Progress with the WFD implementation in five European basins: Significant differences but similar problems.

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Abstract

The river basin approach of the Water Framework Directive (WFD) and the introduction of ecological status represent a shift in the assessment and management of freshwater systems from discipline-specific to more holistic, catchment-based principles. At the core of the WFD's approach are the catchments as highly interconnected systems. Despite the strict timetables, progress towards achieving the WFD objectives has been slow with deterioration in some cases not been halted. In this paper, looking at evidence from five European basins, we identify some of the key implementation challenges faced by each catchment and investigate their potential causes. Despite significant differences - socio-ecological conditions, wide geographic coverage and different levels of ambition in the implementation between these catchments, findings highlight some key similar problems. Gaps in monitoring networks and assessment methodologies used, as well as misunderstandings and lack of ambition with some of the innovations the WFD introduced, have limited the potential of River Basin Management Plans (RBMPs) to deliver water quality improvements. With many of these issues not easy to be resolved at the catchment level, we identify opportunities for policy improvement at the EU or National level that could facilitate the implementation of the Directive and the delivery of water quality improvements the WFD was introduced for.

Keywords: Policy, Systems thinking, Catchment management, Implementation

1. Introduction

The river basin approach of the Water Framework Directive (WFD) and the introduction of ecological status represent a shift in the assessment of freshwater systems from discipline-specific to more holistic, catchment-based principles. WFD assessment and classification of European waters required a new mind-set and procedural elements, that most member states found challenging to address. The directive offered a tailored approach in improving water quality by conceptualising and managing catchments as highly interconnected systems. Despite significant investments in measures, progress towards achieving WFD objectives (reducing the gap) has been slow with deterioration in some cases not been halted. Providing evidence from five European river basins, a policy analysis was carried out reviewing how the Directive has been interpreted and applied, adopting a manager's perspective. These were: Ebro in Spain and Evrotas in Greece (both in the Mediterranean), Sava, which is a continental and trans-boundary shared between Slovenia, Croatia, Bosnia and Herzegovina and Serbia, Adige in Italy (an Alpine basin) and Anglian in UK. The selected case studies encompass a rich set of socio-ecological conditions, and a wide geographic coverage.

2. Common implementation challenges across the case study basins

Issues with characterisation of river basins

In all case study basins the major issue was with their characterisation and their understanding as catchment systems (including pressures, impacts and economic analysis). Discrepancies with the reference conditions have also been identified in all five basins in varying severity. In the Evrotas and Sava the reference conditions have not been established them in time while in Adige and the Anglian RBD, no information on validation of surface water types with biological data was provided. Also, in the Anglian RBD high uncertainties were reported in characterisation (European Commission, 2012). During the first cycle only rivers and lakes were identified. The second cycle brought improvements, making the characterisation of surface water systems more ecologically relevant by charging water body boundaries and designating coastal and transitional types. Similarly, in the Ebro RBD the lack of coherence in the typology and reference conditions has affected the process of determining the status or setting environmental objectives for transitional and coastal water bodies as well as for heavily modified or artificial water bodies (European Commission, 2015a). Furthermore, in the Anglian RBD, Ebro RBD and Evrotas basin, there is a need to revise, improve and make transparent the designation of heavily modified and artificial water bodies.

Unreliable risk assessments compromising the effectiveness of monitoring networks

The pressures and impacts analysis and its implications to the identification of the significant pressures for monitoring, seem to be the greatest issue in all basins. Significant pressures are defined as pressures that on their own, or in conjunction with other parameters such as; other pressures or particular characteristics of the catchment, may lead to failure to achieve one of the WFD objectives (European Communities, 2003a). In Ebro RBD seems to be a mismatch between the pressures operating in the catchment and the ones' reported. Although, water quantity has been a significant problem, there have been relatively low numbers of water bodies identified as being affected by significant abstraction pressures. This could be attributed to the fact that Spain reported to the Water Information System for Europe only the result of the qualitative pressure and impact assessment, which is not accurate in case of water abstraction (European Commission, 2015a). Similarly and despite the large number of dams and river infrastructure existing in Ebro, there have been relatively low numbers of water bodies (<20%) reported as impacted by significant water flow regulations and hydro-morphological alterations (European Commission, 2015a).Current assessment schemes mainly focus on more traditional pressures (e.g. eutrophication, organic pollution) Hering and co-workers (2010), neglecting other pressures have more recently come into focus. One of which includes the implications of climate change in water management. As an example, there are issues identified with regards to the impact of climate change associated with the release of chemical pollutants from snow and glacier melting, an occurrence that have not yet been fully investigated in the case of the Adige basin (Chiogna *et al*., 2016). This brings another question from a managers practice perspective with regards to the reliability of the thresholds of significance used for the pressure inventories. This is apparent in the cases of the Evrotas and Sava basins where the criteria for identification of significant pressures haven't been catchment specific (Central Water Agency, 2006, ISRBC, 2013). Although this practice provides an initial starting point and baseline for the pressure-impact analysis, using one set of thresholds across Europe is not ideal since this fails to recognise the particular characteristics of the water body and its vulnerability to the pressure (European Communities, 2003a).Although the Directive requires the pressure impacts analysis to be a continuous process validated and supplemented by monitoring, generally in Spanish catchments the final and complete assessment of pressures and impacts was wrongly seen as a one-off exercise that was due only in 2005 as part of the preparation of the first RBMP. The Anglian River Basin District (RBD) presents a better example of application of the pressure assessment. A preliminary analysis on pressures and impacts revealed some issues including the identification of the impacts of hydro-morphological pressures on ecological status, the limitations of the traditional General Quality Assessment to represent impact data as well as the challenges in understanding the relationship to link activities to the pressure (Defra, 2005). Even towards the end of the planning cycle, although UK in general had its pressure and impact analysis largely in place according to the WFD 4th implementation report, there were still uncertainties identified in the review of the first river basin management plans in relation to the assessment of status, the pressures and the effect of potential measures (European Commission, 2015b).

Operational monitoring and status classification

Apart from delays with the RBMPs in most of the basins e.g. Evrotas, Sava, Ebro River Basin District (RBD), there have been gaps in monitoring in all cases. A good example that illustrates how the problematic identification of pressures affects the classification of status comes from Ebro RBD. The assessment of pressure impacts in the Ebro RBD has identified 77% of the water bodies (635 water bodies) under no pressures. Comparing this to the number of water bodies at good status in 2009 (226 water bodies) it appears to be a much lower number of surface water bodies in good status than the number of water bodies with no pressure (European Commission, 2015a). Another example of problematic implementation status assessments comes from the Croatian part of the Sava RBD. Although, Biological Quality Elements (BQEs) in operational monitoring were chosen in relation to existing pressures, there is no clear evidence to show which BQEs have been selected to monitor which significant pressures. The RBMP of Croatia also reports that operational monitoring was only carried out in relation to point source pressures, not diffuse sources. Also, in the case of the Anglian RBD there have been, as reported above, problems with the typology as well as uncertainties with reference conditions and the identification of pressures. Those errors could be transferred to the subsequent steps of assessment and subsequently affect the selection of quality elements that will be mentored and used for the overall status assessment (European Communities, 2003a). Another common problem identified in all the basins is related to the methodologies for status assessments. For Adige, Evrotas and Sava methods for assessing ecological status have not been developed for all Biological Quality Elements (BQEs) specified in the WFD. In the case of Ebro RBD there seem to be discrepancies in the assessment methods developed for the biological quality elements. For the Anglian RBD, the main concern was with the large uncertainties resulting from the methodologies followed. Another source of error in implementing operational monitoring and delivering reliable classifications roots in the lack of well-established assessment methodologies for all BQEs, compromising the selection of the most appropriate indicators for significant pressures. In the Evrotas basin the classification of rivers as far as BQSs is concerned was based on monitoring of benthic invertebrates, and fish (fish were not included in the Evrotas tributaries) since for the rest (macroalgae and phytobenthos) it was not feasible to determine the class boundary limits (Nikolaidis *et al*. 2009). In the Anglian RBD despite having one of the most intensive monitoring networks, not all of the relevant quality elements are monitored. Although all relevant BQEs were used in operational monitoring, not all supporting elements were. For example, there is no monitoring of river continuity, tidal regime in coastal waters or fish in lakes according to the information reported to the Commission (European Commission, 2012). More severe gaps in elements monitored are present in the case of the Sava trans-boundary catchment, potentially due to differing levels of the WFD implementation among the countries involved.

For example, while in Slovenia operational monitoring covers most of the relevant quality elements and frequencies, in Croatia for the development of RBMP, a preliminary assessment of the ecological status was made using only physico-chemical and hydro-morphological quality elements instead. Although the required BQEs were reported being monitored in rivers and lakes, the lack of compliant biological assessment methods meant that they were not used to derive ecological status (European Commission, 2015c). In Serbia the monitoring and assessment of the ecological and chemical status for the Sava RBMP have not been fully compliant with the requirements of WFD, while WFD compliant methods have not been implemented in Bosnia and Herzegovina yet. Monitoring of water quality and quantity is still based mostly on traditional monitoring programs, organized at the same monitoring sites as before 1992 (ISRBC 2013).

3. Lessons and opportunities for improvement

Problems or uncertainties at early procedural steps of the RBMP process have knock off effects on the subsequent steps reducing the reliability of their outputs. Acknowledging the ecological variability and socio-political differences that characterise catchments, the WFD calls for a tailored approach in catchment management. In practice, this requires a shift from having a single mandate for the freshwater management across Europe to a more robust understanding of the essential features of those systems. To achieve this, it is essential to strengthen the evidence base to address the complexity of water problems and facilitating public participation (Howarth, 2009). The assessment of pressures and impacts must be seen as an on-going process within the RBMP cycle, and that the process should be kept up to date to enable timely, appropriate and effective water management (European Communities, 2003a). Also, validation of the pressure impacts analysis by using monitoring data is especially important in the context of multiple pressure interactions. As freshwater systems are influenced by pressures whose effects are relevant at multiple spatial and temporal scales, the thresholds of significance for example of a certain pollutant may change based on the specific characteristics of the catchment. For example, even low contaminant loads may become relevant for the ecosystem when it is subject to additional hydrological stressors. The identification of 'significant' pressures maybe proved to be problematic since it could potentially neglect the combined effects of non-significant one's. Therefore, ideally managers should hold a good understanding of the individual and combined effects of pressures that operate in their area. Complex synergistic or antagonistic interactions between multiple pressures are very common (Piggott *et al*., 2015) and therefore they are one of the largest sources of uncertainty when predicting ecological change. A recent study by (Chiogna *et al*. 2016) in the Alpine catchment of Adige shows how unpredictable the impacts of such pressure interactions could be. According to the classification data collected by the relevant authorities, the highest quality values were found in the upstream regions compared to the downstream regions where the ecological status deteriorated. Such a north-south gradient of ecological status classifications across the monitoring points of Adige seems to contradict the evidence that hydropeaking has in general a negative effect on the ecosystem as the data demonstrate that the worst ecological status occurs where the effects of hydropeaking are negligible (Chiogna *et al*. 2016). Operational monitoring should be focused on parameters indicative of quality elements most sensitive to the pressures to which the water body or bodies are subject (European Communities, 2003b). However, the reliability of the overall classification of ecological status, which is based on the selection of those elements, heavily depends on the pressures and impacts analysis, and could be jeopardised by the limited understanding of the interdependencies between pressures and impacts. Also, if a significant pressure is overlooked during the pressures and impacts analysis, the monitoring will probably not be designed to assess it.

4. Discussion and conclusion

The paper aimed to provide insights into the complexities and problems of the monitoring and assessment under the WFD by providing examples of its problematic implementation in five European river basins (Adige, Broadland Rivers, Ebro, Evrotas and Sava). The analysis illustrated the common problems that all face, which could be seen as opportunities for improvements. These are: A) Improving characterisation of river basins (including typology, pressures, impacts, economic analysis and "desired state"); B) Better application of risk assessment for targeted and effective monitoring design; C) Improving element selection for operational monitoring and classification (i.e. Sensitive to pressures); D) Better use of monitoring data to capture pressure-status interactions. Currently, around 47% of water bodies in Europe are threatened by multiple pressures with detrimental impacts to water availability and quality (Schinegger *et al*. 2012). Because of the scientific limits in clarifying the complexities of environmental systems, more research is needed in this area to enable effective monitoring and assessment. The pressure and impact assessment needs to consider the influence of multiple sectors and also facilitates the integration of freshwater policy objectives that were once treated in isolation thereby driving the need to treat water management from an integrated systems perspective. Pressure impacts analysis is a key procedural element for the assessment of status but currently there is limited scientific knowledge in the following areas: 1) how multiple stressors impact on structural and functional biodiversity and how this could affect the ecological status of freshwater ecosystems; 2) how climate change and water scarcity could act as drivers exacerbate multiple-stressor effects and 3) the fate and behavior of emerging pollutants and nano-materials under multiple-stress conditions and their potential impacts on biodiversity has been neglected. The WFD is not prescriptive but leaves to the Member States to design the means to achieve its objectives for good ecological status. As a result there has been a deviation from the Directive's intent with the current implementation of the river basin characterization, the pressure assessments and monitoring involving only technical considerations that might not be transparent to the public, water users and stakeholders (European Communities, 2003b). However, it should be considered that WFD's ecosystems approach for the assessment of surface water system health and the introduction of ecological status represents a shift from disciple specific

approaches towards holistic resource performance assessments and requires different mind-set and monitoring practices. Traditional silo-based management rooted from disciplinary thinking often provides an incomplete representation of the entire environmental system (Jones *et al*. 2011). Therefore, the WFD by integrating multiple perspectives in the decision-making process seeks for robust understanding of the issues and interactions within the catchment (Collins *et al*. 2007). The inclusion of multiple perspectives could also promote interdisciplinarity in water management that is necessary to address such complexities (Voulvoulis 2012). Operationalising the WFD's systemic intent for integration of multiple perspectives has a long way to go, with some evidence of a transition towards an adoption of the ecosystems approach through the integration of Ecosystem Services (ES) in the implementation process (Voulvoulis *et al*., 2017). Even though ES are not explicit in the wording of the WFD, there is a clear connection between the Directive and their delivery (Vlachopoulou *et al*. 2014). Investigating further the relationship between environmental "state" and "impacts" on quality elements monitored under the WFD and how do they link to provision ES could enable greater involvements of the stakeholders in defining the desired freshwater system states. Adopting the ES language a participatory approach for the assessment under the WFD could be facilitated, by translating how changes in water quality status reflects those services and goods they value. The stakeholders could provide a more robust definition on good ecological status based on what they value. Using ES as the proxy of those natural elements of water systems that are ultimately valued by our society, its integration in decision making by explicitly identifying the interdependencies of how human activities within the catchment influence their provision (Asah *et al*. 2014) could support the implementation of the monitoring and assessment under the WFD. Developing methodologies that could quantitatively assess the effects of multiple stressors on the freshwater ES from a biophysical point of view could signify their potential application as indicators of systems state. This could enable the stakeholders to contribute in the process as they can be a useful source of information and have expertise of direct use for the reference condition analysis (European Communities, 2003b). Therefore, the nature of the ES as both a concept and as potential indicators of ecosystem state must be further investigated in order to provide the right conditions to effectively achieve the broader objectives of the Directive.

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