

## **Types and volumes of in-channel wood in three Italian gravel-bed rivers suffering from different degrees of human disturbances**

Typologie et volume du bois charrié par trois cours d'eau italiens caractérisés par des modifications d'origine anthropique différentes

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### **RÉSUMÉ**

L'évaluation de l'influence des apports solides massifs des rivières suscite un intérêt croissant et interpelle plusieurs disciplines (biologie, écologie, géomorphologie et ingénierie hydraulique) en raison des conséquences positives mais aussi potentiellement négatives sur l'environnement. Cette étude analyse les caractéristiques physiques ainsi que les effets de la qualité et de la morphologie du bois charrié dans trois rivières caillouteuses (Brenta, Piave et Tagliamento) situées dans le nord-est de l'Italie et ayant subi des modifications d'origine anthropique différentes. Les résultats montrent que la rivière Tagliamento (la moins modifiée des trois rivières étudiées) contient de plus hautes densités de troncs isolés et de matériaux ligneux rassemblés que les rivières Piave et Brenta. Toujours en considérant ces rivières dans un ordre d'impact anthropique croissant, le même phénomène est constaté pour les volumes de sédiments déposés sur le fond et pour ceux érodés autour des cumuls de matériaux ligneux.

### **ABSTRACT**

The evaluation of the various degree of influence of in-channel large wood is receiving an increasing interest from various disciplines (biology, ecology, geomorphology and hydraulic engineering), because of its both positive and potentially negative effects. This study analyses the physical characteristics, quantity and morphological effects of in-channel wood on three gravel-bed rivers located in north-eastern Italy (Brenta, Piave, and Tagliamento), which are characterized by different ranges of human disturbances. It has been verified that the Tagliamento River (the less impacted of the three study rivers) features the higher spatial density and volumes of single logs and wood jams than the Piave and Brenta. The same transition from the lesser to the higher disturbed river is respected if the volumes of sediments deposited (below) and scoured (around) jams are considered.

### **KEYWORDS**

Brenta River, Large wood, gravel-bed rivers, human impacts, Tagliamento River, Piave River.

## 1 INTRODUCTION

In forested basins, large pieces of wood (length > 1 m; diameter > 0.1 m; hitherto LW) lying on channels increase the morphological diversity and dynamics of the river network, has a beneficial influence on freshwater biodiversity and abundance, and enhance the ecological functionality of both the active channel and the entire river corridor (e.g. Montgomery & Piegay 2003). However, the traditional wood management strategy lied on removing wood from the river corridor. On the other hand, because of the recent urgency of restoring river morphological and ecological processes, a different set of management practices have been experimented, including wood reintroduction into channels deprived of naturally-recruited LW. Beside the positive effects, in densely populated areas LW could increase the damages of high magnitude floods because of wide range of processes such as the collapse of temporary wood jams, the clogging on bridge piers, and local bed scour and bank erosion. Therefore, it is evident how an integrated management of LW and of potential sources of wood from riparian areas is needed. The present paper analyses the physical characteristics, quantity and morphological effects of in-channel wood on three gravel-bed rivers located in north-eastern Italy (Brenta, Piave, and Tagliamento), which are characterized by different ranges of human disturbances.

## 2 MATERIALS AND METHODS

The study was carried out in the intermediate reaches of three gravel-bed rivers located in north-eastern Italy (Figure 1a).

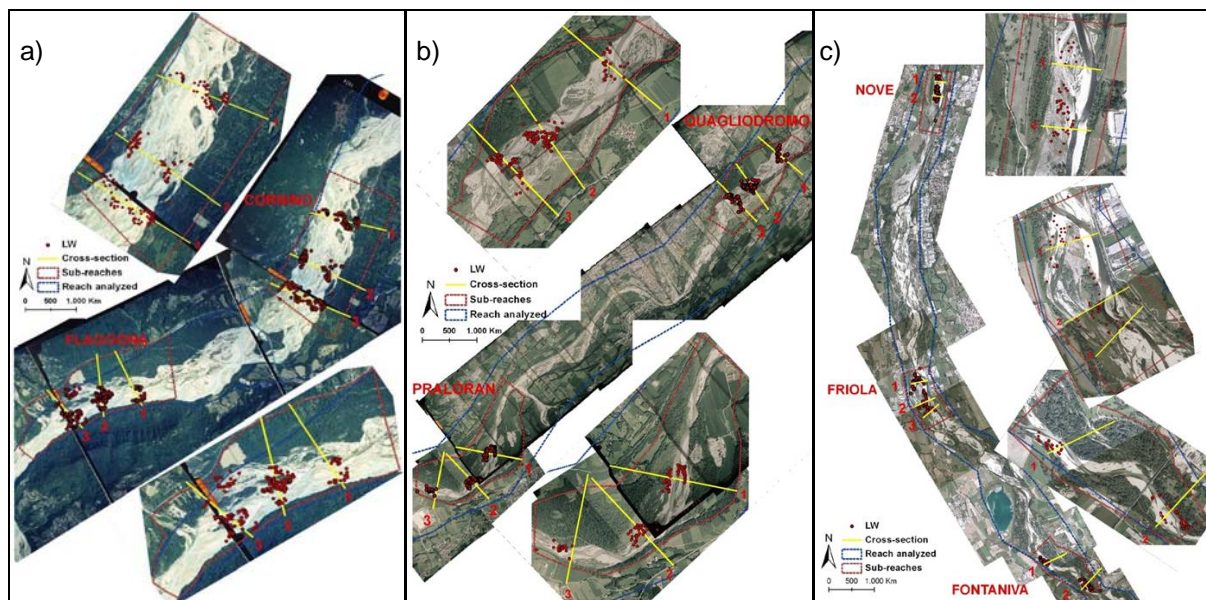


Figure 1. Aerial photographs of the study reaches and subreaches of the study rivers river with the location of cross-sections and of the LW single elements or jams surveyed (a: Tagliamento; b: Piave; c: Brenta).

The three basins are comparable in terms of size, climate, geological settings, and vegetation; likewise, the rivers in the study reaches present an historically similar braided/wandering channel pattern with interspersed vegetated islands. However, the three rivers differ substantially regarding the level of human disturbances. The Tagliamento is the “last large natural alpine river in Europe” because it still retains an essentially pristine hydrological and morphological character. In contrast, a range of human impacts has taken place in the selected reaches of Piave and Brenta rivers (Surian et al., 2009). The chronology of human interventions is quite similar in these two rivers. In most cases channelization commenced during the 19<sup>th</sup> century with the construction of levees, whereas natural reforestation was most intense from the 1950s, when also of dams were constructed. Finally, gravel mining was very intense between the 1950s and the 1980s. As a consequence, the Piave river underwent a strong narrowing during the twentieth century, bed incision up to 2 m, and an associated shift from a dominant braided pattern to a wandering morphology (Comiti et al., 2011). The Brenta river suffered from even more intense impacts, with dramatic channel adjustments (incision up to 8–9 m and halving of active channel width) occurred in response to an alteration of sediment fluxes caused by different human interventions (Surian et al., 2009). Six cross sections were selected and surveyed with DGPS on each of the three study rivers. On transects spanning approximately 200 m around the cross-sections, both single wood pieces and wood jams (accumulations made up of several individual

elements of wood) were surveyed. All wood pieces greater than 0.1 m in diameter and 1m in were measured. The volume of each wood element was calculated from its mid-diameter and length. Additional data concerning tree species, orientation to flow, state of decay, delivery mechanism and position in the channel were collected for each piece and jam. All visible pieces composing log jams were measured and the wood volume of each jam was calculated summing them up. Geometrical dimensions of each jam were also taken in the field by a tape, and the air-wood volume was calculated assuming a solid parallelepiped shape. The volumes of sediment stored or scoured around by each jams were estimated as a solid wedge.

### 3 PRELIMINARY RESULTS AND REMARKS

The results show that, even if the number of jams and isolated logs can vary considerably among cross-section in the same river reach, the Tagliamento River features the higher spatial density of large woods. For instance, the number of wood jams per ha is about 3.7 in the Tagliamento, 2.3 in the Piave and only 1.5 in the Brenta (Figure 2a). If the volume of both single logs and jams is taken into account, the volume of wood per ha is dramatically different in the three rivers, being 3.9, 16.6, and 27.0 in the Brenta, Piave, and Tagliamento river, respectively (Figure 2b). As to the morphological-ecological effects of wood in the river bed, preliminary results show that the volumes of sediments deposited (below) and scoured (around) jams is much higher in the Tagliamento than in the Piave and in the Brenta (e.g. 165, 42, and 3 m<sup>3</sup> of scoured volumes in the three rivers, respectively, Figure 2c).

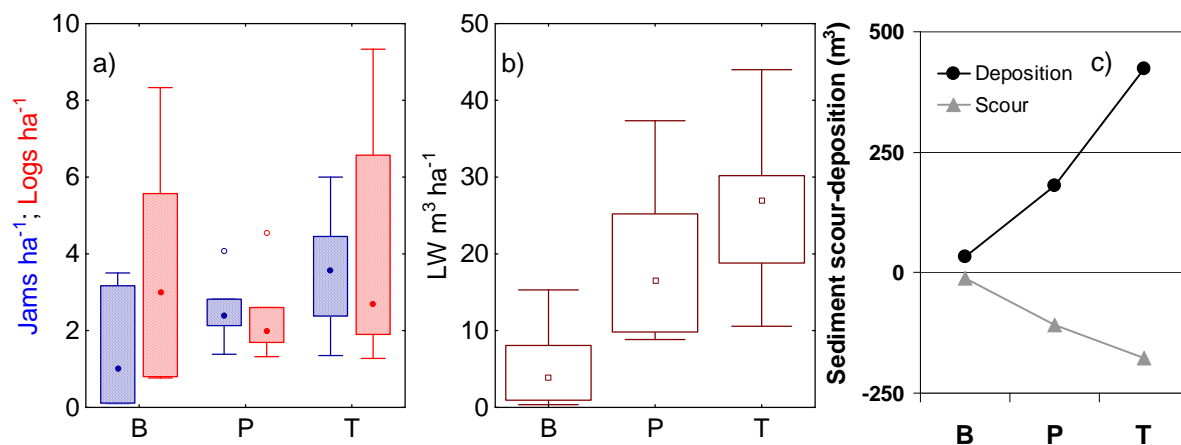


Figure 2. a) Spatial density of wood jams and single logs in the Brenta (B), Piave (P), and Tagliamento (T) Rivers; b) Volumes (including voids) of wood per ha in the three rivers; and c) total amount of sediments deposited and scoured around wood jams in the three rivers.

Interestingly, the dynamics of wood recruitment could be inferred by the state of conservation of trees, which is better in the Tagliamento than in the Piave and Brenta, suggesting that the dynamics of recruitment and transport are faster in Tagliamento than in the other two rivers. This is likely due to fact that in the Tagliamento the floodplains and the island are more densely forested and less protected by human infrastructures and therefore more erodible. The determination of the wood pieces origin based on their orientations along the river suggested that in the Brenta and Piave they are more likely to come from upstream reaches through a process of transportation rather than by a local recruitment through the erosion of riverbanks as in the Tagliamento. Overall, the results confirm the fact that on highly disturbed rivers the amount, density and morphological-ecological impacts of in-channel wood is much reduced. In addition to the ecological and morphological importance of wood in rivers, its quantification is also of the higher importance for the assessment of flood risks potentially linked to the transportation of the wood during extreme flood events and their accumulation near the piers of bridges.

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