Session B2: Integrating ecosystem-based adaptation and ecosystem services into urban management strategies

Ecosystem Services framework as a tool to assess environmental trade-offs and synergies

Zepp, H. and Inostroza, L.

Abstract:

Following EU-directives, many countries in Europe implemented laws and regulations for protecting and improving the natural environment at the local and regional level. Mandatory compensation for the loss of nature is often restricted to replacing urban green by improving rural or peri-urban green spaces. When looking at real world situations occurring in planning, scientists encounter argumentative lock-in-situation. This bears several shortcomings that, on the whole, lead to an ongoing loss of open space.

We argue that the ecosystem services (ES) and nature-based-solutions (NBS) concepts can help to advance in the improvement of environmental conditions of urban landscapes along the full range of spaces from technotopes to ecotopes. We propose amalgamating the ES and NBS concepts into the design of compensation measures. By taking into account the whole urban context, we suggest a methodology to counteract the shortcomings, aimed at strengthening urban resilience.

Keywords:
compensation, environmental trade-offs, urban resilience
1 Rationale

Legislation and every-day-planning can greatly profit of making full and adequate use of the ecosystem services (ES) and nature-based-solutions (NBS) concepts in urban areas. This is a fact, which can greatly improve the application of laws and regulations following EU-directives for protecting and improving the natural environment at the local and regional level.

When looking at real world situations occurring in planning practice from outside, scientists often encounter argumentative lock-in-situation. Environmentalists and environmental authorities remain in fierce opposition with municipal development agencies and developers. The first-named adhere to protection, the latter are in favor of using open space for urban development while offering new economic possibilities, jobs, etc. As a consequence, when it comes to decisions and due to powerful lobbies, many times city councils overrule environmental concerns. Consequently, there is progress for one group of stakeholders only at the expense of the other.

Mandatory compensation for the loss of nature (e.g. according to EIA Directive (85/337/EEC) (Council of the European Union 1985) is often restricted to replacing urban green by improving rural or peri-urban green spaces. Typical compensation measures are planting trees, creating artificial wetlands, and the transformation of arable fields into species-rich meadows. Here, it is possible to identify three different shortcomings:

- Compensation is done by replacing vegetation by vegetation.
  i. The potential ecosystem services of an area to be developed are neglected. The baseline value is the current status.
  ii. The degree of compensation is based on the amount of urban green, neglecting urban blue (above and below ground) and soils. Vegetation serves as an indicator for the value of nature.

- Compensation takes place in distant areas, far away from the place of encroachment on nature and landscape. Thus, benefits are not noticeable on or near the site affected by the land use change.

- On the whole, one consequence is the ongoing loss of open space.

2 Objectives and methodology

This contribution suggests a methodological framework how to counteract the depicted shortcomings in compensation. Thus, it aims at strengthening urban resilience.
When looking at urban areas, we distinguish between four groups of services that are spatially relevant. Firstly, economic and socio-cultural services contribute to the function of cities as places at which population is concentrated. They make up, to a high degree, the character of the urban area. Secondly, the flow of primary provisioning and regulating services are ecosystem services that provide benefits for people, if not precondition for lasting and sustainable living conditions and economically sustainable activities. It is undeniable that most of these ecosystem services are interlinked with material flows from the hinterland and even from supply areas scattered worldwide. Ecosystem services are intricately interconnected and implicate synergies and trade-offs on all scales.

Fig. 1: Spatially relevant services of the urban landscape (selection)

Taking into account the full range of functions in urban areas, we start with initial considerations. It is necessary to take the urban landscape along the full range of spaces from technotopes to ecotopes into account. These means that in our understanding, all types of urban areas belong to the urban ecosystem – not only the green areas. Thus, all urban areas, regardless the respective level of urbanization, can provide a set of specific ecosystem services, even highly urbanized technotopes have to follow the laws of...
nature and modify entangled ecological processes. Restricting the analyses to green areas in the broad sense, as parks, forests, arable fields, and nature reserves is a relevant conceptual and methodological shortcoming, which constrains the chances to ameliorate conditions. Wherever possible, compensations measures should be amalgamated with the ecosystem services and nature-based-solutions concepts. When it comes to environmental impact induced by land use changes, such as construction of industrial, commercial or residential areas, we suggest to enlarge the area under consideration taking into account the urban context, i.e. the neighboring areas that are functionally related to the affected site.

3 Inducement and local context

Among the many challenges the city of Bochum (371,000 inhabitants, part of Germany’s Ruhr metropolis with 5 million inh.; 19th and 20th century coal mining and steel production; structural change; 56,000 students in 7 universities) is facing, two of them affect the area under consideration in the eastern part of the city. The first one is a typical example for glocalisation, depicting a local effect of economic globalization. In Bochum, the multi-national GM/Opel car factory was localized at two sites within the city. After the company’s decision to close down the car production at the end of 2015 and to restructure its material chains, one site was given up and the other one (Fig. 2) is currently being developed to serve as the European logistics center for the distribution of car spare parts. The existing access road connecting the site with the freeway crosses a residential area and will be overloaded by increasing volume of traffic. Alternative corridors are under discussion.

The second challenge arises from discussions within the context of the forthcoming Regional Plan for the Ruhr region. Bochum is urged to designate new areas for residential and for industrial and commercial use (Fig. 3).

Both plans are under debate among various stakeholders from the administration, political parties, stakeholders from economic sectors, civil society (residents, environmentalists), and public authorities. Economic aspects of well-being and nature conservation have to be evaluated and, finally, competent authorities will decide. The traditional approach of an Environmental Impact Assessment would be to assess and judge the possible encroachment on the environment expected in the access road corridors and the development sites. Compensation measures would then be defined that, based on experience, would lead to an upgrading of the quality of already existing open and green spaces. In most cases, this is realized by developing highly valued vegetation in some distance from the location of encroachment. Examples are planting trees or establishing a wetland, or simply compensating by setting aside money for nature conservation purposes without any direct localised effect. Consequently, the living condition of the people of the affected area would not profit from any compensation.
Fig. 2: Alternative corridors for access roads to the GM /Opel European logistics center under discussion (source: City of Bochum 2017).

Fig. 3: Proposed new areas for residential, industrial and commercial use for the Regional Plan.

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4 Methodology

We suggest a stepwise procedure (Tab. 1) ranging from inducement to the final decision to realize, modify, or refuse planning ideas based upon a weighing of synergies, trade-offs, and additional arguments that might be introduced from the scientific to the political arena. Implicit to the procedure is the consideration of compensation measures that is possible by a careful design of the eligible area (step 2). For this area, a broad analysis of the current environmental status is performed (step 3). At first, it includes identification and assessment of ecosystems services strength and weaknesses. This can be performed applying a rough method in order to reach a preliminary assessment (cf. Zepp et al. 2016). Additionally, deficiencies of the area as well as structural weaknesses and environmental loads are to be detected. Also, the citizens’ environmental claims and demands are articulated. Subsequently, still in step 3, sensitive areas are identified, and selected ecosystem services are analysed in depth. Hereafter (steps 4 and 5), positive and negative effects of the project to be realized are investigated, and compared. This gives points to decline, to reject the planning ideas or to search for compensation measures (step 7). A creative phase would

Tab. 1: Stepwise procedure to assess environmental trade-offs.

<table>
<thead>
<tr>
<th>No.</th>
<th>Steps</th>
<th>Tasks and activities</th>
<th>1</th>
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<td>Comparison of positive and negative impacts related to initial planning</td>
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<td>5</td>
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<td>Discussion of Change Detection Results</td>
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<td>6</td>
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<td>7</td>
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<td>8</td>
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Color coding: Stakeholders, Developers | Public Authorities, Public Agencies | Citizens, Civil Society | Experts | Competent Authorities
serve for building of scenarios, developing nature-based solutions as well as strategies to enhance the provision of the area’s ecosystem services, or to counteract disservices and structural deficiencies. Step 8 includes the planning and design of variants and the assessment of its inherent strengths and weaknesses. After another discussion between all actors (step 9), a decision by the competent authorities completes the suggested procedure.

5 Illustration of possible results

Local initiatives claim to keep untouched the open space (Fig. 4) that would be crossed by the northern access road.

Fig 4: Open space (left) and banner of local initiative “profeld” (top) fighting against a proposed new access road (“No street crossing my garden!”).
Figure 5 a-c illustrate mapping results related to step 3. The first map depicts the overall provisioning and regulating ecosystem services that were interpreted based on mapping and interpretation of urban structural units (urban morphology; cf. Zepp et al. 2016). Not surprisingly, the contrast between densely settled areas and the industrial area is obvious. Environmental handicaps stem from former coal mining. Mining caused subsidence and thus left terrain depressions without surface drainage. The sewers are not designed for storm event with rainfall rates of 50 mm/h. Thus, urban flash floods occur in settled areas and special measures have to be taken. The former coal mines and heaps also need special attention. Depending on the manner how they were decontaminated and restored, some restrictions for land use may have to be taken into account. The city’s climate change adaptation plan points to present and future urban heat islands and important open spaces that serve as cooling areas. The examples given in Fig 5 are only some among multiple possible. They give an overall clear picture of the area’s environmental situation and fulfill two other functions. During the evaluation of the possible impacts of development plans (Fig. 6, cf. Mukul et al. 2017) as well as when searching for compensation, these maps serve as the background.

We suggest that compensation should e.g. include countermeasures against urban heat island, realisation of nature-based precautions against urban flash floods, reclamation of brownfields, river restoration and other measures that increase environmental and living conditions in the area affected area. Yet, not all of these ideas can be realized. According to the current federal and provincial legislation, compensation is restricted to the encroachment of legally protected environmental sources (human health, animals, plants, biodiversity, soil, water, air) and has to be done by balancing the loss of biotopes with increasing the quality of biotopes at other places that do not necessarily need to be close to the area of environmental encroachment.
Fig. 5a: Overall provisioning and regulating ecosystem services.

Fig. 5b: Environmental handicaps and loads (former coalmines and heaps; terrain depressions due to mining subsidence).

Fig. 5c: Urban climate (sensitive areas).

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Fig. 6: Evaluation of planning variants can be illustrated using multi-dimensional spider diagrams. High scores signify the respective optimum situations of services that the specific urban landscape is thought to fulfill.

6 Conclusion

The suggested methodology is meant to counteract some of the shortcomings of traditional legally binding regulations for environmental compensation. Eventually, it aims at strengthening urban resilience in a holistic understanding. Among the advantages are the following:

- Compensation takes place in the area affected.
- The evaluation framework is flexible, adaptive and open for public participation.
- Compensation and scenarios take into account 14 potential ecosystem services. More ecosystem services can be easily included according to specific needs.
- Compensation is not only done by replacing vegetation by vegetation. The assessment includes all kinds of technotopes and ecotopes.
- The framework points to trade-offs.

Currently, we are refining the methodology by operationalizing the multidimensional evaluation of both synergies and trade-offs.

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References:


The authors:

Prof. Dr. Harald Zepp
Chair of Applied Physical Geography
Department of Geography
Ruhr-Universität Bochum
Email: harald.zepp@rub.de
Website: http://www.geographie.ruhr-uni-bochum.de/forschung/angewandte-physische-geographie/mitarbeiter-innen/zepp/

Dr. Luis Inostroza
Postdoctoral researcher
Department of Geography
Ruhr-Universität Bochum
Email: luis.inostroza@rub.de
Website: http://www.geographie.ruhr-uni-bochum.de/forschung/angewandte-physische-geographie/mitarbeiter-innen/inostroza/

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Bio:

**Harald Zepp**

Prof. Dr. Harald Zepp studied geography, soil science and geology at the Universities of Heidelberg, Giessen and Bonn. He holds the chair for Applied Physical Geography at the Department of Geography, Ruhr-Universität Bochum. In his research, he focuses on urban landscapes, geocological mapping, geomorphology, and experimental soil hydrology. He is a member editorial board of the scientific journals ‘ERDKUNDE, Archive for Scientific Geography’ and editor-in-chief of ‘Berichte. Geographie und Landeskunde’.

**Luis Inostroza**

Dr. Luis Inostroza is an architect and urban planner, with a PhD in ‘sustainable urban development’ and a postdoc in ‘urban remote sensing’. Dr Inostroza counts with 10 years of working experience in urban planning consultancy (economics) and public administration (director of planning department). His focus of research lays in the urban metabolism, using advanced quantitative spatially explicit methods (GIS and Remote Sensing). He is associated editor of CASES journal (Change and adaptation in socio-ecological systems), and guest editor of Ecosystem Services and Ecological Indicators (Elsevier).