Digital Pathways for Water Sustainability:

Rejuvenation, Resilience & Smart Utilities

CLEAR WATER DYNAMICS

Water, Environment &
Infrastructure Planning

River Rejuvenation Projects in India

India's multi-scale effort to restore rivers through national, state, and local programmes demonstrates an expanding commitment to water-resource revival across hundreds of major projects.

374

Namami Gange Projects

Major initiatives under India's flagship Ganga rejuvenation programme

90+

NRCP Projects

National River Conservation Plan projects across multiple states

13

Major River Basins

Targeted for ecological restoration by MoEFCC

Pollution Abatement

161+ sewage treatment projects under Namami Gange, adding thousands of MLD treatment capacity nationwide

Catchment Restoration

Afforestation, soil conservation, and wetland restoration across 13 major river basins

Community Revival

Hundreds of state-led and NGO-driven projects reviving small rivers and streams locally

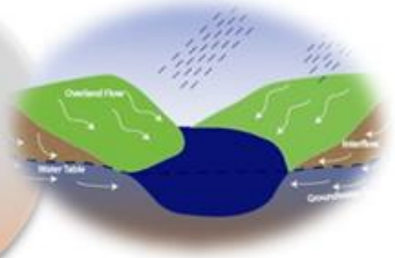
Key Insight: Large national programmes account for 300+ major projects, while including state and local efforts pushes the number into hundreds to thousands.

> "India's river revival is a multi-layered mission — national vision, state action, and local stewardship."

Causes of River Deterioration

Uncontrolled Urbanization and discharge of sewage

Uncontrolled Industrialization and untreated discharge of effluents



Natural flow path obstruction & decrease in river baseflow

Improper Solid Waste Dumping to rivers

Over - Exploitation

Lack of Rainwater Harvesting Measures

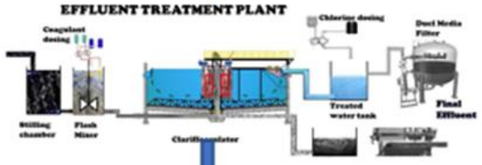
Management of Industrial Effluents

Management of Domestic Sewage and Sullage & Rainwater Harvesting for Households

Solid Waste Management

Sewage Treatment

100% Interception of Industrial effluent



Clear Treated Effluent Discharge to storm drains (adhering to CPCB standards)

100% Interception of Rooftop Rainwater

R

1

Storm Drain

100% Interception of Sullage

3

Sewer Line Underneath Storm Drain

100% Interception of Sewage

Storm Drain

Proper Waste Segregation and Solid Waste Management Facility

100% Interception & Diversion of Sewage to STP

Interceptor and Diversion Structure

Clear Treated Effluent Discharge (adhering to CPCB standards)

2

RIVER STRETCH

LEGEND: R Recharge Pit

Solid Waste from Households

Prevention of Obstructions to Natural Drain Flow Paths

Stream Bank Stabilization and River Front Development

Recharge structures at Open and Barren Lands

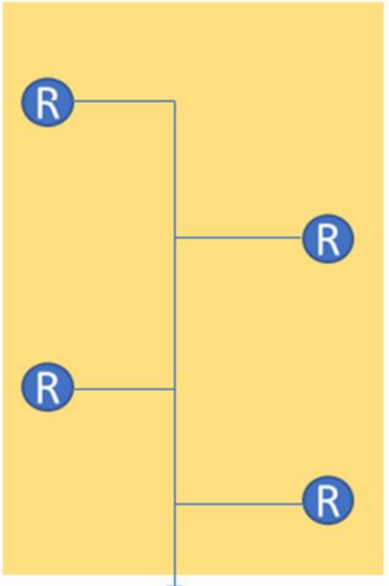
Prevention of direct discharge from service centers

Prevention of direct discharge from Dhobi Ghats

Unobstructed Flow of Runoff from Upland

Riverfront Development

Construction of Recharge Pits in open Government lands close to river banks, at Lowest Elevation Points, to increase the baseflow of the River



ETP

ETP

RIVER STRETCH

LEGEND: R Recharge Pit

River Rejuvenation

Dravyavati River, Jaipur, Rajasthan

Ecological Restoration

Transforming a polluted waterway into a thriving ecosystem through sustainable practices.

Urban Development

5 million square meters of green belt, 17,000+ trees, parks, and tracks along 47.5 km riverfront.

Heritage Conservation

Preserving Jaipur's cultural legacy whilst modernising infrastructure for future generations.

Pollution Control

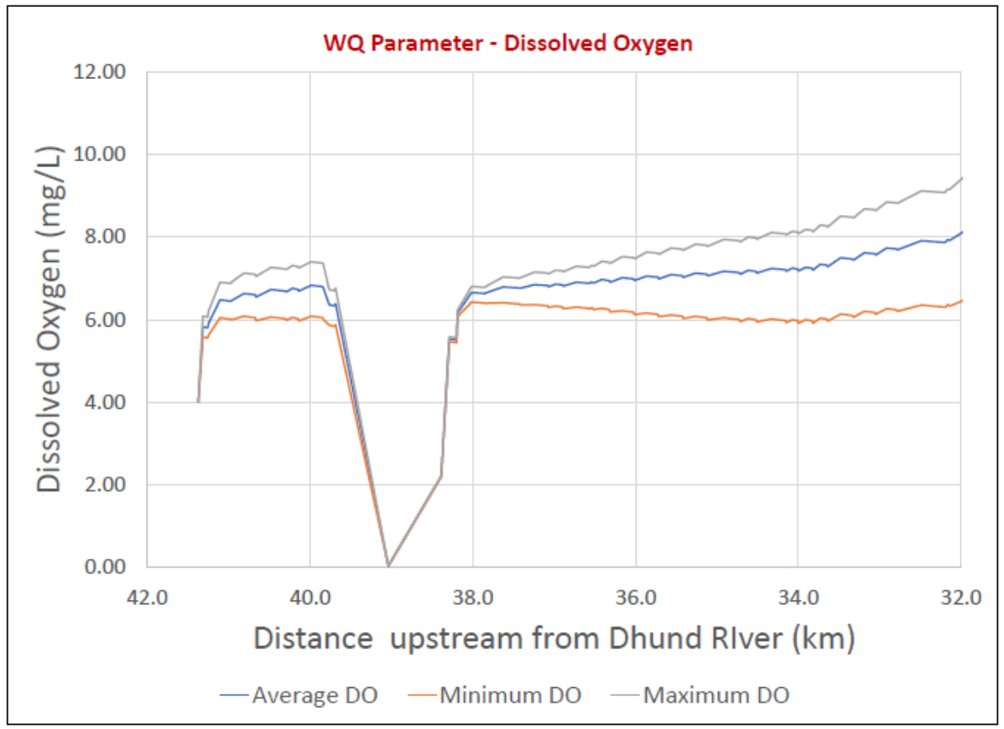
Five sewage treatment plants with 170 MLD capacity treat city sewage before river entry.

Flood Prevention

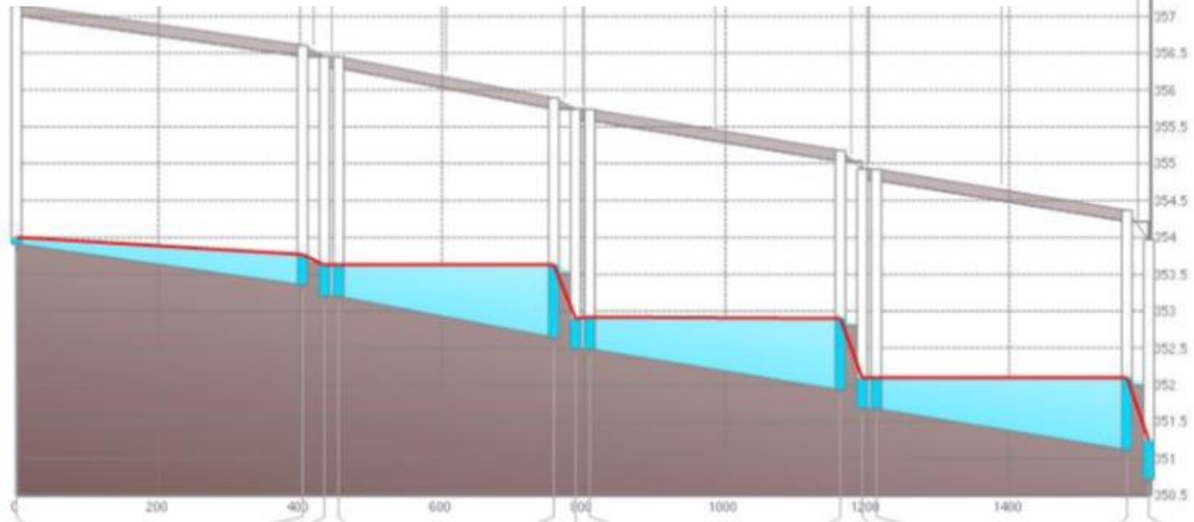
Check dams and 30-kilometre concrete lining with porous concrete for groundwater recharge.

CWD
CLEAR WATER DYNAMICS
Water, Environment & Infrastructure Planning

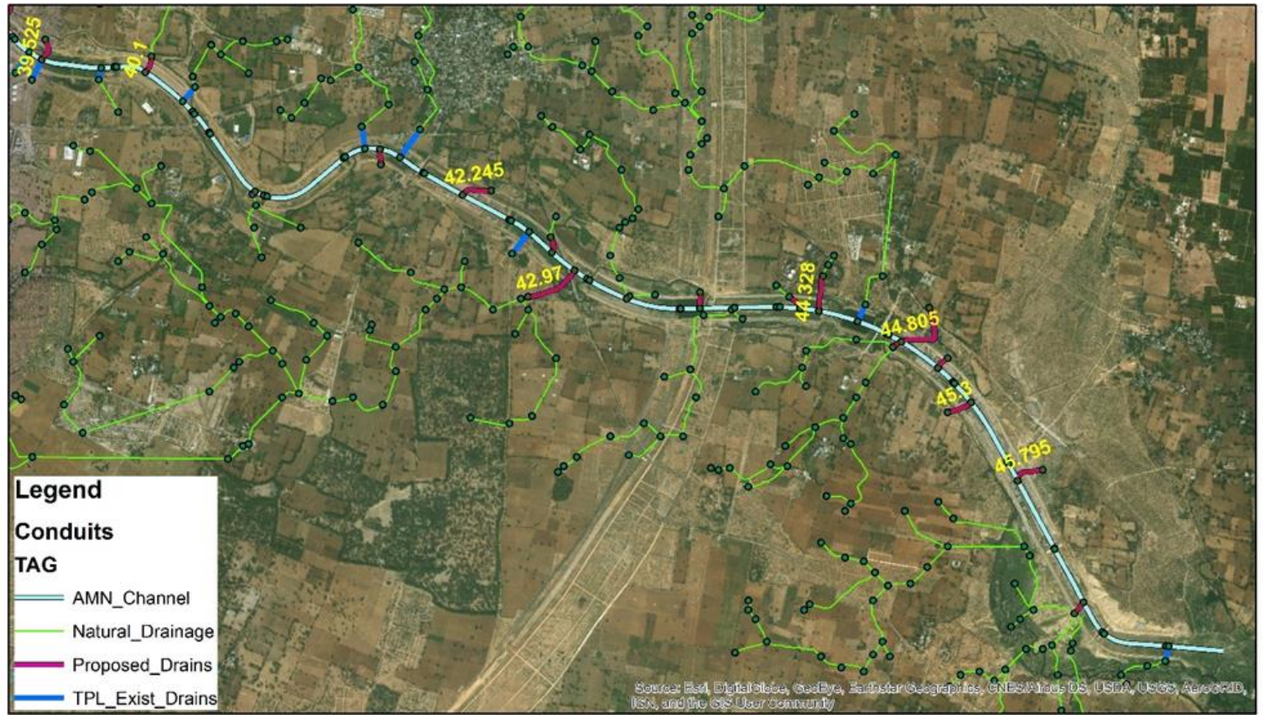
River Rejuvenation – Dravyavati River, Jaipur, Rajasthan



- Dry Weather flow analysis – 105 check dams in series
- Water Quality Modelling (DO, BOD, Nutrients etc.)
- Storm Water Modelling & Design



Storm Drains from chainage 39.225 km to 46.535 km



Building Water Resilience for India's Future

Predictive, adaptive, and digitally empowered frameworks for climate security and sustainable growth

The Crisis: Water Under Pressure

India faces unprecedented water stress as climate change, urbanization, and groundwater depletion converge into a perfect storm threatening our nation's future.

18% of the world's population shares only **4% of global freshwater**—making resilience not optional, but essential for survival.

You cannot manage what you cannot measure.

62%

Irrigation from Groundwater

Over-reliance threatens long-term sustainability

85%

Rural Water Supply

Dependent on depleting aquifers

Alarming Contamination

2023-24 reports reveal widespread groundwater quality deterioration across monitoring stations, threatening public health and water security.

Climate Acceleration

Rising temperatures intensify crop water demand, pushing groundwater withdrawal rates to unsustainable levels and threatening aquifer viability.

Erratic Weather Patterns

Increasing frequency of floods and droughts creates uncertainty, making traditional water infrastructure inadequate for future challenges.

The Solution: Digital + Hybrid Resilience

Resilience goes beyond infrastructure hardening—it integrates **data, technology, and community strategies** to create water systems that withstand, recover from, and adapt to climate shocks.

Real-Time Monitoring

Hydrological tracking of surface and groundwater, water quality sensors, and aquifer health indicators. India-WRIS provides the foundation for comprehensive digital water management.

Predictive Intelligence

AI-driven analytics forecast floods, droughts, and contamination events before they escalate. Early warning systems enable proactive response and resource allocation.

Nature-Based Solutions

Catchment restoration, wetland revival, and aquifer recharge—enhanced by digital monitoring—restore ecological balance and reduce water stress.

Demand Management

Smart irrigation, regulated withdrawals, metering systems, and efficient distribution reduce pressure on water bodies while meeting human needs effectively.

Policy & Governance

Groundwater reform, equitable access frameworks, recharge incentives, and transparent regulation create sustainable long-term management structures.

Community Stewardship

Integrating traditional water wisdom with cutting-edge digital tools empowers local participation and builds adaptive capacity from the ground up.

Systems That Bend, But Never Break

Anticipate Risks

Digital twins and climate-risk mapping identify vulnerabilities before they become crises, enabling strategic planning and prevention.

Absorb Shocks

Adaptive infrastructure and automated command systems maintain essential water services even during extreme weather events and disruptions.

Evolve Stronger

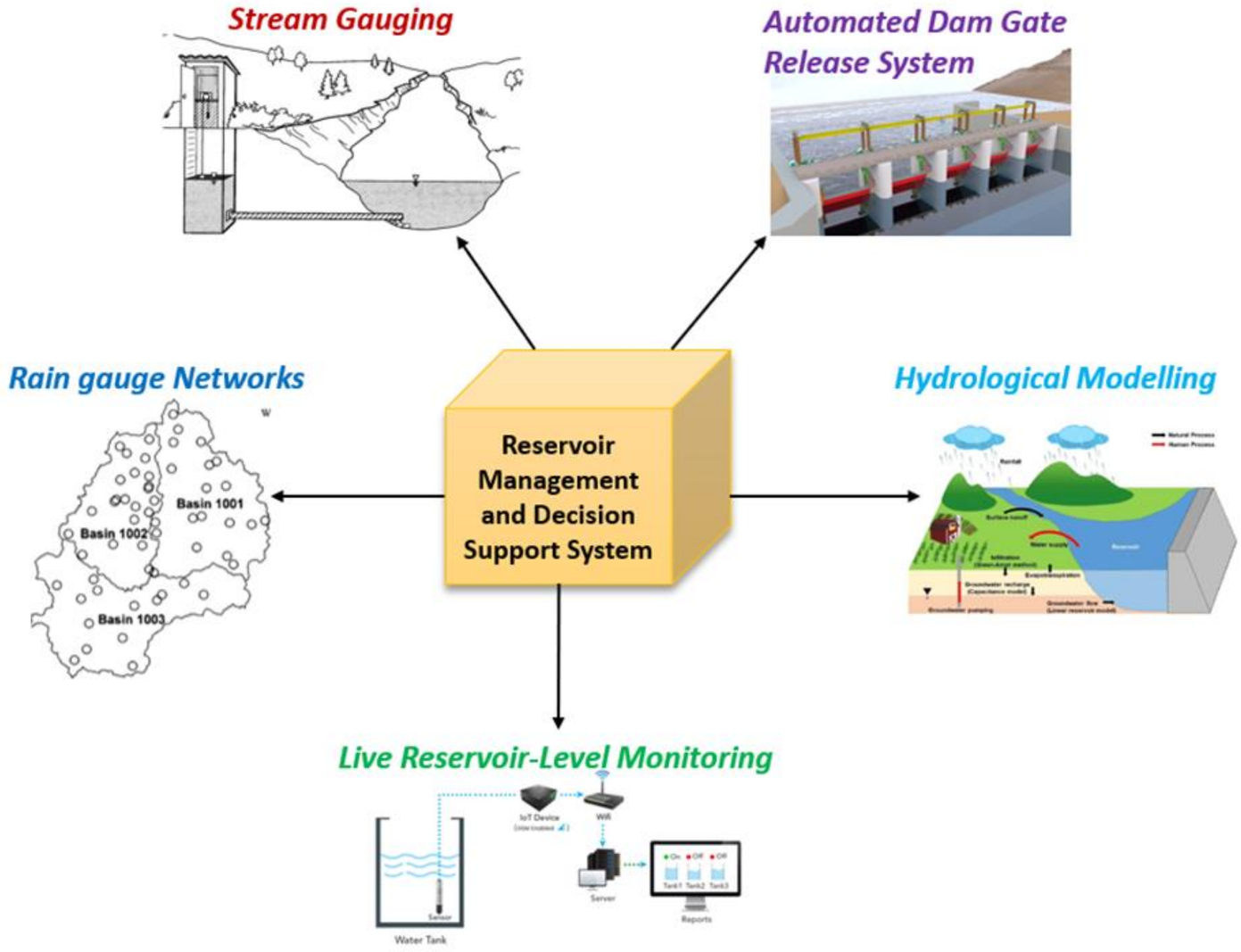
Each challenge builds institutional knowledge and system improvements, creating water security that strengthens with every test.

> Resilience is not a backup option—it is the central pillar of India's water future. By embedding digital monitoring, predictive analytics, restoration, and governance, we secure water for future generations.

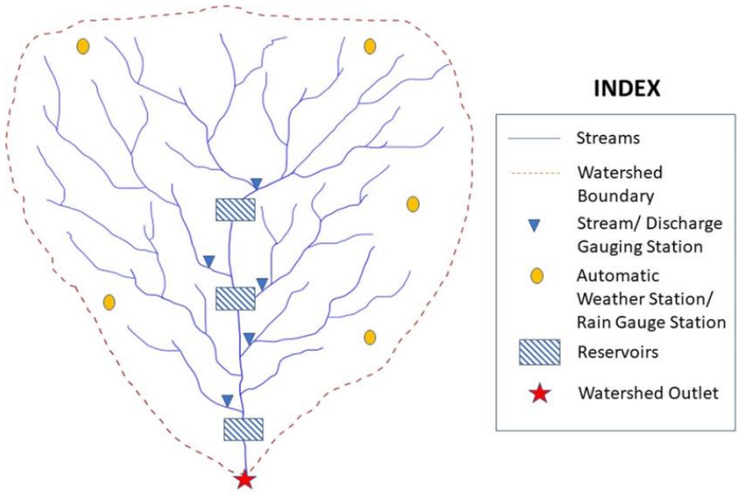
This decade will define India's water security. The choice is clear: build adaptive, data-driven systems that ensure **reliability, sustainability, and equitable access** across all communities—or face escalating crises that threaten economic stability, public health, and social cohesion.

DAM SERIES MANAGEMENT FOR FLOOD CONTROL & RESILIENCE

The main goal of the above reservoir management system is to ensure that the series of dams located on any huge river, works as a single entity rather than individual reservoirs. Such a system provides an effective mechanism for management of these reservoirs using state of the art technologies within a controlled environment. This makes flood management more efficient and minimizes any loss to life and property at the downstream flood plains.

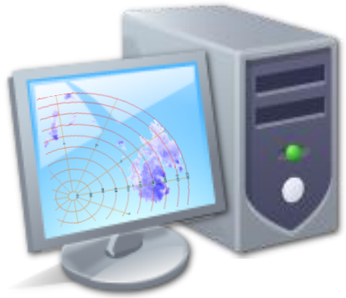


INSTRUMENTATION WITHIN A RESERVOIR CATCHMENT

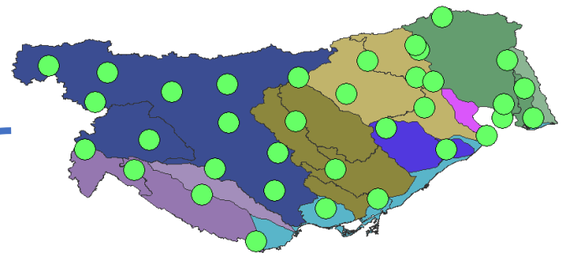


CWD CLEAR WATER DYNAMICS
Water, Environment & Infrastructure Planning

PCSWMM REAL-TIME APPROACH



NOAA WSR-88D Server



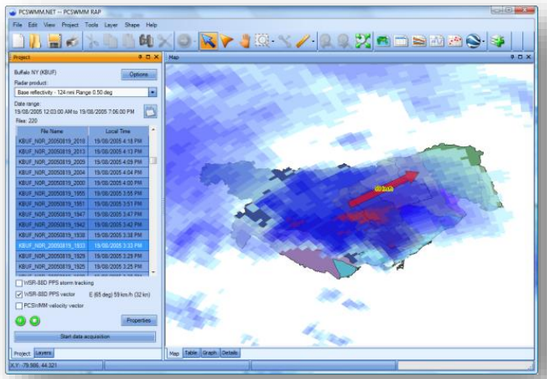
Rain & Flow Gauge Network

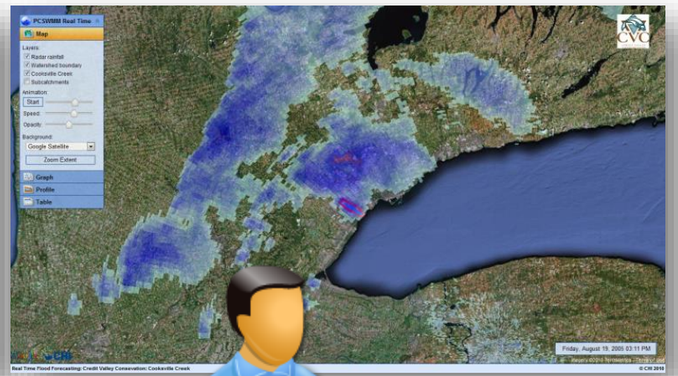
Radar Rainfall Repository

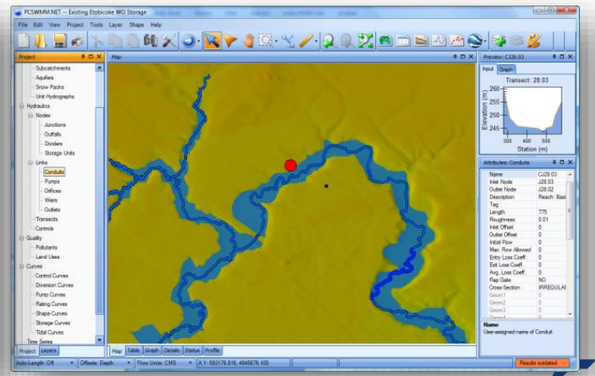
PCSWMM Radar Acquisition & Processing

SQL Server Database

PCSWMM Real-Time Flood Inundation Forecasting



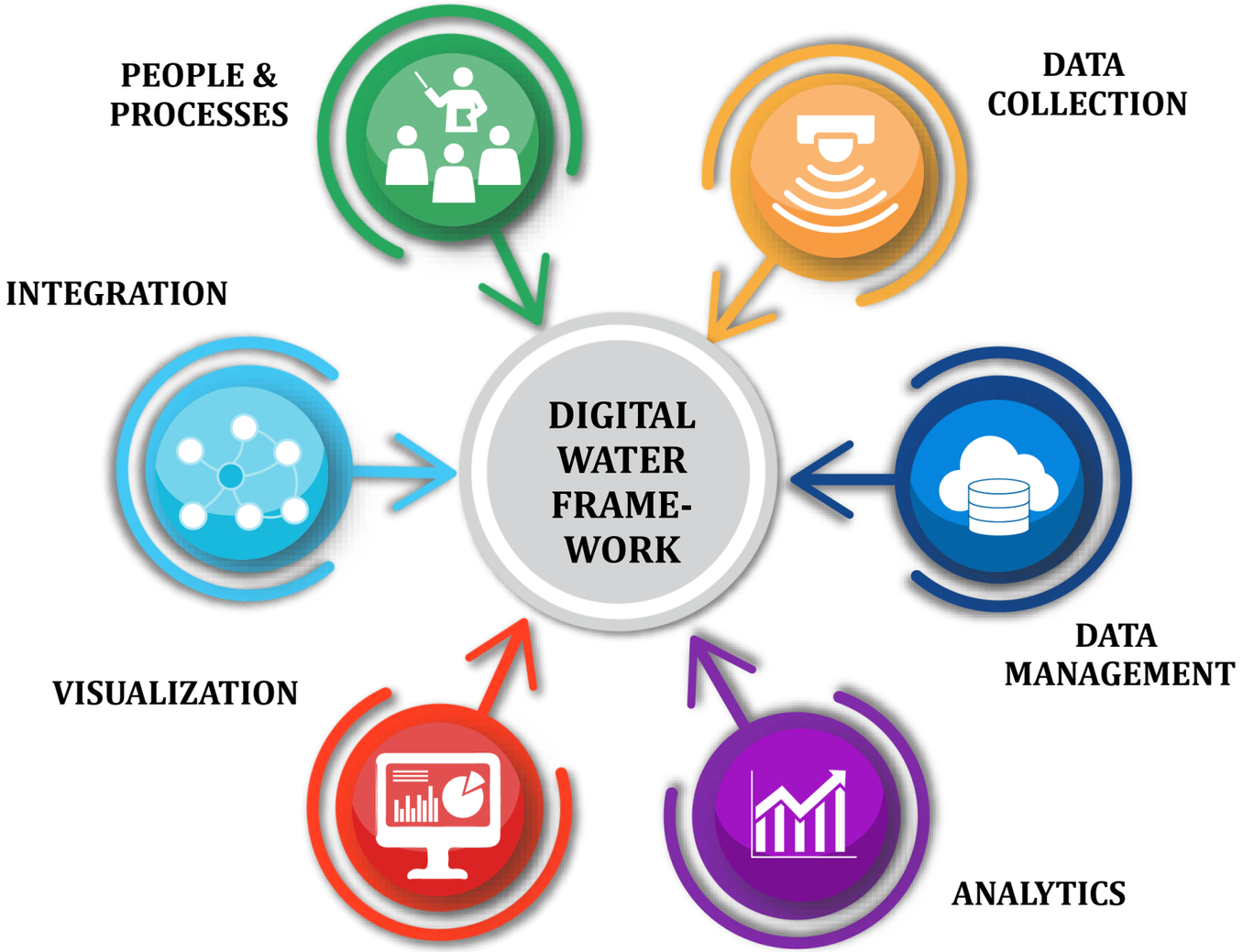




CLEAR WATER DYNAMICS

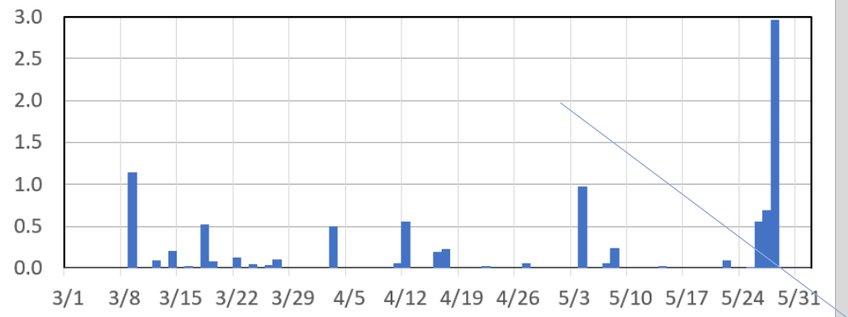
Water, Environment & Infrastructure Planning

Elements of Digital Water Framework

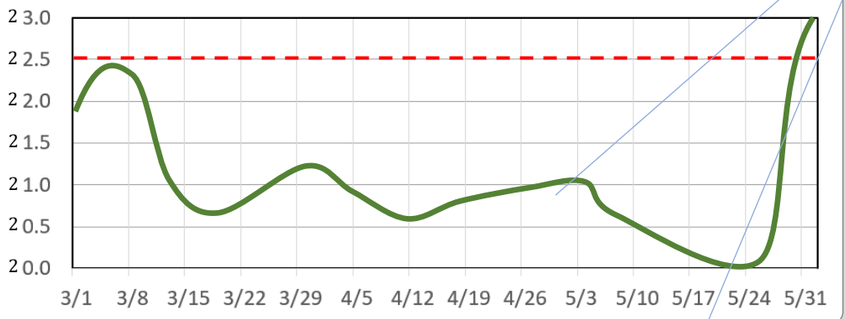


Dashboard – Stormwater Pump Stations & River Levels

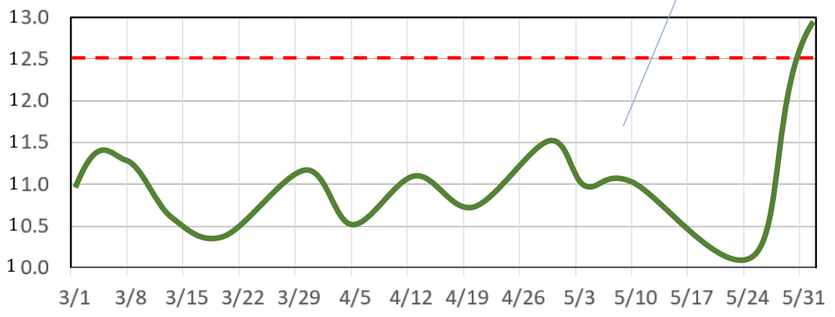
Daily Rainfall (KCMO Airport) – Depth (Inches)



Missouri River (@ KC, MO) – Water Level (ft) - Mr



Kansas River (@ KC, KC) – Water Level (ft) – Kr

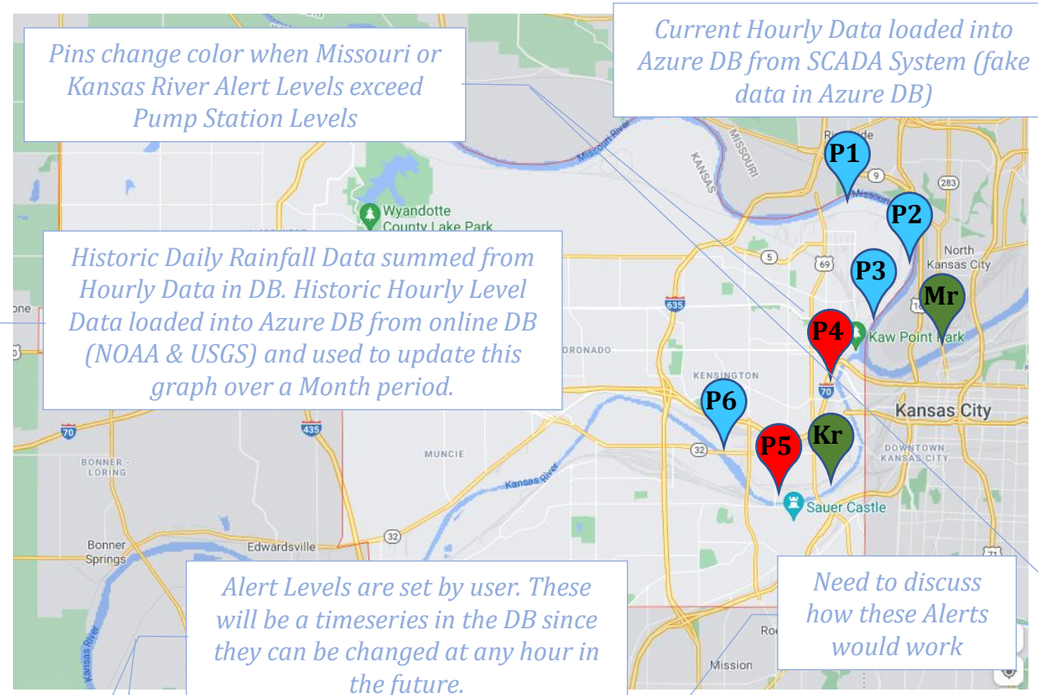


Map (Current Pump Station Activations & River Levels)

Pins change color when Missouri or Kansas River Alert Levels exceed Pump Station Levels

Current Hourly Data loaded into Azure DB from SCADA System (fake data in Azure DB)

Historic Daily Rainfall Data summed from Hourly Data in DB. Historic Hourly Level Data loaded into Azure DB from online DB (NOAA & USGS) and used to update this graph over a Month period.



Alert Levels are set by user. These will be a timeseries in the DB since they can be changed at any hour in the future.

Need to discuss how these Alerts would work

Set Missouri River Level Alert (ft)

22.5

Set Kansas River Level Alert (ft)

12.5

Alerts

Alert Description	Sent (date/time)	Sent (to Responder)
Pump #4 activated	1900-06-10 / 13:05	Trenton
Pump #4 deactivated	1900-06-10 / 15:35	Trenton
Pump #5 activated	1900-05-23 / 22:01	Randal
Pump #5 deactivated	1900-05-24 / 01:05	Randal

CURRENT CONDITIONS

P.S. #1 (P1) – Level (ft)

21.8

P.S. #2 (P2) – Level (ft)

21.9

P.S. #3 (P3) – Level (ft)

22.2

P.S. #4 (P4) – Level (ft)

22.7

P.S. #5 (P5) – Level (ft)

12.8

P.S. #6 (P6) – Level (ft)

12.3

CLEAR WATER DYNAMICS

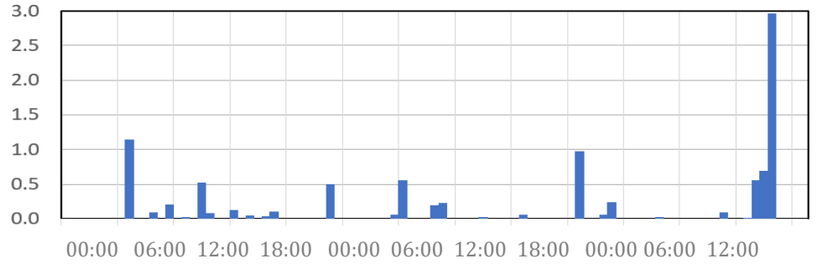
Water, Environment & Infrastructure Planning

Dashboard – Wastewater Treatment Plants (WWTPs)

Rainfall & Flows

Select End Date: *(for graphs below)* 1900-06-10

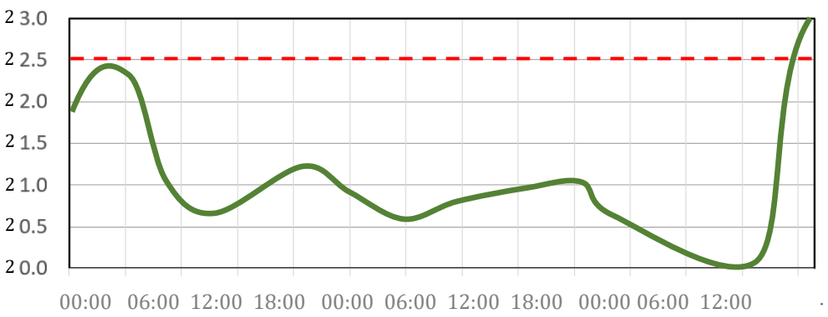
Hourly Rainfall (KCMO Airport) – Depth (Inches)



Select WWTP:

- [x] Kaw Point
- [ ] Plant 20
- [ ] Wolcott
- [ ] No. 14
- [ ] No. 3

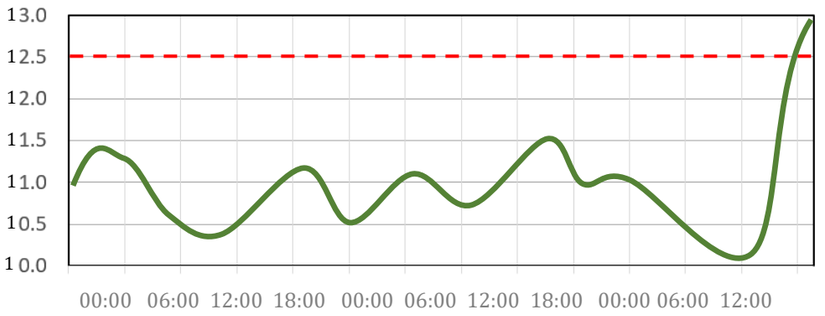
WWTP Hourly Flow (mgd)



WWTP Current Flow (mgd)

23

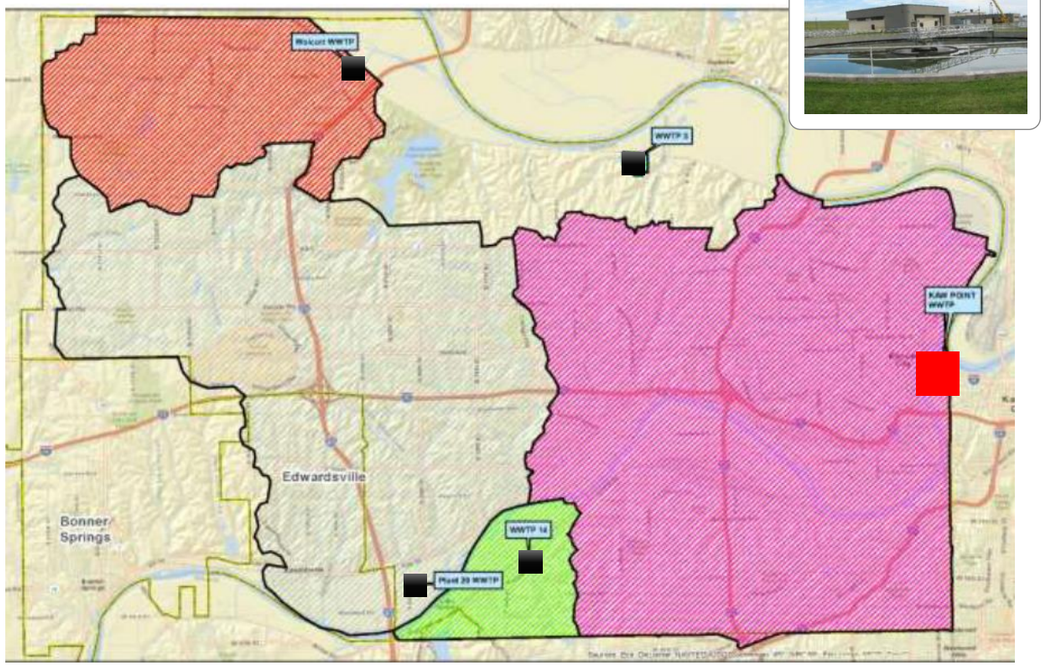
WWTP Influent Pump Station Wet Well Level (ft)



WWTP Current Wet Well Level (feet)

13

Map (WWTPs Locations & Service Areas)



Set WWTP Flow (mgd) Alert

22.5

Set WWTP WW Level (ft) Alert

12.5

Alerts

Select End Date: *(for alerts below)* 1900-06-10

Alert Description	Sent (date/time)	Sent (to Responder)
Kaw Point Flow Norm.	1900-06-10 / 13:05	Trenton
Kaw Point Flow High	1900-06-10 / 15:35	Randal
Kaw Point Level Norm.	1900-05-23 / 22:01	Trenton
Kaw Point Level High	1900-05-24 / 01:05	Randal

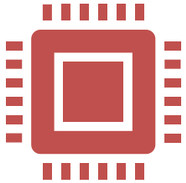
The Invisible Infrastructure

Data is the Pavement for Digital Pathways

Current State:

- We have the engines (AI, ML, Hydrological Models).
- We are starving for the fuel (High-quality, accessible data).
- We have built dams, but they are always closed, so the water benefits are not accessible to people.

A Tale of Two Systems: The Contrast



The USA Standard ('One-Click' Access):

Instant access to USGS streamflow data (Real-time).

HUC boundaries, stream paths & hourly precipitation records are available publicly.

The Indian Reality:

Data often locked behind bureaucratic walls (logins, official requests).

Often not digitized in machine-readable formats.

The Friction:

Innovation dies when data access takes months instead of seconds.

Case Study: Colorado River vs. Ganga Basin

The Colorado River (USA):

Real-time telemetry + forecast available via API at hundreds of points.

The Ganga Basin (India):

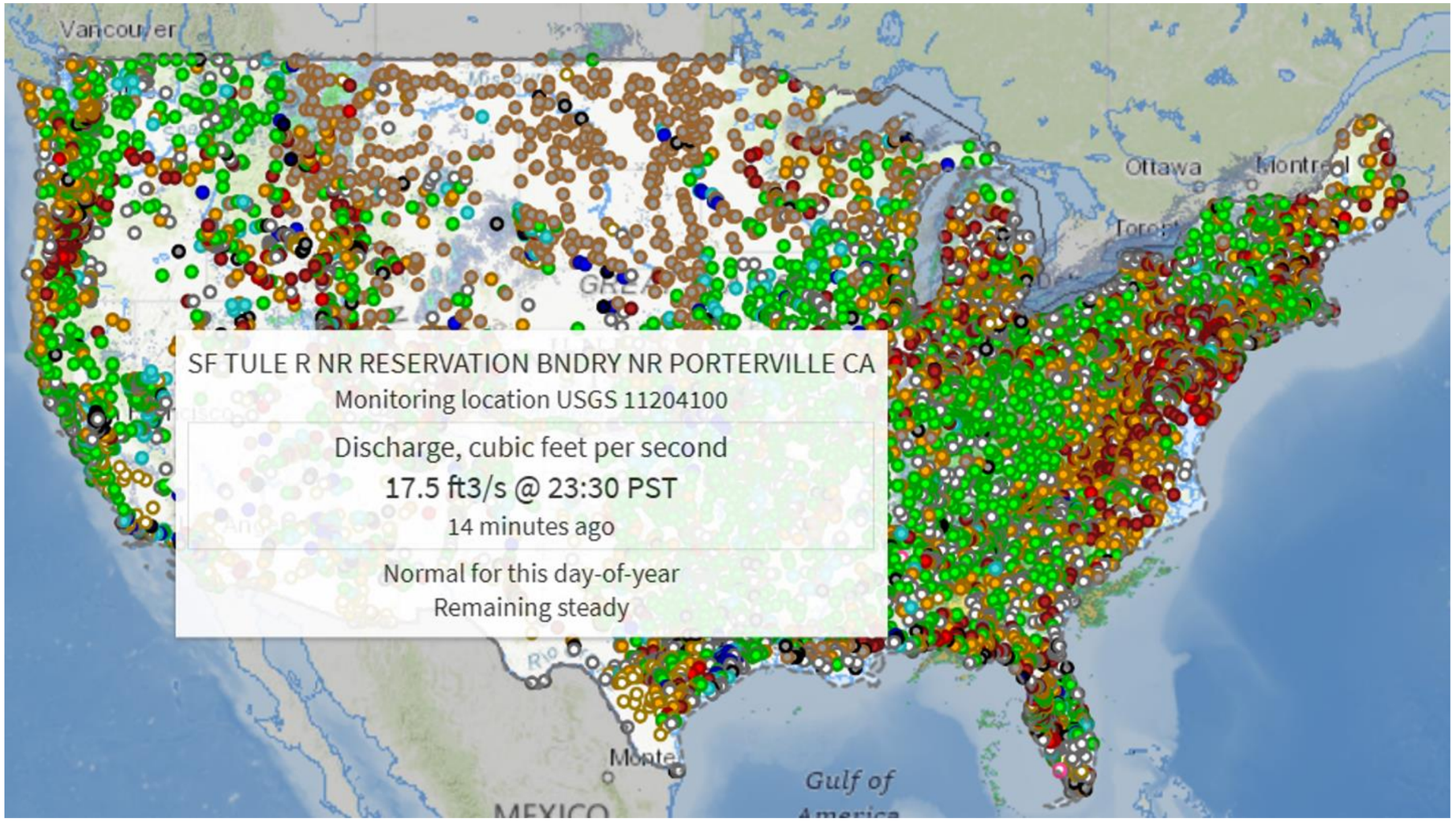
Critical flow data is often classified or delayed.

Reliance on manual readings or non-digitized records.

The Impact:

We are 'flying blind' on flood forecasting compared to global standards.

USGS Stream Gages

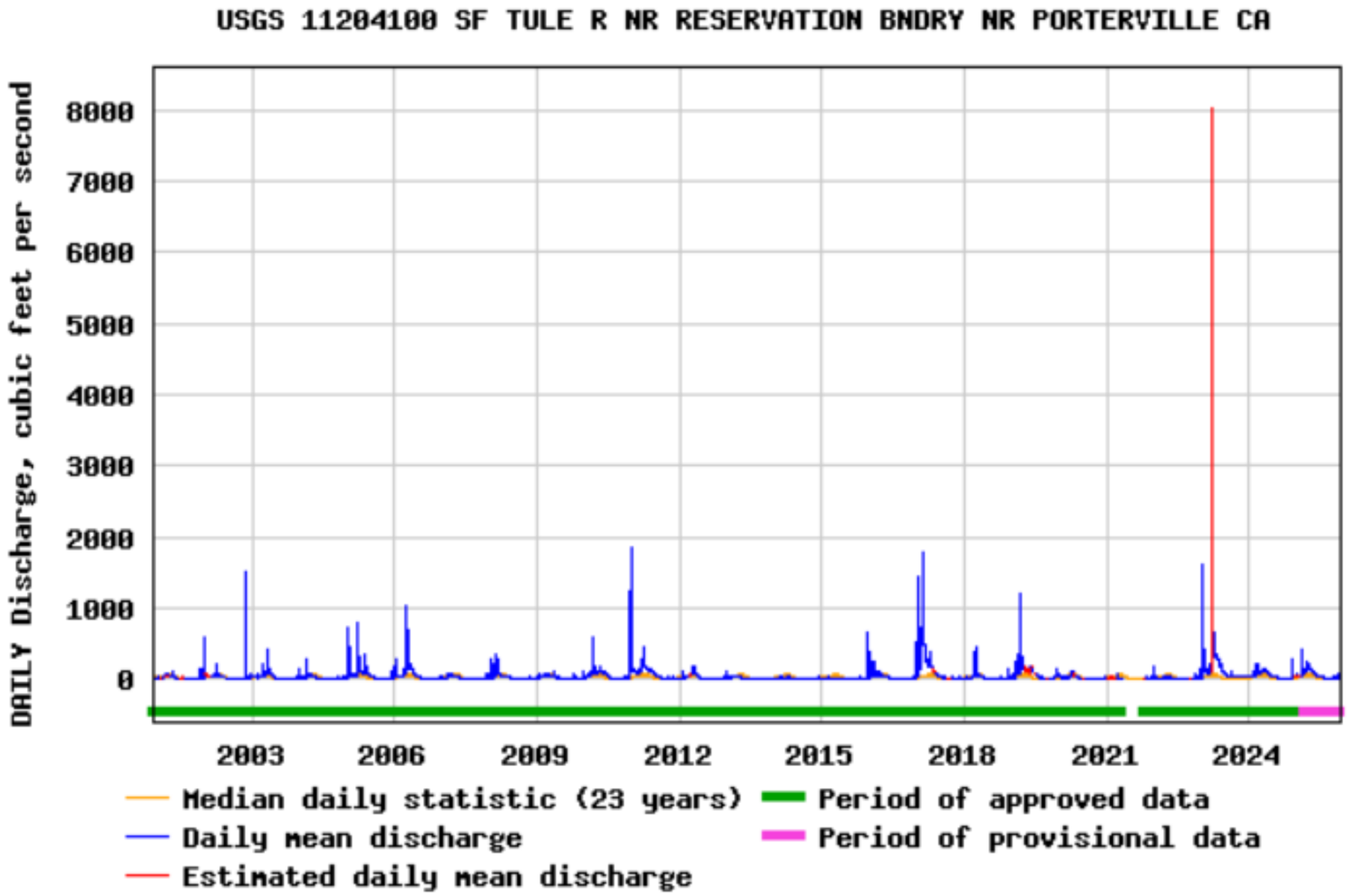


- **No sign-in or firewall** on the data. Anybody can download this data.
- Can write **automated code** and retrieve data for all the gauges!
- Can do the same for gauge **precipitation** as well (including **hourly data**)

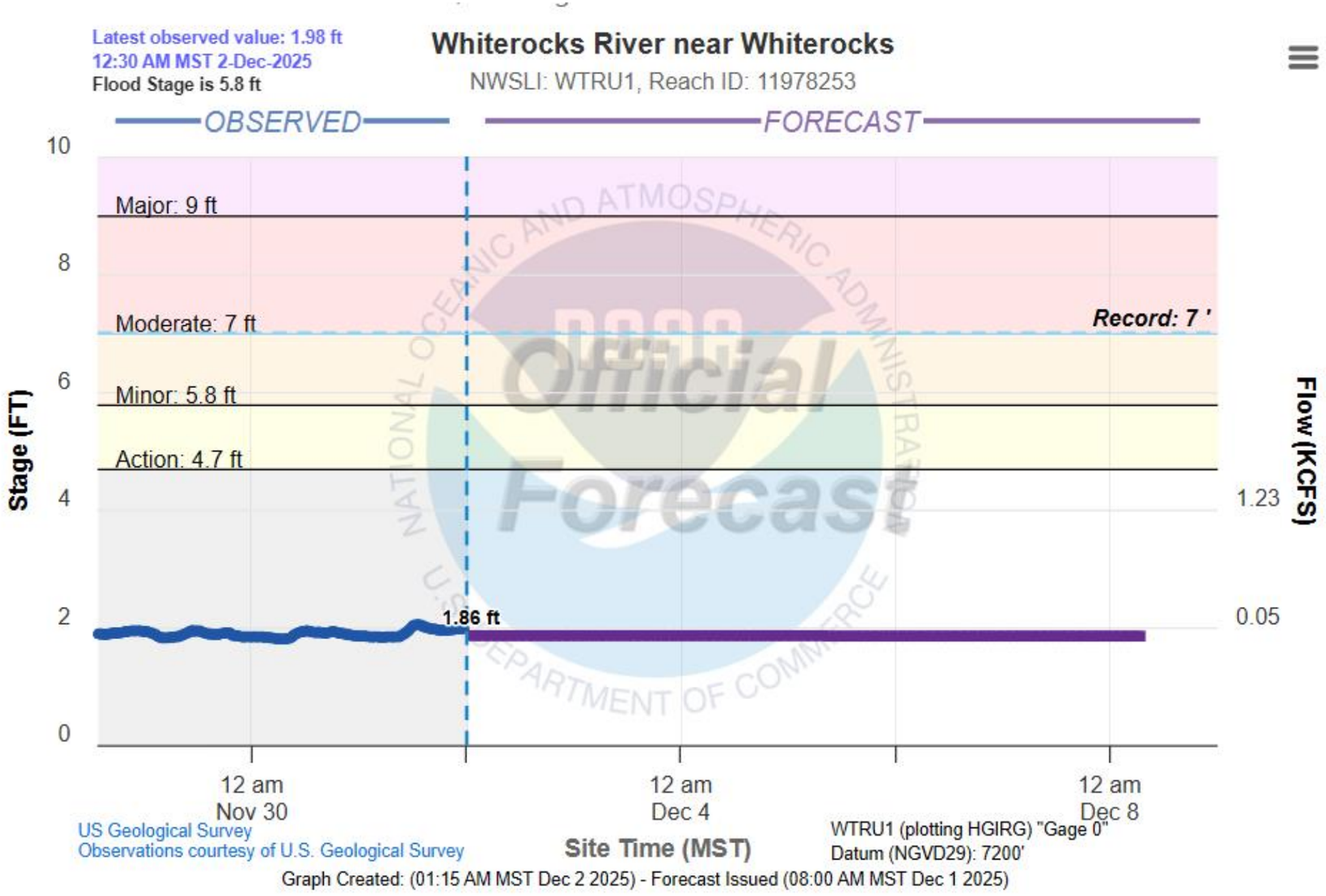
Source : [USGS National Water Board]

CWD CLEAR WATER DYNAMICS | Water, Environment & Infrastructure Planning

Change time span | Subscribe to WaterAlert | View related graphs | Download data | View data records



Forecast Data

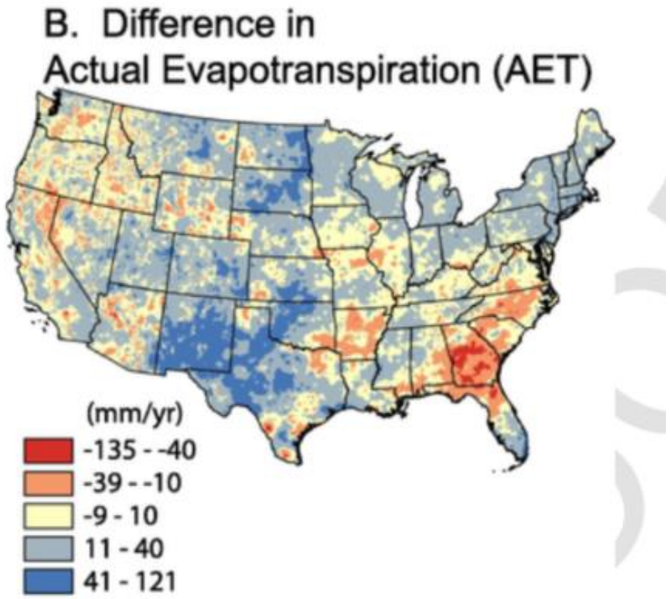


Source : [NOAA National Water Prediction Service (NWPS)]

CLEAR WATER DYNAMICS
Water, Environment & Infrastructure Planning

The Power of Gridded Data

Moving Beyond Point Data to Gridded Intelligence



Open access enables advanced tools:

PRISM & USGS WBM (Water Balance Model) outputs.

Gridded AET (Actual Evapotranspiration) & Runoff data.

India, being **a tropical country, AET** plays an important role in understanding **water demand**, yet it is hardly figured in conversations

Why this matters for India:

Cannot plan for climate resilience using only annual averages and return period design storms.

Similar to IMD gridded data, we need a gridded dataset for all the hydro-climatic variables.

Source : Huntington et al (2018)

The Cost of Invisibility

If We Can't Measure It, We Can't Manage It

Without granular data, 'Smart Utilities' are empty shells.

The 'Data Trust Deficit':

Engineers forced to use global datasets (uncalibrated for India).

Policymakers and scientists working with different sets of facts.

The Call to Action

Democratizing Data for Water Security

We need an 'API-First' Policy:

Data should be machine-readable by default.

The Goal:

An Indian equivalent of the USGS public portal.

India WRIS – Improve accessibility.

The Way Forward

India can achieve water resilience through integrated, digital water management.

A unified platform combining multiple data streams for comprehensive water management.

Real-Time River Discharge

Gauges + IoT sensors

Reservoir Release Data

Transparent operations

Quality Sensors

Lakes & rivers monitoring

Watershed IDs

USGS-style HUC system

Digital Twins

Stormwater + sewer models with
Real Time + Radar Integration Rainfall Data

Aquifer Telemetry

Groundwater monitoring

Outcome: Open data → better planning → risk reduction → equitable allocation

Data is not a luxury - it is the backbone of water security

India can achieve resilience, but only if we digitise every drop.

Thank You

Shyam Prasad: Founder & Director, Clear Water Dynamics Building resilient, data-driven water infrastructure for India

CWD CLEAR WATER DYNAMICS | Water, Environment & Infrastructure Planning