Researchers link climate change to urban and suburban stormwater management

Reviewed by James Ives, M.Psych. (Editor) Jul 30 2019

UMD researchers are connecting climate change to urban and suburban stormwater management, with the ultimate goal of increasing resiliency to major storm events. With models not only predicting more rain, but an increased frequency of particularly intense and destructive storms, flooding is a major concern in communities that are becoming more settled with more asphalt. Flooding doesn't just cause property damage, but it impacts the health of the Chesapeake Bay through increased nutrient runoff and pollution. In a new case study published in the *Journal of Water Resources Planning and Management*, researchers examine two distinct watersheds and demonstrate that even small decentralized stormwater management practices like rain gardens can make a big cumulative difference to the resiliency of a watershed, using predictive modeling to assess what climate change will demand of our future stormwater management systems.

"What we design now is in place for 20 or 30 years, so we should design it with future climate conditions in mind as opposed to what the past rain has looked like," explains Mitchell Pavao-Zuckerman, assistant professor in Environmental Science & Technology. "This work puts emphasis on what's happening in local upland spaces that has immediate implications for the people who are living in these watersheds for future flood mitigation, but connects this to the broader issues of how increased runoff links to the health of the Chesapeake Bay."

With this study, Pavao-Zuckerman and graduate student Emma Giese take a practical look at what suburban areas are currently doing to manage their stormwater, and provide some evidence on how and why to implement green infrastructure based on how these systems will hold up in the future. Pavao-Zuckerman and Giese leveraged data available from the United States Geological Survey (USGS) for two watersheds in Clarksburg, Maryland, a suburban town in Montgomery County that is only growing and continuing to develop. These two watersheds each have a distinct development history - one has several larger-scale detention ponds or stormwater basins for a more traditional approach to stormwater management, while the other has a heavy presence of smaller-scale green infrastructure like rain gardens, dry detention ponds, and sand filters. Both watersheds were monitored before and after development to see the impacts of green infrastructure, and both are near a weather monitoring station with climate data that is readily accessible.

"Green infrastructure consists of things with a much smaller footprint than a stormwater basin, but there are more of them in the watershed, so it comes down to measuring the aggregated effect of a lot of small things in one watershed rather than one or two large things in another watershed," says Pavao-Zuckerman. "Partnering with the USGS to have a good data source at the watershed scale and finding the right model for the question was key."

To model future climate change scenarios for these two watersheds, Pavao-Zuckerman and Giese enlisted the help of Adel Shirmohammadi, professor and associate dean in the College of Agriculture & Natural Resources. "Together, we were able to use the USGS data to train the Soil and Water Assessment Tool or SWAT model, taking into account the geography of the watersheds, slope, soil type, impervious surface, built versus open space, and other parameters to determine how much rainfall actually becomes runoff or flooding risk," says Pavao-Zuckerman.

Using this model, Pavao-Zuckerman and Giese were then able to take climate change projection data for increased storm frequency and rainfall to run a variety of future scenarios and see how these different watersheds would manage. "We've already seen a significant increase in rainfall in the present day, so we were surprised to see that our baseline present day measure was already seeing the effects of increased rain," says Pavao-Zuckerman.

Ultimately, Pavao-Zuckerman and Giese found that the watershed with more green infrastructure was able to buffer and absorb more of the increased rainfall than the more traditionally designed watershed with larger stormwater basins. However, with larger or more intense rain events, both systems failed to handle the amount of rain successfully. "We are seeing more large storm events so either the systems are overwhelmed or are still saturated by the time the next storm event comes," says Pavao-Zuckerman. "So it is really the bigger rain events where we are seeing things not work as well, and that's concerning partly because we know that with climate change these more intense events are going to become more common. This points to the need to plan for these more intense weather events in stormwater management infrastructure."

To combat this issue, Pavao-Zuckerman and Giese did find that increasing the capacity for some of the existing systems or increasing the presence of green infrastructure in the watersheds made them more resilient to future extreme rain events. With that in mind, Pavao-Zuckerman and Giese worked with Amanda Rockler, watershed restoration specialist and senior agent with UMD Extension and the Maryland Sea Grant Program, to provide insight into what was feasible to implement. "Our work allows us to see what the added return on investment in these different climate and stormwater management scenarios might be," says Pavao-Zuckerman. "It's more concrete than just saying more green infrastructure is better, which isn't practical and might have a cost-benefit trade off."

The full article entitled "Assessing Watershed-Scale Stormwater Green Infrastructure Response to Climate Change in Clarksburg, Maryland" is available through the *Journal of Water Resources Planning and Management*, DOI: 10.1061/9780784479018, or through Pavao-Zuckerman's website: https://pavaozuckerman.wordpress.com/publications/

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