Nature-based drainage systems: analysis of ecosystem services in the Manzanares River (Madrid, Spain)

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ABSTRACT

The project “Recovery of the fluvial ecosystem Manzanares-Gavia-Bulera. Green and blue infrastructure Metropolitan Forest of Madrid”, funded under the NextGenerationEU's Recovery, Transformation and Resilience Plan (PRTR), focuses on the recovery of river ecosystems through a nature-based proposal for the adaptation of drainage systems’ outlets. This study presents the research hypothesis and methodology, as well as the Monitoring plan with the selection of indicators to evaluate the potential of the proposed solution to improve ecosystem services, and the pre-project results. Proposed indicators of the Monitoring Plan aim at evaluating the following key aspects: i) eco-hydrogeomorphological quality, ii) river-floodplain connectivity, iii) adaptation to global change, and iv) socio-economic connection.

1. Introduction

In the Manzanares River downstream from Madrid city, sanitation, railway and road infrastructures have confined artificially the riverbed, impairing the river’s ecological functions. More particularly, storm drains and sanitary sewers, built of concrete and sometimes reinforced with breakwaters, cause considerable environmental damage by interrupting the ecological corridor linked to the river, both in terms of the gallery forest and the valuable and delicate river banks.

The proposal for the recovery of river ecosystems consists of removing the current concrete outlets, setting them backwards and creating transition "buffer" areas with soil and vegetation, guaranteeing sufficient width to recover the environmental continuity of the banks and the gallery forest. At the same time, this solution will increase the river space and its capacity to reduce flood damage.

As this proposal implies a potential nature-based solution, its conception, design, execution, operation and monitoring must be supported by the characterization and assessment of ecosystem services. Therefore, this study aims to evaluate the potential of the proposed nature-based solution to improve ecosystem services. The objectives of the study include: i) the research hypothesis and methodology, ii) the selection of indicators of ecosystem services for the Monitoring Plan and pre-project results.

2. Research hypothesis and methodology

The hypothesis for this study is that the improvement of hydraulic, hydrological, geomorphological, ecological, cultural and landscape functions, allows for the recovery or enhancement of the ecosystem services of the riverine environment.

The methodology includes the following steps: 1) collection of available information and selection of indicators of ecosystem services, 2) evaluation of the available information and the possibilities of maintaining the monitoring of the indicators throughout the project, 3) implementation of the Monitoring Plan (pre-project, construction and post-project phases), 4) data collection according to the frequencies established in the Plan, 5) registration of the data in a georeferenced database, 6) preparation of reports.

3. Monitoring Plan: selection of indicators of ecosystem services and pre-project results

The main objectives of the Monitoring Plan are the collection and calculation of sufficient, relevant, and reliable indicators, and the comparative analysis between the initial situation (pre-project phase), the construction phase and that which would result from the execution of the proposed solution (post-project phase). Henceforth, the selection of the ecosystem services' indicators and their evaluation methods was based on relevant bibliography and the authors' own developed methods (Table 1), with the aim of reflecting the objectives of the proposal in relation to the following aspects: i) eco-hydrogeomorphological quality, ii) river-floodplain connectivity, iii) adaptation to global change, and iv) socio-economic connection.

Table 1. Selection of indicators of ecosystem services. NDVI: Normalized Difference Vegetation Index; ind.: individuals.

Aspect to be evaluated	Indicator	Method of evaluation	Units	Reference
Eco-hydrogeomorphological quality	Mean width of the active channel	Field work, digitization on ortophotography	m	MITECO (2019)
	Sedimentary activity (fluvial bars and islands)		Ratio (dimensionless)	Díaz-Redondo et al. (2022)
	Abundance, richness and biomass of ichtiofauna	Field sampling	nº ind., nº ind./m^2, gr/m^2, %	Seber & Le cren (1967)
	Abundance and richness of flying insects			Authors' own method[1] (to be published)
	Abundance and richness of pollinators			
	Abundance and richness of entomofauna			
River-floodplain connectivity	Longitudinal ecological connectivity	Field work, digitization on ortophotography	m	MITECO (2019)
	Permeable surfaces		m^2, %	
	Mean width of the gallery forest		m	
Adaptation to global change	Healthy vegetation cover	Remote sensing (NDVI)	m^2, %	Díaz-Redondo et al. (2022)
	Shading of the active channel			MITECO (2019)
	Trail shading			Authors' own method[2] (to be published)
Socio-economic connection	Agricultural land cover	Digitization on ortophotography	m^2, %	Adapted from Keele et al. (2019)
	Amenity land cover			
	Vegetated surfaces			

[1] Method based on field sampling with a collector box on a vehicle and on metrics calculation in the laboratory. [2] Method based on orthophotography digitization and selection of trail shading and raster image reclassification (NDVI > 0.6) on the selected areas.

Currently, results from the pre-project phase can be summarized as: low eco-hydrogeomorphological quality (i.e., very narrow active channel, no unvegetated islands and predominancy of exotic fish species); low lateral river-floodplain connectivity (i.e., reduced width of the gallery forest), but high longitudinal connectivity (i.e., no transversal barriers); reduced adaptation to global change (i.e., low healthy vegetation cover and low shading of the active channel); and low socio-economic connection (i.e., low agricultural and amenity land cover). These results constitute the baseline for the subsequent comparative analysis with the results of the construction and post-project phases, which will inform on the success of the proposed solution.

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