

Assessing the effect of a catchment-scale restoration project in Wallonia (Belgium)

Peeters A et al.

ALEXANDRE PEETERS

*Hydrology and Fluvial Geomorphology Research Centre, University of Liège,
Allée du 6 août, 2 Bât. B11, 4000 Liège, Belgium*

GISÈLE VERNIERS

*Research Unit in Environmental and Evolutive Biology, University of Namur,
Rue de Bruxelles, 61, 5000 Namur, Belgium*

BERNARD DE LE COURT

*Unnavigable Watercourse Departement, Service Public de Wallonie,
Avenue Reine Astrid, 39, 5000 Namur, Belgium*

In the context of fulfilling the Water Framework Directive requirements, the LIFE+ project Walphy allowed experimental restoration projects to be undertaken on two medium-size catchments of the Meuse basin in Wallonia (Belgium) between 2009 and 2014. A multi-scale assessment of hydromorphological conditions of the Bocq catchment has led to a large-scale restoration project through the removal or modification of 22 barriers and through the rehabilitation of 13 km of modified reaches. The success of the restoration projects was evaluated on the basis of a multi-disciplinary monitoring.

Introduction

The LIFE+ project Walphy was launched in 2009 in order to develop a methodology and tools for attaining the "good ecological status" defined by the European Water Framework Directive. In order to accomplish this, a large-scale restoration project was undertaken on two medium-size catchments of the Meuse basin in Wallonia (Belgium). This five-year long project was funded by the European Union and the *Service Public de Wallonie (SPW)*. It involved three institutions: the SPW was in charge of the experimental restoration projects while the Universities of Liège and Namur were responsible for evaluating the success of the restoration projects.

Description of the study sites

In this paper we focus on the Bocq catchment except its tributary, the Crupet stream. It has a 230 km² drainage area which is covered in order of importance by grassland, cropland and forest. The Bocq is a gravel-bed river, with bed material composed of sandstone (upper Devonian) and limestone (Carboniferous) pebbles.

Its lower course is characterized by a medium slope (6-7 ‰) and a high energy (specific stream powers at the bankfull stage: ~130 W/m²). During recent centuries, this course has been strongly impacted by numerous barriers which impede the free movement of fish and bedload (an average of one weir every 1.8 km).

Its middle course has a lower slope (2 ‰) and thus a lower energy (specific stream powers at the bankfull stage: ~20 W/m²). In some reaches, the river channel has been straightened over the last few centuries, which has led to significant loss of habitat.

Multi-scale assessment and site selection

Before undertaking sustainable rehabilitation measures, a multi-scale assessment of hydromorphological conditions (water body, reach and site) was conducted in order to define river restoration projects.

An evaluation of hydromorphology was first carried out at the water body scale using the Qualphy index (Demortier & Goetghebeur, 1996). The water system was sectorised into homogeneous river reaches using geomorphic variables. The evaluation of each reach was then based on 40 parameters characterizing the river system and its human-induced disturbances (figure 1). In addition, a survey of fish barriers was carried out (figure 2) and their effect on bedload transport was assessed. Finally, historical maps and LIDAR data were used to identify old watercourses. This evaluation helped river managers to identify the most degraded reaches and the causes of alteration.

Finally, the site selection for restoration was made among the most altered reaches on the basis of land issues and project opportunities. The rehabilitation measures were defined after detailed on-site analysis and negotiation with local stakeholders.

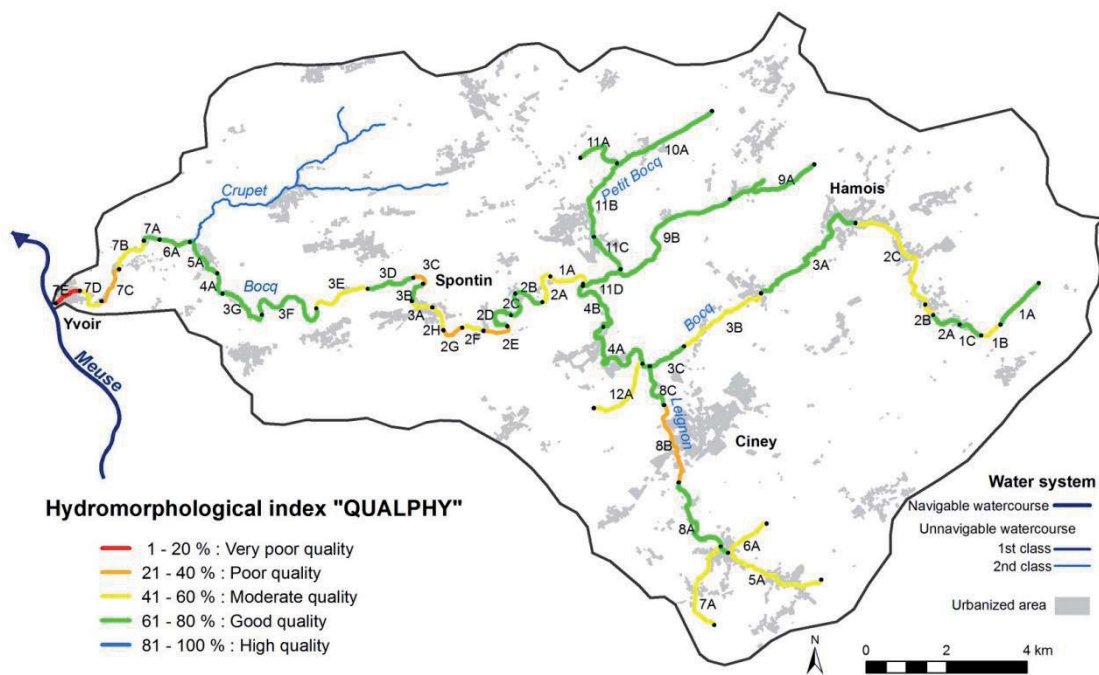


Figure 1: Qualphy index on the Bocq catchment before the Walphy project (Van Brussel, 2005 ; Verniers et al., 2009).

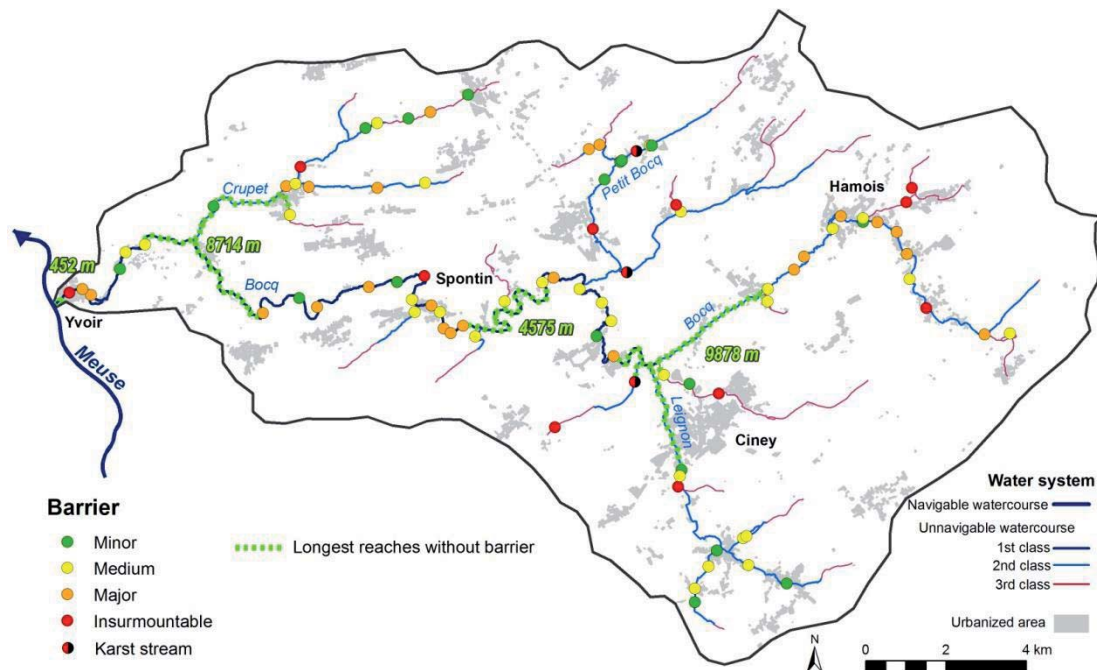


Figure 2: Fish barrier survey on the Bocq catchment before the Walphy project (modified from Fédération des sociétés de pêche Vesdre Amblève, 2004).

Restoration projects

The Bocq catchment has been subject to a large-scale restoration project implemented mainly in the lower and middle course of the Bocq River itself.

22 barriers (mainly old weirs of an average height of 1.35 m) have been removed or modified in order to reconnect the Bocq with the Meuse and to improve access to areas of spawning grounds (figure 3). We implemented a wide variety of technical solutions at an average cost of 68,396 €. Weir removal and by-pass channel were the most frequent options and the most economical. To date, only two barriers remain in the middle Bocq. In addition, 13,3 km of modified reaches were improved through a wide range of rehabilitation techniques such as designing sinuous channels, re-instating spawning grounds, improving fish shelters, improving culvert bed, etc. (Peeters et al., 2013). The rehabilitation focused on the most degraded reaches except in urban area where only few restoration measures could be implemented.

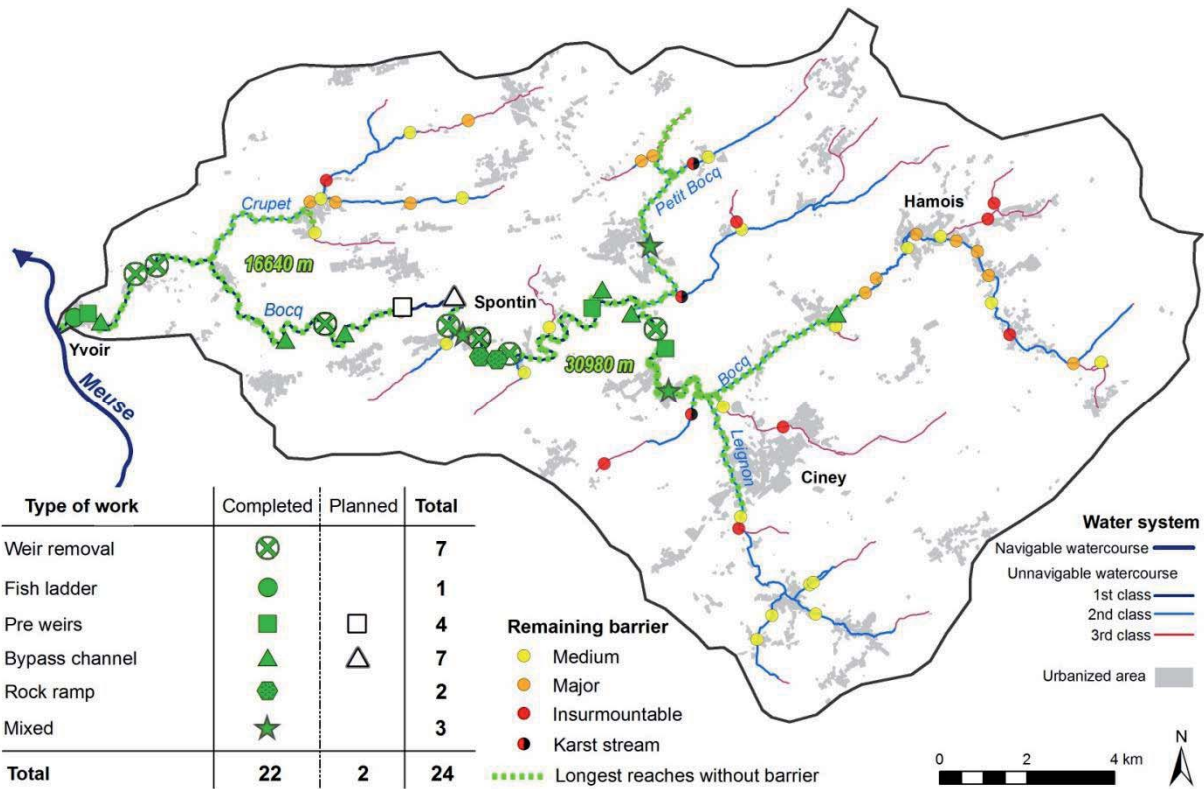


Figure 3: Restoration of the river continuity on the Bocq catchment

A multi-disciplinary monitoring

The success of the restoration projects was evaluated on the basis of a multi-disciplinary monitoring.

Hydromorphological quality was evaluated on five restored sites using microhabitat survey (Pouilly et al., 1995) and three indices of physical quality. For all sites, hydromorphology was significantly improved 1-2 years post-rehabilitation, through the diversification of flows (depth, substrate, water velocity) and the creation of habitats (e.g. fish shelters, spawning areas and woody debris). For example, meandering the Bocq at Emptinale has increased the microhabitat heterogeneity (figure 4), which results in an improvement of the morphological indices. This is especially the case for the reach index (Téléos, 2010) which has increased from poor quality to very good quality.

Assessment of biological quality was based on macroinvertebrates and fish communities. Biological indices have generally showed a status quo or a slight increase 1-2 years post-completion. Nevertheless, ambitious rehabilitation measures such as weir removal and meanders restoration have resulted in the most positive effects, while less ambitious measures such as habitat diversification have led to more contrasted results. The example of the Bocq at Emptinale have showed an improvement of macroinvertebrates (IBGN index increased from 9/20 to 16/20) and fish communities (IBIP index increased from 22/30 to 24/30; biomass from 75 to 222 kg/ha) post-completion. In addition, restoration of the longitudinal connectivity was beneficial for Grayling, designated as Natura 2000 species, and for eels, concerned with the Benelux convention.

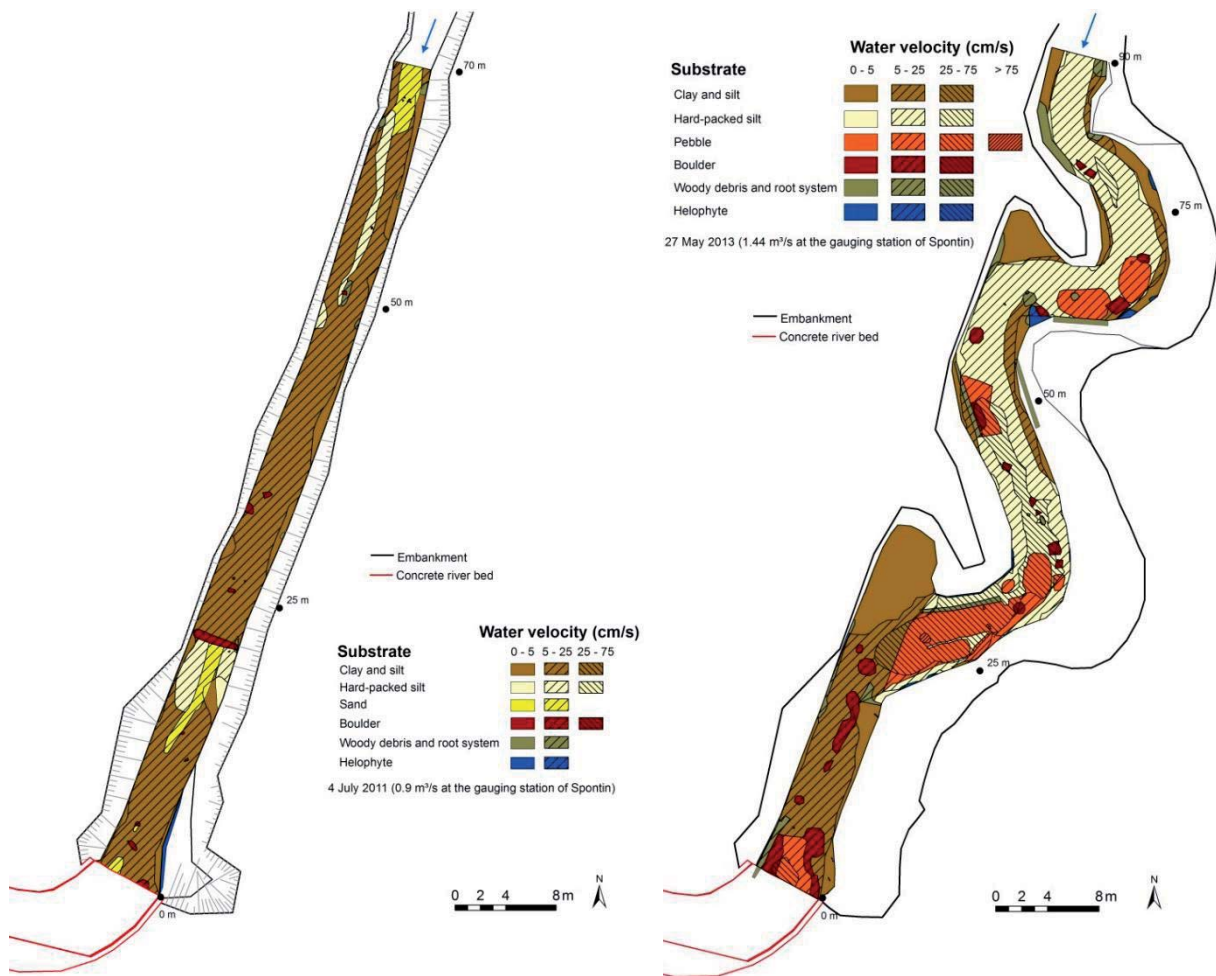


Figure 4: Microhabitats on the Bocq at Emptinale before (left) and after (right) rehabilitation

The geomorphological monitoring has focused on the effect of barriers on sediment transport. For example, topographic surveys and the use of pebble tracers have highlighted a natural bedload transport following a weir removal on the Bocq. Changes to the in-channel morphology (e.g. aggradation, erosion) were analysed following several geomorphologically effective floods.

The effectiveness of spawning gravel rehabilitation was monitored using tagged pebbles and wooden stakes inserted into the gravel bed of three sites. We highlighted for a single site that spawning gravels were unmovable and then subject to clogging. For the rest of the sites, spawning gravel were dispersed downstream after a variable number of flood (depending on the site), reducing the thickness of the spawning ground (example at the figure 5).

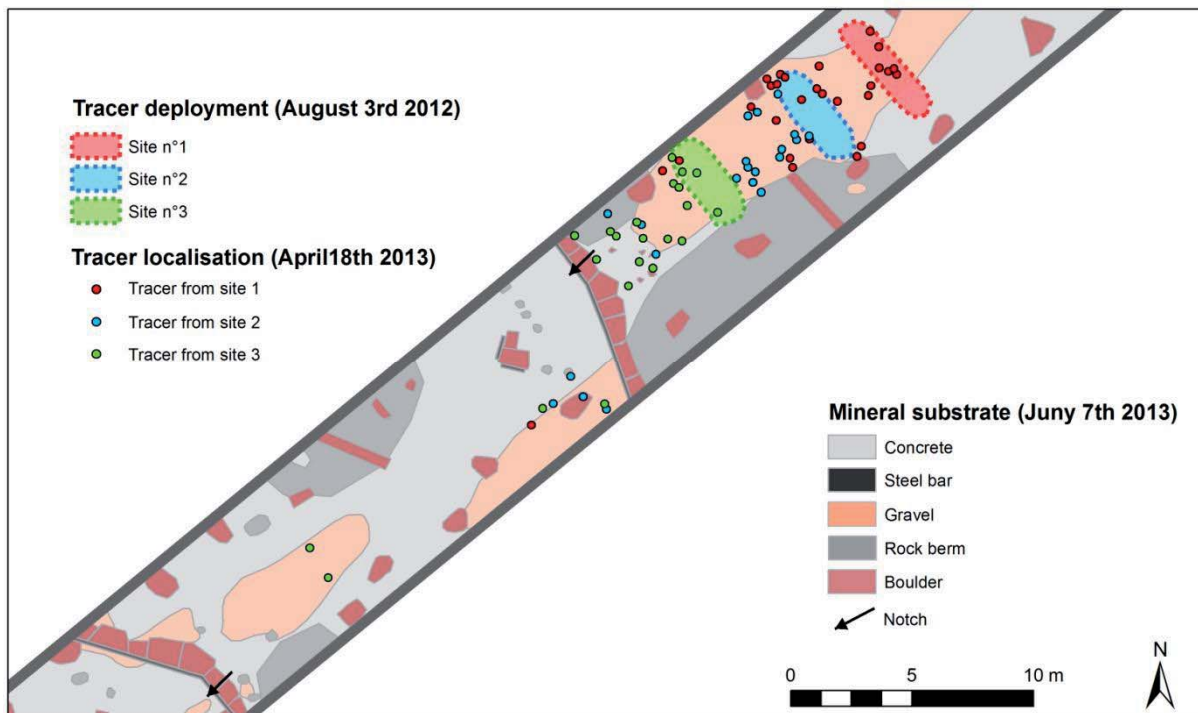


Figure 5: Monitoring of spawning gravel rehabilitation using tagged pebbles on the Bocq at Spontin: tracer localization after a medium discharge ($6.1 \text{ m}^3/\text{s}$)

Conclusion

This large-scale restoration project has been conducted in a relatively short period of time (5 years) considering the significant amount of work. Furthermore, the site-scale monitoring has highlighted a clear improvement in hydromorphology and a less pronounced improvement in biology. The water bodies have been reclassified from heavily modified to natural. Assessments of the biological effects at the water body scale are in progress and we expect the two water bodies to be improved in a longer period of time.

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