

Benthic diatom and macroinvertebrate communities from the impacted bypass channel of Poutès, upper Allier River (France): preliminary results before the dam removal

Les communautés de diatomées et de macroinvertébrés benthiques provenant du chenal court-circuité de Poutès, haut Allier (France) : résultats préliminaires avant le démantèlement du barrage

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RÉSUMÉ

L'effacement d'un barrage pour restaurer la continuité écologique et sédimentaire et la migration des saumons est une première en France. Cette modification de la configuration du barrage de Poutès permet la mise en place d'une étude à long terme. La première étape est l'évaluation des caractéristiques géomorphologiques, sédimentaires et écologiques avant travaux d'un tronçon de 21 km comprenant le tronçon court-circuité (TCC). La présente analyse est basée sur l'étude des diatomées et des macroinvertébrés benthiques prélevés à l'amont, dans le TCC et à l'aval de la restitution. Les résultats obtenus montrent l'impact du barrage sur les communautés dû à un changement de la qualité de l'eau mais également des habitats avec notamment la présence de très longues et profondes mouilles dans le TCC, qui alternent avec des zones de rapides, qui modifient la dynamique fluviale du cours d'eau.

ABSTRACT

For the first time in France a dam is being removed in order to restore ecological and sediment continuity and to allow salmon migration. This modification of the dam of Poutès configuration allows the establishment of a long-term study. The first step is the evaluation of the geomorphological, sedimentary and ecological characteristics before the works in a reach of 21km including the bypassed section. This analysis is based on the study of diatoms and benthic macroinvertebrates collected upstream of the dam, in the bypassed section, and downstream of the penstock pipe release. The results show the impact of the dam on communities arising from a change in the water quality, but also habitats including the presence of very long and deep pools in the bypassed section, which alternate with rapids, which change the river dynamics of watercourse.

MOTS CLES

Benthic macroinvertebrates, bypass channel, dam impacts, diatoms, longitudinal reach

1 INTRODUCTION

Situated in the upper River Allier, the dam of Poutès, built in 1941 in order to produce hydroelectricity, is scheduled to be modified in 2016 in order to restore its sedimentary and ecological continuity. Indeed, even if improvements on the dam were made, the migration of *Salmo salar* is still difficult (downstream migration of smolts and upstream migration of adults). So it will be important to undertake a partial demolition of this site to ensure both the hydroelectricity production and the continuities. In this context, a long –term multi-disciplinary study could be initiated. Thus, in 2013 the aim of the study was to define the baseline condition of the geomorphological, sedimentary and hydroecological situation before the works, and to test the impact of the dam on the bypass channel communities.

2 STUDY SITES

The study was performed in the French Massif Central, in an area impacted by the dam of Poutès. In a 21 km reach of river, four sites were retained: one upstream the dam (site 1), two in the bypass channel (sites 2 and 3) and the last downstream the release of the penstock pipe (site 4).

3 MATERIAL AND METHODS

From 23th to 25th of September 2013, the first hydroecological fieldwork was performed to collect both benthic macroinvertebrates and diatoms. At each site, conductivity, temperature, dissolved oxygen and pH were measured *in-situ* and a sample of water was analyzed in the laboratory to assess the concentrations of calcium, chlorides, magnesium, sodium, ammonium, nitrate, phosphates and sulphates. The organisms were collected in geomorphological unit riffles according to the MMS-GUR sampling method (Beauger, 2008); at each site, 13 samples were taken in mineral substrates of riffles, using a Surber net, and 3 samples were taken in pools using a hand-net. Invertebrates were sorted *in situ*. Diatoms were collected by brushing stones. All samples were preserved in 5% formaldehyde. In the laboratory, organisms were identified to genus (and species when possible), or to tribe or family for macroinvertebrates, and to species for diatoms. To the taxonomic lists, ecological guilds and traits were calculated for each sample for both organisms. Principal Components Analyses (PCA) were performed on taxonomic lists and ecological traits to test the impact of the dam.

4 RESULTS AND DISCUSSION

The PCA of the macroinvertebrate data from the four studied sites underlined the difference between the riffle and the pool units, and hence the differing habitats. A second PCA was performed on the samples taken on the geomorphological unit riffle. Axis 1 of the PCA separated sites 1 and 4 from sites 2 and 3 (Figure 1). Different oligotrophic and oligosaprobic taxa, such as the Ephemeroptera *Acentrella sinaica* and *Epeorus* and the Trichoptera *Chimarra marginata*, were well represented in sites 1 and 4. *Cheumatopsyche lepida*, well represented in site 1, disappears from samples after the dam, as has been observed downstream of a eutrophic dam in Spain (Camargo, 1992). Turbellaria *Dugesia*, a meso-eutrophic and alpha-mesosaprobic taxon, was well represented in site 2 and underlines the impact of the dam and its release on the community.

Axis 1 of the PCA performed on the diatoms separated sites 1 and 4 (and a part of site 3) from the site situated downstream the dam and in the bypass (site 2). Site 1 was characterised by high profile and motile guilds species that could have lived in nutrient rich water, but vulnerable to current, or available to move (Rimet et al. 2010) (Figure 2). Site 2 is characterized by motile, low profile taxa and mainly by planktonic species such as *Aulacoseira ambigua* (Grunow) Simonsen f. *japponica* Tuji & Williams. The planktonic species observed downstream could be linked to the dam, but they can grow in the large and deep pools that are present between two riffles. In sites 3 and 4, low profile species were observed as *Cocconeis placentula* Ehrenberg var. *lineata* (Ehr.) Van Heurck so, species available to withstand to physical disturbance of the environment.

5 CONCLUSION

The distribution of the benthic macroinvertebrates and diatoms clearly underline the impact of the dam on the communities by changing the water quality in the bypass channel, but also by modifying their habitats (high current velocity, presence of deep pool, of organic matter, etc.).

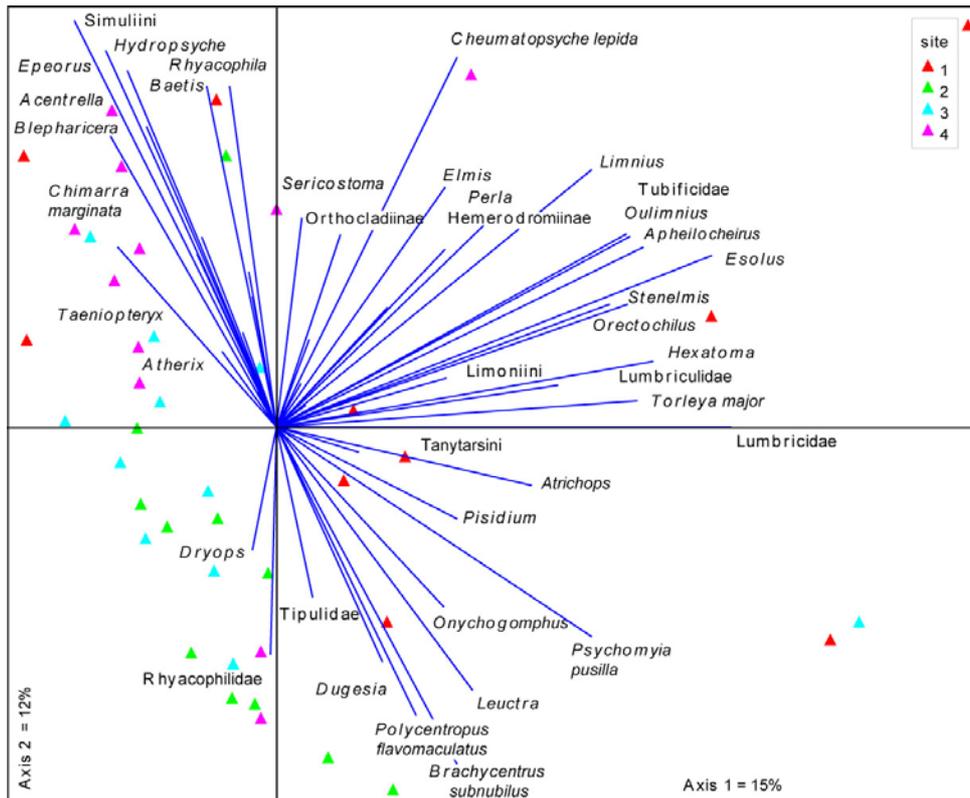


Fig. 1: First factorial plan of the Principal Correspondence Analysis undertaken on the macroinvertebrate data collected in the four riffles of the studied sites.

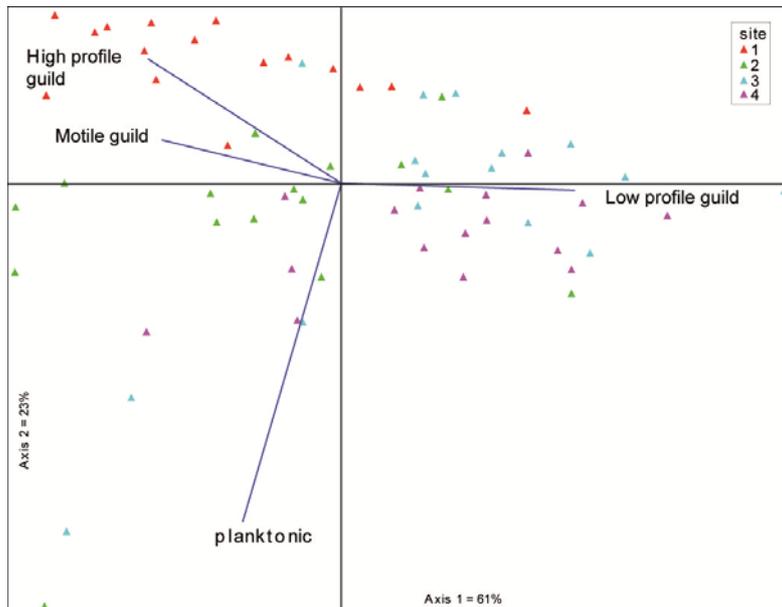


Fig. 2: First factorial plan of the Principal Correspondence Analysis undertaken on the guilds of the diatoms collected in the four studied sites considering all the samples.

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