Book on the design, management and function of green roofs highlights UC research

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Ishi Buffam and Mark Mitchell are at one of the green roofs at the Civic Garden Center of Greater Cincinnati. Credit: Andrew Higley/University of Cincinnati

City workers, city dwellers and city tourists consider green roofs the

lush, enchanted gardens that bring the inspiration of nature into an urban setting. A new book includes research out of the University of Cincinnati that explores the dynamics of nutrient cycling in green roof systems. The research by Ishi Buffam, a UC assistant professor of biological sciences, and Mark Mitchell, a doctoral student in biological sciences, is featured in the book, "Green Roof Ecosystems" by Springer Publishing.

The book takes an ecosystem perspective toward examining the very latest research, design and management of green roofs.

Green roofs provide both beauty and function - such as cooling the so-called urban heat island effect that causes cities to be considerably warmer than the more open and vegetative metropolitan areas that surround them. They also cool the buildings beneath them, saving on energy costs and actually protecting the roof from heat and sun, extending the lifetime of the roof. They can serve as habitats for wildlife such as pollinating insects.

Germany led the early adoption of green roofs, where policies have encouraged green roof implementation for more than 20 years. Their use has been growing in the U.S. over the past decade.

"There's a growing interest in greening cities, which I applaud," says Buffam. "Green roofs reclaim some of the functions of natural ecosystems. They can reduce storm water runoff, which is particularly important in cities like Cincinnati that have combined sewer systems. The more water that's kept out of storm drains, the less raw sewage flowing into local streams and rivers."

Buffam's work largely addresses factors influencing the water quality and surface waters (streams, rivers and lakes) - including management of urban green infrastructure. The researchers' book chapter is an extensive review of national and international research on the processes controlling

nutrient cycling in green roof systems - with an eye toward how to keep vegetation flourishing while minimizing nutrient losses to surface waters.

"Because the system is built to support the vegetation, it has fertilizer integrated into it," explains Buffam. "If there's a storm and the roof becomes saturated, the system is designed to drain so the plants don't drown. As a result, some of those nutrients that are in the fertilizer are going to leach out, and over time, those excess nutrients are flushed out of the system. We're looking at that dynamic over time, and the within-roof ecosystem processes that are important contributors."

The UC researchers also are collaborating with engineers in examining how to design green roofs - particularly the substrate, or soil - so that there's not as much need for fertilization or so that it holds on to the nutrients needed for the vegetation.

"We've seen that many green roofs have an excess of phosphorus, which could be a result of phosphorus-rich compost in the substrate," explains Buffam. "For most buildings, that runoff goes directly into the sewer system and under low-flow conditions it would go to the wastewater treatment plant.

"It's still better than raw sewage overflow that can result during storm conditions, but whenever we see phosphorus-rich water being fed into the system, it is of concern," says Buffam. "So we want to understand how it's coming off, why it's coming off and how green roofs can be better designed so they don't have that issue, because there are so many other positives to having green roofs."

The researchers have studied numerous green roofs around Cincinnati, including the roof at Sanitation District No. 1 in Covington, Ky., the regional pioneer of the green roof infrastructure. They have also studied the green roofs at the Civic Garden Center of Greater Cincinnati, which

drains runoff into barrels for reuse. They also conduct plot-scale experiments at the UC Center for Field Studies where they use trays to build green roof systems. An ongoing experiment with biochar, a powdery substance which has a high water holding capacity, resulted in a striking increase in water retention. That experiment is supported with grant funding from the U.S. Geological Survey in partnership with the Ohio Water Resources Center.

"One possible solution to the phosphorus leaching issue is to add materials into the substrate that would bind the phosphate strongly, as long as it's still plant available," says Buffam.

"Phosphorus is valuable, and it's only going to become more valuable as it becomes more limited and we deplete phosphorus reserves, so we want to look at ways to conserve it instead of dumping it into the water, where it's going to be a nuisance. We haven't found any magic bullets yet."

The book is available online and can be ordered in hard copy next month.

Provided by University of Cincinnati

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