Data-driven models for the long-term health and resilience of urban environments



Over half of the world's population—including four out of five Americans—lives in cities. As urban areas have developed over the past century, most have become less and less prepared to handle climate change. Less densely populated city centers, combined with urban sprawl, have led to increases in heat and emissions along with decreases in tree cover and fresh water.

The climate-conscious cities of the future will need smarter designs that reduce city footprints, improve walkability, and re-introduce nature areas. However, city planners often struggle to predict the effects of climate change and to decide which interventions will be most effective in the context of their city.

Researchers at the University of Notre Dame are creating a solution to this problem powered by a new type of model called a **digital twin city**. Digital twin cities help urban planners by offering a virtual environment to experiment with different solutions to a city's complex problems. Notre Dame researchers are moving beyond existing digital twin models to include climate-related concerns.

Learn More

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To create a digital twin city, researchers build a comprehensive model of the entire urban area by layering five different types of data. The comprehensive digital model is built using data from sensors and the Internet of Things (IoT) that is combined with measurements of the flow of people and goods in the city along with data on the city's infrastructure, buildings, and terrain.

The researchers can then use the model to simulate the effects of new infrastructure investments as well as new threats, including glacial ice melt, sea level rise, water scarcity, storms, hurricanes, floods, and wildfires. The models create predictability so that planners can act in confidence as they make decisions about new designs, buildings, development areas, and infrastructure projects.

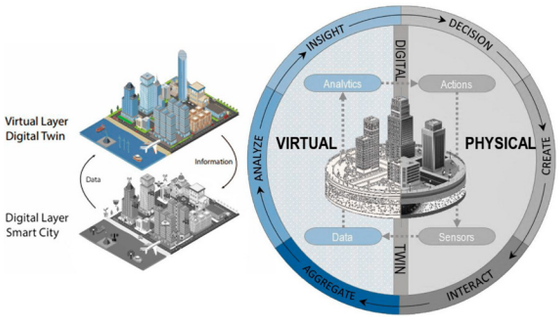
A Broad, Interdisciplinary Approach

Notre Dame's digital twin cities project draws upon a rich, multidisciplinary set of perspectives on integral human development and how cities can promote or undermine it. Collaborators at Notre Dame come from many departments across the School of Architecture, the College of Engineering, and the College of Science. The Lucy Family Insitute for Data and Society and the Rohr Lab of Ecology and Public Health are core partners.

External collaborators bring valuable data and broad experience in the creation of models. These include the MIT Media Lab City Science Lab; NASA Sea Level Rise; the NASA-ISRO Synthetic Aperture Radar (NISAR) satellite; Esri, the world's leading supplier of GIS software; Xylem Water Solutions; the University of Colorado; and Northeastern University.

A Rich Understanding of the Built Environment

All partners and collaborators are guided by Notre Dame's distinctive approach to urban planning, which is grounded in a vision of integral human development and care for our common home.



In particular, Notre Dame's digital twin cities project developed from the work of lead principal investigator Krupali Uplekar Krusche. An associate professor in Notre Dame's School of Architecture, Krusche directs the Digital Historic Architecture and Material Analysis (DHARMA) Lab. The Lab has partnered with the Archaeological Survey of India, the United Nations Educational, Scientific and Cultural Organization (UNESCO), and others to create digital replicas of the Mughal tombs of Agra, India, the Taj Mahal, the Vatican's Belvedere Courtyard, and the Roman Forum.

To begin working at a larger scale—moving from a single building to an entire city—Krusche founded the Development and Advancement of Resilient Cities Alliance (DVARCA) Lab. The DVARCA Lab focuses specifically on interventions for healing, mitigating, and adapting to the effects of climate change.

