Restauration de la rivière Zwarte Beek en Belgique : Évaluation à long terme des effets écologiques du reméandrage

River restoration in the Zwarte Beek in Belgium: Longterm assessment of the ecological effects of remeandering

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RÉSUMÉ

Le reméandrage des rivières est une pratique essentielle de la restauration des écosystèmes, car il permet de rétablir la dynamique naturelle des cours d'eau qui ont été redressés ou canalisés. Ce processus augmente la complexité de l'habitat, fournissant des ressources vitales pour les espèces aquatiques et terrestres, améliorant la qualité de l'eau grâce à la filtration des sédiments et renforçant la connectivité des plaines d'inondation. En recréant des méandres naturels, le reméandrage peut atténuer les risques d'inondation, favoriser la biodiversité et promouvoir la résilience des écosystèmes face aux effets du changement climatique. Cette approche est non seulement bénéfique pour la faune et la flore, mais elle renforce également les services écosystémiques qui soutiennent directement les communautés humaines. Dans la vallée du Zwarte Beek, l'une des vallées fluviales les plus naturelles de Flandre, la restauration de la rivière a été achevée en 2017 et d'anciens méandres ont été reconnectés. Avant et après la restauration, un suivi à long terme des sites de contrôle et des sites à méandres a été effectué et a fourni un riche ensemble de données sur la qualité de l'habitat et les communautés de poissons. Les résultats préliminaires indiquent une augmentation de l'hétérogénéité spatiale des habitats grâce à la création de mares et de radiers, relativement peu de temps après la restauration. Ces mares et ces radiers ne sont toutefois pas encore complètement formés et continuent à se développer. Après un délai de quelques années, la biomasse et la diversité des poissons ont été restaurées et la structure des assemblages de poissons a évolué vers une structure dans laquelle les espèces rhéophiles sont devenues beaucoup plus importantes. Les populations de ces espèces rhéophiles, telles que le chevesne européen, montrent des signes d'amélioration.

ABSTRACT

Remeandering rivers is a critical practice in ecosystem restoration, as it helps restore the natural flow dynamics of waterways that have been straightened or channelized. This process increases habitat complexity, providing vital resources for aquatic and terrestrial species, improving water quality through sediment filtration, and enhancing floodplain connectivity. By recreating natural meanders, remeandering can mitigate flood risks, support biodiversity, and promote the resilience of ecosystems against climate change impacts. This approach not only benefits wildlife but also bolsters ecosystem services that directly support human communities. In the valley of the Zwarte Beek, one of the most natural stream valleys in Flanders, river restoration was completed in 2017 during which old meanders were reconnected. Before and after long-term monitoring of control- and meandering sites have been conducted and have provided a rich dataset of habitat quality and fish communities. Preliminary results indicate an increased spatial heterogeneity of habitats via the creation of pools and riffles, relatively soon after the restoration took place. These pools and riffles are however not fully formed yet and continue to develop. After a delay of a few years, fish biomass and diversity have been restored and fish assemblage structure has shifted to one in which rheophile species have become much more important. Populations of these rheophile species, such as the European chub, show signs of increasingly healthy and sustainable populations. River restorations take time to yield results and long-term datasets are therefore key.

KEYWORDS

fish assemblages, habitat quality, remeandering, river restoration, Zwarte Beek

assemblages de poissons, qualité de l'habitat, reméandrage, restauration des rivières, Zwarte Beek

1 INTRODUCTION

All Earth's ecosystems are under increasing pressure as the human population continues to grow with an estimated population increase to 9 billion by 2050. In addition, it is now widely accepted that 'global change' (i.e. climate change, habitat fragmentation and loss, introduction of alien species, pollution and overexploitation) is leading to the rapid decline and/or even extinction of many species. Biological diversity, i.e. the variety of life forms within a given ecosystem, is often closely linked to the proper functioning of that ecosystem and consequently to the provision of crucial ecosystem services. Maintaining biodiversity is therefore extremely important for the proper functioning of ecosystems and will increasingly require human intervention. Aquatic ecosystems, partly due to habitat loss on a global scale, are among the most sensitive ecosystems with the highest species loss. Anthropogenic changes have led to a stabilisation of morphodynamic processes. Globally, the water level and flow of rivers is controlled by structures such as pumping stations, hydropower plants, dykes, weirs, dams and locks. Such structures have a major impact on river morphology and result in hydrological and geomorphological changes that deteriorate the ecological status of river ecosystems. This has led to degradation of active course development, interruption of longitudinal and lateral continuity and disconnection or loss of habitats related to floodplains. However, functionally intact and biodiverse freshwater ecosystems play an important and unique role for society through producing (e.g. food), regulating (e.g. waste disposal) and cultural (e.g. recreation) ecosystem services. Consequently, the development of environmental directives (e.g. European Water Framework Directive, WFD), management plans and river restoration works is of great importance.

2 WATER FRAMEWORK DIRECTIVE

One of the most important environmental directives for aquatic systems in Europe is the European Water Framework Directive (WFD). This directive has been in force since 22 December 2000 and outlines a uniform water policy across the European Union. The aim of the WFD is to (1) secure water resources and water quality in Europe and (2) mitigate the effects of floods and droughts. To achieve these goals, the WFD requires member states to use water sustainably by, among other things, having management plans drawn up for each river basin. The WFD sets 'good status' as a goal for all water bodies. For natural surface waters, this includes good ecological status, which is determined by a number of biological quality elements (e.g. phytoplankton, macrophytes, phytobenthos, macroinvertebrates, fish, etc.) and a number of hydromorphological, chemical and physico-chemical parameters. However, for artificial and heavily modified surface waters, the objectives may be lower and the target is good ecological potential. In the final assessment, water bodies are divided into classes (very good, good, moderate, insufficient and poor). Thereby, the least good score determines the final score ('one out, all out' principle). In recent years, European rivers have been intensively monitored for WFD objectives. However, good ecological status was achieved for only 40% of water bodies across Europe. In Flanders, all water bodies were divided into (1) larger water systems, so-called Flemish surface water bodies, (2) smaller water bodies, so-called first-order local surface water bodies and (3) second-order local surface water bodies. Of the 506 Flemish water bodies and first-order local water bodies, only 2 (0.4%) achieve good status or good ecological potential at the most recent assessment. Thus, the set objective is hardly ever achieved. No water body achieves very good status. 75 % of water bodies are assessed as poor or insufficient, which implies that major measures are still needed to achieve good status. This worrying result suggests that much more effort is needed to achieve the WFD objectives, especially regarding addressing nitrogen and phosphorus losses from agriculture, further developing and improving public water treatment and improving hydromorphological quality elements.

3 RIVER RESTORATION

River restoration projects aim to increase ecosystem services and, ideally, restore damaged freshwater systems without compromising downstream and coastal ecosystems. There is growing interest in applying river restoration to solve the numerous environmental problems resulting from human misuse of freshwater ecosystems. Nowadays, river restoration is applied worldwide. Multiple degradation factors drive these river restoration works, with loss and homogenisation of aquatic habitat being the most common. These two factors are followed by degradation of fauna and flora, disruption of ecological continuity, bank stabilisation, channel incision, loss of floodplains, changes in flow regime, degradation in water quality, etc. Due to the wide variety of degradation factors, different restoration measures are implemented depending on the driver for the restoration works. River restoration can be passive, with water managers allowing natural processes to take their course to slowly reshape rivers and restore natural heterogeneity. Alternatively, water managers can take specific and active measures to, for example, modify channel shape and structure and/or reintroduce variations in flows, taking into account that river systems are by nature dynamic systems. Still other restoration approaches focus on addressing pollution to improve water quality. The most common restoration measures are habitat and/or channel form restoration with the addition of 'instream' structures, channel and/or bank remodelling, dam removal and re-watering. However, restoring watercourses to their original condition is often no longer possible due to changed land use and other boundary conditions. Yet, in autumn 2016, the water manager (Flemish Environmental Agency) was able to start some relatively large habitat restoration measures in the valley of the Zwarte Beek in Limburg, such as re-walking and rehabilitation of some fish migration bottlenecks, with the aim of restoring functional habitats. The aim was to create the best possible abiotic baseline, allowing the river system to develop spontaneously and naturally. Palmer et al. (2005) established five criteria that must be met for a river restoration project to be considered ecologically successful: (1) The goal of the river restoration project is to restore the river to the least degraded and most ecologically/dynamic condition possible, given the regional context; (2) An ecologically successful river restoration project entails measurable changes in physico-chemical and biological components (e.g. recovery of an extinct fish population, improved water quality, presence of a seasonal floodplain,...); (3) Hydrological, geomorphological and ecological conditions are created so that the restored river becomes a resilient and self-sustaining system, i.e. a system that has the capacity to adapt to changes in the environment. Restoration projects should therefore focus on restoring natural river processes such as river-floodplain exchanges, retention of organic matter, species dispersal, etc.; (4) no long-term damage is done to the system and (5) the results of the river restoration project are monitored and the information is made available.

4 AIMS

In the autumn of 2016, the Flemish Environment Agency started implementing river restoration measures in the Zwarte Beek stream. The works were completed in January 2017. To enable an evaluation of this stream restoration project, the status (both biological quality elements and physical characteristics of the stream) was measured in the summer of 2016 prior to the implementation of the river restoration measures. In the summer of 2019 and the summer of 2024, about 2.5 and 7.5 years after implementation of the river restoration measures, the same measurements were taken using the same methodology in order to check the evolution of different parameters. This study describes any changes in different parameters for evaluation in the context of the Water Framework Directive. First, a comparison of habitat structures and physical properties (such as flow velocity, depth variation, substrate,...) before and after the hydromorphological restoration works allows to observe changes in habitat diversity. A change in habitat diversity most likely results in a change in biota. By determining the fish stock, possible shifts due to a changed structural quality can be observed. Moreover, it can be investigated whether populations of rheophilic species have increased. Shifts in macrophyte and macroinvertebrate communities can also be observed through comparisons between reforested sections and non-forested sections. Fish migration opportunities were also restored during the river restoration works. However, it is necessary to check whether these restoration works have indeed led to shifts in fish stock, especially upstream distribution of species in the sections upstream of the Bervoets weir and the Gestel mill and downstream distribution to the restored Bocht van Laren and Schurfert sub-basins. Particular attention should be paid to brook lamprey, which occur only upstream and, among others, to perch, bitterling, spotted bleak, pike and ide, which occur only downstream. Finally, because of the river restoration works, there may have been a difference in habitat structures and physical characteristics between the meanders that carry the full flow and the meanders where peak discharges are capped using a flood channel. The hypothesis put forward here is that in meanders where peak discharges are capped, certain habitat characteristics (vertical and concave banks, riffles, etc.) develop less quickly or less pronounced. The above research questions can be translated into measurement objectives. The specific measurement objectives in this study are (1) improving habitat structures and physical properties, in particular increasing the average flow velocity in the summer period (June-September), substrate diversity (realising a more diverse substrate mosaic) and depth variation; (2) increasing ecological quality through an increase in the number of characteristic taxa (rheophilic fish species) and (3) removing the barrier effect of weirs. The mitigation measures implemented at both bottlenecks are used by all migratory fish species present in the Zwarte Beek and all length classes of these fish species. All these aspects will provide the required insights in the ecological effects of remeandering.

5 RESULTS AND DISCUSSION

Results and discussion are not yet available at this time but will become available within a few months. They can then be presented at the conference.