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Renaturalizing Floodplains

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Abstract

This manuscript analyzes and discusses viewpoints concerning the renaturalization of floodplains as an instrument of management in large catchments, using natural flood defense schemes. Schemes consider the differentiated supply of ecosystemic services based on river channel/floodplain interactions. Conventional structural methods used to prevent flooding (e.g., longitudinal dikes) are increasingly showing themselves to be less efficient with regard to advances in the problems of environmental management of the territory, especially when combined with extreme events, where the importance of perfecting strategies for harmonizing duly controlled floodable areas and water retention can be seen. Natural flood risk reduction measures are part of a holistic solution for sustainable management of flood risk, conservation of nature, water quality and green economy. They rely upon the inherent ability of floodplains to retain water in the basin, and this can delay and reduce peak flows.

Keywords

Renaturalization, Ecosystem Services, Flooding, Natural Flood Defense Schemes

1. Introduction

A floodplain is the region in a river valley surrounding the river that is flooded when river discharge is significant, and that consists of sedimentary material [1]. A floodplain interacts with the river channel and influences the water balance of the river basin, and it also impacts the flow of water below the surface, water regulation, and erosive processes [2]. The processes of recharging (during a flow flood) and discharging (during dry periods, when ground water is liberated) are the principal ecosystem services of floodplains [3]. How does the renaturalization of a floodplain reduce the risk of floods through natural flood defense

schemes, and thus reestablish the original functions of that part of the basin?

Humans have historically settled in floodplains, due to their modest declivity, highly fertile soils, and availability of water [4]. An estimated 50% of the world's wetlands have been lost [5], mainly due to urbanization [6], and this jeopardizes the hydrological function of catchments [7] and alters their ecosystem services [8]. Interrupting the connection between the channel and the floodplain increases the frequency of flooding, generates socioeconomic problems, and leads to loss of usable water.

2. Discussions

Conventional structural methods used to prevent flooding, such as longitudinal dikes, are often partly ineffective during catastrophic events because, aside from reducing the supply of ecosystem services, they affect the consequences of the problem, not its causes [9]. Strengthening dikes by increasing their height or reinforcement is not a sustainable long-term solution, because it confines flow to the river channel and therefore increases the drainage velocity of water into the hydrographic basin. This separates the channel from the floodplain, reduces storage volume, and increases the amount of floodwater downstream.

Currently, the conservation and restoration of floodplains are recognized as efficient and natural methods of management, and in some cases can substitute for classic engineering approaches [10]. Allowing floodwaters to spread out over certain defined areas reduces the risk of flooding of vulnerable downstream areas and improves the natural hydrological functions of floodplains. Thus, natural flood risk reduction measures are non-technical methods that can contribute to the hydrogeomorphological and ecological restoration of rivers.

For the renaturalization of floodplains to efficiently control floods, the different types of flooding in natural and artificial areas must be controlled, compatible land uses must be considered, and objectives must be integrated to optimize water interactions between the channel and the floodplain [9]. This will allow the flow to be managed in renaturalized areas during floods, and thereby reduce the risk of flooding downstream. Adequate planning is indispensable for the effective implementation of these techniques.

In central Europe, part of the floodplains of the Danube River was restored by removal of dams [11], and this reduced the frequency of flooding and restored the natural hydrologic regime [4]. In Holland, renaturalization of the lower part of the Rhine River (which was channeled in the 19th century in an effort to improve navigation and reduce flooding) reduced the risk of floods by increasing the peak flow capacity, and also increased the wildlife value of the region [12]. Clay extraction for commercial use, which lowered the floodplain and increased its storage capacity, was compatible with economic and socio-ecological considerations. In the United Kingdom, a flood defense scheme was implemented for the Harbourne River, and this was combined conventional methods (damming) and ecological techniques (creation of wetlands) [13].

Developing countries, due to their unique cultural and economic issues, are

often unable to implement floodplain renaturalization projects, however, there are exceptions (**Figure 1**). However, these countries often have many areas available for water regulation, in which effective strategies of water resource management could improve flood control. The Paraíba do Sul River is located in a region of Brazil with the highest gross national product. It has 77 floodplains, 52 (67.5%) of which were considered suitable for management of hydrological functions [1].

Functionally operative floodplains provide important social benefits because they can control downstream flooding, and this can provide important economic benefits. The additional benefits include increased quantity and quality of water, biodiversity, organic material, retention of toxic substances, and interactions of water in the channel and floodplain. Floodplain renaturalization mitigates erosive processes on the riverbanks, reduces silting in the channels, and provides a refuge for fauna, thus improving the reproduction and survival of wildlife [8] [12].

Natural flood risk reduction measures include protection of the hydrological functions of floodplains, reduction or removal of embankments, (re)construction of meanders and flowing side channels, construction of flood bypasses, altering the vegetation to modify hydraulic roughness, removal or lowering of groynes and other hydraulic obstacles in the river channel, and re-meandering the river course or allowing the development of spontaneous river morphology [10]. All of these measures aim to increase the area, depth, and storage time of underground water reserves, and to increase the capacity and effectiveness of the floodplain in accumulation of water.

Renaturalizing a floodplain is more challenging when there have already been large-scale alterations of hydrologic regimes, which have led to unpredictable fluctuations in precipitation and flows [8]. The limited number of studies of hydrological function [6], especially in tropical environments, and the divergent interests of the multiple users are potential sources of conflict when developing floodplain renaturalization projects [14].

Figure 1. This is an area of mineral extraction being excavated from an alluvial floodplain, with an ample deposit of sand in an area located 80 km from the sea, reaching a depth of 4.3 m below sea level. It constituted a possible environmental risk, which was reverted by means of the renaturalization of the rectified river, contributing to the redirection of flow in a single direction, through the use of a containment barrier for underground flow. In this way, the water contribution during the dry season for the main water supply of the metropolitan region of Niteroi, in the Brazilian state of Rio de Janeiro, was improved.

3. Conclusion

A change in thinking is necessary to develop consensuses that the renaturalization of floodplains is a natural and sustainable method to mitigate the flooding of important areas. In particular, technical and structural solutions must yield to solutions that improve natural function and have flow risk management as an objective. Society must learn to live with controlled flooding and provide support for environmental services to guarantee their economic feasibility. Natural flood risk reduction measures are part of a holistic solution for sustainable management of flood risk, conservation of nature and water quality and a green economy, because they rely upon the inherent ability of floodplains to retain water in the basin, and this can delay and reduce peak flows.

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