

## **Urban Ecosystem Services Reviews for Climate Resilience, Energy Supply and Green Space Development**

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In the past years, a review of city concepts on sustainability and resilience revealed an increasing importance of ecosystem services (ES). In the frame of the Sustainable Development Goals, ES and their assessments can be used to support several of the defined 17 goals. This paper highlights the use of an Urban Ecosystem Services Review (uESR) for goals no. 3 “Good Health and Well-Being”, no. 7 “Affordable and Clean Energy” as well as no. 11 “Sustainable Cities and Communities”.

ES provide cities and their inhabitants with benefits from ecosystems while, however, cities also impact on ecosystems. This dependence-impact-interaction in the context of urban development and the food-water-energy- nexus is the subject of this research.

Based on a literature review of worldwide plans, concepts and programmes, Berlin, Singapore and New York City were chosen as case studies for the application of an uESR. This uESR consists of an assessment of the priority ES in each city, the mapping and analysis of said priority ES with the help of GIS-based tools as well as recommendations and the implementation of the findings in urban planning issues.

Since years, Berlin uses the Biotope Area Factor for a rough assessment of biodiversity and ES in the city, while Singapore shaped the concept of the City Biodiversity Index, earlier known as the “Singapore Index on Cities’ Biodiversity”. The PlaNYC for the urban agglomeration of New York is the latest reference document for the resilience of infrastructures and built environment considering climate change and ES. Nevertheless, all of these precursors do not explicitly frame ES as a necessity for human well-being and sustainable development. The priority ES used in this case and which are common for the three selected cities are: recreation and scenic quality, food supply from green roofs and urban gardens, as well as air quality regulation in terms of carbon storage. The nexus approach will be discussed with regards to competition of

- renewable energy supply such as photovoltaic rooftop installations,
- public safety aspects, e.g. water tanks for fire fighting and open spaces and
- extreme weather regulation in terms of technical measures vs. green and blue infrastructure.

We therefore conducted Urban Ecosystem Services Reviews as follows: An introduction to the different concepts on climate resilience, energy supply and green spaces in Berlin, Singapore and New York leads to similarities and differences in handling urban ES. Furthermore, the modelling of the priority ES with GIS-based tools, including proximities, clusters, densities and viewshed assessments leads to a catalogue of best practice. These results can be used in the frame of the food-water-energy nexus to support resilient urban development with regard to the sustainable development goals.