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# Evaluating a functional hydromorphological restoration of a lateral channel of the Upper Rhine (France): first results and implications of the temporal trajectory to restoration

David Eschbach <sup>(1)</sup>, Laurent Schmitt <sup>(1)</sup>, Arthur Zimmermann <sup>(1)</sup>, Quentin Lejeune <sup>(1)</sup>, Pascal Finaud-Guyot <sup>(2)</sup>

Integrated in the RAMSAR area of the Upper Rhine, the Rohrschollen island exhibits a high biodiversity. This artificial island results of many engineering works which impacted typical habitats and biocenoses. The LIFE+ project "Restauration de la dynamique des habitats alluviaux rhénans sur l'île du Rohrschollen", managed by the City of Strasbourg, plans to restore the hydromorphological and ecological functionality of the hydrosystem (dynamic floods, bedload, channel mobility, surface water-groundwater exchanges, renewal of pioneer ecosystems...) making this project one of the most ambitious for the French side.

## I. Study Area and restoration project

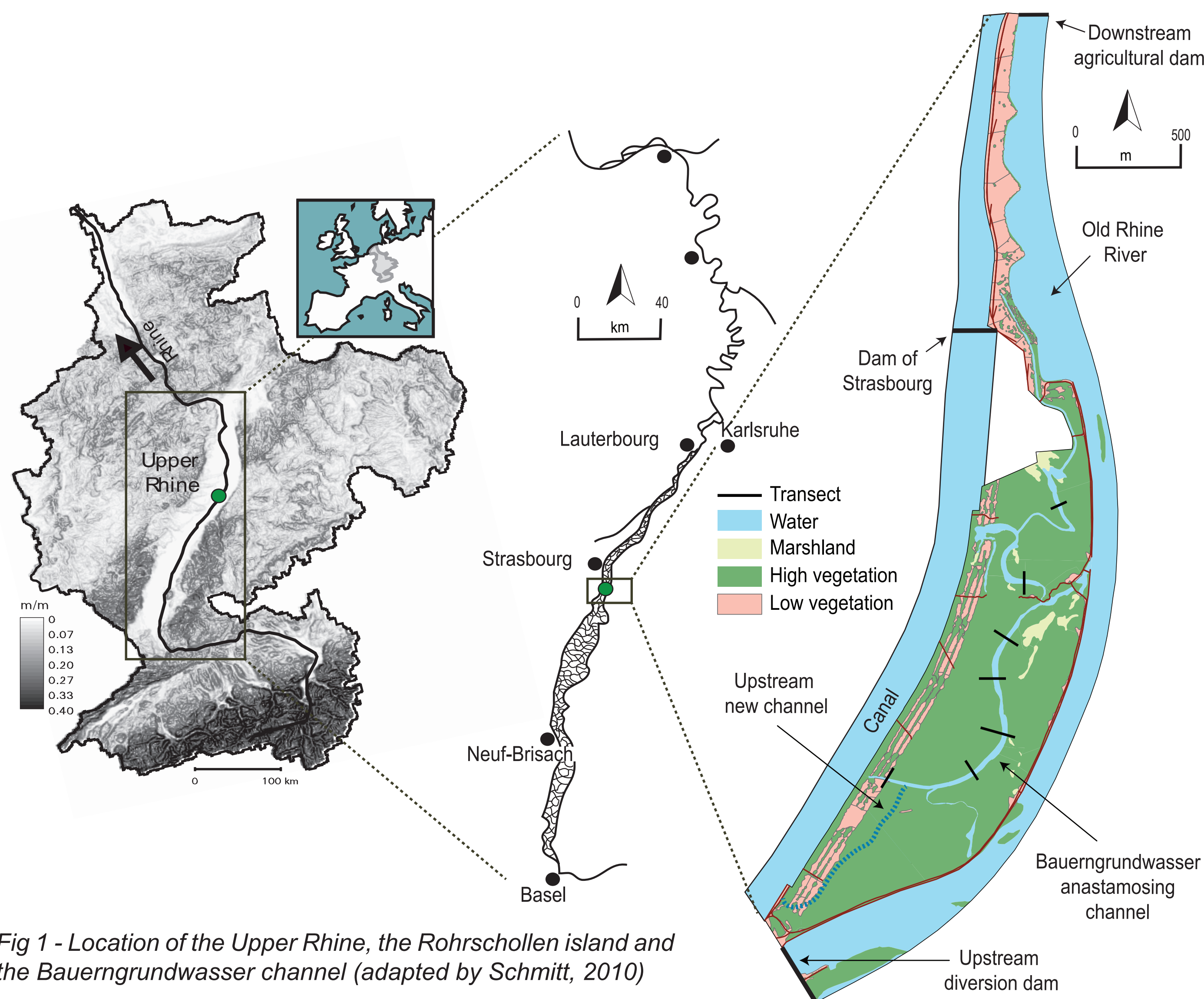


Fig 1 - Location of the Upper Rhine, the Rohrschollen island and the Bauerngrundwasser channel (adapted by Schmitt, 2010)

### Engineering works of the Upper Rhine River

#### 1840-1876: Correction

Rectification and stabilization of a single main channel. A flooding area is maintained between two dikes.

#### 1932-1977: Canalization

Ten dams were built on a French lateral artificial canal. The former main channel became by-passed (Old Rhine).

### The Rohrschollen island and the Bauerngrundwasser anastomosing channel

Surrounded by an upstream diversion dam and a downstream agricultural dam, the Rohrschollen island is flooded only when  $Q > 2800\text{m}^3\cdot\text{s}^{-1}$ . Furthermore, the water velocity is extremely low. During low flow periods, a minimum flow of  $15\text{m}^3\cdot\text{s}^{-1}$  feeds the Old Rhine. The Bauerngrundwasser anastomosing channel is extremely stable (no lateral dynamics, deposition of fine sediments, standing water aquatic communities...).

### Principles of the restoration

The Bauerngrundwasser will be reconnected to the Rhine thanks a new upstream connection channel (800m; Fig.1). When the discharge of the Rhine is higher at  $1500\text{m}^3\cdot\text{s}^{-1}$  a maximum of  $80\text{m}^3\cdot\text{s}^{-1}$  can be injected in the anastomosing channel. The goal is to induce morphodynamics in the channel and dynamic floods in the island.

## II. Objectives of the poster

Characterise the temporal trajectory of the hydrosystem in order to improve the understanding of the current functioning, identify the type of sediments (texture) which will be introduced in the channel by lateral erosion and give long-term evolution tendencies of sediment transport and morphodynamics.

## III. Methods

1. Diachronic analysis of old maps (since 1828) and aerial photos (since 1949)
2. Historical analysis of water and groundwater levels
3. Geomorphological and sedimentological studies of the Bauerngrundwasser on 7 transects (leveling, bathymetry, lidar, laser granulometry of 31 samples, Passega method).

## IV. Results

### Planimetric evolution

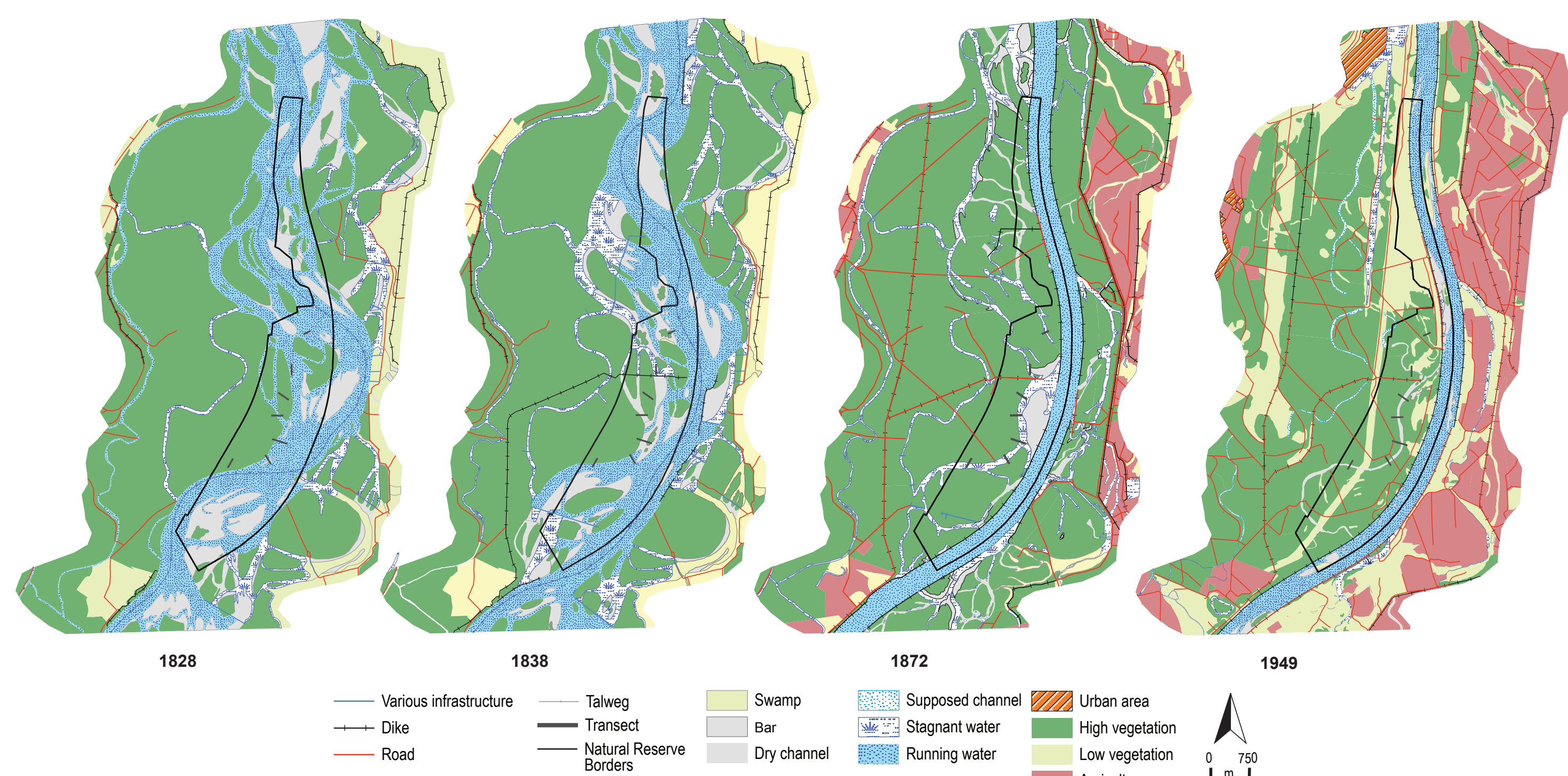


Fig 2 - Diachronic evolution of the eco-morphological units in the Rohrschollen island (Zimmermann, 2012)

Morphodynamics was active at the beginning of the 19<sup>th</sup> century (high lateral mobility, many lateral braiding and anastomosing channels...). The current channel of the Bauerngrundwasser was the main talweg of the Rhine (180 years ago). The narrowing after the beginning of the engineering works is more than 100m.

### Sedimentological study

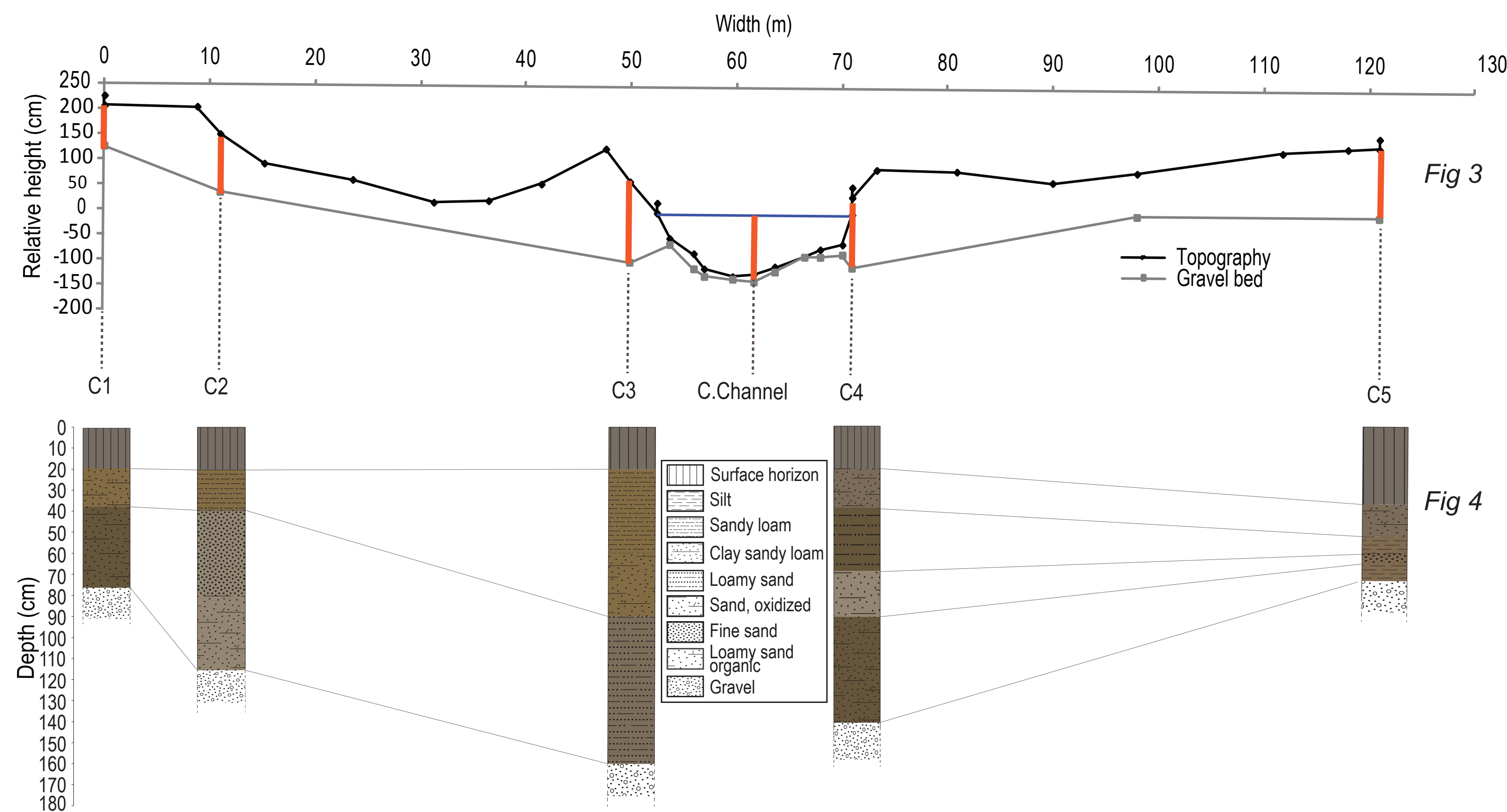


Fig 3 - Transverse profile nr 2 with topographic survey and sedimentological coring  
Fig 4 - Five sedimentological logs according to color and texture (location Fig. 6)

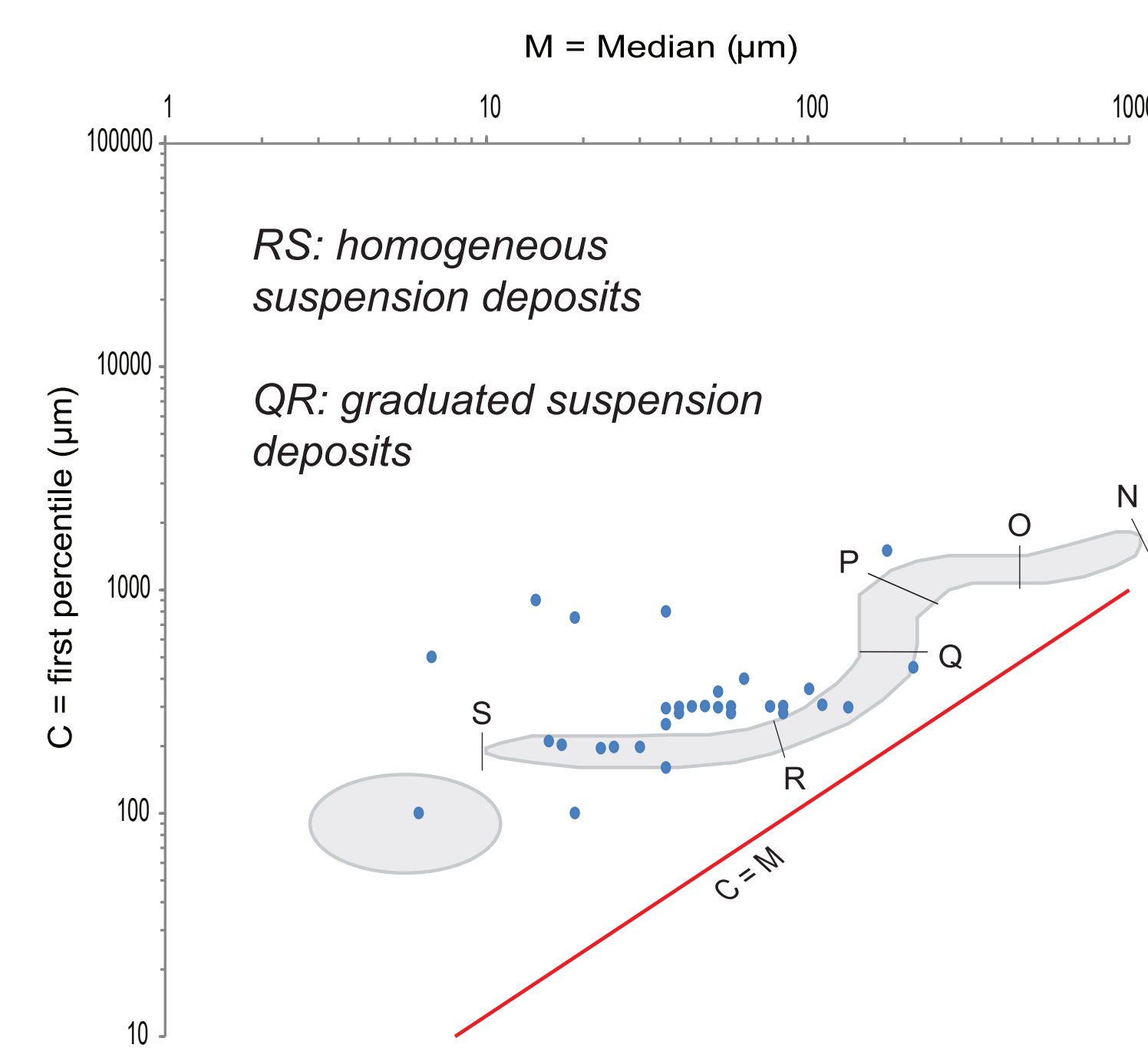


Fig 5 - Passega image (C/M relation; Bravard and Peiry, 1999)

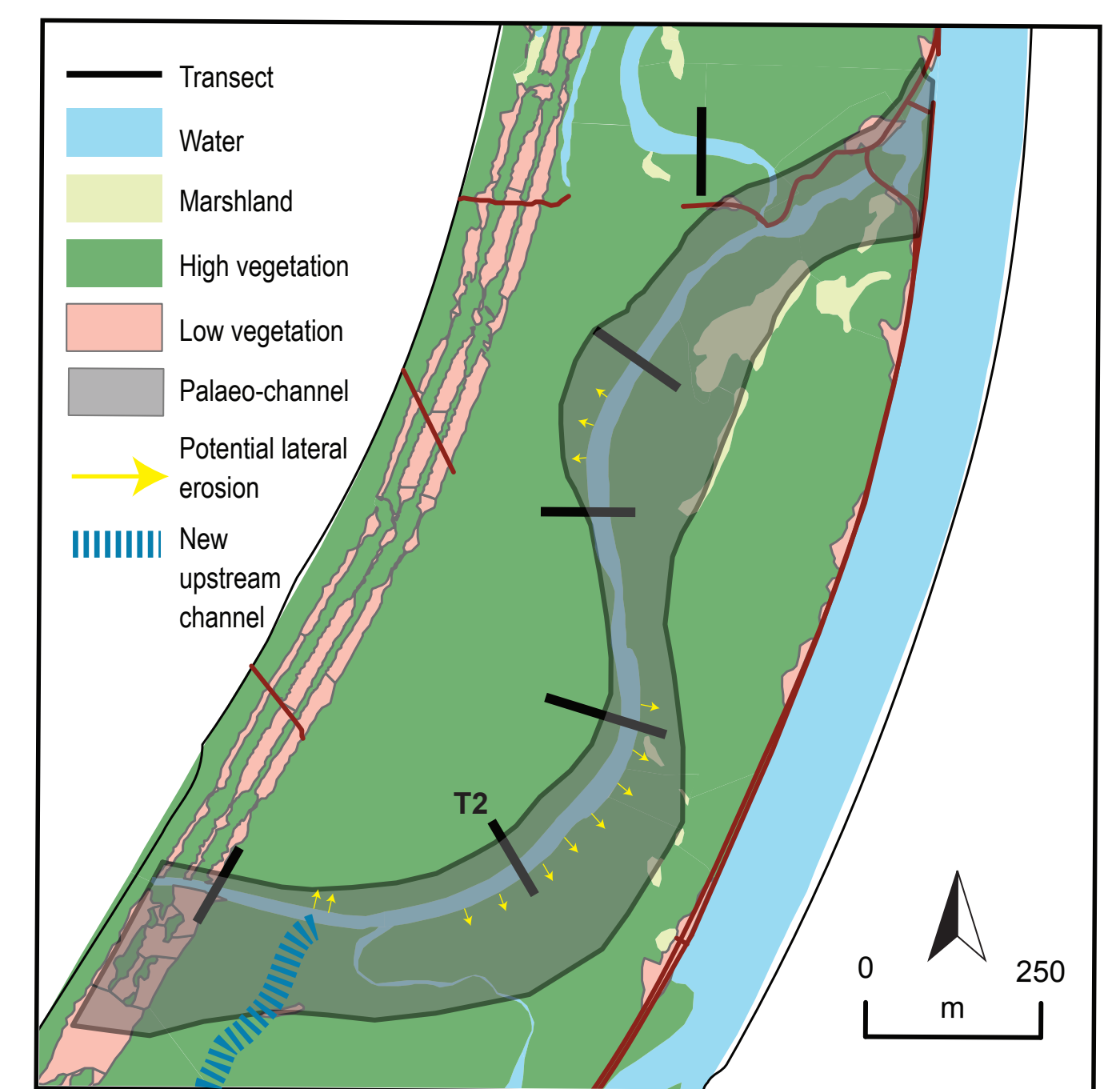


Fig 6 - Spatial estimation of the lateral extension of the palaeo-channel shown by cartographic analysis and sedimentological survey.

The Rhine palaeo-channel before correction has been gradually filled with sand and silt deposits (maximum thickness of 1.60m; Fig. 4). Passega analysis reveals low energy during fine sediment deposition (Fig. 5).

## Conclusion

Potential future lateral erosion (arrows, Fig. 6) will mostly introduce into the channel of the Bauerngrundwasser fine sediments which constitute a limiting factor for the development of aquatic biocenoses. Bedload transport and lateral mobility, who increase alluvial biodiversity will essentially occur along the new upstream channel. This study reveals the importance of taking into account past temporal trajectories (hydrosystem are palimpsests!) in order to increase the efficiency and sustainability of restoration projects.

## Perspectives concerning the whole monitoring program

Pre- and post-restoration scientific monitoring:

- interdisciplinary monitoring (vegetation, macroinvertebrates, water and sediment quality...);
- hydrological monitoring (hydrogeology, hydraulics, gauging, GW-SW exchanges...);
- geomorphological monitoring (PIT tags, erosion chains, transverse and longitudinal profile, laserscanning, high resolution aerial photos...);

Hydraulic modeling incorporating bedload transport and morphological evolution in order to provide to the managers long-term management scenarii;

Development of a simplified but functional monitoring protocol for a long-term survey.

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