



Knowledge and awareness of water quality protection issues within local authorities

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ABSTRACT

The EU Water Framework Directive's (WFD) ambition to achieve good ecological status for waters is an ambitious target due to the complexity of water management governance. Usually, multiple institutions are responsible for water management, often operating within a hierarchical structure, in which each level has different responsibilities. It is essential that knowledge and awareness of plans and policies associated with water management are effectively transferred through the hierarchical structure to the staff responsible for day-to-day activities. This study investigates the level of knowledge and awareness of water quality issues among Local Authority (i.e., local government) staff within Ireland and the extent to which water protection measures are implemented within core functions of local government. There is relatively good knowledge or awareness related to high level issues, including institutions responsible for water management, awareness of WFD and river basin management plans. Knowledge and awareness levels are considerably lower on more specific details, including on water quality status and protection measures being implemented within their jurisdictional areas. Overall, the study suggests that there is considerable scope for improvement in knowledge and awareness, and outlines a series of recommendations to improve priority for water quality protection among Local Authority staff.

1. Introduction

The EU Water Framework Directive (WFD) (2000/60/EC) proposes an integrated framework for the preservation of water quality and sets binding water quality targets for all EU country members. Among the WFD's ambitious targets is the achievement of 'good ecological status' in all water bodies, comprising both ground waters and surface waters. While 'good ecological status' may be the technical goal, the ultimate aim is that the status indicates water-bodies are safe for use, including for drinking water, as well as protecting aquatic ecosystems, and terrestrial ecosystems and wetlands directly depending on them. The maintenance of high water quality in water bodies is complex because there are many factors and sources that contribute to water pollution, across the two broad categories of pollution: point and diffuse water pollution (Moss, 2008). Point source water pollution refers to contaminants that enter the water body in a circumscribed and easily identified area. Diffuse water pollution indicates the release of pollutants from many different places and activities, which may have small individual effect but very large cumulative impacts at basin scale. Different from

previous legislation, the WFD focuses on the hydrological system rather than by administrative units.

Under the WFD EU member states are required to draft a River Basin Management Plan (RBMP) in which actions to protect rivers, lakes, estuaries and coastal waters are outlined at basin scale. The switch of water management from administrative boundaries to a basin scale is one of the major changes introduced by the WFD. This modification of the geographical extent of water management has been made to account for water pollutants that affect water quality beyond administrative boundaries (Kallis and Butler, 2001). Following an ecosystem-based approach to management, catchment-level water management facilitates the assessment of water quality and pollution at the scale of the entire ecosystem, rather than at each administrative unit. However, the new approach of the RBMP requires cooperation across public bodies, which previously worked independently, especially within geographical administrative areas. Therefore, the success of WFD implementation depends to a great extent on the capacity of administrative public bodies to develop effective plans, coordinate activities and share data (Paisley and Henshaw, 2014).

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In Ireland, the Department of Housing, Local Government and Heritage (DHLGH) has overall responsibility for the RBMP, which outlines national governance and management structure for water protection. The general governance structure involves three interlocking elements; policy, technical leadership and implementation. Various public sector bodies are actively engaged across all elements and levels of governance. To ensure effective water management, knowledge of aims and objectives should be effectively transferred to the public bodies that carry out daily activities impacting water quality, especially to staff engaged in day-to-day operational decision making (Ipe, 2003). In particular, the translation of RBMP objectives into management actions is among the responsibilities of 31 Local Authorities, among other actors.¹ The success of the RBMP depends in part on Local Authorities delivering on their responsibilities. The current reporting cycle of the WFD runs from 2016 to 2021 with plans for the next reporting cycle underway. It is an opportune time therefore to examine both the dissemination of knowledge of key water quality metrics among Local Authority staff and the effectiveness of existing water governance hierarchy in transferring high level strategic vision of the RBMP into practical daily actions across the functions of local government. While the focus here is water governance among public sector employees, it is worth noting that responsibility for water quality encompasses a much wider hierarchy of both private and public sector entities and that the sources of pollution, as well as those impacted by water pollution, is extensive.

This paper reports a study on Local Authority (LA) employees' knowledge of water quality and management topics. The results establish a baseline assessment of LA employees' general and specific knowledge on water quality and management. Specifically, the study answers the following questions: 1) whether LA staff are aware of the status of Irish waters and whether there are substantive differences in knowledge across job roles, divisions and working experience; 2) whether LA staff are aware of the objectives of WFD and RBMP; and 3) whether staff within various working divisions are aware of the actions undertaken to improve water quality objectives in their day-to-day activities. Ideally the answers to these questions should be strongly positive but where that is not the case, areas for remedial action to improve the the implementation of the RBMP are easily identifiable. The rest of the paper is organised as follows. The next section outlines the main public bodies in charge of water resource management in Ireland. Section three describes the methodological approach used in the analysis, including the data collection. Analytical results are presented in section four, which is followed by a discussion of the results and policy implications. The final section offers some conclusions and policy recommendations.

2. Background

2.1. The theoretical framework of water governance

Adopted in 2000, the EU WFD is one of the first legislative proposals to adopt ecosystem-scale measures to enhance water governance (Jager et al., 2016; Petersen et al., 2009). For instance, the preamble to the WFD mentions the necessity of providing information and reporting to the general public with a view to ensuring their participation in water management decisions, including the establishment and updating of river basin management plans. However, the urgency to improve water policies is not exclusive to the EU WFD but advocated worldwide (Woodhouse and Muller, 2017). Good water governance underpins the

human right to water and sanitation, which is explicitly recognised in the United Nations General Assembly's resolution 64/292 (28 July 2010) and the Human Rights Council's resolution 15/9 (6 October 2010). Internationally the uptake of innovative and effective water governance is generally unsatisfactory with most water governance failures attributed to scientific knowledge on water governance systems, which is still limited despite growing scholarly expertise (Pahl-Wostl, 2017).

With the objective of supporting the implementation of effective water policy, the Organisation for Economic Co-operation and Development (OECD) has identified seven knowledge gaps in water governance, which cover policy, accountability, funding, capacity, information, administrative, and objectives (Akhmouch et al., 2020). Based on these knowledge gaps, OECD outline 12 water governance principles that are essential for governments to design and implement effective, efficient, and inclusive water policies (Akhmouch and Correia, 2016). The 12 principles relate to (OECD, 2015):

- Clear roles and responsibilities;
- Appropriate scales within basin systems;
- Policy coherence;
- Capacity;
- Data and information;
- Financing;
- Regulatory frameworks;
- Innovative governance;
- Integrity and transparency;
- Stakeholder engagement;
- Trade-offs across users, rural and urban areas, and generations;
- Monitoring and evaluation.

The OECD principles represent a solid theoretical framework to assess the effectiveness of water governance (VanNijnatten, 2020; Jetoo, 2019; Van Rijswijk et al., 2014). In a cross-country assessment Neto et al. (2018) find that four OECD principles are especially critical: policy coherence, financing, managing trade-offs, and ensuring integrity and transparency by all decision-makers and stakeholders. Stakeholder engagement and public participation are other key aspects of water governance (Akhmouch and Clavreul, 2016). Increasing public participation is encouraged not only by OECD, but also by the WFD (Fritsch, 2019; Graversgaard et al., 2018). Participation of stakeholders and local communities in water and other natural resource governance facilitates consensus over management rules that are both economically and ecologically sustainable (Razzaque, 2009; Priscoli, 2004). Based on these considerations, polycentric and multi-level governance systems have been formulated in opposition to central governance (Ostrom, 2010). Under polycentric governance, the authorities of local government, such as municipalities and Local Authorities, are responsible for environmental decision-making, including water quality (Huitema et al., 2009; García et al., 2019). In this way, water governance responsibilities are decentralised and assigned to the public bodies that are closer to local communities and water users (Baldwin et al., 2018). When daily water management operations are delegated from central to local government, assessing whether the strategic vision outlined in the RBMP is effectively disseminated across operational levels of water management is crucial to achieve water quality goals (Rollason et al., 2018). In the assessment of water multi-level governance, key principles to consider are: clarity of roles and responsibilities, capacity building, data, and outcome measurement (Akhmouch and Clavreul, 2016).

The effectiveness of water governance in Ireland has recently been evaluated using the OECD principles as a framework (O'Riordan et al., 2021; Boyle et al., 2021) with several recommendations outlined. Among them is a call to clarify roles across governance tiers and discuss priorities, resourcing and policy coherence. The suggestion about clear definition of roles is particularly relevant for Local Authorities. Other recommendations include increasing capacity across governance

¹ Local Authorities in Ireland are responsible for the provision of public services and facilities such as housing, planning, roads, and environmental protection. The 31 local authorities cover the whole of the Republic of Ireland. The functional area of local authorities often overlap with 'county' boundaries, comprising both urban and rural areas. In the case of larger cities the functional areas are confined to urban areas.

organisations, to scale up lessons learned from projects and local initiatives, and improving data collection and policy outcome measurement. Furthermore, [Antwi et al. \(2021\)](#) find that lack of real-time data and the willingness to share information among and between organisations within Ireland impacts decision-making and scientific-based approaches to improving water quality. Two pan-European studies of the development needs of the WFD draw quite different conclusions. [Carvalho et al. \(2019\)](#) focus on technical weaknesses within the WFD's Programmes of Measures based on a survey of conference participants of a WFD conference, a high majority of which express a good knowledge of WFD in their country. In essence, WFD insiders focus on the technical implementation of issues surrounding monitoring and assessment systems, management measures, and policy integration. In contrast, [Zingraff-Hamed et al. \(2020\)](#) examine a broader range of challenges facing implementation of WFD across a more diverse group of stakeholders. Of a list of 24 potential barriers to WFD implementation, issues surrounding knowledge and communication are quite prominent. Top-down and bottom-up information flow within environmental agencies, "horizontal intersectoral communication", and "communication in lower-level environmental administrations" are among the top-10 barriers identified. These are central to the core question of this research, whether knowledge is disseminated through the LA hierarchy, specifically to staff making daily decisions in areas such as environmental enforcement or planning. In a similar vein [Wuijts et al. \(2021\)](#) suggest that necessary cross-sectoral connections at regional or local level are absent due to a lack of knowledge on the legislative framework, as well as system complexity, and competing interests. In a case-study assessment of learning and knowledge practices in Sweden, [Dawson et al. \(2018\)](#) find that while prioritisation of water-related issues among public officials and politicians has increased over time, that problems with poor coordination and fragmentation of knowledge remain. Across the literature cited above there is a common theme that knowledge or information deficiencies exist within WFD implementation structures, largely based on subjective opinions of stakeholders via interviews, focus groups, or surveys. Empirical studies on how conditions of governance could improve specific water quality issues are scarce ([Wuijts et al., 2018](#)). A meta-analysis of WFD implementation studies finds that three-quarters of papers are descriptive in nature and where studies do have an empirical or evaluative ambition the overwhelming focus is on the public's participation in WFD implementation, with the research emphasis on participation attributed to an absence of well-established participatory mechanisms in many countries prior to the adoption of the WFD ([Boeuf and Fritsch, 2016](#)). Boeuf and Fritsch cite no studies that examine the capacity of countries or organisations, in terms of scientific knowledge or understanding of source-pressure-impacts, to effectively contribute to improving water quality.

2.2. Water governance in Ireland

Irish river basins comprise more than 70,000 km², across 46 catchments with a total of 4829 water bodies. Water quality varies considerably across water bodies. The proportion of water bodies in good or better ecological status is 53% for rivers, 51% for lakes, 38% for estuaries 80% for coastal waters, and at least 92% of groundwater bodies have good chemical and quantitative status ([EPA, 2020b](#)).

There are several public bodies that are directly or indirectly involved in water resource management in Ireland. The 3-year RBMP, developed by Department of Housing, Local Government & Heritage, sets water quality targets and management actions following the WFD guidelines. Included within the WFD/RBMP governance structure are several committees comprising public bodies, including 1) the Water Policy Advisory Committee (WPAC) 2) Water Forum/An Fóram Uisce, 3) The National Co-ordination & Management Committee (NCMC), 4) The National Technical Implementation Group (NTIG), 5) The Regional Local Authority Structures, supported by the Local Authorities Waters Programme (LAWPRO). The Water Policy Advisory Committee provides

high-level policy and monitors the implementation of the RBMP; it also advises the Minister on the progress of plans and measures. The Water Forum/An Fóram Uisce is an independent entity with advisory responsibility and is the only statutory body representative of all stakeholders with an interest in the quality of Ireland's water bodies. The National Co-ordination & Management Committee's role is to ensure that the programme of measures included in the RBMP is actively managed; it is also an interface between science, policy and programme delivery. The National Technical Implementation Group is chaired by the Environmental Protection Agency (EPA) and includes many other public bodies (e.g. Office of Public Works, Inland Fisheries Ireland). Its main duty is to supervise the technical implementation of the RBMP and coordinates the various actors with responsibilities for water management. The Regional Local Authority Structures comprises Local Authorities, which are coordinated by 5 regional committees (Border, Midlands, West, South East and South West). The role of the Regional Committees is to coordinate actions across all public relevant bodies in the region. The Local Authorities Waters Programme is a national initiative situated within Local Authorities that engages with communities and other stakeholders to achieve the objectives of the RBMP.

LAs are responsible for a wide range of functions, including provision of public services, road maintenance, local planning and environmental protection. Many of these services have the potential to influence water quality. For example, planning permissions may produce environmental alterations that ultimately impact on water quality. While LAs are not uniformly structured, all 31 LAs have responsibilities relevant to water quality management. Within LAs' organisational structures there are usually four divisions with involvement in water quality management, namely Environment, Planning, Communities, and Roads divisions. Environment divisions have direct responsibility for water quality management prescribed under legislation. While LAs have responsibilities within their own functional areas, the 5 regional committees coordinate actions across administrative boundaries among LAs and other public bodies to ensure enhance the delivery of water quality measures at water body and catchment scale.

Two key aspects of the RBMP are the creation of the Blue Dot Catchments Programme and the Priority Areas for Actions (PAAs). The Environmental Protection Agency have identified the waters in Ireland that should have a high status objective, and these are commonly known as Blue Dot waters or Blue Dots and include rivers, lakes, estuaries, and coastal waters. The Blue Dot Catchments Programme aims to maintain and restore high-status water bodies, i.e. waters with the highest quality nationally within the Water Framework Directive classification system of High, Good, Moderate, Poor or Bad status. PAAs are areas deemed at risk of not meeting their WFD objectives.

3. Methodology

3.1. Data collection

The data for this study was collected by survey, administered to employees of the four relevant divisions of the Local Authorities (i.e. Environment, Planning, Roads and Communities). The survey questionnaire was piloted on a sample of LA employees of the regional committees, who gave feedback on wording and clarity of the questions. The main survey was completed online between early December 2020 and the end of January 2021. In compliance with General Data Protection Regulations information on the target sample of LA employees was not shared with the authors. Instead, the invitation to participate in the survey was distributed by the Local Governance Management Agency (LGMA) and two reminder emails to complete the survey were sent by the LGMA in January. The total sample size (i.e. the number of employees who received a link to the survey), is 1209 LA staff across 31 LAs. The questionnaire was hosted on the LimeSurvey survey platform (limesurvey.org) and was developed through a recurring process with input from staff from the Local Authorities Water Programme, who have

considerable experience working within various LAs. Their input was crucial in adapting the questionnaire to be suitable for different sized LAs and for different organisational structures across LAs. They also organised participants for a small pilot survey, including collating feedback from pilot participants prior to wider circulation of the survey. The survey questionnaire is available in an online annex.

General knowledge of water quality, WFD and RBMP and actions for water quality management cannot be assessed with a single question. Therefore, several indicators were used as proxies, each capturing one different aspect of the topic. The most relevant indicators for each topic are shown in Table 1. On general knowledge, respondents were asked whether they know the organisations responsible for water quality in Ireland; and questions about water quality both nationally as well as within the LA area.

3.2. Statistical analysis

The main objectives of this study are 1) to provide an overview of the current status of knowledge of water management and actions undertaken to improve water quality within Local Authority administrative areas, and 2) explore systematic differences in knowledge and actions across organisations. The first objective is addressed using descriptive statistics, percentages and frequency tables of the answers. The second part of the analysis is undertaken with regression techniques, with functional forms that depend on the type of dependent variable considered. The dependent variables are summarised in Table 1 and can be broadly divided into binary, multinomial (unordered) or ordered variables.

Variables with a binary outcome are modelled using logistic regression, in which the probability of an outcome equal to 1 for the dependent variable Y is described by the following probability function (Greene, 2003):

$$Pr(Y = 1|X_i, \beta) = \frac{\exp(\beta X_i)}{1 + \exp(\beta X_i)} \quad (1)$$

where X_i is a set of individual characteristics of respondent i , and β represent the effect of X_i on the probability of an answer equal to 1.

One indicator of general knowledge originated from a question that asked respondents their knowledge about the Blue Dot programme. The possible answers are: 1) 'No', 2) 'Yes, but don't have much knowledge of programme', and 3) 'Yes, and aware of the programme and its objectives'. The resulting indicator has three ordered outcomes and is modelled using an ordered logit model. The ordered logit generalises the binary logistic regression to ordinal outcomes (Cameron and Trivedi, 2005). Though knowledge might be measured on a continuous scale when only observed at discrete intervals the ordered logit model is appropriate. Formally, the equation that describes y^* , measuring knowledge or awareness, is the following:

$$y^* = \beta'X + \epsilon$$

where ϵ is an identically and independently distributed (IID) random disturbance. The variable y^* ranges in the interval $[-\infty, +\infty]$ but it is observed only in j discrete intervals, with the following system of censoring (Greene and Hensher, 2009):

$$y = \begin{cases} 0, & \text{if } -\infty < y^* \leq \tau_0 \\ 1, & \text{if } \tau_0 \leq y^* \leq \tau_1 \\ \dots & \\ j, & \text{if } \tau_j \leq y^* < +\infty \end{cases}$$

where τ_0 and τ_1 are threshold parameters to estimate. The probability of outcome j is given by:

$$Prob[y = j|X] = F[\tau_j - \beta'X] - F[\tau_{j-1} - \beta'X], \quad j = 0, 1, \dots, j.$$

Table 1

Indicators for water quality and WFD/RBMP knowledge used in the analysis.

Metric	Question	Answer options	Type of indicator	Statistical model
Indicators of general knowledge				
Water quality, Ireland	In general, how would you describe water quality in Ireland?	Satisfactory Unsatisfactory Don't Know	Multinomial, unordered	Multinomial logit
Water quality, local	In general, how would you describe water quality in your LA?	Satisfactory Unsatisfactory Don't Know	Multinomial, unordered	Multinomial logit
Good ecological status	What proportion of Ireland's 2355 river water bodies assessed nationally do you think are in satisfactory ecological health being in either good or high status?	20–30% 30–40% 40–50% 50–60% 60–70% Don't Know	Binary (1 = 50–60%, 0 = otherwise)	Binary logit
Knowledge of WFD and RBMP				
WFD	Are you familiar with the Water Framework Directive?	Aware Not Aware	Binary	Binary logit
RBMP	Are you aware of the River Basin Management Plan 2018–2021?	Aware Not Aware	Binary	Binary logit
Blue Dots, national	Prior to today were you aware of the Blue Dot Catchment Programme?	Yes, and aware of programme and its objectives Yes, but don't have much knowledge of programme No	Ordinal	Ordered logit
Blue Dots, local	Are you aware if there are any high status objective water bodies, pristine water bodies, also referred to as 'blue dots', within your LA?	Aware Not Aware	Binary	Binary logit
PAAAs	Several 'Priority Areas for Action' have been selected across the country. Are you aware if there are any 'Priority Areas for Action' within your LA?	Aware Not Aware	Binary	Binary logit

WFD: Water Framework Directive; RBMP: River Basin Management Plan; PAA: Priority Area for Action

where $F(\cdot)$ is the logistic density function.

All models were estimated using R; logit models were carried out using the base installation package ‘glm’, while the ordered logit regression was performed with the function ‘porl’ available in the ‘MASS’ package.

4. Results

4.1. Response rate

The survey was answered by 691 employees, however many questionnaires were incomplete, indicating where employees opened the link to the questionnaire but did not submit responses to any questions. In total, 521 questionnaires were answered fully and useful for the analysis. The effective response rate is 43%.

The breakdown of respondents by working division is shown in Fig. 1. Environment divisions returned 257 questionnaires, which corresponds to a response rate of approximately 70%. Roads divisions contributed with 94 responses (33% response rate), Communities divisions returned 91 questionnaires (47% response rate) and Planning divisions returned 79 questionnaires, a 32% response rate. Environment divisions have greatest responsibility for water-related management and a proportionately higher number of responses was anticipated.

4.1.1. General knowledge of water quality and management

The general knowledge of respondents on water quality and management is assessed with four main indicators and reported in Table 2. When asked to indicate the organisations responsible for water quality monitoring in Ireland, most respondents selected the most appropriate answers, i.e. Environmental Protection Agency (about 80%) and LAs (73%). The Geological Survey of Ireland, another acceptable answer, was selected by only 8% of the sample. Substantial minorities selected the government departments responsible for the regulation and protection of natural resources of Ireland (i.e., DECC and DHLGH) as additional options, especially in Planning and Communities divisions.

With respect to opinions on water quality in Ireland, some 40% of respondents perceive water quality to be of satisfactory quality status, 53% unsatisfactory and 6% don’t know. Therefore, almost half of respondents have views on water quality that are at odds with the trend of declining water quality in Irish water bodies (EPA, 2020b). Respondents in the Environment and Planning divisions returned a share of ‘unsatisfactory’ opinion in excess of 60%, while employees in the community and road divisions 32% and 54%, respectively. Opinions did not change significantly based on employee was in a senior management role or not. When asked to consider water quality in their own administrative area, interestingly respondents reported a ‘don’t know’ answer more frequently, globally about 10% of the sample.

A second indicator on water quality knowledge asked respondents to

indicate the proportion of rivers in good ecological status according to WFD definition. The correct answer, i.e. 50–60% of the total, was answered by some 25% of the sample. About 10% of the sample over-estimated river ecological status, while 55% stated 50% or less. The proportion of correct answers was greatest among employees of Environment divisions. Among employees in senior management roles the proportion of correct answers was 30%.

Table 3 shows statistical model results that explore whether answers systematically vary based on personal characteristics of the employees. Overall, the regression models have many estimated coefficients that are not statistically significant, which suggests that personal characteristics are not associated with knowledge of water quality issues. The first model considers respondents’ opinion on water quality in Ireland, which comprises two columns. The first column contains coefficients that indicate the probability of answering ‘satisfactory’ compared to the reference level, i.e. ‘don’t know’, while the second contains coefficients related to the probability of answering ‘unsatisfactory’. Opinions on water quality are significantly associated with role seniority; employees in senior management roles are less likely to consider Irish water quality as ‘unsatisfactory’.

Employees in the Planning division are more likely to express an opinion, whether ‘satisfactory’ or ‘unsatisfactory’, compared to a ‘don’t know’ answer. Senior managers within Planning divisions, however, are much more likely not to have opinions on water quality and tend to answer ‘don’t know’ to this question. Other statistically relevant differences for employees of other divisions were not detected. There is no statistical association between duration of employee experience and opinions on water quality, indicating that opinions on water quality in Ireland are not associated with years of experience within the LA.

With respect to water quality in respondents’ local area, respondents employed in Roads divisions were more likely to express a ‘don’t know’ answer compared to ‘unsatisfactory’. Overall, staff with longer LA service have a higher likelihood of expressing an opinion that local water quality has a satisfactory status. Based on the regression interaction terms between division and respondent’s seniority, upper management levels of the Environment and Roads divisions are less likely to indicate ‘don’t know’.

Job seniority and division were significantly associated with knowledge of the proportion of rivers in a high ecological status. Respondents in senior management roles were 6 times more likely to indicate the correct proportion of rivers in a high ecological status compared to other employees. Compared to the Community division as a reference category, respondents of the Environment and Planning divisions were 8 and 4 times more likely to indicate the correct answer, respectively. An interesting result is related to the conditional analysis of respondents by role seniority and division. The upper management of the Environment division is less likely to answer correctly, while other divisions’ senior managers were broadly comparable.

4.1.2. Knowledge of water framework directive

Answers to indicators capturing the awareness by LA employees of WFD and RBMP issues are reported in Table 4. Overall 82% of respondents cited an awareness of the WFD and its objectives; the share rises to 94% and 87% for employees in the Environment and Planning divisions, respectively. The Community division reported the lowest WFD awareness at 47% of respondents. There is slightly greater awareness of WFD among senior managers at 88% compared 78% among other staff.

General knowledge of the RBMP is slightly lower compared to WFD, as awareness was reported by 77% of respondents. Similarly to the WFD case, the Environment and Planning divisions reported the highest levels of awareness at about 91% and 84% of the employees, respectively. Slightly more than half of respondents from Communities and Roads

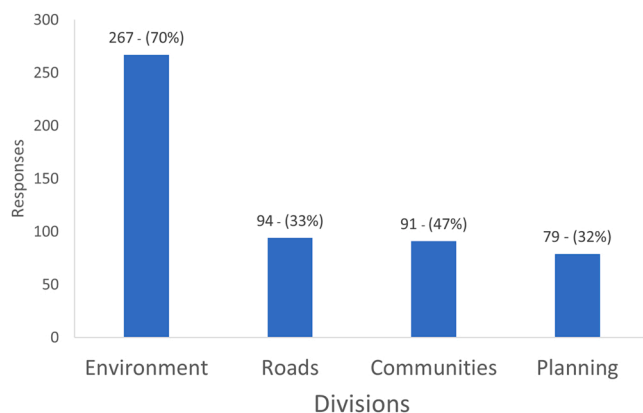


Fig. 1. Respondents by LA (response rate in parenthesis).

Table 2
General knowledge: frequency table.

Question	Options	Sample (%)	Environment Division (%)	Planning Division (%)	Communities Division (%)	Roads Division (%)	Non-senior management roles (%)	Senior management roles (%)
Which of the following organisations are responsible for water quality monitoring or reporting?	Geological Survey of Ireland	9%	12%	8%	3%	5%	8%	9%
	Environmental Protection Agency	79%	84%	82%	68%	77%	76%	85%
	Local Authorities	73%	83%	66%	67%	57%	72%	76%
	DECC ^a	21%	23%	13%	29%	18%	21%	22%
	DHLGH ^a	12%	15%	6%	12%	7%	10%	14%
	Ordnance Survey Ireland	1%	0%	0%	2%	0%	1%	1%
	Met Eireann	0%	2%	0%	1%	1%	1%	2%
How would you describe water quality in Ireland?	Satisfactory	40%	35%	32%	44%	58%	39%	42%
	Unsatisfactory	53%	61%	63%	44%	33%	55%	51%
	Don't Know	6%	4%	4%	12%	9%	6%	7%
How would you describe water quality in your LA?	Satisfactory	48%	44%	49%	45%	62%	48%	48%
	Unsatisfactory	42%	49%	32%	43%	29%	42%	41%
	Don't Know	10%	7%	19%	12%	9%	10%	10%
What proportion of Ireland's 2355 river water bodies assessed nationally do you think are in satisfactory ecological health being in either good or high status?	20–30%	20%	19%	37%	15%	16%	20%	21%
	30–40%	18%	17%	19%	28%	12%	19%	17%
	40–50%	18%	19%	12%	15%	20%	19%	15%
	50–60%	25%	31%	19%	12%	27%	22%	30%
	60–70%	10%	8%	7%	16%	10%	11%	7%
	Don't Know	9%	6%	4%	15%	15%	8%	9%

^a Displayed in the questionnaire as follows: Department of Environment, Climate and Communications (DECC), Department of Housing, Local Government & Heritage (DHLGH)

divisions reported awareness of RBMP. Awareness among senior management roles is higher at 85% compared to 72% among other staff.

The levels of knowledge of specific aspects of RBMP such as the Blue Dot² programme and the PAAs was considerably lower. When respondents were asked whether they were aware of the Blue Dot programme, 52% of respondents answered negatively; around 20% declared to have some knowledge and only around 27% stated to be aware of the programme and its objectives. The awareness of the Blue Dot programme was lowest among Community division staff, where 85% were not aware of the programme. Knowledge of the Blue Dot programme is highest in the Environment division, thought 30% have no awareness of the programme.

When asked about the presence of a Blue Dot water body in their LA area, just 32% of respondents indicated awareness. While there are a relatively small number of Blue Dot catchments across the country, awareness of whether a Blue Dot catchment is situated within a LA area (or not) is an indicator of the priority of RBMP objectives within LA areas. Awareness of Blue Dots is highest at 45% among Environment divisions and lowest among staff of Communities divisions where focus on water related issues is substantially lower. There is no practical difference in awareness of Blue Dot catchments by role seniority.

When respondents were asked whether they were aware of any PAA³ in their local area, 46% of respondents answered positively. This share increased to 67% for Environment division staff. Only 15% and 19% of Community and Roads divisions respectively have knowledge of PAAs within their LAs.

Table 5 shows statistical models that explore variables associated with WFD and water quality related knowledge. The odds ratio for job seniority of respondent is positive and statistically significant in all 5 models, meaning that respondents in senior management roles are more likely to possess a higher degree of WFD/RBMP knowledge. With respect to duration of working experience in LAs, there is no statistical difference in awareness of WFD or RBMP among employees. However, staff

with 10 or more year's experience are twice as likely to be aware of Blue Dot catchments or PAAs than staff with less than 2 year's experience.

The odds ratio associated with division of employment echo the earlier results related to higher awareness among Environment division staff followed by Planning, and Roads staff relative to the Communities division. For example, Environment division staff are 8 times more likely to be aware of Blue Dot catchments in their LA than Communities division staff and over 11 times more likely to be aware of PAAs in their LA. The comparable figure for Planning division staff for Blue Dots is 4 times but in the case of PAAs, Planning division staff are no more likely to be aware of PAAs in their LA area than Communities division staff. Roads and Communities division staff have similar levels of awareness of Blue Dots or PAAs in their LA area. Given the community focus in PAAs it was anticipated that Community division staff would have higher levels of awareness of PAAs than staff in other divisions.

4.1.3. Actions for water quality protection

Activities related to water protection are division-specific, reflecting different functional responsibilities. Survey participants were asked to indicate the actions that are currently undertaken within their LA. It should be noted that answers reflect opinions on actions undertaken rather than data on actual activity.

One question asked across all divisions was whether the objectives of RBMP were included in their decision making (Table 6). Across Environment divisions 61% of staff answered positively, while almost 32% did not know. These proportions differ by seniority, rising to 69% for senior managers compared to 57% in other roles. These differences across (non)-senior management roles are statistically significant based on a Fisher test of independence (p-value < 0.01). A majority of Planning division staff answered 'don't know' (65%) with no statistical difference between senior managers and others (p-value = > 0.10). This is an unexpectedly high figure but may reflect lack of knowledge on whether the procedures were updated since the start of the current WFD cycle (2018–2021) rather than indicating that they don't know if water quality issues are incorporated in their decision making. Responses from Community division staff were similar to those in the Planning division. Last, 38% of Road division staff answered positively concerning inclusion of WFD objectives in their decision-making with respect to roadway and drainage management, with responses significantly different

² The Blue Dot Catchments programme aims to maintain and restore high-status water bodies

³ PAAs are areas deemed at risk of not meeting their WFD objectives and necessitate specific actions to improve water quality.

Table 3
Regression models for the indicators of general knowledge.

	Dependent variable:		
	Water quality, nationally	Water quality, locally	River Ecological status
	(1)	(2)	(3)
Senior Management roles (ref. level: non-senior management roles)	-0.479 (0.565)	-0.283 (0.567)	1.852** (0.878)
Division (ref. level: Communities)			
Environment	0.096 (0.408)	0.240 (0.404)	2.106*** (0.762)
Planning	0.914 (0.570)	-0.218 (0.524)	1.448* (0.870)
Roads	-0.766 (0.515)	-0.383 (0.514)	1.164 (0.883)
Years of experience (ref. level: Less than 2 years)			
2–9 years	-0.296 (0.273)	-0.293 (0.265)	0.157 (0.289)
10 years or more	-0.410 (0.272)	-0.612** (0.267)	0.096 (0.299)
LA region (ref. level: Border)			
Midlands	-0.569 (0.392)	-0.458 (0.378)	0.141 (0.407)
South East	-0.312 (0.442)	-0.263 (0.427)	-0.125 (0.484)
South West	-0.280 (0.394)	-0.226 (0.380)	0.379 (0.406)
West	-0.029 (0.537)	-1.136** (0.519)	0.679 (0.520)
Interactions between role seniority and division			
Senior Management role x Environment	0.820 (0.650)	0.357 (0.644)	-1.887** (0.934)
Senior Management role x Planning	-0.651 (0.827)	0.200 (0.804)	-1.421 (1.090)
Senior Management role x Roads	0.214 (0.779)	0.030 (0.783)	-0.618 (1.074)
Constant	0.933* (0.534)	0.598 (0.520)	-3.076*** (0.840)
Observations	376	376	376
Log Likelihood	-242.067	-251.322	-213.696
Akaike Information Criterion	512.135	530.644	455.392

Standard errors in parenthesis. $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

between senior manager and other roles (p -value < 0.01), similar to the Environment division.

Environment and Communities divisions were asked whether they had commenced a water related enhancement project or identified opportunities to integrate water issues into plans and projects, reported in Table 7. Environment division staff were divided almost equally between yes and no, whereas the majority of respondents of the Communities divisions answered 'Don't know'. While there was no *ex ante* anticipation of likely responses to these questions, they illustrate the wide disparity in knowledge of water-related activities within LAs.

Environment divisions usually have responsibility for enforcement of water pollution incidents. Table 8 lists potential enforcement activities and the proportion of Environment division staff indicating specific measures that are actively used to address either point or diffuse source water pollution. With respect to point source water pollution, Section 4 licence inspections, statutory notices, and unauthorised discharge investigations are cited by the highest number of respondents, implying these are the most frequently used enforcement actions. The proportion of respondents indicating enforcement actions for diffuse source pollution are substantially lower. The most common enforcement action related to diffuse source water pollution is issuing poor land management advisories. 'Cross Report to DAFM' refers to reporting non-compliances to the Department of Agriculture, Food, and Marine

under the Good Agricultural Practice for the Protection of Waters Regulations (GAP Regs/Nitrates Regs), with 59% of staff indicating its use. Cross Compliance is a statutory mechanism designed to ensure the sustainable use of land and the maintenance of natural resources. The absolute number of incidents of cross-compliance reporting is relatively low (EPA, 2020a).

5. Discussion

The stated purpose of the survey on the introductory page of the questionnaire was "to collect data on knowledge and awareness of water quality issues within Local Authority functional areas for the purpose of improving the effectiveness of River Basin Management Planning and achieving national targets with respect to the EU Water Framework Directive." Irrespective of the design, a survey questionnaire eliciting information from staff across a broad range of functional responsibilities, even allowing for questions conditional on the respondent's role, is likely to be inadequate to unequivocally assess staff knowledge and awareness. Instead the survey, as designed, is intended to provide a broad-brush assessment of staff knowledge, which is sufficient to identify where knowledge gaps exist or where remedial actions may be necessary. A more definitive assessment requires an alternative methodological approach, possibly using qualitative interviews.

5.1. General knowledge

The analysis suggests that employees' knowledge of institutions responsible for water quality in Ireland is nominally high, with some differences across divisions. Environment and Planning are the divisions with the greatest knowledge, possibly reflecting interactions with other institutions involved in water management during the course of their work. General knowledge of river ecological status was much lower, with just 25% of respondents correctly reporting ecological status, whereas 46% of respondents either don't know or believe that water quality is satisfactory. For over two decades the Environmental Protection Agency has been documenting the decline in water quality and this statistic suggests that diffusion of that message could be improved. Only a proportion of LA staff might be expected to have detailed knowledge of the issues around water quality but basic knowledge on the status and pressures facing water bodies is essential if LAs are to fulfil their responsibilities across all functional divisions with respect to protecting water quality. Given the importance of LA staff within the context of WFD/RBMP, greater emphasis on knowledge and training with respect to water quality is merited.

A conspicuous finding on water quality knowledge relates to lower knowledge levels among staff in upper management roles within Environment divisions. For example, just 1 in 3 senior managers are aware of the share of rivers with good or high ecological status. Career progression in such roles is not usually dependent on scientific or technical knowledge, however, the lack of awareness of the broader context for water quality in Ireland may influence priorities among competing demands of LA functions. A question asked in this research is whether the strategic vision and priorities related to the RBMP are disseminating through water management governance structures? The survey results suggest that this might not always be the case. While staff in more junior roles appear to have greater knowledge of specific water issues, the lower level of knowledge among staff in senior management roles raises doubt about their awareness of priorities and responsibilities for LAs in implementing the RBMP.

5.2. Knowledge of water framework directive

Awareness of WFD and RBMP is high. The frequency of answers that stated awareness of WFD and RBMP exceeded 75% in both questions. Due to reporting responsibilities and participation in water management governance structures one might anticipate greater in-depth knowledge

Table 4

WFD and RBMP knowledge: frequency table.

Question	Answer Options	Total (%)	Environment Division (%)	Planning Division (%)	Communities Division (%)	Roads Division (%)	Non-senior management roles (%)	Senior management roles (%)
Are you familiar with the Water Framework Directive?	No	18%	5%	13%	52%	28%	21%	12%
	Yes	82%	95%	87%	48%	73%	79%	88%
Are you aware of the River Basin Management Plan 2018–2021?	No	23%	9%	13%	48%	44%	27%	15%
	Yes	77%	91%	84%	52%	56%	73%	85%
Prior to today were you aware of the Blue Dot Catchment Programme?	No	53%	30%	60%	85%	80%	54%	51%
	Yes, but don't have much knowledge of programme	19%	32%	18%	1%	1%	19%	20%
	Yes, and aware of programme and its objectives	28%	37%	22%	13%	19%	27%	29%
The Blue Dot Catchments Programme was created to target the maintenance and restoration of high-status objective water bodies.	Don't know	41%	26%	46%	64%	73%	43%	38%
	No	27%	28%	24%	25%	64%	27%	28%
	Yes	32%	45%	29%	9%	36%	31%	34%
Are you aware if there are any high status objective water bodies, pristine water bodies, also referred to as 'blue dots', within your LA?								
Several 'Priority Areas for Action' have been selected across the country. Are you aware if there are any 'Priority Areas for Action' within your LA?	Not Aware	54%	32%	60%	85%	81%	54%	53%
	Aware	46%	68%	40%	15%	19%	46%	47%

WFD: Water Framework Directive; RBMP: River Basin Management Plan; PAA: Priority Area for Action

Table 5

Regression models for indicators of WFD and RBMP knowledge (Odds ratio).

model:	Dependent variable:				
	Knowledge of WFD <i>logistic</i> (1)	Knowledge of RBMP <i>logistic</i> (2)	Knowledge of Blue Dots <i>ordered logistic</i> (3)	Blue Dots in local area <i>logistic</i> (4)	PAA in local area <i>logistic</i> (5)
Senior Management Role (ref: non-management role)	3.841 ** (1.344)	4.608 ** (1.544)	1.833 ** (0.385)	1.56 (0.368)	1.655 * (0.391)
Years of Experience (ref. level: less than 2 years)					
2–9 years	1.382 (0.519)	0.818 (0.284)	1.289 (0.313)	2.46 * ** (0.689)	1.063 (0.285)
10 years or more	1.297 (0.479)	1.257 (0.441)	1.937 * (0.482)	2.249 * (0.652)	2.083 * (0.577)
Employee's functional area (ref. level: Communities)					
Environment	24.042 * ** (10.747)	12.138 * ** (4.880)	15.992 * ** (5.965)	8.234 * ** (3.598)	11.708 * ** (4.379)
Planning	6.942 * (3.374)	6.323 * (3.130)	4.258 * (1.805)	3.895 (1.936)	3.282 (1.395)
Roads	2.689 (1.046)	1.064 (0.404)	1.361 (0.589)	1.678 (0.848)	1.187 (0.524)
Regional committee (ref. level: Border)					
Midlands	0.603 (0.489)	0.545 (0.378)	0.672 (0.213)	0.238 * ** (0.090)	0.474 * ** (0.191)
South East	0.566 (0.476)	0.549 (0.399)	1.411 (0.518)	0.507 * (0.214)	0.457 * ** (0.206)
South West	0.249 * ** (0.194)	0.168 * ** (0.112)	0.524 * ** (0.168)	0.443 * ** (0.162)	0.278 * ** (0.111)
West	0.447 (0.440)	2.248 (2.745)	2.059 (0.885)	1.11 (0.537)	0.654 (0.343)
Constant	1.112 (0.949)	1.624 (1.210)		0.109 * ** (0.062)	0.272 * ** (0.146)
Cut-off 1			8.605 * (4.122)		
Cut-off 2			46.96 * (23.527)		
Observations	416	415	457	455	453
Log Likelihood	-143.822	-161.181		-242.274	-249.145
Akaike Information Criterion	309.645	344.362		506.547	520.289

Standard errors in parenthesis. $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$ WFD: Water Framework Directive; RBMP: River Basin Management Plan; PAA: Priority Area for Action

Table 6
Inclusion of water quality objectives in decision-making: frequency distribution.

	All	Non-senior management roles	Senior management roles
Environment Division: Have River Basin Management Plan objectives been incorporated into decision making within your LA?			
Yes	61%	58%	69%
No	7%	5%	13%
Don't Know	32%	38%	18%
<i>Fisher test on seniority (p-value)</i>	0.003***		
Planning Division: Has your LA's Planning section updated its internal working process and procedures specifically to incorporate water quality issues in the planning decision process since 2018?			
Yes	26%	28%	25%
No	9%	3%	14%
Don't Know	65%	69%	61%
<i>Fisher test on seniority (p-value)</i>	0.1094		
Communities Division: Have River Basin Management Plan objectives been incorporated into decision making within your LA, such as projects on rural recreation or town & village renewal?			
Yes	23%	17%	31%
No	11%	6%	17%
Don't Know	66%	77%	52%
<i>Fisher test on seniority (p-value)</i>	0.46		
Roads Division: Have River Basin Management Plan objectives been incorporated into decision making within your LA with respect to roadway engineering, maintenance, or drainage?			
Yes	38%	23%	56%
No	19%	16%	22%
Don't Know	44%	61%	22%
<i>Fisher test on seniority (p-value)</i>	0.0014***		

Table 7
Plans and projects of Communities and Environment divisions.

Environment division		
<i>Has your LA commenced any natural water resource related enhancement projects or initiatives in the last 2 years?</i>		
Yes	No	
49%	51%	
Communities division		
<i>Has your LA identified new opportunities to integrate natural water resources into plans or projects?</i>		
Yes	No	Don't know
28%	3%	68%

or awareness of WFD/RBMP among staff in senior management roles. The survey elicited data about high-level awareness rather than in-depth knowledge, information that one would anticipate would disseminate through all hierarchical governance structures. The statistical analysis shows that senior managers across all divisions are 4–5 times more likely to be aware of the WFD/RBMP and about twice as likely to be aware of the Blue Dot programme compared to junior staff. This suggests that information about water management does not circulate effectively to non-senior management roles within LAs. Staff in non-senior management roles include executives and technicians that are responsible for day-to-day operations that impact on water quality. It is crucial that they are aware of water-related issues, particularly, critical initiatives such as

Table 8
Proportion of Environment division staff indicating specific enforcement measures are utilised.

What initiatives does your LA undertake to actively address Point Source Water Pollution?		What initiatives does your LA undertake to actively address Diffuse Source Water Pollution?	
Section 4 Licence inspections (Water Pollution Act, 1977)	80%	Serve statutory notices under legislation	57%
Serve Statutory notices under legislation	73%	Cross Report to DAFM under the Good Agricultural Practice for the Protection of Waters Regulations (GAP Regs/Nitrates Regs)	55%
Prosecute pollution incidents in the courts	63%	Utilise GIS tools to help identify critical source areas for diffuse pollution and target farm inspections in these areas	41%
Carry out a planned programme of farm inspections	65%	Undertake additional monitoring to isolate potential areas of diffuse source pollution	47%
Cross Report to DAFM under the Good Agricultural Practice for the Protection of Waters Regulations (GAP Regs/Nitrates Regs)	59%	Deliver a communications/engagement programme to promote best practice, e.g. pesticide use, slurry spreading	42%
Undertake unauthorised discharge investigations	77%	Promote nutrient management planning	42%
Implement a planned programme targeting water quality issues	52%	Engage with agricultural contractors to communicate best practice	24%
		Issue advisory or warning letters in relation to poor land management practices	66%

DAFM: Department of Agriculture, Food and the Marine; GIS: Geographic information system GAP: Good Agricultural Practice

Blue Dot programme and PAAs.

It was anticipated that staff in Environment divisions would have the highest levels of awareness of water related topics as water management falls closest to their areas of functional responsibility. The relative difference in awareness across divisions is very high. For instance, Environment division staff are 11 times more likely to be aware of PAAs within their LA area than Communities division staff, as reported in Table 5. This finding is particularly relevant in the context of WFD/RBMP advocating a deeper involvement by local communities in water management. The Local Authorities Water Programme is undertaking several initiatives of community engagement to improve awareness of water quality and increase participation in water management. Given the limited knowledge among Communities division staff, especially related to PAAs in their local area, engagement with the public on water protection issues is likely to be low.

5.3. Water quality proofed decision making

The overarching conclusion from survey responses is that most staff are aware of what activities are undertaken for water quality protection and how LAs incorporate water protection in their decision-making. Overall, the large frequency of 'don't know' responses to questions about how RBMP objectives have been incorporated into decision making within their specific division indicates that WFD/RBMP objectives are not clearly appreciated in daily work. The situation among Environment divisions is the most positive, as might be anticipated, nonetheless 32% of Environment division staff do not know whether RBMP objectives are considered in their decision-making, as reported in Table 6. Not all employees in Environment divisions have direct responsibility for water quality, however, as water quality is inextricably linked to many other aspects of environmental quality, strong coordination across all employees in the Environment division is essential.

Planning division staff are responsible for development plans, which set out the planning policies within the LA functional area. Development

plans must be compatible with national and regional planning strategies, and also incorporate an environmental report that highlights any significant environmental effect the plan may have. The survey results raises the question as to whether RBMP objectives are being adequately incorporated in LA development plans.

5.4. Enforcement

A simple comparison of enforcement actions indicates that more enforcement actions arise on point as opposed to diffuse source water pollution. With better resources and enforcement tools, point source pollution is easier to detect and identify the malefactor compared to diffuse source pollution. EPA (2020b) concludes that the most significant pressure on the ecological health and quality of waters is agriculture and that within agriculture the first cited pressure is the run-off of nutrients and sediments from agricultural land. While point source pollution is not to be ignored, a greater enforcement focus on diffuse source pollution is merited.

LAs' enforcement actions are concentrated around a limited number of actions within a larger set of possible measures. As noted earlier, there is relatively low level of cross-compliance reporting. With just 3878 on-farm inspections in 2019, which represents less than 3% of farms, the Environmental Protection Agency is seeking an increase in the level of cross reporting and notes that LAs' reluctance to follow the cross-reporting approach to enforcement is because it can result in loss of stakeholder engagement where financial sanctions are applied and that minor non-compliance can be resolved through other enforcement actions (EPA, 2020a, EPA, 2021). It is therefore surprising that the softer enforcement actions, such as communicating best agricultural practices or promoting nutrient management planning, are among the least utilised enforcement measures.

5.5. International context

While there is an extensive international literature on WFD implementation, especially related to public participation, empirical studies on how conditions of governance could improve specific water quality issues are scarce (Wuijts et al., 2018). A key gap within WFD governance identified among stakeholders is poor coordination, communication and fragmentation of knowledge (Dawson et al., 2018; Zingraff-Hamed et al., 2020). This finding is based on data elicited from stakeholders about WFD governance across countries' full WFD or RBMP organisational structures, including central and local government, and environmental monitoring and protection agencies. The novelty of this research is that it looks within one organisational element of that structure, local government, one where Rollason et al. (2018) suggests that effective dissemination of knowledge across operational levels is crucial to achieve water quality goals. Findings from this Irish case-study are consistent with the wider evidence elsewhere. For example, the high levels of awareness of WFD and RBMP among LA staff, is consistent with the situation in Sweden where prioritisation of water-related issues among public officials has improved (Dawson et al., 2018). However, lower levels of in-depth knowledge (e.g., ecological status or whether water quality is satisfactory, PAAs, or Blue Dot catchments) also echoes the issues of knowledge fragmentation and insufficient resources to synthesise information cited by Dawson et al. (2018) and that poor knowledge communication within public bodies (e.g. environmental agencies, or administrations) is a barrier to WFD implementation, as suggested by Zingraff-Hamed et al. (2020). Although the context of this paper is limited to the Republic of Ireland, similar studies could be replicated in other European countries. But as noted by Boeuf and Fritsch (2016) in a wider WFD implementation context, there are a glut of single-country studies and that cross-country comparative studies may be more helpful to understand the issue of knowledge communication within public bodies and its impact on improving water quality.

6. Recommendations

LA staff have responsibility for day-to-day decisions on many issues that ultimately impact on water quality (e.g. environmental protection, roads drainage, planning and development). Knowledge of water quality and specific issues relevant to the RBMP is relatively high among some LA staff but the survey research demonstrates that there is considerable scope for improvement across all divisions, including among Environment divisions where knowledge is greatest. Based on the survey research, recommendations are outlined below to improve the dissemination of pertinent information through the tiers of water governance within LAs and also improve the knowledge and competencies of staff to help people perform better in their roles. The recommendations fall across three areas: training, dissemination, and networks. .

1. Training

LA staff do not all need the same level of knowledge and expertise related to water quality and WFD/RBMP. Depending on functional area and role, different competencies and knowledge levels are required to effectively complete their work. Training should be established to help people perform better and more efficiently in their jobs.

(a) Induction training

A module on water quality and river basin management should be included in new staff induction training that includes a key learning point that staff should seek assistance from colleagues when issues arise that may have a potential impact on water quality.

(b) Role-based training

Within functions with a more direct link to water quality, bespoke role or function based training should be established with modules focusing on mapping and data resources; interpreting relevant data; guidance on framing of planning conditions.

(c) Continuing professional development

As legislative contexts, scientific knowledge, resources and practices are continually evolving, role-based training should be repeated on a regular recurring basis.

(d) Senior managers

Senior managers may not personally require highly technical or in-depth knowledge to successfully fulfil their roles but specific training for senior management roles should focus on priorities and responsibilities for LAs in implementing the RBMP.

(e) Training provision

Centralised development and provision of training will ensure consistency across LAs. The Local Authority Services National Training Group (LASNTG), which already develops and delivers a broad range of training to LA staff is ideally suited to undertake this role.

2. Dissemination

The survey research confirms that there is room for improvement in the dissemination of information related to water quality among LA staff, including policy priorities and national programmes (e.g. Blue Dots, PAA). While senior managers are members of various RBMP governance structures (e.g. National Co-ordination & Management Committee, Regional Local Authority committees), the survey research fails to demonstrate that more junior staff have sufficient awareness of national priorities related to water quality. This is especially relevant in the Environment and Planning divisions where LA decisions can have a direct impact on water quality.

(a) Each LA should assess its internal communications processes to determine whether staff at all levels are being adequately briefed on water quality issues. Are staff receiving sufficient and regular updates relevant to their job function? Are staff aware of national policy priorities? Do staff understand the motivation behind

internal processes and notifications? Are staff aware when issues should be escalated or when other teams should be notified?

- (b) The Environmental Protection Agency should assess its dissemination strategy for water quality information. The target audience or the people attending its conferences and workshops or reading its reports may not be sufficiently wide. It should consider how it can more actively engage with LA staff, especially in Environment and Planning divisions, across all job levels to improve awareness of the status of water quality and increase understanding of how their work contributes to water quality protection.

3. Networks

Staff working in specific functional areas, such as Environment and Planning, often have extensive workloads shared among relatively small teams. Within smaller teams practical experience and institutional knowledge can be limited, while extensive workloads can limit the time devoted to particular issues. The Network for Ireland's Environmental Compliance and Enforcement (NIECE), whose vision is improving the implementation of environmental protection legislation, is a forum to support public authority staff, including LA staff, share experiences and support each other in environmental protection work.

7. Conclusion

Achieving WFD targets of good ecological status for all water bodies necessitates successful implementation of a myriad of measures. A key element of achieving this is that water governance structures effectively operate and communicate with each other. This research examines one aspect, the extent to which knowledge of water quality issues and RBMP objectives disseminate through water management governance hierarchies into Local Authority functional areas and work responsibilities. Three main questions were addressed: 1) whether employees are aware of the status of water quality in Ireland, 2) whether employees possess technical knowledge on water framework directive and river basin management plan, and 3) whether employees are aware of the actions undertaken for water quality protection and enforcement.

The answers to the three questions are similar. There is a good level of general knowledge, e.g. awareness of WFD and RBMP particularly at national level. Detailed knowledge, specifically related to PAAs and Blue Dot catchments within staff's own LA area, is substantially lower. Knowledge levels are highest among Environment division staff. Knowledge levels also differ by length of service, and by whether in managerial roles or not. Senior managers were 3–4 times more likely to have knowledge of WFD and RBMP compared to junior staff, for example. When focusing on PAAs or Blue Dots within their own functional area that difference in knowledge is substantially lower. Therefore, one can conclude that while general knowledge and awareness levels are relatively high, there is considerable scope for improvement across all divisions.

The dissemination of RBMP priorities and actions through water governance hierarchies is evident. For instance, knowledge among senior managers, who are higher up the hierarchy, is greater than more junior staff, which is consistent with the fact that the same level knowledge and expertise related to water quality and RBMP is not required across all functions and roles. However, there is also some evidence that a better balance may be necessary, especially in functions with direct impact on water quality. For instance, reported water quality knowledge among staff in senior management roles within Environment divisions is relatively low, with just 1 in 3 of such senior managers knowledgeable on the ecological status of rivers. This finding may also reflect the challenging context within which LA staff work, as the competing priorities of LA functions do not all have a direct connection with water quality. Nonetheless, it is imperative that LA staff have a strong understanding of LA responsibilities and how these fit within the wider water governance hierarchy. More than half of LA respondents

were not aware of the Blue Dot catchments and PAAs within their local authority area. The success of initiatives such as the Blue Dots catchment programme and the PAAs relies on broad engagement across all sectors of society to protect water quality. From a local government perspective this means that these initiatives are not just the preserve of the Environment division but require a comprehensive cross-organisation approach to their delivery.

CRedit authorship contribution statement

John Curtis: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft, Writing – review & editing, Project administration, Funding acquisition. **Gianluca Grilli:** Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft, Writing – review & editing, Project administration

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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