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ISSUE PAPER ON URBAN ECOSYSTEMS AND RESOURCE MANAGEMENT

KEY WORDS

Ecosystem, biodiversity, services, resource efficiency

OVERVIEW

This Issue Paper outlines the importance of ecosystems to cities. The social and economic systems that visibly constitute cities are built upon the ecosystems that they supplant, and are perpetually reliant on the flow of ecosystem services both within and beyond the city. The content of this Issue Paper has relevance to various others, in which can be found elements that are discussed here in more, or less, detail. Specifically the topics covered in Issue Paper 6 on Urban Governance; Issue Paper 8 on Urban and Spatial Planning; Issue Paper 10 on Urban-rural Linkages; Issue Paper 11 on Public Space; Issue Paper 15 on Urban Resilience; and Issue Paper 17 on Cities &Climate Change & Disaster Risk Management; have relevance to the current Issue Paper on Urban Ecosystems and Resource Management.

MAIN CONCEPTS

- Urban environment The intersection and overlay of the natural environment, the built environment and the socio-economic environment (Srinivas, 2003)
- Ecological footprint Biocapacity - the planet's biologically productive land areas - can be compared with humanity's demand on nature: our ecological footprint. The ecological footprint represents the productive area required to provide the renewable resources humanity is using and to absorb its waste. The productive area currently occupied by human infrastructure is also included in this calculation, since built-up land is not available for resource regeneration (Rees & Wackernagel (1996); www.globalfootprintnetwork.org).
- Ecosystem services (ES) Ecosystem services are defined as the benefits people obtain from ecosystems, delineated into four categories: supporting services (e.g. habitat for species and genetic resources), provisioning services (e.g. food and medical resources), regulating services (e.g. regulation of local climate and of extreme events); and cultural services (e.g. recreation and tourism) (Millennium Ecosystem Assessment (2005); www.teebweb.org).
- Ecosystem-based Adaptation (EbA) The use of biodiversity and ecosystem services to adapt to the adverse effects of climate change, including the range of opportunities for the sustainable management, conservation, and restoration of ecosystems. Ecosystem-based adaptation is most appropriately integrated into broader adaptation and development strategies (SCBD 2009).
- Green infrastructure (GI) The network of natural and semi-natural areas, features and green spaces in rural and urban, and terrestrial, freshwater, coastal and marine areas, which together enhance ecosystem health and resilience, contribute to biodiversity conservation and benefit human populations through the maintenance and enhancement of

ecosystem services (Naumann et al. 2011:14). The concept of ES differs from GI in that it is an approach to illustrate the dependency of human well-being on ecosystems' capacity to provide essential services. GI, in contrast, is a strategy for safeguarding or enhancing the provision of ES (Albert & Von Haaren, 2014).

- Resource efficient city – a sustainable, resource efficient city can be defined as a city that is significantly decoupled from resource exploitation and ecological impacts and is socio-economically and ecologically sustainable in the long-term (UNEP, 2012).
- Biodiversity – the term given to the variety of life on Earth and the natural patterns it forms. The biodiversity we see today is the fruit of billions of years of evolution, shaped by natural processes and, increasingly, by the influence of humans. It forms the web of life of which we are an integral part and upon which we so fully depend (www.cbd.int).

FIGURES AND KEY FACTS

Ecosystems provide cities with essential goods and services

Ecosystems, both within cities and beyond their boundaries, provide ecosystem services to cities. Although there is no clear distinction between the kind of services provided within city boundaries and beyond them, those within typically include local level benefits such as moderation of the urban microclimate and improvement of air quality, opportunities for recreation, and enhancement of the health of citizens; those surrounding cities may help to moderate extreme climatic events such as flooding and enhance the quality and quantity of water supplied via watersheds; while very distant ecosystems may provide food, medicines and timber. Although difficult to quantify, a growing body of research demonstrates our reliance on these services to build resilience in cities (McPhearson et al., 2014), which is especially important in the face of climate change[1].

Cities are centers of consumption and production

Cities attract and create wealth. An involuntary consequence is that, with most of the world's population now located in cities, they are by default strongly correlated with consumption and production. "…With a [global] population share of just above 50 per cent but occupying less than 2 per cent of the earth's surface, urban areas concentrate 80 per cent of economic output, between 60 and 80 per cent of energy consumption, and approximately 75 per cent of CO2 emissions" (UNEP, 2011). The figure below illustrates that more urbanized regions have a bigger per capita ecological footprint.

[1] Refer to Issue Paper 15 on Urban Resilience for more on this subject

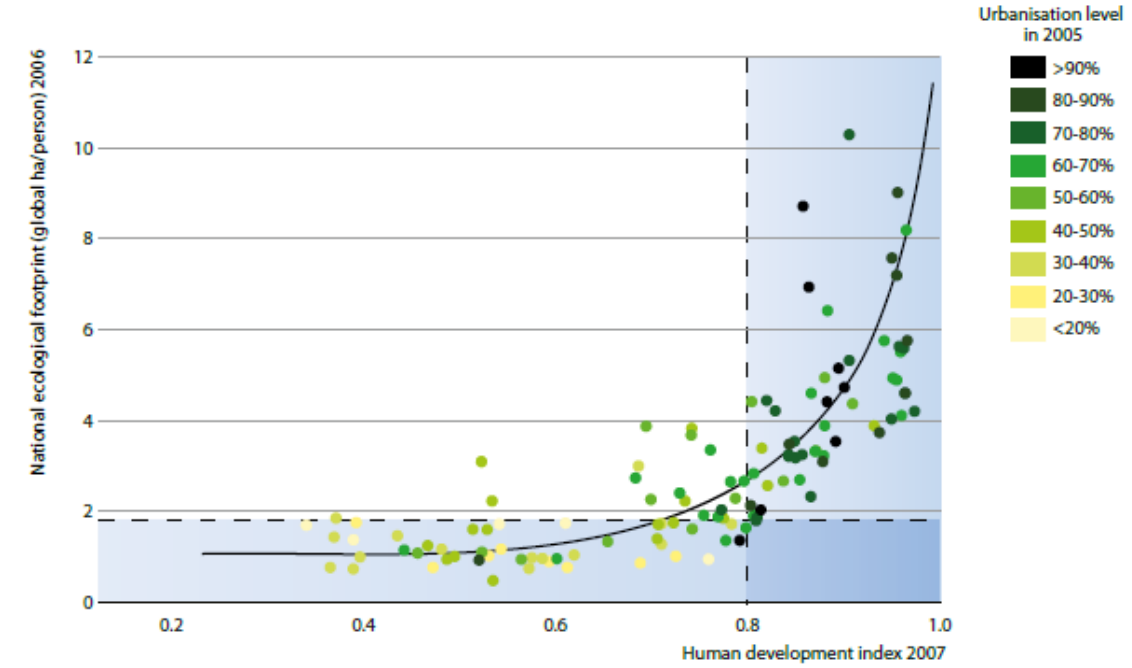

Figure 1: Ecological Footprint by Urbanization Levels of Countries (Source Green Economy Report Cities Chapter, 2011)

Cities have a direct effect on ecosystems

Without good planning, urbanization also affects ecosystems more directly. A global study of urban area expansion in 50 cities also showed that urban development is strongly negatively correlated with forest, cropland and grassland (Bagan & Yamagata, 2014). This is also true for marine ecosystems. An estimated 90 per cent of all wastewater in developing countries is discharged untreated directly into rivers, lakes or the oceans. The resulting de-oxygenated dead zones are now thought to affect more than 245 000 km^2 of marine ecosystems (Diaz & Rosenberg, 2008), equivalent to the total global area of coral reefs.

Cities also offer some of the best solutions to ecological problems

The growing global population requires natural resources for its livelihood and wellbeing, and the density that characterizes urban offers solutions to provide for this population at less cost to our ecosystems. Cities also have agglomeration benefits that provide opportunities for technological and behavioral innovation, and the widespread application of green technologies. When efficiency in the delivery of services, such as piped water, public transport and solid waste collection are less costly to develop, maintain and operate, as in a densely populated urban setting, they contribute to reducing the human impact on local ecosystem and the consequent hazards. Similarly, the physical proximity of many enterprises makes it easier to enforce environmental legislation, and to control ecological damages (Dodman, 2009). Cities are also the stage for deploying old and new mobility solutions with low greenhouse gas emission and resource consumption, such as walking,

biking, and public transport. Cities that include ecological considerations in management and governance pave the way not only for solutions to ecological challenges, but also many social and economic ones[2].

ISSUE SUMMARY

Over the past 50 years ecosystems have been changed more rapidly and extensively than in any comparable period of time in human history and this has put at risk the ecosystems that support human wellbeing (GreenFacts Initiative, 2015). Unsustainable development patterns have resulted in a substantial and largely irreversible loss in the diversity of life on Earth. Approximately 60% (15 out of 24) of the ecosystem services examined during the Millennium Ecosystem Assessment in 2005 were being degraded or used unsustainably (WRI, 2005).

As it stands, many sensitive natural environments such as wetlands and coastal and estuarian ecosystems located within cities, suffer greatly in areas where slums and informality are significant or dominant factors in the urban landscape. In such contexts, these ecosystems are used as primary sources of basic needs (i.e. food, water) while at the same time as sinks for solid and bio waste. They are therefore vulnerable to exploitation and misuse (UNEP, 2012). The loss or degradatuion of ecosystems such as these is also a lost opportunity for often low-cost opportunities to build resilience to climate change.

However exploitation and misuse is not limited to such direct use. Ecosystem damage is largely due to rapidly growing demands for resources, from near and far, and mostly by cities since urban areas are now home to more than half of the human population, and most of the wealthy. Consequently, cities are the front-liners in the challenge to preserve the ecosystems that support humanity. They are tasked with finding ways to establish a harmonious interaction between the natural and built environments.

There is a need for urbanization to be planned and for planning trends to shift towards adopting a more ecosystem-oriented approach. Cities are “systems and components of nested systems” that exist within a wider ecological network (UNU-IAS, 2003).

The ecological footprint of cities is many times their physical size

One can get an idea of the ecological footprint of cities through their water footprint. Overall, urban areas only cover around less than 2% of the Earth’s land surface, but the area upstream of their water sources, their water footprint, covers 41% of the Earth’s surface (McDonald, 2014). Globally cities move 504 billion liters a distance of 27,000 kilometers every day. Laid end to end, all those canals and pipes would stretch halfway around the world (and that’s not counting the many small pipes that move water within cities)[3] (McDonald, 2014). The 100 largest cities in the world occupy less than 1 percent of our planet’s land area, while their watersheds cover over 12 percent.

In addition, the resources utilized in cities – from food to clothing to cars – are produced or extracted, and distributed from, all over the world. As a result of the relative wealth (and hence purchasing power) of their citizens when compared with rural counterparts, cities are globally responsible for a disproportionate share of resource use and the production of waste that

[2] Refer to Issue Paper 11 on Urban Governance for more information

[3] For example, Johannesburg, South Africa, which ultimately gets water from another country — Lesotho, moves it through a tunnel under the mountains, deposits it in the Vaal River, and then eventually extracts it for use in the city. Such large extractions tend to affect to some extent the ecosystem resources of the source. Forty percent 40% of urban watersheds have experienced significant forest loss over the past decade.

accompanies it. The land area required for these needs far exceeds the geographical extent of cities, and they therefore displace original ecosystems, resulting also in the loss of species and unique genetic material. To satisfy the needs mostly of cities, land is needed on an unprecedented scale for agriculture and timber forestry. Extractive activities like fishing and mining, meanwhile, damage ecosystems and/or remove or destroy animals and plants or even entire species. This demand is not unique to cities, but cities the ultimate destination of most these products.

It is, however, important to make a distinction between the impact of urbanization and the impact caused by economic development and increasing levels of production and consumption. Many of the problems that are attributed to 'cities', are a consequence of the economic development of a community rather than of urbanization as such (e.g. increased consumption, dietary changes, greater ownership of durable good). The urban form, when considered independently, can help compensate the negative externalities of development. In developed countries, for instance, often cities present lower per capita GHG emissions than the country average (UNEP, 2011). With 2.8 global hectares per capita, the city of London has an ecological footprint almost 10% lower than the European average (Dodman, 2009).

Services provided by ecosystems in and around cities

Nature (e.g. trees, green areas, wetlands, lakes and streams) in the urban environment produce services which not only provide a benefit for human well being but are also are necessary to sustain the ecosystems themselves. These natural elements directly contribute to public health and increase the quality of life of urban dwellers, e.g. by regulating micro-climate, improving air quality and reducing noise (Chaparro & Terradas, 2009). A variety of examples demonstrate the ecosystem services that are relied upon by city-dwellers, from health and recreation to basic needs like water. Conserving them makes social as well as economic sense. In the City of Cape Town a three-year study calculated that the leverage of municipal expenditure on maintaining and enhancing ecosystems is 1.2–2 times higher than the leverage of all municipal expenditure on the City economy (De Wit et al., 2012).

Disaster risk reduction

The contribution of ecosystems to urban resilience is demonstrated by ways in which they contribute to reducing vulnerability to natural disasters and hazards, which are being exacerbated by climate change[4]. Examples include slowing the flow of flood waters, stabilizing slopes, and protecting coastlines. Cities depend on the flow of ecosystem services and custodianship of ecosystems, outside their boundaries as well as those within them to provide these services. For example in the case of flooding, healthy catchment areas outside cities as well as green open spaces within cities help to slow the flow of water and increase its infiltration. Cities therefore need to partner with "upstream" managers of natural resources[5]. In both cases conservation or restoration of ecosystems provides cost-effective options for adaptation to climate change, and reduction of disaster risk. Every year, an average of four typhoons and many more storms wreak havoc on Vietnam's coastline. A system of sea dykes has been established behind mangroves. Rehabilitation of the mangroves protects the sea dyke and helps avoid sea dyke maintenance expenses. Generally, the larger the mangroves stand, the more damage costs are avoided. Mangrove stands provide a physical barrier that dissipates wave energy. They also stabilize the sea floor and trap sediment. In financial terms, the planning and protection of 12,000 hectares of mangroves cost Vietnam around US$

[4] Refer to Issue Paper 17 on Cities &Climate Change & Disaster Risk Management for more information

[5] Refer to Issue Paper 10 on Issue Paper 10 on Urban-rural Linkages for more information

1.1 million. The cost of dyke maintenance, however, has been reduced by US$ 7.3 million annually. In addition, a typhoon (Wukong) in October of 2000 damaged three northern provinces but did not damage the dykes behind regenerated mangroves (TEEB, 2012).

Health and recreation

Studies are increasingly showing that exposure to natural areas is beneficial to both people's mental and physical health. For example hospital patients were found to recover more quickly from surgery when they had a green view out of their window (Ulrich, 1984). Similarly natural areas in cities provide city dwellers the opportunity to access nature for the purpose of recreation. Bukhansan National Park, located within the city of Seoul, Korea, receives more visitors per unit area than any national park in the world (Korea National Parks Authority, 2009). Urban ecosystems can also have a profound effect on human health by helping to purify air. A recent study estimated that nearly 100, 000 premature deaths related to air pollution could be avoided annually in Brazil, China, the EU, India, Mexico and the US by 2030 through energy efficiency measures in the transport, buildings and industrial sectors (UNEP 2014 Emission Gap Report).

Saving on infrastructure development

An example of successful integration of natural and built environment is given be the city of New York that protects the ecosystem services of its watershed to provide drinking water to the citizens. The project, launched at the end of the 1990s, was not only successful to save one of the biggest fresh water reservoirs of the country, but also contributed to major financial savings for the local government. With an average of about USD 170 million per year spent in in watershed protection projects, the city has avoided the cost of approximately $6 billion to build a filtration plant plus another $250 million per year for maintenance (ecosystemmarketplace.com, 2006).

Citizens need to connect with nature, and benefit from this connection

Ecosystems within cities play the crucial role of exposing city-dwellers to nature, who might otherwise have little or no contact with the natural world. Studies have shown that a separation from nature leads to a dysfunctional, unsustainable lifestyle (Egan, 2012). Therefore, aside from providing services themselves, ecosystems in cities provide this educational function. There is unfortunately a growing disconnect between our societies and our environment and this needs to be re-established for cities to truly become part of the solution. Studies show that city-dwellers are losing touch with nature and are therefore less likely to value these ecosystem services. This is especially true in less wealthy areas and communities (Strife S and Downey L. 2009). A report has revealed a decrease from 40% (pre-1996) to 10% of children in the UK spending recreation time outdoors (www.rspb.org). For this reason, accessible natural areas within cities – and not only the larger-scale ones beyond their borders, are important. This is why many cities have recognized the need to respond to the challenge of "integrating the natural and built form to conserve ecosystem functioning" (UNEP, 2013). For the health and wellbeing of citizens, cities need to provide sufficient public green space – balanced with other types of public space[6] and for it to be accessible to all secors of the population.

[6] Refer to Issue Paper 11 on Public Space for more information

KEY DRIVERS FOR ACTION

Loss of ecosystems services can significantly increase the costs borne by cities. If cities act now in ensuring full functioning urban ecosystems, it will be less expensive than in 10 years' time. However, awareness-raising and capacity building of local administrators is required to catalyze and accelerate action.

An ecosystems approach to city management is an economically sound approach: promoting green infrastructure as ecosystem-based adaptation and mitigation measures

Cities can be critical part of the solution to current environmental problems if they are seen "as part of the biosphere and as part of the bioregions in which they aim to achieve ecological balance." (Jennings & Newman, 2008). One of the most effective ways of doing this is to take nature into account in the city infrastructure (i.e. maximize ecosystem services) as well as consider nature as city infrastructure.

The International Resource Panel Report on cities (2013) estimated infrastructure investments from 2005-2030 at US$41 Trillion[7]. More importantly, it highlighted that ignoring the environmental dimension while building or rebuilding city infrastructure will mean another collapse of infrastructure 30 or 40 years from now, with a much higher financial costs[8].

Investing in "green infrastructure" (e.g. parks, greening of pedestrian corridors, conscious planting of trees) is one of the ways to embrace an ecosystems approach in city management. Considering green assets as equal in importance to cities' networked grey infrastructures, enables better understanding of the value of the range of ecosystem services those ecological assets generates. This is especially important in rapidly expanding cities such as those in Sub-Saharan Africa (Schäffler & Swilling, 2013). Research has found that green infrastructure provides value in moderating temperatures, reducing pollution, and increasing aesthetic value – all of which eventually translate to economic gains. In Barcelona, Spain, it was calculated that a vegetation coverage of 141 tree/ha allowed to remove a total of 305.6t pollutants (166t of PM10, 72.6t of O3, 54.6t of NO2, 6.8t of SO2 and 5.6t of CO), providing a service of an estimated USD 1.2 million USD value to society. In Washington DC, the existing vegetation contributes to remove 540t of air pollutants per year, a service valued USD 1.4 million; it also mitigates summer temperature and reduces air conditioning need, allowing for an overall saving of 25,500Mwhs or USD 4 million a year (Chaparro, L., Terradas, J., 2009).

Sustainable resource efficient cities and preserving ecosystem- based management of cities

Resource efficiency is a concept that is closely associated with ecosystems management since it is often the primary goal for city officials when exploring an integrated approach. There is a strong link between urban quality of life and how cities draw on and manage the natural resources available to them. Resource-efficient cities combine greater productivity and innovation with lower costs and reduced environmental impact.

Resource efficiency is the sustainable management and use of resources throughout their life cycle, from extraction, transport, transformation, consumption to the disposal of waste, in order to avoid scarcity and harmful environmental impacts. The ability to maintain a certain standard of living through natural resource use, despite increased pressure on those resources, is a key balance that must be struck in order to provide for a happy and healthy populace. Under different

[7] About $22.6 trillion would be required for water systems, $9 trillion for energy, $7.8 trillion for air and sea ports (IRP, 2013)
[8] Refer to Issue Paper 18 on Urban Infrastructure and Basic Services for more information

scenarios, the reduced availability of water and other ecosystem services, as compared to a sustainable management scenario, 'business as usual' or increasing degradation, will cost industry and economic growth prospects for the city an estimated US$300-500 million over 25 years. Therefore, minimizing resource extraction, energy consumption and waste generation at the same time as safeguarding ecosystem services is a key facet to resource efficiency, while decoupling resource use from environmental impacts and economic growth contribute to sustainable development and poverty eradication. Equally, the economic value of resource efficiency can be exemplified by comparing the service provided by an ecosystem to a man-made alternative. For instance, on the outskirts of Kampala, Uganda, the Nakivubo Swamps provide a natural treatment and filtration service of the biological waste water from much of the city. The proposed draining of the wetland for additional agricultural land was not taken forward when an assessment of this service showed that running a sewage treatment facility with the same capacity as the swamp would cost the city around US$2 million annually.

Thoughtful planning and design, coupled with legislation and political commitment is also important to resource efficiency. For example, while Atlanta, USA and Barcelona, Spain have a similar size of population, Barcelona's longstanding commitment to planning and designing a compact, mixed-use walkable city has produced a spatial coverage and carbon footprint that is only a fraction of Atlanta's (UN-Habitat, 2013)

PLAFTORMS AND PROJECTS

- Strategic Plan for Biodiversity 2011-2020 and its 20 Aichi Biodiversity Targets. www.cbd.int
- Summit for Cities and Subnational Governments held in parallel with meetings of the Parties to the Convention on Biological Diversity. Details available in 2016 on the CBD website (www.cbd.int).
- Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities: A Global Assessment (http://www.springer.com/gp/book/9789400770874)
- The Global Initiative for Resource Efficient Cities (GI-REC) http://www.unep.org/resourceefficiency/Policy/ResourceEfficientCities/tabid/55541/Default.aspx
- Climate and Clean Air Coalition to Reduce Short Lived Climate Pollutants (CCAC): http://www.ccacoalition.org/

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