Team Name - HydroWizards

Proposal Name: ***UrbanLakeWatch: An Automated Web-based Platform for Urban Lake Monitoring***

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Problem Statement & Motivation

Urban Encroachment

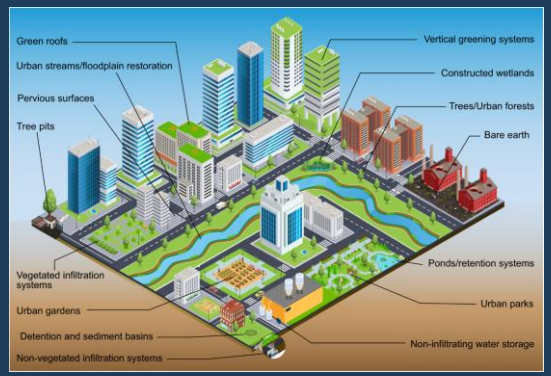
Rapid urbanization is shrinking lake boundaries. Built-up areas expanding at alarming rates around water bodies in tier-1 & tier-2 cities across India.

Water Quality Decline

Algal blooms, turbidity spikes & high TSS levels threaten aquatic ecosystems due to untreated sewage and industrial effluent discharge.

Data Monitoring Gap

Existing monitoring is sporadic, expensive, and ground-survey dependent. No automated, near - real time, open-access platform exists for urban lakes.



*** India has lost over 50% of its urban water bodies in the last 30 years - a silent ecological crisis demanding automated, scalable monitoring.**

Objectives

01 Develop an automated, cloud-based web application for continuous urban lake monitoring.

02 Integrate multi-sensor satellite data (Landsat 5/7/8/9 + Sentinel-2) spanning 2000 to present.

03 Compute automatic user specific 10+ spectral indices including MNDWI, NDWI, NDVI, NDBI, NDCI, Turbidity, TSS, and a composite Lake Health Index.

04 Build an intelligent alert system with threshold-based warnings for encroachment, pollution, and algal bloom risk.

05 Provide interactive time-series trend analysis and downloadable statistics for decision-makers and urban planners.

06 Enable user-defined ROI drawing, flexible date filtering, cloud masking, and modular analysis selection.

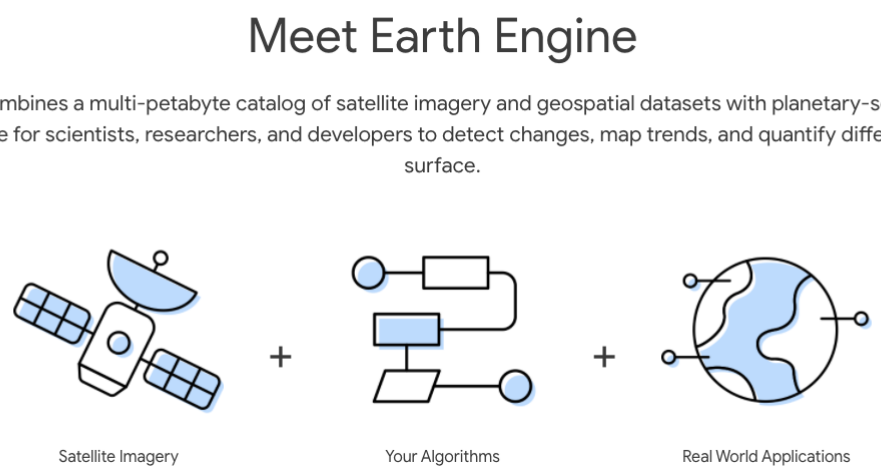
Vision: A fully automated, AI-assisted, near-real time urban lake health observatory powered by GEE

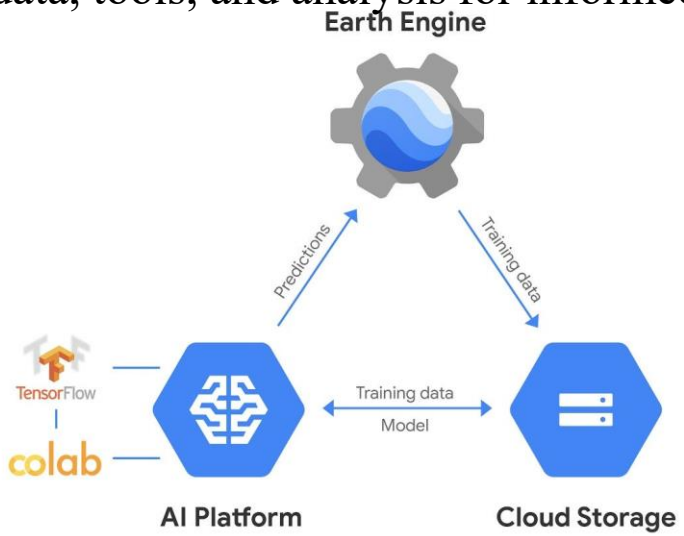
The Traditional GIS Workflow: Bulky Data, Slow Processes, Human Error

Challenges of Traditional GIS Workflows & the Need for Automation

- Have to download and pre-process any data before use
- Less options for automation
- Rigorous and very Time Taking workflows
- Required vast local processing power
- Difficulty in handling Large amount of data in multi-temporal scale
- Limitations in sharing the data to a large population

- ✓ No Data Downloading or Software Installation
- ✓ Fully Automated & Customizable Analysis
- ✓ Zero Local Processing Requirements
- ✓ Handles Massive Datasets Efficiently
- ✓ Processes terabytes of geospatial data with ease
- ✓ Seamless Public Sharing & Collaboration
- ✓ Publish data, tools, and analysis for informed decision-making

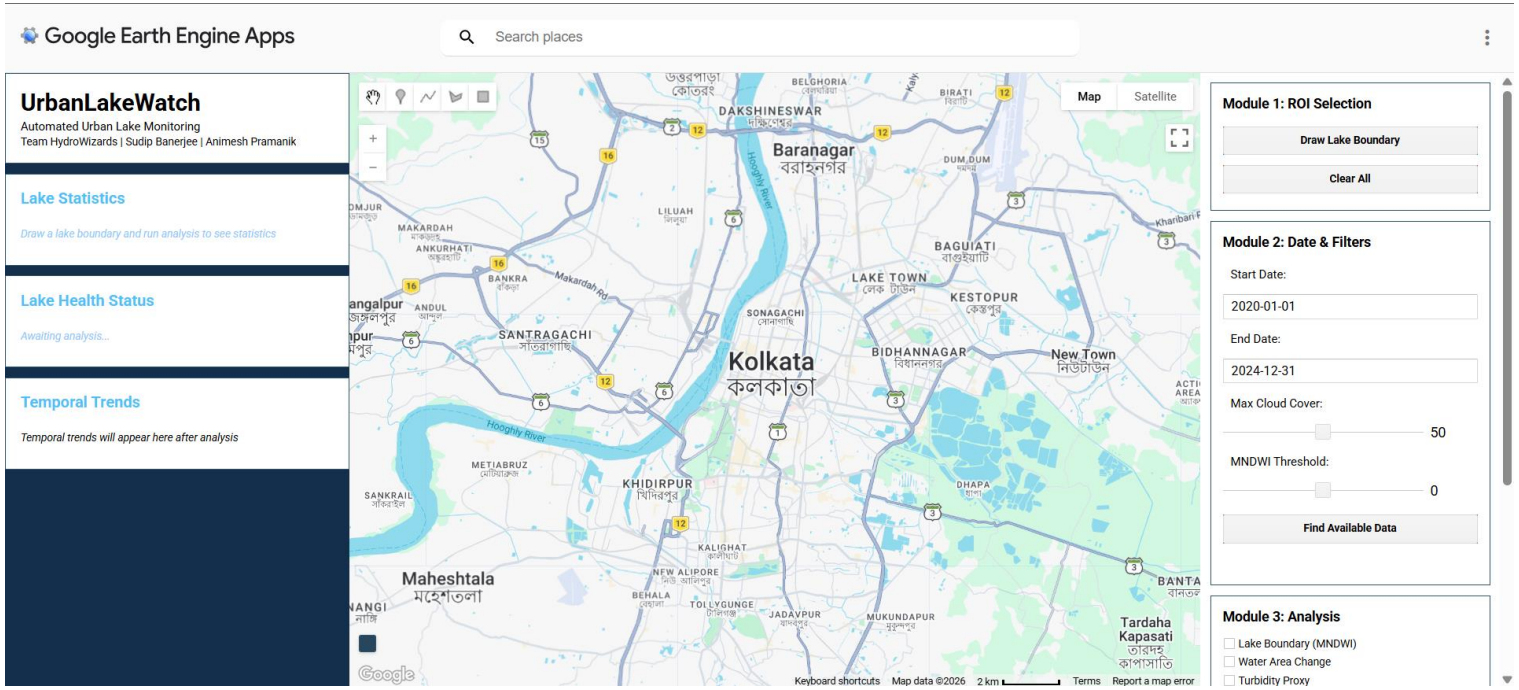




Introducing UrbanLakeWatch (*Developed by Team HydroWizards)*

Automated Urban Lake Mapping, Accessible to All (Link)

- ✓ ***UrbanLakeWatch*** is a web-based urban lake monitoring platform built on Google Earth Engine.
- ✓ Integrates 25+ years of Landsat & Sentinel data for continuous lake analysis.
- ✓ Auto-Detects water loss, algal bloom risk, encroachment, and catchment disturbance.
- ✓ Generates time-series trends and a composite Lake Health Index.
- ✓ Provides automated alerts to support data-driven urban lake conservation.



App Interface

Scan it to get the link to the GEE-based web app

Study Area & Scope

Platform Scope

Target Lakes:

✓ Urban lakes in rapidly growing Indian cities

Geographic Range:

✓ Global — any user-defined AOI on Earth

Temporal Range:

✓ 2000 → Latest Available Imagery

Spatial Resolution:

✓ 10m (Sentinel-2) to 30m (Landsat)

Minimum Lake Size:

✓ ~0.01 km² (1 hectare)

Primary Use Case:

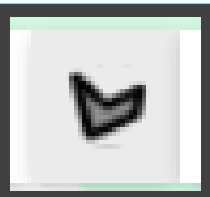
✓ ULBs, Commissioner, Municipality Engineer, Urban planners, PCB, lake conservation NGOs

Example Urban Lakes in India

Lake	Area	Primary Threat
Rabindra Sarobar, Kolkata	~0.78 km²	Encroachment + Pollution
Bellandur Lake, Bangalore	~3.61 km²	Algal foam + Sewage
Hussain Sagar, Hyderabad	~5.7 km²	Eutrophication
Sukhna Lake, Chandigarh	~3.2 km²	Siltation + Shrinkage
Dal Lake, Srinagar	~18 km²	Weed encroachment

**The platform supports ANY user-defined polygon drawn on the map, making it applicable to any lake, pond, or reservoir worldwide.*

System Architecture & Workflow



01

Draw ROI

User defines lake boundary using polygon tool

02

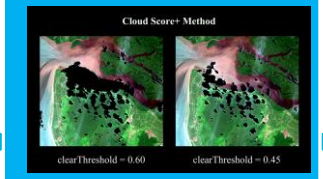
Set Filters

Date range, cloud cover, MNDWI threshold

03

Load Data

Landsat 5/7/8/9 + Sentinel-2 merged



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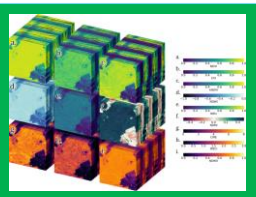
Cloud Mask

QA pixel masking + median composite



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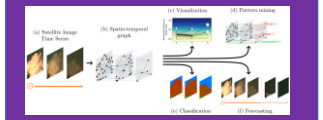
Index Compute

10 spectral indices calculated per image



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Visualize

Map layers + time-series charts

07

Alert Check

Threshold comparison → Health status

OUTPUT: Map Visualizations · Time-Series Charts · Statistics Panel · Health Score · Alert Warnings

Data Sources & Pre-processing

Data	Spatial and Temporal Resolution	Bands Used
Landsat 5 TM 1984 – 2013	30m / 16-day	B1–B7 SR (C02 T1 L2)
Landsat 7 ETM+ 1999 – 2022	30m / 16-day	B1–B7 SR (C02 T1 L2)
Landsat 8 OLI 2013 – Present	30m / 16-day	B2–B7 SR (C02 T1 L2)
Landsat 9 OLI-2 2021 – Present	30m / 16-day	B2–B7 SR (C02 T1 L2)
Sentinel-2 MSI 2015 – Present	10–20m / 5-day	B2,B3,B4,B8,B11,B12 SR

Pre-processing: QA pixel-based cloud masking - Band harmonization to Blue/Green/Red/NIR/SWIR1/SWIR2 - Median compositing - Collections merged via .merge()

Technical Implementation Details

GEE Components Used

- ui.Panel, ui.Map, ui.Chart
- drawingTools() for polygon ROI
- ui.Slider, ui.Textbox, ui.Checkbox
- ui.Chart.image.series for trends
- ImageCollection.filterBounds()
- image.reduceRegion() for stats
- ee.Reducer.sum() / .mean()
- .map() for per-image index calc

Code Architecture

- Modular function design
- loadSatelliteData() — data loader
- addIndices() — index calculator
- computeLakeHealthIndex() — LHI
- displayResults() — map renderer
- generateStatistics() — stats panel
- generateCharts() — chart builder
- assessLakeHealth() — alert engine

Performance Notes

- maxPixels: 1e9 in reduceRegion()
- scale: 30m for all computations
- Server-side lazy evaluation via GEE
- Median composite reduces noise
- filterBounds() limits data volume
- .evaluate() for async stats
- Collections merged server-side
- All indices computed in one .map()

Application UI Design & Layout

LEFT PANEL

Statistics & Charts

Water area (km²)

Area change %

Mean turbidity

Chlorophyll risk

Built-up index

NDVI health

LHI score

6 time-series charts

CENTER MAP

Main Map

Latest composite display

Layer toggles

All indices visualized

Color-coded palettes

Legend overlay

AOI boundary visible

Drawing tools active

Real-time rendering

RIGHT PANEL

Tools & Controls

Module 1: ROI Selection

Module 2: Date & Filters

Module 3: Analysis

Cloud cover slider

MNDWI threshold slider

Analysis checkboxes

Run / Clear buttons

Histogram of imagery

Spectral Indices Implemented

Index	Formula	Application
MNDWI	*(Green − SWIR1) / (Green + SWIR1)*	Lake boundary extraction
NDWI	*(Green − NIR) / (Green + NIR)*	Open water detection
NDVI	*(NIR − Red) / (NIR + Red)*	Vegetation / catchment health
NDBI	*(SWIR1 − NIR) / (SWIR1 + NIR)*	Built-up encroachment
NDCI	*(Red − Green) / (Red + Green)*	Chlorophyll / algal bloom risk
Turbidity	*Red / Green*	Water clarity proxy
TSS	*0.5 × Red + 0.3 × NIR*	Total suspended solids proxy
LHI	*0.3×NDVI − 0.3×NDBI − 0.2×Turb − 0.2×NDCI + 0.5*	Composite lake health score
Water Area	*Sum(pixels where MNDWI > threshold) × pixel_area*	Quantitative area tracking (km²)
Built-up Rate	*ΔNDBI per year within buffer zone*	Encroachment expansion rate

Time-Series Analysis & Statistics Panel

Statistics Computed per Analysis

Water Area:
km² from MNDWI threshold mask

Area Change %:
First vs latest image comparison

Mean Turbidity:
Red/Green ratio mean over AOI

Chlorophyll Risk:
NDCI means algal bloom proxy

Built-up Index %:
NDBI mean × 100 = encroachment

Vegetation Health:
NDVI mean over catchment AOI

Lake Health Index:
Composite score 0.0–1.0

Time-Series Charts Generated

- Water Area vs Time
- Turbidity Trend
- Algal Bloom Risk (NDCI)
- Built-up Encroachment (NDBI)
- Vegetation Health (NDVI)
- Lake Health Index (LHI)

**All charts use ui.Chart.image.series with full temporal coverage across the selected date range.*

Alert System & Lake Health Index

Lake Health Index (LHI) Formula

$$LHI = (0.3 \times NDVI) - (0.3 \times NDBI) - (0.2 \times Turbidity) - (0.2 \times NDCI) + 0.5$$

Normalized composite score · Range: 0.0 (worst) → 1.0 (best)
Weights reflect ecological importance of each component

Threshold-Based Alerts

- ❑ Water loss > 30% → Shrinkage warning
- ❑ NDCI > 0.2 → Algal bloom risk
- ❑ NDBI > 0.2 → Encroachment alert
- ❑ Turbidity > 1.5 → Pollution warning

"⚠ Lake is under stress due to encroachment / pollution / algal bloom risk"

HEALTHY

LHI > 0.6

No major threats. Good water quality and minimal encroachment.

MODERATE

0.4 < LHI ≤ 0.6

Some stress indicators present. Monitor closely.

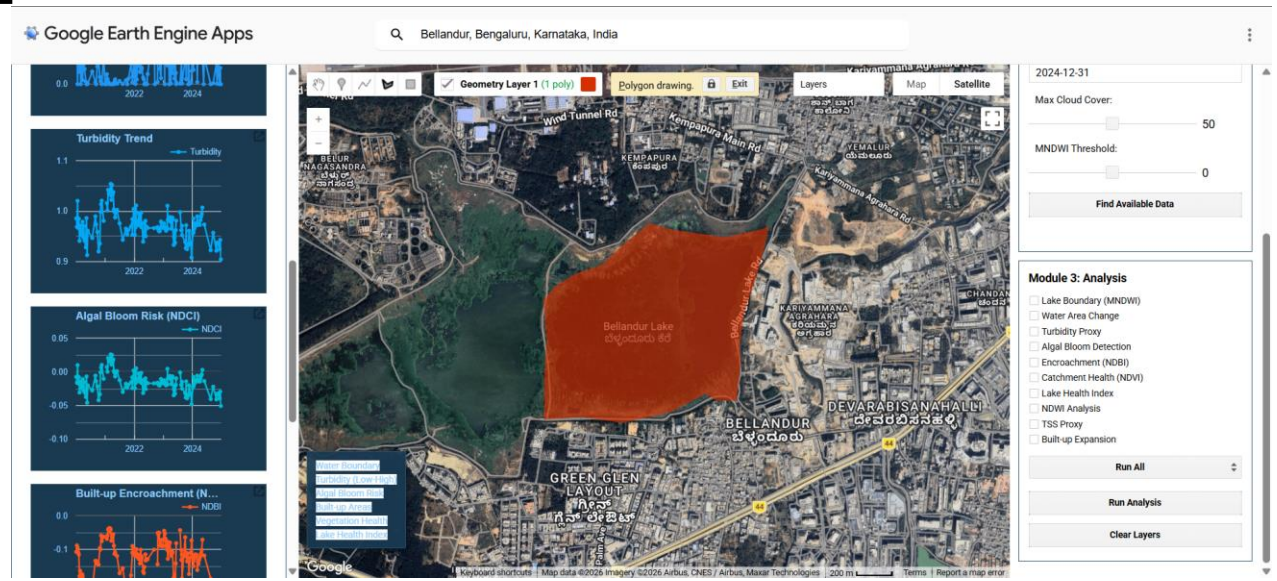
CRITICAL

LHI ≤ 0.4

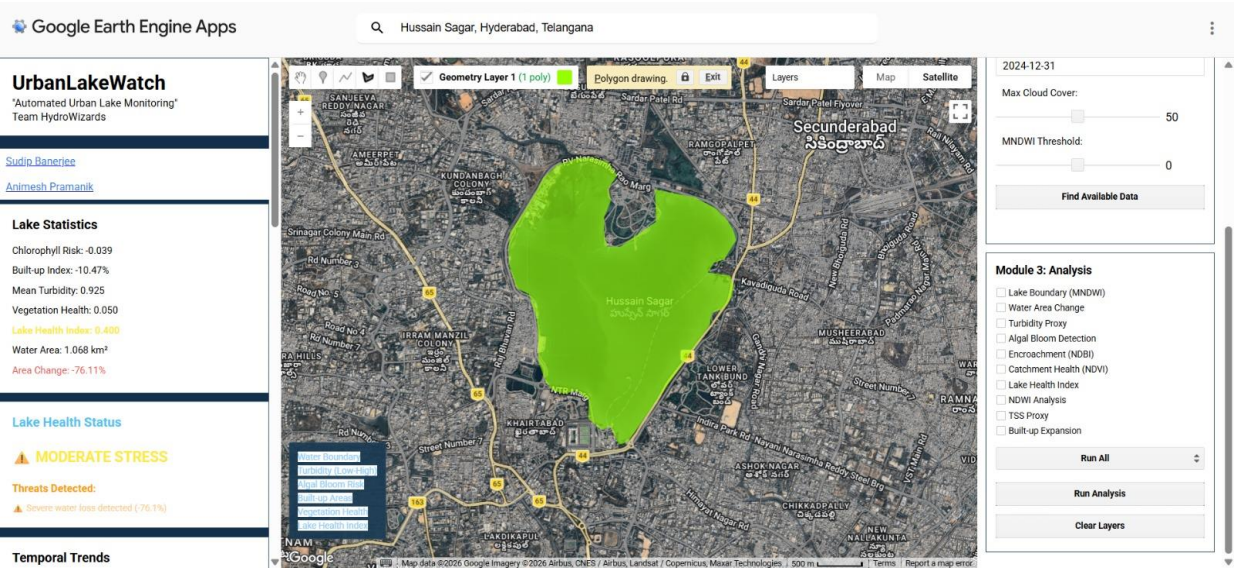
Severe threats detected. Immediate intervention required.

Case Studies

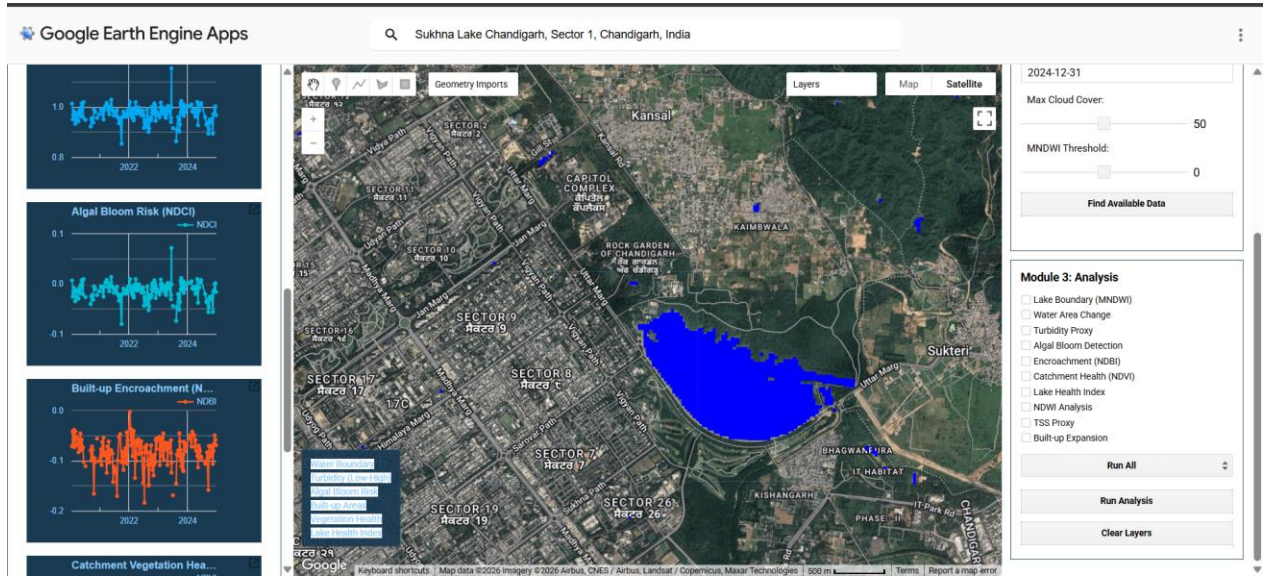
Rabindra Sarobar, Dhakuria, Rabindra Sarobar, Calcutta, West Bengal



Bellandur Lake, Bengaluru, Karnataka, India



Hussain Sagar, Hyderabad, Telangana



Sukhna Lake, Chandigarh

Limitations & Future Scope

Current Limitations

- 10m spatial resolution limits very small lakes (<1 ha)
- Monsoon season cloud cover reduces temporal density
- LHI weights are empirically set (need more validation study)
- Sentinel-2 and Landsat spectral differences can cause minor inconsistency
- Alert thresholds may need regional calibration

Future Scope

- SAR integration (Sentinel-1) for cloud-free monitoring
- Integration with ground truth / IoT sensor data & citizen science
- ML-based water quality classification models
- Multi-lake batch analysis across a city
- Automated monthly PDF reporting
- Mobile-responsive Progressive Web App version
- 3D bathymetry estimation from optical depth

Thank You

UrbanLakeWatch — Automated Web-based Urban Lake Monitoring Platform

Near-Real time statistics, 6 time-series charts, thematic map visualizations

Intelligent alert system with 3-tier health status (Green/Yellow/Red)

100% open-source, cloud-based, no installation, accessible anywhere

Team HydroWizards

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Built on Google Earth Engine - JavaScript API

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