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Summary Report

A Circular Economy Approach to Reviving Bengaluru's Water Systems

April 2026

Introduction

As cities worldwide face growing challenges from rapid urbanization, water scarcity, and climate change, as well as sustainable and equitable water management solutions have become increasingly urgent. In Bengaluru, India, the city faces severe water management challenges brought on by rapid urbanization, water scarcity, and the pressures of climate change. Despite having the highest GDP in India, Bangalore faces a critical water paradox where over 50% of its water comes from increasingly deep wells in depleting aquifers.

To address this paradox, a pilot initiative **"A Circular Economy Approach to Reviving Bengaluru's Water Systems"** supported by Columbia World Projects (CWP) was developed by a multidisciplinary team from Columbia University's Climate School, Graduate School of Architecture, Planning and Preservation (GSAPP), and Mailman School of Public Health. The aim was to understand risks and toxicities in Bangaluru's current water systems, and introduce an urban planning paradigm to shift from large, centralized water management to an integrated system using traditional, nature-based and new technologies using a **Watershed Urbanism** framework.

The project used urban planning paradigms to offer an alternate framework of Watershed Urbanism to situate water preservation, management and lake revitalization in a larger hydrological system; conducted educational outreach to broaden the horizon of water focused curriculum delivered in primary and secondary schools; and examined the possibility of turning traditional drainage channels into public spaces and a "living classroom" to foster public engagement and stewardship, offering a model for other climate-vulnerable cities.

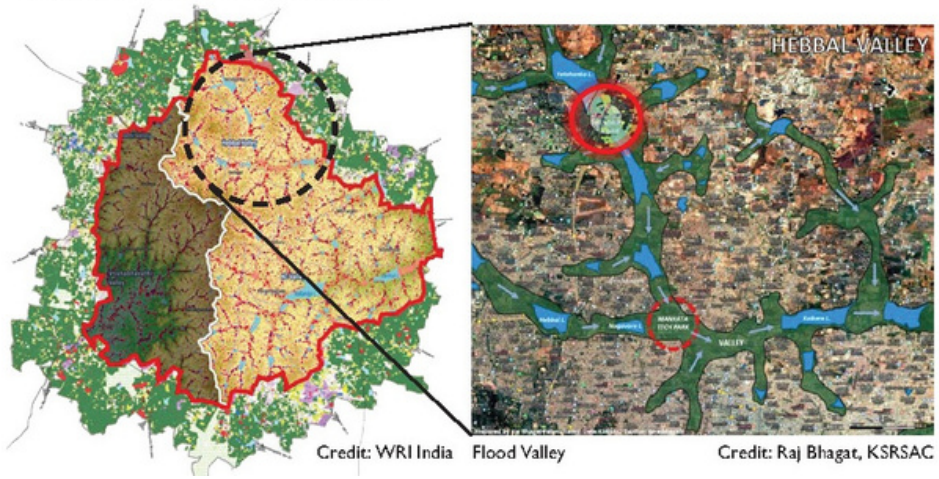
The project also included a scientific research component on groundwater quality and environmental exposure pathways, looking into the effects of inadequate or failing water infrastructure. This work focused on trace metal contamination and groundwater geochemistry in India and examined how water quality may relate to population health outcomes. The research included collaborations with leading Indian institutions, including the Indian Institute of Science (IISc) and the International Institute on Population Sciences (IIPS). These partnerships made it possible to connect environmental measurements with large population health datasets and extended the work beyond Bengaluru to address broader water and health challenges across India.

Background

Historically, Bengaluru relied on a sophisticated network of rain-fed tanks interlinked by drainage channels, which utilized the region's topography and relatively high rainfall compared to the surrounding arid plateau. Bengaluru is shaped through its watersheds and the city's two rivers, the Kaveri to the west and the Pennar to the east. The city's chain of lakes both inside and outside its municipal boundary are formed along natural drainage lines in the valleys. However, an understanding of Bengaluru's landscape as that marked by valleys and ridges has been lost in the collective consciousness of Bengaluru's urban citizens, and as such has been lost in water management strategies.

Between 1992 and 2015, Bengaluru started transforming from 'The Garden City' of India to a 'Silicon Valley' of India, driven by the IT boom and rapid immigration. This explosive growth was addressed in planning terms by importing Colonial Garden City planning models of the 19th Century, while the ground was occupied and filled-up replacing much of its open land with dense built-up areas, without respecting the terrain nor its hydrology.

High Flood Risk Zones of Bengaluru



Credit: WRI India Flood Valley Credit: Raj Bhagat, KSRSAC

High flood-risk zones align closely with Bengaluru's valley corridors that are the city's natural drainage paths. Water collects in these low-lying areas. This is where flooding occurs as in the Hebbal Valley's regions like Kendriya Vihar and Manyata Tech Park. The problem of flooding in the city is further exacerbated by the disappearance of drainage channels that are at best covered-up and built over, or at worst they become open sewers. Hard concrete linings worsen the problem by preventing water percolation.

The "**Circular Economy Approach to Reviving Bengaluru's Water Systems**" project sought to address the challenges of flooding, water scarcity, and contamination by reimagining drainage channels as essential hydrological infrastructure for flood control and aquifer recharge in peri-urban areas of Bangaluru. *What if drainage channels could become a generator of a new holistic approach to public space?* The team explored scenarios through which a drainage channel could become the backbone for new approaches, and to integrate watershed thinking into the planning framework, accounting for and addressing water recharge and purification.

By integrating urban planning with scientific research on groundwater geochemistry, the project sought to revive the concept of the "agricultural commons" to protect vital water resources.

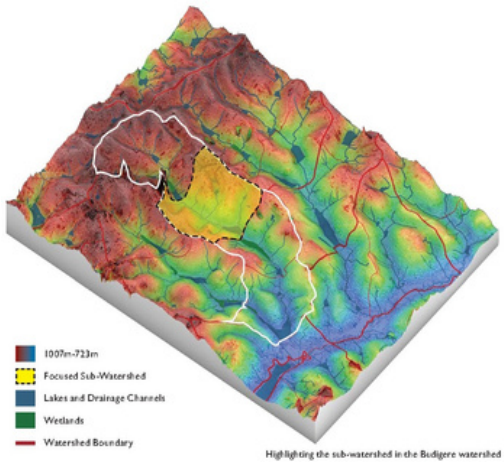
Objectives

- **Shift Urban Paradigms:** Establish "Watershed Thinking" as the standard for lake rejuvenation and flood control.
- **Reintroduce the Commons:** Integrate education with public space renewal to foster social ownership of water resources.
- **Scientific Mapping:** Use trace metals like uranium as tracers to validate groundwater flow paths and identify health risks.
- **Implement Pilot Proposals:** Develop site-specific models for reconfiguring drainage channels into bio-remediation infrastructure.

Methods

Over a nine month period, the project utilized a phased, multidisciplinary approach blending site exploration, GIS mapping, and community engagement:

- **Exploration:** Site visits to the Budigere Watershed and interviews with farmers, NGO staff, and Corporate Social Responsibility (CSR) funders to build partnerships and map existing water initiatives.
- **Framework Development:** Synthesis of GIS data, topography, and hydrology to create the Watershed Urbanism framework.
- **Collaborative Studios:** Facilitation of joint workshops between Columbia GSAPP and CEPT University students to design nature-based solutions.
- **Scientific Research (Months 1-9):** Identify uranium geochemistry through studies to trace aquifer contamination.
- **Dissemination and Engagement (Months 7-9):** Package and present findings and engagement of key stakeholders for next steps.



Highlighting the sub-watershed in the Budigere watershed

Student Engagement & Presentations

Within the project period, the team led a **GSAPP Summer Workshop** from July 21st through August 9th, focused on the Water Crisis in Bengaluru, with 9 students from GSAPP joined by 9 students and their department head of a local university, CEPT, in Bengaluru. Key inputs from partner organizations as well as research from student projects were integrated into the pilot lessons. See here for further information. A final workshop event was held in Bengaluru at the MOD Foundation (one of our collaborators for data collection) and an exhibition of student work, videos, and findings from the pilot was held at GSAPP in the fall of 2025.

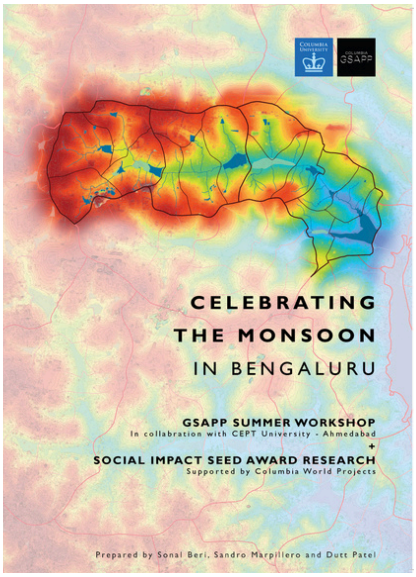
Findings

The project successfully redefined drainage channels viewed through modernist lenses only as direct connectors from upstream to the valley, to consider them instead as critical **hydrological apertures** for flood control and aquifer recharge. Feedback from organizations like the **World Bank, WIPRO Foundation** and **ITC Ltd**. confirmed that the Watershed Urbanism framework is highly effective for large-scale planning and governance. This approach reached the local government, who has established an Urban Design/Planning Committee within the World Bank-funded Karnataka Water Security Resilience Project (KWSRP) to apply a holistic approach to future water projects.

Over the study period, the team completed the publication of research in ***Environmental Science & Technology*** regarding uranium as a source tracer, which received significant national media coverage in India.

Key Outputs

- **Watershed Urbanism Framework:** A system for holistic water management and treatment approach incorporating water systems into urban water planning and infrastructure.
- **Scientific Research:** Validated trace element signatures as tracers for Indian groundwater flow paths.
- **Comprehensive GIS Collateral:** 3D drawings and maps illustrating the "hydrological story" of Bengaluru.
- **Educational Network:** Mapping environmental education stakeholders in Bengaluru including direct engagement with schools' administrators and students.
- **Webinars:** Webinars for dissemination of research to Climate Educators Network at a local and international scale.
- **Exhibition:** Exhibition of student work and research titled "We Stand in a Crisis with Water" at MOD Foundation Bengaluru and Avery Hall, Columbia University.
- **Booklet:** The work has been collected in a booklet "Celebrating the Monsoon in Bengaluru", printed by GSAPP office of communications.



Key Contributions

This project addressed the "Bengaluru Paradox" — a rapidly growing economy coexisting with seemingly contradictory water challenges: recurrent urban flooding and steadily depleting groundwater resources. It demonstrated that Bengaluru's water crisis is not merely a technical issue to be "solved" through conventionally engineered infrastructure, but one that is deeply political, cultural, and ecological.

By focusing on the upstream–downstream dynamics of drainage networks and interconnected lake systems, the Watershed Urbanism approach positioned water management as a catalyst for ecological restoration, climate adaptation, and community-led development. The project also helped address a critical gap in the governance and planning of peri-urban areas, where climate risks are intensifying most rapidly.

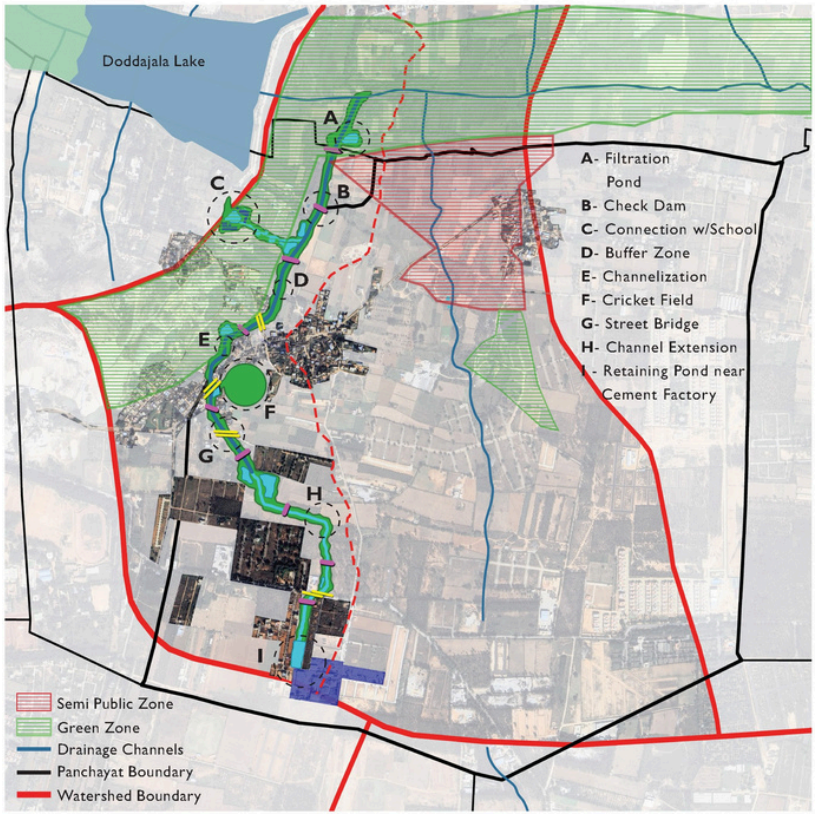
By integrating scientific research, traditional ecological knowledge, urban design, and climate education, the team developed a holistic model for sustainable development. This approach sought to reconnect communities with their environment while creating a shared Knowledge Commons that encourages collective stewardship and long-term resilience. Through the use of advanced media technologies, the project translated complex datasets into accessible and engaging formats such as video, enabling broader public participation and understanding across diverse audiences.

Next Steps

The project will move into advanced modeling and pilot implementation phases to scale up its findings:

- **Institutionalize a model of Watershed Urbanism** for peri urban areas, that integrates hydrological science, traditional ecological knowledge, and polycentric governance. The team proposes to create an AI assisted tool that translates complex geospatial, climate and community data into a decision support system for farmers, village councils and local governments. The tool will offer:
    - A mobile friendly, local language platform providing probabilistic agricultural forecasts and hydrological scenario modeling for peri-urban agricultural areas.
    - AI Driven development scenario simulations, including flood risk mapping comparing watershed informed planning to conventional master planning.
    - Crowd sourced real-time mapping of drainage channels and water bodies by communities and schools to ensure currency of data while fostering citizen engagement.
- **A Pilot Project:** Develop and implement a demonstration project, e.g. check dam or a water pool), based on a site selected through watershed analysis and simulation of a virtual scenario, assessed using the AI model.
- **A Watershed Urbanism Handbook** for scaling the approach through local governance and integration with World Bank's KWSRP.
- **Educational Field Testing:** Collaboration with local partners to field-test a holistic water literacy curriculum in local schools.
- **Advanced Hydrogeological Modeling:** Development of an integrated model for all of India to simulate contaminant transport under changing climate scenarios.

Drainage Channels as Bio-remediation Infrastructure | Pilot Proposal A



Project Team

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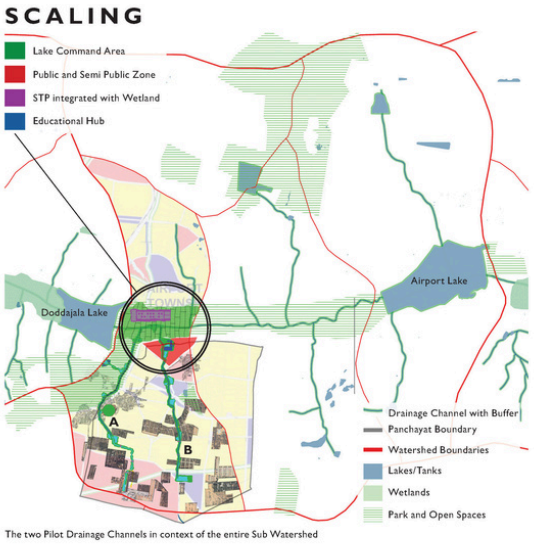
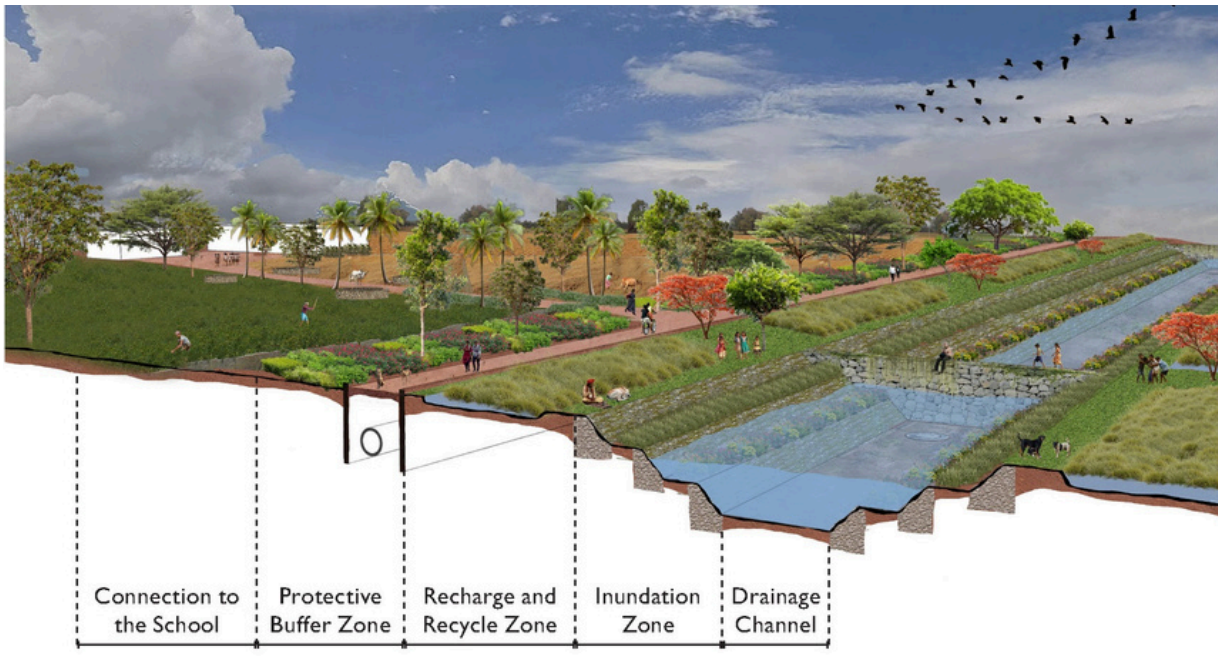
- **Sandro Marpillero**, Adjunct Associate Professor, Graduate School of Architecture, Planning and Preservation, Columbia University
- **Kathrin Schilling**, Assistant Professor, Department of Environmental Health Sciences, Mailman School of Public Health, Columbia University



The two Pilot Drainage Channels in context of the entire Sub Watershed



Additional Resources

Biswas, S., Chattopadhyay, A., Schilling, K. *et al.* Investigating the association between groundwater contaminants and hypertension risk in India: a machine learning-based analysis. *J Expo Sci Environ Epidemiol* **36**, 125–142 (2026). https://doi.org/10.1038/s41370-025-00776-0

Beri, S., Marpillero, S. NIUA Expert Talk, E5 | Watershed Urbanism Framework: Reimagining Urban Growth through Water Systems. September 1, 2025. https://www.youtube.com/watch?v=PNpobjLmEdg

Beri, S., Marpillero, S. Towards Watershed Urbanism | Vimeo Video. https://vimeo.com/1150892213?share=copy&fl=cl&fe=ci

Project Partners

Columbia Climate School
Center for Sustainable Development

COLUMBIA GSAPP

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