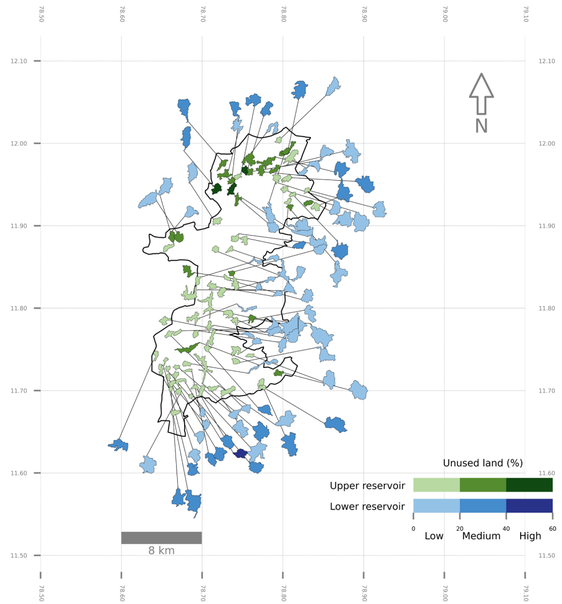
Pairings	Reservoirs	Location (long/lat)		Elevation (m)	Area (acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
26	Upper	78.71	11.81	660	933	480	48	8.3	13	22	15	45	0	0	4	11,980
	Lower	78.82	11.79	180	1580	480	48		9	5	35	41	9	0	0	2,075
27	Upper	78.76	11.95	680	643	470	50	2.93	38	14	17	26	3	0	2	13,152
	Lower	78.79	11.91	210	826	470	50		12	4	38	38	6	0	2	9,498
28	Upper	78.75	11.75	630	551	470	50	9.04	6	17	14	62	0	0	0	10,483
	Lower	78.86	11.77	160	2,003	470	51		25	9	27	37	1	0	1	1,241
29	Upper	78.75	11.88	630	349	460	52	8.72	13	30	15	37	4	0	2	10,378
	Lower	78.86	11.86	170	1,303	460	51		16	6	48	20	7	1	2	2,751
30	Upper	78.72	11.77	702	457	452	53	7.45	17	17	36	26	0	0	3	12,299
	Lower	78.78	11.84	250	324	452	53		5	13	3	79	0	0	0	4864
31	Upper	78.73	11.97	761	666	451	52	4.54	29	15	33	23	0	0	0	15,455
	Lower	78.68	12.02	310	1599	451	53		36	6	23	28	6	0	0	21,472
32	Upper	78.67	11.88	790	423	450	53	5.47	27	23	33	17	0	0	0	17,848
	Lower	78.67	11.97	340	1186	450	52		11	6	11	70	0	0	1	21,614
33	Upper	78.8	11.94	623	264	443	55	5.47	7	9	7	77	0	0	0	8,013
	Lower	78.88	11.93	180	1,439	443	52		27	11	38	22	0	0	1	1,083
34	Upper	78.74	11.9	621	425	441	54	7.88	15	32	16	37	0	0	0	12,766
	Lower	78.87	11.89	180	1603	441	54		10	9	50	26	1	2	1	561
35	Upper	78.74	11.92	660	448	440	54	4.13	24	24	5	47	0	0	0	14,034
	Lower	78.8	11.9	220	657	440	54		11	4	64	21	0	0	1	8,893
36	Upper	78.81	11.96	602	288	432	56	7.34	15	8	10	64	0	0	3	7,631
	Lower	78.91	11.95	170	1,499	432	53		18	11	42	17	10	1	2	0

50 GWh

Pairings	Reservoirs	Location (long/lat)		Elevation (m)	Area (acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
37	Upper	78.69	11.82	700	434	430	56	6.59	10	37	10	43	0	0	0	13,364
	Lower	78.78	11.86	270	271	430	56		0	0	0	100	1	0	0	6,996
38	Upper	78.85	11.92	571	295	411	59	4.56	12	8	11	69	0	0	0	4,002
	Lower	78.9	11.86	160	2325	411	57		20	7	43	21	8	0	2	0
39	Upper	78.73	11.73	626	454	406	59	2.84	4	13	9	74	0	0	0	12,796
	Lower	78.79	11.74	220	366	406	59		1	4	3	89	2	0	0	8583
40	Upper	78.74	11.7	550	471	400	60	7.38	12	38	6	44	0	0	0	10,408
	Lower	78.83	11.66	150	1730	400	59		20	7	60	11	0	0	2	745
41	Upper	78.65	11.87	740	555	400	60	6.16	20	26	26	25	0	0	2	18,503
	Lower	78.68	11.97	340	1391	400	60		18	6	5	71	1	0	0	19,663
42	Upper	78.79	11.95	582	405	392	61	6.76	10	8	21	58	0	0	3	8,972
	Lower	78.88	11.97	190	803	392	61		30	9	2	40	19	0	0	343
43	Upper	78.68	11.81	700	1462	390	60	]6.19	21	11	28	37	0	0	2	15,258
	Lower	78.77	11.8	310	357	390	62		0	0	0	100	0	0	0	6393
44	Upper	78.77	11.96	570	487	370	65	5.84	31	12	19	37	0	0	1	11,044
	Lower	78.86	11.99	200	1,065	370	63		18	4	49	28	0	0	1	3,433
45	Upper	78.82	12	550	463	360	67	6.83	21	9	24	45	0	0	1	8,248
	Lower	78.86	12.1	190	2176	360	66		NA	NA	NA	NA	NA	NA	NA	12309
46	Upper	78.77	11.98	650	852	359	66	1.71	40	11	28	16	0	0	5	12,627
	Lower	78.75	12.03	291	854	359	66		11	5	14	70	0	0	0	15,121
47	Upper	78.82	11.99	550	894	340	70	5.85	16	11	27	46	0	0	0	7,186
	Lower	78.83	12.07	210	1764	340	69		37	7	44	11	2	0	0	10914
48	Upper	78.82	12	502	843	312	77	6.2	12	11	24	53	0	0	0	7,202
	Lower	78.87	12.07	190	1,312	312	77		5	2	6	86	0	0	0	9,959

15 GWh

There is a single lower and 3 upper reservoirs that have the highest potential in terms of land use mitigation. Although numerous upper and lower reservoirs have medium and low potential. Overall, the category of 15 GWh can contribute to a total capacity of 1,215 GWh (with overlapping reservoirs) in the Kalvarayan Hill taluk.



15 GWh

Pairings	Reservoirs	Location (long/lat)		Elevation (m)	Area (acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
1	Upper	78.67	11.7	1000	136	800	9	9.21	12	19	16	52	0	0	0	15,163
	Lower	78.64	11.61	200	807	800	9		9	9	52	17	9	2	2	15,258
2	Upper	78.68	11.71	942	163	762	9	8.73	6	37	9	47	0	0	0	15,522
	Lower	78.74	11.64	180	519	762	9		23	3	61	7	0	0	6	5,573
3	Upper	78.65	11.73	970	157	760	10	9.05	14	15	13	58	0	0	0	18,714
	Lower	78.7	11.64	210	334	760	10		10	8	7	60	13	0	0	9,660
4	Upper	78.66	11.73	1020	89	760	10	6.61	8	18	19	54	0	0	0	18,361
	Lower	78.7	11.67	260	170	760	9		6	5	29	59	0	0	0	10,873
5	Upper	78.66	11.7	950	72	760	10	12.9	12	30	11	45	0	0	0	16,468
	Lower	78.68	11.58	190	621	760	10		30	7	43	16	0	1	3	11,672
6	Upper	78.67	11.71	944	148	754	9	8.85	14	12	33	39	0	0	0	16,646
	Lower	78.7	11.62	190	468	754	10		20	7	52	18	0	1	2	9,398
7	Upper	78.66	11.72	970	108	740	10	6.98	6	14	14	63	0	0	0	17,459
	Lower	78.7	11.65	230	237	740	10		9	7	14	70	0	0	0	9,744
8	Upper	78.66	11.74	894	81	714	10	13.44	1	5	1	92	0	0	0	19,324
	Lower	78.7	11.6	180	454	714	10		25	5	57	10	0	0	2	9,393
9	Upper	78.67	11.73	901	91	701	10	9.15	5	28	13	50	0	0	0	17,597
	Lower	78.74	11.67	200	295	701	10		4	6	14	74	0	0	2	7,221
10	Upper	78.67	11.72	873	129	693	10	10.62	2	6	10	82	0	0	0	16,973
	Lower	78.73	11.62	180	525	693	10		27	3	55	10	1	0	3	6,007
11	Upper	78.66	11.77	890	153	690	10	13.5	15	15	46	23	0	0	0	18,067
	Lower	78.76	11.67	200	244	690	10		3	3	8	85	0	0	0	6,919
12	Upper	78.72	11.87	850	148	660	11	10.52	11	11	36	38	0	0	3	12,910
	Lower	78.83	11.85	190	375	660	11		11	20	22	42	4	0	0	2,500

15 GWh

Pairings	Reservoirs	Location (long/lat)		Elevation (m)	Area (acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
13	Upper	78.67	11.77	830	115	640	11	11.61	1	15	4	78	0	0	0	16,990
	Lower	78.79	11.78	190	252	640	11		9	4	29	51	7	0	0	4,815
14	Upper	78.69	11.69	780	73	620	12	11.8	3	20	0	75	0	0	0	13,638
	Lower	78.78	11.61	160	542	620	11		39	2	48	8	0	1	2	777
15	Upper	78.68	11.73	871	142	608	12	7.66	7	15	43	34	0	0	0	16,714
	Lower	78.77	11.73	263	99	608	12		0	0	0	100	0	0	0	10,865
16	Upper	78.64	11.75	825	136	605	12	11.22	9	23	12	55	0	0	0	20,616
	Lower	78.61	11.63	220	580	605	12		23	6	48	23	0	0	0	19271
17	Upper	78.69	11.77	793	140	603	12	10.74	3	26	18	52	0	0	0	14,793
	Lower	78.8	11.76	190	361	603	11		7	2	25	58	6	0	1	5,729
18	Upper	78.81	11.92	761	108	601	13	9.15	27	25	24	23	0	0	0	7,479
	Lower	78.88	11.84	160	831	601	11		5	5	41	34	14	0	1	2,832
19	Upper	78.81	11.93	783	114	593	12	2.7	13	11	8	65	0	0	0	7,999
	Lower	78.83	11.9	190	639	593	12		6	9	50	31	3	0	1	4,639
20	Upper	78.74	11.84	761	107	581	12	9.76	11	28	7	46	0	0	6	10,093
	Lower	78.84	11.81	180	488	581	12		14	7	56	19	0	0	3	0
21	Upper	78.71	11.76	762	205	581	12	11.19	15	12	54	14	0	0	4	12,599
	Lower	78.82	11.79	181	285	581	12		0	1	10	5	82	0	0	2,437
22	Upper	78.69	11.73	760	93	580	12	11.22	0	1	0	98	0	0	0	16,092
	Lower	78.72	11.61	180	400	580	12		26	3	59	6	0	2	4	7,142
23	Upper	78.74	11.84	751	114	571	13	10.98	20	27	25	25	0	0	0	9,774
	Lower	78.85	11.88	180	429	571	13		19	4	54	19	0	2	1	3,168
24	Upper	78.79	11.73	694	182	564	13	9.1	27	16	5	49	0	0	2	8,250
	Lower	78.9	11.69	130	974	564	13		13	2	42	37	5	0	1	0

15 GWh

Pairings	Reservoirs	Location (long/lat)		Elevation (m)	Area (acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
25	Upper	78.81	11.94	732	103	562	13	8.12	13	16	24	47	0	0	0	7,554
	Lower	78.88	11.87	170	790	562	12		21	6	40	18	14	0	1	1,249
26	Upper	78.65	11.79	790	219	560	12	9.61	13	24	37	25	0	0	0	18,057
	Lower	78.76	11.77	230	165	560	13		7	13	17	63	0	0	0	8420
27	Upper	78.72	11.7	713	163	553	13	9.31	16	25	16	42	0	0	0	12,030
	Lower	78.81	11.66	160	796	553	14		18	8	60	12	0	0	2	2,352
28	Upper	78.74	11.79	720	148	550	13	9.06	13	26	6	54	0	0	0	9,258
	Lower	78.84	11.79	170	507	550	12		6	8	55	30	0	0	0	119
29	Upper	78.74	11.74	710	153	550	13	10.56	18	26	20	33	0	0	0	12,087
	Lower	78.86	11.74	160	607	550	13		6	17	7	69	0	0	0	2,072
30	Upper	78.69	11.71	720	105	550	13	9.8	2	32	3	62	0	0	0	13,805
	Lower	78.76	11.62	170	373	550	13		50	1	44	2	0	0	2	3,426
31	Upper	78.83	11.94	710	97	550	13	8.78	15	11	3	69	0	0	0	5,600
	Lower	78.92	11.91	160	674	550	13		15	7	28	24	23	0	3	0
32	Upper	78.66	11.67	720	162	540	13	10.16	14	25	15	46	0	0	0	14,059
	Lower	78.7	11.57	180	1011	540	13		25	5	41	7	21	0	1	9,708
33	Upper	78.7	11.71	700	185	540	13	9.56	11	18	25	46	0	0	0	12,873
	Lower	78.78	11.62	160	909	540	13		18	4	54	8	13	1	2	1,065
34	Upper	78.71	11.75	710	166	530	13	10.01	16	23	27	30	0	0	3	14,057
	Lower	78.79	11.67	180	384	530	14		21	11	48	17	0	0	1	5001
35	Upper	78.84	11.93	690	164	520	14	3.94	21	12	2	63	0	0	0	5,301
	Lower	78.89	11.91	170	792	520	14		6	6	52	30	5	0	0	0
36	Upper	78.71	11.78	690	155	510	14	10.04	12	20	9	54	0	0	5	12,597
	Lower	78.82	11.79	180	594	510	14		5	3	30	46	14	0	2	2,465

15 GWh

Pairings	Reservoirs	Location (long/lat)		Elevation (m)	Area (acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
37	Upper	78.74	11.87	750	105	510	14	4.53	9	29	9	47	0	0	5	11,422
	Lower	78.79	11.86	240	201	510	14		4	8	28	47	13	0	0	6,018
38	Upper	78.74	11.88	690	185	510	14	9.6	9	33	18	39	0	0	0	11,676
	Lower	78.85	11.88	180	534	510	14		8	7	41	26	17	0	1	2759
39	Upper	78.71	11.72	671	434	501	14	8.85	11	12	27	47	3	0	0	13,825
	Lower	78.77	11.64	170	861	501	14		21	3	62	7	3	1	4	2,882
40	Upper	78.76	11.74	651	105	501	14	9.92	5	27	0	67	0	0	0	10,104
	Lower	78.86	11.71	150	682	501	15		13	9	43	26	9	0	0	1,819
41	Upper	78.72	11.95	810	305	500	14	6.14	48	8	36	8	0	0	0	17,235
	Lower	78.68	12.02	310	624	500	15		38	7	16	36	3	0	0	21795
42	Upper	78.75	11.82	710	248	500	14	5.42	17	16	18	44	0	0	3	8,783
	Lower	78.81	11.83	210	354	500	14		5	4	13	73	4	0	0	2,955
43	Upper	78.74	11.95	711	275	491	15	6	46	12	22	16	0	0	3	15,133
	Lower	78.8	11.9	220	407	491	15		8	3	70	17	0	0	1	8,893
44	Upper	78.68	11.84	730	303	490	14	9.2	28	16	39	17	0	0	0	15,087
	Lower	78.79	11.84	240	168	490	15		6	12	11	71	0	0	0	4,531
45	Upper	78.75	11.97	690	173	490	15	9.73	55	10	16	15	0	0	3	13,548
	Lower	78.86	11.99	200	477	490	14		16	5	46	32	0	0	1	3,433
46	Upper	78.8	11.94	643	150	483	15	9.47	10	13	10	68	0	0	0	8,263
	Lower	78.91	11.9	160	956	483	15		6	4	48	27	12	1	3	0
47	Upper	78.74	11.8	671	239	481	15	4.89	10	34	14	40	0	0	1	9,709
	Lower	78.8	11.77	190	397	481	15		12	4	39	44	0	0	0	5,034
48	Upper	78.76	11.79	641	178	481	15	7.16	20	28	7	45	0	0	0	6,890
	Lower	78.86	11.77	160	1192	481	15		18	8	27	43	1	0	1	1,698

15 GWh

Pairings	Reservoirs	Location (long/lat)		Elevation (m)	Area (acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
49	Upper	78.74	11.96	731	121	481	15	9.29	17	13	2	67	0	0	0	14,399
	Lower	78.77	12.06	250	558	481	15		30	6	48	14	0	0	1	15,228
50	Upper	78.71	11.81	660	441	480	15	9.03	16	17	16	45	0	0	6	12,176
	Lower	78.82	11.79	180	936	480	15		7	6	36	37	13	0	0	2075
51	Upper	78.69	11.75	700	375	480	15	8.6	22	12	39	24	3	0	0	15,237
	Lower	78.79	11.74	220	193	480	15		3	8	5	80	5	0	0	8,619
52	Upper	78.78	11.71	610	114	480	15	9.14	5	24	1	64	0	0	3	8,287
	Lower	78.88	11.66	130	951	480	14		25	2	57	13	1	1	1	0
53	Upper	78.72	11.82	672	236	472	15	7.71	15	23	10	48	0	0	4	10,387
	Lower	78.82	11.82	200	329	472	15		4	2	43	48	0	0	2	1034
54	Upper	78.8	12	661	119	471	15	8.31	13	16	36	32	0	0	2	10,049
	Lower	78.87	12.07	190	555	471	15		1	1	0	99	0	0	0	10,805
55	Upper	78.73	11.97	761	290	470	15	5.07	26	16	26	31	0	0	0	15,635
	Lower	78.75	12.03	291	397	470	15		17	8	25	49	0	0	0	15,550
56	Upper	78.74	11.92	660	183	470	15	7.93	22	23	6	48	0	0	0	14,389
	Lower	78.84	11.9	190	457	470	15		12	9	49	22	0	5	2	4,297
57	Upper	78.74	11.95	731	157	461	16	8.17	22	19	11	48	0	0	0	15,291
	Lower	78.74	12.05	270	433	461	15		38	9	33	19	0	1	0	16,648
58	Upper	78.71	11.82	691	191	461	15	7.57	6	22	11	58	0	0	3	11,685
	Lower	78.8	11.82	230	165	461	16		4	4	13	79	0	0	0	2,866
59	Upper	78.73	11.97	740	207	450	16	6.85	31	26	12	30	0	0	0	16,361
	Lower	78.67	12.05	290	692	450	15		26	9	40	14	7	3	2	22731
60	Upper	78.8	11.97	622	195	442	16	8.59	33	8	31	27	0	0	1	9,229
	Lower	78.9	11.99	180	919	442	16		11	6	56	23	0	2	0	1,492

15 GWh

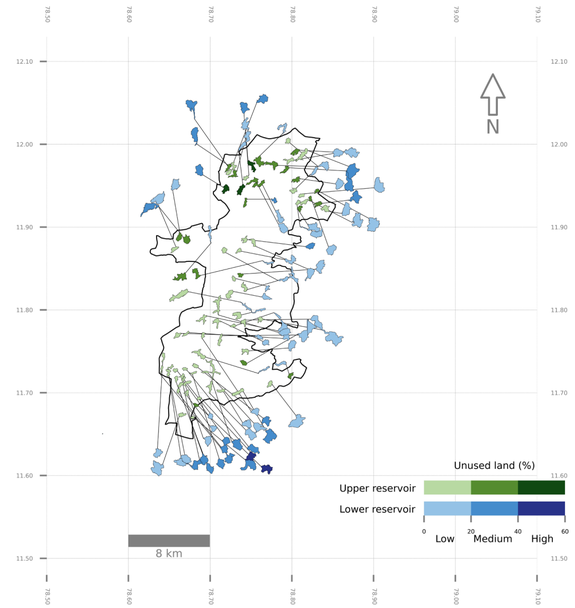
Pairings	Reservoirs	Location (long/lat)		Elevation (m)	Area (acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
61	Upper	78.69	11.83	721	150	439	16	6.78	9	42	4	45	0	0	0	14,048
	Lower	78.77	11.86	282	126	439	17		0	0	0	98	1	0	0	7,248
62	Upper	78.81	11.96	602	196	432	17	8.56	19	9	13	56	0	0	4	7,657
	Lower	78.91	11.95	170	859	432	16		20	12	37	19	10	1	1	0
63	Upper	78.75	11.75	651	256	431	17	1.91	5	18	8	68	0	0	1	10,903
	Lower	78.77	11.76	220	201	431	17		8	13	11	67	0	0	0	8,073
64	Upper	78.75	11.88	630	181	430	17	6.14	17	25	23	26	7	0	2	10,378
	Lower	78.83	11.88	200	287	430	16		31	7	35	27	0	0	0	5,540
65	Upper	78.72	11.9	770	200	430	17	5.84	20	40	20	19	0	0	1	14,970
	Lower	78.68	11.97	340	597	430	17		18	8	5	68	1	0	0	20,358
66	Upper	78.76	11.97	672	170	422	17	7.19	31	22	10	36	0	0	0	12,861
	Lower	78.79	12.05	250	454	422	17		26	6	48	15	0	0	4	13,221
67	Upper	78.67	11.88	790	321	420	17	5	26	20	37	17	0	0	0	17,971
	Lower	78.64	11.94	370	720	420	17		5	2	1	91	0	0	1	23,654
68	Upper	78.77	11.71	567	150	417	17	7.35	8	42	0	47	0	0	0	8,906
	Lower	78.82	11.63	150	1012	417	18		26	8	49	12	3	0	1	0
69	Upper	78.79	11.98	600	366	410	17	8.13	25	10	31	29	0	0	4	10,040
	Lower	78.88	11.97	190	656	410	17		36	10	3	28	23	0	0	343
70	Upper	78.66	11.88	801	217	410	17	2.58	31	11	46	9	0	0	2	19,009
	Lower	78.68	11.92	391	385	410	18		12	6	23	55	3	0	0	18,039
71	Upper	78.79	11.95	582	216	402	18	7.83	11	8	31	47	0	0	3	9,138
	Lower	78.87	11.92	180	461	402	17		16	7	58	18	0	0	0	1683
72	Upper	78.69	11.81	690	455	400	18	7.71	17	17	25	37	0	0	3	14,209
	Lower	78.77	11.83	290	146	400	18		3	19	0	76	0	0	0	5,743

15 GWh

Pairings	Reservoirs	Location (long/lat)		Elevation (m)	Area (acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
73	Upper	78.85	11.92	571	213	391	19	2.42	17	11	15	56	0	0	0	4,002
	Lower	78.88	11.93	180	809	391	18		23	10	43	21	0	1	2	1,083
74	Upper	78.65	11.87	740	194	390	18	6.74	16	41	6	35	0	0	1	18,735
	Lower	78.66	11.96	350	640	390	19		6	3	3	87	0	0	1	22919
75	Upper	78.81	11.99	600	254	390	18	6.62	30	9	36	21	0	0	3	8,427
	Lower	78.83	12.07	210	775	390	19		26	8	49	13	4	0	0	11865
76	Upper	78.7	11.79	691	277	381	19	5.31	7	30	12	50	0	0	0	14,229
	Lower	78.77	11.8	310	175	381	19		0	0	0	97	0	0	0	6,409
77	Upper	78.74	11.7	550	293	370	19	3.91	12	38	10	40	0	0	0	10,478
	Lower	78.75	11.64	180	666	370	18		17	4	67	7	0	0	5	4,715
78	Upper	78.82	12	580	260	370	19	6.67	23	13	28	34	0	0	2	8,248
	Lower	78.79	11.91	210	546	370	19		9	3	37	42	8	0	2	9,498
79	Upper	78.77	11.96	593	251	343	21	4.4	34	14	27	24	0	0	0	11,249
	Lower	78.83	11.97	250	163	343	21		1	9	7	81	0	0	0	5,544
80	Upper	78.82	11.99	550	401	330	21	1.89	14	14	28	43	0	0	0	7,298
	Lower	78.84	11.98	220	325	330	22		17	4	39	39	0	0	1	3,920
81	Upper	78.77	11.98	650	443	325	22	3.02	37	9	33	16	0	0	5	12,627
	Lower	78.79	12.02	325	312	325	22		0	0	0	100	0	0	0	11,135

5 GWh

2 lower and 3 upper reservoirs meet the highest potential criteria for land use mitigation for the category of 5 GWh. Numerous upper and lower reservoirs have medium and low potential. Overall, the category of 5 GWh can contribute to a total capacity of 410 GWh (with some overlaps) in the Kalvarayan Hill taluk.



5 GWh

Pairings	Reservoirs	Location (Long/Lat)		Elevation (m)	Area (Acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
1	Upper	78.65	11.73	990	84	790	3	10.66	18	16	17	50	0	0	0	18,829
	Lower	78.67	11.61	200	270	790	2.9		19	7	63	11	0	0	0	11,639
2	Upper	78.66	11.72	963	61	783	3.1	11.56	4	17	17	62	0	0	0	17,612
	Lower	78.7	11.6	180	208	783	3		29	2	56	12	0	0	0	8,592
3	Upper	78.67	11.7	1000	74	770	3.1	5.02	15	17	18	51	0	0	0	15,313
	Lower	78.7	11.65	230	127	770	3.1		6	9	2	82	0	0	0	9,778
4	Upper	78.66	11.7	950	47	770	3.1	10.39	12	20	16	51	0	0	0	16,552
	Lower	78.73	11.62	180	258	770	3.1		30	3	50	13	1	0	1	6,074
5	Upper	78.66	11.73	1020	57	760	3.1	7.11	11	19	29	42	0	0	0	18,455
	Lower	78.7	11.67	260	99	760	3.2		4	3	27	64	0	0	0	10,873
6	Upper	78.67	11.71	944	80	754	3.2	9.35	13	12	34	40	0	0	0	16,668
	Lower	78.7	11.62	190	244	754	3.2		21	6	55	13	0	1	4	9,398
7	Upper	78.65	11.73	942	44	742	3.3	11.98	3	11	4	81	0	0	0	19,230
	Lower	78.67	11.61	200	250	742	3.1		14	4	61	20	0	0	0	12,332
8	Upper	78.68	11.71	950	84	740	3.1	7.36	8	43	10	38	0	0	0	16,084
	Lower	78.7	11.64	210	213	740	3.4		10	8	8	52	20	0	0	9,683
9	Upper	78.67	11.73	901	50	731	3.2	13.16	8	21	20	50	0	0	0	17,597
	Lower	78.76	11.63	170	271	731	3.4		24	3	53	7	11	0	2	3,213
10	Upper	78.69	11.68	876	58	716	3.4	11.69	21	22	13	42	0	0	0	13,387
	Lower	78.78	11.61	160	285	716	3.5		42	2	49	6	0	0	1	777
11	Upper	78.64	11.73	893	42	703	3.5	12.56	1	4	0	92	0	0	0	19,906
	Lower	78.72	11.63	190	186	703	3.4		24	5	52	13	0	0	6	7,149
12	Upper	78.67	11.72	891	46	701	3.4	10.62	4	10	11	76	0	0	0	16,973
	Lower	78.68	11.61	190	279	701	3.5		35	5	45	12	0	0	3	10,141

5 GWh

Pairings	Reservoirs	Location (Long/Lat)		Elevation (m)	Area (Acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
13	Upper	78.67	11.72	890	55	700	3.4	9.71	2	6	16	75	0	0	0	17,245
	Lower	78.72	11.64	190	186	700	3.6		23	8	59	9	0	0	1	7,327
14	Upper	78.68	11.73	871	79	691	3.4	11.02	9	17	32	41	0	0	0	16,778
	Lower	78.77	11.66	180	229	691	3.6		31	2	45	8	8	1	5	4,948
15	Upper	78.66	11.77	890	98	660	3.5	9.77	15	18	47	19	0	0	0	18,112
	Lower	78.76	11.77	230	93	660	3.5		9	15	24	50	0	0	0	8,420
16	Upper	78.68	11.67	821	34	651	3.8	8.87	5	2	0	91	0	0	0	13,067
	Lower	78.75	11.61	170	420	651	3.8		38	2	50	5	0	2	3	2,959
17	Upper	78.67	11.77	830	58	640	3.7	12.47	0	14	8	78	0	0	0	17,011
	Lower	78.8	11.77	190	131	640	3.8		13	11	43	31	0	0	0	5,654
18	Upper	78.72	11.87	850	94	620	3.7	7.82	15	10	43	27	0	0	4	13,127
	Lower	78.8	11.84	230	101	620	3.7		8	18	6	66	0	0	0	4,214
19	Upper	78.64	11.75	825	71	615	3.9	11.63	8	22	10	59	0	0	0	20,717
	Lower	78.63	11.62	210	211	615	4.1		12	16	55	14	0	0	2	15,585
20	Upper	78.69	11.69	780	46	610	3.9	9.69	3	20	0	74	0	0	0	13,638
	Lower	78.76	11.62	170	246	610	4		45	1	48	3	0	0	3	3,426
21	Upper	78.68	11.72	781	44	601	4	11.85	0	1	0	98	0	0	0	16,431
	Lower	78.72	11.61	180	228	601	3.8		29	2	56	5	0	3	4	7,142
22	Upper	78.81	11.93	783	63	593	3.9	2.84	18	12	15	53	0	0	0	7,999
	Lower	78.83	11.9	190	324	593	4		5	11	46	33	5	0	0	4,639
23	Upper	78.69	11.77	793	67	593	4.1	11.72	1	18	15	64	0	0	0	14,984
	Lower	78.76	11.67	200	167	593	4.1		4	4	12	79	0	0	0	6,919
24	Upper	78.82	11.93	770	55	590	4.1	6.59	22	19	18	39	0	0	0	6,700
	Lower	78.85	11.88	180	291	590	4.1		16	4	49	25	0	4	2	3,168

5 GWh

Pairings	Reservoirs	Location (Long/Lat)		Elevation (m)	Area (Acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
25	Upper	78.73	11.78	792	53	582	4.1	5.33	5	16	1	75	0	0	0	10,822
	Lower	78.79	11.79	210	57	582	4.1		2	1	0	93	4	0	0	4894
26	Upper	78.71	11.76	762	113	581	4.2	11.42	15	13	52	16	0	0	4	12,919
	Lower	78.82	11.79	181	274	581	3.9		0	1	11	1	85	0	0	2,437
27	Upper	78.82	11.93	750	97	580	4	6.57	14	44	12	29	0	0	0	7,165
	Lower	78.89	11.91	170	430	580	4.2		4	5	63	26	2	0	0	0
28	Upper	78.81	11.92	761	84	571	4.2	3.11	24	23	28	23	0	0	0	7,479
	Lower	78.84	11.9	190	288	571	4.3		13	9	44	22	0	8	2	4,297
29	Upper	78.74	11.84	751	74	571	4.2	9.66	22	21	37	17	0	0	0	9,774
	Lower	78.84	11.86	180	326	571	4.2		12	3	71	10	2	0	2	3,520
30	Upper	78.81	11.94	732	74	562	4.2	9.34	13	14	32	41	0	0	0	7,621
	Lower	78.91	11.95	170	452	562	4.3		15	11	45	20	8	0	1	0
31	Upper	78.74	11.79	720	96	550	4.4	8.61	18	27	9	46	0	0	0	9,277
	Lower	78.84	11.78	170	351	550	4.3		5	9	49	32	3	0	2	1,241
32	Upper	78.83	11.94	710	58	550	4.3	7.54	24	12	2	58	0	0	0	5,600
	Lower	78.91	11.9	160	527	550	4.6		4	4	37	29	21	2	3	252
33	Upper	78.74	11.74	710	101	530	4.5	7.85	23	21	24	29	0	0	0	12,217
	Lower	78.82	11.79	180	373	530	4.7		6	4	39	29	22	0	1	2,465
34	Upper	78.72	11.7	713	80	523	4.4	4.81	12	25	16	46	0	0	0	12,053
	Lower	78.75	11.66	190	227	523	4.4		15	4	63	11	0	0	7	6,137
35	Upper	78.74	11.87	750	66	520	4.6	5.91	10	27	9	48	0	0	5	11,432
	Lower	78.8	11.86	230	193	520	4.5		7	4	41	38	9	0	0	5,386
36	Upper	78.66	11.67	720	91	520	4.6	6.82	12	18	17	52	0	0	0	14,263
	Lower	78.64	11.61	200	481	520	4.6		10	10	60	18	0	1	1	15,258

5 GWh

Pairings	Reservoirs	Location (Long/Lat)		Elevation (m)	Area (Acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
37	Upper	78.7	11.71	690	118	510	4.6	6.85	12	17	19	51	0	0	0	13,220
	Lower	78.75	11.64	180	340	510	4.6		17	3	68	6	0	0	3	4,715
38	Upper	78.84	11.93	690	112	510	4.7	3.53	20	10	2	68	0	0	0	5,312
	Lower	78.88	11.93	180	347	510	4.9		22	10	48	19	0	0	0	1,990
39	Upper	78.7	11.72	690	50	510	4.7	9	0	4	0	92	0	0	0	15,284
	Lower	78.77	11.65	180	293	510	4.8		14	3	72	7	0	0	3	4692
40	Upper	78.8	11.72	723	87	503	4.6	1.39	32	26	5	36	0	0	1	8,209
	Lower	78.79	11.74	220	110	503	4.6		4	9	9	72	5	0	0	8,619
41	Upper	78.7	11.79	691	134	501	4.7	9.73	9	21	18	52	0	0	0	14,283
	Lower	78.79	11.78	190	204	501	4.6		9	2	33	47	8	0	0	4,836
42	Upper	78.75	11.82	710	117	500	4.8	5.74	17	17	15	49	0	0	3	8,783
	Lower	78.81	11.83	210	186	500	4.7		3	2	15	73	6	0	0	2,955
43	Upper	78.71	11.72	671	198	491	4.7	8.5	8	9	21	58	4	0	0	14,197
	Lower	78.74	11.64	180	329	491	4.7		23	3	61	8	0	0	5	5,573
44	Upper	78.73	11.84	780	60	490	4.8	4.2	8	31	12	41	0	0	6	10,578
	Lower	78.77	11.83	290	67	490	4.9		4	13	0	83	0	0	0	5,839
45	Upper	78.74	11.88	690	94	490	4.9	7.85	7	32	13	47	0	0	0	11,676
	Lower	78.83	11.88	200	165	490	5		30	6	48	16	0	0	0	5,540
46	Upper	78.76	11.79	641	86	481	4.9	7.8	17	28	4	48	0	0	0	6,970
	Lower	78.86	11.77	160	638	481	5.2		13	8	31	43	3	0	2	1,703
47	Upper	78.73	11.97	764	81	474	5	8.17	18	24	22	35	0	0	0	16,884
	Lower	78.67	12.05	290	351	474	5.2		25	5	38	15	11	4	2	22,991
48	Upper	78.73	11.97	761	122	470	4.9	5.68	24	17	18	41	0	0	0	16,060
	Lower	78.75	12.03	291	238	470	5.3		17	7	29	47	0	0	0	15,809

5 GWh

Pairings	Reservoirs	Location (Long/Lat)		Elevation (m)	Area (Acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
49	Upper	78.72	11.95	810	165	470	5	3.12	49	4	39	8	0	0	0	17,308
	Lower	78.68	11.97	340	277	470	5.2		29	11	10	48	2	0	0	20,702
50	Upper	78.71	11.81	660	222	470	5.1	8.34	16	14	18	46	0	0	6	12,176
	Lower	78.8	11.77	190	274	470	5.4		13	4	38	44	0	0	0	5,034
51	Upper	78.76	11.95	690	138	470	5.1	6.3	35	9	16	28	8	0	5	13,317
	Lower	78.8	11.9	220	275	470	5.4		10	4	70	15	0	0	2	8,893
52	Upper	78.73	11.97	715	87	465	5.1	8.4	16	14	6	63	0	0	0	16,280
	Lower	78.77	12.06	250	274	465	5.3		24	6	57	11	0	0	2	15,608
53	Upper	78.75	11.75	651	105	461	5.1	5.21	3	17	5	76	0	0	0	10,927
	Lower	78.8	11.76	190	234	461	5		8	3	23	58	6	0	2	5,729
54	Upper	78.74	11.96	731	70	461	5.1	8.24	19	17	3	61	0	0	0	14,576
	Lower	78.74	12.05	270	273	461	5.5		37	8	37	15	0	1	0	16,893
55	Upper	78.77	11.95	670	157	460	5.1	3.82	38	4	20	26	12	0	0	12,499
	Lower	78.79	11.91	210	227	460	5		3	3	37	42	14	0	0	9,498
56	Upper	78.71	11.79	680	125	460	5	6.2	19	29	14	35	0	0	3	12,559
	Lower	78.77	11.76	220	125	460	5.2		6	12	16	65	0	0	0	8,073
57	Upper	78.68	11.84	730	174	460	5.3	8.42	31	14	39	14	0	0	0	15,232
	Lower	78.78	11.86	270	64	460	5.1		0	1	0	93	2	0	0	7,078
58	Upper	78.66	11.88	810	134	460	5.1	5.85	39	8	46	6	0	0	1	19,262
	Lower	78.66	11.96	350	288	460	5.2		11	4	6	77	0	0	1	23,228
59	Upper	78.73	11.98	760	94	450	5.3	4.96	33	30	13	23	0	0	0	16,924
	Lower	78.68	12.02	310	321	450	5.2		29	9	11	47	4	0	0	21898
60	Upper	78.8	12	661	86	441	5.4	4.94	14	17	46	19	0	0	3	10,049
	Lower	78.84	11.98	220	217	441	5.5		19	3	46	30	0	1	0	4,021

5 GWh

Pairings	Reservoirs	Location (Long/Lat)		Elevation (m)	Area (Acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
61	Upper	78.75	11.88	630	105	440	5.4	7.62	18	18	21	28	12	0	2	10,378
	Lower	78.83	11.85	190	256	440	5.4		12	24	27	33	4	0	0	2,581
62	Upper	78.69	11.74	690	193	439	5.2	7.38	17	9	41	27	6	0	0	16,177
	Lower	78.77	11.73	251	65	439	5.5		0	0	0	99	0	0	0	10585
63	Upper	78.8	11.97	622	115	432	5.4	7.62	39	9	23	29	0	0	0	9,238
	Lower	78.88	11.94	190	443	432	5.5		36	14	29	20	0	0	1	1,083
64	Upper	78.74	11.92	660	85	419	5.7	3.23	29	24	3	42	0	0	0	14,769
	Lower	78.78	11.93	241	74	419	5.7		22	9	7	63	0	0	0	10,933
65	Upper	78.67	11.88	790	188	410	5.6	5.2	29	14	38	18	0	0	0	18,066
	Lower	78.63	11.93	380	385	410	5.8		21	5	1	71	0	0	1	23,934
66	Upper	78.78	11.98	630	203	410	5.6	5.35	28	6	36	23	0	0	5	10,776
	Lower	78.84	11.98	220	217	410	5.9		19	3	46	30	0	1	0	4,021
67	Upper	78.77	11.71	567	90	407	5.9	5.2	7	40	1	50	0	0	0	9,106
	Lower	78.81	11.66	160	522	407	5.8		18	8	59	12	0	0	2	2,521
68	Upper	78.8	11.94	643	103	403	5.8	2.5	13	18	14	54	0	0	0	8,363
	Lower	78.83	11.97	240	109	403	5.9		1	3	13	83	0	0	0	5,418
69	Upper	78.81	11.96	602	120	402	5.9	4.73	25	11	19	40	0	0	5	7,753
	Lower	78.86	11.95	200	258	402	5.8		13	9	44	34	0	0	0	2,185
70	Upper	78.81	11.99	600	140	400	5.9	4.45	28	9	38	20	0	0	3	8,460
	Lower	78.86	11.99	200	256	400	6		16	5	38	39	0	0	0	3,433
71	Upper	78.8	11.98	582	112	392	5.9	6.77	12	10	19	58	0	0	0	8,761
	Lower	78.88	11.99	190	373	392	6.3		13	6	37	36	1	5	2	2,338
72	Upper	78.85	11.92	571	151	391	6.3	1.77	14	11	18	56	0	0	0	4,002
	Lower	78.87	11.92	180	335	391	6.1		17	8	68	7	0	0	0	1,683

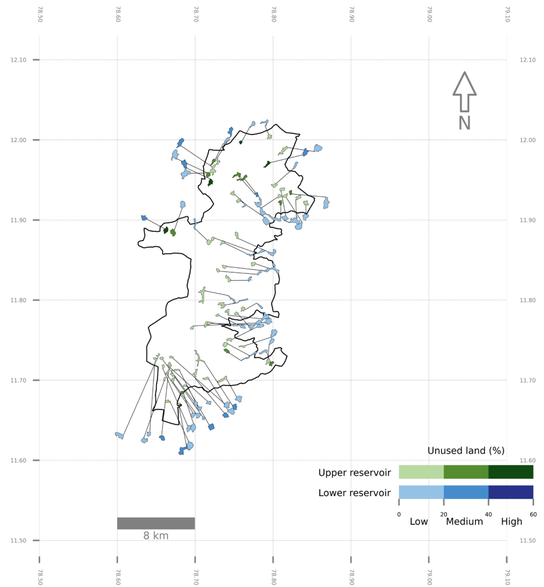
5 GWh

Pairings	Reservoirs	Location (Long/Lat)		Elevation (m)	Area (Acres)	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
73	Upper	78.74	11.95	711	189	381	6.4	4.48	44	10	26	18	0	0	3	15,133
	Lower	78.74	12	330	121	381	6.1		0	0	0	99	0	0	0	15449
74	Upper	78.74	11.7	550	154	380	6.2	6.06	12	36	13	38	0	0	0	10,605
	Lower	78.77	11.64	170	478	380	6.3		22	3	64	7	0	1	3	2,886
75	Upper	78.75	11.98	680	187	370	6.4	2.48	54	9	19	13	0	0	5	13,657
	Lower	78.75	12.02	310	178	370	6.4		15	7	14	63	0	0	0	15,208
76	Upper	78.65	11.87	740	98	370	6.4	6.2	13	49	2	35	0	0	0	19,129
	Lower	78.64	11.94	370	401	370	6.6		2	0	1	95	0	0	2	23,798
77	Upper	78.74	11.8	671	172	361	6.6	1.4	9	36	15	39	0	0	1	9,709
	Lower	78.77	11.8	310	86	361	6.6		0	0	0	97	0	0	0	6,420
78	Upper	78.67	11.82	720	333	359	6.8	7.06	18	7	30	43	0	0	1	16,565
	Lower	78.75	11.8	361	76	359	6.6		0	0	0	100	0	0	0	8,290
79	Upper	78.82	11.99	540	209	350	6.8	5.84	14	12	24	51	0	0	0	7,429
	Lower	78.88	11.97	190	488	350	6.8		36	6	4	24	31	0	0	343
80	Upper	78.77	11.98	650	235	325	7.4	4.23	29	8	41	18	0	0	4	12,627
	Lower	78.79	12.02	325	147	325	7.3		0	0	0	98	0	0	0	11,270
81	Upper	78.67	11.84	760	255	320	7.6	5.29	26	16	34	20	0	0	2	17,014
	Lower	78.7	11.9	440	130	320	7.4		0	0	0	100	0	0	0	15,447
82	Upper	78.72	11.82	672	162	310	7.5	3.85	9	22	11	53	0	0	5	10,588
	Lower	78.77	11.82	362	137	310	7.8		5	39	7	50	0	0	0	5,423

2 GWh

4 upper reservoirs meet the highest potential criteria for land use mitigation in the category of 2 GWh*. Numerous upper and lower reservoirs have medium and low potential. Overall, the category of 2 GWh can contribute to a total capacity of 134 GWh (with overlapping reservoirs) in the Kalvarayan Hill taluk.

*Some reservoirs have not been considered for this study as there were errors with the data.



2 GWh

Pairings	Reservoirs	Location (Long/Lat)		Elevation (m)	Area Acres	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
1	Upper	78.66	11.73	1020	35	770	1.2	8.06	10	9	44	34	0	0	0	18,544
	Lower	78.71	11.66	250	60	770	1.2		5	3	11	81	0	0	0	10,185
2	Upper	78.65	11.73	990	49	770	1.2	9.47	14	14	14	55	0	0	0	19,050
	Lower	78.64	11.63	220	67	770	1.2		16	9	58	10	0	0	3	15,578
3	Upper	78.67	11.7	1000	43	770	1.2	5.29	13	11	18	55	0	0	0	15,426
	Lower	78.7	11.65	230	83	770	1.2		8	12	0	77	0	0	0	9,859
4	Upper	78.66	11.72	970	35	760	1.3	8.66	3	15	14	64	0	0	0	17,714
	Lower	78.69	11.64	210	91	760	1.3		7	7	26	60	0	0	0	10,323
5	Upper	78.66	11.7	950	26	740	1.3	8.23	14	16	15	54	0	0	0	16,594
	Lower	78.63	11.62	210	105	740	1.3		10	13	60	15	0	0	1	15,864
6	Upper	78.67	11.71	970	38	738	1.3	7.05	13	7	26	50	0	0	0	15,922
	Lower	78.71	11.65	232	31	738	1.3		0	0	0	99	0	0	0	9,084
7	Upper	78.65	11.73	956	24	736	1.3	11.83	4	16	2	77	0	0	0	19,299
	Lower	78.61	11.63	220	144	736	1.3		13	4	57	24	0	0	0	19,297
8	Upper	78.67	11.71	944	36	714	1.3	6.45	8	10	20	59	0	0	0	16,792
	Lower	78.7	11.65	230	70	714	1.3		13	10	0	75	0	0	0	10,537
9	Upper	78.67	11.73	901	33	701	1.4	9.6	8	16	24	47	0	0	0	17,597
	Lower	78.74	11.67	200	119	701	1.4		5	4	30	54	0	0	6	7,221
10	Upper	78.68	11.71	942	42	682	1.4	4.72	4	32	4	58	0	0	0	15,740
	Lower	78.7	11.67	260	69	682	1.4		2	2	29	64	0	0	0	10,873
11	Upper	78.67	11.72	891	24	681	1.4	9.22	1	6	6	85	0	0	0	17,007
	Lower	78.66	11.63	210	87	681	1.4		27	7	58	6	0	0	0	13,480
12	Upper	78.69	11.68	876	37	666	1.4	4.42	27	21	7	41	0	0	0	13,387
	Lower	78.7	11.64	210	136	666	1.4		8	4	11	45	31	0	0	9,689

2 GWh

Pairings	Reservoirs	Location (Long/Lat)		Elevation (m)	Area Acres	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
13	Upper	78.67	11.72	890	30	639	1.5	7.31	2	7	16	72	0	0	0	17,306
	Lower	78.72	11.67	251	57	639	1.5		15	8	21	56	0	0	0	9,440
14	Upper	78.68	11.67	821	22	631	1.6	5.78	0	0	0	98	0	0	0	13,081
	Lower	78.68	11.61	190	175	631	1.6		36	5	46	8	0	0	3	10,141
15	Upper	78.7	11.76	817	41	627	1.5	9.8	14	19	35	28	0	0	0	14,722
	Lower	78.8	11.77	190	146	627	1.5		11	5	34	49	0	0	0	5,034
16	Upper	78.82	11.93	770	46	590	1.6	4.79	26	20	22	30	0	0	0	6,757
	Lower	78.87	11.92	180	199	590	1.6		13	9	72	7	0	0	0	1,683
17	Upper	78.69	11.69	780	27	590	1.6	6.3	3	18	0	76	0	0	0	13,638
	Lower	78.72	11.64	190	128	590	1.6		23	8	58	9	0	0	1	7,327
18	Upper	78.72	11.77	780	40	580	1.6	6.08	11	20	30	35	0	0	0	12,321
	Lower	78.79	11.77	200	95	580	1.6		5	3	44	47	0	0	0	6,174
19	Upper	78.81	11.93	783	41	573	1.7	2.64	17	12	21	48	0	0	0	7,999
	Lower	78.79	11.91	210	126	573	1.7		2	4	36	34	23	0	0	9,498
20	Upper	78.72	11.88	821	43	571	1.7	6.35	5	16	44	31	0	0	0	13,030
	Lower	78.79	11.86	250	57	571	1.7		3	6	19	59	10	0	0	6,593
21	Upper	78.73	11.78	792	30	562	1.7	3.15	3	14	2	78	0	0	0	10,870
	Lower	78.76	11.77	230	64	562	1.7		8	10	28	53	0	0	0	8,420
22	Upper	78.81	11.92	761	52	561	1.7	2.01	29	28	15	25	0	0	0	7,529
	Lower	78.81	11.9	200	127	561	1.7		3	1	25	59	11	0	0	7,334
23	Upper	78.82	11.93	750	60	560	1.7	3.96	14	43	8	33	0	0	0	7,230
	Lower	78.84	11.9	190	167	560	1.7		15	9	37	21	0	14	3	4,297
24	Upper	78.81	11.94	732	57	532	1.8	3.39	12	10	38	39	0	0	0	7,660
	Lower	78.82	11.9	200	95	532	1.8		8	3	73	15	0	0	0	6,281

2 GWh

Pairings	Reservoirs	Location (Long/Lat)		Elevation (m)	Area Acres	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
25	Upper	78.71	11.77	781	61	531	1.8	3.48	14	8	63	11	0	0	1	12,677
	Lower	78.75	11.77	250	42	531	1.8		2	11	6	78	0	0	0	9,129
26	Upper	78.73	11.84	780	37	530	1.8	5.34	5	34	14	38	0	0	6	10,578
	Lower	78.78	11.84	250	49	530	1.8		14	8	7	67	0	0	0	4,988
27	Upper	78.66	11.67	720	44	530	1.8	6.04	6	15	4	73	0	0	0	14,480
	Lower	78.7	11.62	190	186	530	1.8		20	7	55	11	0	1	5	9,398
28	Upper	78.74	11.79	720	59	530	1.8	4.65	16	31	7	46	0	0	0	9,326
	Lower	78.79	11.78	190	140	530	1.8		9	1	40	41	9	0	0	4,858
29	Upper	78.72	11.7	713	45	523	1.8	5.13	10	22	15	53	0	0	0	12,077
	Lower	78.75	11.66	190	138	523	1.8		14	4	65	11	0	0	6	6,137
30	Upper	78.74	11.84	751	49	521	1.8	4.99	20	17	43	16	0	0	0	9,774
	Lower	78.8	11.84	230	62	521	1.8		6	15	6	72	0	0	0	4,234
31	Upper	78.76	11.78	720	37	510	1.8	2.23	12	18	18	51	0	0	0	8,289
	Lower	78.78	11.77	210	89	510	1.8		5	2	13	77	0	0	0	7,280
32	Upper	78.8	11.72	723	59	503	1.9	1.45	27	20	7	45	0	0	1	8,277
	Lower	78.79	11.74	220	72	503	1.9		5	6	13	69	6	0	0	8,619
33	Upper	78.7	11.71	690	70	500	1.9	6.31	11	14	20	55	0	0	0	13,431
	Lower	78.74	11.65	190	98	500	1.9		20	2	65	6	0	0	5	6,377
34	Upper	78.84	11.93	690	64	500	1.9	2.38	18	12	0	67	0	0	0	5,438
	Lower	78.83	11.9	190	192	500	1.9		4	11	45	35	6	0	0	4,639
35	Upper	78.79	11.73	694	46	494	1.9	2.14	16	17	3	63	0	0	0	8,737
	Lower	78.8	11.75	200	84	494	1.9		2	3	25	58	13	0	0	6,844
36	Upper	78.71	11.72	671	113	481	1.9	7.12	7	7	13	69	4	0	0	14,235
	Lower	78.75	11.66	190	90	481	1.9		21	2	57	9	0	0	9	6,347

2 GWh

Pairings	Reservoirs	Location (Long/Lat)		Elevation (m)	Area Acres	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
37	Upper	78.72	11.96	801	69	471	2	4.45	31	3	61	4	0	0	0	17,618
	Lower	78.68	11.99	330	191	471	2		18	7	25	43	5	2	0	22,118
38	Upper	78.72	11.95	810	99	470	2.1	3.58	48	3	42	7	0	0	0	17,346
	Lower	78.68	11.97	340	140	470	2.1		38	7	19	30	5	0	0	20,932
39	Upper	78.74	11.87	750	45	468	2	3.34	10	23	10	47	0	0	6	11,474
	Lower	78.77	11.86	282	37	468	2		0	2	0	90	4	0	0	7,329
40	Upper	78.76	11.74	651	40	461	2.1	3.84	4	29	0	64	0	0	0	10,240
	Lower	78.8	11.76	190	156	461	2.1		7	3	21	61	5	0	3	5,729
41	Upper	78.75	11.75	651	54	451	2.1	3.88	3	22	5	70	0	0	0	10,931
	Lower	78.79	11.77	200	91	451	2.1		19	5	38	36	0	0	0	6,284
42	Upper	78.77	11.95	670	91	450	2.1	3.35	35	3	18	30	14	0	0	12,526
	Lower	78.78	11.92	220	134	450	2.1		4	1	29	56	6	0	2	10,261
43	Upper	78.76	11.95	690	90	449	2.1	3.03	36	8	16	24	13	0	2	13,380
	Lower	78.78	11.93	241	49	449	2.1		31	12	9	45	0	0	0	10,972
44	Upper	78.74	11.74	710	67	447	2.1	2.01	22	18	24	35	0	0	0	12,305
	Lower	78.77	11.73	263	37	447	2.1		0	0	0	101	0	0	0	10,865
45	Upper	78.73	11.97	764	43	444	2.1	5.24	19	25	8	46	0	0	0	16,885
	Lower	78.68	12	320	149	444	2.1		30	4	20	40	5	0	0	21,695
46	Upper	78.74	11.75	681	75	441	2.1	3.46	5	16	18	60	0	0	0	11,762
	Lower	78.78	11.73	240	39	441	2.1		0	1	0	92	10	0	0	9,768
47	Upper	78.75	11.92	651	50	431	2.2	4.06	15	28	11	43	0	0	0	13,251
	Lower	78.8	11.9	220	166	431	2.2		8	3	72	15	0	0	1	8,893
48	Upper	78.76	11.79	641	58	431	2.2	1.74	16	32	3	47	0	0	0	7,138
	Lower	78.79	11.79	210	43	431	2.2		3	1	0	89	5	0	0	4,909

2 GWh

Pairings	Reservoirs	Location (Long/Lat)		Elevation (m)	Area Acres	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
49	Upper	78.75	11.93	700	47	430	2.2	1.86	18	37	10	35	0	0	0	14,151
	Lower	78.76	11.92	270	29	430	2.2		0	0	0	98	0	0	0	12,351
50	Upper	78.73	11.96	781	89	430	2.1	2.72	18	9	34	37	0	0	0	16,846
	Lower	78.69	11.96	351	216	430	2.1		7	3	2	88	0	0	0	20,393
51	Upper	78.73	11.98	760	60	430	2.2	2.46	35	23	17	24	0	0	0	16,950
	Lower	78.74	12	330	79	430	2.2		0	0	0	98	0	0	0	15,486
52	Upper	78.76	12	710	36	420	2.2	2.16	56	15	0	19	0	0	6	13,696
	Lower	78.78	12.02	290	71	420	2.2		2	1	1	94	0	0	0	12,970
53	Upper	78.75	11.82	710	73	420	2.3	2.48	16	14	18	51	0	0	0	8,783
	Lower	78.77	11.83	290	43	420	2.3		5	14	0	80	0	0	0	5,934
54	Upper	78.73	11.97	722	59	412	2.3	3.29	19	11	4	65	0	0	0	16,306
	Lower	78.75	12.02	310	114	412	2.3		23	5	21	50	0	0	0	15,410
55	Upper	78.72	11.87	850	77	410	2.3	2.2	16	10	45	25	0	0	3	13,155
	Lower	78.7	11.9	440	71	410	2.3		0	0	0	99	0	0	0	15,876
56	Upper	78.8	11.94	643	69	403	2.3	2.88	14	19	18	49	0	0	0	8,442
	Lower	78.83	11.97	240	67	403	2.3		0	3	16	81	0	0	0	5,454
57	Upper	78.8	11.97	622	69	402	2.3	4.66	50	8	19	22	0	0	0	9,238
	Lower	78.85	11.99	220	117	402	2.3		24	3	57	12	0	0	3	4,619
58	Upper	78.66	11.88	810	97	400	2.4	2.78	42	8	42	7	0	0	0	19,262
	Lower	78.63	11.91	410	97	400	2.4		38	19	19	20	0	0	4	22,615
59	Upper	78.75	11.88	630	68	400	2.3	4.56	17	13	19	27	16	0	2	10,380
	Lower	78.8	11.86	230	114	400	2.3		4	5	35	47	8	0	0	5,386
60	Upper	78.67	11.88	790	116	399	2.5	3.12	26	17	35	22	0	0	0	18,108
	Lower	78.68	11.92	391	124	399	2.5		19	7	28	41	4	0	0	18,936

2 GWh

Pairings	Reservoirs	Location (Long/Lat)		Elevation (m)	Area Acres	Head (m)	Volume (GL)	Separation (km)	Unused (%)	Sparse Veg (%)	Cropland (%)	Tree cover (%)	Waterbodies (%)	Builtup (%)	Roads (%)	Distance from powerlines (m)
61	Upper	78.85	11.92	571	75	381	2.6	1.27	12	13	10	64	0	0	0	4,002
	Lower	78.84	11.9	190	115	381	2.6		5	7	68	18	0	0	0	3,474
62	Upper	78.78	11.85	585	62	375	2.5	2.11	4	8	7	78	0	0	0	6,286
	Lower	78.81	11.83	210	129	375	2.5		3	2	18	69	8	0	0	3,002
63	Upper	78.74	11.8	671	102	361	2.6	1.66	6	32	18	43	0	0	0	9,709
	Lower	78.77	11.8	310	49	361	2.6		0	0	0	96	0	0	0	6,426
64	Upper	78.82	11.99	550	111	350	2.7	3.73	18	12	25	45	0	0	0	7,457
	Lower	78.86	11.99	200	194	350	2.7		13	4	33	49	0	0	0	3,433
65	Upper	78.74	11.7	550	87	350	2.6	2.94	8	37	11	42	0	0	0	10,680
	Lower	78.76	11.67	200	127	350	2.6		5	5	16	73	0	0	0	6,919
66	Upper	78.8	12	661	63	336	2.7	1.24	14	14	50	17	0	0	4	10,062
	Lower	78.79	12.02	325	69	336	2.7		0	0	0	99	0	0	0	11,535
67	Upper	78.71	11.81	660	180	309	3	3.02	15	14	17	47	0	0	7	12,176
	Lower	78.75	11.8	351	54	309	3		0	0	0	99	0	0	0	8,181

04 RECOMMENDATIONS AND SUMMARY

Our evaluation of potential closed-loop pumped storage hydropower (PSH) systems reveals significant technical potential, despite landcover challenges such as protected lands, forests, tribal settlements, croplands, and built-up areas. The technically viable lands identified 311 reservoir pairs in the Kalvarayan Hills, with an overlapping capacity of 14,159 GWh. The largest category of capacity i.e. 1500 GWh, alone has the potential to provide 3000 GWh of capacity from its two non-overlapping pairs. The larger capacities, 1500 GWh, 500 GWh and 150 GWh, can contribute to 9,950 GWh of energy, although they will overlap. Among these, the best sites for developing off-river PSH are the ones with a high share of unused land. Construction of PSH on such sites will ensure minimal impact on land cover. These findings indicate a promising future for PSH in Tamil Nadu.

PSH, known for its flexibility and suitability for extended operation, dominates the global energy storage landscape, accounting for 96% of the installed capacity worldwide (IRADe, 2020). To optimize PSH plants for prolonged grid support, developing regulatory frameworks is necessary. Additionally, exploring off-river PSH projects in Tamil Nadu and across India, along with standardised bid documents, can streamline procurement and development processes, accelerating project implementation. The next part of the analysis will have a cost model which is necessary due to the wide range of costs. Grid modelling is also needed to understand its role in India's energy mix fully. Public awareness and support from think tanks and civil society are crucial for PSH development.

05 REFERENCES

1. Blakers, A., Lu, B., Stocks, M. (2017). 100% renewable electricity in Australia. Energy, Volume 133, Pages 471-482. Available at: https://www.sciencedirect.com/science/article/pii/S0360544217309568 (accessed on 14 May 2024)
2. Central Electricity Authority (2023). Status of pumped storage development in India. Available at: https://cea.nic.in/wp-content/uploads/hpi/2024/02/Pumped_Storage_potential_in_the_country-1.pdf (accessed on 14 May 2024).
3. Connolly, D., MacLaughin, S., and Leahy, M. (2010). Development of a computer program to locate potential sites for pumped hydroelectric energy storage. Energy, Volume 35, Issue 1, January 2010, Pages 375-381. Available at: https://www.sciencedirect.com/science/article/abs/pii/S036054420900437X (accessed on 14 May 2024)
4. Department of Energy (2023). United States of America. Pumped storage hydropower: What is Pumped Storage Hydropower? Available at: https://www.iea.org/news/renewable-electricity-growth-is-accelerating-faster-than-ever-worldwide-supporting-the-emergence-of-the-new-global-energy-economy (accessed on 14 May 2024)
5. International Energy Agency (2021). Renewable electricity growth is accelerating faster than ever worldwide, supporting the emergence of the new global energy economy. Available at: https://www.iea.org/news/renewable-electricity-growth-is-accelerating-faster-than-ever-worldwide-supporting-the-emergence-of-the-new-global-energy-economy (accessed on 14 May 2024)
6. International Energy Agency (2024). Massive expansion of renewable power opens door to achieving global tripling goal set at COP28. Available at: https://www.iea.org/news/massive-expansion-of-renewable-power-opens-door-to-achieving-global-tripling-goal-set-at-cop28 (accessed on 14 May 2024)
7. International Hydropower Association (2022). Pumped storage hydropower: Water batteries for solar and wind power. Available at: https://www.hydropower.org/factsheets/pumped-storage (accessed on 14 May 2024)
8. International Hydropower Association (2023). India trailblazing pumped storage development with new draft guidelines. Available at:https://www.hydropower.org/blog/india-trailblazing-pumped-storage-development-with-new-draft-guidelines(accessed on 14 May 2024)
9. Lu, B., Blakers, A., and Stocks, M. (2017). 90-100% renewable electricity for the South West Interconnected System of Western Australia. Australian National University, March 2017. Available at: https://www.sciencedirect.com/science/article/pii/S0360544217300774 (accessed on 14 May 2024)
10. Lu, B., Stocks, M., Blakers, A., and Anderson, K. (2018). Geographic information system algorithms to locate prospective sites for pumped hydro energy storage. Australian National University. Applied Energy. Volume 222, 15 July 2018, Pages 300-312. Available at: https://www.sciencedirect.com/science/article/pii/S0306261918305270?via%3Dihub (accessed on 14 May 2024)
11. Ministry of Power (2023). Speeding up Hydro Power: Central Electricity Authority Fast-tracks Approval Mechanism for Pumped Storage Projects. Posted On: 08 JUN 2023 by PIB Delhi. Available at: https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1930831 (accessed on 14 May 2024).
12. NREL (2020). A Comparison of the Environmental Effects of Open-Loop and Closed-Loop Pumped Storage Hydropower. US Department of Energy. April 2020. Available at: https://www.energy.gov/sites/prod/files/2020/04/f73/comparison-of-environmental-effects-open-loop-closed-loop-psh-1.pdf (accessed on 14 May 2024)
13. PNNL (2020). Open or Closed: Pumped Storage Hydropower is on the Rise. Pacific Northwest National Laboratory (PNNL). Available at: https://www.pnnl.gov/news-media/open-or-closed-pumped-storage-hydropower-rise (accessed on 14 May 2024)
14. Ridder, K. (2017). Hydropower Storage: All it's pumped up to be? The Appalachian Voice. Available at: https://appvoices.org/2017/12/06/pumped-storage/ (accessed on 14 May 2024)
15. Shankar, A., Saxena, A. K., and Mazumdar, R. (2023). Pumped Storage Plants – Essential for India's Energy Transition. New Delhi: The Energy and Resources Institute. Available at: https://www.teriin.org/sites/default/files/2024-01/Pumped_Storage%20_Plants_Discussion_Paper_2023.pdf (accessed on 14 May 2024)
16. Stocks, M., Stocks, R., Lu, B., Cheng, C., and Blakers, A. (2020). Global Atlas of Closed-Loop Pumped Hydro Energy Storage. Australian National University, December 2020. Available at: https://www.cell.com/joule/fulltext/S2542-4351(20)30559-6?_returnURL=https%3A%2F%2Flinkinghub.elsevier.com%2Fretrieve%2Fpii%2FS2542435120305596%3Fshowall%3Dtrue#%20 (accessed on 14 May 2024)
17. Weber, T., Stocks, R., Blakers, A., Nadolny, A., and Cheng, C. (2024). A global atlas of pumped hydro systems that repurpose existing mining sites. Australian National University. Renewable Energy. Volume 224, April 2024, 120113. Available at: https://www.sciencedirect.com/science/article/pii/S0960148124001782?via%3Dihub (accessed on 14 May 2024)

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