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# The Water Framework Directive's "percentage of surface water bodies at good status": unveiling the hidden side of a "hyperindicator"

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ABSTRACT

The Water Framework Directive (WFD) has provided the means of standardizing the way surface water bodies are monitored throughout the European Union (EU), using a common evaluation measure, the percentage of surface water bodies at good status, based largely on the structure and functioning of aquatic ecosystems. However, the evaluation of good status is based on the way the WFD is implemented, which differs in each country. In this article, we analyze how the WFD is implemented in France, how the water agencies divide up the water bodies, the areas covered by their monitoring networks, and the modalities of obtaining data to provide the EU with the percentage of water bodies at good status. This analysis reveals that it is this hyperindicator itself that is at stake, obtained by successively aggregating values measured in time and space, from the monitoring station to the River Basin District (RBD), reducing vast amounts of information to a single measure per RBD, while long-term monitoring of the major European rivers and their sedimentary budgets, which show improvements in certain quality aspects, are largely overlooked by the WFD. When drawing up the indicator, the agencies identify certain biases but not others. This raises the question of its use and relevance for managers and politicians, at both national and European level.



## 1. Introduction

The Water Framework Directive (Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000) is the major policy instrument of Member States of the European Union for water quality. Designed to homogenize and standardize water quality assessments in all Member States, its principal aim is to stimulate water quality improvement and contribute to the management of all surface waters and groundwater, from upstream watersheds to coastal waters. Surface water quality descriptions are a crucial part of the directive (van Puijenbroek et al., 2015).

### *1.1. Objectives and approaches of the Water Framework Directive*

The implementation of the Water Framework Directive (WFD) in 2000 is a long and complex process, centered on a key objective: to achieve good status for all water bodies by 2015. Good status consists of the combination of the so-called good ecological status and good chemical status for surface waters, and good quantitative and good chemical status for groundwater (WFD, article 18). Good ecological status is defined in Annex V of the WFD in terms of the quality of the biological community, the hydrological and the physicochemical characteristics of surface waters. Each of these three elements is in turn determined by dozens of specific parameters listed in the annexes of the directive. As for good chemical status, it is defined in terms of compliance with all the quality standards established for chemical substances at European level (http://ec.europa.eu/environment/water/water-framework/info/intro_en.htm). Like all European directives, implementation of the WFD requires transposition into national law with specific choices made by each country (Kessen et al., 2010). The assessment of the status of European water bodies by the European Environmental Agency (EEA) is based on information reported by each Member State: "*The quality of the Commission assessments relies on the quality of the Member States' reports and data delivery. Bad or incomplete reporting can lead to wrong and/or incomplete assessments*" (EEA, 2012, vol.1, p.7). This process relies on a step-by-step procedure: it starts with the adaptation of the directive in each country, including the delineation of their river basin districts, composed of numerous water bodies, on which the water quality assessments are performed, based on the chemical and biological monitoring. Setting of objectives then complements

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the assessment of status in each water body; the establishment of an appropriate programme of measures and its implementation is then performed in each State (EC, 2012a, vol.1, p.5EC, 2012aEC, 2012a, vol.1, p.5). The interest of this procedure is that it should provides objective, reliable and comparable environmental information covering the whole of the European Union, based on evidence, available knowledge, and assessment of the quality of the water bodies.

### *1.2. A common Evaluation Indicator: the "hyperindicator"*

Considering the enormous amounts, field and laboratories data are actually transformed, from the river basin district to the European level, into one single integrated indicator, the percentage of water bodies at good status, termed here the "hyperindicator".

The advantages of this procedure are that it provides a common tool for evaluating and comparing the overall state of water bodies and that it supplies information covering the whole of the European Union, while taking into account specific aspects of each State and of regional differences within these States. It is the main integrated metrics of water quality for each river basin district, and allows their comparison and their trends at the European level. It is usually established on the measured or estimated quality of all surface water bodies in each river basin district. The gap between the actual and the targeted hyperindicator, defined in each country, expresses the need for additional environmental measures.

The hyperindicator is based on binary information at the water bodies level: good *vs* bad status composed of two elements: the ecological status and the chemical status. The list of quality elements to define ecological status is based on three groups of elements: biological elements, hydromorphological elements supporting the biological elements, and chemical and physicochemical elements supporting the biological elements. Ecological and chemical status differ in nature; chemical status is frequently affected by pressures experienced upstream of a monitoring station, whereas ecological status is influenced more by local conditions, particularly those affecting aquatic habitats. "Good status" is a mixture of these two approaches.

The specific feature of the hyperindicator is that it is a dimensionless figure, which is extremely flexible as it can be applied to areas varying widely in size. It is thus a quantitative indicator, ranging from 0 to 100% in river basin districts, making it possible to observe changes over time, even when the water quality criteria or the monitored quality elements change. As the hyperindicator is the result of the statistical compilation of the status of all the water bodies in a river basin district, it implies the assessment of both ecological and chemical status of all water bodies within it.

The technical and scientific difficulties of producing the hyperindicator in the various member States have already been studied (Caroni et al., 2013; Bouleau and Pont, 2015). The hyperindicator condenses millions of relevant data into a single figure, and while this reduction of information may suit politicians and environmental economists, it conceals the wide range of problems encountered and their solutions. The water bodies, like the river basin districts, vary widely in size, with an order of magnitude ranging from 1 to 100 depending on the divisions made by the Member States. The hyperindicator aggregates information about varied and constantly redefined aspects of water and aquatic environments. The measurements of water quality and the way they are aggregated lack transparency.

Our general aim here is to examine how public policies, both national and European, inform this indicator, and the problems raised by its use by European authorities to generate reliable and comparable information about water quality measures implemented by individual countries.

We will demonstrate that the hyperindicator is actually a statistical artifact, defined on spatial entities – the river basin district – on the basis of both measured and extrapolated data on all water bodies of each district. It results from multiple and successive integrations of data at three levels: successively (i) temporal, (ii) thematic, (iii) spatial from the basic data generated by the surveillance at each monitoring station to the European level. It is therefore very different from classical water quality indicators, particularly the integrated indicators used in ecology, e.g. the saprobic indicator based on various aquatic species and determined at the station level (Meybeck et al., 1992a,b; Friedrich et al., 1992; Bartram and Balance, 1996).

We are raising the following questions: how the hyperindicator, reported by the European Union, is established at the level of river basin district (Section 3.1)? How the quality elements are submitted to successive integrations and their consequences (3.2)? What are the limitations and biases raised by the spatial surveillance within a river basin district (3.3)? The extrapolation of monitored water bodies to unmonitored ones and the undetected extreme status, are particularly addressed (3.3.3). In our discussion we list the major problems raised by the hyperindicator and its use as a policy instrument to assess improvements in water quality and to implement action programmes (section 4). Finally, we suggest some precautions and recommendations that should be taken by water agencies and the European Union when using this hyperindicator (Section 5).

## 2. Methods

Our study is concerned only with rivers, and not lakes or reservoirs.

It is first based on WFD evaluation reports produced by the European Commission (EC, 2012a,b) and the European Environmental Agency (EEA, 2012; Chave, 2001) and on French national reports on river monitoring, started in 1971 up to the implementation of the WFD, such as those of l'Institut Français de l'Environnement – IFEN (Crouzet et al., 1999), the French Ministry of Environment (MEEDDAT, 2009), and l'Office National de l'Eau et des Milieux Aquatiques (ONEMA, 2013a,b, 2015). We are also considering French technical guidance documents for the water agencies implementing the WFD, and reports of some water agencies (AEAP, 2007; AERM, 2015; AESN, 2010).

We also use in-depth examples from the six river basin districts in metropolitan France and from the water quality surveys operated by the Seine-Normandy and the Rhine-Meuse water Agencies, from 1971 to 2006.The French water agencies were created under the terms of the 1964 Water Law, as public administrations responsible for monitoring water quality in the major river basin districts and have developed the first monitoring station network in 1971 for the first national pollution inventory. The task of collecting watercourse and groundwater samples is today entrusted to public and private laboratories. Based on the results of the inventory, the water agencies then put forward an action programme to a river basin committee composed of representatives of users (representatives of State departments, elected representatives of regional authorities, professional and environmental organizations).

We also used a case study of the monitoring station network of the Seine-Normandy water agency (Agence de l'eau Seine-Normandie, AESN) carried out by one of the authors (Esculier and Andriamahéfa, 2014), and a data quality assessment carried out by this agency, in partnership with researchers working on an interdisciplinary programme studying the environment of the Seine (PIREN-Seine, http://http://www.metis.upmc.fr/piren/), in which the present authors participated. This work is based on statistical analysis of these data and has benefited from interviews