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OVERVIEW

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Making Europe go from bottles to the tap: Political and societal attempts to induce behavioral change

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Abstract

In several European countries and at the level of the European Union, we can observe political and societal attempts to promote the use of tap water. Most prominently, the European Commission proposed revisions for the Drinking Water Directive, which includes strategies for promoting the consumption of tap water. The strategies comprise the following: improving access to tap water, upgrading quality standards for tap water, and enhancing transparency concerning the benefits of tap water. National initiatives in European countries pursue similar strategies that concentrate on enhancing access to tap water and communicating its economic, environmental, and social benefits. By drawing on existent literature in different disciplines, we assess how promising these strategies are for inducing individuals to drink tap water rather than bottled water. Our overview reveals that our knowledge regarding the quality dimension is very good: numerous studies on European countries have shown that dissatisfaction with the sensory properties and health-related concerns prevent individuals from drinking (more) tap water and opting for bottled water instead. The body of research with a specific focus on Europe is significantly smaller concerning the other two dimensions: access to tap water and the benefits of tap water. Nonetheless, there is indicative and preliminary evidence that improved access to tap water and a better communication of the benefits of tap water could positively affect consumption patterns.

This article is categorized under:

Engineering Water > Sustainable Engineering of Water
Human Water > Water Governance
Human Water > Water as Imagined and Represented

KEYWORDS

behavioral change, bottled water, drinking water directive, mobilization, sustainability, tap water

1 | INTRODUCTION

In May 2019, the British newspaper Daily Mail Online (2019) presented advice from the United States Centers for Disease Control and Prevention, which indicated that tap water is not safe for consumption in several member states of the European Union (EU), including Bulgaria, Cyprus, Latvia, Lithuania, and Romania. It is striking that this group of countries mainly consists of East European ones. Orru and Rothstein (2015) explain that the experience of EU accession conditionality and the legacies of elite-centered and legalistic regulatory cultures have resulted in selective compliance with EU rules, which has inhibited an effective way of dealing with the quality of drinking water. Strict regulations have applied to the quality of water intended for human consumption in the EU since the 1980s. However, as the assessment by the Centers for Disease Control and Prevention also shows, differences exist among the individual EU member states (Roccaro, Mancini, & Vagliasindi, 2005).

In 2014, an EU-wide public consultation revealed that citizens feel insecure about the quality of tap water in other EU countries (ECORYS, 2015). Although the main regulatory instrument, the Drinking Water Directive (Council Directive 98/83/EC), has proved effective for regulating tap water quality (Rouse, 2016), its standards are 20 years old. Therefore, in 2016, the European Commission decided to evaluate the parameters for monitoring drinking water quality. The Commission found that not all parameters set in the directive reflect the present state of scientific progress and emerging environmental pressures (European Commission, 2016). It proposed a revision of the Drinking Water Directive in February 2018.

The proposal does not only aim to improve the quality of drinking water, but also strives to increase the use of tap water. Partly because of citizens' insecurities regarding the quality of tap water, consumption of bottled water in the EU, as the supposedly safer alternative, has significantly increased in recent decades (Brei, 2018; Evans & Harvey, 2015; Hawkins, 2017). However, bottled water has several disadvantages, such as higher costs for consumers, the use of raw materials, plastic waste, and carbon dioxide emissions (Botto et al., 2011; Fantin, Scalbi, Ottaviano, & Masoni, 2014). Therefore, changing the consumption patterns toward a higher consumption of tap water has the potential to affect the climate and environment positively (Goggins & Rau, 2016). To induce a shift in drinking water preferences, the proposal highlights three strategies (European Commission, 2016):

- Improve access to water
- Upgrade drinking water standards
- Increase the transparency of the benefits of tap water

The Commission's proposal is in part a reaction to the European Citizens' Initiative "Right2Water," the adoption of the Sustainable Development Goals, and the Paris Agreement to the United Nations Framework Convention on Climate Change. Right2Water (with the full name of the initiative being "Water and sanitation are a human right! Water is a public good, not a commodity!") represents the first European Citizens' Initiative that managed to collect the required number of signatures and to force the European Commission to position itself on the issue of water as a public service and a public good (see Conrad, 2016; Tosun & Triebskorn, 2020). Lowering the consumption of bottled water represents one way of reducing greenhouse gas emissions (see Botto et al., 2011), an aim to which the signatories to the Paris Agreement committed themselves (see Tobin, Schmidt, Tosun, & Burns, 2018). Furthermore, Goal 6 of the Sustainable Development Goals calls on policymakers to ensure the availability and sustainable management of water and sanitation for all (see Tosun & Leininger, 2017).

In what follows, we draw on the existent literature to assess how promising the three strategies embraced by the European Commission are for bringing about the intended behavioral changes and inducing the individuals to drink more tap water instead of bottled water. In a first step, we give an overview of the drinking water consumption patterns across the EU. Second, we map national initiatives (public, private, or hybrid) that are similar to the European Commission and pursue the goal of stimulating behavioral changes. We consider these initiatives to be important complements to the Commission's approach. Then we discuss the literature that offers insights into how access to tap water, tap water standards, and transparency of the benefits of tap water may have an impact on the individuals' willingness to drink more tap water.

2 | DRINKING WATER CONSUMPTION PATTERNS

Tap water is a food product that is subject to regulation, regulatory monitoring, and enforcement (Tosun, 2012). While people usually consider tap water an ordinary commodity, it took a long process and significant public investment to go from "extraordinary" to "ordinary" (Harvey, 2015). In most countries, tap water is provided by public concessions awarded to one supplier per area (Brei, 2018). In some European countries, such as the Netherlands, tap water quality is assured by means of source protection and the treatment as well as the maintenance of the distribution system (Rosario-Ortiz, Rose, Speight, von Gunten, & Schnoor, 2016). With the exception of England and Wales (see Speight, 2015) as well as the Czech Republic, the ownership of drinking water infrastructure across Europe is public (EurEau, 2018).

The European Commission's public consultation on the quality of drinking water gave valuable insights into citizens' perceptions of the drinking water infrastructure as well as into the patterns of drinking water consumption. According to the corresponding report prepared by ECORYS (2015), 82% of Europeans believe there is good access to wholesome and clean water in their residential area. Despite this overall level of agreement across the EU member states, Figure 1 reveals that there is considerable cross-country variation in the share of respondents who indicated that they always drink water directly from the tap. For instance, not a single Maltese respondent indicated that s/he would always drink water from the tap, whereas all Estonian respondents replied that they do so.

Figure 1 reveals further noteworthy observations. For example, 83% of the German respondents stated that they think water quality is good, and 84% even replied that they experience a pleasant sensation when drinking tap water in their residential area (ECORYS, 2015). In addition, as shown in many other sources, the governance arrangements for drinking water services in Germany are very strict and health authorities play an important role in monitoring water quality (EurEau, 2018). Nonetheless, the consumption level of tap water in Germany is relatively low (see also Elmadfa & Meyer, 2015; Etale, Jobin, & Siegrist, 2018). Another interesting observation is that, with the exception of Austria, respondents in the northern European countries reported the highest intake of tap water.

Bottled water is carbonated or non-carbonated drinking water (distilled water, mineral water, spring water, or well water), which is sold in glass or plastic bottles of different serving sizes. In developing countries, water insecurity (in terms of both quantity and quality) has resulted in a shift of consumption patterns toward bottled water (Cohen & Ray, 2018; Pacheco-Vega, 2019). In developed countries, consumption of bottled water has increased as well (Brei, 2018; Evans & Harvey, 2015; Hawkins, 2017). This is puzzling, considering the easy access to good quality tap water in the great majority of these countries (Doria, 2006). In this context, Hawkins (2011, 2017) alludes to several factors that have facilitated the growth of the market for bottled water, including changes in drinking practices, the beverage companies' marketing strategies, the development of polyethylene terephthalate (PET) bottles, advances in branding techniques, and drinking water scares (see also Holt, 2012). A market that grew considerably and consistently over the years is, for example, France, where the population has access to good quality tap water and where citizens trust its quality. Brei (2018) illustrates how companies such as Danone or Nestlé managed to transform water into a lifestyle commodity. Consequently, the consumption of bottled water in France has grown over time. Yet, as Figure 2 shows, the bottled water market is even greater in Italy (Botto et al., 2011; Cidu, Frau, & Tore, 2011; Evans & Harvey, 2015;

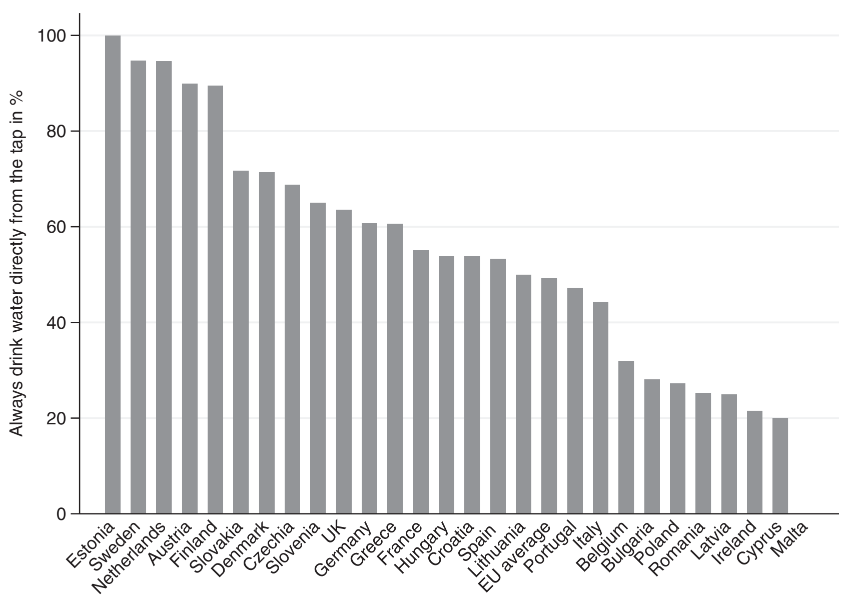


FIGURE 1 Consumption of tap water in Europe, 2014. Own elaboration based on ECORYS (2015)

Lorenzoni et al., 2019; Niccolucci et al., 2011) and Germany (Elmadfa & Meyer, 2015; Evans & Harvey, 2015; Hoffmann & Bronnmann, 2019).

Figure 3 is based on an ordinary least squares (OLS) regression where the bottled water consumption per capita is the outcome variable (see Figure 2) and the share of respondents indicating that they always drink tap water (see Figure 1) is the explanatory variable. When inspecting Figure 3, we can see a negative but statistically significant relationship between the consumption of bottled water and tap water. The countries positioned within the gray-shaded 95% confidence interval fit the linear prediction better than the countries outside this area.

Italy and Germany represent empirical observations with the greatest distance from the regression line, indicating that the consumption of bottled water per capita is higher than one would expect if the consumption of tap water was a perfect determinant of drinking bottled water. For Germany, Elmadfa and Meyer (2015) argue that one possible reason for the low consumption levels of tap water could be a preference for carbonated water, which is typically distributed in bottles. For Italy, Johnstone and Serret (2012) point to the dissatisfaction of Italians with the quality of tap water as an explanation for the high consumption of bottled water. Conversely, in the Nordic countries, for instance, the consumption of bottled water per capita is lower than predicted by the regression model. In the case of Sweden and the

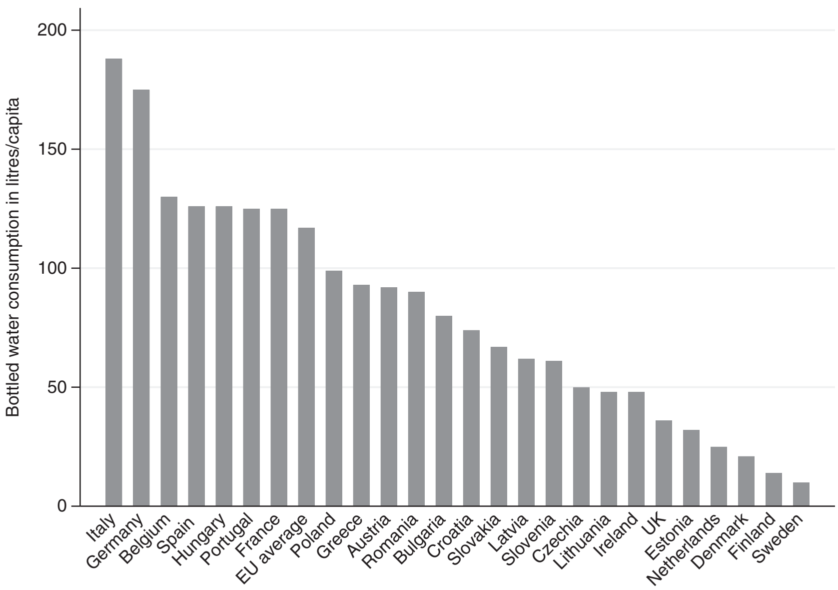


FIGURE 2 Consumption of bottled water in Europe, 2017. Own elaboration based on EFBW (2019)

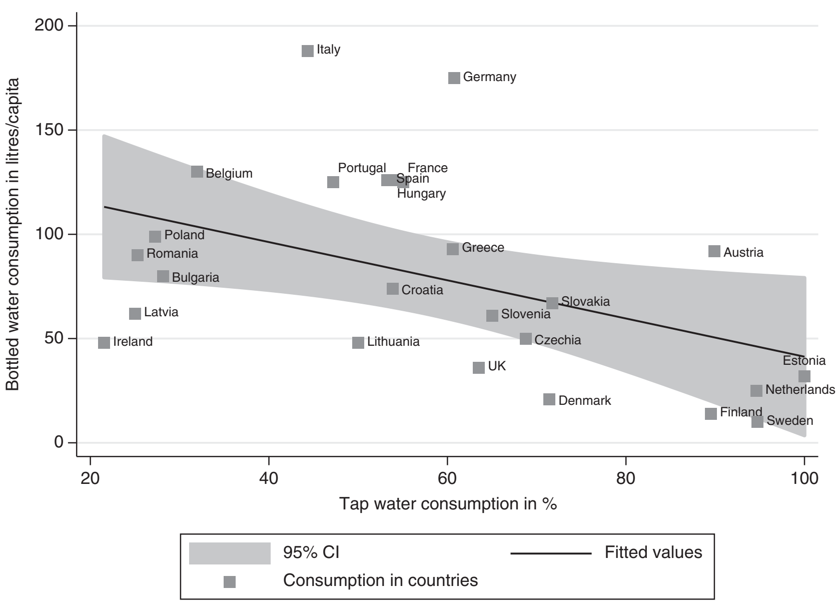


FIGURE 3 Relationship between tap and bottled water consumption. Own analysis based on the data reported in Figures 1 and 2. The OLS regression coefficient of −0.9 is significant at the 5% level. The adjusted model fit indicator R^2 is 17%

Netherlands, the satisfaction with the quality of tap water is identified as an important explanation for the low levels of bottled water consumption (Johnstone & Serret, 2012).

More generally, having reviewed the research on consumer choice of tap water and bottled water, Güngör-Demirci, Lee, Mirzaei, and Younos (2016) identify the following explanatory factors to be relevant: water quality, health issues, taste and odor issues, convenience, price, and awareness of environmental issues. A factor that needs to be added to this list is the importance of the industry and its successful attempts to create markets for bottled water (Brei, 2018; Hawkins, 2011, 2017; Holt, 2012). In other words, an individual's decision to consume tap water is not only affected by the features of the tap water available in a region or country but also by the characteristics of the market for bottled water. Public policy and initiatives by civil society can have an impact on both sets of factors.

3 | NATIONAL INITIATIVES FOR PROMOTING TAP WATER

Recently, Europe has witnessed a proliferation of national initiatives that aim to promote the drinking of tap water (see Table 1; see Table A1 in the Appendix for a full list of the initiatives and their characteristics). Initiatives are in place in nearly all EU member states (and members of the European Economic Area and Switzerland), except for in Austria, Cyprus, the Czech Republic, Lithuania, Norway, and Slovakia. The number of initiatives per country ranges from one to four. The earliest initiative we could identify dates back to 2004 and the most recent ones started in 2019. The initiatives differ with regard to their overarching motivation for promoting tap water, their more specific aims and strategies as well as the addressees of their respective campaigns. Furthermore, different types of organizers run the campaigns.

To get a better sense of the various interests behind the initiatives, it is worth inspecting who organizes them. Many initiatives are launched by water providers including water associations, utilities, or companies (26%). These actors actively promote tap water as their own product and service. Nonprofit organizations (19%) mostly focus on

TABLE 1 National initiatives promoting tap water

Initiator types	Number	Percent
Citizens	8	17.0
Private companies	5	10.6
National governments	5	10.6
Local governments	5	10.6
Nonprofit organizations	9	19.1
Water associations/utilities/companies	12	25.5
Other	4	8.5
Overarching motivation		
Environmental protection	37	78.7
Plastic waste	25	53.2
Climate change	7	14.9
Sustainability	4	8.5
Consumer protection	2	4.3
Health	1	2.1
Addressees		
Citizens	35	74.5
Restaurants, hotels	15	31.9
Businesses, organizations	8	17.0
Political institutions	4	8.5

Note: Total percentages deviate from 100% because some initiatives have multiple overarching motivations or addressees.

environmental and consumer protection. The private sector is also involved with some initiatives (11%) as they regard tap water a business opportunity. In Malta, for instance, filtered drinking water can now be purchased from WaterPoint Outlets.

Interestingly, local as well as some national governments have launched tap water advertising campaigns (11% each), too. For instance, the Danish government, at the beginning of its presidency of the European Union Council in 2012, decided to abandon water bottles and instead serve tap water only, which resulted in the nickname "tap water presidency" (van Dalen, 2014). Other examples are Iceland, which decided to brand its tap water as a luxury product and launch a YouTube campaign in an effort to lower the consumption of bottled water mainly bought by tourists, and Sweden, which introduced a sustainability label for its tap water. Governments also support or cooperate with tap water promoting initiatives. Forty percent of the initiatives received financial support from governments. One example of a cooperation between a local government and a water company is "London on Tap," a campaign initiated by the Mayor of London and Thames Water. The campaign was successful in reducing consumption of bottled water by 8% in 2008 after specifically targeting the access to tap water in restaurants (Sahakian & Wilhite, 2014). Many smaller initiatives can be traced back to single citizens (17%), who, for instance, started asking restaurants to provide free tap water and created an online map showing the location of restaurants serving tap water. Other, less frequent actor types include a church association, a foundation, a single politician, and a retailer in Italy.

Most initiatives also set out explicitly their motivation for taking action. The great majority of initiatives mentions environmental protection (79%). Among these, about 53% explicitly refer to the goal of reducing plastic pollution stemming from PET bottles. Almost 15% state that they strive to reduce carbon dioxide emissions. Almost 9% of the initiatives generally refer to improving sustainability or sustainable water management. Only 4% refer to consumer protection and one initiative targets the health of young people.

The initiatives use a range of strategies for bringing about the intended changes in people's water drinking behavior. Most initiatives directly address citizens (75%). Some of these inform citizens where tap water is available free of charge, whereas others elaborate on the advantages and disadvantages of different types of drinking water and their provision, often by using "labeling" strategies. Such information-based strategies are promising as research has shown that the information provided to consumers plays an important role in influencing their preferences (Güngör-Demirci et al., 2016).

A different group of initiatives installs public water fountains, water refill stations, or provides reusable bottles. Other initiatives organize tasting events or engage in "branding" to convince citizens of the sensory qualities of tap water. For example, the five major regional water public utility service providers in Hungary launched a campaign to raise awareness and provide information on the benefits of tap water. The Dutch government committed itself to funding water fountains at schools. In the United Kingdom, water refill stations play an important role for promoting the use of tap water. In Portugal, several initiatives seek to promote tap water by distributing reusable bottles, while the Spanish water association ProGrifo supports tasting events.

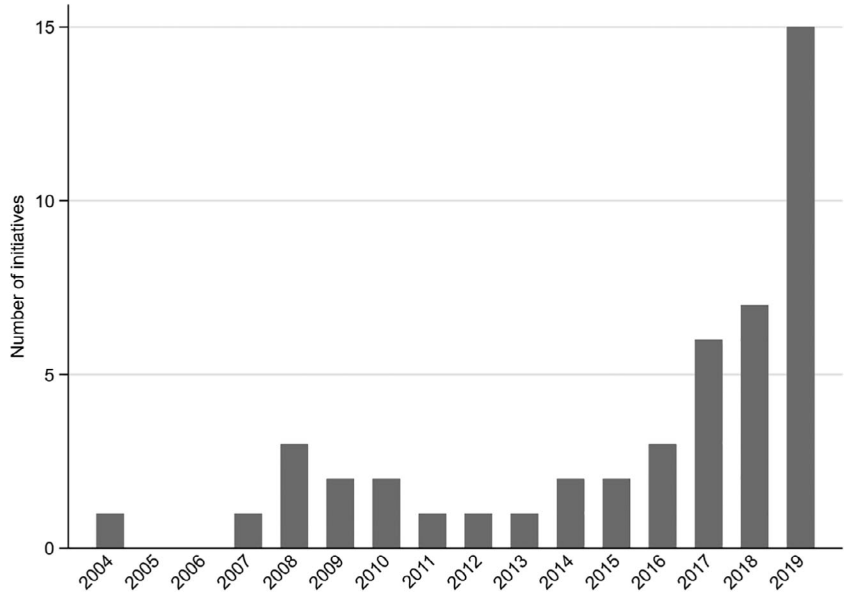
Some initiatives address bars, cafés, hotels, and restaurants in an effort to make them provide either free tap water or sell the tap water at a reasonable price (32%). The dominant tools of these initiatives are window stickers (which help customers to identify membership in a given initiative), online maps, and Smartphone apps, which guide citizens to places that serve tap water free of charge and enhance their visibility. This is, for example, the case with the Croatian Freewa project, which uses a web platform and a Smartphone app to map free drinking water locations worldwide. Similar initiatives also exist in Belgium and Estonia. Some initiatives address businesses, organizations, and public authorities, with the aim of improving access to tap water at workplaces or in public spaces (17%). Furthermore, a few initiatives target political institutions, such as the government or parliament, in order to trigger regulatory action (9%). Recently, some EU member states or their regional entities explored or initiated legislation to oblige bars, cafés, and restaurants to serve free tap water. In this context, the case of Wallonia in Belgium is particularly noteworthy since the regional government intends to make it obligatory for restaurants and public places to offer tap water free of charge.

Figure 4 gives an overview on the formation of initiatives over time. We can observe a sharp increase in the number of initiatives since 2017. In 2019, the most recent year for which we have observations, 15 new initiatives were launched.

4 | ASSESSMENT OF THE COMMISSION'S STRATEGIES IN LIGHT OF THE LITERATURE

We now review the literature in order to assess the promise of the EU Commission's strategy to increase the use of tap water by providing better access to tap water, improving its quality, and by making the benefits of drinking tap water

FIGURE 4 Number of new initiatives over time. Data based on own research



transparent. All three strategies embraced by the Commission seek to change people's behavior concerning their choice of tap water. In what follows, we discuss both studies that refer to the political, sociocultural, or socioeconomic contexts (the "macro" level) and the individuals (the "micro" level). These two perspectives are interrelated and even if the focus is on policy measures, the eventual analytical interest of the reviewed studies concerns the question of how the intended behavioral changes can be realized.

4.1 | Behavioral change through changes in access to tap water

The most drastic move to promote tap water would be to impede access to bottled water. Some municipal and regional governments (in Australia, Canada, Hong Kong, and the United States) have instituted bans on the commercialization of bottled water in the public sphere (Díez, Antigüedad, Agirre, & Rico, 2018). For example, the government of the Canadian provinces of Manitoba and Nova Scotia have banned bottled water in provincially owned facilities (Pacheco-Vega, 2019). In the European context, bans on bottled water have not been considered and represent an unlikely move for politicians.

However, evidence exists from behavioral studies carried out in European universities where access to bottled water was reduced (Güngör-Demirci et al., 2016). For example, Díez et al. (2018) report that in cafeterias of the University of the Basque Country, where no bottled water was sold and where glass jugs and tap water were available free of charge, the presence of bottled water in fixed lunch menus was reduced to 6% of the sold menus. The effect on tap water consumption can be related to improved availability (Qian, 2018) as well as to the signaling of desired behavior, and the mechanism of social conformity (Etale et al., 2018; Santos & van der Linden, 2016).

Another possibility is to highlight access to tap water—a strategy several national initiatives have embraced in order to promote the use of tap water, as we have already shown. The 2008 "London on Tap" campaign, for example, concentrated on changing the social norms related to ordering bottled water in restaurants and making it socially acceptable or even desirable (Sahakian & Wilhite, 2014). The "London on Tap" campaign was very successful as bottled water sales dropped in the participating restaurants after its launch and a survey carried out by Thames Water with around 5,000 respondents indicated that they were drinking less bottled water than a year ago (Sahakian & Wilhite, 2014).

The European Citizens' Initiative Right2Water supported a shift in water consumption patterns in favor of tap water. The organizers of the initiative argued that, due to its high regulation, tap water in Europe has health and safety benefits over bottled water (Díez et al., 2018). Another argument put forth in the context of Right2Water suggests that the privatization of water services could potentially result in lower regulation and consequently in lower water quality (see Tosun & Triebskorn, 2020). Survey data gathered for 64 Spanish cities revealed that the respondents considered the quality of tap water to be lower when the urban water services were in the hands of a private company (García-Rubio, Tortajada, & González-Gómez, 2016).

Thus, although the literature on European countries we can draw on is very small, there is indicative and preliminary evidence that reducing access to bottled water as well as facilitating access to tap water can have an impact on the individuals' choice for tap water. Nonetheless, the most important conclusion from our analysis of the literature is that more research is needed if we are to learn about the generalizability and robustness of the effects observed by the studies presented here.

4.2 | Behavioral change through better (information on) quality of tap water

As mentioned above, consumer surveys usually stress two main factors that explain an individual's preference for bottled water: dissatisfaction with the sensory properties of tap water and health-related concerns (Doria, 2006; Güngör-Demirci et al., 2016). Based on a survey of 10,000 households in 10 member countries of the Organization for Economic Co-operation and Development (OECD), Johnstone and Serret (2012) analyzed the degree of satisfaction with water quality. In total, 66% were satisfied with the quality of their tap water for drinking purposes. Respondents who were dissatisfied with their tap water stated health concerns twice as often as taste problems. On the contrary, in countries with a high level of satisfaction, taste is of greater concern than health for those who are dissatisfied.

In a German study, two consumer groups that either preferred tap water or bottled water were asked to evaluate the perceived quality of both water types in an online survey. Interestingly, the two groups showed opposite evaluations, although tap water in Germany should not differ significantly from bottled water due to the high quality: bottled water consumers constantly evaluated tap water as less healthy and of poorer quality. Vice versa, tap water consumers rated tap water better in all categories (Debbeler, Gamp, Blumenschein, Keim, & Renner, 2018). In a qualitative study conducted on the University of Birmingham campus in the United Kingdom, the majority of participants believed that bottled water had some health benefits but were not able to specify these (Ward et al., 2009). Perceived health risks thus often seem to reflect beliefs rather than actual experiences or objective criteria of water quality (Debbeler et al., 2018; Ward et al., 2009). We therefore conducted a brief literature review on tap water quality, focusing in particular on the current activities of the EU to upgrade drinking water standards.

Strict control regulations on water have applied since the 1980s, in particular the Council Directive 98/83/EC on the quality of water intended for human consumption. In general, the parameters in Annex I to the Directive are based on the World Health Organization (WHO) Guidelines for drinking water, which were last modified in 2017 (WHO, 2017). The proposed amendment of Annex I as part of the general revision of the Drinking Water Directive (Council of the European Union, 2019) also follows the WHO's recommendations (with a few exceptions) and addresses current issues of drinking water quality as well as topics of emerging concern, including disinfection by-products (DBPs), polyfluoroalkyl substances (PFASs), toxins released by algal blooms (Microcystin-LR), and adjustments for heavy metals (for details, see Appendix 2).

4.2.1 | Evaluation of health-related quality

The primary health risk associated with the consumption of drinking water is infection due to microbial contamination, which can potentially shorten the life spans of immunocompromised individuals. About 64% of documented waterborne disease outbreaks worldwide can be traced back to contaminated drinking water (Karanis, Kourenti, & Smith, 2007). Although very rare, microbial contamination of tap water has been reported in various European countries. Within the periods of 2004–2010 (Baldursson & Karanis, 2011) and 2011–2016 (Efstratiou, Ongerth, & Karanis, 2017), Europe reported 16.5 and 9%, respectively, of the documented outbreaks worldwide, with most cases in the United Kingdom and Ireland. When assessing these figures, it has to be kept in mind that the vast majority of disease outbreaks worldwide occurs in countries with poor water supply and sanitation, but these are usually not recorded (Karanis et al., 2007).

The main diagnosis of waterborne disease outbreaks was gastroenteritis, usually caused by *Cryptosporidium* or *Giardia* infections, which have emerged over recent decades as major waterborne pathogens in the developed world. They are transmitted via the fecal–oral route and are endemic to many animals (Garcés-Sanchez, Wilderer, Munch, Horn, & Lebuhn, 2009; Slifko, Smith, & Rose, 2000). Most of the outbreaks in Europe were associated with contaminated surface water used for drinking water supply (e.g., caused by the entry of wastewater or polluted surface runoff during heavy rainfall) in combination with insufficient treatment (Böhmer & Resch, 2000; Carmena, Aguinagalde, Zigorraga, Fernández-Crespo, & Ocio, 2007; Méndez et al., 2004; Setty et al., 2018). In Europe, on average, surface water is used for one third of drinking water supplies and two thirds are provided by ground water (Roccaro et al., 2005). While some countries use both raw water sources (e.g., Germany, France, and Italy), others use predominantly surface waters (e.g., Spain, United Kingdom, and Ireland) or almost exclusively groundwater (e.g., the Netherlands, Denmark, and Austria). Given that surface water is much more vulnerable to microbial contamination, the implementation of state-of-the-art multi-barrier systems is indispensable for the adequate treatment of drinking water supplies (WHO, 2017).

A topic of growing concern in the context of microbial contamination is the environmental spread of antibiotic-resistant bacteria (ARB) (Berendonk et al., 2015). The presence of ARB in drinking water is mainly observed in areas with poor water supply and sanitation (O'Flaherty, Borrego, Balcázar, & Cummins, 2018), but a few recent studies report findings of ARB in the drinking water of developed countries, for example, Canada (Fernando et al., 2016), France (Madec et al., 2016), and Poland (Leginowicz, Siedlecka, & Piekarska, 2018). Although the risk to human health of ARB from the environment is not yet fully understood, it should be managed under the precautionary principle (Manaia, 2017).

To prevent the spread of infectious waterborne diseases, disinfection is applied in drinking water treatment when necessary. Chlorination is the most commonly used disinfection method because of its efficient and cost-effective properties. However, the consequence of using chemical disinfectants is the formation of so-called disinfection by-products (DBPs), mainly due to the reaction of chlorine with naturally occurring organic matter present in the raw water (Bond, Goslan, Parsons, & Jefferson, 2012). To date, more than 600 DBPs have been reported in the literature (Krasner, 2009; Richardson, Plewa, Wagner, Schoeny, & Demarini, 2007). The main risks from exposure to DBPs are cancer and reproductive effects (Nieuwenhuijsen et al., 2009). So far, the Directive 98/83/EC regulates trihalomethanes (THM) and bromate. Within the planned amendment of the Drinking Water Directive, standard levels for additional DBPs have been proposed (see Appendix 2). In order to prevent harmful effects from lifelong intake, some European countries have already set much stricter standard levels than the Directive 98/83/EC, in particular for THMs (Roccaro et al., 2005).

Several studies have examined the health-related risks of DBPs in drinking water (e.g., Krasner et al., 2016; Nieuwenhuijsen et al., 2009; Richardson et al., 2007; Villanueva et al., 2007). However, the WHO notes that the risks to health from DBPs are extremely small in comparison to the risks associated with inadequate disinfection (WHO, 2017). Many European countries have already applied low disinfectant doses, resulting in low residual chlorine concentrations in the treated drinking water (predominantly ranging between 0 and <1 mg/L) (e.g., Goslan et al., 2014; Krasner et al., 2016). In addition, many waterworks are trying to lower their DBP levels by introducing enhanced treatment techniques that reduce the content of natural organic matter in the raw water, which is the most important factor for the generation of DBPs (Malliarou, Collins, Graham, & Nieuwenhuijsen, 2005). The latter is particularly important, since trends of increasing concentration of natural organic matter in sources of drinking water supply (especially in the Northern Hemisphere) have been well recognized over recent decades (Delpla, Jung, Baures, Clement, & Thomas, 2009).

Regarding the inorganic compounds in drinking water, only a few chemicals have been shown to cause worldwide health effects as a consequence of drinking water consumption; these include fluoride, arsenic, and nitrate (WHO, 2017). A large harmonized study examined the major and trace elements in 1,785 bottled water samples and 579 tap water samples collected all over the European territory (e.g., Banks, Birke, Flem, & Reimann, 2015; Birke, Demetriades, & de Vivo, 2010; Birke, Rauch, Harazim, Lorenz, & Glatte, 2010; Birke, Rauch, Lorenz, & Kringel, 2010; Bityukova & Petersell, 2010; Dinelli et al., 2012a, 2012b; Frengstad, Lax, Tarvainen, Jæger, & Wigum, 2010). For most of the parameters, a level of 99% compliance with EU standards or better was achieved for tap water. Only a few samples exceeded the standard values for the three hazardous parameters mentioned above. For nitrate in particular the compliance appears to be 100% for tap water, reflecting the success of the major effort of the EU to ensure tap water quality (Banks et al., 2015).

Thus, for inorganic compounds, the quality of tap water does not appear to be inferior when compared to bottled water (Banks et al., 2015; Cidu et al., 2011; Demetriades, 2010; Frengstad et al., 2010). Some bottled waters, which are natural mineral waters, even contain trace elements significantly higher than those commonly accepted in drinking water (Cicchella et al., 2010; Dinelli et al., 2012a). For instance, only 32% of the analyzed bottled water samples from Germany fulfilled the requirements for being labeled as "suitable for the preparation of baby food," mainly because of high fluoride concentrations (Birke, Rauch, Lorenz, & Kringel, 2010).

However, care should be taken in some areas where tap water is affected by lead from old domestic plumbing (WHO, 2017). Lead was often used as installation material in buildings, though since the 1950s it has been largely superseded by copper (Banks et al., 2015; Postawa, 2015). Although the replacement of old lead water pipes is now enforced by stricter standards, which came into force in all European member states in 2013 at the latest (1998/83/EC), lead released from drinking water pipelines remains a problem in several countries. For example, elevated concentrations of lead in tap water have been reported for regions in Germany (Völker, Schreiber, & Kistemann, 2010), Italy (Veschetti et al., 2010), France (Le Bot, Lucas, Lacroix, & Glorennec, 2016), and Poland (Postawa, 2015). The plan of reducing the maximum level of lead permissible in drinking water, as detailed in the amendment of the Drinking Water Directive (see Appendix 2), will further enforce the replacement of old water distribution systems. In addition, the amendment also addresses the harmonization of standards for materials that are allowed to be in contact with drinking water (Council of the European Union, 2019).

In the recent past, some contaminants of emerging concern were detected in drinking water or received increased attention. Polyfluoroalkyl substances (PFASs) are a group of organic industrial chemicals, which are used, in a wide range of products due to their unique water and fat repellent properties for coatings. For these reasons, the persistent PFASs are widely distributed in the environment. Consequently, drinking water has been identified as one of the main routes of human exposure (Llorca et al., 2012). Although very rare, PFAS concentrations above the proposed standard value of 0.1 μg/L (Council of the European Union, 2019, see Appendix 2) were detected in tap water samples from Spain, France, and Germany (Llorca et al., 2012; Schwanz, Llorca, Farré, & Barceló, 2016). In contrast, all tap water and bottled water samples from Germany that were analyzed by Gellrich, Brunn, and Stahl (2013) were far below this limit.

An increasing trend in the presence of harmful cyanobacterial blooms in water has been observed worldwide, particularly in the context of climate change (Huisman et al., 2018). Prominent examples include Lake Erie (United States) and Lake Taihu (China), in which toxin-producing species were already contaminating drinking water supplies. Freshwater cyanobacterial blooms producing toxins are also a serious problem in European countries, especially in those experiencing groundwater shortage and which are thus dependent on surface water reservoirs for drinking water supply, such as Serbia (Svircev, Krstic, Miladinov-Mikov, Baltic, & Vidovic, 2009).

Pharmaceutical residues and their transformation products have been sporadically detected in drinking water due to the increasing sensitivity of analytical methods (Beek et al., 2016; Hofman-Caris et al., 2019; Leusch et al., 2018; WHO, 2012). Worldwide, more than 3,000 human pharmaceutical substances are being administered at a total rate of 100,000 tons per year. In parallel, the yearly antibiotic consumption in livestock was estimated in 2010 at above 60,000 tons (Beek et al., 2016). Urban wastewater was identified as the main emission pathway, though industry, hospitals, and livestock farming can also be significant sources on a local scale (Hofman-Caris et al., 2019; OECD, 2019).

Recently, the detection of microplastics in drinking water triggered discussions on the potential risks to human health. However, since there is no standard procedure available for the sampling and analysis of microplastic particles, the quality of the studies has been questioned. Koelmans et al. (2019) therefore conclude that better data are required for evaluating the occurrence of microplastics in drinking water and for gaining a better understanding of the potential risks to human health.

4.2.2 | Importance of sensory properties of tap water

Several studies were conducted to evaluate the taste of tap water. For instance, Marcussen et al. (2013) related the taste of tap water samples from 20 Danish waterworks to their chemical compositions. The parameter "saltiness" was the most important sensory property and positively correlated to the concentrations of sodium and totally dissolved solids, and to conductivity, the last two attributes being a measure of the overall level of mineralization. In addition, all these parameters revealed a strong negative correlation to the degree of "refreshment." Platikanov et al. (2017) similarly found that Spanish water samples rich in sodium chloride were less preferred. In a French study, the most preferred types of water were those with medium mineralization, which were described as "tasteless" and "cooler" (Teillet, Urbano, Cordelle, & Schlich, 2010). While tap water did not perform differently from bottled water in the French study (Teillet et al., 2010), most of the volunteers preferred bottled water in the Spanish study (Platikanov et al., 2017). In a blind tasting test in Germany, which included two consumer groups that either preferred tap water or bottled water, neither group was able to distinguish tap water from bottled water (Debbeler et al., 2018).

4.2.3 | Summary

Overall, the quality of drinking water in Europe can be evaluated as good, largely due to the implementation of the strict regulations demanded by the Drinking Water Directive. However, every now and then, problems with drinking water quality are reported for some European countries, particularly if surface water is used in combination with inadequate treatment technologies. In addition, several contaminants of emerging concern for drinking water have received increasing attention in recent years. At the same time, the number and quantity of anthropogenic chemicals are growing at an unprecedented pace, making it increasingly challenging to secure the quality of drinking water. However, the presence of anthropogenic chemicals represent a challenge for the quality of both tap water and bottled mineral water.

It appears a reasonable move of the European Commission to upgrade the water quality standards as a means of promoting the use of tap water. Considering that safety concerns are the single most important reason for European citizens to resist tap water (Doria, 2006), a credible policy approach to increasing the safety of tap water is indispensable. However, perceived risks often differ from science-based estimates of the risks (Debbeler et al., 2018; Ward et al., 2009). Hence, public health campaigns should address these issues in order to promote healthy and sustainable consumer choices. Another important measure is to improve the sensory quality of tap water, which is already an emerging key issue for waterworks (Doria, 2010; Lin, 2019; Platikanov et al., 2017).

4.3 | Behavioral change through a better communication of benefits

The third strategy used by the European Commission and some national initiatives on tap water focuses on elucidating the positive health, environmental, and social impacts of tap water use (see, e.g., Goggins & Rau, 2016; Wilk, 2006). Business studies and research in economics have stressed the positive impact of switching from bottled water to tap water for protecting the climate and the environment (see, e.g., Díez et al., 2018; Hawkins, 2011). For example, Torretta (2013) alludes to the resources and energy needed to produce the plastic for bottled water as well as to the carbon dioxide emissions resulting from the transportation of bottled water. Botto et al. (2011) compare the carbon dioxide performance of tap water and PET-bottled natural mineral water in Italy and show that drinking 1.5 L of tap water instead of bottled water saves 0.34 kg of carbon dioxide equivalent. The authors conclude that replacing the daily intake of bottled water with tap water (2 L/day) could prevent 163.50 kg of carbon dioxide equivalent of greenhouse gas emissions per year (Botto et al., 2011, p. 388).

Makov, Meylan, Powell, and Shepon (2019) examine the energy and climate change impacts of drinking water stations, which are used (e.g., in London) for bottle refills on-the-go. The water for such stations is drawn directly from the municipal water system, filtered and treated by ozone, and then either chilled or not (if served at room temperature). The authors conclude that the consumption of drinking water from the stations has lower impacts on climate change than bottled water (when served at room temperature). Relying on data for bottled water sales in 2010 in Israel, the authors contend that a substitution of the sales by 10% would result in a reduction of about 3,850–4,500 metric tons of carbon dioxide equivalents. That reduction in carbon dioxide emissions would correspond to the equivalent of taking roughly 2,000–2,700 cars off the road each year (Makov et al., 2019, p. 325). Torretta (2013) presents an analysis of a water kiosk in a town of 9,000 inhabitants in Northern Italy, which supplied still and sparkling water with a better organoleptic quality due to additional treatment as compared to regular tap water. The analysis reveals a reduction of carbon dioxide emission by about one fifth, a reduction of the raw materials necessary to produce PET bottles, and a reduction in plastic waste. Furthermore, the costs for drinking water supply were reduced for the inhabitants of the city.

Despite the evidence on the benefits of tap water, consumers have been found to resist the consumption of tap water even if they are provided with corresponding information (Wilk, 2006). Gheorghe, Purcărea, and Gheorghe (2019) refer to established explanatory models of pro-environmental behavior and test among other factors the importance of knowledge on environmental issues and their causes in order to explain the disposition of Romanian university students to drinking tap water instead of bottled water. The empirical findings reveal that the students surveyed are likely to continue drinking bottled water as long as they perceive it as being safer and more hygienic than tap water. Thus, in this particular case, providing information on the positive environmental benefits of tap water is unlikely to lead to behavioral change. The reluctance of consumers to drink tap water rather than bottled water is strengthened by distrust in political elites and institutions (Hawkins, 2011) and the portrayal of tap water in the media (see also Holt, 2012; Queiroz, 2012).

Parag and Roberts (2009) and Bleser and Nelson (2011) contend that one of the reasons why consumers resist the consumption of tap water is the failure of the institutions responsible for distributing tap water to engage in adequate communication with their users (Bleser & Nelson, 2011; Parag & Roberts, 2009). Consequently, they claim that the distributors of tap water have to establish more transparent and effective communications systems in order to remedy potential mistrust in the quality of tap water, which aligns with the strategies by the European Commission and the national initiatives.

Similar to studies on how access to water affects consumers' water drinking choices, the literature on the effects of making the various benefits of drinking tap water transparent is very limited. However, we can rely on fringe literature that has demonstrated the effectiveness of stressing the benefits or co-benefits of changing individual behavior. Bain et al. (2016), for example, show that “communicating co-benefits could motivate action on climate change where traditional approaches have stalled.” From this study, we conclude that in societies where water access and water quality are good and where citizens trust political elites and institutions, communicating the benefits of drinking tap water could potentially lead to changes in behavior. The authors show that by stressing the benefits of action intended to combat climate change, the actions of those convinced and of those unconvinced that climate change is real do differ—though only slightly in degree.

5 | RESEARCH AGENDA

Our review of the literature on political and societal attempts in Europe to increase tap water consumption has provided important insights. At the same time, our review has also uncovered several research gaps that could guide future research. The limitations in research refer to both analyses at the macro and micro levels (see Table 2 for an overview).

Most studies on the impact of access to tap water are based on nonrepresentative student samples in the United States (Güngör-Demirci et al., 2016). An evident gap concerning the microlevel perspective consists in generating data on the basis of representative samples for European countries. The number of studies that compare individuals in different countries with a view to assessing cross-cultural differences in tap water consumption are low (Johnstone & Serret, 2012) and should be increased. The same limitation applies to comparative research that concentrates on the macro level and examines, for example, the governance of water services (public, private, or public–private partnerships) and their impact on tap water consumption (García-Rubio et al., 2016). Another research avenue worth pursing refers to the Walloon government's attempt to make it obligatory for restaurants and public places to offer water free of charge. If this initiative results in a legal obligation, it would be very interesting to examine in detail the behavior changes it may have brought about among Belgians.

Whether individuals would change their water drinking preferences if provided with objective information on the quality of tap water requires further investigation. Furthermore, it is uncertain whether an upgrade in drinking water standards increases individuals' trust in the safety of tap water, and whether trust is ultimately decisive for water drinking preferences (Hawkins, 2011). Another finding in the literature is that bottled water is preferred over tap water because of its taste (Parag & Roberts, 2009). Improving the sensory quality of tap water seems reasonable; however, there is still only limited data on whether improving the sensory qualities of tap water would also induce people to

TABLE 2 Research agenda

Dimension	Level of analysis	Direction for future research
Access to tap water	Micro	Does improved access to tap water increase individual tap water consumption?
	Macro	Is tap water consumption higher in countries with better access to tap water?
	Macro	Is tap water consumption higher in countries with a more restricted bottled water market?
Quality of water	Micro	Does information on the quality of tap water influence individuals' consumption patterns?
	Micro	Does an upgrade in drinking water standards increase individuals' trust in the safety of tap water?
	Micro	Does improving the sensory qualities of tap water increase tap water consumption?
	Macro	Do higher drinking water standards increase tap water consumption?
Transparency on benefits	Micro	Does information on the benefits of tap water influence individuals' consumption patterns?
	Micro	Under which circumstances does providing information on the benefits of tap water lead to increased tap water consumption? What is the impact of trust in political elites and institutions?
National initiatives	Micro	How successful are initiatives in inducing behavioral change?
	Macro	Which factors foster the success of initiatives in increasing tap water consumption?

change their drinking water preference. These questions can be addressed on the micro level by analyzing survey data or conducting experiments, as well as on the macro level by comparing drinking water standards and their impact on drinking water consumption patterns.

Studies on how knowledge on the benefits of tap water affects consumers' choices are mainly based on non-representative survey data (Gheorghe et al., 2019). Therefore, replications of these studies based on representative samples in (several) European countries are encouraged. At the macro level, future studies could compare the effects of national initiatives that explicitly aim to increase tap water use by better communicating its benefits. This brings us to the last set of limitations, which concern the national initiatives presented above. Future research should consider examining whether these initiatives change the perceptions, intentions, and actions of individuals regarding tap water use. More information is needed concerning the characteristics of these initiatives, their strategies, and their success.

6 | CONCLUSION

Tap water within the EU is of very high quality and is delivered 24 hr/day and 7 days/week directly at the point of use. The revisions of the pertinent standards for drinking water that are being negotiated between the European Parliament and the governments of the member states will further increase the quality of tap water. This widely shared view among (scientific) experts deserves recognition among consumers. Interestingly, the high consumption of bottled water in some European countries, such as Italy or Germany, contradicts this assessment and has a range of negative economic, environmental, and social effects.

To remedy this situation, the promotion of tap water features prominently on the political agenda of the European Commission, but we can also observe the launch of pertinent political or civil-society initiatives in several member states. As we have shown, the Commission strives to attain this goal by improving access to tap water, upgrading the quality of tap water, and by making the benefits of tap water more transparent. The initiatives in the member states concentrate on improving (information on the) access to tap water and communicating the benefits of tap water. While these initiatives do not regulate the quality of tap water, some of them invest heavily in demonstrating that tap water tastes as good as bottled water.

The literature on access to tap water and how it affects tap water consumption turned out to be very limited. The findings suggest that making tap water available (in canteens or restaurants) can bring about behavioral changes. The underlying mechanism seems to refer to changes in the social acceptability of drinking tap water. Similarly, only a few studies examine the impacts on individual behavior of communicating the various benefits of tap water more explicitly. Taken together, the literature shows that communicating benefits can stimulate the consumption of tap water, but only in settings where the individuals trust that tap water is safe. In other words, the capacity of water suppliers is an important factor to consider when examining the consumption of drinking water.

Research has also shown that sensory qualities, together with safety concerns, are responsible for low levels of tap water consumption. Therefore, attempts to promote tap water use should always communicate the safety of tap water as well as invest in convincing citizens of its taste. The better the taste of tap water (assuming that it is also safe for human consumption), the higher are the chances that the drinking behavior will change in favor of tap water.

In this review, we focused on the impact of access to, quality, and the benefits of tap water on consumer behavior. Therefore, the insights provided are limited, as we had to leave other influential factors aside. Most prominently, the bottled water industry is found to have influenced consumption behavior in some countries due to several factors, including the industries' marketing efforts, liberal market regulations, or the development of PET bottles (see, e.g., Brei, 2018; Hawkins, 2011, 2017; Holt, 2012; Wilk, 2006). There is also indication of the bottled water industry mobilizing against interference in individuals' consumption behavior by the state and other institutions. For instance, when the current German minister for the environment called on the German population to drink more tap water, her move was heavily criticized by the bottled water industry in the media (Handelsblatt, 2019). The bottled water industry also mobilized against a report by Germany's leading consumer protection organization Stiftung Warentest, in which the organization compared the quality of tap water and bottled water (WELT ONLINE, 2020). However, the EU Commission is not targeting the bottled water industry, which is why we discussed this aspect at certain instances only. Overall, if more people are to drink tap water, a set of different strategies and instruments must be adopted that complement each other and provide individuals with a consistent incentive to change their drinking behavior. From that perspective, the European Commission's threefold strategy appears promising and, together with the recently launched national initiatives that can adapt the Commission's approach to the local or regional contexts, we can expect the use of tap water to increase.

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CONFLICT OF INTEREST

The authors have declared no conflicts of interest for this article.

AUTHOR CONTRIBUTIONS

Jale Tosun: Conceptualization; data curation; formal analysis; investigation; visualization; writing-original draft; writing-review and editing. **Ulrike Scherer:** Conceptualization; data curation; formal analysis; investigation; visualization; writing-original draft; writing-review and editing. **Simon Schaub:** Conceptualization; data curation; formal analysis; investigation; visualization; writing-original draft; writing-review and editing. **Harald Horn:** Conceptualization; data curation; formal analysis; investigation; visualization; writing-original draft; writing-review and editing.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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