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## **A new tool to characterize the socio-environmental dimensions of Urban rivers: Urban River Socio-environmental index (URBS)**

Un nouvel outil pour caractériser les dimensions socio-environnementales des rivières urbaines : l'indice socio-environnemental des rivières urbaines (URBS)

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### **RÉSUMÉ**

De nombreuses études ont mis en évidence les altérations hydrogéomorphologiques et écologiques très importantes dues aux conséquences hydrologiques de l'étalement urbain. Le plus souvent, les recherches n'ont pas intégré les dimensions sociales. Nous proposons une approche interdisciplinaire intégrant les enjeux biophysiques et sociaux à partir de l'exemple de l'agglomération parisienne. Dans cet article un indice socio-environnemental des rivières urbaines (URBS) est proposé comme outil pour quantifier la qualité de l'environnement aquatique et la connectivité sociale. L'indice présente une formulation multicritère. Il est constitué de 4 composantes calculées à l'échelle du tronçon (Hydrogéomorphologie ; Macroinvertébrés ; Végétation riveraine ; Connectivité sociale). Cet indice est appliqué pour évaluer l'organisation des tronçons le long du cours d'eau et pour fournir une typologie socio-environnementale fonctionnelle à même d'orienter les décisions de gestion. Pour illustrer la discussion, l'URBS a été appliqué au cas de la rivière Morbras (20 km de long), située en banlieue parisienne pour évaluer la situation actuelle.

### **ABSTRACT**

Numerous studies have highlighted the dramatic hydrogeomorphological and ecological alterations due to the hydrological consequences of urban sprawl. Most often research has not integrated social dimensions. We propose an interdisciplinary approach integrating the biophysical and social issues based on the example of the Paris urban area. In this paper, aiming to provide a practical tool to assess environmental quality, an Urban River Socio-environmental index (URBS) is proposed to quantify the quality of fluvial environment and the social connectivity. The Index presents a multi-criteria formulation. It is composed of 4 indicators calculated at the reach scale (Hydrogeomorphology; Macroinvertebrates; Riparian vegetation; Social connectivity). This Index is applied to assess the reach organization along the stream and to provide a detailed socio-environmental functional typology. To exemplify the discussion, URBS was applied to the case of the Morbras River (20km long), to assess the current situation.

### **MOTS CLES**

Ecological indicators, River restoration, Social Connectivity, Socio-ecosystem, Urban river

## 1 INTRODUCTION

Urban streams are often considered as our least restorable ecosystems but constitute an important part of the hydrographic network in megalopolis and crucial environmental infrastructures for future urban development. In the Paris conurbation, the streams of order 1 to 2 in the Strahler's classification constitute 72.4 % among the 4 850 km of rivers that cross the Paris region. By 2015, only 18 % of these streams were classified as of good ecological status, leading to numerous restoration projects stimulated by the European Water Framework Directive. Although the issues of water quantity and quality are amply addressed, the environmental diagnosis of small urban streams often remains poorly understood. However, they are home to fauna and flora and constitute privileged places for reclaiming nature in cities and improving inhabitant's quality of life in the world's major and dense cities. Therefore, the need to develop the socio-environmental research on suburban streams in the temperate western world is becoming increasingly crucial (Francis, 2014). The PARISTREAMS project considers suburban streams as hybrids, i.e., as fragments of the socionature. The project proposes a holistic overview to promote a renewed and deeply integrative approach to river management issues. More precisely, the paper aims to propose a transdisciplinary approach integrating the biophysical and social dimensions.

## 2 METHODS

The small size of the watersheds allows us to favor a small-scale approach with high frequency measurements for the characterization of the channel, the banks and the floodplain directly on the field. We propose an original approach based on complementary methods to characterize the hydrogeomorphological and ecological functioning and the social connectivity of streams.

The study is based on 4 specific indicators that integrate between 4 and 6 different metrics calculated at the reach scale. The characterization of hydromorphology is based on field data acquired systematically all along the river to describe (i) channel cross-section geometry; (ii) riffle-pool alternation sequences and (iii) obstacles to flow and stormwater discharges (de Milleville et al., submitted). The riparian vegetation is characterized by the vegetation cover, the vegetation diversity and dynamics, its vitality and native status. To evaluate the aquatic biodiversity and the habitat quality, the characterization of macroinvertebrates communities is based on extensive investigation using a standardized protocol (standards for bioindicators monitored by the WFD) on 5 representative reaches of the hydrogeomorphological diversity of the river studied. Also, we used social geography approach of the environment. The analysis is based on the adaptation of the concept of social connectivity (Kondolf & Pinto, 2017) to small rivers. Describing the social connectivity is based on the characterization of the materiality of landscapes. This involves qualifying the spatial configuration of the river and their surroundings through different criteria, as this influences the relationships that riparians/users have with it. It is based on 4 metrics characterizing the visibility, the attractiveness, the accessibility and the equipment of stream and its banks.

## 3 RESULTS

The 4 indicators reveal a high longitudinal biological and morphological variability which highlight the necessity of small-scale investigations to avoid too general and simplistic approach of their functioning in the case of restoration project. The great longitudinal diversity of environmental quality in response to different pressures corresponds also to an additional diversity of social connectivity.

To propose a synthetic view of the issues of river restoration of urban streams, we propose a synthetic index combining specific indicators. The Urban River Socio-environmental index (URBS) presents a multi-criteria formulation to assess the reach organization along the stream and to provide a detailed socio-environmental functional typology for each stream studied.

To illustrate the discussion, URBS was applied to the case of the Morbras stream (20km long), located in the Paris suburbs.

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