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Is river rehabilitation economically viable in water-scarce basins?

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ABSTRACT

Decisions on river rehabilitation actions are often based on cost-benefit analyses taking into account the costs and benefits of the considered management actions, but ecosystem services are often not included as benefits, despite recent evidences on the effects of river rehabilitations on ecosystem services. A cost-benefit analysis integrating market and non-market costs and benefits was undertaken in this study to assess the economic feasibility of a river rehabilitation project in a water scarce region, the Yarqon River Rehabilitation project (Israel). In this case, the costs included both the capital costs of implementing rehabilitation measures (including maintenance costs) and the opportunity costs of water allocation (foregone benefits to farmers from water provisioning for agriculture). The benefits of rehabilitation included the net marginal benefits of the cultural ecosystem services at local scale (estimated with a hedonic pricing method), and at regional scale (estimated with a value function transfer), in addition to the habitat service gene-pool protection (estimated with a replacement cost method). Bearing in mind the uncertainties surrounding water resource management decisions, especially in water scarce areas, a sensitivity and risk analysis was conducted using an analysis that included both Monte Carlo simulations and the standardized regression coefficients method. The rehabilitation of the Yarqon River provided positive net present values (approximately $139 million in 30-year period). This was thanks to the provision of cultural ecosystem services and despite the high rehabilitation costs, and that the massive water reallocation involved high foregone benefits to farmers. Therefore, these results highlight that river rehabilitation in water scarce regions can be economically viable due to the social amenity demand for urban rivers.

1. Introduction

Currently, freshwater ecosystems are under threat from the effects of multiple anthropogenic stressors, including organic and inorganic pollution from point and non-point sources, geomorphological alterations, land use changes, water abstraction, invasive species, and pathogens (Vörösmarty et al., 2010). Because of these threats, the provision of many valuable goods and services from freshwater ecosystems are hampered (Dodds et al., 2013). To counteract the deleterious effects of these anthropogenic threats on freshwater ecosystems, water authorities develop management plans that include management actions such as river restorations to improve the ecological status of freshwater ecosystems (Bernhardt et al., 2005). In many cases, successful stream and river restorations have resulted in improved water quality, enhanced biodiversity, reduced flood risk, enhanced water purification capacity, and increased recreational opportunities (Wilson and Carpenter, 1999; Kenney et al., 2012; Martínez-Paz et al., 2014). Despite this fact, water authorities often rely on incomplete information when deciding among management actions on freshwater ecosystems. For example, the economic analysis of the costs and benefits of the alternative management actions do not normally include the monetary benefits associated with the provision of ecosystem services (Engel and Schaefer, 2013). Given this context, several monetary valuation methods have been developed to quantify the "instrumental value" of freshwater ecosystem services (Tallis and Lubchenco, 2014). In fact, several studies have quantified the changes in the monetary value of ecosystem services that are affected by the implementation of river rehabilitation projects (Choe et al., 1996; Bateman et al., 2006). Furthermore, some of these studies compared the monetary values of the multiple benefits with the rehabilitation costs (Loomis et al., 2000; Kenney et al., 2012), and some even performed a complete cost-benefit analysis (CBA) of river rehabilitation projects including ecosystem service estimates (Alam, 2008;

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Trenholm et al., 2013; Acuña et al., 2013). Overall, results from these studies have shown that freshwater ecosystems rehabilitation actions might be economically feasible if both market (e.g., water provisioning) and non-market (e.g., aesthetic information) benefits are considered.

In water scarce regions such as the Mediterranean region, water quantity and quality impacts are main drivers for ecological river degradation (González et al., 2012). In addition to an improvement in the sanitation services, frequently, ecologically successful river rehabilitation plans entail water allocation management decisions among different and competing users (e.g., environmental flows, water for irrigation, and water supply for urban areas), which might be a critical issue if water is scarce. In fact, many regions currently striving for economic and social development are challenged by increasingly related water problems such as availability of the resource (GWP, 2000). Besides, many of these countries foresee significant population growth and may experience a decrease in water availability due to climate change (Evans, 2009). The integration of ecosystem services into a cost-benefit analysis might help water authorities to properly evaluate rehabilitation plan's trade-offs and support the selection of the most socially optimal measures under water scarcity contexts (Engel and Schaefer, 2013). There are few studies assessing the costs and benefits of rehabilitation actions considering water allocation issues under water scarcity circumstances (Becker and Friedler, 2013; Halaburka et al., 2013; Becker et al., 2014; Chen et al., 2015). Similarly to what previously stated, the inclusion of the non-marketed benefits have supposed a turning point that had significantly changed the results of the economic assessment towards favouring rehabilitation of rivers in scarce regions.

In line with these studies, we performed a cost-benefit analysis of the Yarqon River Rehabilitation Project (YRRP) in Israel, considering costs and benefits related with the provision of ecosystem services. We aimed to ascertain if urban river rehabilitation actions such as water reallocation from irrigation agriculture to environmental flows in water scarce regions provided positive or negative values. The issue is explored in the Israeli water policy context, where a significant disregard for the environmental quality of rivers at the expense of agricultural sector, is giving way to the use of alternative water sources and the rehabilitation of urban rivers for their ecological and amenity value (Gasith et al., 2010; Tal and Katz, 2012). With this aim in mind, we considered the rehabilitation trade-offs on both market and non-market benefit values, and both the capital costs of implementing rehabilitation measures (including maintenance costs) and the opportunity costs of water allocation (foregone benefits to farmers from water provisioning for agriculture).

2. Policy context: drivers of environmental degradation and rehabilitation of israeli rivers

After the creation of the State of Israel in 1948, agriculture was conceived and promoted as the leading economic sector for nationalistic reasons (Menahem, 1998). At the same time, rapid population growth and industrial production contributed to the demand for water, increasing the competition among water

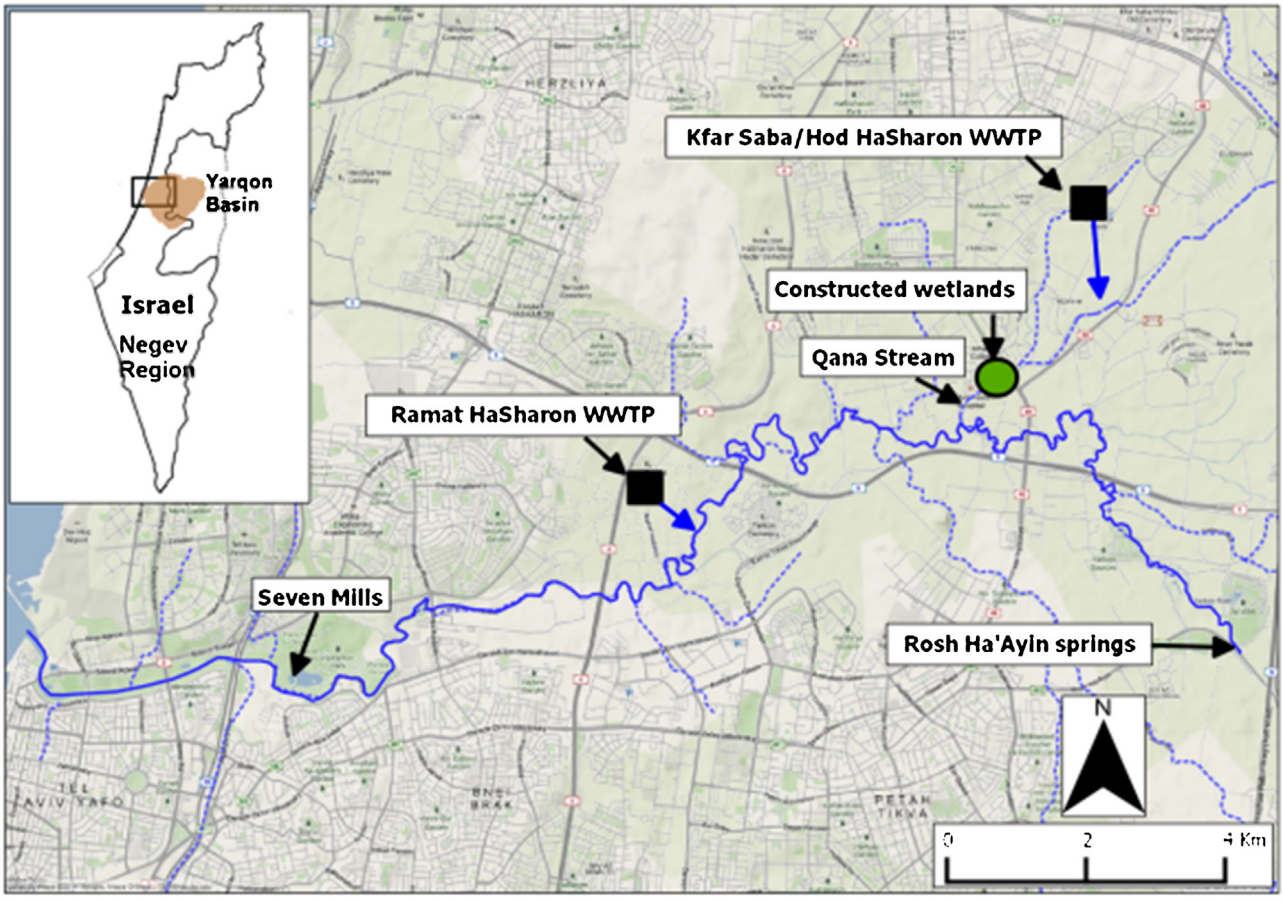

Fig. 1. Location of the Yarqon River.