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Green-blue Infrastructure For Sustainable Cities: Innovative Socio-technical Solutions Bringing Multifunctional value

Les trames vertes et bleues pour les villes durables : des solutions socio-techniques innovantes apportant une valeur multifonctions

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RÉSUMÉ

La nouvelle vision pour les systèmes de drainage des eaux pluviales/de surface, qui est en train de devenir de rigueur, est d'utiliser les trames vertes et bleues pour apporter un maximum d'avantages via la modification des villes pour l'approvisionnement et le contrôle de la quantité et la qualité de l'eau, le contrôle des infrastructures et de la biodiversité. Récemment, une nouvelle perspective a émergé, visant à utiliser la nature dans le contexte d'une infrastructure performative. Les principes pour aboutir à cette nouvelle perspective sont d'utiliser la nature dans les villes pour contrôler la quantité, gérer la qualité, fournir des ressources en eau et prévenir la pollution, et utiliser les possibilités plus larges que cela apporte pour créer et maintenir des espaces plus adaptés aux personnes et à la nature. Le projet "Villes Vertes/bleues" JPI URBAN UE développe de nouveaux outils et techniques pour assurer qu'une valeur multifonctions soit recherchée et intégrée dans les projets liés à l'eau en zone urbaine. Cela nécessite de regrouper urbanisme, planification urbaine et sensibilité à l'eau dans une approche cohérente pouvant être utilisée par les principaux praticiens et décideurs. Un cadre pour veiller à ce que cela se produise est présenté, et son utilisation est illustrée par des études de cas de villes, dans un contexte de résistance aux inondations dans le cadre du CRC pour les "Villes Sensibles à l'Eau" en Australie, et en utilisant la nature comme infrastructure performative.

ABSTRACT

The new vision for surface/stormwater drainage systems, which is becoming *de rigueur*, is to use blue-green infrastructure to deliver maximum benefits via modifying cities for the provision and control of water quantity, quality, amenity and biodiversity. Recently a new perspective has emerged to use nature in the context of performative infrastructure. The principles in achieving this new perspective are to use nature in cities at a range of scales to control the quantity; manage quality; provide water resources & prevent pollution and utilise the wider opportunities this brings to create and sustain better places for people and nature. The JPI URBAN EU 'Green/blue cities' project is developing new tools and techniques to ensure that multifunctional value is sought after and delivered by water related projects in the urban area. This requires the bringing together of urban design, planning and water sensitivity in a coherent approach that can be used by the main practitioners and decision makers. A framework to ensure this happens is presented and its' use in case study cities illustrated based on a flood resilience framework developed as part of the CRC for Water Sensitive Cities in Australia and using nature as performative infrastructure.

KEYWORDS

Blue, green, multiple benefits, stormwater, water sensitivity

1 INTRODUCTION

The management of surface or stormwater is undergoing a transition from mainly underground, buried, piped drainage to systems that are mainly above ground and utilise green/blue infrastructure features. This is providing opportunities to maximise the wider benefits that such systems may bring as illustrated in Figure 1. Whilst those responsible for urban drainage are more or less aware and act upon these opportunities, there are still many barriers to uptake and some reluctance on the part of certain professionals and decision makers to maximise the potential for multiple benefits (Thorne et al, *in press*). This is especially true for those who deal with 'green spaces' in urban areas who rarely consider the needs of and opportunities from surface water (e.g. Derkzen et al, 2015). Therefore a clear guide as to how to set about ensuring maximum benefits are attained from taking a multifunctional infrastructural approach to surface water management will help to support the decision making processes and encourage professionals to take up the approach and this is presented here.

A framework for this has been developed as part of the JPI URBAN EU project 'Green/blue cities' [<http://jpi-urbaneurope.eu/project-green-blue-cities/>] based on the concepts developed in the CRC for Water Sensitive Cities for bringing flood resilience into a water sensitive city (Gersonius et al, 2014) and using the ground breaking research of Bacchin (2016) on nature as performative infrastructure. The framework is being applied in applications in two European cities: Kiruna in Northern Sweden and Zwolle in the Netherlands (Leonhardt et al, 2015) and also in Elwood in Melbourne, Australia (Salinas-Rodriguez et al, 2014) and builds on the application in Porto Alegre, Brasil (Bacchin, 2016). The need to think broadly and in terms of scenario planning as well as using tools such as decision-trees for adaptive management is, for most of the stakeholders, novel (Brisley et al, 2015). The framework is supporting this development of capacity in those involved and in so doing, the further bringing of quality, safety, security and greater sustainability to urban living.

The framework is supported by a spatio-temporal approach and GIS design tool for the retrofitting of Blue/Green infrastructure (BGI) in the existing built environment. A hybrid (soft/hard) landscape infrastructure matrix is modelled, spanning vertical, horizontal and temporal dimensions. Topological-topographic network design and five landscape design principles (contingency, diversity, in-built flexibility, appropriation and sensitivity) guide the modelling process. Although rather complex for practitioner use, the framework and design tool are being used in partnership with two communities as outlined below.

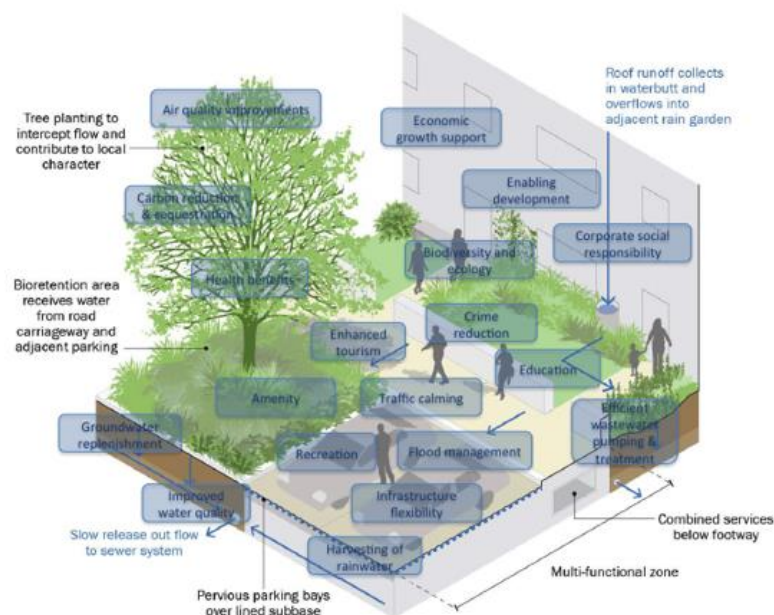


Figure 1 Diagrammatic illustration of the potential for getting a wide range of benefits from using blue-green infrastructure to manage surface water in urban areas (adapted from Woods-Ballard et al, 2015).

2 BRINGING TOGETHER CONCEPTS AND TOOLS

A number of existing concepts and tools have been brought together to support the delivery of the framework, including: Water Sensitivity and Water Sensitive Urban Design (WSUD) (Ferguson et al,

2013); Flood & drought resilience (Rijke et al, 2014); Multiple functionality of infrastructure systems; Multiple use of land in urban areas; Sustainability and liveability; A clear business case (e.g. Nylen & Kiparsky, 2015); adaptive management (e.g. Brisley et al, 2015) and Nature as performative infrastructure (Bacchin, 2016). Sustainability is the over-arching vision (e.g. Raskin et al, 2010) and water sensitivity, the vehicle by which the various threads listed can be delivered; but the impermanence of first-decisions is also recognised in the need to use for example, decision trees to plan for adaptation. In committing to this vision, stakeholders now require a clear and defensible business case (e.g. Berkley Law, 2015), although many are not yet clear how to handle the many uncertainties in the process. The framework links a number of principles to expected outcomes (i.e. what society and people value such as a good quality of life, rather than specific 'things' that are delivered by services). Taking advantage of 'performative nature' for urban infrastructure has been shown to be effective in planning how to deal with e.g. flooding in urban areas (Bacchin, 2016) but requires a multi-layered approach from pan-city through catchment to local scales (Figure 2).



Figure 2 application of the multi-dimensional and multi-layered approach to BGI and Nature as Infrastructure (adapted from Bacchin, 2016).

Working in partnerships, especially for the funders and decision makers and engaging with communities is essential in formulating the blue-green vision and bringing water sensitivity and multi-functioning infrastructure systems, as is giving due consideration to the difficulties of engaging with uncertainties in the process (e.g. Ray & Brown, 2015). The guidance to the framework sets out a clear step-by-step approach that includes the use of driver-pressures-state-impact-responses, coupled with scenario planning. This has been tested in workshops with the communities of Zwolle, Kiruna and Elwood (Ferguson et al, 2013) and also in direct engagement in Porto Alegre. These, and other case applications of the process in a number of countries has revealed that it helps stakeholders and decision makers to better understand and account for uncertainty in decision making. Nonetheless this type of approach is still seen as novel by many in urban planning.

2.1 Maximising benefits

Benefits from using 'nature' and BGI are more widespread than their primary function and there are important cross-sector and cross-scale linkages. Such infrastructure provides significant externality value and can contribute significantly to public goods. Yet this is often overlooked in this regard due to the 'silo' nature in which public services are provided (Kirby & Russell, 2015). As yet, BGI benefits estimation is confined to a limited perspective due to the available evidence as to the value of a wide range of benefits. There are a number of supporting tools and guidance that provide benefits information, most of which rely on benefits transfer from case examples. The benefit estimates are mainly derived from ecosystem services categories and/or green infrastructure with some specific BGI benefits added. There are other benefits that may be possible to achieve, such as obtaining energy from water systems, that are being increasingly shown to be viable, but these have not yet been routinely considered in water system opportunities alongside BGI (e.g. Jayasooriya & Ng, 2014), hence the need for the new framework to bring together the various and often disparate sources of information and tools and techniques (e.g. Horton et al, 2015).

3 SUMMARY AND CONCLUSION

Although the framework and accompanying GIS based design tool are aimed at helping a range of practitioners maximise the potential multiple benefits from using BGI, this needs to be considered in the context of the myriad of other systems and services that are needed in urban areas. There is a need to work together in partnerships to not only agree on the vision for delivering this, but in the funding of and benefiting from the use of BGI as well as deciding when and where to follow pre-set decision pathways. The projects described here have been (Porto Alegre) and are being applied in cities of rather differing characteristics, in Kiruna where the climate is sub-arctic and the city needs to be relocated due to mining activities, in Zwolle, where the climate is temperate but there is no major upheaval and in Elwood where flooding from all major sources is a challenge. Nevertheless the approach to securing multi-benefits is the same; rather the context and details of delivery on the ground vary. In Kiruna, the strong focus on relocating the city and making it as sustainable as possible, but with funding primarily from a tight group of stakeholders puts a rather different perspective on the ambitions and actual delivery than for Zwolle where the vision is more focused on the local citizens, consortia, and is typical of European city municipalities, and like Elwood, has liveability at the heart. Tools such as the framework presented allow the stakeholders and decision makers to ensure that they make the most of BGI opportunities at the same time as assuring resilience to the benefit of all.

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