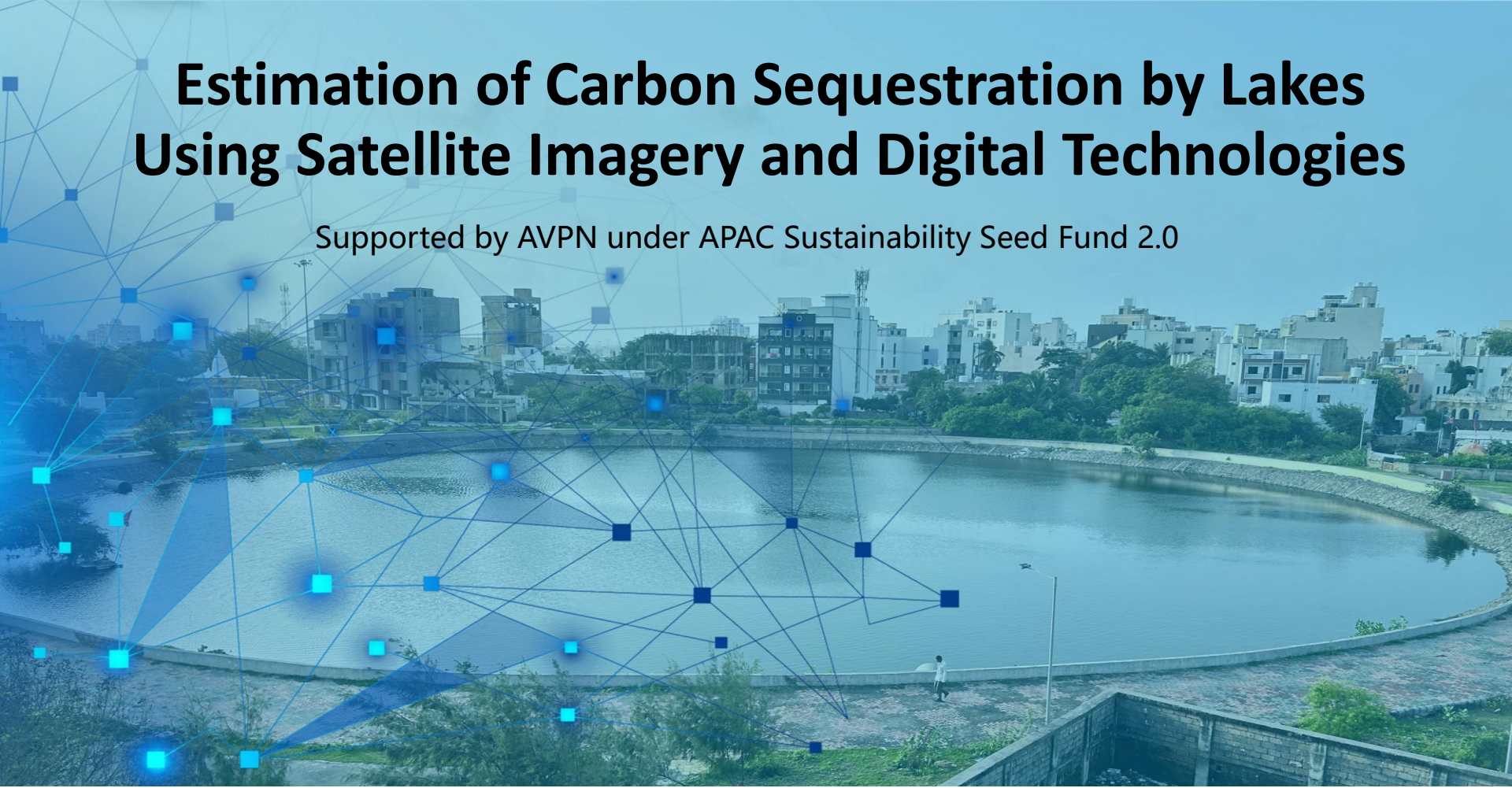
Estimation of Carbon Sequestration by Lakes Using Satellite Imagery and Digital Technologies

Supported by AVPN under APAC Sustainability Seed Fund 2.0



CWAS CENTER FOR WATER AND SANITATION | CRDF CEPT RESEARCH AND DEVELOPMENT FOUNDATION | CEPT UNIVERSITY

About Us

CEPT University's core focus is human habitat. Through its education, research and advisory activities, it strives to improve the impact of habitat professions in enriching the lives of people in India's villages, towns and cities.

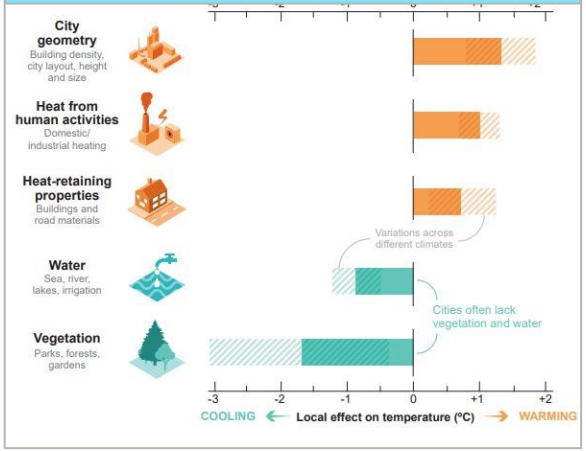
CEPT Research and Development Foundation (CRDF) has been established by the University to manage their research and capacity building activities. There are nine domain-focused centers in the CRDF. The Center for Water and Sanitation (CWAS) is among the first center to be established.

CWAS began its work in 2009 with focus on improving water and sanitation services in India. It carries out activities related to action research and capacity building – working closely with city and state governments, enabling them to improve delivery of services.

Lakes are important in context of climate change

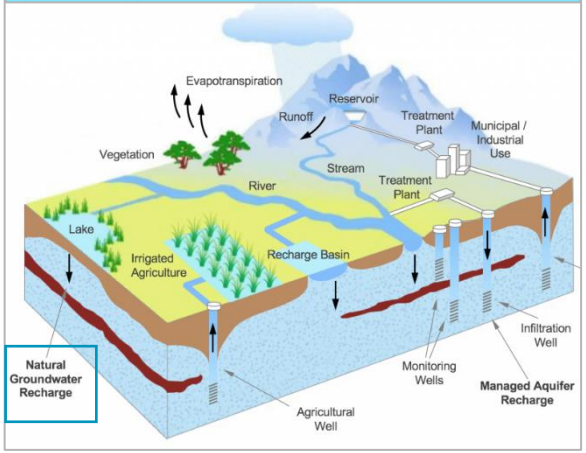
For influencing urban water ecosystems…

Regulating urban temperatures



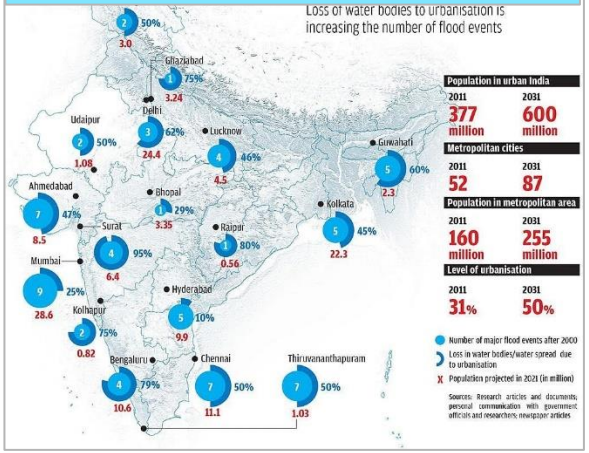
Intergovernmental Panel on Climate Change (IPCC). (2023). Linking Global to Regional Climate Change. In Climate Change 2021 – The Physical Science Basis: Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (pp. 1363–1512). chapter, Cambridge: Cambridge University Press.

Groundwater recharge and maintaining water cycle



INOWAS, accessed from inowas.com, Feb 2025. (adapted from California Department of Water Resources)

Stormwater drainage and reduced risk of flooding

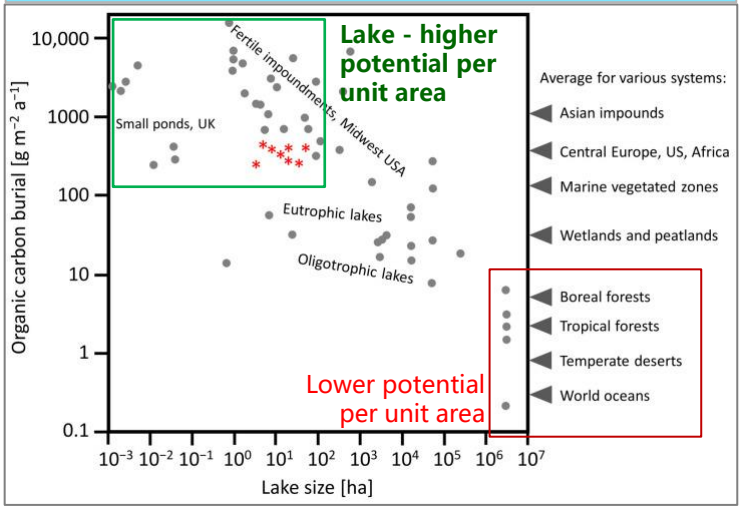


Source: Two sides of the same coin: Shrinking water bodies and urban floods, Down to Earth, August 2020

Lakes are important in context of climate change

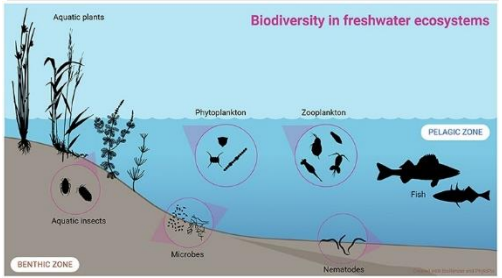
For Climate Change mitigation…

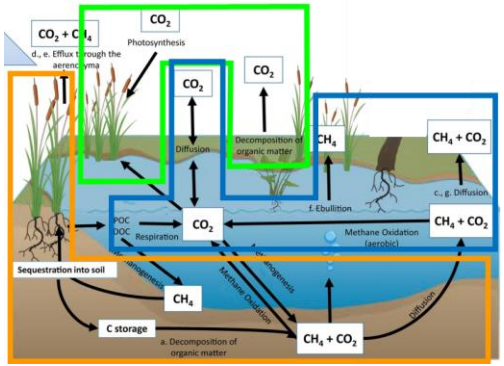
High potential of carbon sequestration in lakes



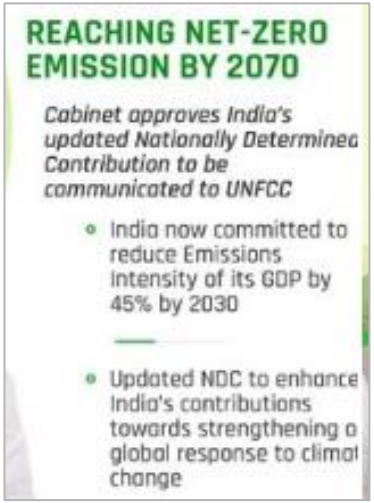
Skwierawski A. (2022). Carbon Sequestration Potential in the Restoration of Highly Eutrophic Shallow Lakes. International journal of environmental research and public health, 19(10), 6308. https://doi.org/10.3390/ijerph19106308

Lakes further support other ecological elements that also sequester carbon

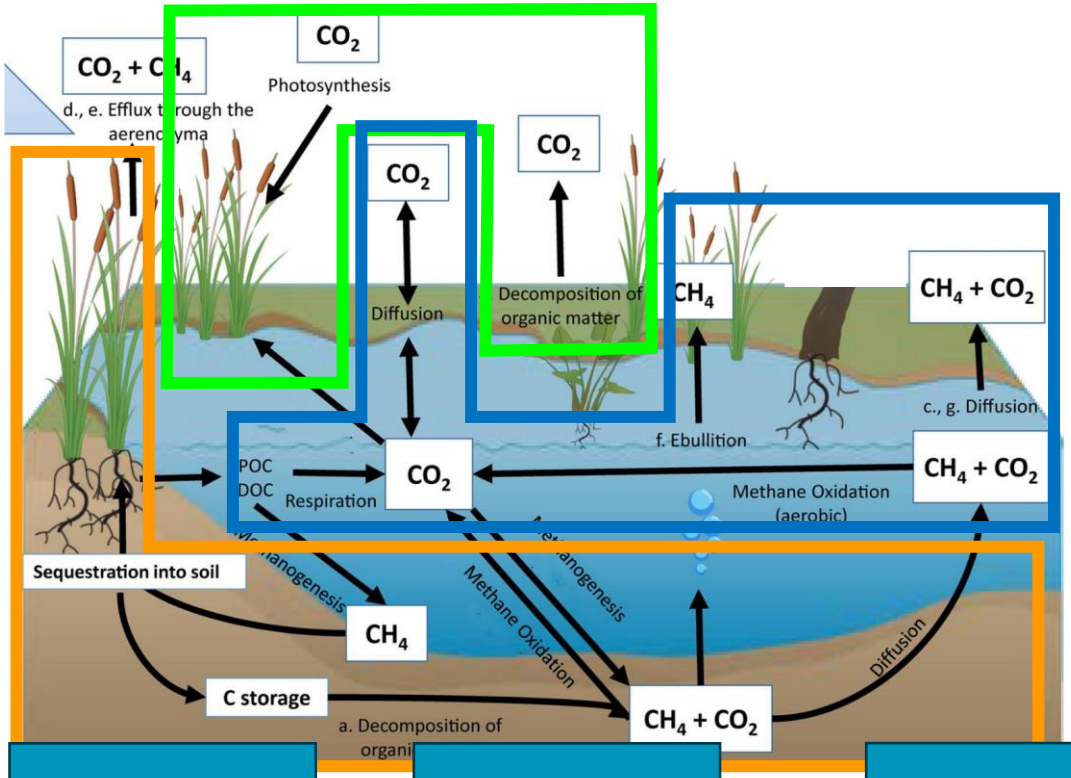




Focus on water bodies - nature based solutions for carbon neutrality?



Carbon sequestration pathways in lakes



1. Photosynthesis by aquatic plants and algae

- Aquatic plants and algae absorb CO_2 from the atmosphere and water during the process of photosynthesis.
- They convert CO_2 into organic carbon in the form of biomass (plant material) and store it.

2. Sedimentation of organic matter and dissolved organic carbon

- When plants, algae, and other living organisms die, they settle at the bottom of the lake as sediment.
- Over time, the organic carbon in this material gets buried in the sediment and becomes part of long-term carbon storage in lakes
- Some organic carbon dissolves in the lake water and can be transported to the lake through rivers, streams, and runoff from the surrounding land.
- This dissolved organic carbon can be buried in sediments or taken up by organisms in the lake.

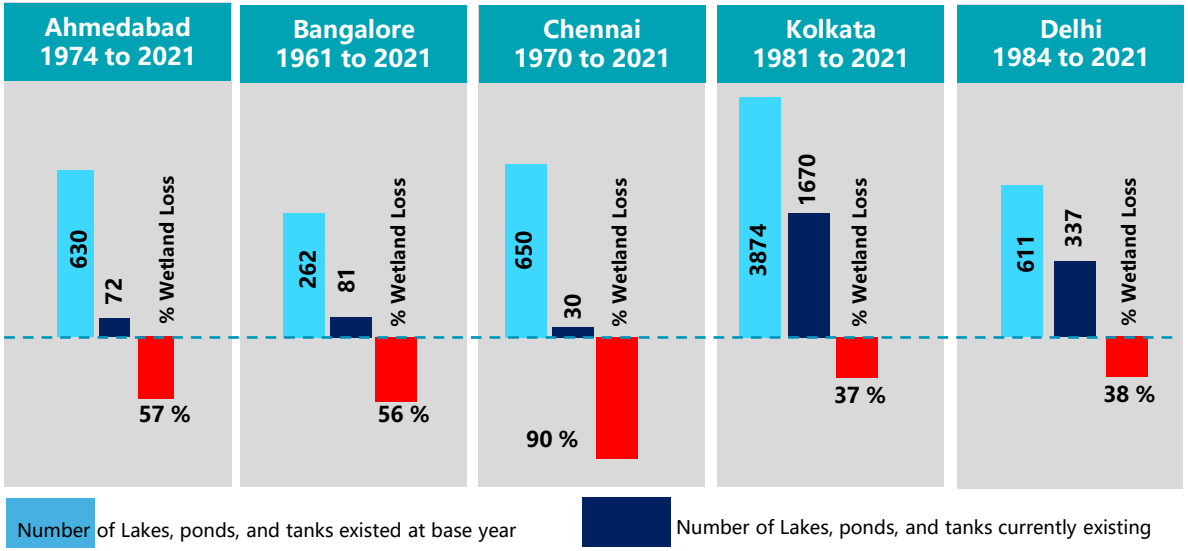
3. Dissolution of atmospheric CO_2 into the water

- CO_2 from the atmosphere dissolves into lake water and it forms carbonic acid. This further dissociates into bicarbonate and carbonate and gets stored into lake water. This process is influenced by the pH, temperature, and alkalinity of the lake.

Source: Spatiotemporal Variations in the Carbon Sequestration Capacity of Plateau Lake Wetlands Regulated by Land Use Control under Policy Guidance, August 2023

But lakes are degrading and require urgent attention!

- 70 % of surface water in India is unfit for consumption due to water pollution and contamination issues.
- **50 % of lakes across the globe** have **shrunk** from 1992 – 2021
- Degradation of lakes also linked to food insecurity and loss of livelihoods

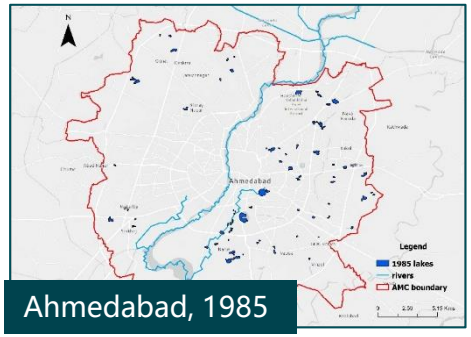


Source:
1. "Water Pollution Is Killing Millions of Indians. Here's How Technology and Reliable Data Can Change That." World Economic Forum, October 2019
2. Yao, Fangfang, et al. "Satellites Reveal Widespread Decline in Global Lake Water Storage." Science, vol. 380, no. 6646, 2023, pp. 146–150, May 2023
3. Nayak, P.K. Fisher communities in transition: understanding change from a livelihood perspective in Chilika Lagoon, India. Maritime Studies 16, 13 (2017)

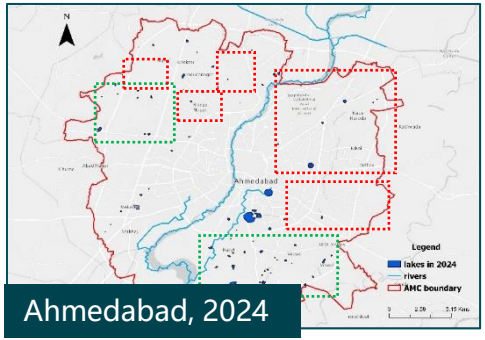
Source: 1. https://www.downtoearth.org.in/governance/as-told-to-parliament-august-5-2024-118-million-rural-households-provided-tap-water-connections-in-last-5-years; 2. https://www.indiatoday.in/india/story/exclusive-how-delhi-lost-its-own-lakes-1559937-2019-07-01; 3. https://www.deccanherald.com/science/disappearing-lakes-2154767; 4. Mondal, Biraj & Kumari, Suchitra & Ghosh, Arijit & Mishra, Prabuddh. (2022). Transformation and risk assessment of the East Kolkata Wetlands (India) using fuzzy MCDM method and geospatial technology. GEOGRAPHY ENVIRONMENT SUSTAINABILITY. 3. 191-203. 10.1016/j.geosus.2022.07.002. 5. https://www.hindustantimes.com/cities/india-lost-one-third-of-its-natural-wetlands-from-1970-to-2014/story-QmhTehlWAcep0cSHdbzufI.html#:~:text=According%20to%20the%20report%20released,%2C%20and%20Pune%20(37%25). 6. Dean, Walter E. and Gorham, Eville, "Magnitude and Significance of Carbon Burial in Lakes, Reservoirs, and Peatlands" (1998). USGS Staff -- Published Research. 299.

Lakes getting Disappeared!

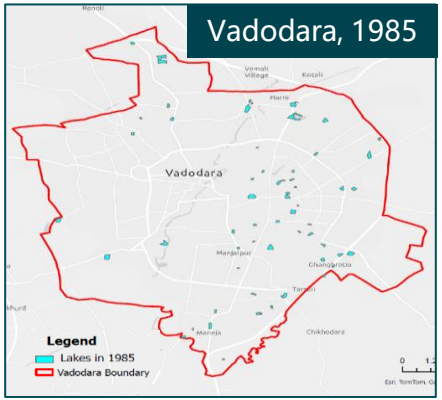
...but also, visible cases of lake conservation



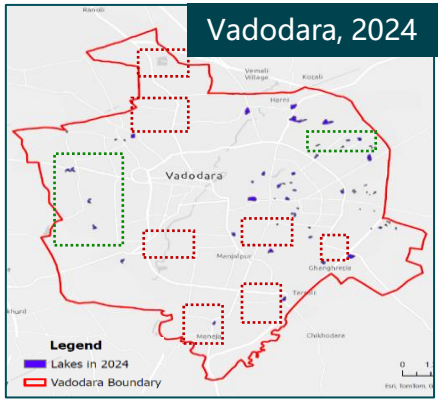
Ahmedabad, 1985



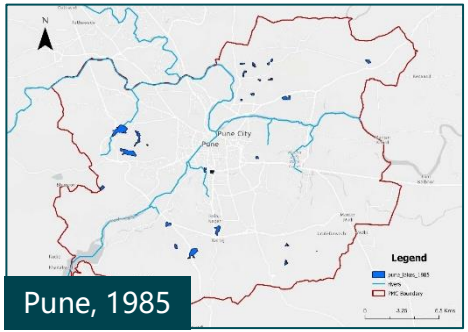
Ahmedabad, 2024



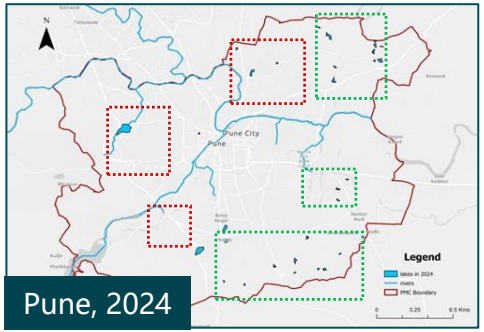
Vadodara, 1985



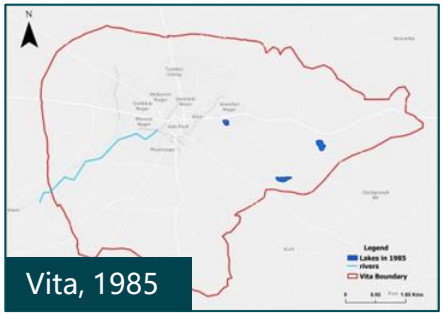
Vadodara, 2024



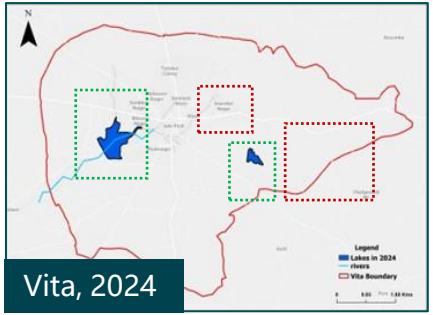
Pune, 1985



Pune, 2024



Vita, 1985



Vita, 2024

Reasons for degradation?

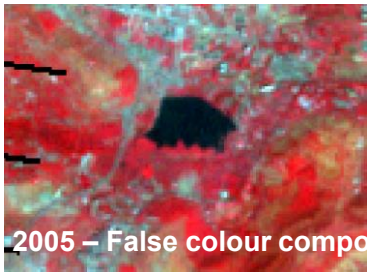
Dried up lake or real estate??

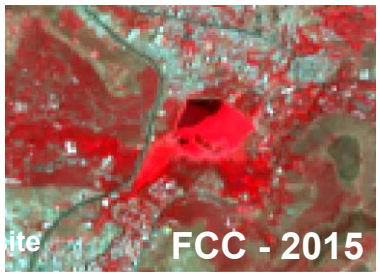
A case of a vanished Lake in Vadodara...

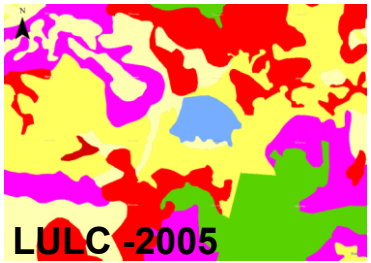
The Lake in the Bhayli area was converted into a residential project.

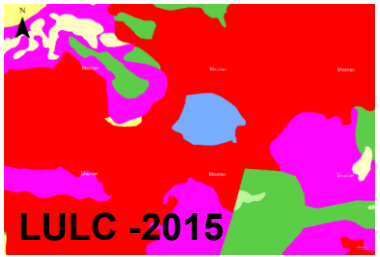
Source: Google earth imagery retrieved on 20 January 2025

Landuse change around the lake affected health- Case of Pashan Lake in Pune where the surrounding land use has changed from agricultural to built-up leading to eutrophication of lake. The surface area remains the same









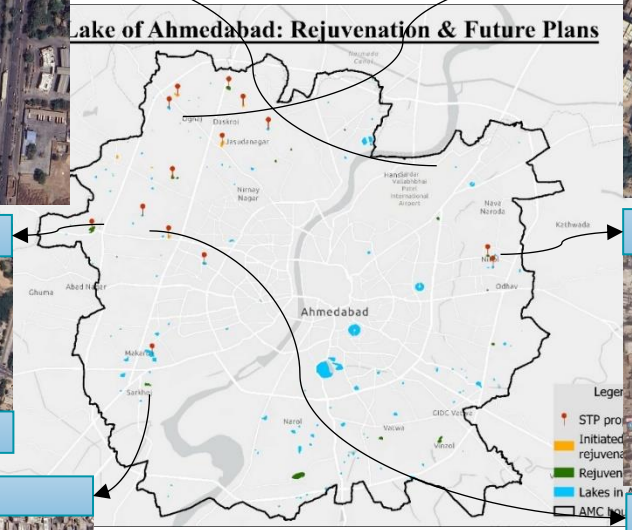
Shrinkage after rejuvenation? Need to focus on urban catchments

Lake rejuvenation – Fully Implemented

Case 1: Sajipur lake, Ahmedabad

Case 3: Shilaj lake, Ahmedabad

Case 2: Sarkhej Village lake, Ahmedabad



Lake rejuvenation – Actions Initiated

Case 1: Sola new lake, Ahmedabad

Case 2: Nikol lake – in rejuvenation since 2020

Case 3: Thaltej lake, Ahmedabad

- An internal report by AMC concluded that a major issue is lack of inclusion of water bodies in statutory plans.
- Another report by High Level Committee (HLC) on Urban Planning in Gujarat also noted that "redevelopment in most cases has happened by **reclamation of lake land** effectively reducing the overall water spread of the lake."

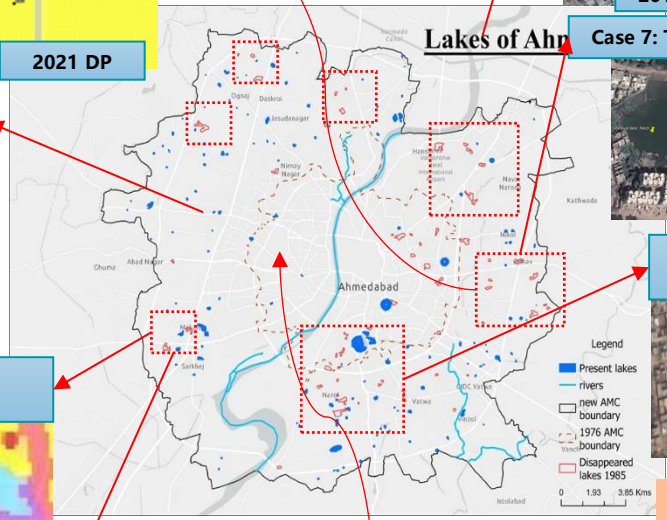
Why and how do lakes disappear?

Case 1: Kanetri lake, Nikol - Lake land encroached, not recognized in DP

Case 2: Thaltej lake - construction of boundary wall and removal of encroached areas.

Case 3: Navu Talav – Encoached & degraded lake, recognized in DP but no actions for maintenance

Case 4: Sakri lake – Shrunk due to less inflow



Case 5: Memnagar lake, maintained boundary but no inflow!

Case 6: Kamal Talav, Naroda – 2 lakes divided by drainage, one lake encroached, not recognized in DP

Case 7: Two lakes in Nikol – interrupted topography due to built up in center

Case 8: Sunthal Talav, Narol – Solid Waste Dumping, lake shrunk & dried

The issue with 4 major lakes (Vastrapur, Memnagar, Thaltej, and Sola) also recognized by the **National Green Tribunal in a** suo motu cognizance and **notice to** district officials, CPCB, GPCB - **total area of 4 major water bodies decreased by 46%**. Source: https://indianexpress.com/article/cities/ahmedabad/ngt-report-ahmedabads-disappearing-lakes-10116651/

- An internal report by AMC concluded that a major issue is lack of inclusion of water bodies in statutory plans.
- Another report by High Level Committee (HLC) on Urban Planning in Gujarat also noted that "redevelopment in most cases has happened by reclamation of lake land effectively reducing the overall water spread of the lake."

Defining and assessing lake health

What parameters define “health” of a lake?

Lake health is defined as the overall ecological, physical, and chemical state of a lake, which determines its ability to support biodiversity and sustain its functions over time. A healthy lake maintains a balanced ecosystem, supports diverse aquatic life, and provides clean water for various human and ecological needs.

“presence” of water

- Does the lake dry out in certain months?
- Is the dry period increasing?
- Is the average surface area coverage decreasing annually?
- Is the lake perimeter protected?
- Is the lake recognized in local land-use plans?

Use-case fitness

Water Quality Classes By Central Pollution Control Board, India

Class	Designated Best Use	Criteria
A	Drinking Water Source without conventional treatment but after disinfection	- Total Coliform Organism MPN/100ml ≤ 50 - pH: 6.5 – 8.5 - Dissolved Oxygen ≥ 6 mg/l - Biochemical Oxygen Demand (BOD, 5 days, 20°C) ≤ 2 mg/l
B	Outdoor bathing (Organised)	- Total Coliform Organism MPN/100ml ≤ 500 - pH: 6.5 – 8.5 - Dissolved Oxygen ≥ 5 mg/l - Biochemical Oxygen Demand (BOD, 5 days, 20°C) ≤ 3 mg/l
C	Drinking Water Source after conventional treatment and disinfection	- Total Coliform Organism MPN/100ml ≤ 5000 - pH: 6.0 – 9.0 - Dissolved Oxygen ≥ 4 mg/l - Biochemical Oxygen Demand (BOD, 5 days, 20°C) ≤ 3 mg/l
D	Propagation of Wild life and Fisheries	- pH: 6.5 – 8.5 - Dissolved Oxygen ≥ 4 mg/l - Free Ammonia (as N) ≤ 1.2 mg/l
E	Irrigation, Industrial Cooling, Controlled Waste Disposal	- pH: 6.0 – 8.5 - Electrical Conductivity at 25°C (µmhos/cm) ≤ 2250 - Sodium Absorption Ratio ≤ 26 - Boron ≤ 2 mg/l
<E	Not meeting A, B, C, D & E criteria	- —

Nutrient load, biomass and water quality

	Trophic State Index	Chlorophyll CHLA (µg/L)	Total Phosphorus TP (mgP/L)	Total Nitrogen TN (mgN/L)
Oligotrophic	0	0.3	0.003	0.06
	10	0.6	0.005	0.10
	20	1.3	0.010	0.16
	30	2.5	0.020	0.27
Mesotrophic	40	5.0	0.040	0.40
	50	10.0	0.094	0.70
	60	20.0	0.20	1.2
Eutrophic	70	40.0	0.40	2.0
	80	80.0	0.82	3.4
	90	160	0.34	5.6
	100	320	0.58	9.0

Water quality index

WQI value	Water Quality	Remarks
63-100	Good to Excellent	Non-Polluted
50-63	Medium to Good	Non-Polluted
38-50	Bad	Polluted
< 38	Bad to very Bad	Heavily Polluted

22 lakes selected across 6 cities for studying lake health

- Representing different climatic and geographic conditions
- Different population ranges
- Availability of accredited labs

Ahmedabad


Shilaj lake 71,580 m2


Makarba lake 96,400 m2


Chharodi lake 25,700 m2


Malek Saban 1,05,000 m2


Isanpur lake 32,405 Sq.m.

Pune

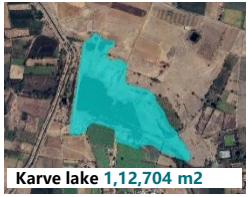

Pashan lake 6,06,134 m2


Katraj lake 92,068 m2


Jambhulwadi 3,27,270 m2

Vita


Vivekananda 3,34,688 m2


Karve lake 1,12,704 m2

Vadodara


Mahadev Talav 14,250 m2


Gotri lake 39,860 m2


Tarsali lake 26,150 m2


Vasna lake 19,100 m2


Sama lake 52,900 m2


Harni lake 85,101 m2

Anjar

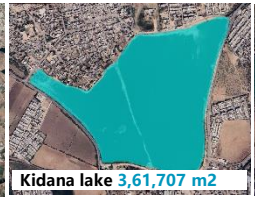

Savasar lake 33,700 m2


Satapar lake 11,230 m2


Toral Sarovar 8,860 m2

Gandhidham


Shinay lake 23,56,527m2


Kidana lake 3,61,707 m2


Galpadar Lake 94,350 m2

Note: Area of lakes has been estimated using satellite imagery on Google Earth for the period of February to April 2025. These are indicative estimates and not based on actual ground measurements.

Lab-based water quality tests for selected lakes

To understand lake health, water sampling and testing were carried out across 22 lakes in 6 cities, covering 21 water quality parameters. The sampling was conducted from December to July and has been planned systematically.

- From each lakes, two distinct points (opposite sides of the lakes) have been selected, from where water samples have been collected.
- For some of the larger lakes, **two to three individual samples were collected**, and a composite sample was prepared for each lake by mixing equal volumes of water from Point 1 and Point 2.

Challenges –

- **Frequent cloud cover** during Monsoon (July to September) **made scheduling of water testing difficult.**
- **Composite sampling points did not provide consistent results**; hence, as per the recommendation by experts, composite sampling was discontinued, and a **new distinct sampling location, P3** was introduced for direct collection to improve reliability.
- Due to algae growth and solid waste littering around selected sampling points, collection was bit difficult. However, wherever required, we changed the sampling points for those specific locations.

Water quality testing dashboards to understand trends and house lab data

By Water Quality Index,

The lake health can be analyzed by Water Quality Index values which is based on water quality parameters like calculation of pH, BOD, %DO Saturation, Fecal coliform and DO score.

WQI value	Water Quality	Remarks
63-100	Good to Excellent	Non-Polluted
50-63	Medium to Good	Non-Polluted
38-50	Bad	Polluted
< 38	Bad to very Bad	Heavily Polluted

City	Lake Name	Jan	Feb	Mar	Apr-May	Jun	Jul
Ahmedabad	Makarba						
	Chharodi						
	Isanpur lake						
	Malek Saban lake						
	Shilaj						
Pune	Pashan lake						
	Jambhulwadi						
	Katraj						
Vadodara	Sama						
	Gotri lake						
	Vasna Village lake						
	Mahadev lake						
	Tarsalilake						
	Harni lake						
Anjar	Sawasar Lake						
	Toral Lake						
	Satapar Lake						
Vita	Vivekanand lake						
	Karve lake						
Gandhidham	Galpadar lake						
	Shinay lake						
	Kidana lake						

By Central Pollution Control Board, India

Depending on the water quality parameter ranges, their dedicated usage is allotted, and the lake health is monitored. CPCB has categorized 5 classes of lakes mentioned below.

CPCB class	Designated Best-Use
A	Drinking Water Source Without Conventional Treatment after Disinfection
B	Outdoor Bathing
C	Drinking Water Source after Conventional Treatment and disinfectio
D	Propagation of Wildlife and Fisheries
E or Below-E	Irrigation, Industrial Cooling, Controlled Waste Disposal

City	Lake Name	Jan	Feb	Mar	Apr-May	Jun	Jul
Ahmedabad	Makarba						
	Chharodi						
	Isanpur lake						
	Malek Saban lake						
	Shilaj						
Pune	Pashan lake						
	Jambhulwadi						
	Katraj						
Vadodara	Sama						
	Gotri lake						
	Vasna Village lake						
	Mahadev lake						
	Tarsali lake						
	Harni lake						
Anjar	Sawasar Lake						
	Toral Lake						
	Satapar Lake						
Vita	Vivekanand lake						
	Karve lake						
Gandhidham	Galpadar lake						
	Shinay lake						
	Kidana lake						

- An **interactive dashboard** developed for **lake-wise and city-wise analysis**. It presents the Water Quality Index (WQI) and CPCB classification based on key parameters such as DO, pH, BOD, COD, Total Coliform, and Fecal Coliform.

Scaling solution using Satellite Imagery and Digital Technologies

Application of remote sensing techniques for lakes

Water Quantity

NDWI, or Normalized Difference Water Index,

is a remote sensing index that uses spectral bands from satellite imagery to identify and quantify the presence and amount of liquid water in water bodies. Water strongly absorbs visible light (Green band) and reflects less in the NIR (near infrared) band, resulting in high values for water bodies.

Formula: (Green - NIR) / (Green + NIR)

MNDWI, or the Modified Normalized Difference Water Index improves upon NDWI by more effectively suppressing built-up land and other noise, leading to more accurate water extraction.

Floating Vegetation

NDVI, or Normalized Difference Vegetation Index,

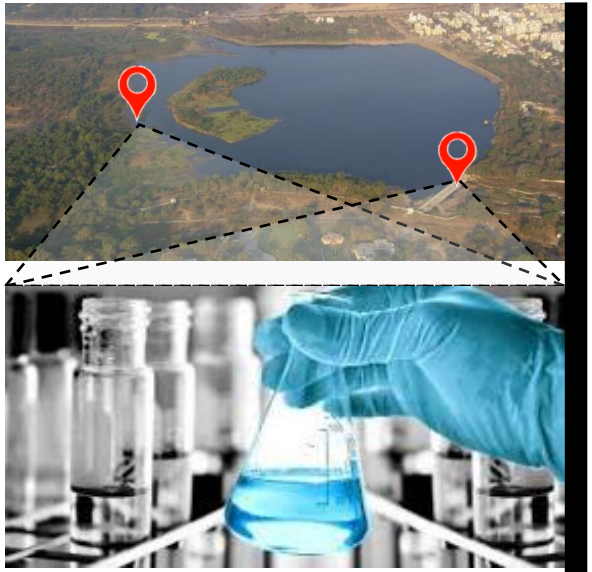
is a remote sensing technique that measures the health and density of vegetation. Healthy green vegetation absorbs strongly in the red light spectrum (used for photosynthesis) and reflects much more strongly in the near-infrared spectrum.

Formula:(NIR - Red) / (NIR + Red)

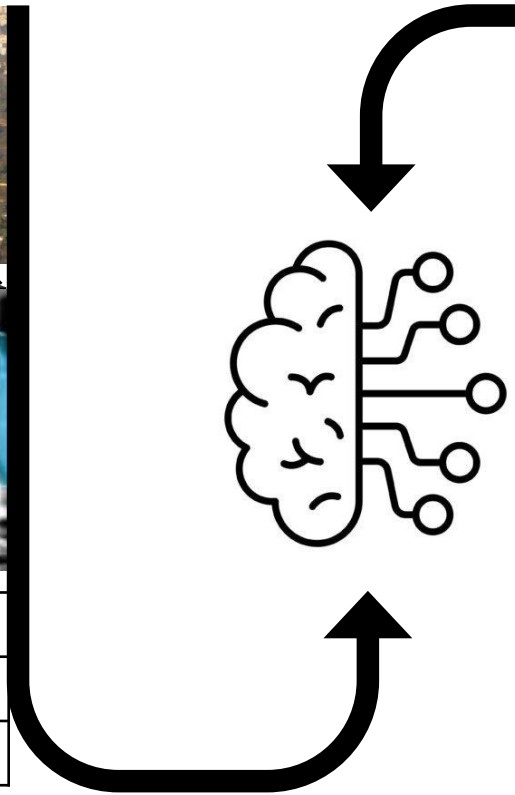
Water Quality

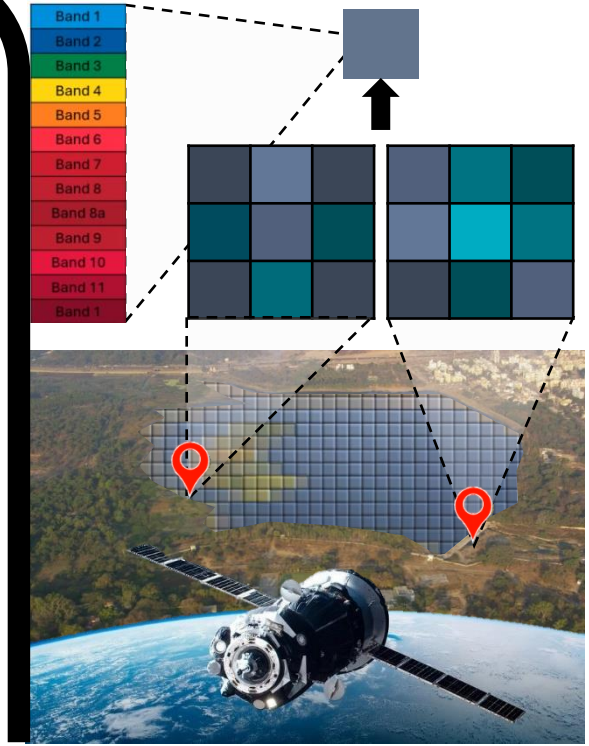
No.	Parameters	Research paper title	Source
1	pH	Satellite Imagery for Monitoring and Predicting Water Quality in Kutch Region	https://www.omdena.com/blog/satellite-imagery-for-water-quality-monitoring - April 2022
2	Dissolved Oxygen (DO)	Satellite Imagery for Monitoring and Predicting Water Quality in Kutch Region	https://www.omdena.com/blog/satellite-imagery-for-water-quality-monitoring - April 2022
3	Chlorophyll-A	Normalized difference chlorophyll index: A novel model for remote estimation of chlorophyll-a concentration in turbid productive waters	https://doi.org/10.1016/j.rse.2011.10.016 - Sachidananda Mishra, Deepak R. Mishra, November 2011
4	Total Suspended Solids (TSS)	Calibration and validation of a generic multisensor algorithm for mapping of total suspended matter in turbid waters	https://doi.org/10.1016/j.rse.2009.11.022 - B. Nechad, K.G. Ruddick, Y. Park, January 2010
5	Dissolved Organic Carbon (DOC)	Estimation of water quality in a reservoir from Sentinel-2 MSI and Landsat-8 OLI sensors	https://doi.org/10.5194/isprs-annals-V-3-2020-401-2020 Fernanda M. C. Pizani, Philippe Maillard, Adrielly F. F. Ferreira, Camila C. de Amorim, August 2020
6	Colored Dissolved Organic Matter (CDOM)		
7	Biochemical Oxygen Demand (BOD)	Water quality change in reservoirs of Shenzhen, China: detection using LANDSAT/TM data	https://doi.org/10.1016/j.scitotenv.2004.02.020 Yunpeng Wang, May 2004
8	Turbidity	Satellite remote sensing of water turbidity in Alqueva reservoir and implications on lake modelling	https://doi.org/10.5194/hess-16-1623-2012 M. Potes, M. J. Costa, R. Salgado, June 2012
9	Alkalinity	Surface pCO2 variability in two contrasting basins of North Indian Ocean using satellite data	https://doi.org/10.1016/j.dsr.2021.103665
10	Surface temperature	Algorithm for Automated Mapping of Land Surface Temperature Using LANDSAT 8 Satellite Data	https://doi.org/10.1155/2016/1480307 Ugur Avdan, February 2016
11	Salinity	Mapping water salinity using Landsat-8 OLI satellite images (Case study: Karun basin located in Iran)	https://doi.org/10.1016/j.asr.2019.12.007 Mohsen Ansari, Mehdi Akhoondzadeh, December 2019

Machine learning - Equating known water quality values with pixel colors in satellite images to build relationships



pH	DO	TDS	TSS
DIC	DOC	Nitrate	Phosphate
BOD	COD	Chlorophyll	Salinity





Testing different workflows to achieve accuracy

Estimating water quality

1. Using formulas from existing research — 1 month lab data
2. ML for calibrating only the coefficients on existing formulas — **40%** Training fit — 3 months lab data
3. ML training raw band values against lab tested values to develop fuzzy logic relationships

   Average band value of all pixels in lake area against average of known lab value of parameters from sampling location 1, 2 and composite

Ridge Regression model	Random forest model	XGBoost model
51% Training Accuracy	**35%** Training Accuracy	**80%** Training Accuracy

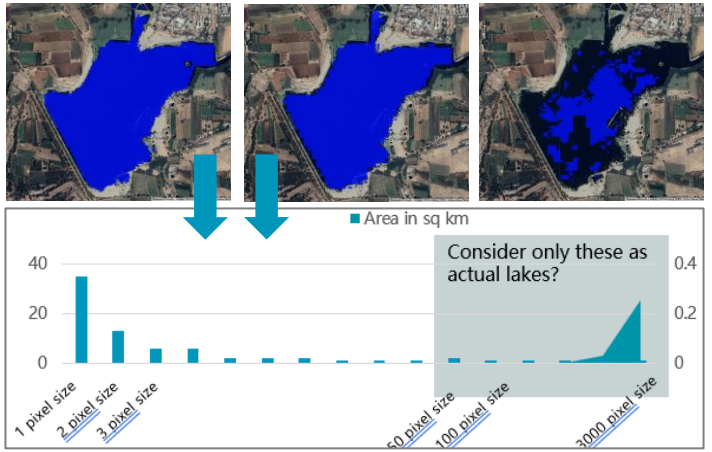
   4 months lab data
4. Combination of Random forest + XGBoost model
   Data cleaning to improve training accuracy. Removing ND / NA / BDL — **80%** Training fit — Training Accuracy
5. Regression model with RF with XGB + 50m Lake Area Buffer data — **87%** Training fit

   Limiting "unknown value" pixels to 50 m around the sample point instead of average full lake surface. This accounts for variations inside the lake and improvement in accuracy. Dropped composite samples for lab testing and increased point samples at each lake — 6 months lab data
6. Ensemble model / "Best of" model / Optimized ensemble

   Stacking results of different models to give balances results / selecting best fitted result of each model — **71%** Training fit
7. Multi output ensemble — 7 months lab data

Detecting water bodies

NDWI (Normalized Difference Water Index)	MNDWI (Modified NDWI)	AWEI (Automated Water Extraction Index)

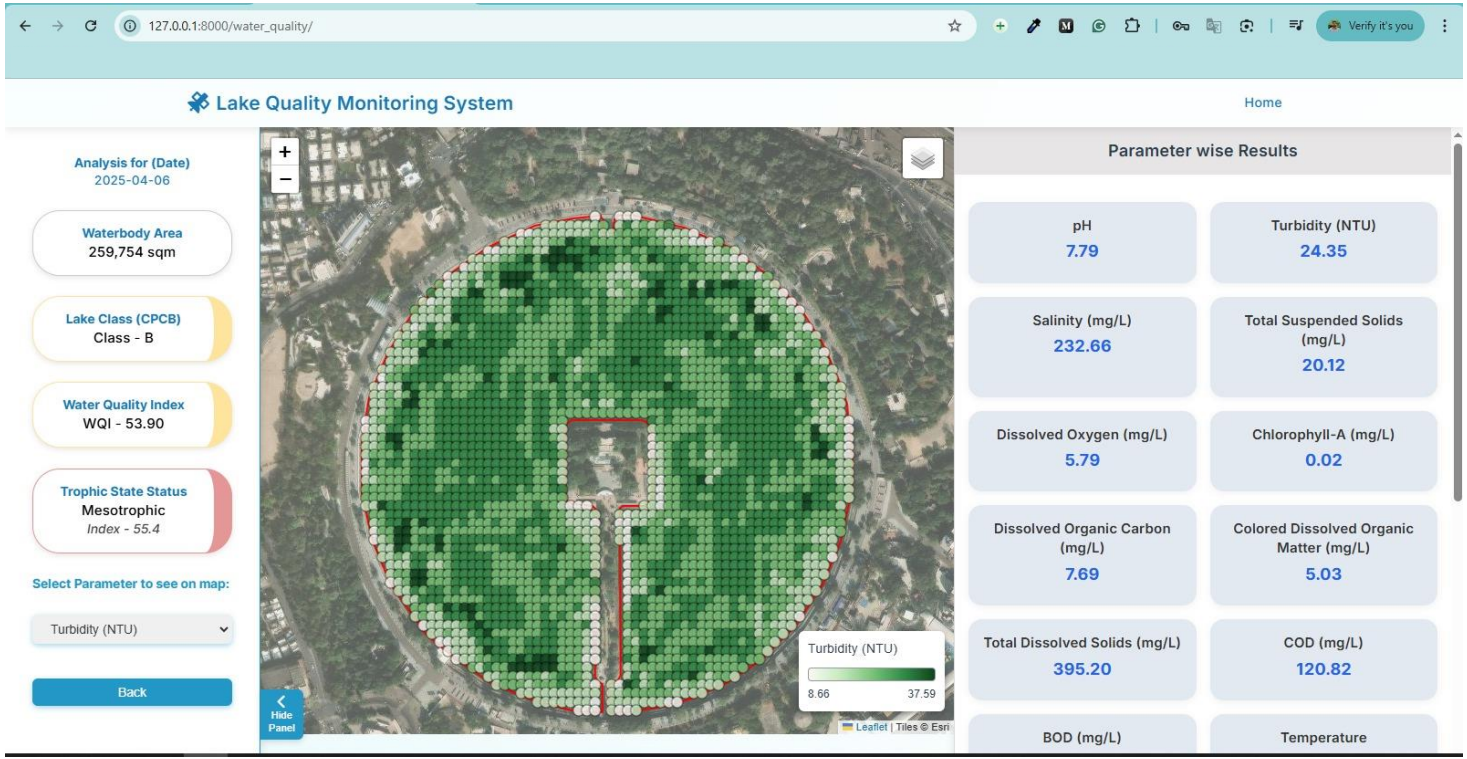


Stacking results and cross checking with Open Street Maps to remove detection of artificial pools

Improve by selection of localized threshold values – generate consistent and unbroken boundaries, accurate number of water bodies

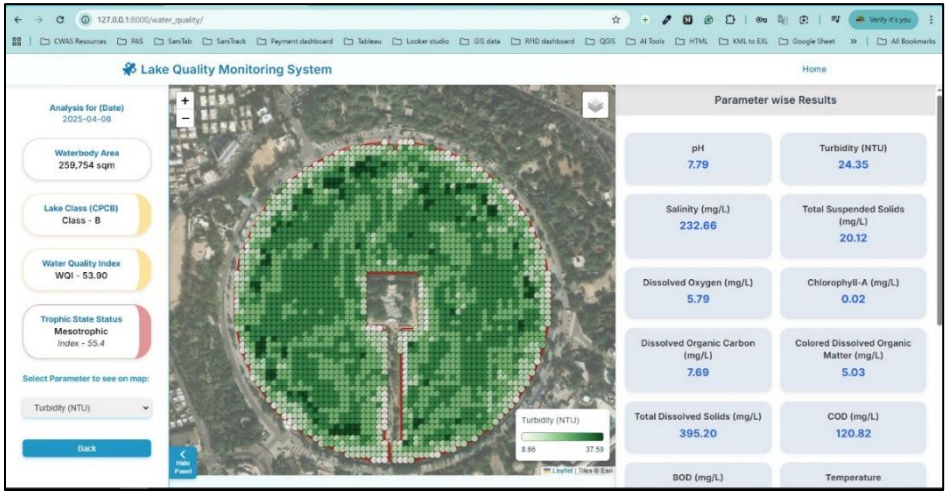
Developing a user friendly platform using Satellite Imagery

Tool showing water quality as per CPCB class, Water Quality Index (WQI) and area of the waterbodies identified as per satellite imagery.



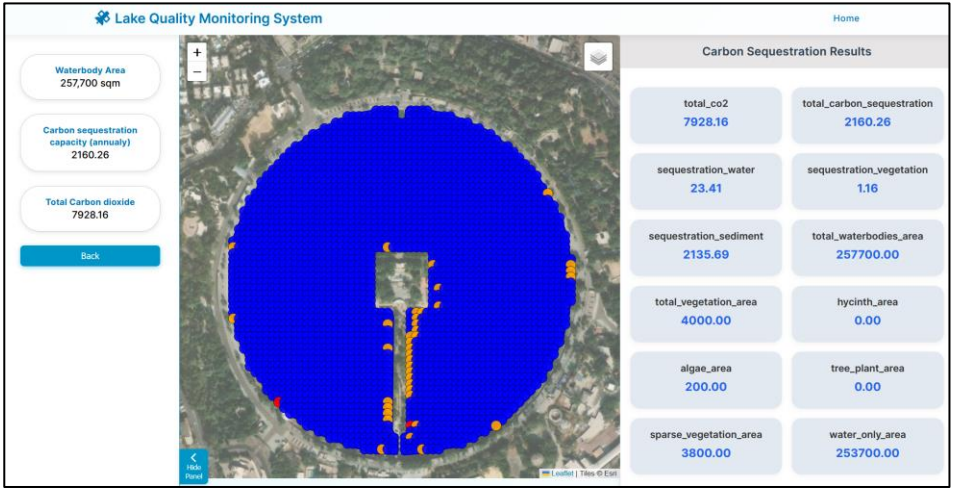
Analysis modules user development

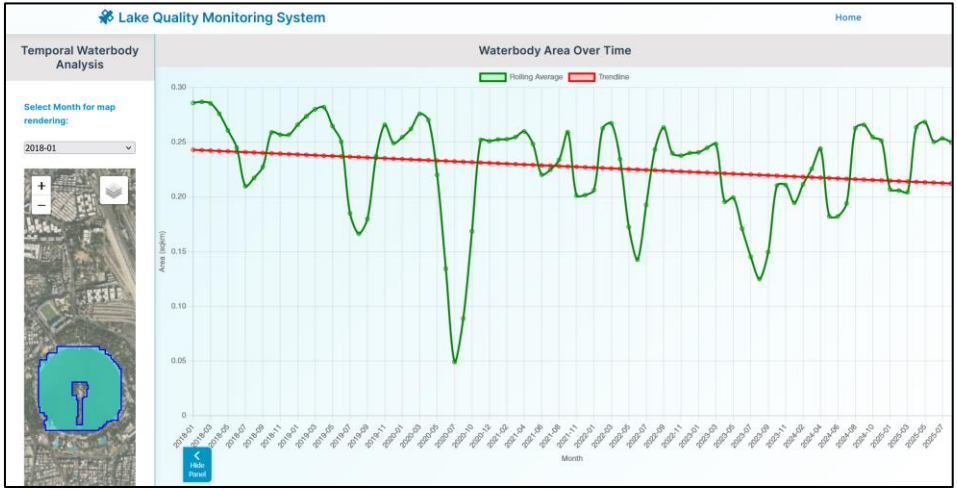
Spatio-temporal analysis – "detect" lakes → Water quality estimation + Sequestration potential calculation + Temporal prediction



Analysis modules user development

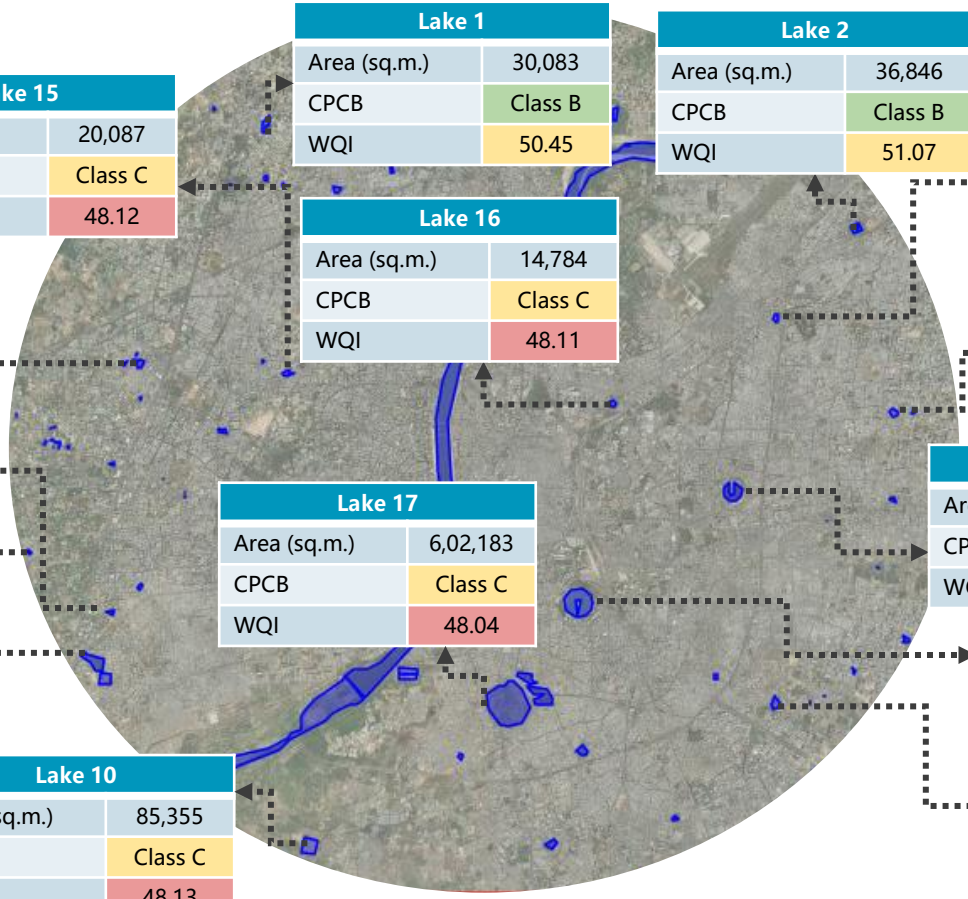
Spatio-temporal analysis – “detect” lakes → Water quality estimation + Sequestration potential calculation + Temporal prediction






What can these analysis modules do?

Lake water quality profile of a city



Lake 1	
Area (sq.m.)	30,083
CPCB	Class B
WQI	50.45

Lake 2	
Area (sq.m.)	36,846
CPCB	Class B
WQI	51.07

Lake 3	
Area (sq.m.)	11,520
CPCB	Class C
WQI	48.13

Lake 4	
Area (sq.m.)	23,251
CPCB	Class C
WQI	48.94

Lake 5	
Area (sq.m.)	
CPCB	Class C
WQI	48.84

Lake 6	
Area (sq.m.)	2,59,754
CPCB	Class B
WQI	53.72

Lake 7	
Area (sq.m.)	30,817
CPCB	Class B
WQI	51.09

Lake 10	
Area (sq.m.)	85,355
CPCB	Class C
WQI	48.13

Lake 11	
Area (sq.m.)	93,472
CPCB	Class B
WQI	52.07

Lake 12	
Area (sq.m.)	5,470
CPCB	Class C
WQI	48.76

Lake 13	
Area (sq.m.)	8,981
CPCB	Class C
WQI	48.46

Lake 14	
Area (sq.m.)	20,426
CPCB	Class C
WQI	49.18

Lake 15	
Area (sq.m.)	20,087
CPCB	Class C
WQI	48.12

Lake 16	
Area (sq.m.)	14,784
CPCB	Class C
WQI	48.11

Lake 17	
Area (sq.m.)	6,02,183
CPCB	Class C
WQI	48.04

Note: Lake water quality data shown here are indicative and used for demonstration purposes to illustrate how it can be used at scale to assess the water quality of all lakes in the city.

Temporal prediction - Will more lakes disappear in the future?

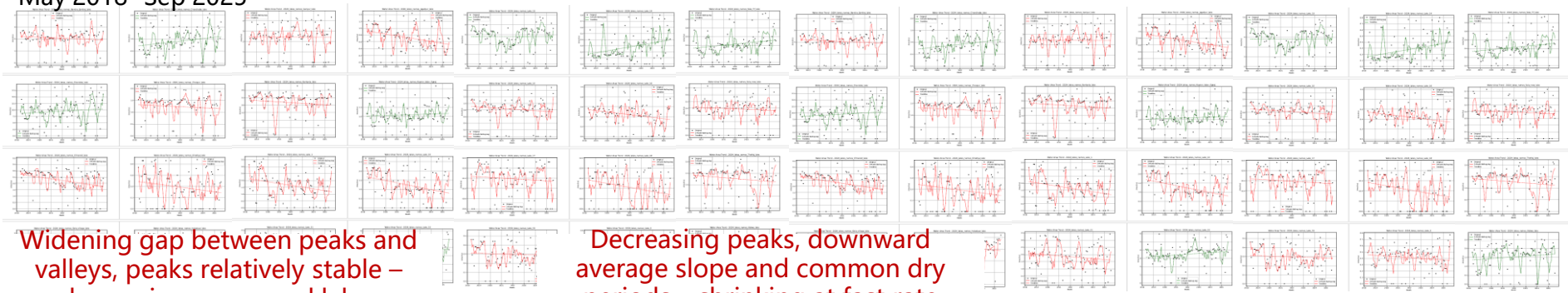
Checking temporal change in water spread for Ahmedabad - Selected 122 lakes

For each lake plotting monthly water surface area visible from 2018-2025 using NDWI nodule

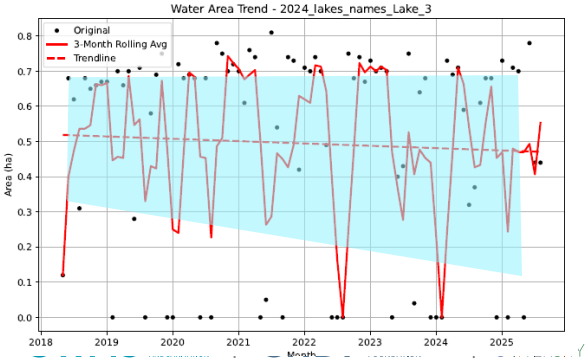
49 Lakes are showing positive trend (Increasing surface area)

73 Lakes are in danger (decreasing surface area trend)

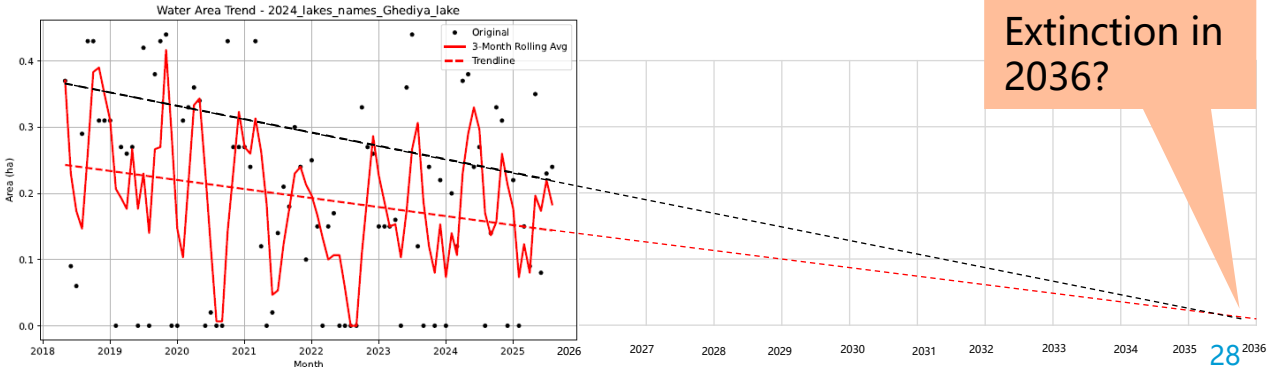
May 2018- Sep 2025



Widening gap between peaks and valleys, peaks relatively stable – becoming a seasonal lake



Decreasing peaks, downward average slope and common dry periods – shrinking at fast rate



Estimating carbon stock – Initial estimates for lakes

Sequestration by wetland vegetation

Area under vegetation × carbon conversion coefficient × biomass/ unit area

+

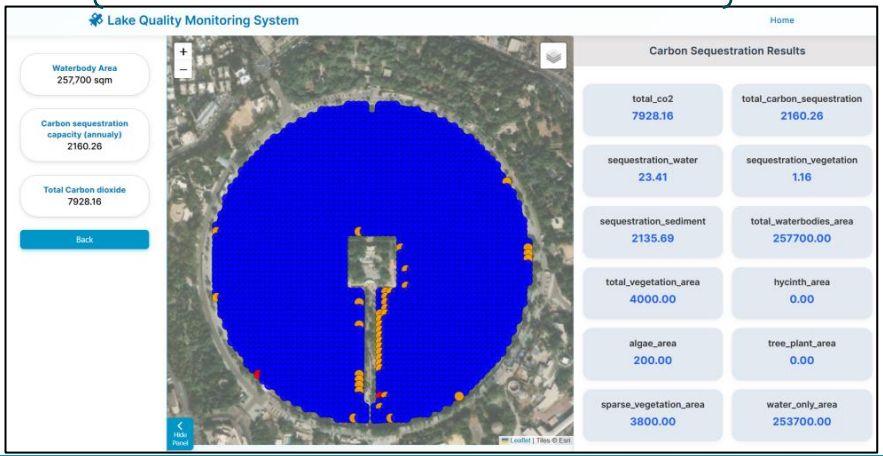
Sequestration in water

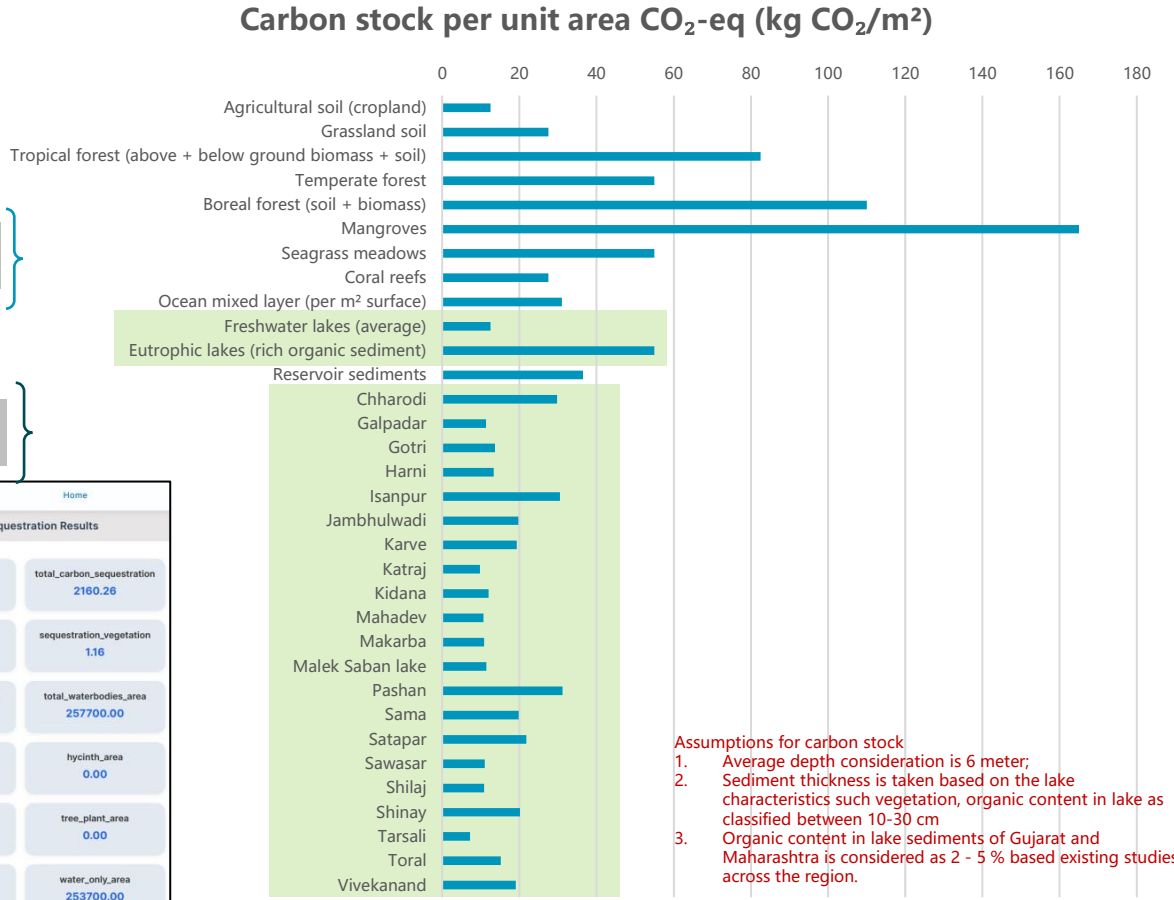
(dissolved organic carbon + dissolved inorganic carbon) × depth of lake × area of lake

+

Sequestration by wetland sediment

dry bulk density of sediments × thickness of sediment layer × organic carbon in sediment × area of sediment





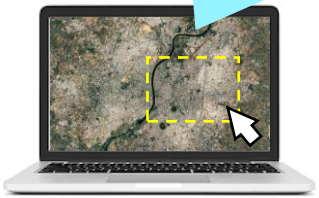
Assumptions for carbon stock

1. Average depth consideration is 6 meter;
2. Sediment thickness is taken based on the lake characteristics such vegetation, organic content in lake as classified between 10-30 cm
3. Organic content in lake sediments of Gujarat and Maharashtra is considered as 2 - 5 % based existing studies across the region.


What information do decision-makers need to take conservation actions?

Moving towards actionable insights that enable conservation measures

Select your area of interest



Remote sensing modules run in the background

Actionable insights translating results

Surface area of this lake is reducing year on year – **Check for encroachments**

High Nitrogen detected – **Check sewage outflows**

Dry lake this year – **Check for stormwater blockage**

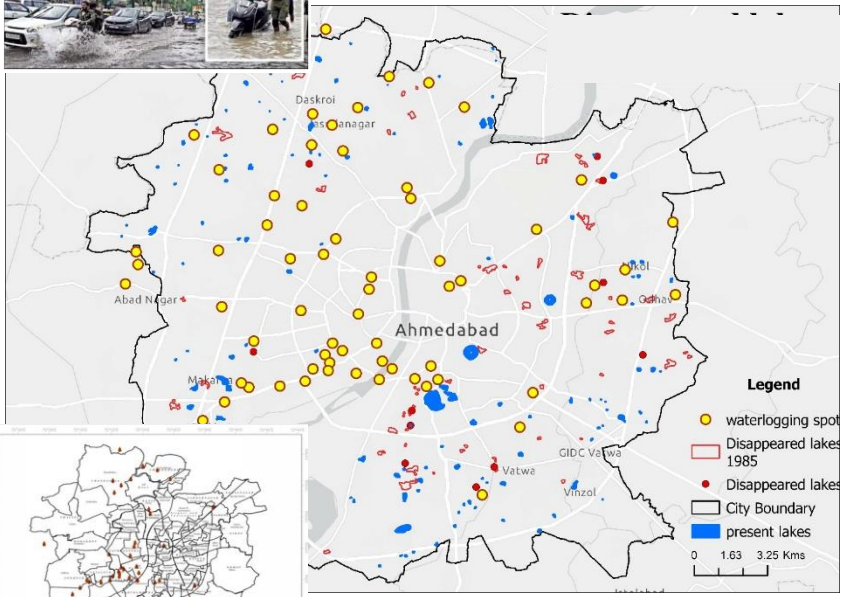
Prompting field visit, priorities in improvement planning and action by city

Measurable parameter	Potential cause	Potential improvement action
Area shrinkage and seasonal drying	Area Encroachment	Boundary and embankment protection, encroachment removal
High turbidity	Catchment breakdown	Catchment rejuvenation, stormwater management, de-siltation
High NDVI inside lakebed area	Siltation	Stormwater inflow debris traps
Low DO, High phosphorus/ nitrogen	Algal bloom	Buffer vegetation revival
High BOD, COD, Coliforms	Hyacinth invasion	Invasive specie removal
High potassium	Sewage inflow	Wastewater diversion or treatment
Alkaline pH	Solid waste dumping	Aeration mechanisms
Acidic pH	Industrial Effluents	Solid waste management
	Agricultural runoff	

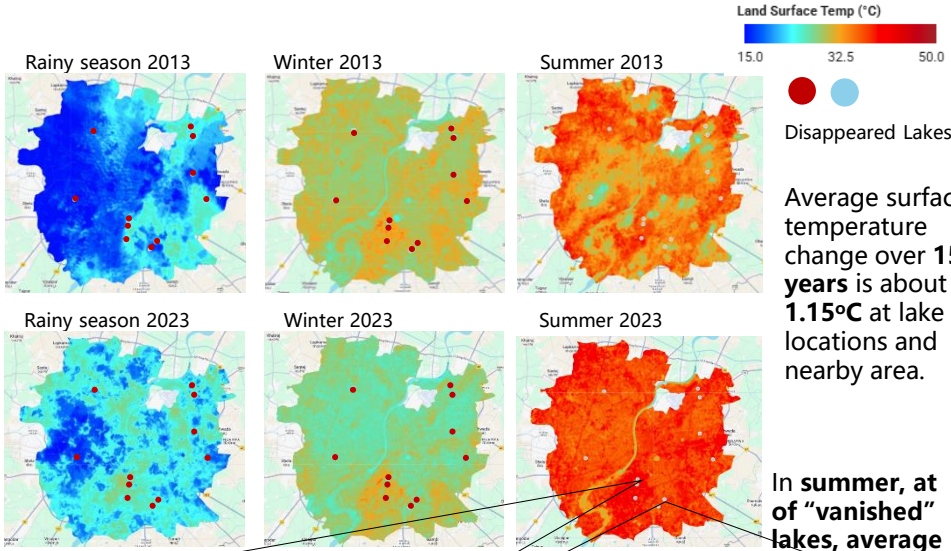
Further climate analysis possible for researchers

Lakes related to flood vulnerability?

Localities without lake buffers face flooding in monsoons

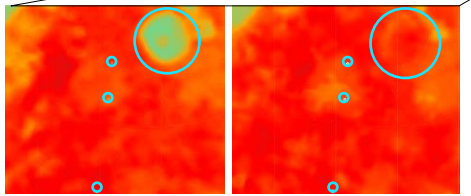


Urban temperatures linked to disappeared lakes?



Average surface temperature change over **15 years** is about **+ 1.15°C** at lake locations and nearby area.

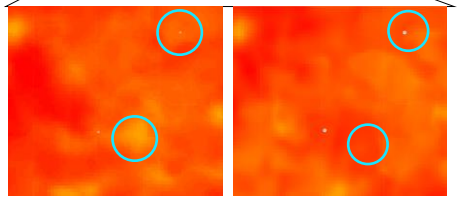
In **summer, at site of "vanished" lakes, average variation of +3.3°C**



Chandoliya and surrounding lakes, Ahmedabad

Summer 2009 - 29.2°C

Summer 2024 – 39.1°C



Bibi Talav, Ahmedabad

Summer 2009 - 35.7°C

Summer 2024 - 37.2°C

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Source1: https://timesofindia.indiatimes.com/city/ahmedabad/32-new-waterlogging-spots-in-ahmedabad-exacerbate-monsoon-troubles-for-residents/articleshow/113006828.cms | Source2: https://portfolio.cept.ac.in/2022/M/ft/geovisualization-and-spatial-analysis-studio-ge4004-monsoon-2022/study-of-flash-floods-a-case-study-of-ahmadabad-monsoon-2022-pge22459

Knowledge partnerships and stakeholder engagement

Urban Decision makers

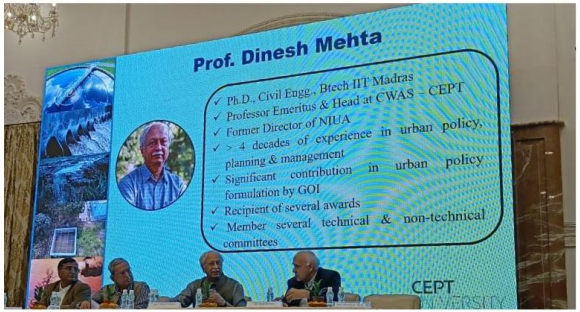
- Training of more than 500 municipal officials from over 400 cities of Maharashtra
- Training focussed on lake governance and showcasing the tool to understand their interest and get feedback
- Participants includes Municipal Engineers, technical supervisor and sanitary inspectors from the water works and sanitation departments of the cities of Maharashtra.
- Ahmedabad planning large scale water quality testing – interested in satellite image applications

Civil society organizations

- Engaged with stakeholders like local citizens and municipal officials at a seminar organised by SOCLEEN NGO in Vadodara.
- The participants expressed their interest in using such technology that simplifies complexity for lake management and supporting their lake conservation efforts.

Sector experts

- Abstract selected and workshop planned at IWA conference in December



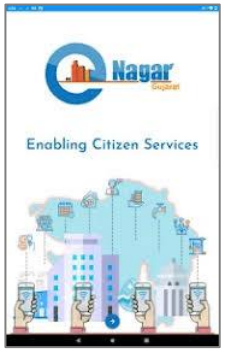
Enhanced capacity of the organisation

Enhancement of team capacity

- ✓ Understanding ML/AI industry methods, language
- ✓ Development of user-front end
- ✓ Understanding lake science - water quality parameters and trends
- ✓ Opportunity for flexible research project – different from regular grant/CSR projects

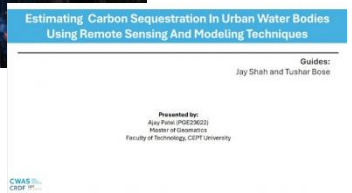
CWAS identity as a “tech enabler”

Invitation by Gujarat state (GUDM) to provide feedback on their e-services portal



Presentation to CEPT University students on “Emerging tech and urban services”

Student Research projects guided by CWAS team



Presentation at PDEU training program on “Future of Smart Cities: From Challenges to Hands-on Solutions through AI, and Technology”

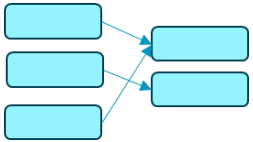
Way forward

Tool improvement

Continuing water quality testing to capture seasonal variability of monsoon and early winter.

Strengthening the training as well as estimation accuracy of machine learning models.

Developing the module of prediction of water quality parameters.



Developing module for "actionable-insights"

Knowledge partnership and Stakeholder engagement

Roundtables – Consultation with sector experts to validate methodologies

Feedback from users - city governments, citizen groups – and more training to incorporate in decision making process

Scaling up usage - Incorporating experience and introducing the tool in ongoing capacity building efforts under SBM, AMRUT and Majhi Vasundhara

स्वच्छ भारत

अमृत 2.0 Atal Mission for Rejuvenation and Urban Transformation

Lending credibility and reaching the right audiences – Integrating with ISRO's VEDAS portal

Visualisation of Earth Observation Data and Archival System
Space Applications Centre, ISRO

Digital Water HUB at CWAS

Leveraging CWAS knowledge of data systems and tech in urban spaces to enhance services

Thank you

CWAS CENTER FOR WATER AND SANITATION | CRDF CEPT RESEARCH AND DEVELOPMENT FOUNDATION | CEPT UNIVERSITY

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About us

The Center for Water and Sanitation (CWAS) is a part of CEPT Research and Development Foundation (CRDF) at CEPT University. CWAS undertakes action-research, implementation support, capacity building and advocacy in the field of urban water and sanitation. Acting as a thought catalyst and facilitator, CWAS works closely with all levels of governments - national, state and local to support them in delivering water and sanitation services in an efficient, effective and equitable manner.

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