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Editorial: Socio-ecological dynamics of green roof ecosystems

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Editorial on the Research Topic
Socio-ecological dynamics of green roof ecosystems

Human use of plant material for dwellings and roofing dates back thousands of years. The first known appearance of a green roof was in Ziggurat of Ancient Mesopotamia (circa 4000 BC). Later, turf walls and roofs were essential elements used during the Viking era (circa AD 800) to insulate buildings during winter. By 1982 the first green roof building standards were established in Germany and public policy began to incentivize or require the construction of green roofs. In the late 1990's and early 2000's more research on green roofs began to emerge focusing on plant and growing media selection, stormwater management, and insulation capacity. In 2007 the first major review on green roofs was published (Oberndorfer et al., 2007), which called for a broadened research agenda focusing on a range of ecosystem services.

During the last decade, ecological research of green roofs shifted from relatively simple horticultural studies to a suite of approaches highlighting green roofs as complex dynamic ecological systems positioned within the larger urban ecosystem (Williams et al., 2014; Wang et al., 2022). Additionally, emerging research highlights the potential psychological and social benefits of green roofs (White and Gatersleben, 2011; Williams et al., 2019). However, the range and extent of the socio-ecological benefits associated with green roofs compared to other types of green spaces and ground-level ecosystems is not yet clear.

The aim of the current Research Topic was to encourage a wider socio-ecological perspective around green roof research. Author contributions focused on the broader social benefits of green roofs as well as their ecological limitations. Ecological characteristics of green roofs are similar to some existing ground-level habitats (Lundholm, 2005), but green roofs are constructed ecosystems (Lundholm, 2015) that are created from engineered materials on engineered structures and may not ever come to resemble ground-level habitat or provide the same level of ecological services. Several studies in the current Research Topic explore this idea by pairing ground-level sites with green roofs.

In their three year study of arthropod community development on paired green roof and ground-level sites, Kyrö et al. concluded that green roofs that were established with

similar substrates and vegetation filter arthropods in a way that produces novel communities on green roofs that are more similar to each other than those at ground-level. In another study using paired ground-level and green roof sites, Partridge and Clark found that small urban green roofs within a larger and, potentially, higher quality ground-level habitat may not provide additional habitat for foraging birds. In addition to creating habitat space, green roofs are thought to generate greater connectivity for organisms in urban space. However, Butcher et al. modeled plant and animal-mediated pollen dispersal patterns using two model organisms on paired ground-level and green roof sites in urban and non-urban settings and found comparatively less long-distance pollen dispersal in plants in more urban sites suggesting that less gene flow may occur among populations in urbanized landscapes, even those on green roofs. Together these studies suggest that green roofs are not a one-for-one replacement of lost ground-level ecosystems. Characteristics of the green roof, such as size, the quality of the surrounding habitat, and plant selection contribute to the quality and degree of ecological benefits of the green roof ecosystems.

Given that green roofs are constructed ecosystems, they are built based on the preferences of designers and customers that choose to finance the creation of a green roof. While tax incentives and grant programs help encourage the installation of new green roofs, installation costs remain expensive and out of reach for less affluent individuals and communities. Plants are a particularly high cost, because they require propagation, installation, and regular maintenance. In their mini-review, Schrieke et al. explore these and other socio-ecological factors influencing green roof plant selection. They argue that the use of spontaneous plants, those that colonize green roofs without being sown purposefully, could deliver socio-ecological benefits such as prolonged flowering, increased biodiversity, and increased resiliency at a lower cost compared with conventional extensive green roofs planted with propagated succulents or other drought tolerant species.

All green roofs are subject to spontaneous plant colonization which can sometimes result in dramatic shifts in plant community structure through time (Aloisio et al., 2017; Aloisio et al., 2019). In their paper, Aloisio et al. describe an educational program in which high school students, under the mentorship of undergraduates, studied green roof plant successional dynamics as part of a National Science Foundation funded near-peer research mentoring program. Their results highlight the educational value of green roofs and other urban green spaces.

The remaining two papers continue to broaden the scope of the sociological benefits of green roofs by focusing on green roofs on urban hospitals. In their paper O'Hara et al. began by analyzing the existing literature and real-life examples of green roofs on urban hospitals. They summarize their findings by outlining the overlapping societal, economic, and environmental benefits of green roofs on urban hospitals in a Venn diagram in Figure 7. In their paper, Starry et al. identified 100 hospitals in the United States that had some sort of green roof. Their survey of hospital administrators identified patient experience and marketing as two common ways in which the green roofs were deemed successful. They also presented a small pilot study that showed no clear effect of green roof exposure on saliva cortisol levels. Interviews with hospital green roofs practitioners revealed that therapy was often a motivator for usage.

Despite the myriad of ecological benefits that green roofs provide, this Research Topic suggests that green roofs may not replace ground-level ecosystems and are, therefore, not likely to be a panacea for severe habitat degradation in urban areas. Nonetheless, green roofs provide added sociological, economic, and educational benefits in urban areas that should be further researched and integrated into policy and incentive programs aimed at expanding the number of green roofs.

Author contributions

JA: Conceptualization, Writing – original draft, Writing – review & editing. JL: Writing – review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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