Making climate models simple

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For many years, climate change has been a looming threat on the minds of infrastructure engineers. But recently, this threat has become much more apparent to the general public. Many effects of climate change can be damaging to infrastructure: changes in extreme temperatures, variations in precipitation, severe weather, increased sea levels, and in some areas, a decrease of clean water availability.

"Record-breaking rainfall has triggered more than 20 severe flood events in parts of Texas, Oklahoma, Louisiana, Arkansas, Missouri, Iowa, Florida, North Carolina, and South Carolina in 2015 and 2016," reports Carnegie Mellon University Department of Civil and Environmental Engineering Professor Costa Samaras. "These events have led to the closure of two airports, flooding of more than 200 homes, numerous evacuations, cars stalled in high water requiring rescue, and deadly flash flooding."

There has been a big increase in weather and climate disasters with damages in the billions of dollars in the U.S. over the last few years. And these numbers will only continue to rise as the climate worsens and our civil infrastructure becomes more and more overloaded. In order to save future lives, as well as our cities, civil and environmental engineers need to incorporate climate change information into their design standards moving forward. But this is much easier said than done.

This is why Samaras, along with CEE Graduate Research Assistant Lauren Cook and Iowa State University Research Assistant Professor Christopher Anderson came up with a solution. In their paper, "Framework for Incorporating Downscaled Climate Output into Existing Engineering Methods: Application to Precipitation Frequency Curves," the team lays out a five-step framework to guide the revision of design standards through the use of publically available climate model outputs of future precipitation. This will help engineers define the relevant aspects of the existing standards that need to be updated, then select the relevant climate data to update the standards appropriately.

"The problem lies in how to use the output from many different climate models," Samaras says. "Most agree on the direction of temperature change, but trend and magnitude of precipitation varies by location, leading to uncertainty on exactly how much rain to expect. This makes models and data on climate change hard to apply to infrastructure design, which requires very specific and concrete instructions."

Because climate models can't provide highly location-specific information, it is very difficult for infrastructure designers and other stakeholders to implement these models into their decision-making. But because infrastructure design standards are so widely used, the potential public consequences of ignoring the future effects of climate change can be widespread and devastating.

So far, the team has tested their new model by applying it to a common input of storm water infrastructure design: depth-duration-frequency curves. These curves and their application will determine the performance and resilience of storm water infrastructure during future extreme events.

"The research being done here at Carnegie Mellon can lead to big advances in how cities and communities prepare and design for the impacts of climate change," Samaras says. "It's our duty as engineers to consider how infrastructure performs both now, and in the future."

More information: Lauren M. Cook et al, Framework for Incorporating Downscaled Climate Output into Existing Engineering Methods: Application to Precipitation Frequency Curves, *Journal of Infrastructure Systems* (2017). DOI: 10.1061/(ASCE)IS.1943-555X.0000382

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