Microsoft

AI for Earth Grantee Profile

India Institute of Science

EqWater project

Summary

Dr. Yogesh Simmhan is part of an interdisciplinary team that is applying their experience with the Internet of Things to the challenge of water management in megacities. As part of the EqWater project, Dr. Simmhan will use data analytics and machine learning to identify inequities in water distribution and develop data-based recommendations to resolve them.

Enabling equitable water distribution to residents in megacities

Everyone has the right to “sufficient, continuous, safe, acceptable, physically accessible, and affordable water for personal and domestic use,” according to the United Nations. And although there is sufficient water on our planet to achieve this, 844 million people don’t even have access to a basic drinking water service, according to the World Health Organization. Furthermore, by 2025, water-stressed conditions will be a reality for half the world’s population. In India, “currently, 600 million Indians face high to extreme water stress,” a situation that is only expected to worsen. According to a report by NITI Aayog (a policy think tank of the Government of India), “by 2030, the country’s water demand is projected to be twice the available supply, implying severe water scarcity for hundreds of millions of people and an eventual ~6% loss in the country’s GDP.”

> By 2030, India’s water demand is projected to be twice the available supply.

Large cities are not immune to the challenges of meeting minimum water rights. In fact, according to Trucost, 14 of the 20 megacities in the world (that is, cities with populations exceeding 10 million people) are experiencing water scarcity or drought conditions. Water scarcity can take two forms—physical scarcity (insufficient supply) and economic scarcity (lack of access). One challenge facing the governing bodies of major cities and megacities is to ensure shared and equitable access to water for all residents. As populations within cities explode, the supporting infrastructure can’t always keep pace, exacerbating economic water scarcity. As the report by NITI Aayog points out, water crises affecting other global cities (such as Cape Town) serve as an example of the risks and challenges facing India’s own cities. Indeed, “by 2020, 21 major cities, including Delhi, Bangalore (Bengaluru), and Hyderabad, are expected to reach zero groundwater levels, affecting access for 100 million people."

Using scalable analytics to better manage a precious resource

How can megacities in water-stressed regions work towards ensuring minimum and equitable water availability for their residents? The EqWater project in India is looking at this very question, attempting to address the gap between the haves and the have-nots of water access in megacities across India. The project acknowledges that although there may be adequate water supply within a city for its residents, the distribution of that water is not necessarily equitable, meaning some residents have more than they need (leading to wastage) while others may not even have sufficient supply to meet the minimum requirements to support healthy life. The three-year project (2017–2020) supported by the IMPRINT initiative of the Government of India is targeting the southern neighborhoods of Bengaluru.

Dr. Simmhan is part of an interdisciplinary team that is applying their experience with IoT to the challenge of water management in megacities. [Photo courtesy Dr. Simmhan]

The EqWater project is an interdisciplinary collaboration between a team of investigators from civil engineering, cyberphysical systems, management studies, and data science, and is applying Internet of Things (IoT) technologies over the water distribution network to address this challenge. Dr. Yogesh Simmhan, an assistant professor in the Department of Computational and Data Sciences at the Indian Institute of Science in Bengaluru and one of the investigators, is using data analytics, machine learning, hydraulic models, and optimization and scheduling algorithms to:

- Understand and model the inequity in access to water for individual neighborhoods and residents of the city.
- Identify the causes of inequitable distribution.
- Develop interventions to address the inequitable distribution, such as improved water scheduling by the city utility, detecting and correcting leakages due to aging infrastructure and pilferage, and establishing incentives for residents to ensure fair usage.

The project is taking advantage of the data collection already in place by Bengaluru Water Supply Sewerage Board (BWSSB) and municipality:

- Sensor data that shows how much water is flowing through the pipes in individual neighborhoods on a roughly hourly basis (these provide data with coarse spatial granularity but fine temporal granularity).
- Residential metering data at the individual residence level, collected on an approximately monthly basis through manual meter readings (this provides data with fine spatial granularity but coarse temporal granularity).
- Data on how much water is piped through large reservoirs within and on the outskirts of the city (data with coarse granularity).
- Demographic and socioeconomic data—for example, census data on the number of residents and income levels of each household (from various public data sources, with varying degrees of granularity).
- Seasonal weather data.

Using this data, the team has been able to create a model to predict peak demand and identify gaps in the supply chain. They are using data analytics and machine learning to highlight inequities based on both location (ranging from individual district metering areas [DMAs] in the city to specific residents) and time (both seasonally and at various time scales). Microsoft Azure and machine learning resources provided by a Microsoft AI for Earth grant are being used to develop analytics and visualization over the multi-dimensional observational sources (both spatial and temporal), provide the computing power required to scale the outcomes of the resulting model to larger regions using big data platform services, and perform deep learning if required.

The team has already completed phase one of the work on Azure—modeling the distribution of water across the city and mapping which neighborhoods are getting more, and which are getting less. Over the next year, they will use these findings to identify the root causes for the inequities and develop recommendations for data-based intervention strategies. These interventions will take into account both technical and policy challenges. For example, in neighborhoods at higher elevations, the pumps may not have the capacity to pump sufficient water without a physical infrastructure upgrade. From a policy perspective, where a disparity in

> "Scalability and sophisticated analytics were an immediate challenge, so Microsoft Azure cloud and machine learning resources were a major boost to the project." – Dr. Simmhan

distribution is identified, the data may help answer whether the best course of action is to address the gap or invest in other improvement measures within the neighborhood. By using data and analytics to generate the intervention recommendations, the decisions can be made scientifically rather than using an ad hoc, instinctive approach.

Moving forward

The team will ultimately present their recommendations to city policymakers. This work has the potential to transform water management in the city of Bengaluru into a data-driven approach that supports water allocation transparency and equity. It will enable data-based resource allocation policies, the enactment of these policies through specific distribution schedules, and dynamic adaptation of those schedules based on real-time consumption demand and environmental factors, helping to avoid excess supply that can lead to wastages. Furthermore, it will offer transparency to residents about water consumption—their own, their neighborhood's, and the city's—which should ultimately help reduce overall demand and assist with water conservation efforts. Equity and sustainability of water resource management are the key metrics for success. This work also has the potential to serve as a template for other megacities.

Looking ahead, the team is aiming to gather more detailed data from the field by installing more sensors in a subset of the DMAs to capture more real-time data (both spatial and temporal) with the hope of enabling even more efficient and economical delivery of water services.

About the project team

Dr. Simmhan is a computer scientist and researcher focused on distributed systems—spanning everything from cloud computing to big data platforms to algorithms. Prior to joining the Department of Computational and Data Sciences at the Indian Institute of Science, Dr. Simmhan was part of the research faculty at the University of Southern California. In that role, he worked with the Los Angeles Department of Water and Power—the largest municipal utility in the United States—on a project to upgrade its power grid to a smart grid. This experience has proved a valuable foundation for his work with the Bengaluru EqWater project. He also has a PhD in computer science from Indiana University in Bloomington.

As part of the EqWater project, Dr. Simmhan works as part of an interdisciplinary team led by principal investigator Professor MS Mohan Kumar, a hydrologist and water engineer. The other members of the team include Professors Rajesh Sundaresan, R Parthasarathy, Bharadwaj Amrutur, Chiranjib Bhattacharyya and PN Ravindra, and represent disciplines including civil engineering, electronics, communications, management, and water research.

Resources

Primary Contact

Yogesh Simmhan
Computational and Data Sciences, Indian Institute of Science, Bengaluru
simmhan@iisc.ac.in

Press

"Green warriors from India receive Microsoft AI for Earth grants to enable a sustainable future."
Microsoft News Center India. November 2018.
https://news.microsoft.com/en-in/features/microsoft-ai-for-earth-grant-recipients-india/

Websites

EqWater | IMPRINT India
DREAM:Lab
Microsoft AI for Earth
Microsoft environmental sustainability

Documentation

"Human Rights to Water and Sanitation." United Nations Water. Accessed March 15, 2019.
http://www.unwater.org/water-facts/human-rights/

"Goal 6: Ensure access to water and sanitation for all." *Sustainable Development Goals*. United Nations. Accessed March 15, 2019. https://www.un.org/sustainabledevelopment/water-and-sanitation/

"Drinking-water." World Health Organization. February 7, 2018.
https://www.who.int/news-room/fact-sheets/detail/drinking-water

Composite Water Management Index: A Tool for Water Management. NITI Aayog. June 2018. http://www.niti.gov.in/writereaddata/files/document_publication/2018-05-18-Water-index-Report_vS6B.pdf

Libby Bernick. "Business Growth in an Era of Water Scarcity: Revenue at Risk." Trucost. October 22, 2015. https://www.trucost.com/trucost-blog/business-growth-water-scarcity-revenue-risk/

Obeng, Letitia & Bahri, Akissa & Grobicki, Ania. (2015).
Water Scarcity and Global Megacities. 10.13140/RG.2.1.1123.2080.
https://www.researchgate.net/publication/285769705_Water_Scarcity_and_Global_Megacities