Wood resources in dynamic Danube floodplains – historical reconstruction and implications for management and restoration

Les ressources de bois dans les plaines d'inondations du Danube : reconstitution historique et implications pour la gestion et la restauration

Severin Hohensinner[1]; Anton Drescher[2]; Otto Eckmüllner[3]; Gregory Egger[4]; Sylvia Gierlinger[5]; Herbert Hager[3] and Gertrud Haidvogl[1]

[1]Inst. of Hydrobiology & Aquatic Ecosystem Management, Univ. of Natural Resources & Life Sciences Vienna (BOKU), Austria (severin.hohensinner@boku.ac.at). [2]Inst. for Plant Sciences, Karl-Franzens-University Graz, Austria. [3]Dept. of Forest & Soil Science, BOKU Vienna. [4]Karlsruhe Institute of Technology (KIT), WWF Inst. for Floodplains Ecology, Rastatt, Germany. [5]Inst. of Social Ecology, IFF, Alpen-Adria-University Klagenfurt, Austria.

RÉSUMÉ

Que savons-nous de la productivité naturelle des forêts alluviales des grands fleuves avant les travaux de régulation de la fin du 19ème siècle ? Quelle était leur importance en termes de ressources et de source d'énergie ? Ces modèles historiques (pré-aménagements) peuvent-ils être utilisés pour définir des objectifs en termes de gestion durable des forêts alluviales actuelles ? Une équipe interdisciplinaire composée de géomorphologues fluviaux, d'écologues forestiers et d'historiens environnementaux a étudié la dynamique des paysages fluviaux dans la région de Vienne (Autriche) au début du 19ème siècle (1825). L'objectif était de reconstituer la production annuelle potentielle de bois avant les travaux de chenalisation. Nos modèles de reconstitution des forêts alluviales et les sources historiques ont montré que la production naturelle de bois dans ces plaines alluviales était supérieure à celle observée dans des forêts alluviales actuelles quasi-naturelles. Cependant, les productions de bois issues de forêts de peupliers hybrides gérées dans un but commercial restent plus élevées. Mais leurs modes de gestion ne sont pas compatibles avec des objectifs de conservation. Notre étude plaide pour une redynamisation partielle des tronçons de cours d'eau actuellement endigués et chenalisés. Le développement de telles pratiques serait en accord avec les exigences des directives européennes (Directive Habitat, Directive Cadre sur l'Eau, Directive Energies Renouvelables).

ABSTRACT

What do we know about the natural productivity of riparian forests prior to river regulation and about their function as a source of raw materials and renewable energy? Can we draw conclusions for a sustainable resource management based on historical vegetation models today? An interdisciplinary research team consisting of river morphologists, vegetation/forest ecologists, and environmental historians investigated the Viennese Danube river landscape around 1825. The main research goal was to reconstruct the potential annual timber yield prior to river channelization. The riparian vegetation models and the historical research show that the natural wood productivity in the pre-channelization Danube floodplain was higher than in comparable near-natural riparian forests today. In comparison, current commercial forests with hybrid poplars yield higher amounts of wood. They are, however, not adequate for sustainable forestry because of nature conservation concerns. Our study results call for the partial re-dynamization of embanked river reaches. This would also comply with the requirements of the EU Habitat Directive, EU Water Framework Directive and the EU Directive for Renewable Energy Sources.

KEYWORDS

Danube River; historical reconstruction; restoration; riparian forest; woody biomass

INTRODUCTION

Forests in general and riparian forests in particular face an area of conflict – that between forestry revenue maximization and ecological, nature conservation-oriented forest management. Many of the remaining riparian forests along large European rivers were designated as protected areas according to the Flora-Fauna-Habitat Directive (NATURA 2000, 92/43/EWG). In addition, consideration must be given to the requirements of the EU Water Framework Directive (WFD, 2000/60/EC), which aim at achieving a good ecological status of river systems. Recently, the potential role of renewable energy sources in at least partially covering Europe's energy demand is gaining increasing public and political awareness (see Renewables Directive 2009/28/EC).

Today, the fragments of the former riparian forests are heavily impaired by river regulation, construction of reservoirs and dikes, and drawdown of the groundwater table due to channel incision. Moreover, native tree species have been exchanged by other species or alien species in order to maximize wood productivity. On the other side, current restoration projects aim at the partial re-dynamization of stabilized and degraded river-floodplain systems.

Against this background the project *"Enough wood for city and river? Vienna's wood resources in dynamic Danube floodplains"* was designed to model the natural productivity of riparian forests on the Danube River prior to regulation and to estimate their potential function as a source of raw materials and renewable energy. Based on preceding research projects, we selected the 18-km-long Danube section in Vienna prior to regulation around 1825 as a study site. It comprises the total up to 8.5-km-wide postglacial valley floor (recent floodplain) close to the historical city center.

1 METHOD

An interdisciplinary research team consisting of river morphologists, vegetation/forest ecologists, and environmental historians focused on three central topics:

(1) River morphological/forest ecological site conditions and natural productivity potential for wood resources in dynamic Danube floodplains before channelization,

(2) Historical use of locally available wood resources in a biomass-based society,

(3) Development possibilities of Danube riparian forests against the background of ecological and nature conservation requirements and the objectives for a sustainable management of renewable resources.

A new model for estimating the former wood productivity under dynamic hydromorphological conditions provided the basis for answering the research questions. Because site age is a key factor for the development of the riparian vegetation, emphasis was put on the detailed reconstruction of the fluvial dynamics and the persistence of the floodplain terrain since the 16th century (compare Hohensinner et al., 2013a, 2013b). Generally, two scenarios were distinguished: Scenario 1 ("total natural wood potential"), assuming that the entire Viennese floodplain in 1825 showed riparian forests without any direct human influences; and Scenario 2, taking into account the actual historical land uses and forest management. The resulting values for the wood productivity in the dynamic river landscape were then compared with sample data from different types of stabilized riparian forests along the Danube River today.

2 RESULTS

The main results for Scenario 1 are shown in figure 1. Accordingly, the 77.07 km^2 river landscape could potentially produce approximately 1.6 million solid cubic meter (scm) of wood. On average, c. 6,400 scm wood was released annually into the Danube River due to lateral erosion and avulsion processes ("woody debris"). The annual rate of wood growth was much bigger (c. 76,100 scm). Figure 1 also shows the annual wood consumption of the Viennese inhabitants at that time, which was more than 10 times higher than the annual growth rate.

The riparian vegetation models show that the natural wood productivity in the dynamic pre-channelization Danube floodplain was higher than in comparable near-natural riparian forests that are used for timber production today.

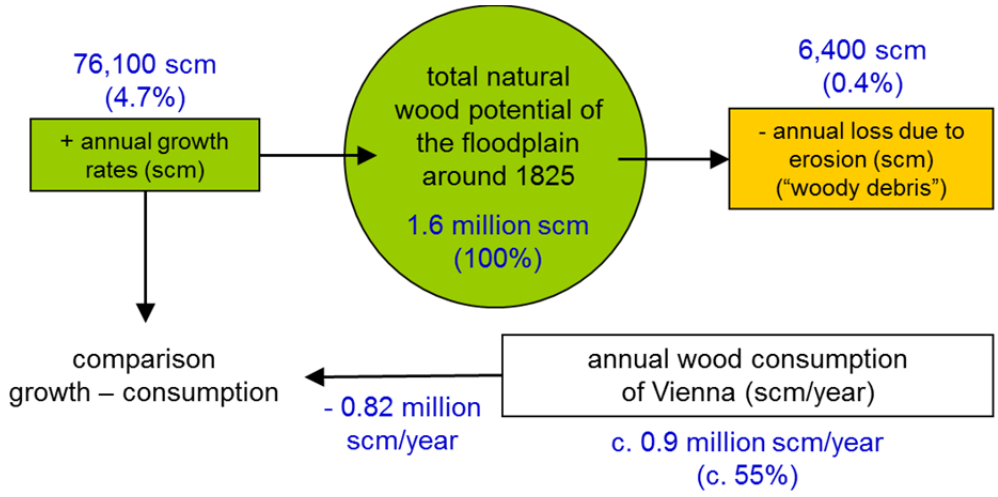

Fig. 1: Synthesis of Scenario 1 ("total natural wood potential")
(scm = solid cubic meter wood; percentages related to the total available wood in the floodplain)

On average, the current annual growth rates are 25 % lower than in the historical reference state (standardized values per hectare forest). Even taking historical wood uses into account (Scenario 2), annual rates are only 17 % lower than in the totally undisturbed reference state. In comparison, current commercial forests with hybrid poplars can yield much higher amounts of wood (44 % higher than the reference value). Nonetheless, such alien species are not an adequate choice because they do not meet the demands of modern sustainable forest management from the perspective of nature conservation (i.e. NATURA 2000).

3 CONCLUSION

The results of the project show that a partial re-dynamization of embanked and stabilized river reaches would meet several legal specifications and socio-economic demands:

(4) According to the EU Flora-Fauna-Habitat Directive, originally typical softwood forests (priority habitats 91E0*) that are severely endangered today would benefit from the amplified fluvial dynamics.

(5) The restoration of river banks and floodplain water bodies supports the aim to achieve a good ecological status according to the EU Water Framework Directive. Here, the river-type-specific status functions as a reference.

(6) In addition it would provide new sources for ecological compatible and sustainable biomass energy as stipulated by the EU Directive for Renewable Energy Sources.

From the perspective of a modern management of riverine landscapes, this calls for a compromise between sustainable (commercial) forest uses, restoration of river-floodplain systems, and protection/promotion of dynamic riparian forests.

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