Bringing together riverside citizen perception and scientific monitoring to better describe water quality: Case of Liberia River (Costa Rica)

Combiner la perception des riverains et la surveillance scientifique pour mieux décrire la qualité de l'eau : Cas de la rivière Liberia (Costa Rica)

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RÉSUMÉ

La perception environnementale joue un rôle de plus en plus important dans la gestion des ressources et des milieux naturels. La condition écologique des rivières affecte notamment la qualité de vie et la santé des riverains. Un dispositif largement répandu dans la gestion des rivières est la mise en œuvre de protocoles de surveillance de la qualité de l'eau. Mais comment la perception citoyenne peut-elle renforcer les connaissances scientifiques ? Pour répondre à cette question, nous avons réalisé des campagnes de mesure de la qualité de l'eau d'une rivière urbaine située au Costa Rica, en appliquant la réglementation du pays. En parallèle, nous avons enquêté sur la perception de la condition environnementale du cours d'eau auprès de la population riveraine. Le protocole de mesure, basé sur le suivi d'indicateurs physico-chimiques, bactériologiques et biologiques (macro-invertébrés), a permis de mieux connaître la dynamique spatio-temporelle de la qualité de l'eau. L'analyse des perceptions a mis en évidence le ressenti d'une dégradation de la qualité de la rivière. Ainsi, pour une grande partie de la population, la rivière est un espace plutôt sale et dangereux, davantage utilisé comme zone de passage que pour le loisir. La dégradation est perçue principalement par la présence de déchets solides et de rejets d'eaux usées. Au final, la perception de la dégradation corrobore la plupart des résultats scientifiques, met en évidence des zones mal connues par la population et permet de raffiner les observations dans les zones très fréquentées.

ABSTRACT

Environmental perception plays an increasing role in natural resources and environmental management. The ecological condition of rivers particularly affects the life quality of riverside populations. A widely used river management device is the implementation of water quality monitoring programs. But, how can citizen perception strengthen scientific knowledge during the monitoring efforts? To answer this question, we have monitored water quality in an urban river in Costa Rica according to the national regulation, and in parallel surveyed the citizen's environmental perception of that river. The monitoring program was based on physicochemical, bacteriological and macro-invertebrate indicators to assess river water quality dynamically in space and time. The analysis of citizen perception revealed a decline in the river ecological condition. Thus, for most of the population, the river is a soiled and dangerous transit area rather than a leisure place. We finally found that perceived degradation supports most scientific results. It brings to light areas poorly known to populations and allows refining observations on highly visited areas.

MOTS CLES

Citizen perception, water quality, monitoring, urban river, Costa Rica

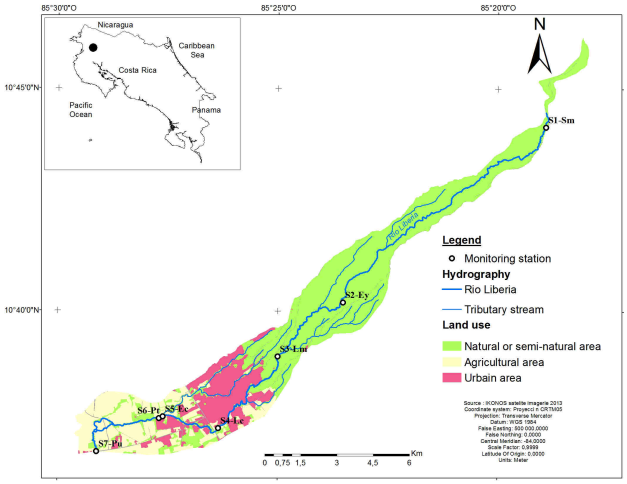
1 INTRODUCTION

Urban rivers are subject to degradations that affect ecosystems, as well as the health and quality of life of the riverine population. To reduce degradations, restore and protect rivers, managers need to collect data for characterizing water quality and the overall aquatic environment condition to fully understand its dynamics, as well as for showing the links between people and the river. Hydrological and water quality monitoring networks, plus specific hydro-morphological assessment protocols are the main sources of information (Birk et al., 2012). However, understanding the perception of riverine population and users has become a necessity: it allows completing knowledge from monitoring networks and measuring campaigns, to know the relationships between individuals and their natural environments, and to understand the diversity of views and expectations (Rivière-Honegger et al., 2014; Taylor and de Loë, 2012). The objective of this study is to show how citizen perception can complement knowledge acquired from monitoring endeavours.

2 STUDY SITE AND METHODOLOGY

2.1 Liberia River

The Liberia River drains a 46 km^2-basin in the Northern Pacific part of Costa Rica. Under dry-tropical climate, its waters coming from the Rincon de la Vieja volcano ensures a perrenial regime, while all its tributaries are ephemeral. The main river goes through the Liberia City whose 38 500 inhabitants are mainly engaged in commercial activities, tourism and agriculture. The main pressures over the river and its tributaries are linked to rainfall runoff, waste water discharges, solid waste dumping and riverbank urbanization.



Liberia river catchment: Limits, hydrography, main land uses and monitoring station network

2.1.1 Liberia River Monitoring

Seven monitoring stations located on the main stream of the Liberia River were surveyed since 2013. Six monitoring sites target the main parameters to follow the water quality of the Liberia River: three upstream stations are chosen as reference for natural conditions and three stations to assess urban pressures following a variety of land cover and riparian conditions. The seventh station controls the wastewater treatment plant effluents. Sampling and analyses protocols for physicochemical, biological, and microbiological parameters follow the recommendations of Costa-Rican current regulations (MINAE-2007). The ecological condition of riparian areas was assessed through field campaigns observing morphological and ecological continuity of riparian vegetation criteria.

2.1.2 Liberia River citizen perception monitoring

A survey for assessing the citizen perception of the Liberia River ecological condition was carried out from June to September 2016. Two sub-populations where separately sampled. First, 100 inhabitants were surveyed through a proportional stratified sampling protocol according to district population. Second, all local businesses located within 50 meters from the river or its tributaries, were identified. A total of 32 business managers were surveyed. The survey included several components from which two provide relevant pieces of information for this study: 1) Visiting habits to the river (where, how often and why) and 2) Perception on the ecological condition as well as river-related dangers and hazards.

2.2 Methodology

The methodology presents four steps:

- Construction of water quality indices and spatial analysis related to pressures described by land uses and riparian conditions;
- Synthesis of the citizen visiting habits and environmental perception of the river;
- “Hot spot” analysis and localisation from the citizen visiting habits and degradation perception;
- Comparison between monitoring station localisation and identified “hot spots”.

3 MAIN RESULTS

Results on water quality monitoring indicate, with some temporal variability, an upstream-downstream decline in all the physicochemical, bacteriological and macro-invertebrate indices assessed, from incipient pollution conditions (upstream stations) to severe pollution (downstream stations). Moreover, the monitoring station of the wastewater treatment plant consistently presents very severe pollution conditions. The spatial analysis of pressures from land use and riparian conditions shows significant correlations (α = 5%) for most pressure descriptors with the physicochemical and bacteriological indices, while biological index presented correlations with specific urban pressures (α = 20%).

Results on citizens' behaviour and perceptions show that a higher proportion of inhabitants (73%) visit the river and they do it more often than the businesses (38%). The Liberia River is mainly a transit area for the inhabitants. Businesses are involved in volunteer activities such as clean-up or reforestation campaigns (54% for both). Leisure activities are the second reason for visiting (31% for both) the river. Inhabitants and businesses have a negative perception of the river water quality (according to visual and odour criteria, and presence of solid wastes) but have a positive perception of the current condition of riverbank vegetation. The river is finally perceived as an unclean and dangerous place. And both populations identified hazards such as accidents, different water-related diseases and insecurity (sexual and drug related violence).

The survey on inhabitants and economic actors enabled us to map numerous “hot spots”: places commonly described as thoroughfares, leisure sites and/or highly degraded sites. The inhabitants mentioned 42 spots for short stays or transit, whereas the businesses mentioned 10 spots. The inhabitants identified 54 highly degraded sites while the businesses identified 25. When we plot for each spot the number of visiting people versus the number of highly degraded opinions, we observe spatial patterns corresponding to the main urban axes. The most frequently mentioned features are bridges. The landfill and the wastewater treatment plant also stand out as degraded landmarks.

All the seven monitoring sites were mentioned by the interviewed people as hot spots. Upstream locations have been mentioned as visited, and appear as non-degraded sites, while downstream locations have been mentioned as very visited and frequently described as degraded. The perception analysis also allowed us to identify four zones of interest that were not still monitored: two located in the main river, and two on the tributaries.

4 CONCLUSIONS

We finally found that perceived degradation supports most scientific results. It brings to light poorly known areas and allows refining observations on highly visited areas. The spatial modelling of the "hot spots" gave feedback on the localisation of current river monitoring stations and allowed identifying complementary locations where water quality indexes are needed: these locations were monitored during fall 2017.

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