

Formation and environmental significance of vegetated islands in a European mountain river

Formation et importance environnementale des îlots de végétation dans une rivière européenne de montagne

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RÉSUMÉ

Les recherches sur les îlots de végétation de la rivière de montagne Czarny Dunajec indiquent qu'ils naissent du dépôt de larges débris d'origine végétale comme par exemple de jeunes saules, qui une fois accumulés en amas fournissent un abri aux plantes herbacées, ou encore des agglomérats terreux générés par l'érosion des berges. Les gros débris ligneux sont très mobiles en rivière et, suite à des crues successives, s'accumulent pour former des amoncellements de bois à la tête des îles. Ces morceaux de bois ajoutent de nouveaux segments aux îles existantes qui croissent progressivement en amont, contrairement aux observations faites dans les rivières du Nord-Ouest du Pacifique, É-U, où la croissance se fait plutôt en aval des îles, celles-ci se développant le long d'arbres tombés à l'eau. Grâce à la disponibilité de propagules et aux inondations fréquentes, les îlots possèdent une grande diversité de plantes terrestres : les îlots plus grands que 120 m² et de plus de 4 ans possèdent un plus grand nombre de taxons que la moyenne des taxons répertoriés sur les sites forestiers situés sur les berges. Avec leur formation relativement rapide et leur grande biodiversité, les îlots de végétation en permettant le développement spontané d'une morphologie en tresses avec des îles végétalisées pourraient être un moyen rapide et efficace de restauration des rivières des Carpates Polonaises.

ABSTRACT

Investigation of vegetated islands in the mountainous Czarny Dunajec River indicated that pioneer islands originate in connection with the deposition of large vegetative particles: from sprouting willow wood, due to shelter provided for herbaceous plants by large wood, and from turf clods generated by bank failure. Large wood in the river is highly mobile and at successive floods accumulates in jams formed at the head of islands. Wood sprouting adds new segments to the existing islands, resulting in their progressive upstream growth which contrasts with a downstream growth of the islands developing along stable, large fallen trees, that was reported from the rivers of the Pacific Northwest, USA. Due to the availability of propagules and frequent flood disturbance, vegetated islands exhibit large diversity of terrestrial plants; islands larger than 120 m² and older than 4 years support greater number of plant taxa than the average found on the plots of riparian forest. With relatively fast development of vegetated islands in mountain rivers and their high biodiversity, allowing the spontaneous development of island-braided morphology can be seen as a rapid and cost-effective method of the restoration of Polish Carpathian rivers.

KEYWORDS

Flood flows, island formation, large wood deposition, plant diversity, vegetated island.

1 INTRODUCTION

Vegetated islands seem to have been a common feature of mountain rivers under natural conditions (Gurnell and Petts, 2002). However, during the last two centuries island formation in Polish Carpathian rivers was inhibited due to considerable human impacts. In the 19th century and the first half of the 20th century, high sediment supply to the rivers favoured development of bar-braided channel pattern. In the second half of the 20th century, intense channelization works led to widespread formation of single-thread channels, precluding the occurrence of islands. The Czarny Dunajec is a river that still supports reaches with numerous vegetated islands, hence allowing observations on the origin, development and environmental significance of such features. Understanding these aspects of island occurrence in mountain rivers may be useful for developing fast and cost-effective methods of river restoration in mountain areas.

2 STUDY METHODS

The study focuses on three aspects related to the occurrence of vegetated islands in the Czarny Dunajec River. First, observations of 23 pioneer islands, 1-3 years old, were performed aiming to determine the process responsible for their origin. Second, using a sample of 16 established islands, we performed dendrochronological dating of trees growing in their particular zones (island centre, left and right marginal zones, distal and proximal zones, island head). Age structure of the trees growing in different zones of the islands was subsequently used as a proxy of island development pattern. Third, an inventory of vascular plant taxa on 50 islands was made and compared with that performed on 10 plots of riparian forest. The investigated islands ranged from 1 to 35 years in age and their area varied between 2 and 20370 m². This part of the study was intended to recognise the significance of vegetated islands in the overall biodiversity of terrestrial habitats in the mountain river, with the plants used as a proxy of all terrestrial biota inhabiting the ecosystem.

3 RESULTS

Observations of pioneer islands in the Czarny Dunajec indicated that all of them originated in connection with the deposition of large vegetative particles on exposed river sediments. The most common were willow shrubs and trees that sprouted dense shoots from the canopy and trunk. Less frequently the accumulations of large wood, especially tree root wads and wood jams, induced the deposition of fine sediments and propagules in the lee of the obstacles, subsequently providing shelter for the developing seedlings of herbaceous plants and trees. Finally, there also occurred clods of turf delivered by bank failures, subsequently transported and deposited on gravel bars together with the soil and numerous herbaceous plants.

Dendrochronological dating of trees growing on the established islands in the river indicated that the oldest trees grow in the central, best protected part of the islands. The decrease in tree age from the island centre is more pronounced in the upstream than in the downstream direction. As a result of riparian forest and river management, wood debris in the river is highly mobile and at successive floods accumulates in jams formed at the head of islands (Wyżga and Zawiejska, 2010). Trapping wood and mineral sediment at the island head and successive sprouting of the wood adds new segments to the existing islands, resulting in their upstream growth. That pattern of island formation contrasts with the downstream growth of the islands developing along stable, large fallen trees, that was reported from the rivers of the Pacific Northwest, USA (Fetherston et al., 1995). Upstream island growth seems characteristic of European mountain rivers from which large wood pieces are typically removed and where the resultant lack of key-member fallen trees prevents island development in their hydraulic shadow.

The inventory of vascular plant taxa growing on islands and in the riparian forest indicated that islands are hot spots of terrestrial plant diversity in the river corridor, with many islands supporting richer plant communities than the riparian forest (Figure 1). The taxa richness increased non-linearly with increasing area (Figure 1) and age of the islands; with the rapid increase of the number of plant taxa in the early stage of island development, islands larger than 120 m² and older than 4 years supported greater number of taxa than the average found on the plots of riparian forest. Moreover, the total number of taxa found on the islands was greater than that recorded in the riparian forest. All this seems to reflect the availability of propagules delivered to the islands by flood waters and wind, and

frequent flood disturbance of the relatively low-elevated surfaces, resulting in the formation of numerous niches with diverse habitat characteristics.

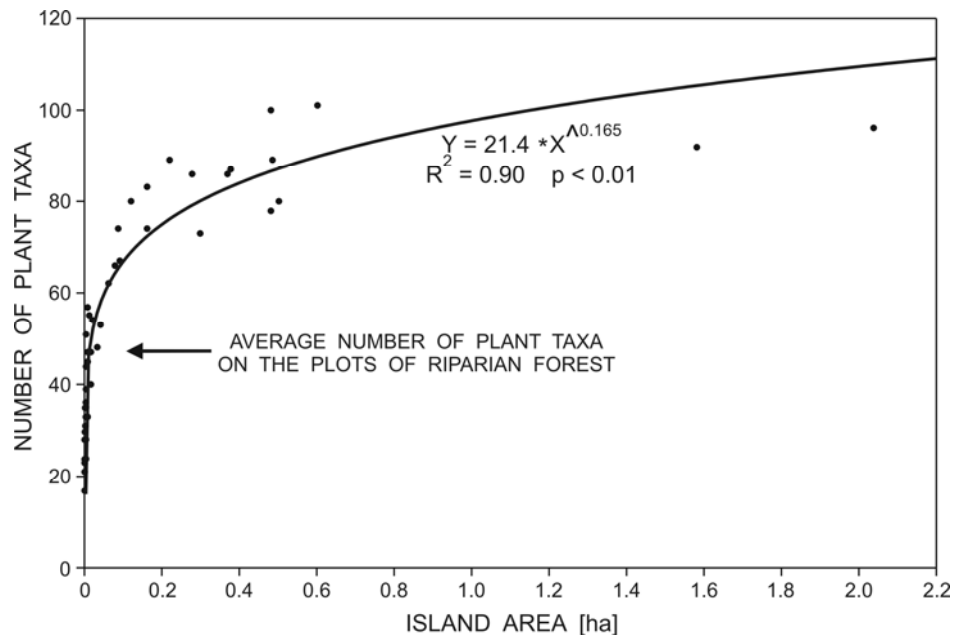


Figure 1. Scatter plot and estimated regression relationship between the number of vascular plant taxa growing on islands in the Czarny Dunajec and island area. The diversity of plant communities of the islands is shown on the background of the average number of plant taxa found on the plots of riparian forest.

4 CONCLUSIONS

Vegetated islands originate and develop in close connection with the delivery of large wood from the riparian forest. Islands exhibit especially high diversity of plant communities as they are located directly on the way of propagule transport by flood waters and are subjected to frequent flood disturbance.

Vegetated islands are highly dynamic elements of the mountain river ecosystem. With absent or considerably limited human interventions in the environment of mountain rivers, islands can originate and attain a highly biodiverse stage of development within a few years. Given the relatively fast development of vegetated islands in mountain rivers and their high biodiversity, allowing the spontaneous development of island-braided morphology can be seen as a rapid and cost-effective method of the restoration of rivers draining the Polish Carpathians and other mountain areas.

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