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Assessing floodplain restoration success using soil morphology indicators

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Floodplains are complex ecological systems that fulfil different ecological, economic and social functions related to physical, chemical, and biological processes. The fluvial dynamics of most rivers in industrialized countries have been altered to such an extent that floodplains are now one of the most threatened ecosystems worldwide. This adverse impact has been widely recognized and, nowadays, extensive attempts are underway to return rivers to more natural conditions and restore their ecological quality and essential ecosystem functions. As a consequence, the number of restoration projects worldwide is rapidly increasing. However, despite an estimated global cost of more than 1 billion dollars annually, there is a crucial lack of monitoring and quantitative evaluations. Indeed, most projects are never monitored post-restoration (NRC 1992). In Switzerland, only 35% of the projects include a monitoring program mainly based on flora and fauna (BAFU).

The design, selection and optimization of indicators for project monitoring are of major importance for sustainable management of riverine ecosystems. However, despite the growing body of literature on potential indicators and criteria for assessing the success of restoration projects no standardised or generally applicable method exists. Furthermore, soils are rarely considered among the possible indicators despite their crucial roles in ecosystems such as decomposition, supplying resources (habitats, gene pool, biomass, and raw materials), and environmental interactions (storage, filtering, transformation). We therefore hypothesized that soils may constitute an appropriate synthetic and functional indicator for the evaluation of river restoration success, especially in the framework of river widening aiming to increase the terrestrial biodiversity.

In agreement with the current concepts of river restoration, we propose an assessment tool for floodplain restoration based on three soil morphology criteria (soil diversity, soil typicality, and soil dynamism) and their associated indicators (for example soil Shannon indexes, frequency of soils with specific characteristics, elevation variations due to the fluvial dynamic). The success of floodplain restoration is assessed through comparisons of these criteria between the restored river sector and a reference that could be a near natural floodplain or an embanked floodplain.

As a test case, we used a near natural floodplain along the Rhine River as reference site. We then assessed the performance of the method by assessing how well the selected indicators explained a data set of soil physico-chemical characteristics in a principal component analysis. We applied this pedological tool to assess the efficiency of two rivers widening: the Thur (River Thur, CCES project RECORD: http://www.swiss-experiment.ch/index.php/Record:Home), and the Emme River restorations (http://www.bve.be.ch/site/bve_tba_dok_down_wasserbau_emme.pdf). In agreement with other studies, our results confirmed that these restoration projects were partial success.

This study demonstrated that soil morphology presents multiple advantages as an indicator of floodplain restoration: ease of use, spatial delimitation of the floodplain, information on past events and fluvial dynamic, and different spatial levels of observation (topsoil horizons, deep horizons, and complete soil profiles).