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Perception of bottlenecks in the implementation of the European Water Framework Directive
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Perception of Bottlenecks in the Implementation of the European Water Framework Directive

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ABSTRACT: The European Water Framework Directive (WFD) entered into force in December 2000; it marks a decisive turn in European water governance and related policies, management practices and restoration trends. After 20 years of implementation through two management cycles, EU member states have transposed the WFD requirements into national law, performed baseline assessments of water bodies, and implemented first measures such as hydromorphological river restoration which aims to achieve 'good ecological status', or at least the potential level targeted for that particular water body, by 2027. So far, however, WFD implementation has shown limited

success; this weak result has given rise to studies, which are mainly discussions about possible technical limitations of WFD implementation and the appropriateness of monitoring procedures. This paper complements these studies by exploring governance-related bottlenecks that have emerged in the last two decades, as perceived by scientists and practitioners. An online survey was conducted which built on a list of 24 barriers to WFD implementation; these barriers had been identified previously by more than 40 researchers during a workshop in January 2019 and through a literature review. In this survey, the list of perceived barriers to WFD implementation was shared to 130 scientists and practitioners, who were asked to prioritise the items on list. Taken together, four main barriers to WFD implementation were identified: 1) problems related to horizontal intersectoral communication, 2) insufficient land reserves, 3) insufficient staff capacities, and 4) inadequate funding. The results of the analysis of WFD implementation indicated a bottleneck at the governance level that was due to insufficient horizontal collaboration and communication. This result is not in line with previous surveys that identified policy integration as the main bottleneck. We conclude from this that the governance dimension of WFD implementation merits more attention in terms of both research and political consultation in order to identify the needs for action that are key to improved WFD implementation.

KEYWORDS: Water governance, water-related institutions, cross-sectoral river management, river restoration, European Water Framework Directive

INTRODUCTION

Water policy in Europe had been based on country-by-country sectoral regulations for drinking water, fish, sediments, organic pollution, and chemical pollution control. In 2000, however, European water governance took a decisive turn with the adoption of the integrated Water Framework Directive (WFD) (2000/60/EC) (Zingraff-Hamed et al., 2017b). The WFD's goal is to protect and enhance the ecological status of all European water bodies, including rivers, lakes, transitional and coastal water bodies, as well as groundwater; it aims to do so by using an integrated approach to human impacts, status monitoring and management scope. It represents one of the most ambitious environmental policies in the world (Hering et al., 2010) and has inspired water legislation in many non-European countries (Heldt et al., 2017). During its first management cycle, between 2009 and 2015, EU member states succeeded in translating the WFD requirements into national legislation. They did so by 1) adjusting their national water management systems – which did not always correspond to a river's actual catchment area – in such a way as to implement the international river basin districts requested by the WFD, 2) by adapting ongoing monitoring procedures using new metrics, and 3) by performing baseline assessments of water bodies. In order to support WFD implementation a range of actions were taken; these included: establishing implementation procedures, setting ambitious deadlines, drawing up portfolios of measures to be implemented, developing ecological assessment methods for evaluating water body status, funding research on effective measures, and setting up monitoring and learning arenas. While regional and local authorities made substantial efforts by carrying out the first restoration measures under the WFD, during the first cycle no country achieved good ecological status or potential for all its water bodies, the last being required for heavily modified or artificial water bodies. Since the beginning of the second cycle (2015-2021), authorities have greatly increased their efforts to implement measures by carrying out, for example, hydromorphological river restorations (Hering et al., 2010; Zingraff-Hamed et al., 2017a), with the aim of achieving good ecological status/potential by 2027. Results are still limited, however, despite the substantial efforts made by EU member states to support the success of WFD implementation. In 2018, the European Environment Agency (EEA) reported that 60% of surface water bodies had not yet reached the required level of good ecological status/potential and that no significant improvement had occurred since WFD ratification (EEA, 2018). Because significant numbers of water bodies were not assessed in 2009, it has been difficult to analyse the overall changing trends in the status of the water bodies between 2009 (as reported in the first set of River Basin Management Plans, or RBMPs) and 2015 (as reported in the second set of RBMPs). For water bodies that were assessed in both 2009 and 2015,

the percentage of those with good ecological status shows a negative trend (EEA, 2018: 33). Why has the WFD failed to improve the quality of our surface water bodies despite it being one of the most ambitious environmental directives worldwide and even though considerable efforts have been undertaken for more than 20 years? In order to overcome limitations in WFD implementation, it is important to review the achievements and problems that have been encountered.

Ten years after its inception, the WFD was first examined by ecologists and hydrologists; they mostly investigated the monitoring procedures for the baseline assessments of water body status. They concluded that while the new monitoring tools support the design of RBMPs, they may not properly reflect the success of restoration (Hering et al., 2010). The first WFD fitness check was demanded by the European Commission in order to allow them to assess the effectiveness of WFD implementation (according to §19(2) of the WFD); it was carried out in 2012. The results highlighted the fact that other water-related directives – such as the Floods Directive (2007/60/EC) – needed to be more closely aligned with WFD goals and that there was also a further need for integration into other sectoral policy fields such as agriculture (EC, 2012). This was the first time that governance and institutional aspects were mentioned as WFD implementation limitations. The latest fitness check, carried out in 2019 (EC, 2019a), reconfirmed these findings, considering the WFD to be "broadly fit for purpose", but with implementation nonetheless facing a number of challenges, some of which were related to governance and institutional aspects. Various independent evaluations were also performed in order to identify limiting factors for WFD implementation (Borja and Rodríguez, 2010; Carvalho et al., 2019; Reyjol et al., 2014; Brack and al.; 2017; Rouillard et al., 2018; Voulvoulis et al., 2017). Most of those studies, however, only analysed strengths and weaknesses from a natural sciences perspective and focused on instrument limitations and technical measures. Consequently, recommendations for improvement have mainly focused on technical aspects (concerning, for example, the effectiveness of measures), biological limitations (such as species-specific recovery times) and monitoring tools (such as pressure-specific assessment procedures) (IGB, 2019). A few studies also considered governance and institutional aspects, but only as an isolated parameter (Carvalho et al., 2019; IGB, 2019).

Governance aspects are related to how society (or groups within it including government, business and civil society organisations) organises to make decisions or implement them. The important distinguishing features (adapted from the Institute on Governance, or IOG, 2019) include, 1) who has a voice in making decisions, 2) how decisions are made, and 3) who is accountable. Environmental governance can be understood as the set of regulatory procedures, mechanisms and organisations through which political actors influence environmental actions and outcomes. Governance is not the same as government; it does, however, include the actions of the state such as providing financing mechanisms and legal frameworks, and it encompasses non-state actors such as communities, businesses, and NGOs (Lemos and Agrawal, 2006). For water governance particularly, we refer to research on the "efficiency and legitimacy of actors, procedures and organizational arrangements that aim to manage water through formal and informal institutions" (Lepenies et al., 2018). As the implementation of the WFD represents complex work involving several hierarchical levels of government and administration (EU, national, federal state, administrative district, county, community) and requires, among others, agreements on river basin management across administrative and political borders (including international borders) and agreements with stakeholders beyond the water sector, it is necessary to investigate potential limitations in the governance and institutional context of WFD implementation within those complex political structures.

The terminology used in the literature and in the discourse on river basin governance is ambiguous and diverse; some studies, for example, distinguish between 'limits' and 'barriers' while others use these terms interchangeably. In this paper, limits are insurmountable and are inherent to the system (Dow et al., 2013), while barriers can be defined as the consequence of actions that questioned the efficacy and legitimacy of a response (Adger et al., 2007). Limits, that is to say, depend on the system, while barriers depend on the goals of a particular measure (Barnett, 2010). Unlike limits, therefore, barriers can be

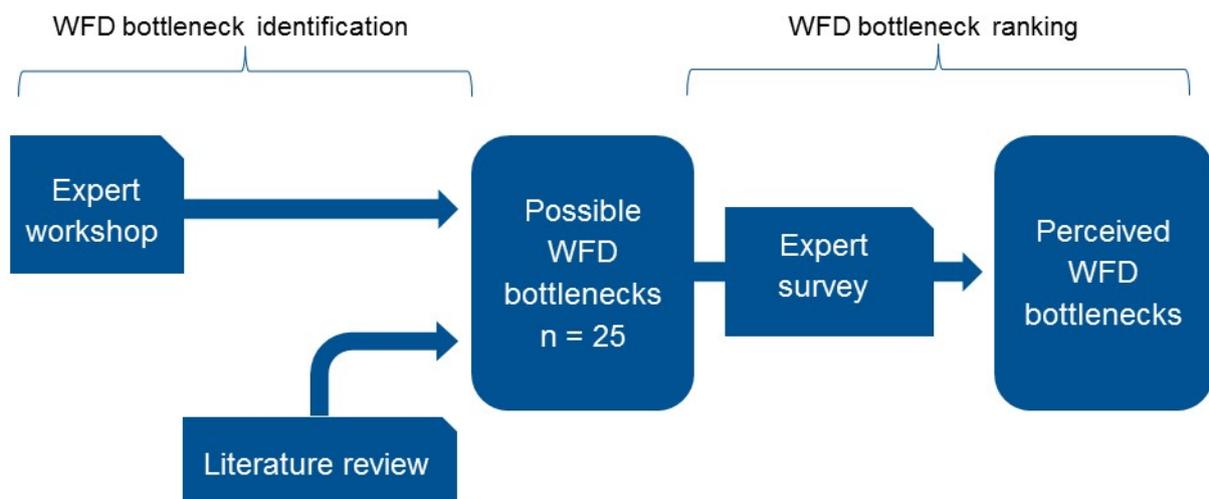
overcome if, for example, sufficient technical and financial resources are available. A bottleneck – the central term we use in this article – is a barrier that causes congestion in a system and brings about inefficiencies or significant delays but is not itself a characteristic of the system.

Our investigations aim to fill this knowledge gap; we ask which governance-related bottlenecks to WFD implementation can be identified by studying the perceptions of barriers of WFD experts at the scientific, administrative and operational levels. The objectives of this paper are to: 1) analyse governance-related barriers over the last 20 years of the WFD's lifespan in most of the EU member states, 2) identify bottlenecks, and 3) discuss ways to mitigate or overcome them. The authors draw on two decades of scientific research as well as practical insights on the implementation of the WFD; we aim to provide findings that are relevant at the operational, administrative and policy levels.

METHODS

The methodological approach to identifying possible WFD bottlenecks is based on a two-step process. We first identified bottlenecks in an expert workshop, and then cross-checked and complemented them with a simple literature review; we used these bottlenecks in an online survey where they were ranked by 130 experts and scientists (Figure 1).

Figure 1. Methodological approach to identifying and ranking potential WFD bottlenecks.



Identification of potential bottlenecks

The expert workshop was held at the Helmholtz Centre for Environmental Research (UFZ) in Leipzig, Germany, in January 2019. The attendees were from 10 countries, mostly Central European; they included more than 40 researchers and members of social science disciplines working on WFD implementation and European water policy. They came together to discuss WFD limitations and, in the course of the workshop, identified a need to particularly evaluate the barriers to WFD implementation from a governance and institutional perspective and with a broader expert basis; such an evaluation would complement the existing research on barriers that has come from a technical and ecological point of view (Brack and al., 2017; Carvalho et al., 2019; Voulvoulis et al., 2017).

Following the expert workshop, we felt a need to ensure that we did not overlook potential bottlenecks already discussed in the relevant scientific literature; in June 2019, we therefore carried out a review of the thematic literature on the lessons learned from WFD implementation. We used the database Scopus and, in order to restrict the number of relevant publications, we used the search terms

'Water Framework Directive', combined with 'lessons' and 'river*'. In total, 36 publications were selected using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method (Moher et al., 2009). All selected publications were assessed for relevance by screening the title, keywords and abstracts; they were then classified by the authors into three categories, with 18 publications being considered not relevant, 12 relevant, and 6 highly relevant. The level or degree of relevance depended on whether they contained information on positive or negative factors (strengths and weaknesses) for WFD implementation, or lessons learned on how to improve WFD implementation. We then performed an in-depth analysis (see Table A1). Based on the expert workshop and the literature review, a list of 25 potential bottlenecks was compiled and then integrated into the survey design (see Table 1).

Table 1. List of identified bottlenecks for WFD implementation.

Identified bottlenecks	Identified in workshop	Identified in literature
Integrated river basin paradigm		✓
Ecosystem-based river basin management		✓
Subsidiarity principle that allows decision-making to be made by agencies closest to the problem within the basin		✓
Levels of government involved in Integrated River Basin Management		✓
Actor constellation/collaboration in charge of WFD implementation	✓	✓
Public participation		✓
Climate change context		✓
Emerging stressors (other than climate change)		✓
Listing of preselected measures		✓
Large scale of the Programmes of Measures (PoMs)		✓
Goal-oriented PoMs	✓	
Difficulty of communication in lower-level environmental administrations	✓	
Obstacles regarding the top-down information flow in the environmental agencies	✓	
Obstacles regarding the bottom-up information flow in the environmental agencies	✓	
Obstacles in horizontal intersectoral communication	✓	
Insufficient land reserves (land use policy)	✓	
Personal qualification for the implementation of the WFD	✓	
Available staff resources for the implementation of the WFD	✓	✓
Weak translation of PoMs/RBMPs into distinct detailed measures	✓	
Insufficient bottom-up feedback mechanisms	✓	
Lack of prohibition of deterioration of the ecological status	✓	
Monetary evaluation of measures of success		✓
Current financial mechanisms	✓	✓
Lack of technical knowledge	✓	
Conflicts with other EU directives	✓	✓

Furthermore, drawing on insights from literature on European water governance (see, for example, Zingraff-Hamed et al., 2017b) and international experiences, we expected there to be differences between the types of bottlenecks ranked as important/relevant by survey respondents with an academic (and thus more research-oriented) background, and those ranked as important/relevant by respondents with actual experience in the field (water sector) and/or in WFD implementation.

Survey

We considered the list of bottlenecks shown in Table 1 to be the core item of our survey and we thus developed the survey questions in such a way as to deepen some of the aspects related to these barriers. We mainly followed the methodological approach taken by other surveys that have been conducted on WFD implementation, such as that by Carvalho et al. (2019). The survey design was developed by the co-authors in an iterative discussion process.

Survey form

The standardised multiple-choice questionnaire (Form A2) contained questions addressing the following ten items:

- Background information on the participants
- Self-identification of the academic or hands-on knowledge of the participants
- Evaluation of the country-specific expertise of the participants
- Self-assessment of knowledge about WFD implementation
- Potential conflicts or synergies between the WFD and other EU directives
- Role of the WFD in the improvement of Integrated Water Resources Management
- Identification of WFD implementation barriers
- Evaluation of the need for an increase in participation (public and sectoral) in order to successfully implement the WFD
- Evaluation of the need for stronger policy integration with the WFD
- The best approach to ensuring successful or effective implementation up to 2027 and beyond

The survey was set up online via the platform SoSci Survey and was offered in three languages: English, French and German. The survey form was activated on 23 September 2019 and closed on 31 October 2019. It required approximately 20 minutes to complete and was anonymous.

Contact dataset

We established a contact dataset of 330 scientists working on the WFD and on water or water-related environmental governance. Participants were selected on the basis of their publication record and their field of research. We particularly emphasised inviting at least five scientists from each EU member state and Norway (Table A3). In order to compare opinions from academia and practice, we added 202 German and 74 French staff members of the national and regional water agencies in charge of WFD implementation (Language limitations were responsible for our restricting of invitations to German and French practitioners). Individual invitations were sent via email between 23 September 2019 and 1 October 2019. Contacted persons received a reminder on 15 October and on 21 October 2019. This dataset of contacts represented only a starting point, however, and we invited those who were contacted to share the survey link with their colleagues; it was also shared on social media such as Twitter.

Participation rate

In total, 330 scientists and 276 staff members of water agencies were invited to participate in the survey. Overall, 130 respondents fully completed the survey (Figure 2), which is equal to a response rate of 21.5%; by comparison, the WFD fitness check had a participation rate of 0.5% (EC, 2019).

Participants with particular areas of expertise responded from all EU member states except Malta (Figure 3). We observed that an important part of the respondents’ expertise was gained through WFD implementation in Germany (47.7%), followed by the Netherlands and France (about 10% each). Interestingly, the country-specific participation rate of the WFD fitness check carried out by the European Commission also showed that Germany was over-represented (60%), followed by France (7%), Spain (6.3%), Austria (6.1%), Italy (5%), and the Netherlands (2.5%).

Figure 2. Respondent distribution considering a) their disciplinary background and b) their experience with the WFD.

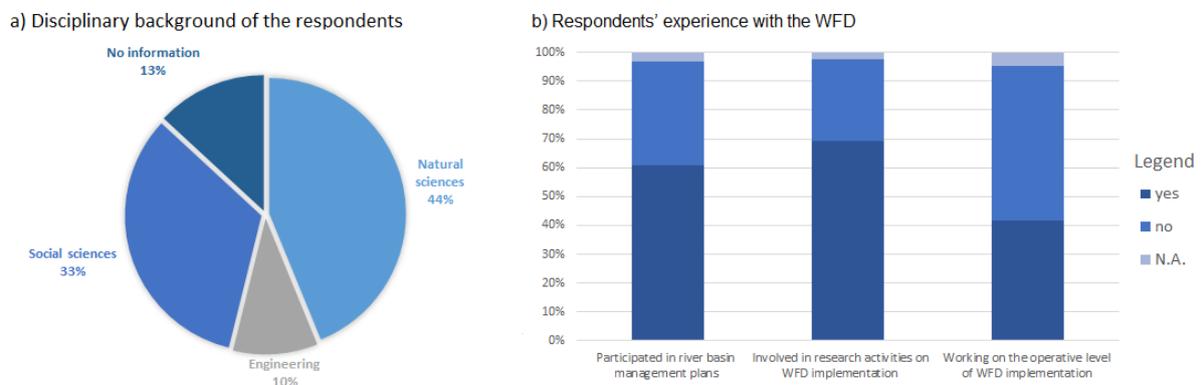
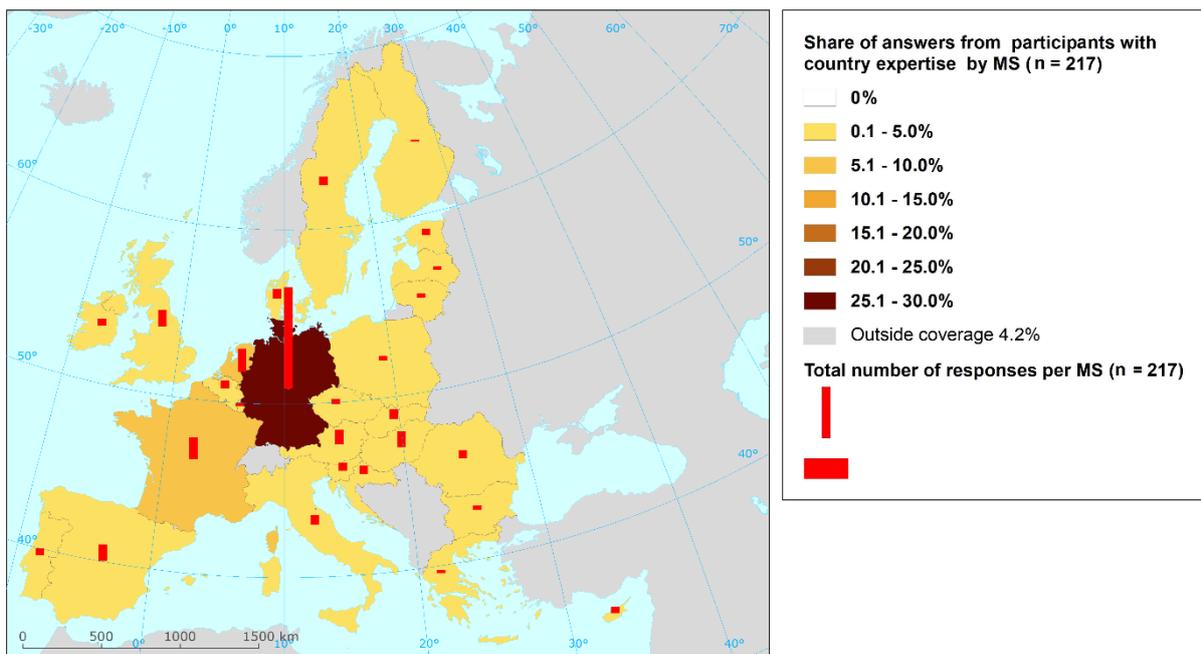


Figure 3. Coverage of member states among survey respondents (Map source: European Environmental Agency 2017, modified).



Participants’ disciplinary background was well balanced: 43.9% of respondents identified themselves as natural scientists (ecologists, hydrologists and biologists), 33.1% as social scientists (political scientists, lawyers and economists), and 10.0% as engineers. (The remaining 13.1% did not provide information on their scientific background.) We further checked for participants’ knowledge on WFD implementation: 93.1% of the respondents indicated that they were familiar with the implementation of the WFD; in comparison, only 35% of the respondents of the WFD fitness check that was organised by the EC identified themselves as ‘experts’. Participants’ knowledge can further be differentiated between those who have gained hands-on knowledge through real-life experience from involvement in the design of RBMPs or similar activities (60.8%), and those who gathered scientific knowledge from WFD-oriented research activities (69.2%). Among the respondents, 41.5% had knowledge on the operative level. Most of our respondents were water experts, that is to say, staff of water agencies as well as researchers in water policy, water management, water governance and river basin management. Around 30% of the respondents, however, had expertise in environmental law and governance, sustainable land use systems, landscape planning, political science, agricultural economics, and resource and land use.

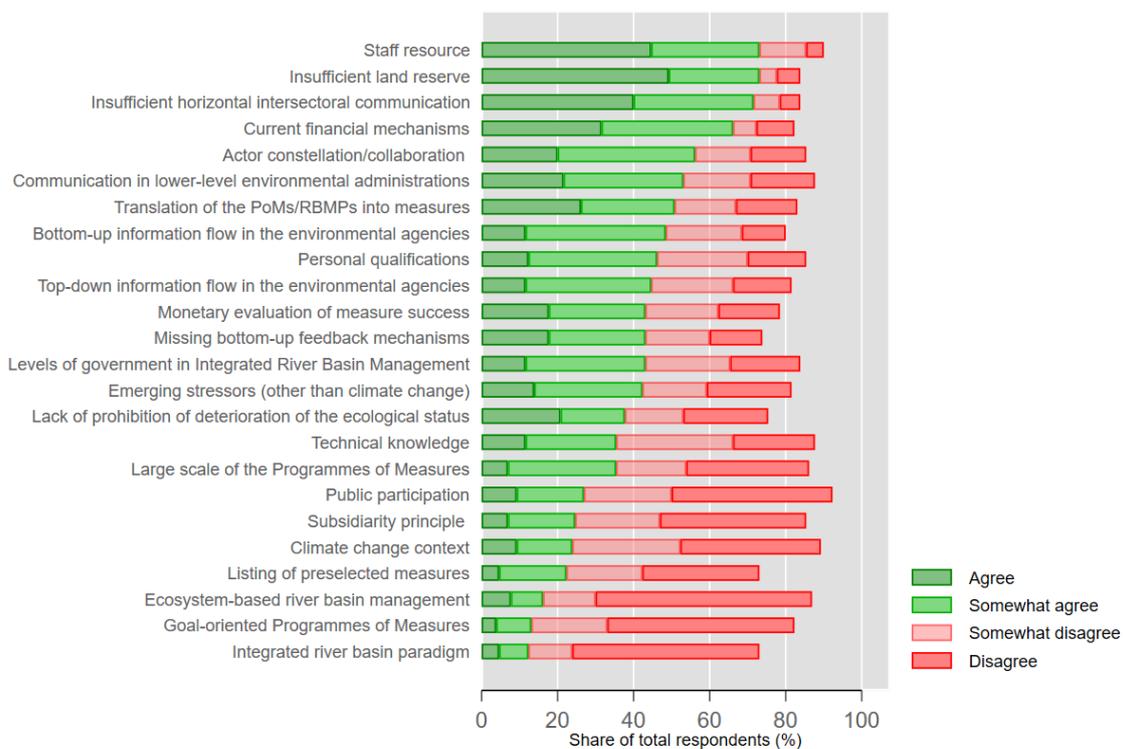
RESULTS

Ranking WFD implementation bottlenecks

The overwhelming majority of respondents (90.8%) agreed that barriers to the implementation of the WFD exist (only 3.8% disagreed and 5.4% did not answer this question).

In the subsequent part of the survey, we presented the list of potential barriers retrieved from the literature review and the authors’ own expertise. The respondents’ responses are shown in Figure 4.

Figure 4. Survey respondents’ agreement or disagreement as to the various possible barriers to WFD implementation.



Note: Data sorted by mean rank; PoMs = Programmes of Measures; RBMPs = River Basin Management Plans.

The highest-ranked barriers are insufficient staff resource and land reserves for implementing measures, lack of horizontal intersectoral communication, and problems with current financial mechanisms; more than 70% of the experts agreed, or somewhat agreed, that the first three aspects represented barriers to the effective implementation of the WFD; insufficient funding was regarded as a significant challenge by more than 66% of the respondents. While 15 of the 24 listed barriers were considered to be barriers for WFD implementation by at least 40% of the respondents, only 7 were identified as barriers by the majority of the respondents.

We found that, overall, there are only slight differences between respondents with hands-on knowledge and those with an academic knowledge base. When we combined the 'agree' and 'somewhat agree' answers, more than 50% of the respondents with hands-on knowledge identified the same four barriers: insufficient land reserves, lack of horizontal intersectoral communication, insufficient staff capacities available and financial mechanisms.

The top four

Over 70% of respondents agreed that insufficient land reserves were a barrier to the WFD. It is the barrier that is most often identified by respondents with hands-on knowledge (more than 80%), while it was mentioned only fourth most often by respondents with academic knowledge. One expert working in a German water agency noted in the survey form that "lacking possibilities to acquire land represents a crucial issue". Another German water agency staff member added that, "surrounding land use strongly impacts water bodies and, therefore, watershed management should be integrated". This point already relates to problems with horizontal intersectoral communication, another important impediment to effective WFD implementation.

A similar share of respondents (more than 70%) with hands-on and academic knowledge identified 'insufficient staff capacities' as the second most important barrier. One German water agency staff member stated that "lacking personnel at implementing authorities" is a significant issue. Another German expert further explained that there is a lack of "staff of water authorities [Wasserwirtschaftsäämter] tasked with the implementation and maintenance of measures [Arbeiter an Flussmeisterstellen]".

Interestingly, financial mechanisms were identified as a barrier by more than half of the respondents (70% of the respondents with academic knowledge and slightly less than 60% of the respondents with hands-on knowledge), with comments on funding relating to different aspects of implementation. One respondent with expertise in Spain referred to the "high cost for monitoring programs"; another expert familiar with WFD implementation in Italy stated that a combination of several aspects impedes the implementation of economic analyses, namely "lack of expertise" together with the "lack of resources" to get the expertise.

Lack of horizontal intersectoral communication is another important impediment to effective WFD implementation; it was the second most common reason given in the survey, with around 70% of respondents agreeing, or somewhat agreeing, on the hindrance it presented. Participants indicated that a lack of horizontal intersectoral communication is closely related to insufficient land reserves, assuming that the lack of integration of watershed management into surrounding land use practices is also due to poor or non-existent, intersectoral communication.

Surprisingly, experts also mentioned some issues that were not included in our initial list of potential barriers; most prominent among these was a "lack of political will" to implement the WFD. One expert who was familiar with implementation in Spain stated that, "political will is the biggest obstacle, there is no will to change business as usual". Another respondent with knowledge on the Scandinavian countries added that, "[t]he overall and main barrier is lack of political will or prioritisation to improve the environment". Experts from Germany criticised the lack of political will "to make unpopular decisions, e.g. compulsory land acquisition for renaturation" and "to make land users more accountable with regard

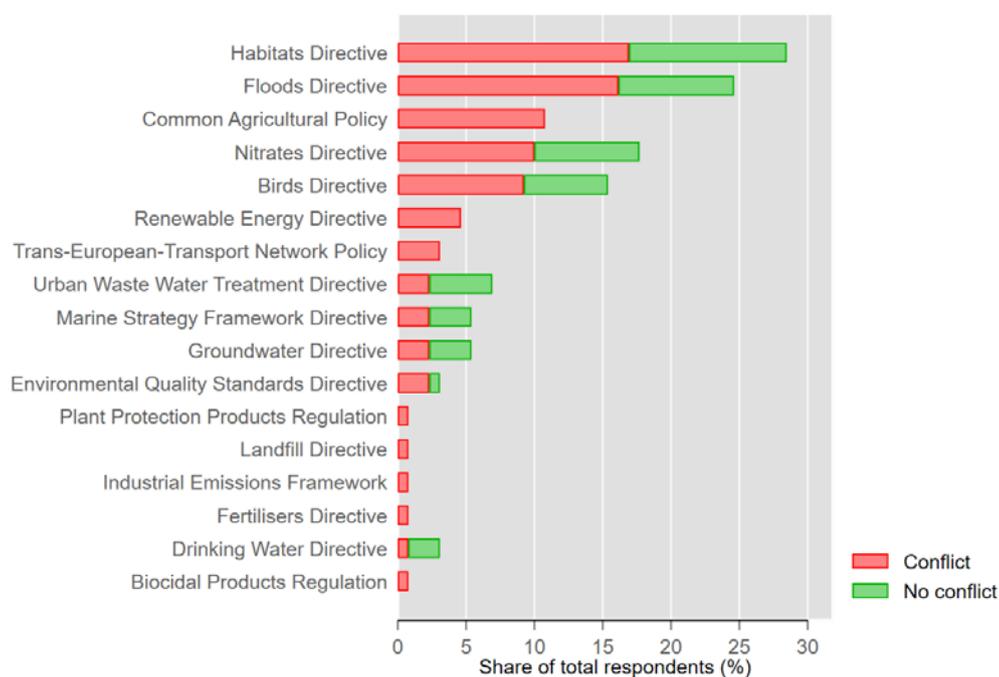
to water quality and waterbody structure". The voluntary principle inherent in the directive was mentioned frequently; a member of a German water agency stated, for instance, that, "the complete voluntary nature of measures with regard to water bodies of the third category represents a main barrier", while another expert added that, "municipalities are responsible for water bodies of the third category (small streams). However, measures are voluntary, which is the reason why nearly no measures are planned nor implemented despite significant funding offered by the state of Bavaria". The citing of a lack of political will is also often connected to the agricultural sector (see results in the next section on the conflict between agricultural policies and other EU policies). Finally, respondents referred to several other issues: complicated and overlong approval procedures, legal actions against measures taken by associations and private citizens, emerging challenges such as concern about droughts or contaminants, the general problem of path dependencies with regard to existing land use types, and issues of motivation ("as only the lowest grade is decisive, success is not visible and motivation drops to zero").

WFD and other EU legislation: Common Agricultural Policy unanimously seen as conflicting

We tried to shed some light on cross-sectoral issues by looking at the relationship between the WFD and other EU policies. Respondents' knowledge on EU directives other than the WFD was quite high (83.1%). When asked whether they agreed that other EU policies have an influence on WFD implementation, 70% of respondents agreed and only 9.2% disagreed. (The remaining 20.8% did not provide an answer.)

Respondents were further asked whether they see a conflict between the WFD and other specific EU legislation (Figure 5). Participants responded that they felt there were conflicts between the WFD and the Habitats Directive (16.9%) and well as the Floods (16.2%), Nitrates (10.0%), and Birds (9.2%) Directives; conflicts between the WFD and the Common Agricultural Policy (CAP) were mentioned by 10.8% of respondents. While some respondents mentioned synergies between these EU policies and the WFD, the majority emphasised conflicts; most respondents who denied conflicts, furthermore, did not provide any justification while respondents mentioning conflicts mostly provided explanations for their assessment.

Figure 5. Conflicts between the WFD and other EU legislation, according to survey respondents.



Interestingly, despite it being an environmental policy the Habitats Directive was most often referred to as being in conflict with the WFD; the Floods Directive was mentioned second most often as being partly in conflict with the WFD. Some of the respondents shared comments on the lack of clarity in the relationship between these three directives; one expert, for instance, stated that the "aforementioned [Habitats and Floods] Directives should actually have synergistic effects. Nevertheless, there are repeated conflicts of objectives, e.g. flood polders as protection measures conflict with the relocation of dykes and land-use adjustments". Another respondent also referred to conflicts in the implementation of the WFD and the Floods Directive (FD), stating that, "the objective of the Floods Directive is to protect human life and property and this is the objective which is very often in conflict of objectives of WFD which is the good ecological status/potential. It is necessary to set up priorities on [the] national level, and this is complicated as e.g. nature protection is in principle against FD measures but without any concrete argument. The consensus is done on [the] very local level based on communication with local stakeholders which is probably good, but it is very time consuming. And Directives' time frames become unrealistic to fulfil".

The Nitrates Directive was mentioned third most often, with respondents indicating a relationship to the WFD that ranged from synergy to conflict. A German expert with a legal background stated that the "link between environmental quality targets and emission limits or measures in other sectors is missing".

The CAP was clearly perceived as conflicting with the WFD. Respondents stated that "a lack of cross sectoral evaluations leading to sub-optimal measures being implemented, e.g. targeting phosphorus discharge from waste water in cases where agricultural runoff may be more important". The conflict between the CAP and the WFD is also perceived as a lack of the political will to change agricultural practices. "The key issue in my opinion is a lack of political will to restrict farming activities", a researcher from the Netherlands stated. A respondent from Ireland mentioned a "conflict between agricultural intensification policy and protection of water resources"; one from the Netherlands referred to the problem of "balancing between economy and ecology, certainly when agriculture is concerned"; a Spanish respondent mentioned the "perverse incentives coming from other (stronger) policies such as CAP"; and a Dutch respondent hinted at the issue of the strong agricultural lobby.

In addition, the Renewable Energy Directive and the Trans-European Transport Network (TEN-T) policy were assessed as conflicting with the WFD; respondents commented for example that, "the WFD is only binding for enforcement agencies. However, this is not directly the case for third parties such as hydropower plants. Related to this aspect are issues with the improper use of exemptions Article 4.7 ('overriding public interest') is used too easily, e.g. with regard to flood prevention measures".

Furthermore, there are also problems of enforcement; a German researcher, for instance, criticised the "lack of control of [legal/policy] requirements [Auflagen]". In the case of Bavaria, a water practitioner referred to the problem of "existing hydropower plants with unlimited water rights", commenting that most of them "lack passages for fish or existing passages do not function properly".

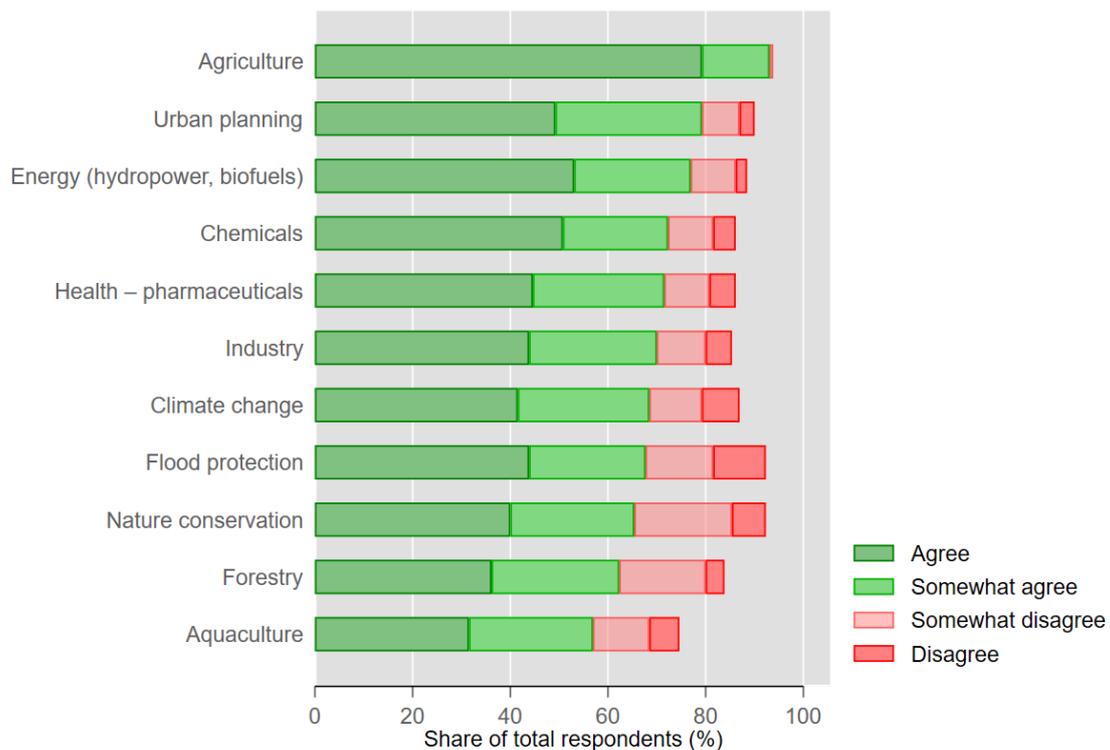
When looking at EU conservation policies (the Habitats Directive and the Birds Directive), one expert noted that it is "not necessarily [that] the directives are in conflict, but the policies and the actions derived practically block WFD implementation in several fields". Another respondent added that, "many of the directives I am familiar with can support the targets set by the WFD (e.g. Marine Strategy Framework and Habitats Directives). It depends on their implementation". Some experts provided more detailed explanations for these implementation conflicts; one expert, for instance, pointed towards problems in the transfer of directives into policy measures by stating that, nature conservation directives, the Renewable Energy Directive as well as the Nitrates Directive can cause problems in implementation because their approaches are different and wordings are not always clear. Also, the types of instruments are not well coordinated.

Another respondent pointed towards the issue of "different bodies [that are] responsible for implementation, [of directives'] different timelines and priorities". One expert provided an example of

issues with non-equivalent timelines by stating that, "the [Dangerous] Substances Directive requires biotech monitoring on new substances in 2013 with the same ambition level for the substances listed in Decision 2455-2001-EC [of the Environmental Quality Standards Directive]". Finally, one respondent indicated that issues in funding were a reason for implementation conflicts, stating that, "the [directives] I know are coherent, the conflict is in European Funds (mainly CAP, that should ironically respect and contribute to WFD implementation but goes against it)".

We further asked respondents about the extent to which they agreed that certain policy fields needed stronger integration with the WFD; response patterns (Figure 6) show a very high agreement with the ones presented above. Most respondents agreed that agricultural policy needed stronger integration with the WFD (93.9% approval); the approval ranking was second-highest for the energy sector (88.5% approval) and third-highest for urban planning (90.0% approval). Disagreement was highest (10 to 30%) with respect to stronger integration of flood protection and nature conservation policies with the WFD; this is also in line with previous findings.

Figure 6. Policy fields which, according to survey respondents, need stronger policy integration with the WFD.



Multiple decision pool: cross-sectoral stakeholder constellations and public participation

We asked participants for their opinion on two potential areas for implementation improvements: the involvement of actors/stakeholders from non-water-related sectors, and public participation. As a starting point, we asked respondents how they evaluated the current cross-sectoral involvement in the implementation of the Programmes of Measures (PoMs) which must be elaborated upon for each cycle of the WFD; nearly half of the experts (46.9%) stated that such involvement is missing while only 3.9% of experts rated the involvement as good and 31.5% regarded the current involvement as sufficient; in short, the majority of respondents agreed that there was a need for improvement.

We further asked participants at which level they saw the greatest need for increased effort with regard to sector integration and public participation (participants could choose only one response option per aspect). Responses on sector integration (Table 2) show that the highest share of experts (21.5%) saw policy design at the national level as being in greatest need of improvement; this was followed by local measure implementation (18.5%), and regional planning instruments (16.9%). According to 7.7% of respondents, all levels should be addressed, and a comparatively smaller share of the respondents (6.9%) saw a potential for increased sector integration at the EU level. Only 2.3% of experts did not see a need for better integration.

Table 2. Perceived need for better sectoral integration and public participation.

	Sectoral integration (share of respondents in %)	Public participation (share of respondents in %)
Policy design at the national level	21.5	0.8
Local measures implementation	18.5	35.4
Regional planning instruments	16.9	14.6
RBMP/PoM development	11.5	11.5
Policy design at the EU level	6.9	1.5
No need for integration/participation	2.3	15.4
Other levels	8.5	1.5
No response	13.9	19.2

Note: RBMP = River Basin Management Plan; PoM = Programme of Measures.

Insufficient public participation was considered to be more of a problem by practitioners (40%) than by respondents with academic knowledge (20%); one German practitioner explained that, "stakeholders are not sufficiently integrated in each implementation step (problem definition, identification of measures, evaluation of measures, monitoring). Consequently, participative decision-making is not adequately used, and even rejected". The highest share of respondents saw the greatest need for increased public participation in the implementation of measures at the local level (35.4%); this was followed by regional planning instruments (14.6%). The second-highest share of respondents (15.4%) did not see any need for increased public participation (Table 2); 11.5% of the respondents saw the need for increased participation at the river basin scale, in RBMP and PoM development. Public participation in the designing of policies at the EU or national level was perceived as being of little importance, at 1.5% and 0.8%, respectively.

Best approach for continuing WFD implementation

Respondents were subsequently asked for their opinion as to which approach should be taken for continuing the ambitious WFD implementation up to and beyond 2027; more specifically, we presented a list of potential approaches as found in the literature, and asked respondents to make a choice (multiple answers were allowed). Most experts stressed the need to link water with other policies at the EU and regional levels (58.5%) (Table 3); improvement in cooperation between water-related authorities and organisations was ranked second (46.2%); this was followed by the promotion of nature-based solution implementation (40.8%), the involvement of the general public as well as communities at the planning stage (40.8%), and the integration of cross-scale participation and cooperation (40.0%). Less than 40 percent of respondents stressed the need to either 1) implement more radical and combined measures (39.2%); 2) implement sustainable and appropriate mitigation measures (37.7%); 3) promote integrated RBMPs (37.7%); 4) improve governance organisation (37.7%); or 5) combine conservation and restoration

goals (33.9%). Only 21.5% expressed the need to increase the number of projects and 14.6% felt the need to improve synergy in policies.

Table 3. Preferred approaches to continued WFD implementation.

	Share of respondents (%)
Link water with other policies at the European and regional levels	58.5
Improve cooperation between institutions	46.2
Promote implementation of nature-based solutions	40.8
Involve the public and communities in planning	40.8
Integrate cross-scale participation and cooperation	40.0
Implement more radical and combined measures	39.2
Implement sustainable and appropriate mitigation measures	37.7
Promote plans for Integrated River Basin Management	37.7
Improve governance organisation	37.7
Combine conservation and restoration goals	33.9
Increase numbers of projects	21.5
Improve policy transfer	14.6
Other	15.4

Respondents also named several other approaches which strongly overlapped with the bottlenecks that had been identified earlier by respondents; they primarily asked for sufficient funding and more personnel and stressed the need for more obligatory (rather than voluntary) measures. The need for stronger political will was also emphasised as being necessary for the achievement of ambitious targets.

DISCUSSION

The adoption of the EU WFD in 2000 has been an important turn in European water governance and river management. It demands that all water bodies of the EU member states uniformly achieve a good ecological status or potential, depending on their classification as natural or artificial; it further specified that this should be achieved by integrated management and communication among stakeholders at the catchment level. The most recent report of the European Environment Agency, however, showed that in the almost 20 years since implementation of the WFD in 2000, the ecological status of water bodies has changed little (EEA, 2018). In this study, we investigated why the WFD has failed to improve the quality of our surface water bodies despite it being one of the most ambitious environmental directives worldwide, and despite having undertaken considerable efforts over the last two decades. We particularly investigated the possibility of governance bottlenecks being the problem. As the results of our survey among academics and practitioners confirmed, a wide variety of factors have contributed to implementation deficits; we will discuss their governance dimensions below.

Importance of, and interdependencies between, barriers

The results of the survey show that almost all participants (more than 90%) agreed on the existence of WFD implementation bottlenecks; the recognition of this problem is itself a first step towards a solution. Despite the survey having a limited reach and short duration, a high number of responses was received; many of the respondents also surprised us with detailed feedback and examples and shared extensive

and substantial knowledge and interest in the underlying reasons for insufficient WFD implementation. We took from this that many academics as well as staff of water agencies (practitioners) were interested in the problems of WFD implementation. The number of text comments provided by respondents added significant further qualitative value to the survey responses by providing more detailed information on respondents' assessments of WFD implementation. The respondents ranked the four main barriers to WFD implementation as (in order of importance): 1) insufficient land reserves, 2) problems relating to horizontal intersectoral communication, 3) insufficient available staff resource, and 4) problems with financial mechanisms, especially lack of funding. The ranking of these barriers by the survey respondents, together with the additional information provided by them, resulted in important new insights on the perceived current relevance of implementation barriers in many EU member states.

As stated above, one bottleneck for WFD implementation according to the ranking in our survey was 'insufficient land reserves'; in the scientific literature we reviewed in advance of the survey, this was not emphasised as being one of the most important barriers. The qualitative answers of the respondents enabled us to draw the link between this bottleneck to WFD implementation and both pollution reduction and morphological river restoration. First, according to the results of the water bodies assessment in 2018, the major pressure on water bodies is diffuse and point-source pollution; because of the often-high opportunity costs of land use, management measures aimed at decreasing the concentration of pollutants in water are seldom realised if they require more land and/or land use changes. Second, according to the concept of 'more room for the river' ('Flusskorridore' and 'espace de liberté', e.g. described by Guzeli et al. in 2020), re-establishment of river functions and related biodiversity requires sufficient space to allow for the necessary river dynamics. Particularly in the mid-1900s, rivers were often forced into narrow and artificially stabilised channels in order to gain new land (mostly for urbanisation and agriculture), avoid flooding, increase the channel gradient for hydro power generation, and/or secure human health; unfortunately, this also led to large-scale destruction of aquatic and water-dependent habitats (Walsh et al., 2005). To achieve WFD ecological goals, water agencies often have no alternative but to purchase expensive plots of land in order to achieve morphological river restoration (Wiering et al., 2018). One explanation for the high ranking of the barrier 'land reserves' may be that a high percentage of the respondents were water authorities staff working at the local level and focusing on morphological river restoration; lack of land reserves is perceived by the respondents as a "killer challenge for implementation" even if it was not related to WFD design per se. If agricultural land is at stake, prices are usually driven up by the EU CAP, particularly direct payments; this results in high opportunity costs for farmers when selling the land or designating it as a flood plain; it can further be argued that plots close to rivers are often very fertile, promising high yields and good farming income and thus driving up land prices. In the case of urban or economic development areas, the situation may be even worse and prices for land much higher. The WFD implementation barrier 'lack of land reserves' is thus interrelated with other identified bottlenecks such as 'lack of funding' and 'lack of horizontal sectoral communication'; the latter is important since the required land use changes are usually not in the area of responsibility of water agencies but are rather the responsibility of landscape planning authorities that decide on the availability of land reserves for, for example, urban expansion or river restoration. Local governments can integrate a water agency's land need into land use and regional development plans, but this requires intersectoral communication. Voluntary land reallocation may represent a promising tool for obtaining public land for restoration purposes; in that regard, alternative governance models – including collaborative planning – have already been discussed and successfully implemented in different political contexts (Warner et al., 2012). Overcoming this barrier thus requires horizontal intersectoral communication between water experts, landscape planners, agricultural administration and the private sector (Kochskämper et al., 2018). Lack of intersectoral communication has been identified as an important barrier to implementation of the WFD, thus illustrating the complex interdependencies between different WFD implementation bottlenecks.

Another barrier to implementation of the WFD is the lack of current funding mechanisms. Staff of water agencies mentioned that much more money is needed to implement measures such as buying additional plots of land. The limits of the existing financial mechanisms have already been identified as a challenge for WFD implementation (Farmer, 2011; Grygoruk and Okruszko, 2015; Hermans, 2010), including the latest WFD fitness check (EC, 2019a, 2019b). The WFD does not have its own designated EU funding scheme or budget for implementation; it is integrated into the budget of the EU LIFE financing instrument. EU LIFE accounts for about 10% of available funding for WFD implementation; this is a relatively small amount compared to what the EU spends through CAP or through regional disbursement of funds, which could also be made available for WFD implementation. Interestingly, the European Court of Auditors (ECA, 2014) highlighted that while an important part of the European Agricultural Fund for Rural Development (EAFRD) is earmarked for water protection efforts, the portion of the budget that targets water-related issues has not been spent because of lack of funding requests. As a result, WFD implementation depends on financial instruments in other sectoral policies where, again, horizontal intersectoral communication has been identified as a barrier to the implementation of the WFD.

The lack of horizontal intersectoral communication appears also to be the major bottleneck in relation to land availability and funding. This barrier is not only a lack of formal integration of policies from different sectors, it refers also to direct communication between the sectors and their related stakeholders. It would be necessary to improve the quantity and quality of communication in order to discuss both the areas and topics that can be integrated and the implementation of measures. Various levels of administration and various sectors have started to communicate more systematically in the course of WFD implementation, through the establishment of river basin stakeholder settings like round tables or similar fora. These are often not really effective, however, as they tend to mirror current power asymmetries among sectors and thus often do not interact on 'equal terms' (Theesfeld and Schleyer, 2011). Intersectoral communication is time-consuming and requires participants to practise multidisciplinary communication techniques, especially if the communication has not yet been formalised through institutional structures such as mandatory regular working groups or interdepartmental coordination.

Lack of staff capacity has also been identified as one of the greatest barriers and thus may represent another important bottleneck to WFD implementation. Staff capacity can be improved through the allocation of more funds by national governments. Qualifications, however, are of greater importance than the number of people working on the task, and survey respondents also ranked insufficient qualifications of WFD-related personnel as a potential bottleneck. While universities have an important role to play in this respect, water agencies should also encourage ongoing qualification programmes and long-term education of staff on, for example, communication tools. The rapid staff turnover in some water agencies (for example, of county administrations) also undermines staff qualifications and the quality of communication. Finally, intense intersectoral cooperation can define polycentric governance models. Experience shows that so-called polycentric governance models – which are necessary for effective WFD implementation – require a high level of trust between stakeholders (Zingraff-Hamed et al., 2019); this trust level is hampered by a high staff turnover.

Lack of the horizontal intersectoral communication that is needed in order to claim the funding and land necessary for WFD implementation, combined with the high turnover of stakeholder representatives, constitutes a weakness that translates into a bottleneck. The result of this lack of communication and impermanence of stakeholder representatives is inefficiency and/or significant delays; it is not, however, a characteristic of the system itself.

Conflicts and synergies between EU policies

Article 11 of the Treaty on the Functioning of the European Union states that, "Environmental protection requirements must be integrated into the definition and implementation of the Union policies and

activities, in particular with a view to promoting sustainable development" (EC, 2012). Results of the survey, however, show that stakeholders acknowledge conflicts between the WFD – aimed at achieving ecological quality standards – and other EU policies and programmes. Sectoral objectives and interests are usually manifested in such specific sectoral policies as, for example, water-related (environmental) objectives, and sectoral interests are similarly formulated and pursued within the WFD. EU objectives that conflict with other policies that affect water management require particularly well-designed and effective governance mechanisms at all levels if they are to manage the interdependencies between (often diverging) sectoral objectives and interests. Polycentric governance is a comprehensive and smart way to approach the intersectoral communication and negotiation that is necessary to reduce potential conflicts and create innovation (Zingraff-Hamed et al., 2019). The WFD, in principle, is designed to facilitate those cross-sectoral interactions and communications; it can thus serve as a sort of boundary policy (Schleyer et al., 2015) enabling discussions and negotiations within the water sector and with other sectors; what we find in practice, however, and what was confirmed by the survey respondents, is that there is a lack of effective, inclusive and equal cross-sectoral communication and interaction. There is, of course, a broad range of governance mechanisms available that have the potential to approach and eventually mitigate conflicts between sectors and related policies; indeed, there are good examples that have already been applied in the context of WFD implementation (Jager et al., 2016). It is beyond the scope of this paper, however, to present and discuss concrete options. We argue instead that, first, finding the most productive and effective forms and combinations of governance models is a complex and dynamic learning process for all involved stakeholders; we further argue that discovering such a diversity of forms is an 'empirical' process that should be embraced and fostered. Second, polycentric governance mechanisms are characterised, almost by definition, by complex governance and policy constellations; they are thus where conflicts need to be addressed and synergies explored. Below, we highlight some of the more prominent conflicts and synergies between EU policies which affect WFD implementation. The lack of sector involvement at the policy level was already identified during the first WFD fitness check (EC, 2019b) and by scientists (IGB, 2019; Carvalho et al., 2019), and was reconfirmed in the second fitness check. Survey results showed that there were three EU policies/directives whose implementation was perceived as strongly conflicting with WFD implementation; five other EU policies/directives, when they are implemented, are expected to be in both conflict and synergy with the WFD (EC, 2019a).

The CAP and the Nitrates Directive, first of all, have been pointed out by our respondents as particularly conflicting with the WFD. Removing diffuse pollution is one of the greatest challenges of reaching many of the WFD objectives since water quality is the baseline requirement for ecological quality. The CAP – in particular the direct payments in Pillar I – has a great influence on the amount of fertilisers and pesticides used on crops and the resulting pollutant inflow into water bodies. CAP reform in 2013 (for the period 2014 – 2020) set ambitious goals for integrating water policy objectives; however, according to the European Court of Auditors (ECA) report entitled *Integration of EU water policy objectives with the CAP: a partial success* (ECA, 2014), new CAP instruments designed to address agri-environmental issues contribute little to meeting WFD objectives. The ECA observed that regional development programmes are not well aligned with River Basin Management Plans, a situation which sometimes causes negative side effects (*ibid*). With respect to cross-compliance, one of the weaknesses is that important water-related issues are not yet – or not sufficiently – included; an example is the requirements for farmers to limit the use of phosphorus on their land and the application of pesticides in the immediate vicinity of water bodies. The ECA also frequently observed breaches of water-related cross-compliance requirements at the farm and land level; this resulted in, for example, nitrate outputs being higher than 170 kg/ha in nitrate vulnerable zones (*ibid*). Another weakness is that sanctions are not calculated based on the cost of the damage caused; the calculation of such damages is complex, mainly due to the problem of estimating the value of mostly non-marketable ecosystem services reduced by short- or long-term pollution. Another weakness is that certain requirements, such as the size of buffer

strips, are fuzzy and vary between EU member states. The CAP's reluctance to account for farming-induced water problems is related to the lack of the political will and resources to act positively for the environment if requirements oppose agricultural interests. Further integration of EU agricultural policies with the WFD is hampered because of a divergence among policy makers in terms of policy goals and ideology (Schaub, 2019; Meergans and Lenschow, 2018; Vogeler et al., 2019).

Two other EU policies were also recognised by the respondents as being in substantial conflict with the WFD objectives: the European Renewable Energy Directive (RED) and the TEN-T policy. The RED sets country-specific, overall quite ambitious, targets for all member states concerning the share of energy that should come from renewable resources by 2020. The directive thus promotes, among other things, the development of hydropower. Renewable energy is generally perceived as being a nature-friendly energy source; hydropower, however, on the one hand addresses the energy security problem in the context of the Kyoto Protocol, and on the other hand is seen as massively degrading river ecosystems and local biodiversity (Abazaj et al., 2016). The objectives of the RED and the WFD should be achieved in a mutually supportive manner through – instead of building new hydropower plants – modernising and upgrading existing infrastructure in order to increase productivity and decrease environmental impact. Similarly, the TEN-T policy seeks the further channelisation of rivers to increase their navigability; in order to mitigate conflicts between authorities planning RBMPs and those developing the TEN-T programme, collaborative planning and intersectoral coordination is necessary.

Some respondents identified directives aiming at environmental protection as having potential synergies with WFD objectives; these included the Habitats, Birds, Nitrates, and Marine Strategy Framework Directives. The majority of the respondents, however, also mentioned conflicts, an analysis of which showed that the various directives are not necessarily perceived to be in conflict at the level of objectives; it seems instead that they conflict as soon as they are put into practice, and that it is less the design of the directives, and more some of the policy measures derived from the directives, that inhibit reaching WFD objectives. These conflicts constitute both an opportunity and a challenge, for both policy-making and research, to identify underlying trade-offs and to develop approaches and measures that will address and manage them. The 1991 EU Nitrates Directive (ND), for example, aims at monitoring and reducing nitrate contamination in water bodies since it is a serious threat to ecosystems and human health. While we expected a strong synergy between the WFD and the ND, respondents instead perceived there to be a conflict between them; we assume that, rather than the problem being the objectives and design of the directive, the respondents' perceptions were based on the weak implementation of the ND. Studies at the European level showed that, since its beginning, the implementation of the ND has been severely behind schedule (Goodchild, 1998); furthermore, after almost 30 years, ND implementation still faces major weaknesses, an example of this being Italy's Lombardy Plain where water monitoring has shown an increase of nitrate concentration since 2008. This failure of the ND to maintain its schedule of nitrates reduction is not an isolated case (Musacchio et al., 2019); in 2013, eight EU member states failed to implement the ND because they had not designated nitrate vulnerable zones or monitored nitrate concentrations in groundwater to find where they exceeded the 50mg/l limit for safe drinking water. According to the ND, nitrate inflows must be reduced and local governance has a key role in enforcing rules and implementing systematic control; furthermore, as shown by the ECA, stakeholder information and education may be key for reducing pollutant inflows (ECA, 2014). The conflicts with the Habitats and Birds Directives are more complex; they result from weak harmonisation of objectives between those directives and the WFD: the Habitats and Birds Directives are aimed mainly at species conservation, while the WFD targets habitat restoration. Restoration and conservation conflict in many ways (Dobson et al., 1997); indeed, some man-made habitats such as water reservoirs offer habitats for a few protected species such as birds, but present a major obstacle for many other species such as migratory fish. Another example is the dry grassland on old riverbanks that have resulted from the channelisation of freshwater bodies; in such settings, the riverbank has dried up due to river incision and now temporarily hosts protected plant species such as orchids (Egger et al., 2019).

From the perspective of the Habitats and Birds Directives, the morphological restoration of such a channelised river should be restricted since it would affect a protected habitat. The incoherence between these directives is made visible through research on governance aspects; examination of these bottlenecks provides an opportunity to clarify the goals of EU policies.

Finally, the Floods Directive has also been recognised as partly conflicting with the WFD. The text of the directive itself contains many potential synergies with the WFD; however, this would require coordination with land use planning and the development of RBMPs and should include, for example, agricultural or forestry activities that can be altered to increase the retention capacity of a riverine area; furthermore, such an approach could benefit from accessing EAFRD funding.

In summary, the analysis of policy conflicts has revealed that several policies conflict with the WFD and that compromises must be found in terms of their prioritisation and facilitation. The policies under scrutiny have high synergetic potential with respect to the WFD, but their often-weak implementation can lead to conflict; respondents identified the cause of their weak implementation as being a lack of intersectoral communication and of political will, especially considering the integration of the WFD aims into agricultural and hydropower-energy policies. Stronger EU policy integration had already been suggested as a way to address present and future water challenges (Kirschke et al., 2019). While some researchers have suggested that sustainability should be driven by a nexus approach to policy on water, energy, climate, food and natural resources (Benson et al., 2015) other studies have shown that integration per se does not necessarily improve policy performance (Tosun and Lang, 2017); moreover, research also acknowledges that the WFD is only a 'soft' tool which very much depends on political will for its implementation (Hermans, 2010; Hovik, 2019); accordingly, prioritisation of the objectives of certain directives may have a stronger impact on their implementation than integration, even though this may come at the risk of creating winners and losers in the integration process. Another and more resilient path to ensuring better integration between these different policies is an increase in collaborative planning, with involvement of all relevant stakeholders in decision-making processes (Mollinga, 2008), and in the coordination – and ideally collaboration – between sectors and organisations; such increased collaboration would include inter- and transdisciplinary partnerships between academics, policymakers and practitioners (Waylen et al., 2019). De Vito et al. (2020) provide examples of interconnected governance structures that are able to adopt stricter measures than are fragmented institutions.

Intense collaborative planning between stakeholders

In line with the scientific literature which sees the integrated river basin paradigm as a great strength of the WFD (Giakoumis and Voulvoulis, 2019), only a few respondents saw this as a barrier to WFD implementation. Notably, considering the WFD (§ 14) demand for active stakeholder involvement and participatory processes at the river basin scale (RBMP and PoM development), only 11.5% of respondents saw the need for increased participation at that level; this could mean that respondents were satisfied with the intensity of collaborative planning at this level. Survey results showed that the cross-sectoral stakeholder constellation should be improved at the national level, specifically to improve the design of the respective policies. A collaborative policy-making process requires adaptation of national water governance in order to achieve high quality polycentric governance where all organisations are represented and where there is strong governmental leadership (Zingraff-Hamed et al., 2019). In such a negotiation process, environmental agencies have been identified as having a major role to play as leaders and facilitators of interests (Clare, 2011).

Our survey results show that the cross-sectoral stakeholder constellation should also be improved at the local level in order to ensure effective implementation of measures. Respondents also highlighted a need for more public participation at this level. Regional water authorities, based on hydrological scales, have the power to decide on the measures and how to implement them; however, the lack of a deliberative culture and the existence of weak governmental leadership was identified by the

respondents as being a strong barrier to an effective participatory process. Practitioners more than researchers, interestingly, regard aspects related to participation of civil society as being problematic. Our review of the literature suggests that compulsory public participation is a strength of the WFD but that it should be improved if implementation is to improve, as it is often limited to what is legally required in terms of dissemination of information and formal consultation (Giakoumis and Voulvoulis, 2019; Gourbesville, 2008). Public participation is often associated with high project acceptance, and studies show that the right to participate and the number of organisations or interest groups represented is a key success factor. Accordingly, the absence of some key stakeholders may explain the participants' dissatisfaction with the designed measures (Parés et al., 2015).

No European one-size-fits-all solution will suit the organisation of increased quantitative and qualitative sectoral cooperation; it could be a start, however, that the synergetic effects are already being considered at the EU level and that intersectoral cooperation is required for implementation of directives. The fact that participants at the river basin scale remained largely powerless was a key reason for the disappointment expressed with regard to WFD implementation. As highlighted by our survey and our analysis, the call for a stronger connection of participation with real power in planning and implementation is decisive for the development of new concepts like living labs or real world labs (Rogga et al., 2018; Jahn and Keil, 2016). Another related governance issue could be the empowerment of river basin authorities to satisfy the expectations generated and expressed in participatory processes (Jager et al., 2016). River basin authorities provide the local knowledge that supports authorities at other levels, an element which may also increase cost-effectiveness (Graversgaard et al., 2017). Importantly, more coordination will necessarily require more financial and human resources; in particular, cross-sectoral cooperation often demands more resources than sectoral cooperation as the actors 'speak different languages' and thus building trust takes time and effort. Top-down incentives to initiate national cross-sectoral cooperation appear appropriate, however, with the particulars of how cooperation is arranged being assigned to the different national identities; the appropriateness of this approach is supported by our results, which show the greatest needs for integration as being policy design at the national level and implementation of measures at the local level.

Research limitations

Our research includes certain limitations. First, our analysis explicitly addresses the governance dimension of WFD implementation; that is, it turns a somewhat blind eye to other dimensions of WFD implementation (and their related shortcomings). While acknowledging the work of other scholars on analysing implementation challenges from a natural sciences perspective (Carvalho et al., 2019), our analysis concerns itself particularly with governance challenges; it contributes to a holistic and integrated picture of all the governance challenges faced in the course of implementing the WFD, which must be addressed in an informed and integrated manner across different perspectives.

The second limitation of this paper is its particular focus on the implementation challenges that were identified in the literature as being most crucial: insufficient land reserves, a lack of horizontal intersectoral communication, insufficient staff capacities, and inadequate funds. Acknowledging their integrated nature, however, we do provide an integrated analysis of those challenges in later chapters.

Third, from a methodological perspective one could argue that the 36 publications selected for a detailed literature review do not represent the entire broad perspective on the WFD and the challenges relating to its implementation. As described above, however, we do consider the selected publications to provide insights into governance-related challenges that are sufficient (and sufficiently targeted) for guiding the analysis that builds on them. With regard to methodology, we also acknowledge a bias in the selection of survey recipients and survey respondents; in spite of a clear focus on Germany, the Netherlands and France, however, we believe that the results generated by the surveys and the

recommendations derived from them are sufficiently generalisable to the EU as a whole as well as to other individual EU member states.

Finally, it is important to note that this survey is largely reporting on the perceptions of bottlenecks rather than investigating the underlying mechanisms of, and/or theories about, why there is ineffective implementation of the WFD. For this, more theoretical work and more testing of different governance theories would be required. The discussion is mostly based on the assumption that many of the bottlenecks identified could be overcome or mitigated; from the empirical survey results, however, we cannot deduce an optimal way to resolve the conflicts we identify as this is beyond the scope of this research.

CONCLUSIONS

The adoption of the WFD in 2000 has been celebrated as a milestone in European and even international water resources management and protection. Even so, while important achievements have been made, severe implementation shortcomings persist; these are largely expressed in the lag between the ambitious goals of the WFD and the actual quality of waterbodies. As the governance and institutional dimensions of such shortcomings have received limited scholarly attention so far, this article has set out to bridge this gap; through questionnaires for scientists and practitioners, and inputs from a literature review, it investigated 1) which governance-specific and institution-specific shortcomings persist, 2) whether there is an emerging consensus on which of them are the most relevant, and 3) which changes would be required for overcoming, or at least mitigating, the shortcomings and thus ultimately improving the effectiveness of WFD implementation.

It is, first of all, important to note that there is considerable agreement among experts – both those involved in WFD implementation and those with a more academic perspective – about which bottlenecks are the most crucial when it comes to shortcomings in WFD implementation: insufficient land reserves, lack of intersectoral communication and integration, insufficient staff capacities and inadequate financing. The study identified that weak implementation is rooted in a combination of the lack of the horizontal intersectoral communication that is needed in order to claim funding and land, and that is hindered by the transitory nature of stakeholders. Rapid turnover is also a bottleneck – even if not a characteristic of the system itself – because it causes congestion in a system as well as inefficiencies or significant delays. It is important to note, as well, that these are largely aspects that do not feature prominently in academic research on WFD implementation; this reconfirms our suggestion that the governance dimension of WFD implementation merits more attention.

Second, conflicts between different EU directives (and other issue-specific legislation) are also bottlenecks to effective WFD implementation. Better integration between EU directives would be the best approach to continued WFD implementation. It has been argued by many scholars that a nexus approach for water, energy, climate, food and natural resource policies can achieve sustainability and stronger implementation. While the European Commission has already started integrating EU policies, it may be time for a more strongly integrated WFD, one which regulates all aspects of water governance at the river basin level, including environmental quality, energy production, and land use standards. Integration per se, however, does not necessarily improve policy performance. The research identified five changes that are urgently needed in order to bring about a more efficient EU policy integration: 1) diverging policy goals – as in the case of the CAP and the WFD – should be prioritised and homogenised; 2) directives should provide for better alignment between the instruments, which is to say between regional development programmes and River Basin Management Plans, and between River Basin Management Plans and the Trans-European Transport Network development plan; 3) the WFD, the CAP and the ND should include stronger rules for addressing water-related issues; 4) the weaknesses of the EU directives should be urgently corrected, for instance the European Renewable Energy Directive should request the renewal of hydropower plants in order to meet environmental goals instead of accepting the

construction of new ones; 5) sectoral-level EU policies should find a way to respond to the WFD's aim of stimulating intersectoral collaboration. It is, however, beyond the scope of this empirical survey of perceived bottlenecks to assess an optimal way to resolve the conflicts between EU directives.

Third, the paper highlights the need for intersectoral communication and integration at all levels from river basin to local. This reconfirms previous findings on the importance of cross-level integration; it also, however, highlights other challenges (such as staff capacities, including communication skills) that are required for such cross-level integration.

These findings also highlight the ample room that remains for further scholarly research. Among other things, there needs to be a more detailed exploration – through in-depth, qualitative studies – of the exact nature of individual governance-related and institution-related bottlenecks and their influence on overall implementation shortcomings. At the same time, further analysis is warranted of the interdependencies and potential vicious circles between different bottlenecks. Comparative studies (across geographic regions, governance scales and/or bottlenecks) can then help to ascertain specific findings, potentially also providing the basis for more insightful policy recommendations.

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REFERENCES

- Abazaj, J.; Moen, Ø. and Ruud, A. 2016. Striking the balance between renewable energy generation and water status protection: Hydropower in the context of the European Renewable Energy Directive and Water Framework Directive. *Environmental Policy and Governance* 26(5): 409-421.
- Adger, W.N.; Agrawala, S.; Mirza, M.M.Q.; Conde, C.; O'Brien, K.; Pulhin, J.; Pulwarty, R.; Smit, B. and Takahashi, K. 2007. Assessment of adaptation practices, options, constraints and capacity. In Parry, M.L.; Palutikof, J.P.; van der Linden P.J. and Hanson C.E. (Ed), *Climate change 2007: Impacts, adaptation and vulnerability*, pp. 717-743. Cambridge, UK: Cambridge University Press.
- Barnett, J. 2010. Adapting to climate change: Three key challenges for research and policy – An editorial essay. *Wiley Interdisciplinary Reviews: Climate Change* 1(3): 314-317.
- Benson, D.; Gain A.K. and Rouillard, J.J. 2015. Water governance in a comparative perspective: From IWRM to a 'nexus' approach? *Water Alternatives* 8(1): 756-773.
- Borja, Á. and Rodríguez, J.G. 2010. Problems associated with the 'one-out, all-out' principle, when using multiple ecosystem components in assessing the ecological status of marine waters. *Marine Pollution Bulletin* 60: 1143-1146.
- Brack, W.; Dulio, V.; Agerstrand, M.; Allan, I.; Altenburger, R.; Brinkmann, M. and Bunke, D. 2017. Towards the review of the Water Framework Directive: Recommendations for more efficient assessment and management of chemical contamination in European surface water resources. *Science of the Total Environment* 576: 720-737.
- Carvalho, L.; Mackay, E.B.; Cardoso, A.C.; Baattrup-Pedersen, A.; Birk, S.; Blackstock, K.L.; Borics, G.; Borja, A.; Feld, C.K.; Ferreira, M.T.; Globovnik, L.; Grizzetti, B.; Hendry, S.; Hering, D.; Kelly, M.; Langaas, S.; Meissner, K.

- Panagopoulos, Y.; Penning, E.; Rouillard, J.; Sabater, S.; Schmedtje, U.; Spears, B.M.; Venohr, M.; van de Bund W. and Solheim, A.L. 2019. Protecting and restoring Europe's waters: An analysis of the future development needs of the Water Framework Directive. *Science of the Total Environment* 658: 1228-1238.
- Clare, R. 2011. Leadership in collaborative policy-making: An analysis of agency roles in regulatory negotiations. *Policy Sciences* 34(1): 221-245.
- Commission, E. 2012. A blueprint to safeguard Europe's water resources. Brussels: European Commission.[673 COM(2012)].
- De Vito, L.; Fairbrother, M. and Russel, D. 2020. Implementing the Water Framework Directive and tackling diffuse pollution from agriculture: Lessons from England and Scotland. *Water* 12(1): 244.
- Dobson, A.P.; Bradshaw A.D. and Baker, A.J.M. 1997. Hopes for the future: Restoration ecology and conservation biology. *Science* 277(5325): 515-522.
- Dow, K.; Berkhout, F.; Preston, B.L.; Klein, R.J.T.; Midgley, G. and Shaw, M.R. 2013. Limits to adaptation: An actor-centered, risk-based approach to defining limits to social adaptation provides a useful analytic framing for identifying and anticipating these limits and informing debates over society's responses to climate change. *Nature Climate Change* 3: 305-308
- EC. 2019a. Evaluation of EU water legislation concludes that it is broadly fit for purpose but implementation needs to speed up. Brussel, Belgium: EC. Available from https://ec.europa.eu/info/news/evaluation-eu-water-legislation-concludes-it-broadly-fit-purpose-implementation-needs-speed-2019-dec-12_en
- EC. 2019b. Factual summary report on the public consultation for the fitness check of the Water Framework Directive and associated directives and the Flood Directive. Brussel, Belgium: EC. https://ec.europa.eu/info/law/better-regulation/initiatives/ares-2017-5128184/public-consultation_de
- ECA. 2014. Special Report – Integration of EU water policy objectives with the CAP: a partial success. Luxembourg: EU04.
- EEA. 2018. European waters – Assessment of status and pressures 2018. Brussel.
- Egger, G.; Gräßler, L.; Reich, M.; Komposch, C.; Dister, E.; Schneider E. and Norbert, M. 2019. Ecosystem Alpine river – Permanent change. In Muhar, S.; Egger, A.M.G. and Siegrist, D. (Ed), *Rivers of the Alps – Diversity in nature and culture*, pp. 511. Bern, Germany: Haupt.
- Farmer, A.M. 2011. Cross-scale governance and the analysis of policy implementation for water management, with particular regard to climate adaptation, industrial pollution and impacts of agriculture. *Journal of Water and Climate Change* 2(2-3): 123-142.
- Giakoumis, T. and Voulvoulis, N. 2019. Water Framework Directive programmes of measures: Lessons from the 1st planning cycle of a catchment in England. *Science of the Total Environment* 668: 903-916.
- Goodchild, R.G. 1998. EU policies for the reduction of nitrogen in water: the example of the Nitrates Directive. *Environmental Pollution* 102(1, Supplement 1): 737-740.
- Gourbesville, P. 2008. Integrated river basin management, ICT and DSS: Challenges and needs. *Physics and Chemistry of the Earth* 33(5): 312-321.
- Graversgaard, M.; B.H. Jacobsen, C. Kjeldsen and T. Dalgaard. 2017. Stakeholder Engagement and Knowledge Co-Creation in Water Planning: Can Public Participation Increase Cost-Effectiveness? *Water* 9(3): 191.
- Grygoruk, M. and Okruszko, T. 2015. Do water management and climate-adapted management of wetlands interfere in practice? Lessons from the Biebrza valley, Poland. In *GeoPlanet: Earth and Planetary Sciences*, 53-67. Springer Verlag.
- Guzelj, M.; Hauer, C. and Egger, G. 2020. The third dimension in river restoration: how anthropogenic disturbance changes boundary conditions for ecological mitigation. *Scientific Reports*, 10(1), 13106.
- Heldt, S.; Rodríguez-de-Francisco, J.C.; Dombrowsky, I.; Feld C.K. and Karthe, D. 2017. Is the EU WFD suitable to support IWRM planning in non-European countries? Lessons learnt from the introduction of IWRM and River Basin Management in Mongolia. *Environmental Science and Policy* 75: 28-37.
- Hering, D.; Borja, A.; Carstensen, J.; Carvalho, L.; Elliott, M.; Feld, C.K.; Heiskanen, A.S.; Johnson, R.K.; Moe, J.; Pont, D.; Solheim A.L. and de Bund, W. 2010. The European Water Framework Directive at the age of 10: a critical review of the achievements with recommendations for the future. *Science of the Total Environment* 408(19): 4007-19.

- Hermans, L.M. 2010. An Approach to Support Learning from International Experience with Water Policy. *Water Resources Management* 25(1): 373-393.
- Hovik, S. 2019. Integrated Water Quality Governance and Sectoral Responsibility: The EU Water Framework Directive's Impact on Agricultural Sector Policies in Norway. *Water* 11(11): 2215.
- IGB. 2019. IGB Policy Brief: Strengths and weaknesses of the Water Framework Directive. Berlin, Germany: IGB.
- IOG. 2019. What is governance? Institute on Governance, <https://iog.ca/what-is-governance>
- Jager, N.W.; Challies, E.; Kochskämper, E.; Newig, J.; Benson, D.; Blackstock, K.; Collins, K.; Ernst, A.; Evers, M.; Feichtinger, J.; Fritsch, O.; Gooch, G.; Grund, W.; Hedelin, B.; Hernández-Mora, N.; Hüesker, F.; Huitema, D.; Irvine, K.; Klinke, A.; Lange, L.; Loupsans, D.; Lubell, M.; Maganda, C.; Matczak, P.; Parés, M.; Saarikoski, H.; Slavíková, L.; van der Arend S. and von Korff Y. 2016. Transforming European water governance? Participation and river basin management under the EU Water Framework Directive in 13 member states. *Water* 8(4): 156.
- Jahn, T. and Keil, F. 2016. Reallabore im Kontext transdisziplinärer Forschung. *GAIA* 25(4): 247-252.
- Kirschke, S.; Häger, A.; Kirschke D. and Völker, J. 2019. Agricultural nitrogen pollution of freshwater in Germany. The governance of sustaining a complex problem. *Water* 11(12): 2450.
- Kochskämper, E.; Jager, N.W.; Challies E. and Newig, J. 2018. *Participation for effective environmental governance? Evidence from implementing the European Water Framework Directive*. London and New York: Taylor & Francis Ltd.
- Lemos, M.C. and Agrawal, A. 2006. Environmental governance. *Annual Review of Environment and Resources* 31(1): 297-325.
- Lepenes, R.; Hüesker, F.; Beck S. and Brugnach, M. 2018. Discovering the political implications of coproduction in water governance. *Water* 10(10): 1475.
- Meergans, F. and Lenschow, A. 2018. Die Nitratbelastung in der Region Weser-Ems: Inkohärenzen in Wasser-, Energie- und Landwirtschaftspolitik. In Czada, R.; Fürst, D. (Ed), *Regieren in Niedersachsen*, pp. 105-117. Kiel, Hamburg: Wachholtz, Murmann Publishers.
- Moher, D.; Liberati, A.; Tetzlaff, J. and Altman, D. 2009. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Annals of Internal Medicine* 151: 264-269.
- Mollinga, P.P. 2008. Water, politics and development: Framing a political sociology of water resources management. *Water Alternatives* 1(1): 7-23.
- Musacchio, A.; Re, V.; Mas-Pla, J. and Sacchi, E. 2019. EU Nitrates Directive, from theory to practice: Environmental effectiveness and influence of regional governance on its performance. *Ambio* 49: 504-516
- Parés, M.; Brugué, Q.; Espluga, J.; Miralles, J. and Ballester, A. 2015. The strengths and weaknesses of deliberation on river basin management planning: Analysing the Water Framework Directive implementation in Catalonia (Spain). *Environmental Policy and Governance* 25(2): 97-110.
- Reyjol, Y.; Argillier, C.; Bonne, W.; Borja, A.; Buijse, A.D.; Cardoso, A.C.; Daufresne, M.; Kernan, M.; Ferreira, M.T.; Poikane, S.; Prat, N.; Solheim, A.L.; Stroffek, S.; Usseglio-Polatera, P.; Villeneuve B. and van de Bund, W. 2014. Assessing the ecological status in the context of the European Water Framework Directive: where do we go now? *Science of the Total Environment* 497-498: 332-344.
- Rogga, S.; Zscheischler, J. and Gaasch, N. 2018. How much of the real-world laboratory is hidden in current transdisciplinary research? *Gaia* 27(S1): 18-22.
- Rouillard, J.; Lago, M.; Abhold, K.; Roeschel, L.; Kafyeke, T.; Klimmek H. and Mattheiß, V. 2018. Protecting and restoring biodiversity across the freshwater, coastal and marine realms: Is the existing EU policy framework fit for purpose? *Environmental Policy and Governance* 28(2): 114-128.
- Schaub, S. 2019. Salient to whom? The positioning of German political parties on agricultural pollutants in water bodies. *Water* 11(11): 2278.
- Schleyer, C.; Görg, C.; Hauck J. and Winkler, K.J. 2015. Opportunities and challenges for mainstreaming the ecosystem services concept in the multi-level policy-making within the EU. *Ecosystem Services* 16: 174-181.
- Theesfeld, I. and Schleyer, C. 2011. *Institutional requirements for Integrated Water Resource Management in Germany*. München, Germany: Acatech
- Tosun, J. and Lang, A. 2017. Policy integration: Mapping the different concepts. *Policy Studies* 38(6): 553-570.

- Vogeler, C.S.; Möck, M.; Bandelow, N. and Schröder, B. 2019. Livestock farming at the expense of water resources? The water-energy-food-nexus in regions with intensive livestock farming. *Water* 11(11): 2330.
- Voulvoulis, N.; K.D. Arpon and Giakoumis, T. 2017. The EU Water Framework Directive: From great expectations to problems with implementation. *Science of the Total Environment* 575: 358-366.
- Walsh, C.J.; Roy, A.H.; Feminella, J.W.; Cottingham, P.D.; Groffman, P.M. and Morgan, R.P. 2005. The urban stream syndrome: Current knowledge and the search for a cure. *Journal of the North American Benthological Society* 24: 706-723.
- Warner, J.F.; van Buuren, A. and Edelenbos, J. (Eds). 2012. *Making space for the river: Governance experiences with multifunctional river flood management in the US and Europe*. IWA Publishing. Vol. 11.
- Waylen, K.A.; Blackstock, K.L.; Tindale, S.J. and Juárez-Bourke, A. 2019. Governing integration: Insights from integrating implementation of European water policies. *Water* 11(3): 598.
- Wiering, M.A.; Liefferink, D.; Kaufmann, M. and Kurstjens, N. 2018. *The implementation of the Water Framework Directive: A focused comparison of governance arrangements to improve water quality*. Radboud, Netherland: Institute for management research.
- Zingraff-Hamed, A.; Greulich, S.; Pauleit, S. and Wantzen, K.M. 2017a. Urban and rural river restoration in France: A typology. *Restoration Ecology* 25(6): 994-1004.
- Zingraff-Hamed, A.; Greulich, S.; Wantzen, K.M. and Pauleit, S. 2017b. Societal drivers of European water governance: a comparison of urban river restoration practices in France and Germany. *Water* 9(3): 206.
- Zingraff-Hamed, A.; Martin, J.; Lupp, G.; Linnerooth-Bayer, J. and Pauleit, S. 2019. Designing a resilient waterscape using a living lab and catalyzing polycentric governance. *Landscape Architecture Frontiers* 7(3): 12-31.

APPENDIX

Table A1. Summary of the results of the literature review

Positive aspects of local, national and EU-wide water governance of WFD implementation

Integrative River basin Management paradigm	(Giakoumis and Voulvoulis, 2019; Gourbesville, 2008; Heldt et al., 2017)
Ecosystem-based Integrative River Basin Management	(Heldt et al., 2017)
Inclusion of public and multiple stakeholder participation for design, implementation and monitoring of programs and measures	(Heldt et al., 2017; Khalid et al., 2018)
Application of the subsidiarity principle allowing decision making to be made by agencies closest to an issue in the river basin	(Khalid et al., 2018)
Involvement of different levels of government in Integrative River Basin Management enables large-scale measures	(Khalid et al., 2018)

Negative aspect of local, national and EU-wide water governance of WFD implementation

National simplification of information relating to the WFD during translation of the WFD in national water governance structures	(Farmer, 2011)
Lack of available funding to implement the WFD	(Farmer, 2011; Grygoruk and Okruszko, 2015; Hermans, 2011)
WFD is a soft tool that requires strong political will to be implemented	(Heldt et al., 2017; Hermans, 2011)
WFD often in conflict with other policies focusing on emerging stressors like Climate Change (increase of flood, drought, and changing ecosystems)	(Grygoruk and Okruszko, 2015; Stratmann and Albrecht, 2015)

Limited knowledge of many stakeholders joining the decision-making process limits the resulting 'measures' decided by them	(Giakoumis and Voulvoulis, 2019)
Local Integrative River Basin Management Plans are not functional	(Heldt et al., 2017)
Conflicts between WFD requirements and the hydropower sector	(Lindström and Ruud, 2017)
National mechanisms of planning and participation are not harmonized with the WFD participative approach.	(Hermans, 2011; Morris, 2007; Ulén and Kalisky, 2005)

Table A2. Number of scientists from each country invited to participate in the survey (* not an EU Member State but a European Free Trade Association implementing the WFD in on a voluntary basis)

Country	Number of academics contacted
Austria	8
Belgium	5
Bulgaria	9
Croatia	6
Cyprus	5
Czech Republic	6
Denmark	6
Estonia	5
Finland	10
France	11
Germany	87
Greece	5
Hungary	10
Ireland	5
Italy	11
Latvia	5
Lithuania	5
Luxembourg	5
Malta	5
Netherlands	28
Norway*	6
Poland	6
Portugal	5
Romania	10
Slovakia	8
Slovenia	6
Spain	8
Sweden	10
Switzerland	7
United Kingdom	26

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