

Delimiting Freedom Space for Rivers Using GIS and Remote Sensing: Tools for managing functional and resilient river systems

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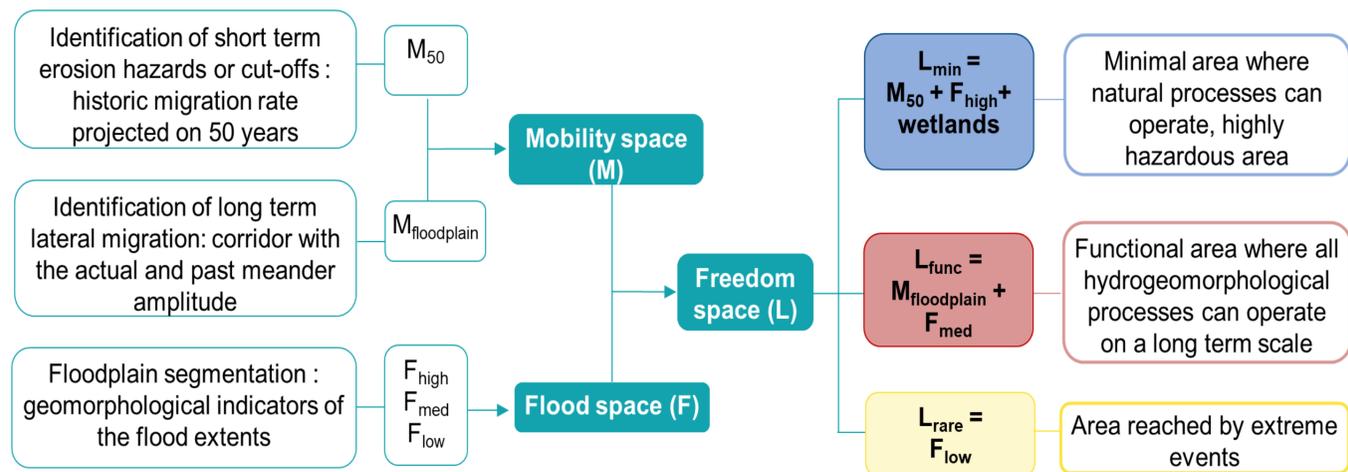


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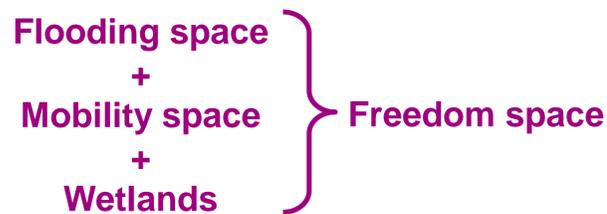
Giving more space to rivers is being increasingly considered worldwide as a more sustainable alternative to hard engineering structures for managing fluvial risks. Momentum has been building over the last decade through several initiatives, including “Room for the River” in the Netherlands, “Making Space for Water” and “Working with Natural Processes” in the UK, River Corridor Planning in Vermont, USA and the concept of “Freedom Space” (Espace de liberté) in France.

In Quebec, the concept of “freedom space” of rivers corresponds to zones that are either frequently flooded or actively eroding and includes riparian wetlands.



ABSTRACT

Freedom Space has been determined for several rivers in Quebec, Canada. This incorporates the space where flooding and erosion naturally occurs, coupled with that required to preserve existing, or recreate lost, riparian wetlands. Applications of the concept include sustainable planning and design of catchment development and watercourse crossings, natural flood management, long-term river restoration and increased resilience to climate change.



BACKGROUND

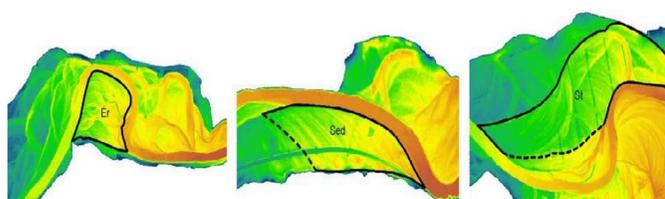
- Bank erosion and flooding are natural processes. Not all eroding banks are problematic and need to be controlled
- Urban development and agriculture often constrain the space needed by a river for these processes to occur
- Freedom space mapping makes it possible to identify areas of flooding and mobility where it is best to let the river adjust naturally (Biron et al. 2014)
- Practical constraint: freedom space mapping is fieldwork intensive
- High resolution elevation data (LiDAR) is used to identify hydrogeomorphological features and already plays a key role in the evaluation of flood zones and the functional floodplain extent (Demers et al. 2014)
- LiDAR may be used in other steps in the mapping of freedom space, potentially reducing fieldwork needs and covering larger areas
- A better understanding is needed of the advantages and loss of precision when relying heavily on LiDAR

OBJECTIVES

- Use (LiDAR) to simplify the freedom space mapping procedure
- Explore alternative techniques to account for the absence of certain field data that compliments the standard geomorphological approaches
- Investigate ways to map the freedom space of areas with a strong presence of alluvial terraces and deltaic formations

LIDAR

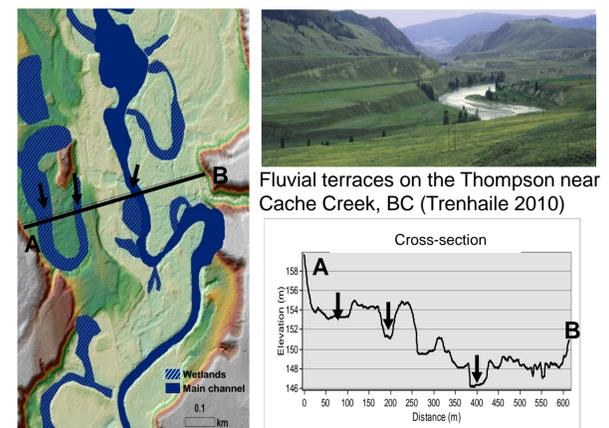
- Flooding zones are delineated by combining hydrogeomorphology and hydraulic modeling
- Typically extensive field work is required:
 - indicators of flooding (alluvial deposits on floodplain, scouring from extreme floods, bank erosion, ice scars)
 - non-flooding (non-alluvial deposits, extensive pedogenesis indicating long term stability)
- In this study we used only LiDAR to identify indicators of flooding while zones of non-flooding were evaluated by means of hydraulic modeling of floods of 100-yr return periods to determine features to include or exclude of the flooding space
- Justification: presence of fluvial terraces – disconnected erosional and depositional features
- Advantage: reduce field work requirements, evaluate greater areas
- Limitation: loss in precision in the delimiting of non flooding zones



Identification of erosional (Er), depositional (Sed) and stable (St) of the Matane River using LiDAR (from Demers et al. 2014).

RESULTS

- Additional complexity due to presence of abandoned channels and fluvial terraces
- Formed due to the lowering of base level
- Use hydraulic modeling to identify areas of disconnected floodplain
- Use of LiDAR to identify terrace features



Cross-section of the Mastigouche River, Qc, using LiDAR data, showing abandoned channel and formation of fluvial terraces

CONCLUSIONS AND FUTURE WORK

- The intensive use of LiDAR data for multiple stages of freedom space evaluation highlights its utility for analysis of river processes
- LiDAR allows for wider application of Freedom Space mapping for rivers in Quebec
- Guidelines on freedom space mapping using LiDAR data should be provided to stakeholders in the hope to encourage a wide use of freedom space maps in river management
- Freedom Space methods can be used to update risk identification protocols developed prior to LiDAR availability (e.g. Meander Belt Width in Ontario, Canada)
- The concept of Freedom Space offers a framework for holistic management of fluvial risks. This may be applied to dynamic UK rivers to better reflect erosion risks

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