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Water quality for citizen confidence: The implementation process of 2020 EU Drinking Water Directive in Nordic countries

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ABSTRACT

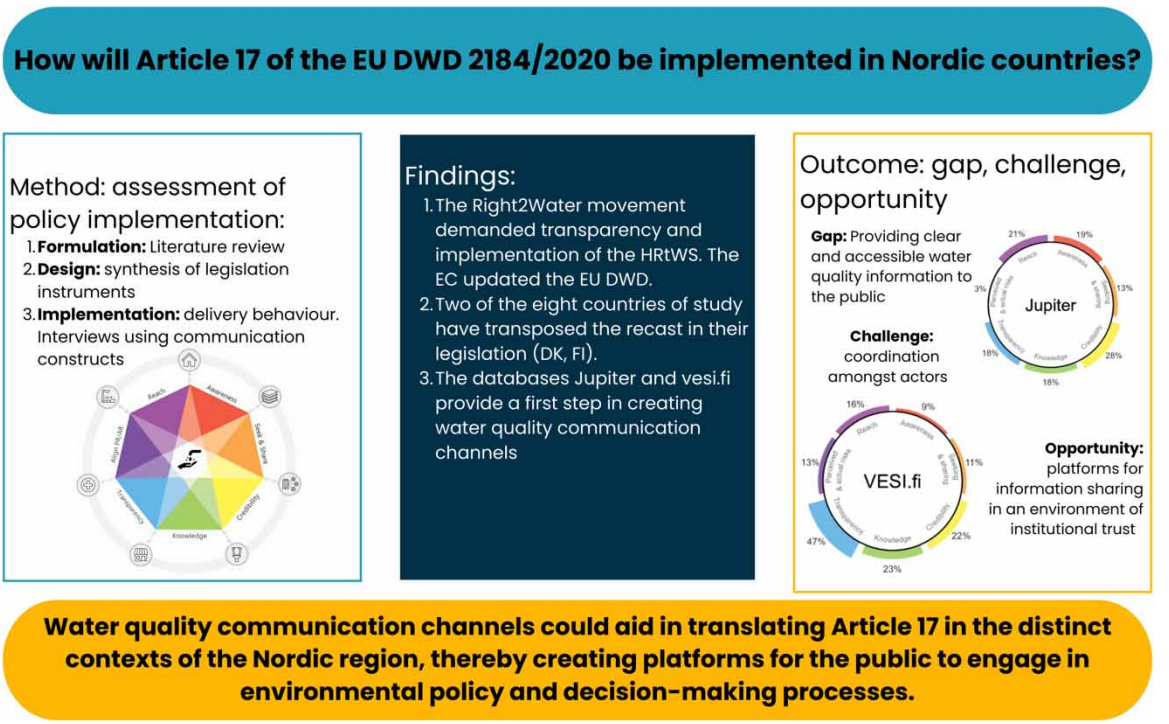
The European Union Drinking Water Directive aims to protect human health and promote safe water consumption. The 2020 revision, particularly Article 17, directed member states to provide public access to information on drinking water. This update responded to citizen initiatives calling for the active participation of end-users in water services and greater transparency from water utilities. Difficulties in implementing previous versions of the directive highlighted divergences between policy purposes, local capacity to implement, and public response. These divergences are explored through eight case studies of Nordic countries and analysed using the policy implementation framework. We employed a mixed-method, multi-stage approach. Policy formulation was characterized through a literature review, policy design by synthesizing legislative instruments, and policy implementation via an analysis of delivery behaviour based on interviews. We identified the main drivers of the directive's update and contrasted these with the ongoing implementation process in the countries studied. Our results point to a different and highly contextual implementation, which differs from the primary drivers of the policy update, namely, the establishment of public confidence in water services.

Key words: Citizen confidence, Communication, Drinking Water, EU drinking water directive, Policy implementation, Water quality

HIGHLIGHTS

- The EU DWD 2020/2184, through article 17, requires MS to provide drinking water information to the public. This requirement arrived as an outcome of the Right2Water ECI.
- Eight Nordic country case studies, analysed using a policy implementation framework, reveal differential implementation advancements and difficulties in aligning policy goals, local implementation capacity, and public response.
- The quality of life at a particular place and time is related to the quality of the water service. Water utilities play a complex role of providers of a basic resource, developers of water quality data, and guarantors of trust between end-users and policymakers.

GRAPHICAL ABSTRACT



1. INTRODUCTION

The European Union Drinking Water Directive (EU DWD) is a legislative instrument aimed at ensuring the safety and quality of drinking water across EU member states (MS) (European Parliament and Council of the European Union, 2020). The EU DWD has influenced the ways water utilities conduct their services and ensure compliance with national regulations in Europe (Jenkins, 2005, 2008). Previous evaluations of the transposition of this instrument found the slow implementation of the directive, prompting legal actions against some of the countries of study (Roccaro *et al*., 2005). Jenkins (2010) found differing levels of compliance with the directive in association with distinct political ideologies, when analysing the policy implementation in Northern Ireland, England, and Wales (Jenkins, 2010). In addition, compliance with water quality standards has not been straightforward because the same parametric values apply to all MS despite different geographical, geochemical, economic, and social conditions across the EU (Weinthal *et al*., 2005; Dolan *et al*., 2013; Ramm, 2022). These implementation challenges have rendered mixed compliance outcomes, some of which have been addressed in regular revision periods of the policy (Tosun *et al*., 2020; Andries *et al*., 2024).

The 2020 recast of the EU DWD (2020/2184) introduced, among several other updates, Article 17 instructing member states to provide clear and accessible information to the public regarding water quality and drinking water risks (European Parliament and Council of the European Union, 2020). Article 17 of 2020/2184 replaces Article 13 of the previous version of the directive (98/83EC), which required member states to make up-to-date information available to consumers and report on the quality of water intended for consumption every 3 years (Council of European Union, 1998). An important difference between the two is that Article 17 of the recast

specifies frequency (regularly and at least once a year) and type (water quality, price of water, and volume consumed) of water service information end-users must receive without having to request it and in the most accessible possible form (European Parliament and Council of the European Union, 2020, p. 29). This update is of relevance since few other regional policy instruments have made such an emphasis on making water services information available and accessible to end-users (Andries *et al*., 2024).

The focus on provision of water service information to end-users can be understood through distinct perspectives. The 98/83/EC directive acknowledged *individuals' rights* to obtain adequate information about the quality of water intended for human consumption (Council of European Union, 1998 recital 32). The 2020/2184 recast aims to *improve transparency and increase citizens' confidence* by providing relevant water quality information (European Parliament and Council of the European Union, 2020 recital 40). Some authors suggested the 2020 update could potentially induce a reduction in bottled water consumption (Tosun *et al*., 2020). Theory on policy implementation and public administration provides useful lenses to help study how these distinct perspectives come to play in regional policy instruments (Pierre & Peters, 2012). For example, Jenkins (2010) noted the importance of documenting the political and historical context in which a policy is formed while analysing the implementation of earlier versions of the Directive[1] in England and Wales (Council Directive 80/778/EEC, 1980; Jenkins, 2010). In his work, Jenkins (2008) also argued that focusing on the policy formation stage offers a valuable perspective for evaluating the success of policy implementation (Winter, 2005; Jenkins, 2008). In the case of the 2020/2184 DWD update, the policy formation stage was influenced by a European Citizen Initiative (ECI) promoting the Human Right to Water and Sanitation (HRtWS) and the Sustainable Development Goal 6 (SDG6) (Right2Water, 2014).

In 2013, the ECI Right2Water gathered more than 1.6 million signatures of citizen support demanding, among others, the active implementation of the HRtWS in the EU (Right2Water, 2014; Lippitsch, 2020; Laaninen, 2021; van den Berge *et al*., 2022). A year later, the European Commission (EC) presented the recast of the EU DWD as a way to address the demands of the ECI, aiming to increase confidence in tap drinking water. However, challenges in the implementation of previous versions of the EU DWD warn of the gaps between the stated purposes of the water policy and its implementation at country and local levels (Jenkins, 2008; Brouwer *et al*., 2020; Tosun *et al*., 2020). An example was provided by Gunnarsdottir *et al*. (2020), when they studied the uptake of risk-based approaches in the regulations of large- and medium-scale water supply systems in Nordic countries, finding far less advancement in smaller water supplies (Gunnarsdottir *et al*., 2020). Similarly, the goal of increasing consumer's confidence in water services could run short when compared against the initial demands of the ECI since trust[2] in tap water has been found to encompass a broad and complex range of variables, associated with the ways end-users interact with information (de França Doria, 2010; Weisner *et al*., 2020).

Consumer confidence in drinking water quality has been found to be influenced by joint and individualistic perceptions of trust towards the water supplier (Heino & Anttiroiko, 2016; Brouwer *et al*., 2020; Grupper *et al*., 2021; Schubert *et al*., 2024). Usually, water providers address issues of mistrust and/or reliability through the establishment of communication channels to inform end-users about updates in the water service (Heino &

[1] Council Directive 80/778/EEC of 15 July 1980 relating to the quality of water intended for human consumption.

[2] *Confidence* is mentioned twice in the 2020/2184 EU DWD. Recital 11 relates parameter monitoring to increasing and maintaining *consumer confidence* in water quality. Recital 40 relates consumer knowledge of relevant information and improved transparency to *citizen's confidence* in the water supplied. Since EU directives provide general direction to MS, the interpretation and implementation of the word *confidence* is discretionary. Here, and elsewhere in the article, we operationalise *confidence* as a state of assurance, or the *trust* consumers could have in the service and quality of water.

Anttiroiko, 2016; Seeger *et al*., 2018). However, research on communication strategies and their relationship to policy implementation in water services is relatively scarce (Sallaku *et al*., 2018; Tian *et al*., 2021; Giacomini *et al*., 2022). Heino & Anttiroiko (2016) analysed information needs, communication channels, and communication asymmetry in Finland, revealing the instrumental and supply-oriented view that some water utilities have on utility-customer communication. More recently, Brouwer *et al.* (2020) found, after surveying how end-users perceive the quality and safety of their tap water in the Netherlands, that transparency and availability of information about treatment and quality could contribute to increase customer trust (Brouwer *et al*., 2020). Thus, a gap remains in understanding the communication strategies used between water utilities and consumers, and whether they help increase confidence in tap drinking water.

The prescribed instructions for the establishment of confidence in water services contrast with the distinct views and relationship asymmetries between water service providers and end-users (Quevauviller, 2010; Praxis Group, 2012; Heino & Anttiroiko, 2016). Hence, there is a need to document the existing approaches to provide water quality information to end-users and assess whether these could constitute effective communication strategies to encourage consumer confidence in drinking water quality (Heino & Anttiroiko, 2016; Bartram & Setty, 2021; Venot *et al*., 2022). Dissemination of water quality information to the public requires special consideration of the efforts and resources needed, as well as the contextual factors that determine success (Seeger *et al*., 2018). The study of communication practices could ease these tensions by documenting current approaches and designing communication strategies with honest consideration of the people at the receiving end of the water supply scheme (Cash *et al*., 2003).

The EU DWD 2020/2184 was adopted in December 2020, entered into force in January 2021, and since January 2023 MS have had to put efforts into transposing the Directive into national law and start complying with its provisions. In this article, we used the *integrated implementation model* (Winter, 2005) as a framework to study the policy implementation process of Article 17 of the 2020/2184 EU DWD. Through this approach, we identified the origins and drivers of the directive's update. Then, we used these drivers to document the advances, gaps, and challenges in the implementation of Article 17 of the EU 2020 DWD 2020/184 both at country and small water utility levels. We focus on the Nordic countries to assess the implementation of Article 17 because most households in this region have universal household piped water, there is a longstanding notion of compliance with water quality standards, and despite this, there is still work to be done to ensure universal access to safe drinking water (Heino & Anttiroiko, 2016; Gunnarsdottir *et al*., 2017; Hyllestad *et al*., 2020). Thus, our study focuses on the implementation of the recast in Denmark, Finland, Iceland, Norway, and Sweden – along with the self-governing nations of Åland Islands, Faroe Islands, and Greenland.

2. METHODS

2.1. Research approach

Our work aimed to answer three research questions: *what were the main drivers for the inclusion of Article 17 and Annex IV in the 2020/2184 recast of the EU DWD? What are the existing approaches to provide water quality information to end-users in Nordic countries?* and *could these approaches constitute effective communication strategies to encourage consumer confidence in tap drinking water quality?*

Since Article 17 of the 2020/2184 EU DWD is embedded in the EU DWD policy update, we adopted a policy implementation research approach to answer our research questions. Policy implementation research is a subdiscipline of public administration and policy analysis literature. It focuses on analysing the content, causes, and consequences of public policies, with special attention to how legislation is executed from a behavioural

perspective (Pierre & Peters, 2012). Studies of policy implementation can follow a top-bottom, bottom-up (Sabatier, 1986; Saetren & Hupe, 2018), or integrative approach (Winter, 2005).

Winter (2005) proposed the integrated implementation model (IIM) to study policy implementation, consisting of four interrelated variables: policy formulation, policy design, implementation process, and implementation results. The policy formulation identifies the main drivers and politics of policy formation, policy design characterizes the goals, instruments for obtaining these goals, and the entity(ies) charged with carrying out the goals; the implementation process aims to understand the organizational behaviours when executing the policy, that is, studying policy outputs as delivery behaviours and policy outcomes as target group behaviours (Winter, 2005).

We chose the IIM (Winter, 2005) as the theoretical framework to guide our analysis of Article 17 of the 2020/2184 DWD since it allowed us to study the policy update as an active continuum, from its political and societal origins to the current strategies of implementation in the Nordic countries. First, we developed a literature review to characterize the policy formulation of the 2020/2184 recast. Second, we evaluated the policy design and implementation process by synthesising the relevant legislation instruments in each of the countries of study and interviewing representatives from entities in charge of implementing the EU DWD 2020/2184, i.e., government agencies and water utilities. To evaluate whether policy outputs (i.e., delivery behaviours) can establish effective communication channels that create confidence in tap drinking water, we analysed interview data using an adapted set of communication constructs derived from the literature on behaviour systems and water quality perceptions (de Franca Doria *et al*., 2005; Michie *et al*., 2011). This study considers the first three variables of IIM, since the recast of the 2020/2184 EU DWD is relatively recent and assessing policy outcomes and implementation results is beyond the scope of the research project.

2.2. Characterisation of policy formulation

We conducted a literature review to identify relevant publications related to the EU DWD and its updates. First, we developed an online search using electronic databases (Scopus, Web of Science, Google Scholar, EUR-Lex, opengrey.eu, and Connected papers) and a general search strategy ('European Union' AND 'Drinking Water Directive' AND update*). Second, title and abstracts were screened for geographical relevance and full online accessibility ($n = 247$). Third, the final set of publications, coming from the previous search and additional records from hand search of reference lists comprised 43 full texts,[3] listed in the supplemental information (S1). The resulting bibliography included official EU reports, special rapporteur reports, peer-reviewed articles, media, and webpages. Data were analysed through thematic content analysis to identify topics and themes related to the EU DWD and the drivers of the 200/2184 update. The results are presented in a narrative form to highlight the stream of events leading up to the directive's update.

2.3. Assessment of policy design and implementation process

2.3.1. Policy design

Specific legislation regarding public access to water services information in the countries of study was identified via official online platforms and personal communication with environmental agencies and authorities. The contents of the legislation instruments were assessed against the requirements of Article 17. The legislation instruments were organized in a country versus legislation table, see Table 1.

[3] The bibliography consists of 1 bill, 1 book, 25 journal articles, reports, and 12 webpages. For details, see Supplemental Information 1 (S1).

Table 1 | Legislation instruments, entities in charge, and advancements on implementing Article 17 (EU DWD 2020 /2184) Nordic Countries[a].

Article 17/country	AX	DK	FO[b]	FI	GL	IS	NO	SE
Overall legal framework for drinking water quality	Reg on WQ and Surveillance (17/11/2015/1352) – led by the Environmental and Health Protection Authority (AMHM) Decree 85:2023 on water supply information system and information	Reg on WQ and Surveillance (Decree on water quality and supervision of water supply facilities BEK nr 1023 of 29/06/2023) and Water Act (nr 602 of 10/05/2022) – led by the Environmental Protection Agency Reporting obligations into Jupiter Database (Ch. 6, Bek. Nr. 1023 of 29/06/2023) Order on the publication of information by water utilities to consumers (Bek nr. 538 of 28/05/2024)	Drinking Water Regulation (nr. 127/2013) -led by the Food and Veterinary Authority Recently adopted the EU DWD 98/83	Reg on WQ and Surveillance (17/11/2015/1352) - led by National Supervisory Authority for Welfare (Valvira) Water services act (119/2001) Decree 6/2023 on water supply information system and information	Self-government ordinance on water quality and supervision of water supply facilities The self-government's executive order no. 63 of 4 November 2021 on water quality and supervision of water supply facilities	Drinking Water Regulation (536/2001) with changes (145/2008 and 570/2018) and Food Act (95/1995) drinking water is defined as food – demanding HACCP to food producers. Nine LCAs operated by the 69 municipalities are responsible of surveillance.	Regulation on Water Supply and Drinking Water (FOR 2016-12-22-1868). Food Act LOV-2018-06-22-76 - Five regional food safety authorities (Mattilsynet)	Swedish food act (SFS, 2006:804). Swedish Drinking Water Regulation (20230101 by LIVSFS 2022:12) Public Water Services Act (SFS 2006:412 lag om allmänna vattentjänster) The Swedish Environmental Code (1998:808) requires information on the quality of water to be communicated

(*Continued.*)

Table 1 | Continued

Article 17/country	AX	DK	FO[b]	FI	GL	IS	NO	SE
Paragraph 1 Member states shall ensure that adequate up-to-date information on water intended for human consumption is available in accordance with Annex IV, while complying with applicable data protection rules	Information on water quality at each water supply should be available either in Internet or upon request. Water quality analysis results are at Åland's environmental and health protection authority, but they are not available online.	Information on water quality at each water supply should be available at the water supply homepage. Data are also available on the database Jupiter. The new order on the publication of information instructs water utilities to inform consumers regularly and at least once a year.	N/A	Information on water quality at each water supply should be on database VATI and from there connected to vesi.fi publicly available webpage for latest water quality. The 2014 Water Services Act mandated water suppliers working within the scope of a municipality to enter their WSS data into VEETI The recent Act on water services refers to drinking water directive on how the obligation to provide information is implemented.	Not required. Data available in Jupiter, but only in Danish. Regulations require annual summary report to be submitted by the utility to the regulator. A summary report must be published in public every fifth year on the water quality.	LCAs are to deliver a yearly report on results from monitoring to MAST. This is to be summarized into a report accessible to users. LCAs shall inform users on non-compliance to regulation, on remedial action taken and guidance. All LCAs display water quality information on the website but to varying degrees Large and some medium size water supplies have various information on the website and in a yearly report.	Information should be available from each water supply on their website or results should be mailed to the users. Four of the six largest cities publish yearly or monthly reports on their webpage. A national database is built from the suppliers' reports to the Food Safety Authorities. Based on this Norwegian Institute of Public Health publishes a yearly report with compiled data.	Information on water quality should be made available on the website of the water supply owner. Large water supplies have yearly reports. Small water supplies obliged to answer quality questions from users within short notice. Reporting on drinking water will become mandatory when the Swedish Food Agency's regulations LIVSFS (2022:12) are updated with a reporting obligation for water producers and suppliers, as per Section 34 b of the Food Regulation (2006:813).

(*Continued.*)

Table 1 | Continued

Article 17/country	AX	DK	FO[b]	FI	GL	IS	NO	SE
Paragraph 2 Member states shall ensure that all persons supplied with water intended for human consumption receive the following information: Information on the quality of water The price of water, per litre and cubic metre The volume consumed at least per year or billing period. Comparisons of the yearly water consumption Link to website containing information set out in Annex IV.	The relevant information about volume consumed and price are reported via water bill Authorities are advised to upload relevant information on their own Internet pages.	Information generally available on utility's webpage. Information on price, volume consumed, trends, and comparisons of annual water consumption is provided to water recipients on invoices or via Digital Post, with an opt-out option for digital delivery.	N/A	In decree 6/2023 on water supply information system and information, section 3 lists information to be available in the annual billing of water (or available in similar fashion) considering points 2-4. Points 1 and 5 included in degree by a link to website. Billing of water based on consumption.	Not required. Water quality data available on Jupiter, however, only in Danish. Link to Jupiter on Nukissiorfiit website. Price: Unit price is the same for all piped consumers despite highly variable production costs. Water is free for un-piped households fetching at community tap point. Price is available online on Nukissiorfiit webpage (Nukissiorfiit Vand, (2024)).	Not required in current DW regulation. Tariffs for water and per cubic metre are available on the municipality's website for larger supplies. Drinking water not metered for households and tariff is fixed fee for household according to size or real estate appraisal Water is metered for industry and gets yearly overview of water use via bill. Industry gets yearly overview of water use via bill.	Prices per cubic meter can be found on the municipality's webpage. By 2022, water meters were installed in 37.4% of the households. The water consumption is probably still unknown for a large part of the population.	Not required in DW regulation. LIVSFS 2022:12 32 § Operators providing drinking water must: Inform consumers and advise them immediately if water use is restricted or other health measures are taken. Notify consumers about corrective actions. Inform consumers when the health risk is resolved, and normal.

Note: AX, Aaland; DK, Denmark; FO, Faroe Islands; FI, Finland; IS, Iceland; NO, Norway; SE, Sweden, GR, Greenland.

[a]Information on legislation transposition was last updated July 2024.

[b]Not applicable (N/A).

2.3.2. Policy implementation

Two sets of interviews were conducted to assess *delivery behaviours* in each country, i.e., the existing water quality communication strategies to provide water service information to the public. The first set of interviews was described by Gunnarsdottir *et al.* (2023). Briefly, a questionnaire was prepared in English with general questions about water services, including two questions assessing communication about water quality information at country or governmental organizations, surveillance authorities, and at the small water supply level:

- *How are water quality rules and regulation communicated with; the authorities, the water supplier, users/consumers? Can information exchange be improved and then how?*
- *Is the latest drinking water quality information for your water supply available to the public and consumers, and how are they presented?*

The questionnaire was translated into local languages by the country research representative(s) in the project. Interviewees received an introduction to the project and interview outline before participating. Interviews were conducted via web-based conferences, face-to-face, or telephone; recorded; and transcribed in the interviewee's preferred language. A total of 53 individual interviews across the eight countries of study were conducted, comprising interviews from small water supplies (27), representatives from water supplier associations (5), and government authorities (21) (Gunnarsdottir *et al.*, 2023).

Through the literature review, legislation synthesis, and the first set of interviews, we identified two online water quality databases that already provide access to water quality information: Jupiter in Denmark (GEUS, 2022), and vesi.fi in Finland (Finnish Environment Agency, 2022). We hypothesized that these databases could constitute important platforms of information provision and thus designed an additional questionnaire to capture the current approaches to provide access to water quality data through these databases. Two sets of online and in-person interviews with representatives from government, state, and research institutions, along with surveillance authorities in charge of overseeing and maintaining these databases, were developed during the first semester of 2022. The full questionnaire to assess the current practices to provide information to the public through these databases can be found in the supplemental information (S2).

Interview data were analysed using predefined communication constructs (reach, awareness, seek/share, credibility, knowledge, transparency, and alignment of perceived and actual risk) to identify notions of and nuances associated with *delivery behaviour* (Winter, 2005). These constructs stem from research on drinking water quality perceptions (Lidskog, 1996; de Franca Doria *et al.*, 2005; Seeger *et al.*, 2018; Brouwer *et al.*, 2020; Grupper *et al.*, 2021) and behaviour systems (Michie *et al.*, 2011). The process of deriving these constructs and their definitions can be found in the supplemental information (S3). The graphical output of this analysis shows the frequency with which each construct was mentioned, referred to, or noted by our interviewees, and thus, overlaps in texts are present. Reviewed literature, legislation, and interview data were analysed following QDA phases (Baptiste, 2001) and conducted using NVivo 10, RStudio (R Core Team, 2023; Posit team, 2024), and the tidyverse package (Wickham *et al.*, 2019).

3. RESULTS

3.1. Policy formulation: the recast of the EU DWD to address the Right2Water ECI

The current EU DWD (EU 2020/2184) was formally adopted by the European Parliament on 16 December 2020 and entered into force on January 12, 2021 (European Parliament and Council of the European Union, 2020). It updated water quality standards, introduced the risk-based approach to safeguard drinking water, established new hygienic requirements for materials in contact with drinking water, called for improved water access for vulnerable and marginalized groups, and presented a watch-list mechanism to address concerns about endocrine

disruptors, pharmaceuticals, and microplastics (EUR-Lex, 2015). It also required MS to ensure end-users have access to information 'on the quality of the water, the price of water intended for human consumption, the volume consumed by the household, comparisons of yearly water consumption' (European Council, 2019). This recast updated a 23-year-old legislation (EU 98/83), which had been amended in 2009 and 2015. The EC welcomed the EU 2020/2184, indicating this update would guarantee safer access to water for all Europeans, while ensuring the highest standards for drinking water (European Commission, 2020).

Seven years before the adoption of the EU 2020/2184, in April 2013, the Right2Water movement became the first successful ECI since the introduction of the ECI in the 2007 Lisbon Treaty (EUR-Lex, 2007; Bieler, 2017; European Commission, 2020; van den Berge *et al*., 2022). The Right2Water movement initiated the ECI to raise three demands: stop the liberalization of water services, guarantee water and sanitation for all in Europe, and increase efforts to achieve universal access to water and sanitation (Right2Water, 2014). It was organized via a citizen's committee formed by representatives of the European Public Service Union (EPSU), backed by an international coalition of non-governmental organizations, academics, and political activists. Concerns about water concessions, alongside the deterioration of water services provided by Veolia in Berlin between 2003 and 2011, brought citizens onto the streets to demand transparency and more control over their water services (van den Berge *et al*., 2022). The Right2Water movement successfully gathered these concerns and citizen signatures from 27 European countries and collected more than1.6 million signatures (Right2Water, 2014). In May 2014, Thessaloniki activists organised a referendum that helped stop the privatisation of the city's water company, while the right to water was adopted in the Slovenian constitution in 2016 (van den Berge *et al*., 2022).

The success of the ECI prompted responses from all political levels within the EU. The EC removed water from the Concession Directive proposal in June 2013 (European Commission, 2013). It acknowledged water as a public good, stated its commitment to safe water and sanitation, within and outside Europe, and recognized the responsibility of local authorities for affordable water services. It also recognized the need for improved transparency about urban wastewater and drinking water management and for structured dialogue between stakeholders on transparency in the water sector (European Commission, 2020). That same year an EU-wide consultation assessed citizen views on the quality of drinking water and found that 23% of respondents considered they were not well informed about the quality of drinking water, 87% claimed water quality monitoring should be more transparent, and 67% wanted easily-understandable information on the quality of their water (European Commission, 2017). Moreover, in 2014, an EU-wide public consultation revealed that EU citizens felt insecure about the quality of tap water, and 23% of respondents claimed they were not well informed about the quality of their drinking water (ECORYS, 2015; Tosun *et al*., 2020).

In addition, the EC launched an evaluation of the impact of the DWD on production and delivery of safe drinking water in the EU and on human health. It was found that the EU 98/83 helped improve compliance to standards for chemical and microbiological parameters. It also found that, in general, citizen's views of their quality of water varied geographically but were overall satisfactory. In evaluating the impact on health, epidemiological data showed an increase in the incidence of diseases associated with pathogenic *Escherichia coli*. In addition, there was no monitoring of *Legionella pneumophila* despite it being a major source of increased health risk related to household and indoor public drinking water (European Commission, 2016). These results should be interpreted with caution because there is limited access to Europe-wide epidemiological information about waterborne diseases, and these infections may not be exclusively related to drinking water.

These evaluations brought five major legislation changes in the 2020 DWD: the requirement to develop risk assessment and risk management of both the catchment areas for abstraction and the water supply system; updated monitoring guidelines, the introduction of *Legionella pneumophila* as a microbiological parameter to monitor in priority premises; the obligation of utilities to provide water access to all; and an instruction to actively

provide water services information to end-users (European Commission, 2016, 2021; World Health Organization, 2017; Dettori *et al*., 2022). These changes summarize, to some extent, the spirit of the HRtWS and the aims of UN SDG6.

Target 6b of SDG6 concerns participation of local communities in water and sanitation management. Realising the HRtWS and SDG6b entails access to information and participation in the decision-making processes concerning water, water services, and water sources. However, it is unclear which are the appropriate forms to address the right to information or roles of users in decision-making processes (Bartram *et al.*, 2018). In this regard, Article 17 of the 2020 EU DWD is one of the first regional mandates providing a set of specific requirements for the provision of water quality information to consumers (European Parliament and Council of the European Union, 2020).

These requirements may shape upcoming water service communication strategies that aim to create a sense of transparency between water suppliers and end-users across MS. This was a key driver of the ECI that prompted the EU DWD update. Some authors argue that the inclusion of Article 17 in the EU 2020/2184 recast was a way to ensure accountability from water suppliers and relevant authorities, and an indirect response of the EC to the Right2Water ECI (Andries *et al*., 2024, p. 11). However, problems may arise when MS implement the directive as larger water suppliers with existing communication mechanisms could advance their compliance with ease, while others fall behind due to capacity constraints (Gunnarsdottir *et al*., 2023).

3.2. State of implementation: current legislation and communication approaches for the implementation of Article 17 in Nordic countries

To assess the state of implementation of Article 17, we followed the IIM (Winter, 2005), hence in what follows, we present the *policy design* (i.e., synthesis of legislation instruments and entities in charge) and *policy implementation* (i.e., analysis of delivery behaviour) per country.

3.2.1. Policy design

Article 17 in the EU DWD 2020/2184 requires MS to provide sufficient and current information on water for human consumption. This includes the provision of water service information through invoicing or smart applications (outlined in paragraph 2), covering quality indicators, price, volume consumed, yearly consumption comparisons, and additional information through a website link. Compliance with Directives 2003/4/EC[4] and 2007/2/EC[5] is also required (stated in paragraph 3) (European Parliament and Council of the European Union, 2020). The focus on producing, providing, and delivering water quality information plays a pivotal role in establishing confidence in tap drinking water and transparency from water providers. Table 1 presents the information found on *legislation instruments and entities in charge* of advancing each one of the paragraphs of Article 17 in the eight Nordic countries.

All the countries of study have a legislative framework on drinking water quality, which is either binding to the 2020/2184 EU DWD or adhering to the spirit of the DWD. Since the publication of the recast, some Nordic MS have put efforts to transpose and update their own legislation, e.g., Denmark, Finland, and Sweden. A common and immediately available platform for providing water quality information is the use of water supplier's webpages and social media, which were found to be used in five (Åland, Denmark, Iceland, Norway, and Sweden)

[4] Directive 2003/4/EC of the European Parliament and of the Council of 28 January 2003 on public access to environmental information and repealing Council Directive 90/313/EEC.

[5] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community.

of the eight countries of study. The frequency of the production and sharing of water quality information goes from 5-year reports to annual reports. Monthly reports via water bills commonly indicate the volume consumed and the price per cubic metre (Table 1).

Drinking water quality in Nordic countries is monitored through a combination of legal frameworks, agencies, surveillance authorities, and water supplies. Legal frameworks include the regulations and acts defining requirements and standards of water quality, e.g. the Regulation on Water Quality and Surveillance in Denmark or the Regulation on Water Supply and Drinking Water in Iceland. By June 2024, the 2020/2184 directive had been transposed in Finland and Denmark. Finland currently holds a specific decree regulating water supply information system and information (Table 1). Surveillance authorities take a central role in monitoring and ensuring water safety since they oversee the work of water suppliers, by conducting inspections, taking samples, and analysing water quality parameters against standards. Water suppliers are the frontrunners in producing water quality data, as self-check in the production of drinking water, as operational, or as part of the compliance monitoring. In some cases, credited laboratories also take samples, analyse, and report to the water supplier and/or the surveillance authority. Water quality monitoring frequency at water services and national level can be as low as once a year and usually constraints to larger water supplies (Gunnarsdottir *et al.*, 2017, 2020).

3.2.2. Policy implementation

Public disclosure of water quality and risks is shaped by regional and local traits in Nordic nations. Denmark, Finland, Iceland, Norway, and Sweden require water quality reports on websites, primarily for larger population water services. This aligns with the ECI since Finland, Denmark, and Sweden were among the 27 Member States supporting the Right2Water movement (Tosun *et al.*, 2020). In the Faroe Islands and Åland, information is made available to the public only upon request, while Denmark, Greenland, and Finland have access to regional databases (Jupiter and vesi.fi, respectively). These databases store information on groundwater, drinking water, geotechnical data, and water quality monitoring – and are made available to the public through webpages (VESI, 2020; GEUS, 2022; Nukissiorfiit Vand, 2024).

In Nordic countries, there is a legal obligation for public access to water quality information, often facilitated upon request or through webpage platforms, aligning with Article 17, paragraph 1. This falls short of ensuring compliance with Article 17 of the EU DWD 2020/2184, which specifically calls for periodic disclosure of water services data to the public. Although some national associations and benchmarking organisations provide access to water quality data (Seppälä, 2015; Laitinen, 2016), they are not easily accessible to all. This could impact the intentions of the EU DWD 2020/2184 of reaching those who are disengaged or vulnerable. In what follows, we depict the analysis of *delivery behaviour* in each of the countries of study.

Åland: A self-governing state with an autonomous parliament, Åland is an active EU member that actively adopts and implements Finland's legislation in certain areas, such as health protection and water legislation (FINLEX, 1991). However, Åland recently exempted water suppliers serving less than 100 m^3 of domestic water per day or the needs of fewer than 500 people from the requirement for a risk management plan (ÅLAND MINISTRY OF ENVIRONMENT, 2023). Åland could use Finland's water quality database (vesi.fi), but language and database system disparities pose challenges in aligning the island's water quality data with the Finnish reporting system. The environmental and health protection authority in Åland holds the water quality monitoring results, which are presently unavailable online. Nevertheless, as the analysis results are not confidential, they could be accessed by anyone. Water companies and municipalities have pledged to make the analysis results accessible either online or through their social media platforms.

Denmark: Jupiter is a centralized database managed by the Geological Survey of Denmark (GEUS, 2022). Established in 1926 and digitized in 1975, Jupiter serves as a hydrogeological archive, offering subsurface

geological profile data. Since 2007, the database has granted online read-only access to the public and writing access to public authorities. It includes a central database, a public data model, a user-management system, and a suite of Simple Object Access Protocol web services and applications. These components allow diverse users, including ministries, municipalities, drilling companies, researchers, citizens, and journalists, to access the database via a free user account. The public data model encompasses borehole data, surface soil and water samples, water supply, and soil pollution data, with stakeholder agreement from municipalities, regions, state agencies, and the geological service. Authorized laboratories produce water quality data, which is entered into the database (Hansen & Thomsen, 2017).

To extract and see water quality data, a user needs knowledge of specialized database queries (e.g., SQL, structured query language) or to be part of an organization that accesses Jupiter via dedicated programmes. It is estimated that less than half of Denmark's population know of, or accesses Jupiter. According to one interviewee:

> *'GEUS conducted an in-depth user survey of Jupiter in 2018. The consensus was that it is a huge advantage to have a common database. Also, it is publicly available and can be used for most things according to your needs. But, if you take a new person who has never heard of Jupiter and GEUS before and put them in front of all those websites, solutions, term, and so on, it can be difficult. It is not easy to understand except for those who have worked with it for some years'.*

Availability to broader audiences would improve the database. Denmark has legislated reporting obligations (Chapter 6 of the Decree on water quality and supervision of water supply facilities, BEK nr 1023 of 29/06/2023), through which the Environmental Protection Agency, drilling companies, municipalities, water suppliers, and laboratories can access and add data to Jupiter. The database is technically public because certain organizations can access the data, the Drinking Water Directive (EU 2020/2184) requires member states to ensure that '*all persons supplied with water intended for human consumption*' have access to clear and current information about their water consumption, the cost per litre, and water quality. Some questions about water quality remain difficult to answer for a proportion of the population, according to one interviewee:

> *'We have a lot of inquiries from municipalities (98) and a fair number from citizens, for example on hardness. There are not so many inquiries from drilling companies, probably because they learn how to use Jupiter in their training. We have also many journalists who come with a lot of questions that are difficult to answer'.*

The delivery behaviour analysis, i.e., the extent to which the database Jupiter and its online structure facilitate the provision of water quality information to the public and render confidence in tap drinking water can be viewed in Figure 1. The notion of Jupiter as a repository of expert knowledge and credibility has been cultivated since the 1970s, which was evident in 28 and 18% of interviewee responses. This perception reaches entities, agencies, universities, and some portion of the population (21%), contributing to a degree of water quality awareness (19%). However, the database falls short in facilitating information seeking and sharing (13%), which could relate to lowered alignment of perceived and actual water quality risks by the public (3%).

Faroe Islands: As a non-EU member, the Faroe Islands is not obliged to follow European Union legislation, including the EU DWD. Nevertheless, the Faroe Islands voluntarily implemented the EU DWD 98/83 in 2013 and follow its requirements to ensure the safety and quality of drinking water supply. Most Faroese water supply systems are owned by municipalities, which are responsible for the quality of the drinking water. Some, especially larger municipalities, provide information on drinking water quality on their websites, although they are not obliged to do so:

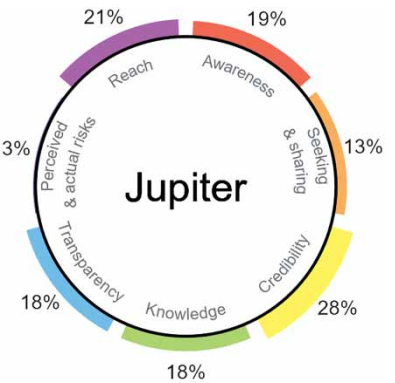


Fig. 1 | Delivery behaviour analysis of the Jupiter database using seven communication constructs. The percentages show how often each construct was mentioned, referred to, or noted by our interviewees (See Supplemental information S3).

'Both routine and expanded sample results are available on our home page. This is not a requirement in regulation, but a good service to people. If you continually give people information regarding water-related issues (sampling results, maintenance), then people are more satisfied and calmer'.

If *E. coli* is detected in the drinking water, the associated municipality is responsible for issuing boil water advisories on the radio and their websites. Before the implementation of the EU DWD 98/83 in 2013, it was unusual to hear about drinking water quality problems on the radio, but now it is more common, especially in the autumn when heavy rain can adversely affect water quality. Consumers are accordingly more aware of water quality issues, including in small water supply systems:

'Noticed that the different municipalities have become better at announcing boiling alerts on the radio. People are more aware of receiving clean drinking water, due to the implementation of the regulation in 2013, especially in the small water supply systems'.

Finland: On January 12, 2023, the Finnish Ministry of Agriculture and Forestry issued decree 6/2023, pursuant to the country's water management act, transposing Article 17 of EU DWD (2020/2184) into the Finnish legislation and instructing water utilities to 'inform users on potable water quality, wastewater treatment and on payments. The utility is obliged to send this information once a year to clients with the water bill or in other easily accessible form' (FINLEX, 2023). Access to water quality information is found through vesi.fi, a dedicated water quality information portal owned by the Ministry of Agriculture and Forestry of Finland and operated by the Finnish Environment Institute (SYKE) (VESI, 2020).

The vesi.fi data management system evolved from two prior systems, VEETI and VATI. VEETI compiled data from around 200 municipal water supplies and nearly 1,000 small rural water cooperatives, adhering to the requirements of the 2014 Water Services Act. It collected operational data on abstraction points, rates, groundwater yields, financial aspects, treatment plant performance, and water supply and sanitation operations. A dedicated water quality portal, the VATI database, ran concurrently with VEETI from 2019. VATI served as a platform for municipalities to submit water quality data and upload information on sampling programs (Laitinen, 2016).

The 2020 EU DWD prompted SYKE, Ministries, and Health Authorities to connect VATI and VEETI, creating a single publicly available water quality portal for Finland: vesi.fi. This water quality portal faces the challenge of

reconciling the different conditions between large, medium, and small water supplies. The portal is operational, but smaller water utilities may not be reporting water quality data as promptly as larger ones. This could result in an incomplete representation of water quality monitoring systems:

'*It is the municipal authorities who update and enter the data. They have the sampling plan and oversee entering the data. However, at the moment, it important to clarify that not all water sampling data are brought into the database. It is important to note that there are more than 1,000 water supplies in Finland, all of them have a water quality monitoring programme, but not all of them have the capacity to manage and upload water quality analysis on a regular basis*'.

Still, the new access to water quality information contributes to the necessary dialogue on water quality risks between water suppliers, health authorities, and end-users:

'There are many ways the user can contact the water supplier: maybe if people notice that they have brown water at their homes with feces, they will inform the water supplier and the municipality. Another approach is professionals from the local hospital notice an increase in cases of waterborne diseases, they can also inform about this'.

The delivery behaviour analysis, i.e., the extent to which the vesi.fi and its online structure could facilitate the provision of water quality information to the public and render confidence in tap drinking water, can be viewed in Figure 2. The vesi.fi database interviews reflect the intention of fostering transparency (47%), credibility (22%), along with establishing the database as a source of water quality knowledge (23%) that is accessible and user-friendly to end-users. Since the database is relatively new, its reach (16%) is yet to be evaluated as well as its potential capacity to generate awareness (9%) and facilitate information seeking and sharing (11%).

Greenland: Being a non-EU member, Greenland is not obligated to report on EU DWD 2184/2020 implementation. Nevertheless, the 2021 self-government's executive order aligns closely with 2020 EU DWD guidelines. It requires informing the public about contamination events and mandates the national utility (Nukissiorfiit) to submit an annual summary report on water quality to the regulator (Government of Greenland, 2021). For information on water quality Nukissiorfiit provides a link to the Jupiter database (Nukissiorfiit Vand, 2024), although participation in the Jupiter database is not required by the Greenland drinking water regulation. The inclusion of Greenland drinking water data in the Jupiter database started in 2016–2017, replacing an older Nukissiorfiit

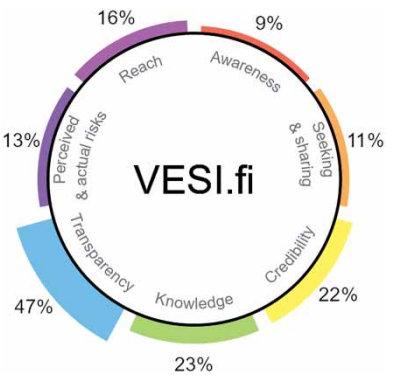


Fig. 2 | Delivery behaviour analysis of the vesi.fi database using seven communication constructs. The percentages show how often each construct was mentioned, referred to, or noted by our interviewees (See Supplemental information S3).

information platform. Data are entered by authorized laboratories and approved by the Greenland government, similar to the protocol used by Danish municipalities. The 2021 regulation made the inspecting authority responsible for publishing a national water quality report every 5 years – though no report has yet (2023) been made available to the public. Greenland's water quality data are not easily accessible through Jupiter and are only available in Danish, further inhibiting public access to information on drinking water quality.

Iceland: In Iceland, regulated water supplies are those that serve more than 50 people or 20 households/summerhouses, as well as those used for food production activities like dairy farming. There are about 800 regulated water supplies, serving 96% of the population. If a water supply serves more than 500 people, it is usually municipally owned; otherwise, it is typically user owned (Gunnarsdottir *et al*., 2020).

The nine LCAs (Local Competent Authorities) are responsible for monitoring and surveillance. Each LCA has a website where information on water quality issues is available for large- and medium-sized supplies. If information is not available online, it can be requested. Five out of the nine LCAs provide both microbiological and chemical monitoring results. However, information for small supplies is only accessible upon request.

'If people ask, they are sent the results. Often people are then speculating in some production. And then these audit monitoring of chemicals is what they want to have a look at'.

Quoting one small water supply operator on the issue on the availability of information:

'There is a need for central registration system. Water supplies could then publish their results online. Both surveillance authority and we could enter information as on water quality, WSP, inspections carried out and action taken. Then the management of these water utilities would be better than it is today'.

The large suppliers serving more than 5,000 inhabitants have their own website with some online information, as an annual report including information on water source, yield, people served, and tariff. According to the current drinking water legislation (Nr.536/2001, paragr.16), the LCAs shall submit an annual report to the Food Authority (MAST) on the results of drinking water sampling; and MAST shall compile and publish an annual report on the condition of drinking water for the purpose of disseminating information to consumers. The LCAs have been slow to deliver data. Since 2015, only one annual report has been completed for the whole country and all regulated supplies, reporting on the period 2002–2012 (Food and Veterinary Authority of Iceland, 2015). Since then, reports have been published regularly for water supplies serving more than 500 people.

Norway: Water supply system size determines whether and how water quality data are reported in Norway. Systems producing 10 m^3 or supplying at least 50 people daily must register, obtain approval, and report compliance with drinking water quality standards to the Norwegian Food Safety Authority. There are 1,500 water suppliers publicly registered in Norway, distributing water to approximately 88% of the country's population (Hyllestad, 2021). The Food and Safety Authority collects data via the MATS system of the Food Authority (Norwegian Food Safety Authority, 2023) and transfers it annually to the Water Works Register (VREG). The information in VREG all comes from self-reported data from water suppliers and includes administrative matters, transportation systems, water sources raw water quality, water treatment plants, and routine tests on water quality. A recent report found significant uncertainties and delays in data reporting to the register, mainly due to difficulties in accessing and using the database (Steinberg & Hyllestad, 2017). According to one interviewee:

'I think the legal framework is good, but I think we need some improvements in our data collection. The data system we have today is actually very bad. It is hard to understand and not intuitively at all. We should have better data collection systems so it can be easier for us to get information from water samples'.

Municipalities report water supply data on their webpages. The city of Oslo, for example, provides a yearly outlook of microbiological and physicochemical test results, while Bergen provides monthly test results (Bergen kommune, 2023). Although Norway has a low burden of disease associated with enteropathogens, outbreaks still occur and in cases of sudden changes or potential disease outbreaks related to water quality, the authorities issue boiling water advisories. A 2019 study in the city of Askøy assessed a large gastroenteritis outbreak and related it to a reservoir contamination event with *Campylobacter* (Hyllestad *et al*., 2020). Despite issuing a boiling water advisory via mobile phone text messaging, a proportion of the population did not receive and/or follow the instruction to boil water – suggesting that they had not received the information on water quality risks, had purchased bottled water, had decided the risk was low, or had chosen not to drink water (Hyllestad, 2021).

Sweden: At the local level, drinking water production and quality monitoring is usually a responsibility of municipalities, while the Swedish National Food Agency is the national entity responsible for drinking water quality (Bendz & Boholm, 2020). It is important to mention the recent legislation update, LIVSFS 2022:12, applies only to operations supplying at least 10 m^3 of drinking water per day or serve at least 50 people. The Swedish Food Agency regulations on drinking water require that information and advice be provided to consumers in the event of acute health risks via the most immediate channels available (e.g., T.V, radio, SMS, websites, email, and social media) and provide guidelines on how to disclose information and criteria for emitting boil water advisories (Swedish Food Agency, 2023). Although there is no legal requirement for routine provision of drinking water quality information to end-users, some water suppliers provide such information via their website. Thus, access to water quality information is system-specific and varies greatly depending on the size of the water supplier:

> *'Community associations and other individual operators are requested to submit their summaries and accounts, but it is safe to say that it is far from everyone that obliges. Some do not take any samples at all; others hire consultants who forget to send a copy to us. With that said most communities post their analysis results on the website/bulletin board so members can see them'*

3.3. Discussion: gaps and challenges for the implementation of Article 17

There is differential access to water services information in Nordic countries. Our analysis of policy design shows some countries with an earlier headway which, in the case of Denmark, could indicate a notion of public confidence in tap drinking water (CLEANTECHWATCH, 2020; BEK Nr 538 Af 28/05/2024, 2024). However, distinct relationships with the EU affect the speed of implementation of directives. Åland, Denmark, Finland, and Sweden are members of the EU, whereas Iceland and Norway are members of European Free Trade Association (EFTA) and participate in the internal market of Europe through the European Economic Area (EEA) which directs them to include EU policies if they are implemented in the EEA agreement. The self-governing nations of Faroe Islands and Greenland are not directly mandated to transpose the policy into their legislation, but as being part of the Nordic region, they have been adopting notions of previous versions of the water policy and are likely to follow-up with the updates. As members of EFTA, Norway and Iceland will not transpose the new EU directive into their legislation until it has been implemented into the EEA agreement. This highlights how the political contexts and the organization of delivering institutions influence the pace at which the EU policy is being transposed, translated, and finally implemented in each of the countries of study.

One of the main drivers of the Right2Water movement was user difficulty in obtaining information about water services, often obstructed by long bureaucratic procedures (van den Berge *et al*., 2022). The cases explored in this article illustrate that public access to information on water services and quality in Nordic countries is not straightforward. It depends on users' ability to navigate complex programming languages, is able or willing to request it,

or is accessible to individuals in specific professional roles. Typically, water suppliers have monitoring programmes producing information for the surveillance and safety assurance of the produced water. Nonetheless, extending these monitoring programmes and releasing user-friendly water quality and risks reports to the public could be seen as a sign of trustworthiness, openness, and transparency (Brouwer *et al.*, 2020). Often, access to information has been considered as a procedure in encouraging community participation (Jiménez *et al.*, 2019). However, effective inclusion of end-users entails the creation of institutional trust (Lidskog, 1996; de Franca Doria *et al.*, 2005). Thus, providing access to water quality information to the public requires a shift in the conceptualization, design, and implementation of water quality monitoring programmes, and of communication and participation approaches by water suppliers.

From the conducted interviews, we identified a set of gaps hindering the establishment of concrete communication channels to provide the public information about water quality and risks:

- Little consideration has been given to making understandable and up-to-date water quality information available to the public.
- End-user access to up-to-date water quality information is upon request, through water quality reports, or through complex databases. Thus, water quality communication occurs infrequently or responds to emergencies. In this case the transmission of messages, such as boiling water advisories, can be hindered if the end-user does not consider the water supplier a reliable source of information.
- There is little reflection on the financial feasibility and associated constraints that may hinder some water suppliers from contributing to the fulfilment of the requirements of the updated EU DWD 2020/2184.

These gaps highlight four key challenges: fostering collaboration to create communication channels between end-users and suppliers, defining strategies engaging end-users with current and comprehensible information, coordinating across countries, institutions, and authorities, and building surveillance and database management capacities in local and municipal authorities.

Building channels of communication for the implementation of Article 17 of the EU DWD in Nordic countries can be achieved through existing platforms and the already established pathways between organizations. The Jupiter Database case demonstrates the benefits of collaboration between state agencies, such as the Ministry of Climate, Energy, and Utilities, and local authorities, such as municipalities, in Denmark. The self-government of Greenland, Nukissiorfiit, takes advantage of the water quality database, despite language barriers. Likewise, the Finnish water quality portal (vesi.fi) emerged from collaboration between the Finnish Environment Institute (SYKE), the National Supervisory Authority for Welfare and Health (Valvira) and local authorities (municipalities). The MATS database in Norway, operated by the Norwegian Food Safety Authority, receives water quality and supply information from local water suppliers and municipalities.

Trust in water services can be approached by providing information about the quality and safety of drinking water. The same cognitive-emotive processes that affect risk perception in general are those influencing how end-users perceive drinking water risks (de França Doria, 2010). These are complex and delineated by trust in institutions, external information, familiarity, demographics, and perceived control. Heuristics, biases, risk characteristics, and personal/societal level of exposure are additional factors influencing the ways in which individuals and communities understand water risks (Brouwer *et al.*, 2020). Earlier work on societal attitudes of trust identified the need for active knowledge creators that provide information for individual judgements of risks, i.e., 'islands of certainty' (Lidskog, 1996). Provision of water quality information via these 'islands of certainty' could aid in what Brouwer *et al.* (2020) identified as a call for transparency from end-users: 'not because they will likely read information on water quality data, but because they find it a sign of trustworthiness when these data are not withheld'.

Provision and access to environmental information is essential for the public to engage in environmental policy and decision-making processes (European Parliament, 2003; Wolf, 2013). The differential implementation of the EU DWD 2020/2184 illustrates how the policy goal of providing access to drinking water quality information is being translated within the operational context of each water utility in the Nordic region. Previous research on policy translation in water services has highlighted the need to view discrepancies between policy design and implementation not as signs of faulty execution, but rather as expressions of operational contexts (Mukhtarov, 2014; Tutusaus Luque, 2019; Tutusaus & Schwartz, 2020). In this line, fostering water quality communication channels could aid in translating Article 17 in the distinct contexts of the Nordic region.

4. CONCLUSIONS

This study reveals the challenges of actively sharing water quality information with the public and notes the distinct paths of implementing a policy that aims to build confidence between water service providers and end-users. Directive 98/83/EC required the provision of water quality data derived from monitoring with some frequency, without indicating how it should be disseminated to the public. The EU DWD 2020/2184 and the 7th Environment Action Programme stipulate that the public should have regular access to drinking water quality information, without having to request it, and in the most accessible format possible (European Parliament & European Union, 2013; European Parliament and Council of the European Union, 2020).

Our literature review identified two main drivers for the EU DWD 2020/2184 update. First, the Right2Water movement, triggered by the water concessions directive and declining water services quality in 2013, effectively gathered signatures across the union, gave the EC a direct citizen mandate to address persistent failures in realizing HRtWS and SDG6 in Europe. This movement underscored the importance of transparency and structured dialogues among all actors in the water sector. Second, the social movement coincided with the necessary update of the EU DWD 98/83 EC – a drinking water policy that had undergone several amendments prior to the ECI and was already due for an update. These drivers, however, diverge from the initial objectives of the Right2Water ECI, and some authors argue the policy update fails to address the specific demands of the movement (Fischbach-Pattel, 2017; van den Berge *et al.*, 2022). The ECI movement had significant political success in some countries (Slovenia, Greece, Germany), which prompted the EC to revise the EU DWD as a means to answer the calls from the social movement (Andries *et al.*, 2024).

Implementing Article 17 of the EU DWD 2184/2020 has the potential to advance SDG 6b by offering comprehensive information on water quantity, quality, risks, usage, and tariffs to all water end-users, fostering perceptions of supplier transparency. Our analysis of implementation challenges in Nordic countries reveals varying states of advancement. Denmark's nationwide database (Jupiter) is dependent on end-users' knowledge, while Greenland faces limitations due to linguistic barriers. Finland's collaborative database for water quality data is accessible, but there are concerns about its reach to smaller water utilities, given issues with language barriers, data input and limited possibility of using the system in Åland. Cities with existing digital infrastructure, like Oslo in Norway, find it easier to establish access to water quality data, while smaller towns rely on SMS or door-to-door bulletins for communication.

The quality of life at a particular place and time is related to the quality of the water service. Our work exposes numerous interplays among actors at different levels endeavouring to work in a coherent manner to ensure safe water at the tap in Nordic households, a common place of security and identity (Lidskog, 1996). The analysis of literature exposed the update of the EU DWD as a process triggered by scientific evidence, synergised by citizen initiatives, but in the end funnelled to create a sense of legitimacy within the EU. Our gap analysis considers the path that each country will have and how this path could create a sense of water

security among end-users. It is worth reflecting on the complex role played by water utilities as providers of a basic resource, developers of water quality data, and guarantors of trust between end-users and policymakers.

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AUTHOR CONTRIBUTIONS

We follow the CRedit taxonomy to outline individual contributions. Conceptualization: ABV, MJG, JB. Formal analysis: ABV. Investigation: ABV, MJG, PMR, HJA, KSG, SMG, ME, LTH, PEJ, JYM, MM, KP, AB, FCK, and JB. Methodology and research design: ABV. Supervision: MJG, JB. Validation: ABV, MJG, PMR, HJA, KSG, SMG, ME, LTH, PEJ, JYM, MM, KP, AB, FCK, ad JB. Visualization: ABV. Writing – original draft: ABV. Writing – review and editing: ABV, MJG, PMR, HJA, KSG, SMG, ME, LTH, PEJ, JYM, MM, KP, AB, FCK, and JB.

DATA AVAILABILITY STATEMENT

Data cannot be made publicly available; readers should contact the corresponding author for details.

CONFLICT OF INTEREST

The authors declare there is no conflict.

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