

## **The Vinalopó River (Alicante, Spain): a restoration proposal for a non-perennial Mediterranean river with multiple anthropogenic pressures**

Le fleuve Vinalopó (Alicante, Espagne): une proposition de restauration d'un fleuve méditerranéen non pérenne aux multiples pressions anthropiques

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### **RÉSUMÉ**

Le fleuve Vinalopó est le cours d'eau principal de la province d'Alicante. Il est considérée comme une fleuve non pérenne (NPR), bien que le régime hydrologique soit artificiellement modifié par le détournement de ses eaux, le captage des eaux souterraines et les déversements de nombreuses stations d'épuration des eaux usées (STEP). En outre, le climat méditerranéen du bassin, caractérisé par des périodes de précipitations intenses, rend la région vulnérable aux risques d'inondation. En raison de cela, dans les années 60 et 70, des défenses structurelles ont été construites dans certains milieux urbains, entraînant la perte de la connectivité longitudinale, latérale et verticale. Par ailleurs, la présence d'espèces exotiques envahissantes végétales et animales met en danger les communautés autochtones. En conséquence, du fait d'une mauvaise gestion des ressources hydriques et des nombreuses pressions anthropiques, son hydrodynamique, son intégrité écomorphologique et les services écosystémiques qu'il fournit à la société ont été notablement altérés. Dans ce cadre, le Centre d'Etudes et d'Expérimentation des Travaux Publics (CEDEX) a mené une étude qui propose des alternatives de restauration pour la récupération environnementale globale de l'ensemble du bassin. La proposition comprend des actions pour parvenir à une utilisation durable des ressources en eau, pour reconquérir le territoire fluvial, pour augmenter les connaissances environnementales au sein des communautés locales et pour gérer le processus de restauration de manière adaptative.

### **ABSTRACT**

The Vinalopó River is the main waterway within the province of Alicante. It is considered a non-perennial river (NPR), although the hydrological regime is artificially altered to some extent by diversion of its waters, groundwater abstraction and discharges of several waste-water treatment plants (WWTP). In addition to that, the Mediterranean climate of the basin, with periods of intense rainfall, makes the area prone to flood risk. Hence, in the 60 and 70's decades, structural flood defences were built in some urban areas, where the river has lost longitudinal, lateral and vertical connectivity. Finally, the presence of both plant and animal invasive alien species endangers autochthonous communities. Therefore, as a result of the inadequate management of the water resources in the basin, and the numerous anthropogenic pressures, its hydrodynamics, its ecomorphological integrity, and the ecosystem services it provides to society have been notably altered. In this context, the Centre for Studies and Experimentation on Public Works (CEDEX) has drawn up a study which proposes restoration alternatives for the comprehensive environmental recovery of the whole basin. The restoration proposal includes actions to achieve sustainable use of water resources, to regain the fluvial territory, to raise environmental knowledge within local communities and to manage the restoration process in an adaptive way.

### **KEYWORDS**

Eco-hydromorphology, fluvial territory, non-perennial river, Vinalopó River, water resources management

## 1 INTRODUCTION

River-floodplain systems are among the most endangered ecosystems worldwide. In the Mediterranean Region, non-perennial rivers and streams (NPRS) are particularly predominant as a result of dry climate conditions, land use and modified hydrology (Skoulikidis *et al.* 2017). Specifically, alluvial zones along these rivers are greatly disturbed due to the alterations caused by human activity. Among other pressures, they normally endure occupation of the fluvial territory either by crops or by infrastructure, channelisations and transversal barriers, overexploitation of available water resources and polluting discharges.

The Vinalopó River (Alicante, Spain), which could be considered to a certain extent a NPRS, is exposed to a wide range of stressors. The range and extent of the pressures that this river is facing within the current global change context demands a sustainable land and water resources management, including active society involvement and European Environmental Directives compliance. In the challenge of restoring this type of rivers with countless stressors, efforts need to be directed towards re-establishing natural processes, allowing the recovery of major ecological dynamics and promoting the system's resilience or self-adjustment capacity to external perturbations, thus applying a process-based restoration (PBR) approach (Beechie *et al.* 2010).

In this context, where the Vinalopó River faces numerous pressures that threaten its viability as a river system, the CEDEX has drawn up a study which aims at aiding to address holistically this situation, and which proposes restoration alternatives for the comprehensive environmental recovery of the basin.

## 2 METHODS

### 2.1 Study site

The Vinalopó River basin, whose surface covers approximately 1,692 km<sup>2</sup>, is located in the southern area of the Júcar River Basin District (JRBD), being a bordering basin that spans three autonomous communities: Valencian Community, Castilla-La Mancha and Murcia (CHJ, 2015). It is, therefore, an inter-community basin in a strict sense, whose management is the responsibility of the Júcar River Authority (JRA). The Vinalopó River originates from a series of sources and springs in the Sierra de Mariola Natural Park. The main source, Font de la Coveta spring, is located at an altitude of 783 m.a.s.l. Its course initially follows a NE-SW direction until it reaches the municipality of Villena, where it takes a NW-SE direction until it reaches the 'azarbe de Dalt', an irrigation ditch that directs to Salinas de Santa Pola Natural Park and the Mediterranean Sea.

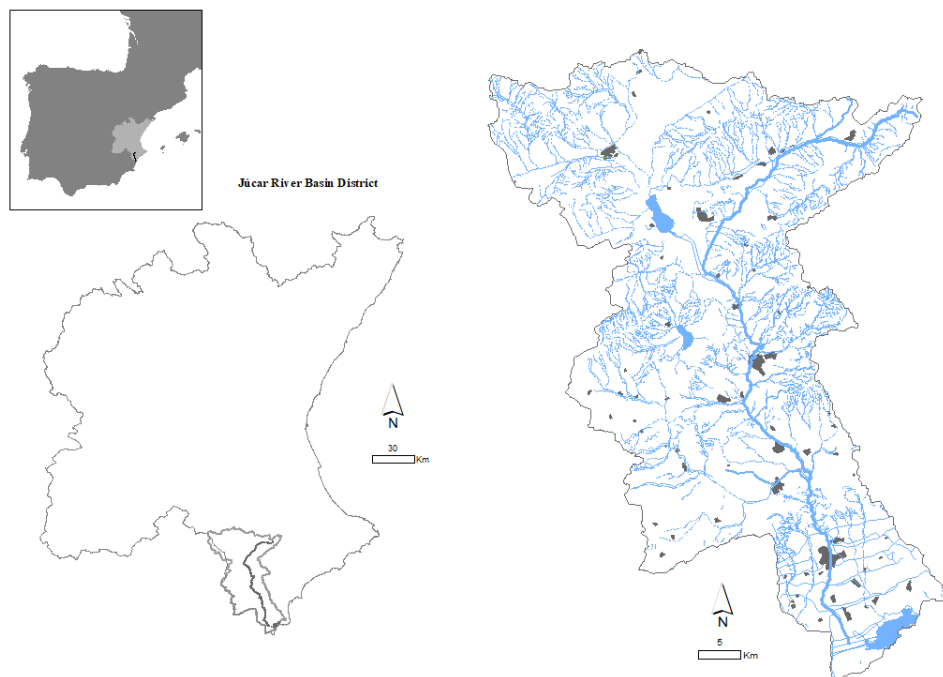


Figure 1. Location of the Vinalopó River basin.

## 2.2 Diagnosis

Although the Vinalopó River can be considered a NPRS, the hydrological regime is artificially altered to some extent due to a diversion of its waters at the Beneixama weir, 10 km downstream from its source. The riverbed remains dry along a segment of around 22 km, and it is even occupied by crops. The channel only regains some flow after receiving the effluents from the Villena waste-water treatment plant (WWTP), and successive discharges from other WWTP along its course to the sea allow it to maintain a continuous flow. Additionally, transversal obstacles, such as dams and weirs, canalizations in almost all urban reaches, and the occupation of the fluvial corridor, have caused alterations in hydrogeomorphological processes and in longitudinal and transversal connectivity, thus increasing the risk of flooding and erosion in certain basin areas. The alterations both in the hydrological regime and the morphology of the active channel have led to the presence of plant and animal invasive alien species, which have encountered good conditions to spread, posing a threat to local biodiversity, particularly aquatic and riverbank species.

## 3 RESTORATION TARGETS

Under that scenario, the selected restoration targets have been formulated to guide the actions towards the environmental recovery of the basin, considering not only ecological, but also socio-economic aspects. Those include: i) Achieving the sustainable use of the water resources of the basin through the adaptation to the availability of the resource, both surface and underground, and the redefinition of the e-flow regime. ii) Improving the ecological status of river ecosystems, in parallel with target one, and by means of revegetation of riverbanks, exotic species control and renaturalization of urban reaches. iii) Improving the chemical quality of the surface waterbodies of the basin, mainly by improving the quality of wastewater effluents from WWTPs. iv) Recovering the territory and the river continuity, through the removal of transversal or longitudinal barriers to the channel and thus giving space for movement to the river and favouring the riverbed - riverbank - floodplain interactions. v) Enhancing environmental and specifically fluvial knowledge of local people, which will allow to consolidate scientifically valid concepts about rivers and the terrestrial and aquatic ecosystems that they support, as well as about the benefits they bring to society and the need to keep them in good condition in order to enjoy them. vi) Managing in adaptive way the environmental and socio-economic recovery process by implementing a continuous monitoring and evaluation programme from the beginning of the actions. This will allow the reinforcement of weak points within the recovery process and the enhancement of those actions that obtain the best results.

## 4 CONCLUSION

The restoration proposal has tried to be consistent with the criteria and objectives of water management plans at the Spanish national level and at the JRBD, as well as with those of other existing sectoral plans, whether at the national, regional or local level. The proposed objectives and actions for the Vinalopó River have addressed a wide range of hydrological, geomorphological, ecological, administrative and social issues. However, the economic perspective has not been considered in sufficient detail. Prior to design and execute those measures proposed here, managers should consider not only the economic costs of carrying out actions, but also the environmental cost of not implementing them. Finally river management in the Vinalopó basin must be oriented in such a way that each action implemented favours synergies with other measures applied in the basin, thus multiplying the effect of them and speeding up the recovery process. The multifunctionality of the proposed measures is, therefore, essential to achieve the environmental objectives in the river, and to expand and strengthen the network of ecological connections in the basin, in turn increasing the resilience of the river system to face current and future socio-environmental changes.

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