HARNESSING TECHNOLOGY FOR SMART LAKE MANAGEMENT

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NEED TO FOCUS ON LAKE HEALTH FOR CLIMATE RESILIENCE

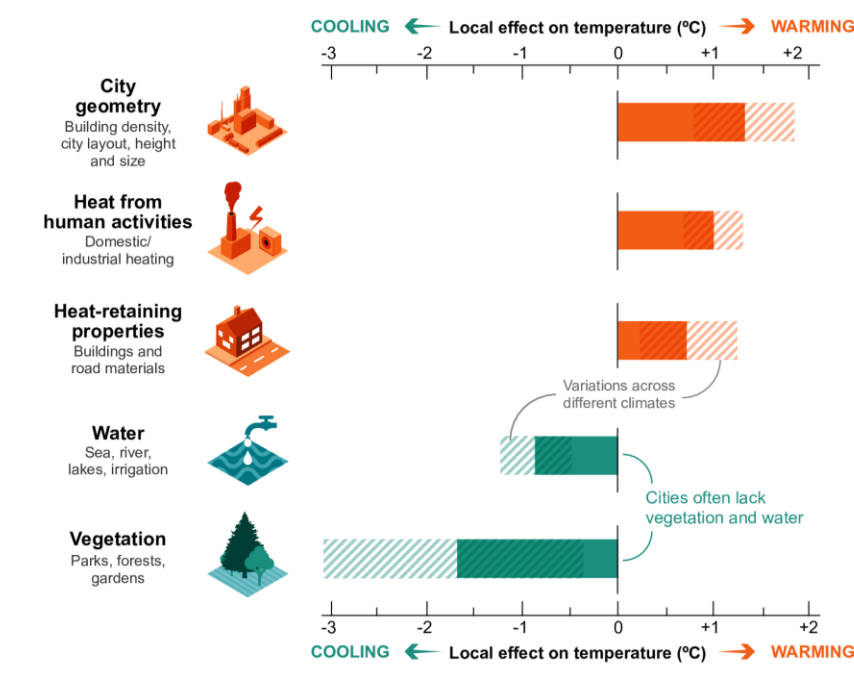### Natural cooling system, regulating urban temperatures

Figure 1 – Component impact on temperature (source: IPCC)

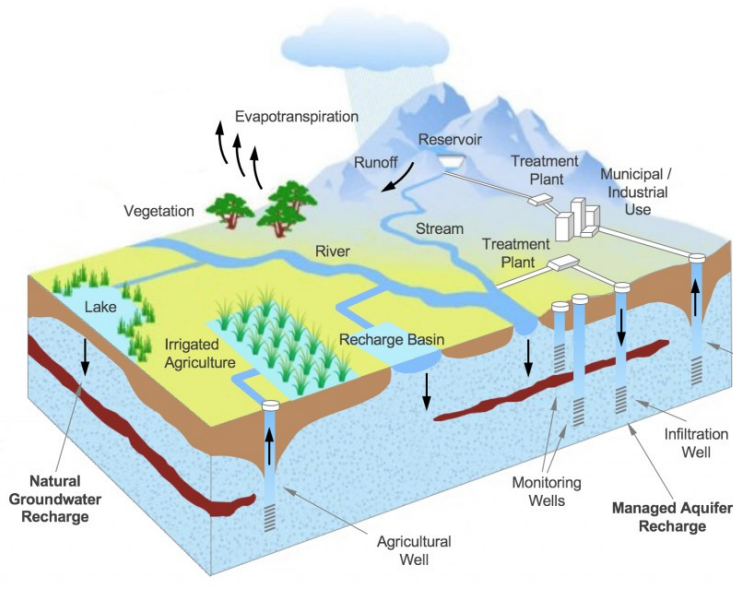### Groundwater recharge and maintaining water cycle

Figure 2 – Aquifer recharge (source: INOWAS)
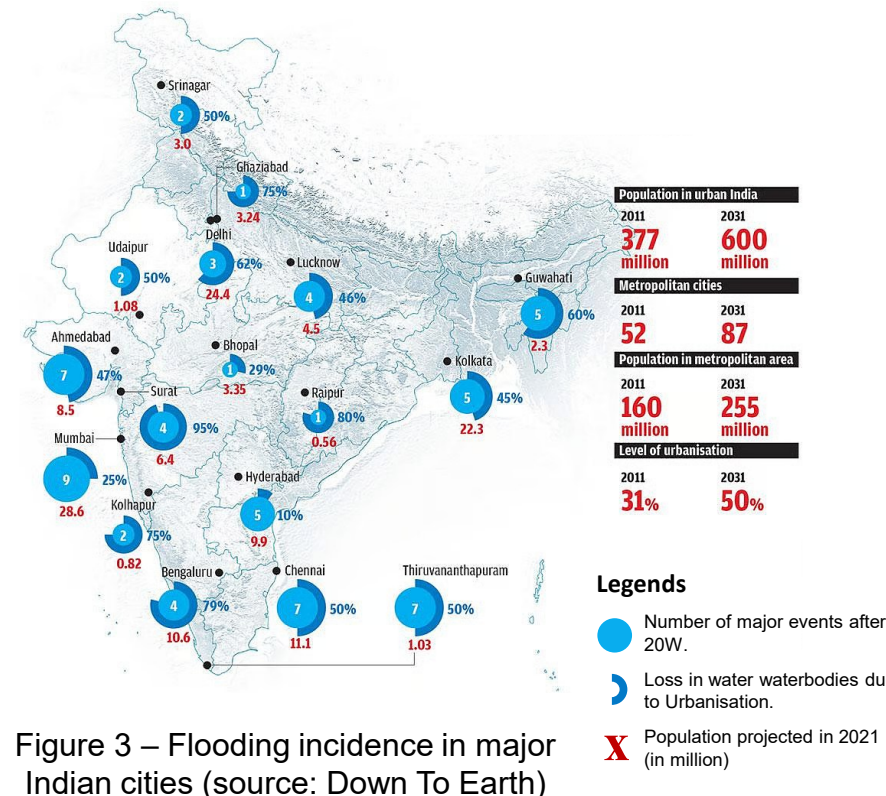
Control on urban flooding

Figure 3 – Flooding incidence in major Indian cities (source: Down To Earth)

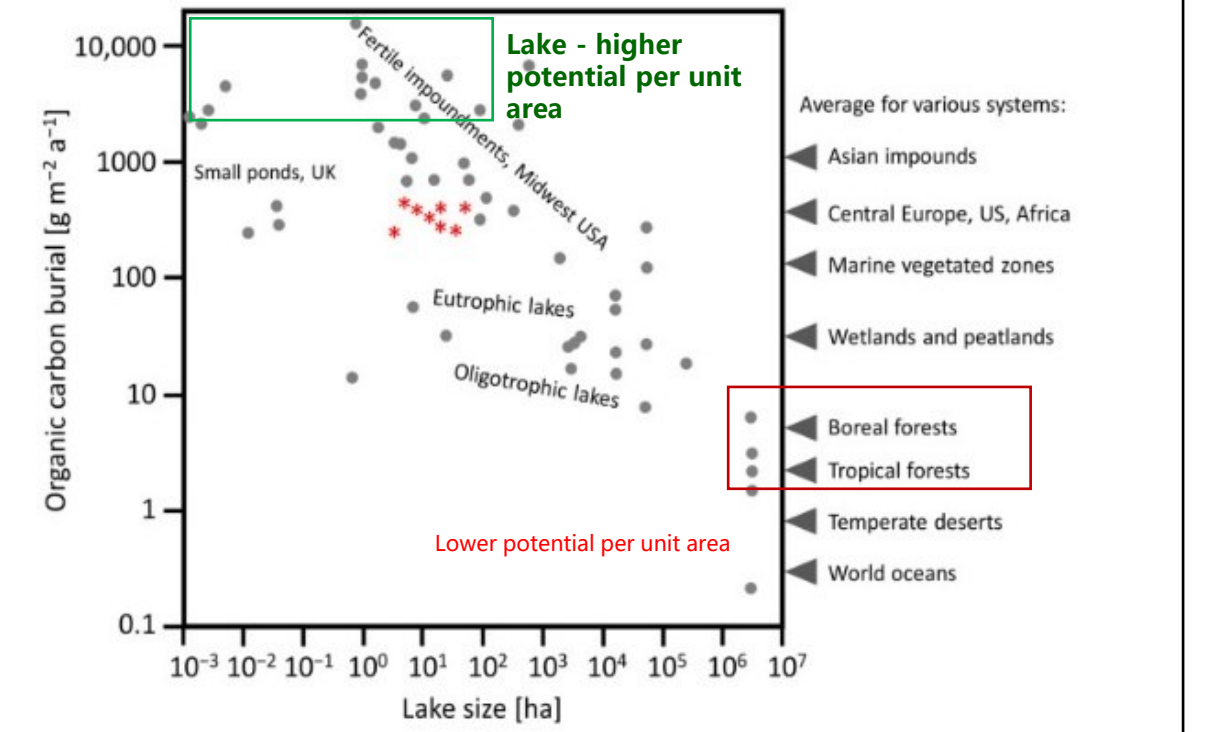### High potential of carbon sequestration - nature based solutions for carbon neutrality?

Figure 4 – Various ecosystem carbon sequestration potential (source: Skwierawski, 2022)
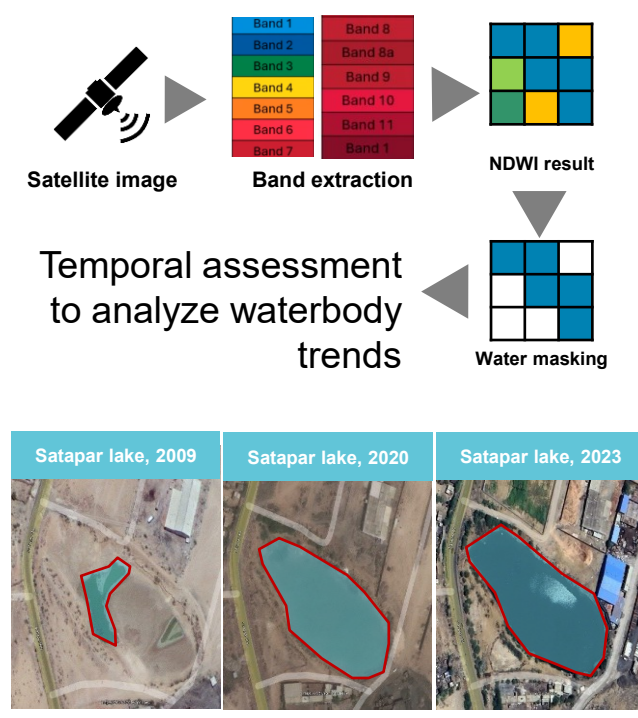
HARNESSING TECHNOLOGY FOR LAKE HEALTH MONITORING

1. Understanding Lake health

1. "presence" of water

2. Nutrient load, biomass and water quality parameters

3. Use-case fitness – CPCB quality classes

4. Water quality index

2. Remote Sensing lakes from satellite images

NDWI, or Normalized Difference Water Index - uses spectral bands from satellite imagery to identify and quantify the presence and amount of liquid water in water bodies.

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

NDVI, or Normalized Difference Vegetation Index, measures the health and density of vegetation.

3. Water Quality Assessment

Carrying out water quality testing of lake water on monthly basis to generate water quality database of 20 parameters for lakes.

• pH	• Chl-a	• BOD	• NO₃
• Turbidity	• DOC	• Temp	• K⁺
• Salinity	• CDOM	• DIC	• TP
• TSS	• TDS	• TOC	• TN
• DO	• COD	• TIC	• FC

Based on this developing Water Quality Index and analyzing the water quality and its usability through CPCB classes.

6 cities
22 Lakes
20 Parameters

4. Machine learning

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

Building on the results insight are being developed into an alert management system

ASSESSMENT FRAMEWORK

Institutions and Policies
Roles of local bodies, state agencies, and national policies

Integrated Approach
Linking urban planning, waste management, watershed conservation, and development plans with lake health.

Data & Technology Use
Remote sensing, and public dashboards for transparency and adaptive management.

Data truthing
Frequent water quality testing of selected lakes

Stakeholder Participations
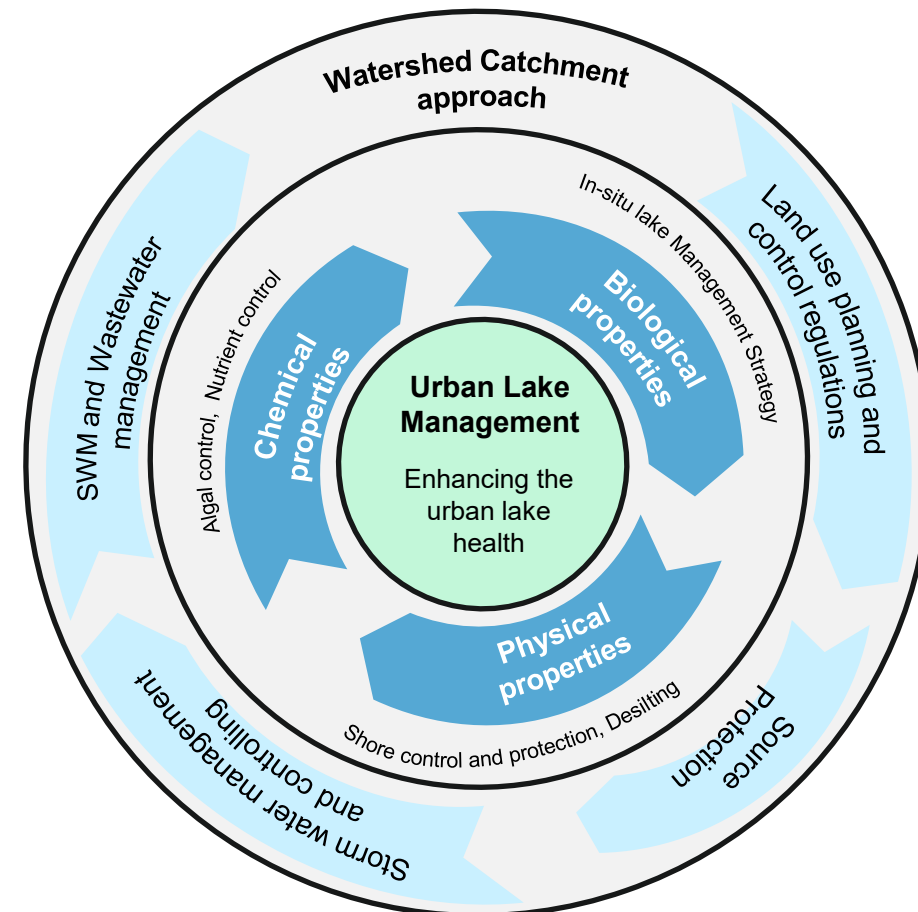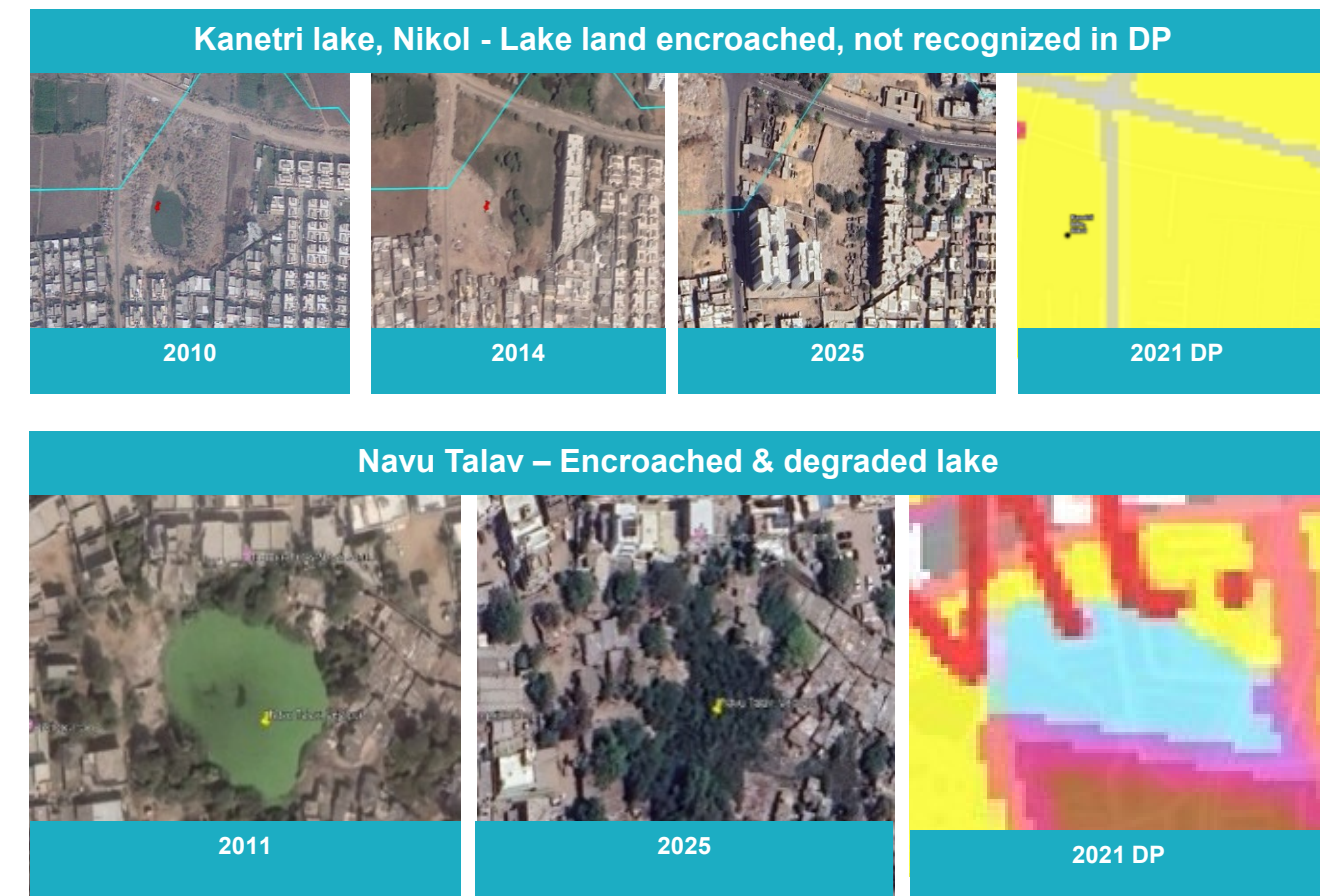Inclusion of communities, NGOs, researchers, and industries in decision-making

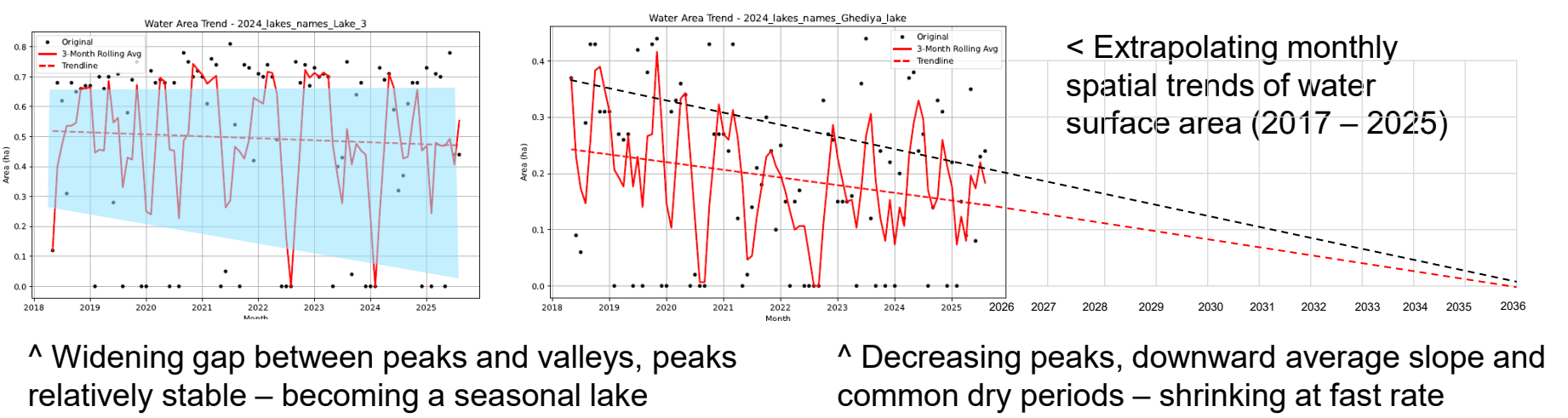Figure 5 – Lake assessment framework

ANALYSIS AND INSIGHTS

Comparing temporal changes in satellite images and development plans

Kanetri lake, Nikol - Lake land encroached, not recognized in DP
2010 | 2014 | 2025 | 2021 DP

<- Natural drainage system with lake in conjugation with seasonal stream was first disrupted due to road network development. As lake stopped filling up, the land was taken over for development. The land was not marked as a water body in the local development plan.

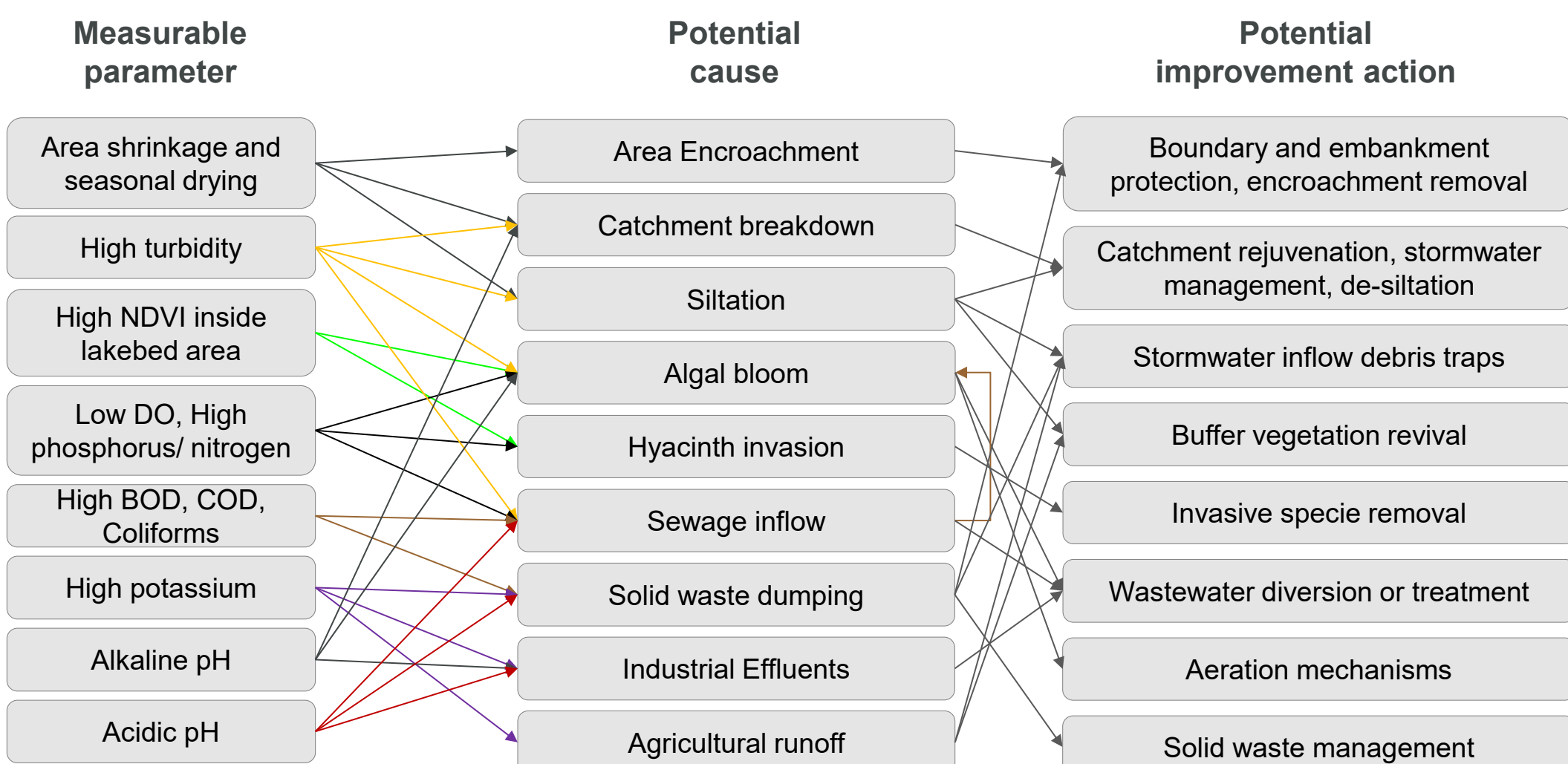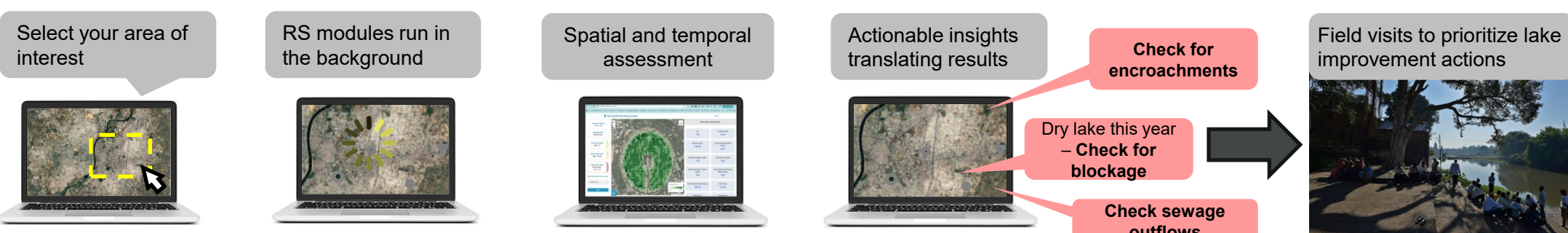Navu Talav – Encroached & degraded lake
2011 | 2025 | 2021 DP

<- Encroachment of lake by slum dwellers and unmonitored filling of land with construction waste led to disappearance of lake even though the land was protected as a water body in the development plan.

Predicting "lake extinction" with spatial trends

< Extrapolating monthly spatial trends of water surface area (2017 – 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
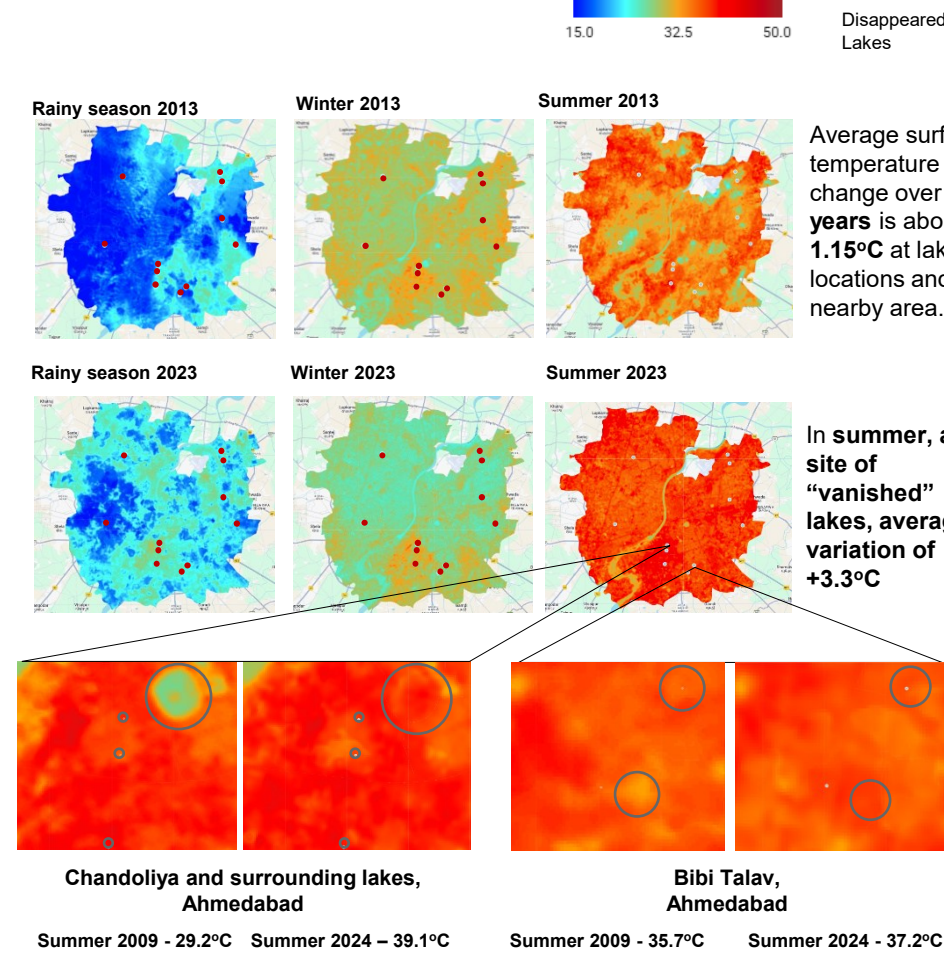
ALERT MANAGEMENT SYSTEM

Actionable insights which will assist the local government to understand the temporal, spatial and seasonal variation in lake health across and will provide the alerts for proactive decision-making process for conservation measures

Select your area of interest | RS modules run in the background | Spatial and temporal assessment | Actionable insights translating results | Field visits to prioritize lake improvement actions

Check for encroachments
Dry lake this year – Check for blockage
Check sewage outflows

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	

Urban temperature rise linked to extinction of lakes?

Rainy season 2013 | Winter 2013 | Summer 2013
Rainy season 2023 | Winter 2023 | Summer 2023

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

Variation in lakes water quality

Water quality in lakes improves in winter compared to summer season, with most urban lakes categorized as polluted or heavily polluted. The following results show examples of variation in Dissolved Oxygen –

2022: Pre monsoon 5.2 mg/l, Post monsoon 7.1 mg/l
2023: Pre monsoon 5.6 mg/l, Post monsoon 7.7 mg/l
2025: Pre monsoon 6.3 mg/l, Post monsoon 6.12 mg/l

DO levels Pre Monsoon – decreasing over time. Reasons for this are sewage discharge, depletion of water extent and increasing local temperatures

Reasons for overall water quality depletion

Discharge of sewage and industrial waste discharge, solid waste dumping and construction waste disposal in seasonal lakes and decrease in natural barrier and filters around lake area like sand and grassland. Impacting on environment benefits of lakes

References: 1. Doblas-Reyes, F. J., Sörensson, A. A., Almazroui, M., et al. (2021). *Linking global to regional climate change.* In V. Masson-Delmotte et al. (Eds.), *Climate change 2021: The physical science basis* (pp. 1363–1512). Cambridge University Press. https://doi.org/10.1017/9781009157896_012
2. DTE Staff. (2020, August 7). Two sides of the same coin: Shrinking water bodies and urban floods. Down to Earth. https://www.downtoearth.org.in/urbanisation/two-sides-of-the-same-coin-shrinking-water-bodies-and-urban-floods-72702
3. 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