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C. R. Geoscience 337 (2005) 487–495
COMPTES RENDUS GEOSCIENCE
http://france.elsevier.com/direct/CRAS2A/

Géomatériaux (Sédimentologie)

Impact des crues sur les bilans sédimentaires de chenaux secondaires de la Loire moyenne (France)

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Reçu le 27 septembre 2004 ; accepté après révision le 20 décembre 2004

Disponible sur Internet le 22 janvier 2005

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Résumé

Lors des crues, les volumes sédimentés et érodés dans les chenaux secondaires végétalisés de la Loire moyenne sont quantifiés grâce à un suivi topographique réalisé sur le site de Bréhémont (France). On met ainsi en évidence une forte variabilité temporelle du processus de comblement des annexes hydrauliques. Au seuil amont, l'hydrodynamisme conditionne les possibilités d'approvisionnement des chenaux, où s'opposent les zones basses et nues dans lesquelles transitent les sédiments, et les zones hautes et végétalisées où domine l'archivage. Les crues, modérées ou importantes, accentuent la morphologie asymétrique des chenaux, favorisant ainsi l'exhaussement et le rattachement des zones végétalisées aux îles déjà présentes. ***Pour citer cet article : S. Rodrigues et al., C. R. Geoscience 337 (2005).***

Abstract

Flood impact on sedimentary budgets in secondary channels of the middle reaches of the Loire River (France). Volumes of sediments eroded and deposited during floods were quantified in a vegetated secondary channel of the Loire River at the study site of Bréhémont (France). The topographic survey highlights the temporal variability in filling of secondary channels. Upstream riffle of secondary channels governs sedimentary supply. In these channels, sediments show a by-passing in the lower parts and an accretion in the higher vegetated areas. The asymmetrical morphology is reinforced during both intense and moderate floods. Sedimentary accretion in the vegetated areas leads progressively to channel narrowing. ***To cite this article: S. Rodrigues et al., C. R. Geoscience 337 (2005).***

Mots-clés : Chenaux ; Loire ; Suivi topographique ; Zones végétalisées ; Transit ; Archivage ; Érosion ; Sédimentation ; France

Keywords: Channels; Loire River; Topographic survey; Vegetated areas; By-passing; Accretion; Erosion; Sedimentation; France

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1631-0713/$ – see front matter
doi:10.1016/j.crte.2004.12.005

Abridged English version

1. Introduction

Although channel incision is a natural process, its rapid increase in European rivers is the cause of many environmental problems [1]. The main channel incision of the Loire River is a consequence of dyking, building of oblique groynes to maintain navigation during low flows, and intense sediment extraction between 1945 and 1980 [1]. The mean water channel deepening has led to the evolution from a multiple-channel pattern to a single-channel pattern. The giving up of secondary channels by waters has induced a significant colonization of these areas by vegetation and more particularly the black Poplar, *Populus nigra* (L). The topographic survey carried out on a secondary channel of the site of Bréhémont inundated during floods should allow identifying areas of erosion and deposition and evaluating volumes of sediments removed or deposited during floods.

2. Study site setting

The site of Bréhémont is located in the middle reaches of the Loire River, 30 km downstream the city of Tours, on the left bank of the stream (Fig. 1). At the gauging station of Tours, average discharge is 374 $m^3 s^{-1}$ and approximately 1500 $m^3 s^{-1}$ for the 1-in 2-year flood. In this area, the Loire River is an anabranching river [4,9]; the braided main channel is fringed by permanent islands and secondary channels only submerged during floods. In-channel woody vegetation is mainly composed of *Salix spp*. and *Populus nigra* (L) [2]. The morphological units distinguished in the secondary channel A, where the topographic survey was realized, are (1) an upstream riffle bordered by two elongated depressions (third-order channels SC1 and SC2) and by a vegetated area (ZV1), (2) two almost circular pools (M1 and M2), (3) a median riffle and (4) a third-order channel SC3 running alongside a higher vegetated zone (ZV2). In 1995, fluvial maintenance operations were performed; only the threes bands ML1 to ML3 were kept.

3. Methods

Fifteen topographic cross-sections (Fig. 1) were surveyed using a total station after floods of varying intensities (Fig. 2). Points measured at slope breaks were also recorded to improve the survey accuracy. Moreover, 31 scour chains were installed to analyse erosion and deposition processes during one event [6].

For each cross-section, eroded and deposited volumes (VES and VDS, respectively) were determined between two surveys (Fig. 3) according to the following calculations. The VES and VDS were defined on a 1 m wide strip and correspond to the product of the eroded or deposited cross-sectional area [7] by 1 m. The eroded and deposited cross-sectional areas were estimated. The VES corresponds to the volume of sediment located between the two surveys where the recent topographic surface is beneath the old surface. VDS corresponds to the volume of sediment where the recent topographic surface is above the old surface.

Digital elevation models (DEM) were computed for each survey using linear interpolation. Volumes calculated by grid subtraction are (1) the total differential volume (VDT), calculated on the base of the surface flooded between to surveys, (2) the iso-surface volume (VIS), estimated for each comparison on the systematically flooded surface (excluding banks and vegetated areas).

4. Topographic evolution during floods

4.1. Longitudinal evolution of eroded and deposited volumes estimated by cross-sections

Cross-sections analysis shows high values of VES and VDS in the upstream part of channel A. These values are lower between cross-sections ST3 and ST7 (Fig. 4). In the downstream part of the channel VES is more important than VDS. The ratio between $|VDS + VES|$ and the section width indicates that the secondary channel A could be divided into three reaches where sedimentary activity can be linked with the presence of vegetation: the upstream reach (0–135 m), where sedimentary processes are strong, the middle reach (135–400 m) and the downstream reach (400–550 m), where sedimentary processes are less important.

4.2. Erosion and deposition areas: definition and volume estimation

The analysis of DEMs between surveys L1 and L2 shows that 5770 m^3 of sediments were deposited