Un guide méthodologique pour l'évaluation des performances des ouvrages de maîtrise à la source des eaux pluviales

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Le développement d'un guide méthodologique pour l'évaluation de la performance des ouvrages de maîtrise à la source des eaux pluviales

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RÉSUMÉ

L'évaluation *in situ* des performances des ouvrages de maîtrise à la source des eaux pluviales pose un grand nombre de questions d'ordre méthodologique. Ainsi, dans le cadre de trois projets de recherche français dédiés à ce type d'évaluation, Matriochkas, Micromegas et Roulépur, un groupe de travail sur l'harmonisation des méthodes a été constitué afin de faciliter l'inter-comparaison des résultats issus des projets, mais aussi de rédiger un guide méthodologique à destination des acteurs opérationnels pouvant être amenés à faire ce type d'étude. Ce guide propose une démarche où la performance est évaluée pour chaque fonction de service visée pour l'ouvrage, en réponse à des enjeux locaux. La première partie du guide détaille les fonctions de service pouvant être attendues de ce type d'ouvrage. Ensuite, des indicateurs de performance sont déclinés pour une sélection de fonctions de service couramment rencontrées dans le contexte français et qui ont pu être abordées au cours des projets. Ces indicateurs se regroupent en trois catégories : les indicateurs hydrologiques (relatifs aux flux d'eau), les indicateurs pollutifs (relatifs aux polluants) et les indicateurs sociotechniques. Le guide s'appuie sur des exemples issus des trois projets pour présenter des cas pratiques de dispositifs métrologiques et d'application des indicateurs proposés.

ABSTRACT

Evaluating the performance of sustainable drainage systems (SuDS) in a field context presents a number of methodological problems. For this reason, as a part of three French research projects focused on this type of evaluation, Matriochkas, Micromegas and Roulepur, a working group on methodological harmonisation was established in order to facilitate the inter-comparison of results between the projects and propose a methodological guideline for practitioners carrying out such evaluations. The guideline proposes an approach where performance is evaluated with respect to a service function that the SuDS aims to achieve, itself identified from local issues. Its first section presents the various service functions which may be assigned to these devices. Next, performance indicators are defined for a selection of the identified service functions, common within the French context and studied as a part of the three projects. Three categories of indicators are identified: hydrologic indicators (relative to water flows), pollutant indicators and socio-technical indicators. Examples of instrumentation and of the application of the proposed indicators drawn from the experience of the three projects are also presented.

KEYWORDS

Guidelines, methodology, performance, stormwater, SuDS,

1 INTRODUCTION

Over the past decades, in a context combining increased urbanisation and growing concerns over the quality of the environment, urban drainage has undergone a paradigm shift. Approaches have evolved from one of rapid drainage using devices with the sole objective of evacuating stormwater, to one of on-site management using systems designed to achieve multiple objectives, known under a large number of names across the world, including sustainable drainage systems (SuDS), low impact development (LID), water sensitive urban design (WSUD), alternative techniques (*techniques alternatives* in French) and source control (Fletcher et al., 2014).

As these techniques are relatively recent, their performance in the complex conditions of the field context is not yet fully characterized or understood (Geberemariam, 2016). Thus, *in situ* performance evaluations are required in order to (i) validate that SuDS achieve the expected objectives, (ii) improve understanding of factors affecting performance and (iii) provide a basis for improving system design and optimizing performance.

Such evaluations raise a number of methodological questions. For one thing, given the multifunctional nature of these devices, performance is not a single concept but one which must be defined with respect to the objectives or functions of the system studied (Moura et al., 2011). Once the type of performance is defined, questions arise as to which performance indicators should be used to evaluate each function. The last phase is to select relevant methods for evaluating the performance indicators; this step often requires the implementation of a monitoring system, which must also be defined.

In order to harmonize methods for SuDS performance evaluation, a working group was established between three coordinated French research projects, Matriochkas, Micromegas and Roulépur, all focused on evaluating the performance of SuDS devices and financed as a part of a call for projects by the French Biodiversity Agency (AFB) and the French Water Agencies on micropollutants in urban water. The working group included both researchers and practitioners from several different institutions and served two objectives: (i) to facilitate the inter-comparison of results from the twelve sites studied as a part of the three projects and (ii) to propose a guideline for practitioners needing to carry out performance evaluations. The present article focuses on the latter objective.

2 METHODS

2.1 Working group organisation

The working group met regularly from the beginning of the projects in 2015 in order to discuss (i) the types of performance to be evaluated, (ii) the definition of performance indicators, (ii) the methods for evaluating indicators and, in particular, the monitoring systems to implement when measurements are required and (iv) the application of these indicators to the sites studied in the three projects.

2.2 Methodological approach

An approach was developed based on functional analysis, wherein performance is evaluated with respect to service functions intended for the device, themselves defined in response to issues within the local environmental, hydrologic, urban and political context (Figure 1).

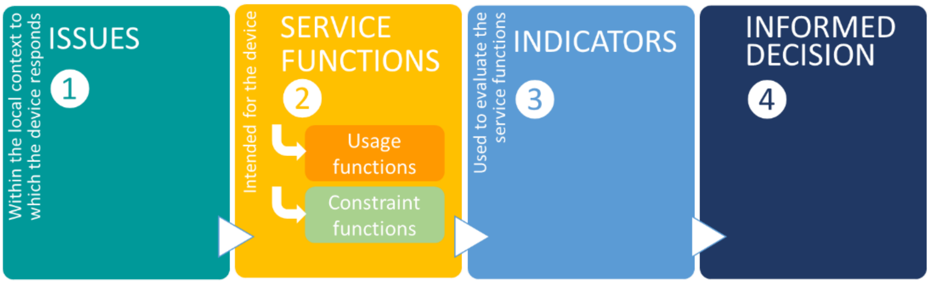

Figure 1: Approach for evaluating performance

Two types of service functions can be distinguished: usage functions, for which a device was created and constraint functions, which are constraints on the device behaviour and design given that it exists (AFNOR, 1996). Performance indicators were defined with respect to a selection of service functions, common to those observed within the French context and studied within the three research projects.

3 RESULTS AND DISCUSSION

3.1 Definition of issues and functions

Six issues to which sustainable drainage systems (SuDS) may respond were identified (Figure 2): flood reduction, resource preservation, ecological preservation, built environment protection, urban environmental quality and efficient management. Service functions which may be assigned to SuDS in response to each issue were identified; between two and six functions were associated with each issue, each of which was categorized as either a usage or a constraint function.

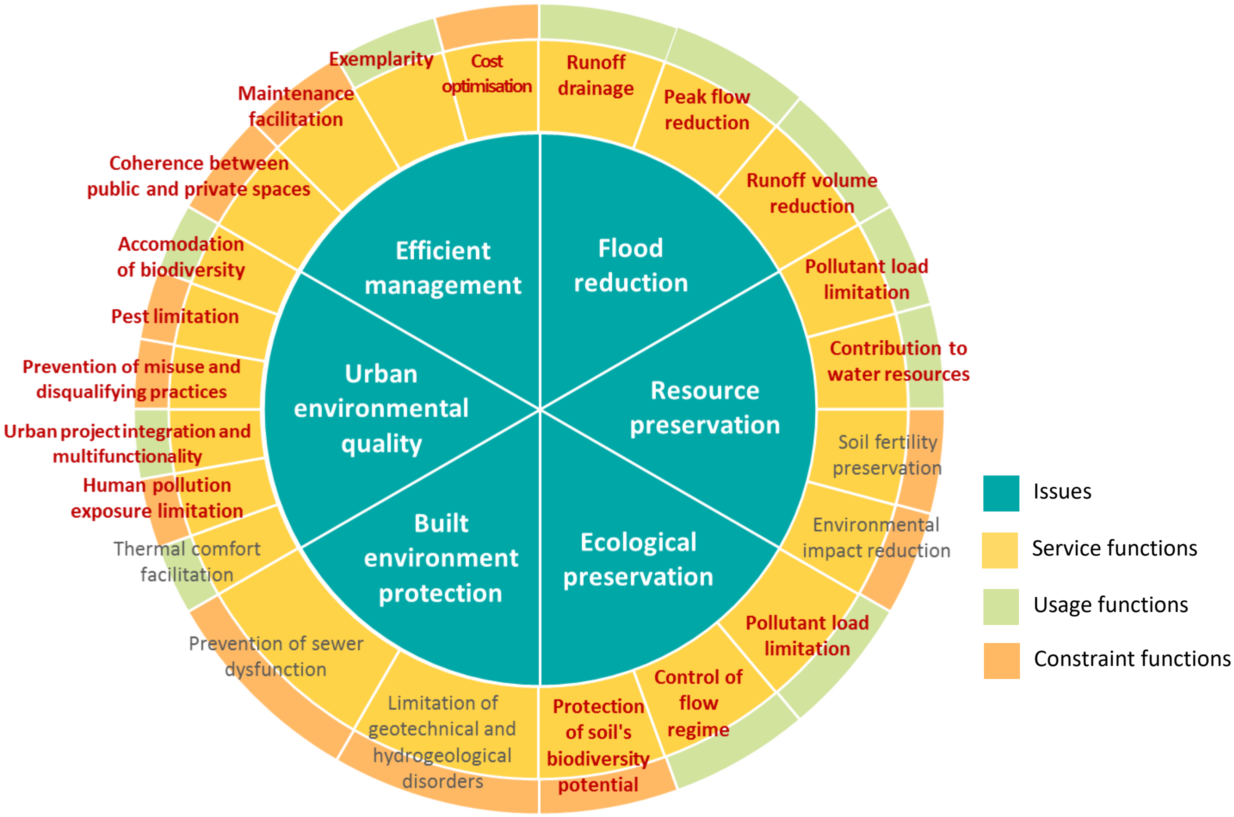

Figure 2: Issues to which SuDS may respond and service functions which may be expected; functions for which performance indicators are proposed are shown in bold, red text.

Complementary or conflictual relationships exist between several service functions. When a complementary relationship exists, designing for one service function may provide benefits in terms of the other service function, even if it was not intended at the time of conception. For example, a system may be designed for volume reduction in order to limit flood risk, but volume reduction will also provide benefits in terms of pollutant load limitation. Functions may also respond to two issues; this is notably the case for pollutant load limitation which can respond to both resource and ecological preservation issues. Although the pollutants of concern are likely to be different between the two issues (for example, if the quality of a water body is to be preserved for recreational bathing, human pathogens are of greatest concern, whereas ecosystem preservation requires control of substances leading to eutrophication or ecotoxicity), designing for one of these objectives is likely to provide benefits for the other.

Conversely, when conflictual relationships exist between functions, fulfilling one function could potentially have negative effects on another function. This is the case, for example, between pollutant load limitation, which often involves retaining pollutants in the topsoil of a SuDS device, and the protection of the soil's biodegradation potential, which may be degraded if the soil is polluted. A conflict may also exist between accommodating biodiversity and pest limitation, as some species may be seen as nuisances while also contributing to biodiversity. Likewise, there may be a conflict between functions best achieved by infiltration (volume reduction, contribution to water resources) and prevention of geotechnical or hydrogeological disorders caused by infiltration. In all of these cases, there are trade-offs between functions which require value judgements to find an optimal balance.

3.2 Performance indicators and monitoring

The guideline proposes performance indicators for the 17 service functions shown in red, bold text in Figure 2. Four types of indicators are identified: (i) *relative indicators*, which compare a value (often measured at a system outlet) to a reference corresponding to situation before or without the system; (ii) *normative indicators*, which compare a measured value to a level considered to be acceptable; (iii) *descriptive indicators*, which describe a system's behaviour, allowing for comparison with values from other systems, and (iv) *explicative indicators*, which seek to explain a level of performance observed. For some functions, several indicators are proposed, which provide different types of information and may be more or less difficult to evaluate (for example, some indicators are relevant at the event time scale, others at the annual scale).

Indicators are divided into three categories: hydrologic indicators (relative to water flows or volumes), pollutant indicators (relative to pollutant loads or concentrations) and socio-technical indicators (relative to governance and / or social acceptance and use).

The collection of data necessary for the evaluation of each category of indicator is also discussed, including the identification of the system to be evaluated and the types of measurements to be carried out (flow measurement for hydrologic indicators, flow measurement and analysis of concentrations in water and/or soil for pollutant indicators and characterisation of the socio-technical system through interviews, surveys or observations of human actors for socio-technical indicators). Recommendations as to the metrology necessary to evaluate hydrologic and pollutant indicators are provided. Examples of the metrology implemented on the 12 sites studied as a part of the three projects illustrate practical difficulties associated with monitoring campaigns of SuDS devices, such as the need to choose equipment that is adapted to a site's constraints (e.g. little available space, no electrical connection) or the necessity of using a reference catchment to represent diffuse flows.

Because data collection is often costly and time-consuming, readers are encouraged to seriously consider the feasibility and relevance of the monitoring campaign (given the technical and organisational constraints and the economic, material and human resources available) before investing in the campaign. It is also acknowledged that field monitoring campaigns may not always yield all of the data expected due to unexpected constraints or data invalidation. In this case, it may be necessary to use adapted, non-ideal indicators. For example, it is generally desirable to evaluate relative indicators (for example, concentration reduction) for paired samples from the same event. However, sometimes paired samples are not obtained due to technical difficulties. In this case, distributions established over several events (or median values from these distributions) may be compared rather than paired values for each event.

4 CONCLUSIONS

A guideline was established to aid practitioners needing to evaluate the performance of sustainable drainage systems (SuDS) as a part of three French research projects dedicated to this goal, in parallel with monitoring campaigns at 12 different sites, enabling the practical experience derived from these projects to be taken into account. The guideline recommends first identifying the issues to which a device responds within the local context and the service functions intended to respond to these issues. Performance indicators are proposed for most of the common service functions and recommendations are made as to methods for acquiring the information required for evaluating these indicators. Once the indicators have been evaluated, the user will have at his disposal information enabling him to make an informed decision regarding the behavior and performance of the device.

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