

Assessment of Urban Ecosystem Services using Ecosystem Service Reviews and GIS-based Tools

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1 Context and Motivation

In the past years, research topics like urban sprawl, ecosystem services and sustainable food, water and energy supply gained growing interest in the light of a changing climate. With regard to a continuously increasing number of people in fast expanding cities, so-called urban services and ecosystem services may see limitations and need to be subject to further examination. By now, more than half of the population lives in cities and urban areas which account for about 3 % of the global land area¹, making them the main consumers of ecosystem services.

2 Methodology

The term Ecosystem Services (ES) refers to "the benefits people obtain from ecosystems" (MA 2005). That is, the environment supplies the inhabitants of cities with:

Provisioning Services	Regulating Services	Cultural Services
e.g. food, water, raw materials and energy	e.g. carbon sequestration, climate regulation, air and water purification, waste decomposition	e.g. scientific discovery, recreation, eco-tourism
Supporting Services		
e.g. nutrient cycle, primary production, soil formation		

Figure 1: Overview on the four types of Ecosystem Services (MA 2005).

While cities are dependent on global ecosystem services for survival, they also largely benefit from internal urban ecosystem services (Bolund and Hunhammar (1999)). Ecosystem service provision can be substantial within urban areas as they host a number of ecosystem processes, which deliver services for human well-being. Such locally generated ES include air quality regulation or recreational opportunities. Climate change mitigation and adaptation as well as resilience are thus further topics to be merged into the concept of sustainable (urban) development.

The TEEB Manual for Cities (TEEB - The Economics of Ecosystems and Biodiversity (2011)) highlights the analyses of ES as vital for sustainable cities. Therein, a valuation approach that includes monetary,

¹ While the regional coverage may be as high as 32% (GASTON, K. J., ÁVILA-JIMÉNEZ, M. L., EDMONDSON, J. L. & JONES, J. 2013. REVIEW: Managing urban ecosystems for goods and services. *Journal of Applied Ecology*, 50, 830-840.)

quantitative and qualitative values is described. To perform such a valuation, a set of methods (e.g. Cost-Benefit Analysis, SWOT Analysis, GIS-based approaches for localization) may be used. One of the basic steps is the Ecosystem Service Review (ESR) established by the World Resources Institute (WRI). In 2012, the WRI set up a concept on how to proceed in a valuation for businesses (World Resources Institute (WRI) et al. (2012)). The ESR enables the identification of priority ES on different spatial scales and the subsequent determination of risks, opportunities, costs and benefits of measures to address ES.

A classical ESR is conducted in five steps. In order to value ES in urban areas, this concept needs modification and enhancement. EIFER is going to conduct such an enhanced ESR in Singapore (Fig. 2).

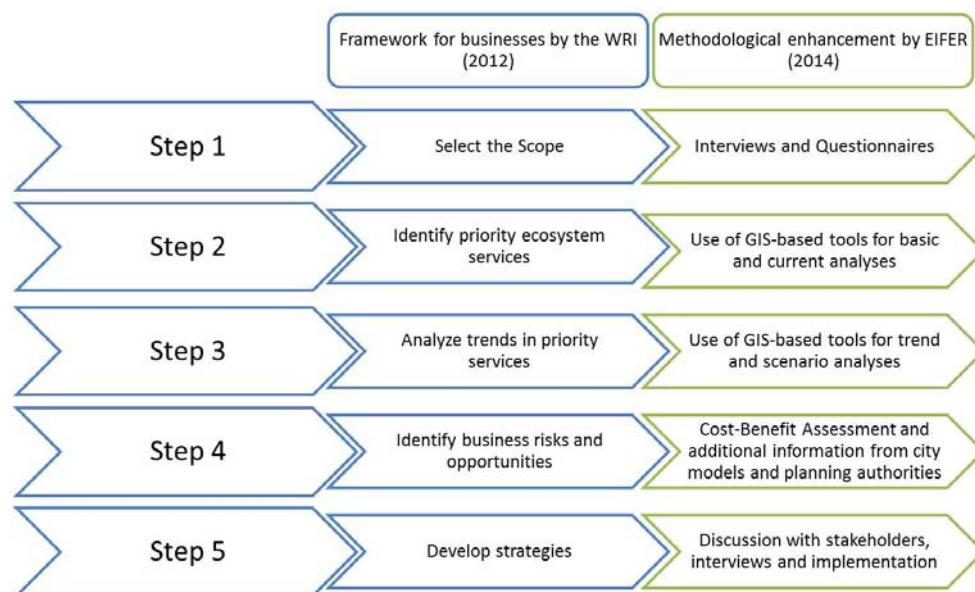


Figure 2: The 5-step methodological framework of an Ecosystem Service Review as established by the World Resource Institute (2012) for businesses and the enhancements made by EIFER (2014) for a complex urban system

Therein, Step 1 consists of prioritization of the relevant ES in the study area. This is achieved by an online questionnaire sent to different stakeholders and a literature review. Despite Singapore being part of the C40², no actions or case studies have been published yet. The Top 7 priority services are then analysed in Step 2. Step 2 takes into account planned measures and assesses risks and opportunities arising from these measures. This section of the ESR is conducted using GIS-based assessment tools, e.g. the toolbox of InVEST³ by the Natural Capital Project. In Step 3, scenarios are analyzed regarding the optimal realization of the measures identified for specific ES. Also, this step is supported by GIS-based tools for a localization of measures. Step 4 consists of a cost-benefit comparison of the ES which may lead to a revision of Step 3. The last Step 5 aims at an evaluation of the benefits and the implementation of the modelled findings into land use and urban planning goals.

3 Results

In Singapore, the Housing and Development Board started the Greenprint program which includes several ecosystem services. Additionally, Singapore developed its own standards. The Building and Construction

² A climate network of megacities worldwide with the goal to reduce greenhouse gas emissions (C40 Cities Climate Leadership Group)

³ Integrated Valuation of Environmental Services and Tradeoffs

Authority, for example, labels buildings, districts and parks with a so-called “Green Mark” (Building and Construction Authority Singapore (2013)), and “greenery” is the major reason why Singapore calls itself “Garden City”. Most research projects considering ecosystem services are often concerned with only one or few ecosystem services (Haines-Young and Potschin, 2010). EIFER chose an integrated approach across all types of ES. Aside from a qualitative analysis of priority ecosystem services, a localized quantitative assessment of benefits for inhabitants and environment will be conducted. The first evaluation of the questionnaires defined the Top 7 ecosystem services which are (no ranking indicated):

- Food provision
- Fresh water provision
- Air quality regulation
- Waste water treatment
- Habitat
- Aesthetic quality and
- Recreation

The preliminary mapping and analyses in InVEST show high aesthetic quality in Singapore downtown but also on the island of Pulau Ubin, northeast of Singapore and on Sentosa, an attraction island and tourist magnet. Also, Singapore has a high potential of using urban greenery, especially green rooftops for local and sustainable food production and air quality regulation.

The expected further results are: (1) a qualitative identification of priority ES, (2) quantitative analyses based on indicators, (3) a localization of ES in the study area and (4) a quantitative assessment of costs, benefits, risks and opportunities.

4 Conclusions

EIFER conducts an integrated assessment of ecosystem services in Singapore. The results include:

- Identification of priority ecosystem services in the case study (qualitative);
- Investigation of indicators and factors underlining the Greenprint program, the Green Mark label and the Sustainable Development Blueprint (quantitative);
- Localization of ecosystem services in Singapore (qualitative) and
- Assessment of costs, benefits, risks and opportunities (quantitative).

The results are presented as analysis maps and a set of indicators for decision-making processes.

5 Bibliography

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