Global water use may outstrip supply by mid-century

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Population growth could cause global demand for water to outpace supply by mid-century if current levels of consumption continue. But it wouldn't be the first time this has happened, a Duke University study finds.

Using a delayed-feedback mathematical model that analyzes historic data to help project future trends, the researchers identified a regularly recurring pattern of global water use in recent centuries. Periods of increased demand for water—often coinciding with population growth or other major demographic and social changes—were followed by periods of rapid innovation of new water technologies that helped end or ease any shortages.

Based on this recurring pattern, the model predicts a similar period of innovation could occur in coming decades.

"Researchers in other fields have previously used this model to predict earthquakes and other complex processes, including events like the boom and bust of the stock market during financial crises, but this is the first time it's been applied to water use," said Anthony Parolari, postdoctoral research associate in civil and environmental engineering at Duke, who led the new study.

"What the model shows us is that there will likely be a new phase of change in the global water supply system by the mid-21st century," Parolari said.

"This could take the form of a gradual move toward new policies that encourage a sustainable rate of water use, or it could be a technological advancement that provides a new source of water for us to tap into. There's a range of possibilities," he said.

Data on global water use shows we are currently in a period of relatively stagnant growth, he said. Per-capita water use has been declining since 1980, largely due to improved efficiency measures and heightened public awareness of the importance of conserving Earth's limited supply of freshwater. This has helped offset the impacts of recent population growth.

"But if population growth trends continue, per-capita water use will have to decline even more sharply for there to be enough water to meet demand," he said. The world's population is projected to surge to 9.6 billion by 2050, up from an estimated 7 billion today.

"For every new person who is born, how much more water can we supply? The model suggests we may reach a tipping point where efficiency measures are no longer sufficient and water scarcity either impacts population growth or pushes us to find new water supplies," Parolari said.

Water recycling, and finding new and better ways to remove salt from seawater, are among the more likely technological advances that could help alleviate or avoid future water shortages, he said.

Parolari was inspired to conduct his study by the work of Austrian physicist and philosopher Heinz von Foerster, who in 1960 collaborated with students to publish a tongue-in-cheek study in the journal *Science* predicting that through feedbacks between human demographics and technological development, population growth would overcome any limitation imposed on it by finite resources and become infinite by

November 13, 2026 - the 115th anniversary of von Foerster's birthday. The prediction became known as the Doomsday Equation.

"Historically, many hypotheses about future population and resource trends have been pessimistic. Von Foerster's hypothesis poked fun at these projections. But the serious part of his study provided an alternative and exciting view of the future: Humans are creative and resourceful, and when push comes to shove, we find new ways to either increase our supply or use what we have more efficiently," Parolari said. "Our model supports this more optimistic outlook. The demand for water will push us to innovate as it has repeatedly done before."

Parolari and his colleagues published their study this month in the peer-reviewed journal *Wiley Interdisciplinary Reviews: Water*. His co-authors on the new commentary were Gabriel G. Katul, Theodore S. Coile Professor of hydrology and micrometeorology at Duke's Nicholas School of the Environment, and Amilcare Porporato, Addy Professor of civil and environmental engineering at the Nicholas School and Duke's Pratt School of Engineering.

More information: "The Doomsday Equation and 50 Years Beyond: New Perspectives on the Human-Water System," Anthony J. Parolari, Gabriel G. Katul and Amilcare Porporato. WIREs Water, Mar. 11, 2015. DOI: 10.1002/wat2.1080

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