Supporting Urban Sustainability with Ecosystem Science: Long-Term Dynamics of Green (Vegetated) Roofs

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The world is rapidly urbanizing, with two-thirds of global inhabitants expected to live in cities by the year 2050. At the same time, many cities are becoming more and more densely developed, in an effort to increase efficiency and reduce energy use. A common consequence of these changes is a loss of natural green spaces. Lack of sufficient high-quality green spaces in cities accentuates urban challenges including urban heat islands, air pollution, flooding, and biodiversity loss – degrading both natural ecosystems and people's quality of life.

One of the main approaches taken to try to address these challenges, is to (re)construct nature by planning, designing and implementing urban green spaces of various types. These Nature-based solutions can help by contributing Ecosystem Services, i.e. support for human well-being from functioning ecosystems. One approach, green roofs (GR) (roofs with plants and soil-like substrate overlaying a building structure) has arisen as a prevalent Nature-based solution in cities worldwide, installed for their ability to provide needed ecosystem services including reduction of stormwater runoff, localized cooling, carbon sequestration, aesthetic enhancement, and biodiversity support. Green roofs represent an intriguing strategy using living architecture to try to get the most out of otherwise-unused space in an urban setting where vegetation can be hard to come by – particularly relevant in the dense urban core where space is at a premium. Many cities worldwide have thus embraced green roofs as part of their urban planning strategies to address environmental challenges.

The assumption on installing a GR is that the key ecosystem services will be provided at a high level for the 50+ years lifespan of the roof. However, as living systems, green roofs are dynamic over time due to changes in soil and vegetation properties. In spite of this, to date almost all GR research has used newly constructed (<2 yrs old) green roofs or small plots. Thus, there is a critical knowledge gap regarding the dynamics of green roof ecosystems and their ecosystem services over the longer term.

In my presentation, I will give an overview of the body of knowledge relating GR ecosystem characteristics to their provided services, with a particular focus on hydrological and biogeochemical function – i.e. the ability of the system to hold on to water, carbon, and nutrients – and on the long-term trajectory of green roof ecosystems under different design and environmental conditions. I will describe some of the contributions to this research field by our research group, which is guided by questions including: "What are the key factors influencing GR ecosystem function and ecosystem service provision, including carbon sequestration, water and nutrient retention, biodiversity, and aesthetic appeal?", "How do GR change as they age and under varying environmental conditions?", and "What are the implications for GR design and management?"

My academic journey originated in the fields of ecosystem science, hydrology and biogeochemistry, looking at how landscape characteristics like forest vegetation and soil properties within a watershed, affect water quality and aquatic ecosystems in streams and lakes. Over the past decade, I have been intrigued to find that many of the same kinds of relationships, principles, and scientific tools can help shed light on GR ecosystems and their performance.

My aim is to contribute to knowledge supporting cities in becoming more resilient and sustainable through strategic use of Nature-based solutions like GR. I believe that this aim is best served by combining approaches from different disciplines including landscape architecture, engineering, horticulture, soil science, and ecosystem ecology, and by collaborating with societal stakeholders who often have experience and insight into these ecosystems, and associated urban challenges.