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Assessing the synergies and trade-offs between ecosystem services provided by urban floodplains: The case of the Warta River Valley in Poznań, Poland



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While ecosystem services (ES) provided by green areas receive increased recognition, there is a shortage of knowledge on the role of blue spaces to contribute to the delivery of ES. The aim of this paper is to investigate ES provided by the urban floodplain of the Warta River in Poznań, Poland. To achieve this, we used a set of methods, including a field survey, spatial analysis, and analysis of source materials. The paper documents both the services of public interest, as well as ones that can be overlooked by the public due to their "hidden nature". The results strengthen the idea that assessment of social and ecological benefits from urban floodplains should be conducted jointly to account for the different categories of ES. A complex exploration of the ES delivery may help

1. Introduction

A lot of cities are situated in river valleys, which constitute significant factors for their development. Moreover, urban sections of river valleys are a component of green infrastructure (EEA, 2011; Tzoulas et al., 2007) and a place of particular investment pressure (Polish Urban MAES, 2015).

Provisioning, regulating and cultural ecosystem services (ES) associated with urban rivers can substantially contribute to fulfilling the needs of urban citizens and help improve their quality of life (Maes et al., 2016; Zepp et al., 2016). While services provided by green spaces receive increased recognition (Hegetschweiler et al., 2017; Pulighe et al., 2016), there is a shortage of knowledge on the role of the blue component to contribute to the delivery of ES (e.g. Prescott and Ninsalam, 2016; Weber and Ringold, 2015; Aberg and Tapsell, 2013; Eden and Tunstall, 2006; Gobster and Westphal, 1998). Addressing the multi-layered benefits of freshwaters require integration of socio-cultural and environmental information and using a mixed-methods approach (Luederitz et al., 2015; Lundy and Wade, 2011) and pose a great challenge in describing the complex relation in the urban socio-ecological system (Kremer et al., 2015).

The presented paper considers ES of the urban section of floodplain, including the river, in the light of the study for the Warta River Valley in Poznań, Poland. Place-based perspective can help better understand issues of multi-functionality and is seen as the basis of the successful application of the ES concept (Vollmer et al., 2016; Church et al., 2015; Potschin and Haines-Young, 2013). The main objectives of the study included: (1) assessing cultural ecosystem services (CES) of the Warta River Valley used by visitors; (2) recognizing the regulating ecosystem services (RES) (3) identification of possible bundles, synergies, and trade-offs between CES and RES (4) providing recommendations to policy-makers for further management of the river site.

In relation to the CES, we concentrate on recreational service as highly related to the study area. An assessment of the RES took into account habitats for wildlife and connectivity, local climate regulation (mitigation of urban heat island) and flood control. It should be stressed that other services could also be supplied by the urban rivers, such as water provision, commercial fish production, and sewage purification (Elmqvist et al., 2015; Maes et al., 2014; Zhao et al., 2013). However, these services do not occur at the study site; thus, we do not consider them in our research.

2. Study area

The study site is located within the city center of Poznań. With about 542,300 inhabitants, it is the fifth-largest city in Poland (Statistical Yearbook, 2016). Its administrative area covers 262 km^2 , of which about 57% is green and blue (Urban Atlas, 2012). The Warta River is the hydrographic axis of Poznań. This third longest river in Poland (the total length of 795 km) runs through Poznań from south to north for a distance of 20.2 km (from km 230.8 to km 251.0 of the river). The city's history is inseparably connected with the river. The

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Source: Maps - prepared by the authors on the basis of Urban Atlas; photographs – own resources.

Fig. 1. Study area.

Source: Maps - prepared by the authors on the basis of Urban Atlas; photographs - own resources.

oldest settlement in Poznań was established on an island at the fork of the Warta River and its tributary Cybina no later than at the beginning of the 9th and 10th century (Kóčka-Krenz, 2007). For centuries, the Warta River has been used for fisheries, drinking, cleaning, and processing, as well as for military defense and transportation (Kaniecki, 2004). However, together with the spatial development of the city, the intensive link between Poznań and Warta River has been lost. For the past several decades, the Warta River and its floodplain were perceived by its inhabitants as an uninteresting and unattractive part of the city. This has resulted in many areas around the river becoming deserted or neglected. Nowadays, the improvement in the quality of riverside became a very important goal of development strategies in Poznań, which aspire to create new living, recreational, and working zones in this previously unappealing urban environment (Development strategy for the city of Poznań to 2030; Development strategy for the Warta River, 2012-2030).

We chose for analysis a 2 km-long section of the Warta floodplain between the Queen Jadwiga Bridge and the Bolesław Chrobry Bridge (Fig. 1). The width of the Warta's riverbed reaches from 53 to 61 m, while the floodplain's width reaches from 119 to 209 m. The study area covers 42 ha and is the most intensely used section of the Warta Valley in Poznań. It is located close to the city center and the Cathedral Island, which are important heritage sites of Poland's medieval history. The floodplain is composed of sand, gravel and partially of aggregate mud (Kaniecki, 2004). Its geomorphology has been strongly transformed. The slopes of the Warta Valley have been profiled, while the floodplain has been elevated by a few meters in comparison to the original state. The riverbed has been straightened, and the riverbanks have been covered with concrete slabs. The last river regulation works were conducted between 1969 and 73. At that time, the cavities in the riverbed were filled up, and most of the trees and bushes were cut down, shaping a flat area that slopes down evenly towards the riverbed (Kaniecki, 1994). Presently, the study site can be characterized as a large open space in the middle of a densely built city center. The landscape of the floodplain seen from a distance is monotonous, dominated by grass vegetation. However, little fluvial forms, such as natural levees, point bars, alluviums and groynes could be seen from close-up, especially when the water level in the riverbed is low. The mosaic of fluvial forms is a result of natural alluvial processes differentiating the morphology of the floodplain since the time of river regulation (Borysiak, 1994).

The mean water within the analyzed section of the Warta River reaches 261 cm; a bank-full water depth reaches 375 cm (Poznań City Office, 2015). The ecological state of the river is assessed as good, which takes into account the biological, hydro-morphological and physicochemical characteristics (Regional Inspectorate of Environmental Protection, 2015). However, the chemical state of Warta does not fulfill the higher requirements for the areas of water supply. Upstream, a few kilometers from the study area, there is a "Dębina" municipal water intake. Its functioning is based on the artificial infiltration of water from the Warta River. The standards exceed such river water quality indicators as total suspension, BOD₅, COD-Cr, Kjeldahl nitrogen, nitrates, volatile phenols and surface active agents. The biggest threat to the quality of water in Warta are discharges of urban wastewater and agricultural pollution (Regional Inspectorate of Environmental Protection, 2016) to which the catchment of the Warta River located above the study area is exposed.

Until recently, the study site was used for leisure and recreation only to a small extent. However, in recent years, citizens have been visiting this blue-green space situated within walking distance from their houses, schools, or work more and more often. In the direct vicinity of the study site, residential and commercial facilities are being built; the historical buildings located nearby are more and more often adapted for this kind of function. An infrastructure increasing the recreational opportunities has been introduced within the research area. A temporary river harbor (on the west riverbank) and a water tram stop (on the east riverbank) have been located in the neighborhood of the Bolesław Chrobry Bridge. Each year from May to October, the area on Download English Version:

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