CORRESPONDENCE:

Adapting to climate change through urban green infrastructure

To the Editor — Jones *et al.*[1] lay out the strong case for the many virtues of using 'ecoysytem-based approaches to adaptation' (EbA) to address current and future climate change. However, their article did not mention the burgeoning use of this approach within cities to address climate-related impacts and other environmental ills, where it is commonly being called 'urban green infrastructure' (UGI). Because most of the world's population will increasingly reside in urban areas, UGI ecological practices have the potential to benefit the most people as a buffer against climate change.

Some UGI approaches are familiar and old, such as urban park systems and urban forestry, including street trees. Others are comparatively new but increasingly well proven, such as green roofs[2]. The performance, costs and benefits of other possible approaches are still being assessed. Examples include bio-swales, innovative 'green street' techniques, permeable pavements, green walls or rain gardens. Research is needed to assess quantitatively how effective UGI approaches are compared with alternative engineered systems such as, for example, using higher albedo pavements and roofs for mitigation of urban heat islands. We also need to evaluate their overall benefits when implemented at large scales, which will be necessary to make an impact on urban climate, hydrology and ecology.

But the case for UGI as compared with 'hard infrastructure' adaptation solutions — termed 'grey infrastructure' solutions among urban practitioners — has the same basic rationale and merit as for EbA: multiple co-benefits. As a prime example, consider storm-water management in combined sewage overflow watersheds, where even moderate rainfalls lead to untreated sewage being shunted into local waterways. This problem will be exacerbated in cities that experience increases in precipitation from global warming combined with an increasing use of water by the growing urban populations. In this case, grey infrastructure solutions such as large-storage detention tanks can be pursued at great cost, running to billions of dollars[3,4]. However, storage systems that send water to treatment facilities will only deliver the one benefit of temporary runoff detention.

Green infrastructure solutions to this problem will deliver not only detention benefits but also retention benefits, which keeps precipitation from entering the system and being processed as wastewater. In this way, the processing energy and burden on treatment facilites are reduced. But there are also other benefits. For example, natural hydrologic recharge to currently impervious areas can be restored. Also, through evapotranspiration cooling, searing urban surface temperatures and the urban heat-island effect can be reduced. This in turn reduces building energy needs and greenhouse-gas-related emissions[5]. Some projects have successfully restored endangered ecosystems on rooftops[6].

The large potential prospective funding flows for adaptation measures that Jones *et al.* highlight should recognize UGI as an important category of EbA strategies that are specifically appropriate within cities worldwide. ❐

References

1. Jones, H. P., Hole, D. G. & Zavaleta, E. S. *Nature Clim. Change* **2,** 504–509 (2012).
2. Oberndorfer, E. *et al. BioScience* **57,** 823–833 (2007).
3. O'Connor Houstoun, F. *Philly's Proposed Green Stormwater Plan* (2010); available via http://go.nature.com/cN4Pg1
4. Garrison, N. *et al. Rooftops to Rivers II: Green Strategies for Controlling Stormwater and Combined Sewer Overflows* (National Resources Defence Council, 2011); available via http://go.nature.com/obw5Bt
5. Gaffin, S. R. *et al. A Temperature and Seasonal Energy Analysis of Green, White and Black Roofs* (Columbia Univ. Center for Climate Systems Research, 2010); available via http://go.nature.com/LMvAyC
6. Snodgrass, E. C. & McIntyre, L. *The Green Roof Manual: A Professional Guide to Design, Installation, and Maintenance* (Timber, 2010).

Stuart R. Gaffin*, Cynthia Rosenzweig and Angela Y. Y. Kong
Center for Climate Systems Research, Columbia University, 2880 Broadway, New York, New York 10025, USA.
*e-mail: srg43@columbia.edu