Predicting Droughts and Floods

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Climate change has brought increased concern over the rise of extreme weather events around the globe. Water resources are fundamentally impacted by climate change with more regions of the world affected by extreme weather, such as droughts. Incidents of heavy rain leading to flooding have increased as well.

Such events can have far-reaching effects on human health, the environment and our society. The growing prevalence of drought conditions increases the risk of water shortages and wild fires as well as water- and food-borne diseases. Heavy precipitation affects the quality of surface and groundwater, can contaminate the water supply, and cause substantial disruption to settlements, commerce, and the infrastructure that sustains these communities.

Pierre Gentine, Assistant Professor of Applied Mathematics, studies the relationship between hydrology and atmospheric science, and its impact on climate change. His research began in Morocco from 2002 to 2004 as an engineer with the French space agency. There, he studied hydrology in a semi-arid region – a transition between the desert and a vegetated region.

Based on the data collected during those years, he has developed simple models to understand the hydrological cycle and the link between water resources and climate change. While other scientists are analyzing huge data sets in supercomputers, Gentine's models are simplified, to explain what's happening in the global climate in broad terms.

Gentine's research focuses on land and atmosphere interactions and the inherent feedback between the two systems. The overall motivation of his work is to improve the estimation of evaporation over land, which in turn improves water resources management, weather and climatic forecasts.

"The Sahara desert was once green, some centuries ago, and is now totally dry," Gentine says. "We expect these semi-arid regions to evolve in the same way."

His scenarios predict more extreme weather – drier in places now experiencing drought, and wetter in regions beset with floods. In dry regions, increasing temperatures will make the soil even drier, which will stress vegetation, and result in less transpiration into the atmosphere. That, in turn, will lead to less rainfall. "With this feedback loop, the phenomena become worse."

It's just the opposite in areas now experiencing higher than normal rainfalls, which has led to extensive flooding. Warm temperatures will increase humidity, and water from the soil will evaporate, putting more water into the atmosphere, creating the likelihood of even more precipitation.

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