



HAL
open science

Gravel-bed river morphodynamics and large wood dynamics

Maxime Boivin, Thomas Buffin-Bélanger, Hervé Piégay

► **To cite this version:**

Maxime Boivin, Thomas Buffin-Bélanger, Hervé Piégay. Gravel-bed river morphodynamics and large wood dynamics. Gravel Bed Rivers 8 : Gravel Bed Rivers and Disasters, Sep 2015, Kyoto / Takayama, Japan. . hal-01313061

HAL Id: hal-01313061

<https://univ-lyon3.hal.science/hal-01313061v1>

Submitted on 9 May 2016

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

*Maxime Boivin^{1,2,3}, Thomas Buffin-Bélanger^{1,2} and Hervé Piégay³

* Corresponding author: maxime.boivin@uqar.ca

¹ Laboratoire de recherche en géomorphologie et dynamique fluviale, Université du Québec à Rimouski, 300 allée des Ursulines, local D-505, Rimouski, Québec, Canada

² Centre d'études nordiques / Center for Northern studies, Université Laval, 2405 rue de la Terrasse, local 1202, Pavillon Abitibi-Price, Québec, Québec, Canada

³ UMR 5600, Environnement, ville et société, CNRS, plateforme ISIG, 15, parvis René Descartes, Lyon, France



1 Context and stakes

- Clear need to develop management tools and strategies to deal with large wood in medium to large rivers (Kasprak et al., 2012) and in rivers of cold regions (Piégay et al. 2015, Boivin et al. 2015).
- An issue with gravel-bed rivers of the Gaspé Peninsula, Québec (Canada)
 - Active channel shifting due to high-energy flows and non-cohesive banks
 - prone to recruit and transport vast quantities of large wood (LW) in river.
- Case of the delta of the Saint-Jean River
 - accumulated wood since 1960, forming a natural raft of more than 3-km long and leading to frequent avulsions over that time period.
 - unique opportunity to better understand the interactions between river morphodynamics and large wood flux at the basin scale.

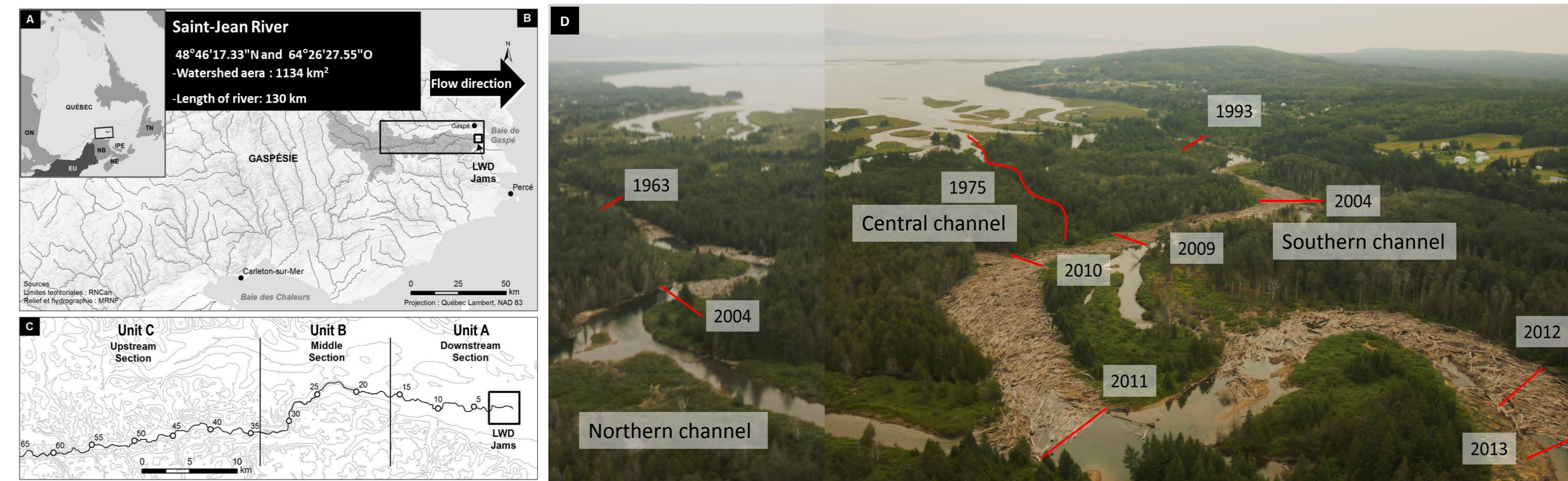


Fig. 1. (A) Large-scale map showing the general location of the Saint-Jean River, Canada. (B) Location of the Saint-Jean River on the Gaspé Peninsula. (C) Detailed map showing the studied river corridor with distance from river mouth in km. (D) Aerial photography (drone) in July 2014 and drawing showing the evolution of the large wood raft surfaces in three channels of the Saint-Jean River delta between 1963 and 2013.

2 Objectives and methods

A) This study aims to determine:

- Biomorphological trajectory of the reach over 1963–2014;
- The geomorphic controls on wood recruitment and deposits;
- Internannual wood mobility according to discharge conditions;

B) Methodology

1) Historical analysis of

- Channel forms, channel shifting and wood recruited volumes from a set of aerial photos and satellite imagery (1963 to 2013);
- River discharge, precipitation and historical land-use from archived data;

- Annual surveys from 2010 to 2013 to locate and estimate wood deposits in-channel and standing wood volumes to define characteristics of evolving river morphologies; and to examine the expansion of the raft in the delta.

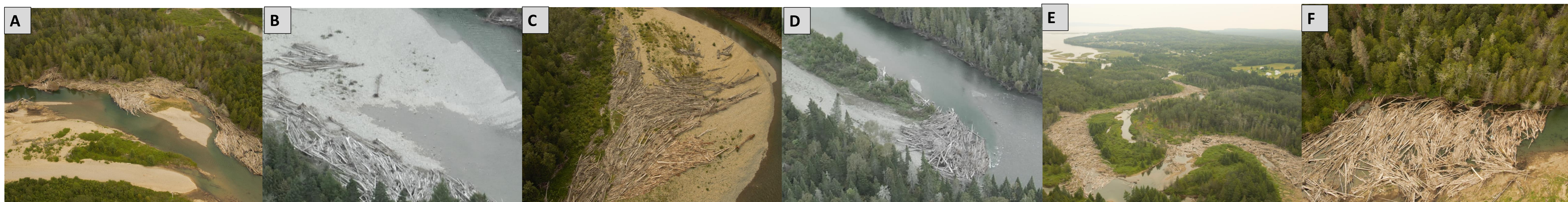


Fig. 2. Five examples of large wood accumulations in the fluvial corridor of Saint-Jean River. (A) meander jams; (B) secondary channel jams; (C) bank deposits jams; (D) bar apex jams and; (E-F) large jams raft.

3 Results

A) Biomorphological trajectory

- Analysis of the biomorphological trajectory between 1963 and 2013 reveal:

- an increase in the annual maximum discharge,
- an increase for bar area
- an increase for erosion and wood production.
- and a relationship between wood mobility and discharge conditions.

- The most important changes are concentrated in units A and C.

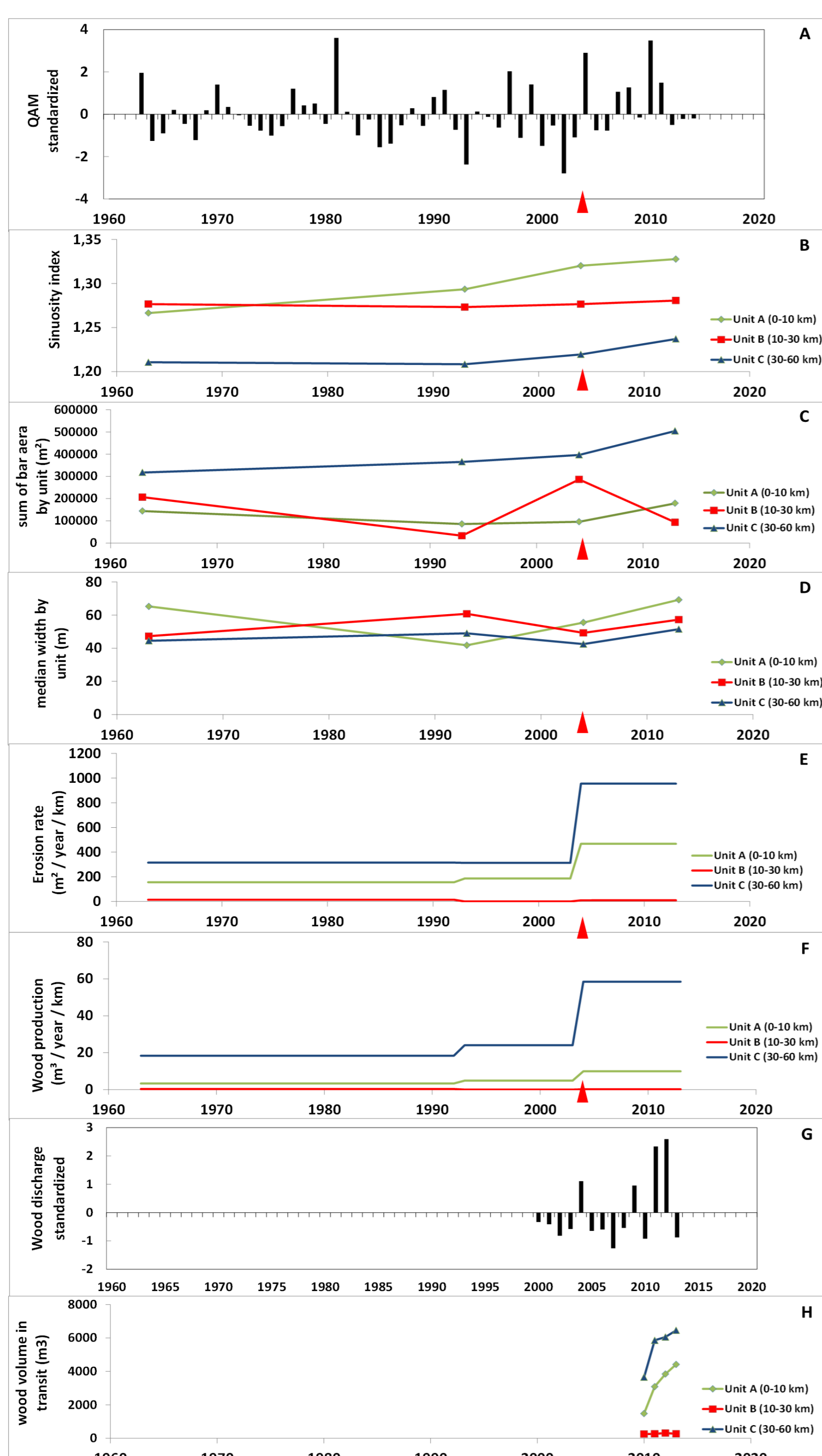


Fig. 3. Biomorphological trajectory of Saint-Jean River over the period 1963–2013 for the three geomorphological units area. QAM: maximum annual discharge.

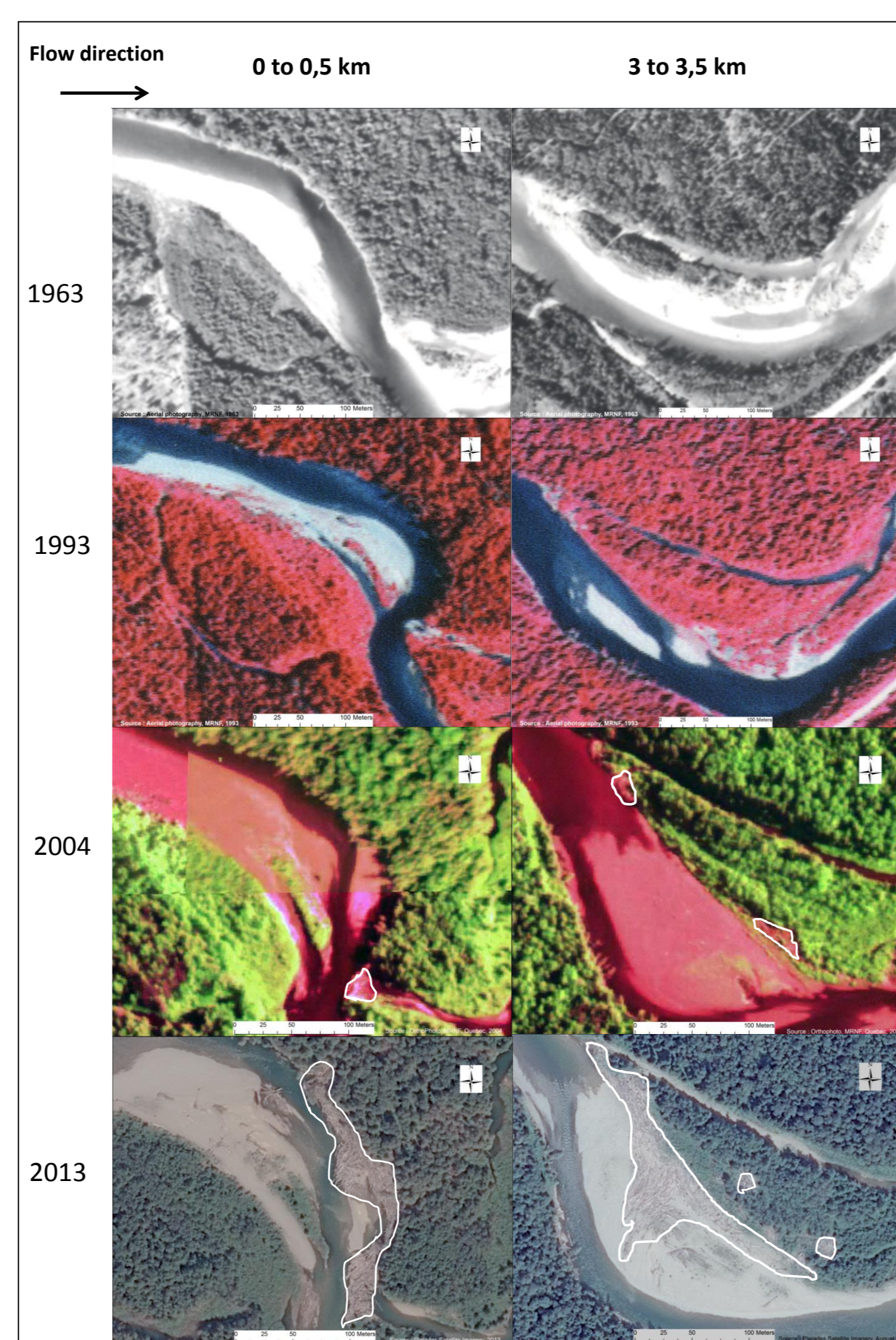


Fig. 4. Two examples of change in the trajectory of channel biomorphology. White line indicate the wood surface.

B) Interrelations between large wood and morphology

- Units A and unit C are both recruiting and trapping wood
- Large wood volume is strongly related with sinuosity, bar surface area and low unit stream power

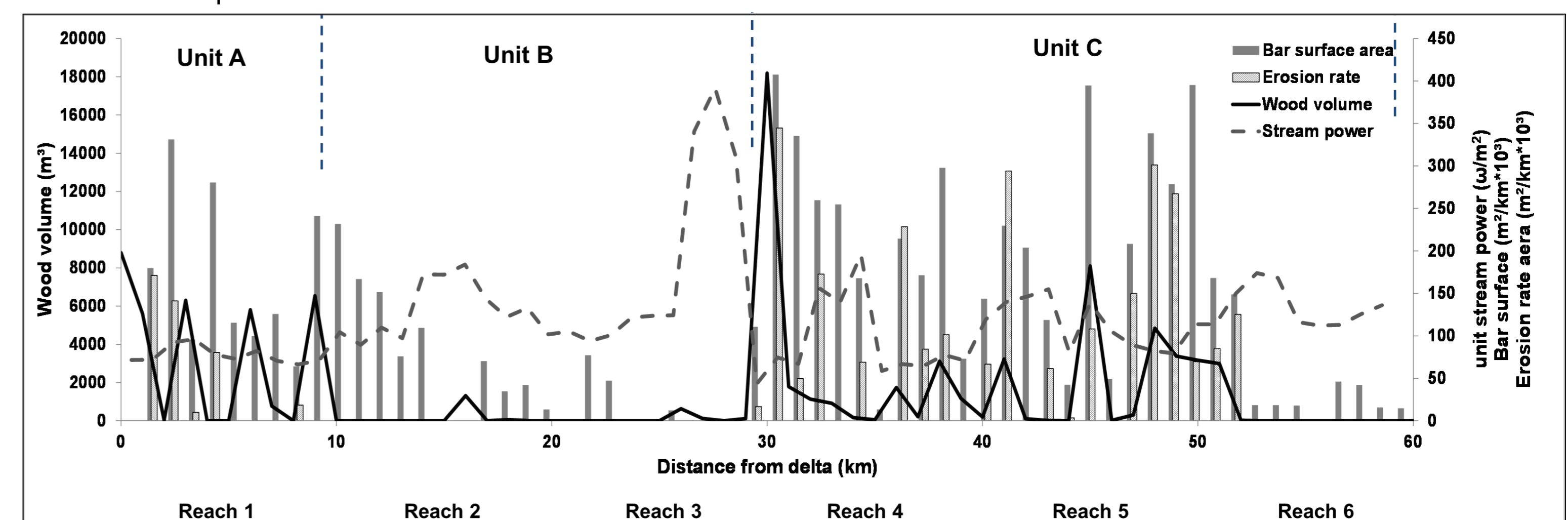


Fig. 5. Geomorphological impacts (bar surface area, erosion rate and unit stream power) on LW dynamic.

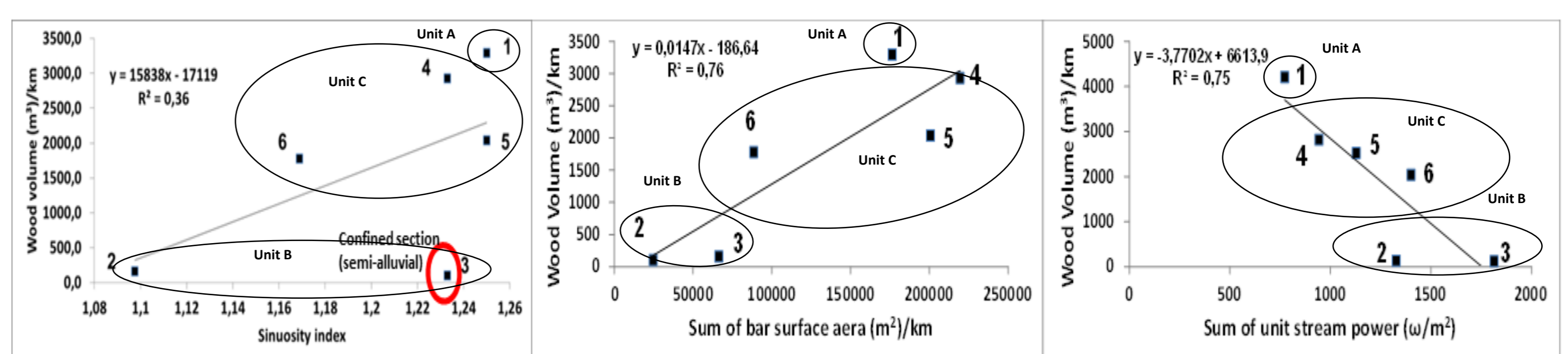


Fig. 6. Geomorphological relation between sinuosity, bar surface area and unit stream power on LW dynamic for the six different reaches. Number (1) indicate the reach in fluvial corridor (Fig.5) and circle indicate the unit.

4 Discussion



Fig. 7. Aerial view of the Saint-Jean delta in July 2015, after dismantling of the main large raft in the south channel. *The red circle represents the deposition area of the removed wood of the raft in winter 2015.

- Changes in fluvial dynamics can change dynamics of large wood in river;

- More erosion => increase in wood recruitment
- Increase in bar surface area => increasing roughness and deposition area for LW and more wood available in the channel for transport during flood.
- Discharge conditions => relationship with wood mobility

- The morphological trajectory of the Saint-Jean River suggests an increase in fluvial dynamics leading to larger recruitment of wood and increasing wood volume trapped in the river corridor since 2004.

- A combined approach using morphological trajectory can identify keys variables (discharge, erosion rate, bar surface area, sinuosity and unit stream power) necessary for understanding LW dynamics and fluvial dynamics in gravel-bed river systems.

- Managers of the river have decided to dismantle 1.2 km long of the main raft (fig. 7).

- The results of our studies have helped to consolidate the manager's position in the dismantling of the raft. The analysis of the biomorphological dynamics encourages managers to work preventively to avoid the return of the raft.

References:

Boivin M., Buffin-Bélanger T., Piégay H. (2015) The raft of the Saint-Jean River, Gaspé (Québec, Canada): a dynamic feature trapping most wood transported from the catchment. *Geomorphology* 231: 270–280.
 Kasprak A., Magilligan F.J., Nislow K.H., Snyder N.P. (2012). A Lidar-derived evaluation of watershed-scale large woody debris sources and recruitment mechanisms: coastal Maine, USA. *River Research and Applications* 28: 1462–1476.
 Piégay H., Benacchio V., Boivin M., Lemaire P., Macvicar B., Moulin B., Ruiz-Villanueva V., Buffin-Bélanger T., Michel K., Stoffel M., Tougne L. (2015). Wood is good but it moves? Associated problems and research issues. Third International Conference Wood in World Rivers 3-2015. Padova, Italy. 6-10th July 2015.

Acknowledgements: We thank the fluvial group at UQAR for their excellent assistance during fieldwork.