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Ecosystem services generated by Nature-based Solutions: a proposal for the accounting frame

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Nature-based solutions (NBS) are intended to use complex system processes of nature to reduce risks and to improve human well-being. An ecosystem services-based approach can constitute the analytical basis to develop a multi-purpose framework able to identify and assess the multi-benefits generated by NBS. An ecosystem services analytical framework goes beyond individual sustainability-related issues and beyond the traditional mono-sectoral view, such as water and waste management, urban regeneration, transport, energy efficiency in buildings, resilience and climate change in a separate way. Although all these issues have ecosystem services (ES) as a common denominator, is not currently possible to synoptically consider the results across different sectoral themes. This paper aims to show how an ecosystem services framework can link all these sectoral issues and how to systematically account for occurring changes to allow a common, consistent basis for trade-off analysis among different policy issues. First an ecosystem services classification specifically for the NBS at the local scale for the urban contexts is tailored. Second, an attempt is made to build an ecosystem services accounting framework. Finally an illustrative example demonstrates how to account for ecosystem services can contribute to the assessment of issues such as resilience, climate change mitigation and adaptation, and risk management.

Keywords: nature based solutions; ecosystem services; ES classification; ES accounting; urban resilience
Nature-based solutions for enhancing urban regulating services
Davide Geneletti, Chiara Cortinovis, University of Trento

Regulating ecosystem services are linked to some of the most pressing urban challenges, from climate change adaptation to health. The integration of their mapping and assessment in urban planning is fundamental to achieve the associated policy goals, and to effectively design and implement nature-based solutions. However, such integration is made difficult by a limited flow of knowledge from science to planning practice. With the aim of providing planners with relevant information for integrating regulating services in urban plans, we studied a set of key regulating services (including air filtration, water regulation, noise reduction, micro-climate regulation), focusing on the analysis of the spatial interaction between the service providing units (e.g., urban green space) and the service benefitting areas. This resulted in a conceptual framework, based on a literature review, which illustrates the spatial properties of the providing units that determine their ecosystem service potential, and investigates the role played by ecosystem types and structure, spatial and temporal scales and environmental conditions of the context.

A case study illustrating how the framework can operationally assist planning practice by designing nature-based solutions is presented for the city of Trento, Italy. The case application focuses on the brownfield regeneration interventions through nature-based solutions, as part of an urban planning exercise. The proposed nature-based solutions involve different type of urban greening interventions, which are compared in terms of the provision of a set of ecosystem services, and the fruition by different groups of beneficiaries. First, we identify possible regeneration scenarios by simulating different types of greening interventions in brownfield sites, using a Geographical Information System (GIS). Second, we modelled the spatial distribution of key ecosystem services (among which microclimate regulation, noise mitigation and recreation) provided by these redevelopment scenarios. Third, we quantified the beneficiaries of these services, and their vulnerability, by using demographic and socio-economic information. Finally, the information was combined using multicriteria analysis to identify the types and location of interventions that provide the highest benefits to citizens, considering different perspectives (i.e., assigning different priorities to different types of benefits). The results helped to answer questions such as: which brownfield can be more effectively transformed through nature-based solutions? Which level of performance of the new green areas is required to increase the wellbeing of the surrounding inhabitants? In which area the same investment is expected to obtain the biggest gain? Applications of the results in the general context of urban planning are discussed.

Keywords: regulating services, urban planning, microclimate regulation, brownfield redevelopment, beneficiaries
A review of indicators and assessment methodologies of the socio-cultural impacts of nature-based solutions

Sara Rocha, Dora Almassy, Laszlo Pinter, Kathrin Hörschelmann, Stella Ivanova, Anja Werner, Central Europe University

Nature-based solutions (NBSs) sustainably use or mirror nature’s features in the interest of addressing current urban challenges. NBS provide long-term sustainable solutions that have the ability to provide multiple co-benefits such as environmental, social, cultural and economic benefits, as well as support resilience building and provide cost-effective solutions.

The proposed presentation offers a review of state-of-the-art literature on the social and cultural impacts of NBS and its available indicators and assessment methods, as part of the NATure based URban innoVATION (NATURVATION) project, a Horizon 2020 four-year research project.

In this review, we focused on the socio-cultural impacts of NBS in order to contribute to the understanding of the NBS potential to deliver socio-cultural impacts, by taking stock of the existing knowledge concerning NBS impacts and the available indicators capable of measuring such impacts in cities.

In regards to the methodology, a systematic literature review was conducted during July and August of 2017 related to the assessment of socio-cultural impacts of NBS, and 272 articles were selected and analysed. All included articles were screened by specific criteria that targeted articles concerning NBS or green/blue infrastructure in cities, in which socio-cultural impacts of NBS were addressed and indicators used to access, measure or evaluate the socio-cultural impacts of NBS were identified.

In urban environments, multiple socio-cultural impacts are recognised in the scientific literature in connection to NBS. The main categories of NBS socio-cultural impacts that emerged as relevant categories from the review of the literature include: health and well-being, social interaction, social justice and equity, aesthetics, cultural heritage and sense of place, recreation, biodiversity and nature appreciation, spiritual and religious, among others.

Results show that concerning the assessment of socio-cultural impacts of NBS, currently the most studied NBS impact categories are well-being, health, recreation and aesthetical impacts. Regarding the urban setting where NBS can take place, the results express that there is a dominance of the literature focusing on the assessment and evaluation of socio-cultural impacts of NBS in parks and urban forests, as well as greened grey infrastructure and non-specified urban green and blue spaces.

Keywords: nature-based solutions, socio-cultural impacts, assessment, indicators, urban
Economic valuation of green blue infrastructure recent trends and evidence from Europe
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Within the European Union, the concept of multi-functionality is utilized to emphasize on the many services which Urban Green Blue Infrastructure (UGBI) and, more in general, nature-based solutions (NBS) display in addition to their prime purposes related to commodity outputs (Millennium Ecosystem Assessment, 2005). As a result, UGBI is less put into the context of the production of goods, but rather into the context of natural resources’ protection, spaces for leisure, education and wellbeing, cultural and heritage landscapes, i.e. Ecosystem Services.

The recently emerging “Green Infrastructure” approach is characterized by the recognition of the full range of economic, social, cultural and environmental functions and benefits. The economic implications, in particular, are increasingly focusing researchers, policy makers and practitioners’ attention from new perspectives, mirroring the needs and claims of the growing population of urban dwellers. Landscape architects, planners, city managers and other practitioners have started incorporating metrics and performance standards as an emerging part of best practice mostly throughout North America and Europe, but also in Asia and Africa. Estimating the value of the various services and benefits that ecosystems and biodiversity generate may be done with a variety of valuation approaches. All of these have their advantages and disadvantages. Numerous theoretical and technical tools have been developed to understand different economic valuation aspects and more in general sustainability, adapting methodologies and designing new frameworks, especially in the emerging research area of the landscape economy.

Better understanding of economic values, associated with design and management strategies and practices, opportunity costs and ecosystem functions and services, enables decision makers and practitioners to successfully engage in trade-off analysis and to identify the potential benefits and losses associated with specific urban landscape governance models. The incorporation of the economic valuation of NBS in decision-making and POE instruments is considered enhancing the implementation of the Green Infrastructure approach towards balanced and inclusive urban and architectural projects for renewed and resilient cities.

The common concept of sustainable development has been reflected extensively in the various definitions of the three benefit categories – environmental, social and economic – while strategies’ interactions, synergies and trade-offs area still to be tackled. In the work carried out, the priority has been, consequently, to verify whether the environmental, social and economic design strategies and related outcomes of selected cases studies are in conflict or converging, as far as the more general sustainability objectives are concerned. The proposed contribution highlight most recent evidence of economic benefits from UGI in Europe, describing specific applied valuation methods, as well as stakeholders and governance models implemented. In combination with a selected data-base of environmental, social and economic benefits of UGBI, the research aims at encouraging thoughtful discussion and commentary on the fundamental issues those works raise, engaging multiple stakeholders in the sustainable design and management of urban and peri-urban ecosystems and their many valuable goods and services.

Keywords: economic valuation, ecosystem services; landscape economy; sustainability assessment; urban green blue infrastructure.
How to Successfully Achieve Implementation of Nature-based Solution in Flood Protection: A Case Study of Pilsen, Czech Republic

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Manifestations of climate change currently have very significant adverse (economic) impacts. Adaptation to such change (e.g., in the form of more frequent floods or droughts) induces considerable social costs. More and more cities deal with this problem by using adaptation measures. Until recently, “traditional” adaptation of cities relied mostly on technical measures (“grey infrastructure”). Alternative solutions to technical measures are nature-based solutions (NBS), which can be seen as complements to technical measures and can be implemented directly in the urban area. Nature-based solutions provide in addition to their contribution to urban adaptation a number of other environmental benefits and ecosystem services (e.g., reduction of storm water runoff, improvement of air quality, an increase in aesthetic value etc.) and other economic and social benefits (e.g., an increase in market value of buildings, energy/water cost savings etc.).

The real-world implementation of NBS faces numerous barriers. The objective of this contribution is to present a way of supporting the implementation process of NBS in cities, especially in case if they should be built (at least partly) on private land. One of the obstacles to the NBS implementation on private land is low awareness of the benefits of such measures that improve the population’s well-being. Low awareness reduces stakeholders’ willingness to consider their implementation (including negotiations with the land owners about provision of land for this purpose).

City Pilsen has to deal with floods on regular basis – there were seven big floods between 2002 and 2014. On the Lobezská louka case study we have demonstrated the potential an economic assessment in the form of cost-benefit analysis has in decision-making on further application of NBS in cities. The initial plan of possible measures on Lobezská louka covered an area of approximately 14 ha. Only the first phase covering the measures on public land has been implemented so far. The other two phases are mostly located on privately owned land. The implementation is connected with negotiation as the landowners should be compensated for providing the land (e.g., buyouts, long-term leases or some kind of so-called payments for ecosystem services). Thus, it is essential to convince the public and the decision-makers about the necessity of the next two phases. We demonstrate the environmental and social benefits of urban wetlands restoration in the form of cost-benefit analysis. Considering also the local aspects, the ex-post cost-benefit analysis of the first phase of the urban wetland restoration showed that the annual benefits of this measure amount to EUR 1.47 million. When comparing the total annual benefits and costs, the benefits exceed the costs nearly 25 times. It means the annualised costs are only 4% of the total annual benefits.

These results can support not only the decision-making process about implementation of further phases of restoring the urban wetlands in Pilsen, but also implementation of other nature-based solutions in general. Case study shows that information from economic evaluation may be used as a crucial argument in social debate.

Keywords: cost benefit analysis, decision-making process, ecosystems services, nature-based solution, wetlands.
Assessing Urban Green Infrastructure in the Munich Northern Region: trends and indicators
Romina D’Ascanio, University of Roma Tre, Maria Beatrice Andreucci, University of Sapienza Roma

In the last decades, much attention was given to making inner cities liveable again, often with success (Andreucci, 2017). Inner cities have been greened and became attractive living districts for the affluent. Yet, it also pushed less desirable functions and the less affluent to peri-urban areas. Often peri-urban areas and its inhabitants have to deal with multiple burdens: social-cultural, environmental as well as a lack of access and availability of qualitative green spaces which represent a focal point for providing ecosystem services and opportunities for inclusiveness. Moreover, peri-urban areas are multifunctional and interrelated zones with potential for change (Hong, Nakagoshi, 2017).

However, the equitable fruition of green open space requires considering various aims and expectations, as well as cultural backgrounds and socio-economic situations of the different individuals who live and work in these areas. The work developed, which is the result of a Short Term Scientific Mission within COST Action "Green Infrastructure approach: linking environmental with social aspects in studying and managing urban forests" and workshops from Le Notre Lanscape Forum 2017 held in Munich, was aimed at better understanding the correlation between social-cultural patterns and green open spaces at different scales.

The City and the Region of Munich try to cope with the downsides of recent success. The Bavarian State Office for Statistics and Data has estimated for the region of Munich a growth of 3.2 million inhabitants by 2035. By 2030, the City of Munich expects to count about 1.72 million inhabitants, which represents an increase of almost 15% compared to 2013 (Munich: Future Perspective, 2013). Consequently, the pressure on housing, in particular on affordable housing is increasing and with it the need for qualitative green public spaces, as these green areas are becoming more and more crucial to maintain the quality of life.

The proposed contribution, analyses the region of Munich at three different scale levels: (i) region level with a particular focus on the northern part of Region between Freising and Munich; (ii) Munich city level; and (iii) district level, zooming in on the northern district of Feldmoching. Currently, this area, situated within the urban fringe, has a more peri-urban character with a crossover of functions, rural and urban features, as well as intensive built-up and natural areas. Yet, as recently as March 2017, this areas has been designated as the last urban expansion area of Munich, which means that this area will in the coming decades shift from a peri-urban to an urban area. For each of these three levels, the research makes use of a spatial analysis based on quantitative and qualitative indicators to evaluate green space availability and their social and cultural relevance.

The peri-urban area of Munich is a dynamic zone, which comprises an unbalanced mixture of urban and rural functions, but with valuable natural, agricultural, heritage and touristic resources. Furthermore, the aesthetic and spatial dimensions of open green space systems are especially important for the peri-urban situations, because, they are often spaces without a distinct character (Andreucci, D’Ascanio et al, 2018).

Input for the study comes from a data collection from local census, land use spatial maps and desktop studies. Results from the different scale levels about availability of green spaces, urban growth and social pattern have been compared in order to define indicators for the livability of the peri-urban area of Munich in the prospective of its growth.

Keywords: green infrastructure, urban growth, peri-urban landscape, green strategy, Munich
SECTION 2: POLICY APPROACHES AND BUSINESS MODELS FOR NATURE-BASED SOLUTIONS IMPLEMENTATION

Policy Instruments for NBS to Landslide Risk Management in Urban Areas in the Hilly Areas of Sri Lanka
Priyanka Dissanayake and Federica Ranghieri, World Bank

Landslides had been traditionally considered as an insignificant disaster and now a common occurrence in the hilly areas of Sri Lanka. Most landslides appear to have occurred only within the Southern, Uva, Sabaragamuwa and Central provinces, and in the peripheries of the Western Province bordering the Southern Province in Sri Lanka. Heavy rainfall across the country in May 2017 resulted in severe landslides and floods in fifteen (15) districts that resulted over 200 deaths mainly due to landslides. The increased human intervention on hill slopes have increased the frequency and the intensity of landslides. The demand for land in hilly areas has led to the use of marginal land, prone to landslides in unstable slopes. Inadequate drainage in buildings, cut slopes and fills and blocked contour drains increase the infiltration run off which was previously distributed over the slope. In many areas, the risk-informed nature based solutions can be effective in reducing the occurrence and impact of such landslides. However, control of landslides in upland areas requires an integrated approach. There needs to be land use planning, good land management practices in cropping, grazing and forestry, careful road construction, terracing and other contour-aligned practices in fields and plantations, and participation of local communities. Policies related to sand mining and construction, road construction, gem mining, agriculture, clearing of plantation and deforestation do significantly contribute to landslides. The application of NBS for landslide risk management is still limited in Sri Lanka and the lack of specific policy instruments for NBS is a major hindrance to the application of NSB. Therefore, the paper will review the existing Legal, regulatory and institutional frameworks for landslides mitigation and will make recommendations to strengthen the existing development and agriculture related policies and to formulate suitable policies for NBS for landslide management in Sri Lanka.

**Keywords:** landslides; marginal land; risk management; policies; nature based solutions
Governance for Green Infrastructures in European City Regions: The Cases of Manchester, Copenhagen and the Ruhr

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The design, management and implementation of sustainable spatial strategies are a prerequisite to environmental sustainability in cities and city regions across Europe. The neoliberal agenda forces regions into a ruthless competition for capital and people. This often leads to an imbalance between short-term economic interests and long-term sustainability goals, generally preferring the former. From a spatial perspective, the management of green infrastructures on a regional scale – understood as “strategically planned and delivered network comprising the broadest range of high quality green spaces and other environmental features” (Natural England 2009, p. 7) – is of crucial importance for the sustainable development of cities and city regions.

With regard to the management of green infrastructure a lot of experimental strategic spatial planning initiatives in different contexts are currently taking place. While the planning rhetoric (“rules on paper”) and the hegemonic green infrastructure discourse clearly show a high sensibility for sustainability goals on a city-regional scale, we argue for a more context-sensitive and critical approach that allows us to reconstruct the “micro-practices” behind different green infrastructure strategies across Europe. We specifically ask for the transformative potential of strategic “green” spatial planning initiatives and their impact on existent planning cultures, understood as complex institutional patterns comprising both formal and informal institutional spheres (rules, procedures, instruments as well as cognitive frames and shared mental models of planning activists).

We highlight the diversity of sustainability endeavors in three different European city-regions (Greater Manchester, Copenhagen and the Ruhr) by taking into account the different cultural histories and path dependencies, the culturally “filtered” processes of spatial strategy making and the specific interests behind such strategies, the manifold patterns of strategic institutional capacity building and the concrete implementation of instruments.

We extend our view on the case study regions by using a wide set of land use metrics based in GIS data. With this data, we enrich our case study description to classify and highlight structures and differences in green infrastructure supply, which is a prerequisite for nature based solutions.

**Keywords:** green infrastructure; governance; planning culture; GIS land use metrics; cross-cultural comparison
There is growing recognition that natural ecosystems can provide valuable services at different scales. Investing in urban green systems can provide social, economic and environmental benefits improving health and well-being and increasing resilience to climate change. Market Based Instruments, such as Payments for Ecosystem Services (PES) can be effective in the conservation and enhancement of natural resources. A PES is a voluntary transaction between service users and service providers that are conditional on agreed rules of natural resource management for generating offsite services.

In 2005 Milan Municipality launched the project “Adopt a green spot” following a PES scheme. The Municipality designed three contract typologies: financial sponsorships, technical sponsorships and technical collaborations. The main differential characteristics of the considered business models regard who designs the green spaces and who provides the economic contribution for its maintenance.

The paper highlights which are the strengths and weaknesses of the business models adopted to manage urban green spaces and to involve citizens and private companies in the protection and enhancement of urban ecosystem services. 432 contracts (33% technical sponsorship; 47% financial sponsorship; 20% technical collaboration) have been signed for a total of 231,644 m2 public green spaces adopted. The financial resources generated by the PES scheme amount to 1,763,540,78 €. The interest in the initiative is confirmed by the wide range of stakeholders who joined it: citizens, universities, private companies, condominiums and associations. The major amount of resources came from private companies (87%) and investments are mainly concentrated in the central areas of the city even if the extension of green areas adopted is smaller. “Adopt a green spot” demonstrates that PES schemes can be implemented at urban level through the involvement of several stakeholders. Results can be used to shape and design PES schemes and other policy instruments at urban level in order to enhance the protection of green areas and of ecosystem provided by them.

**Keywords:** business models, payments for ecosystem services, urban policies, NBSs financial schemes, stakeholders engagement
When Urban Nature is Invisible: Storytelling in Urban Planning and Management in Aalborg

Enza Lissandrello, Aalborg University:

The paper elaborates on the theory and the practice of storytelling in urban planning and management as a policy instrument to bring nature as a part and element of a strategic urban planning, intended as strategies of public deliberation. The paper frames analysis on storytelling as a generative power mechanism able to highlight strategic dimensions of public deliberation. The case study develops from Aalborg stories of the re-opening of Østerå, the stream passing through the old city center and covered nowadays by roads. Østerå has been a part of Aalborg’s history and became closed around the 1890’s for sanitary reasons. Østerå became therefore an ‘invisible nature’ deleted by the cityscape which inhabitants do not have memory. Recently the re-opening was envisioned as a part of Aalborg urban planning strategy 2025, as the ‘blue area’ that could represent and visualize the urban transition from the old industrial city of the ‘smoking chimneys’ in which urban nature was neglected and eroded by processes of modernization to a sustainable city in which knowledge circulate wider and means to bring nature back to the city. This return is identified by urban planners as an important step of a contemporary urban transition. The case shows how urban nature is together urban history and urban future and how urban transitions are placing nature as a focus point of livability and urban renewal. The method of storytelling illustrates the kind of strategies of public deliberation urban nature can bring to urban planning as potential - for planners and policy makers - urban imaginaries of future and as a participatory method in which citizens, politicians and stakeholders can recognize as a part of urban values. The paper concludes on the outcomes in terms of policy instrument based on storytelling, and the meaning to bring nature as a part and element of a strategic urban planning.

The case of Østerå shows the invisibility of the urban nature and how a storytelling approach adopted by planners and policy makers worked in the direction of revealed an invisible nature so difficult to figure out in terms of benefit from urban citizens, politicians and stakeholders and so the values of the re-opening of the stream. The first reaction to Østerå re-opening was indeed not well received by the public. The main concern was about the content of the project. Citizens did not have memories of a stream through the city, lying just under the concrete, and it was difficult for people to envision a nature that was actually invisible. Storytelling was therefore a powerful means of negotiation to articulate urban nature. The Østerå area has been articulated and negotiated in a time in which not much nature was left to be seen, the public needed to become sensible to the hidden potentials of urban nature and the visibility and value of it in the urban context. Planners and policy makers engaged in storytelling qualifying truth and justifying the return of the urban nature. A new planning strategy was created to illustrate this ‘invisible nature’ in the city and its strategic potentials also through the use of metaphors.

Storytelling in Aalborg used a variety of tropes and illustrations, but also concrete material actions as the opening of a small part of the stream for the public to see ‘water running’ under the cement. Nature and the water under the city, their strategic interpretation in urban planning along the time has shaped and re-shaped throughout the policy making process from visions to deliberation. The paper scrutinizes these stories and the actors behind as well as the potential actions for persuasion, the representation of values and commitment for action. The paper concludes identifying the main lessons about storytelling for urban nature interventions and the potential of this method for bringing back urban nature to the city as a strategy for contemporary sustainable transition pathways.

**Keywords:** urban transitions, sustainable transition pathways, future, urban planning strategies, public deliberation, participatory methods
SECTION 3: IMPACTS OF NATURE-BASED SOLUTIONS IN CITIES - CASE STUDIES

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From risk perception understanding to Nature Based Solution implementation, the case of Glinščica river basin (Slovenia)

The past experiences about strategies aimed at reducing flood risk have clearly shown that grey infrastructure solutions alone cannot provide a complete protection. Throughout the 1960s to 1980s, the principal means of mitigating the impacts of floods remained physical flood control (e.g. via the construction of levees, dikes, diversion channels, dams and related structures). Furthermore, evidences demonstrated that it requires not only a deep understanding of the main physical phenomena to be addressed, but also acknowledgment about stakeholders’ role, objectives, interdependencies, network of interaction and their risk perception(s). Thus, the institutional context needs to evolve in order to enable the necessary shift to take place from Grey Solutions (GS) to Nature Based Solution (NBS). Within this context, practitioners and policy makers need to consider NBSs as an essential part of policy strategies, including for instance biodiversity protection measures, spatial planning, environmental assessment or economic incentives. In order to realize their full potentials, NBSs need to be developed by including the experience and risk perception(s) of all the relevant stakeholders, such that solutions contribute to achieve all dimensions of sustainability. Hence, an understanding of how people perceive water-related risk may assist community understanding consensus building and contribute to planning, research and policy on flood risk using NBS.

To this aim, a multi-step methodology based on the integration between Problem Structuring Methods (PSM) and Ambiguity Analysis has been developed and experimentally tested in the Glinščica river basin (Slovenia) in order to improve the implementation of Nature Based Solution (NBS) to reduce the flood risk. The developed methodology consists in two main phases: i) a Problem Structuring Method (PSM) to elicit and structure available knowledge on the subject under analysis, investigating stakeholders’ role, objectives, interdependencies, and network of interaction between individuals, groups and organizations who are affected by flood risk, through semi-structured interviews and Fuzzy Cognitive Maps (FCM) building; ii) Risk Perception (RP) and Ambiguity Analysis (AA) and exploration of the stakeholders’ decision-making through FCM Analysis. Specifically, the AA aims to detect and analyse the main differences concerning RP and understanding of NBSs role, identifying potential reasons of conflict, capable of hampering NBS policy implementation. Whereas the preliminary study of the decision-making processes has been developed in order to qualitatively assess the potential stakeholders’ reactions in case of risk, to support the starting point to a collaborative decision-making for the selection and implementation of the most suitable NBS for reducing risk. The results enriched the empirical evidence in support of improving understanding of stakeholders’ decision-making processes, which is critical in developing NBS implementation policies.

Keywords: Nature Based Solution, Urban Resilience, Risk Perception, Problem Structuring Method, Stakeholders’ Engagement
Acute and ongoing symptoms of urban distress: prioritising the intervention of Nature Based Solutions in Perth, Western Australia

Marco Amati, Joe Hurley, Kath Phelan  RMIT, Alex Saunders, Bryan Boruff, John Duncan, University of Western Australia, Peter Caccetta, Joanne Chia, CSIRO, Floreat Laboratory

Urban vegetation contributes to a range of ecosystem services including the enhancement of health and wellbeing, filtration of storm water and air pollution, the provision of habitat for species diversity and amelioration of urban heat islands. All of these generate economic benefits through reduced energy costs for heating and cooling, savings on infrastructure, reduced health care costs and increased property values. Australian urban areas are characterised by their low density, which encourages the growth of vegetation in gardens and residential streets. However, Australian urban areas are subject to pressures to increase density reducing the space for vegetation. The objective of our project is to allow decision makers to prioritise the deployment of nature based solutions across Australia cities in the face of this ongoing pressure, while prioritising areas that are in urgent need of greening. As we argue in this paper, prioritising this deployment involves reaching a deep understanding about the ongoing reasons for the growth and decline of urban vegetation. It also involves identifying areas, which are in need of acute intervention. In Australian cities public and private landowners have an important and ongoing role in both exacerbating and alleviating tree canopy loss. Australian cities are subject to intense waves of heat that have severe impacts on livelihoods and economic productivity. The hotspots that these waves produce are unequally dispersed, requiring an urgent greening intervention. In this study, we report on the drivers of urban vegetation loss in Perth, Western Australia and demonstrate a tool for combining information about urban heat islands in a vulnerability index. The project has three aims: 1. to identify the drivers of canopy cover growth and loss across Perth’s residential neighborhoods; 2. to examine the extent to which these drivers are associated with variability in canopy cover on public and private lands and 3. to identify urban hotspots in Perth to develop an index of vulnerability. Using high-resolution digital aerial imagery acquired as part of CSIRO’s Urban Monitor® Program we first quantified the distribution of tree canopy on both private and public land within Perth’s residential neighborhoods. Next, using regression analysis we explored the factors contributing to tree canopy extent and the factors contributing to variability across public and private land whilst providing insight into how planning policy and development trends have contributed to canopy reduction and distributions. Finally, we compared these findings with the prevalence of hotspots and propose a ranking of local areas by their vulnerability to heat and socio-economic disadvantage.

Keywords: urban forest, residential tree canopy, high resolution remote sensing, public and private greenspace, urban hotspots
Nature based solutions for water pollution control in Gorla Maggiore (Italy)
Giulio Conte, Fabio Masi, Anacleto Rizzo, RIDRA Srl, Camino Lique, Bruna Grizzetti, JRC

There is a significant amount of pollution being discharged by Combined Sewer Overflows (CSOs) into surface water bodies all across Europe. During heavy rain events, the excess flow of mixed sewage and rainwater cannot be treated in the normal wastewater treatment plants. Thus, part of this water flow, with the associated waste and toxic materials, is discharged directly into rivers and lakes from CSO. The pollution problems caused by CSOs are expected to exacerbate with climate change, with the modification of rain events patterns. In the Italian Lombardy Region, which is one of the most populated and industrialized regions in Europe, there are thousands of CSOs that contribute to increase the pollution of natural water bodies. These water bodies frequently do not reach the Good Ecological Status required by the EU Water Framework Directive, partly due to the effect of CSOs.

The two possible solutions to reduce the pollution coming from CSOs are upstream control, which avoids rainwater to flow into the sewer system, or downstream control, which treats the CSO. The typical infrastructure used in the second option is an underground storage tank that accumulates the most polluted water and pumps it back to the wastewater treatment plant after the rain events. An alternative to this grey infrastructure is to construct a green infrastructure or nature-based solution that stores and treats the polluted water on-site through natural purification processes.

The first example of this kind of green infrastructure in Italy is the Gorla Maggiore water park that was inaugurated in March 2013. Gorla Maggiore is a municipality with 5,000 inhabitants located in the Province of Varese (Lombardy Region). The water park covers a green recreational area adjacent to the Olona River and includes a set of constructed wetlands that treats the CSO.

Through the EU research project OpenNESS (http://www.openness-project.eu/) - that selected the Gorla Maggiore water park as a case study - we applied a multi-criteria analysis to assess the cost-effectiveness of a multi-purpose nature-based solution for water pollution control in a peri-urban area, and account for the multiple benefits it provides.

The main findings from this research are that the nature-based solution or green infrastructure (a series of constructed wetlands surrounded by a park) performs equal or even better than the grey infrastructure alternative for water purification and flood protection, it has a similar cost, and it provides additional benefits (like wildlife support and recreation) specially valued by the local residents and stakeholders. A third alternative reflecting the previous situation (a poplar plantation) was also assessed and valued. The best performing and most preferred alternative is the green infrastructure, followed by far by the grey infrastructure and the poplar plantation.

This study provides evidence of (a) the effectiveness of investments on nature-based solutions, (b) the multi-functionality of nature-based solutions for watershed management, (c) on the potential of nature-based solutions for improving well-being, and (d) the utility of using ecosystem services as criteria in the decision analysis, making explicit also hidden benefits.

Keywords: water management, constructed wetland, ecosystem services, integrated valuation, multi-criteria analysis
Prosumer-Based Urban Regeneration Driven by Green Roofs
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The overarching aim of the paper is to demonstrate a prospective prosumer business model for extensive or semi-extensive green roof retrofitting as urban nature-based solutions. Such a mass-scale process is a future necessity, because urban heat islands (UHIs) mitigation has been emerging as an arising problem lately, especially as more than a half of the global population since 2005 has been living in urban agglomerations. It is estimated that the heat accumulation in roofs is responsible in 40% of the average entire UHI effect impact. Therefore, lowering such accumulation is an important challenge for the cities of the future. The green roofs are the most common solution which has a potential of mitigating the UHIs, even though in many cases they are not designed with such intention and they address the discussed problem only as a side effect. Although planning regulations in many developed countries strongly encourage using them in new constructions, their occurrence is still far from having a significant impact on climate to any extent. The main reason is that green roofs have not been used in existing buildings almost in the whole world, especially in the older ones, and even now they are not a standard as they are still two times more expensive than a regular structure. Furthermore, the UHIs are strongest in deprived urban areas, where the property owners usually cannot afford retrofitting the roofs to the green ones and where new buildings are rarely constructed. The air pollution is also prone to grow there, due to a typical street cross-section, impeding diffusion of the air pollutants to concentrations below dangerous levels, while the street traffic is hard to be limited without a negative economic impact and an analogical social response consequently.

To overcome these bottlenecks we propose introducing green roofs into existing urban tissue basing on the prosumer approach, which will provide constant benefits for the users and become a cornerstone for a financial model that will make them affordable for low-income inhabitants of cities. It is necessary as developing the deprived urban areas is crucial not only for social cohesion, but it is also a question of validating the financial model in hardest conditions.

Micro biogas plants are an invention from developing countries worth promoting worldwide and elements of distributed generation grids simultaneously. They are cheap and reliable enough to be introduced to the less developed urban neighbourhoods and their primary feedstock is organic household waste. The gas produced there is capable of making households self-sufficient in terms of the supply for cooking purposes. The benefit of such a solution is not only starting treating issues of municipal organic waste not as a problem, but as an asset, but also exploring the opportunity of reinforcing it by introducing urban farming at the green roofs, which is potentially a very convenient option. While green roofs are absorbing CO2, other greenhouse gases and air pollutants, producing biogas from the waste is a way to contribute further to reaching the same goals. There is some further synergy between green roofs and micro biogas plants, as a by-product of this process, a digestate, can be used as a fertiliser for growing edible plants, which is also creating kind of branch of urban circular economy with a short circulation path and reintroducing some elements of natural economy instead of commodity exchange therein. We also aim at developing tools for more common and meaningful engagement in addressing UHI effect and the air pollution by empowering the stakeholders in an uneasy economic situation, otherwise having very limited options of positive influence on the climate they live in.

Keywords: green roofs, micro biogas plants, Urban Heat Island (UHI), air pollution, prosumer economy
WSUD and LLD, a match for Nature Based Climate Adaptive Design in a coastal area? A qualitative comparative design analysis of the new public spaces at the East bank in Ostend

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Every year, our environment suffers from climate change related natural hazards such as flooding and droughts. In the following years, the impact of these climate change related problems will increase, challenging our society even more. The manner to deal with these challenges in an urban context has not reached any consensus between urban planners and policy makers. As most of these strategies lack a holistic design approach, it is often unclear which of these efforts or measures will lead to the desired effects. On the East Bank, in the Belgian coastal city of Ostend, a match was made between the WSUD strategy (Water Sensitive Urban Design Strategy) and an LLD strategy (Landscape Led Design Strategy) within the framework of the EU funded project SCAPE to incorporate a broader perspective. The urban landscape of the East Bank, configured by its former harbour activities, draws the context of the climate adaptive design. As flooding and drought in combination with heat stress forms the main challenges here, technical solutions were combined with a more holistic design strategy to tackle this water related issues of the site. To test the effectiveness of the design scheme and the WSUD strategy, two pilot sites (H. Baelskaaai and the Victorialaan) at the East Bank are compared in a comparative analysis of plans and unstructured interviews with the stakeholders. One of the pilots (H. Baelskaaai) obtained the WSUD strategy, the other one (Victorialaan) the combined WSUD-LLD approach. It’s clear that the combined WSUD-LLD strategy provides a valuable asset to any future design of the public realm in an urban coastal context.

The holistic approach not only offers the design more depth and differentiation, but also a multi-layered analysis of the site, including: reconversion, history, ambitions of the city and stakeholder input. It’s this multi-layered approach, which leads to an aesthetical design and offers the project to go even further than the pure technical, functional our esthetical elements. As a result, the implemented solutions are evaluated in a broader perspective and will clarify why a specific solution was used on a specific place. Moreover, the process of evaluation on a multi-layered level, can support sustainable decision-making and stimulate coproduction between local governments and private partners. This, in turn, offers the partnership the opportunity and financial bases to test alternative – out of the box – approaches for the reconversion of the public realm.

Testing the combined scheme on projects of a larger scale, which offer more complexity and multidirectional interaction, requires more research. This in a holistic longitudinal way.

Keywords: climate change, LLD, WSUD, urban development, Ostend, SCAPE
Nature-based solutions for a more performing urban nature
Andrea Balestrini, LAND srl

Contemporary cities are facing momentous challenges due both for the strong shift of socio-economic trends and for harsh environmental conditions. Post-industrialization and digitalization are global phenomena that are changing investments, infrastructural demand and everyday life behaviours in our cities. However, recent economic and geopolitical uncertainty exacerbate existing contrasts and inequalities in metropolitan areas. In addition to this, climate change shape urban agendas in terms of economic damages and hazards to human and ecosystem health.

Such challenges and infra-sectorial trends deeply influence urban planning and management requiring a novel approach for public administrations, practitioners and private stakeholders. The European Union developed the Green Infrastructure strategy (COM(2013) 249 final) in order to provide a shared research platform and planning tool to approach urban development and ecosystem restoration in a more integrated and multidisciplinary way.

“Green infrastructure planning is a successfully tested tool to provide environmental, economic and social benefits through natural solutions” (EC, 2013): nature-based solutions (NBS) are cost-effective and low-maintenance technical solutions able to provide multiple benefits by supporting, restoring or creating urban nature.

NBS assessment is fundamental to evaluate existing and planned ecosystems, their performance and impacts, as well as to provide adequate solutions to societal challenges. Project indicators should be related to selected NBS and local available tools: in the H2020-financed project UNaLab we are striving to identify across three different pilot projects common indicators that would be feasible for local administration to monitor.

NBS are depending on their local environment and societal context: therefore, they require a place-based approach, although referring to international guidelines and research results. Within UNaLab we are developing a climate-resilient landscape on a former military barrack in Genova. The harsh site and social background led to rebalance suggested NBS and assessment tools, bringing us to reckon that NBS design are highly context-sensitive: a successful solution in Copenhagen could turn out completely ineffective in Genova, not only for its different climate features.

Climate change adaption is the main scope of another project within a territorial river park in a highly urbanized region: Lura flood retention basins, in Como province. Their major scope was to provide safe flooding areas to prevent severe damages in Milan metropolitan area during increasingly frequent heavy rain events. The project aims to go beyond mere mitigation of flood risk in the region; design solutions introduced NBS to foster biodiversity (riparian vegetation and afforestation areas with autochthonous species, wetlands, bioswales) and territorial recreation (rest areas, viewpoints, bridges, cycle routes). Moreover, the project is a multi-sectorial platform for territorial cooperation: park authority, regional government, local municipalities, associations and property owners have been involved to define shared effective solutions, such as the future maintenance, that will be carried out by farmers.

Biodiversity is also the focus of the newly designed Saint-Laurent Biodiversity Corridor in Montreal. A landscape international competition led us to rethink a wide industrial and residential neighbourhood as a landscape lab to implement a novel open space network, with 6 ha of urban forest and a 18 km corridor. The masterplan guidelines aim also to create 30 ha of new green roofs in the neighbourhood to strengthen biodiversity and water resilience; definitely one of the urban policy and financial issues that NBS can contribute to generate.

NBS are proving to be solutions to make our cities more liveable, because more resilient. Strategically planned urban nature provides resilience in a broader way: ecosystem resilience to climate change implies resilience to social conflicts, to economic damages and financial uncertainty. Urban landscape assumes therefore a leading role in urban transformation process as common ground for our future cities.

Keywords: climate adaption, ecosystem performance, assessment tools, territorial cooperation, liveable cities