Ecosystem Services 22 (2016) 392–401

Contents lists available at ScienceDirect

Ecosystem Services

journal homepage: www.elsevier.com/locate/ecoser

Integrated valuation of a nature-based solution for water pollution control. Highlighting hidden benefits

Camino Liquete[a,*], Angel Udias[a], Giulio Conte[b], Bruna Grizzetti[a], Fabio Masi[b]

[a] European Commission, Joint Research Centre (JRC), Directorate D – Sustainable Resources, Via Enrico Fermi 2749, 21027 Ispra, VA, Italy
[b] IRIDRA Srl, Via La Marmora 51, Florence 50121, Italy

ARTICLE INFO

Keywords:
Sustainable urban drainage systems
Constructed wetland
Ecosystem services
Integrated valuation
Multi-criteria analysis
Water management

ABSTRACT

In this study we assess multiple benefits (environmental, social and economic) provided by a multi-purpose green infrastructure (a series of constructed wetlands surrounded by a park) in a peri-urban area, and compare it with the alternative grey infrastructure and with the previous situation (a poplar plantation). We apply a multi-criteria analysis as a basis for integrated valuation. We address specific policy needs (strategic objectives) for the local territorial planning in the implementation of the EU Water Framework Directive. The analysis is used retrospectively (*ex post* evaluation) but our results could also be used prospectively to appraise new proposals of constructed wetlands under similar circumstances.

The results reflect that the green infrastructure performs equal or even better than the grey infrastructure alternative for water purification and flood protection, it has a similar cost, and it provides additional benefits (like wildlife support and recreation). The most preferred alternative is the green infrastructure, followed by the grey infrastructure and the poplar plantation.

This study demonstrates (a) the effectiveness of investments on nature-based solutions, (b) the potential of green infrastructures for delivering a broad range of ecosystem services, and (c) the utility of integrating different value systems and stakeholders' viewpoints to support environmental decision-making.

1. Introduction

Natural ecosystems are hypothesized to provide viable (cost-efficient and effective) solutions to tackle numerous societal challenges such as climate change, disaster prevention, sustainable cities and water resource management. In the present EU policy context, the use of natural ecosystems as smart solutions is promoted by several strategies. The EU Biodiversity Strategy[1] have set specific policy targets for maintaining and enhancing ecosystems and their services by establishing green infrastructures and restoring degraded ecosystems. Green infrastructures[2] are considered to provide multiple benefits contributing to achieve the objectives of several policies, including climate change and environmental policies, disaster risk management, health and consumer policies and the Common Agricultural Policy. Specifically for water policy, the recent Blueprint to safeguard Europe's water resources[3] indicated that green infrastructures and nature-based solutions, such as natural water retention measures, can greatly contribute to the provisioning of ecosystem services and should be adopted as measures in the implementation of the Water Framework Directive and the Flood Directive through the territorial planning. Therefore there is a great interest in investing in nature-based solutions assuring multiple ecosystem services. But how to measure the effectiveness of these measures and how to account for the multiple benefits they provide? These are the two key questions we want to address in the present study, based on a real case application.

Nature-based solutions are defined as actions inspired by, supported by or copied from nature that help societies address a variety of environmental, social and economic challenges in sustainable ways (DG Research and Innovation, 2015). Other definitions highlight the contribution of well-managed and diverse ecosystems to enhance human resilience and sustainable development, thus focusing on ecosystem services. For instance, Maes and Jacobs (2015) define nature-based solutions as *any transition to a use of ecosystem services with decreased input of non-renewable natural capital and increased investment in renewable natural processes*. Eggermont et al. (2015) differentiate three types of nature-based solutions that share the aim of

* Corresponding author.
E-mail address: camino.liquete@gmail.com (C. Liquete).
[1] European Commission, 2011 COM(2011) 244 final.
[2] European Commission, 2013 COM(2013) 249 final.
[3] European Commission, 2012 COM(2012) 673 final.

http://dx.doi.org/10.1016/j.ecoser.2016.09.011
Received 4 December 2015; Received in revised form 24 June 2016; Accepted 19 September 2016
Available online 30 September 2016

improving the delivery of a range of ecosystem services: solutions of no or minimal intervention in ecosystems, interventions in managed ecosystems and landscapes that look for sustainability and multi-functionality, and creation or deep modification of ecosystems usually to build green or blue infrastructures. The case study shown in this paper corresponds to the third type. Any of these visions implies that maintaining and enhancing natural capital and ecosystem services is of crucial importance. In Europe, investing in nature-based solutions can lead to wide socio-economic benefits, provision of jobs, and low-carbon technology innovations, that is, to sustainable economy and development as envisaged by the EU Horizon 2020 vision (Maes and Jacobs, 2015). Some of the nature-based engineered solutions already used in urban planning and water management (e.g. green roofs, bio-infiltration rain gardens, vegetation in street canyons) have demonstrated to be more efficient, cost-effective, adaptable, multi-purpose and long-lasting than the so-called 'grey infrastructure' alternatives (e.g. Gill et al., 2007; Pugh et al., 2012; Ellis, 2013; Flynn and Traver, 2013; Raje et al., 2013).

In order to support the implementation of innovative nature-based solutions in environmental management and land use planning, valuation becomes essential. Valuation can refer to monetisation (assessing a monetary value) or to an estimation of worth or importance (Dendoncker et al., 2014). In this case, valuing for sustainability and for environmental decision-making requires to account for ecological, social and economic aspects, which are considered the three pillars of integrated valuation (Boeraeve et al., 2014; Dendoncker et al., 2014; Gómez-Baggethun et al., 2014). One of the possible methodologies to achieve value integration is multi-criteria analyses (MCA). MCA is a framework for exploring and ranking the performance of alternative decision options according to multiple objectives (Belton and Stewart, 2002; Hajkowicz and Collins 2007). It can combine a wide assortment of information (e.g. qualitative and quantitative) and opinions. The approach has been largely applied for water resource management (Hajkowicz and Collins, 2007). MCA establishes preferences between options (usually identifying the most preferred option) by reference to an explicit set of objectives for which it has established measurable criteria (Department for Communities and Local Government, 2009). Their aim is to simplify handling complex information to take difficult decisions in a consistent way.

In this study we assess the benefits of a multi-purpose nature-based solution for water pollution control in a peri-urban area located in Gorla Maggiore (northern Italy), using an ecosystem service approach and applying an integrated valuation based on MCA for local water management. This solution is compared with the alternatives "doing nothing" and with the construction of a conventional grey infrastructure. This case study gives an example of integrating different value systems and stakeholders' viewpoints, thus providing hands-on guidance for integrated valuation in ecosystem service assessments linked to (water) decision-making.

2. Study area: the alternatives

The study area is located in Gorla Maggiore, a small municipality in northern Italy (Fig. 1). Gorla Maggiore is one of the case studies of the EU FP7 project OpenNESS (http://www.openness-project.eu/). This project has 27 case studies across Europe to test practical solutions that integrate the concepts of natural capital and ecosystem services into land, water and urban management. In particular, the main objectives of the Gorla Maggiore case are:

- To investigate all the benefits that a neo-ecosystem could provide in terms of ecosystem services (water purification, flood regulation, natural habitat, recreation).
- To compare the green infrastructure (water park) with other conventional grey infrastructures and with the previous situation (a private poplar plantation).
- To integrate the ecosystem service approach in the decision-making process and in river basin management plans, through the direct

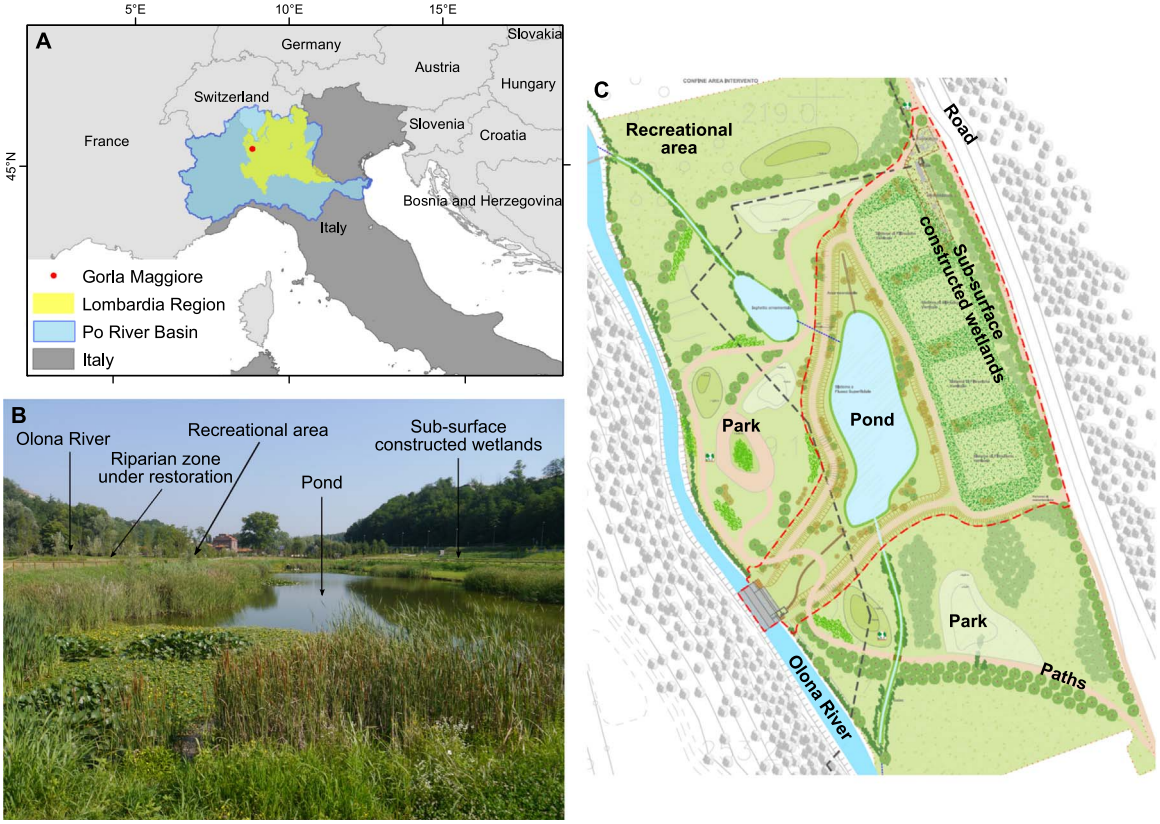

Fig. 1. Location, illustration and map of the study area with the present nature-based solution.