Empowerment of discourses in environmental economic policies: The case of French water management

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Abstract :

Empowerment of discourses and subjective perceptions is a real issue for economic policy makers, even in the environmental field in order to promote public acceptance. Q methodology appears as a transparent and operational alternative to complement traditional economic tools as it catches subjectivity of perceptions on a huge variety of topics. This paper offers an overview of some theoretical and empirical applications of its use in environmental and economic public policies and an illustration on water governance. Our study, conducted in a region of France on 35 participants by face-to-face interviews, highlights the usefulness of such a method to understand consensus and disagreements between a large diversity of stakeholders on the controversial use of water. Thus, participants sorted 33 statements representing means to preserve and manage the resource in a better way. This study deals with various topics: reduction of domestic consumption, reduction of agricultural and industrial consumption, preservation of the resource in quality and quantity, city planning and innovation, water governance and information, solidarity and intergenerational issues. We finally obtained five perspectives of thoughts (Active management guided by the tradeoff quantity/quality, Everyone's involvement for a sustainable management of water, Tackle local issues thanks to knowledge, Technological optimization to compensate lack of citizen investment and Pricing and regulation to support water preservation). Concretely, we develop these views as a decision support tool on water management to calibrate potential action scenarios for economic policy makers.

Keywords : Q Methodology, Water policy, France, Environmental economics

Introduction

Since the Fifth assessment report, the Intergovernmental Panel on Climate Change is providing a Summary for Policymakers including headline statements, a top-level summary and narrative key of findings in the scientific area to fight against climate change. In order to be accepted, implementation of these scientific recommendations should consider also the populations concerned, who are at the heart of these evolutions. In that context, this paper

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underlines the necessity to consider all subjective discourses in environmental economic policies. On the path to understand more the subjective perceptions of individuals, Stephenson introduced Q methodology in 1953, binding qualitative and quantitative approaches to create a state of play of visions on a defined topic (Stephenson, 1953). Existing literature shows many links between this method and economics in order to complete traditional economic tools (Baker et al., 2006). In this context, the intend of this paper is to consolidate its use in the field of environmental economics and to show the potential implications for policy makers. Thus, the following words establish the link between policy analysis and concrete applications of Q methodology on environmental issues in the recent academic literature.

In 1999, Durning underlined the possibility of a paradigm shift in policy analysis from a traditional objective scheme towards a post positivist one, favoring subjectivity with the use of Q methodology. According to him, the role of Q methodology is predominant to guide policy analysis in a way that consider more intrinsic perceptions of stakeholders (Durning, 1999). Thus, he underlines five uses of this method in policy analysis that we will transpose with concrete examples of applications in the environmental sphere.

First Durning (1999) claims that Q methodology can be useful to **"obtain insights into the context of policy issues"**. In environmental economics, it can be the case when stakeholders have divergence of interests like for the sharing of a common pool. For instance in their paper, Levesque et al.(2019) show the opposite perceptions on the regulation to allocate water from Saint Pierre's lake, which is facing conflicts of use. Durning (1999) also underlines that Q methodology can helps both **to define the meaning of non-efficiency criteria and to identify different problem definitions**. For Bischoff et al. (2018), in environmental policy, the definition of fairness is crucial for cultural water and for water right of indigenous populations. Moreover, in that example environmental economic actors and their own interests can shape problems related to the sharing of a common pool, when they have divergent needs on water use (Bischoff et al., 2018). Thus, efficiency and fair policies can be discussed as they depend both on individual and collective interests but also on subjective definitions of a problem. Q methodology is pertinent as shown by Barry et al. (1999), because the success of an implemented policy and its public acceptance relies also on the knowledge by policy makers of societal viewpoints.

Furthermore, Durning (1999) pursues by saying that Q methodology **can help to identify preferences of different groups** like it is the case in Forouzani et al. (2013) and Ward's (2013) papers. In their paper, Forouzani et al. (2013) highlight 7 profiles clearly separated in two groups: some are mainly composed by farmers, and others by specialists, with diverging visions on Water Agricultural poverty. More than disparities in preferences between types of actor, profiles can also divide participants into diverse perceptions. In its paper, Ward (2013) shows three main profiles on the program "Integrated Water Resource Management" with different degrees of acceptance. Thus, Q methodology can also underline preferences of groups depending on the types and activities of the participants or some other characteristics. Durning (1999) finishes by a last use of Q methodology in policy analysis: Q methodology can **assist in evaluations** for instance to understand efficiency of policies implemented. As an example, the paper of Frantzi et al. (2009) uses the method to understand efficiency of international cooperation policy around Mediterranean action plan and environmental diplomacy.

These five points regarding the use of Q methodology in environmental economic policies highlight the usefulness of such a method as an exploratory and complementary approach for other economic tools. Specifically, this environmental panorama of applications offers an insight on the utility of actor-based methods in environmental economic policy to confirm public acceptance. Thus, this paper focuses on the literature regarding the link between Q methodology and its use in environmental economics and public policies through a conceptual and empirical evidence. It offers also a case study on French water management, which is actually at the core of a huge debate between stakeholders. To go further, the paper promotes also potential intervention scenarios based on participants' views and raises many issues of collective interest. How can we empower discourses in environmental economic policies? How Q methodology can calibrate scenarios to guide policy makers to solve environmental issues? How French water management illustrates the power of Q methodology to consider stakeholders' discourses in order to favor public acceptance of policies?

To answer these questions, we conducted a Q-study between November 2019 and February 2020 in a French region with a large variety of stakeholders. This study is an illustration of the operational use of Q methodology in environmental policies. As the method considers that all views are important on a common issue, it empowers each discourse that can play a role in final decisions. We finally found five ways of thinking on water management and preservation as follows: Active management guided by the tradeoff quantity/quality, Everyone's involvement for sustainable management of water, Tackle local issues thanks to knowledge, Technological optimization to compensate lack of citizen investment, and pricing and regulation to support water preservation. Moreover, Q methodology presents an interest for policy makers in environmental economics and management of natural resources as it gives a panorama of concerns and expectations. Typically, our study on water management is a concrete application that shows how a conflictual situation can be analyzed through the statistical and subjective prism of Q methodology. It contributes to put words on conflicts of use and disagreements but also to underline commonality and consensus between factors. This approach is necessary to build an accepted policy to manage and preserve water in a better way on this French studied territory.

These results strengthen existing literature providing a conceptual and empirical framework for the use of Q methodology in environmental economic policies. It shows that the method is transferable to real fields like the case of water management in France with a multitude of stakeholders. This paper intends to help policy makers to define efficient choices and intervention scenarios, relying on consensus areas and dealing with disagreements. To do so, this article introduces a conceptual and empirical framework of the use of Q methodology in environmental economic policies and more precisely on water field (2). Then, the context and method are described focusing on our French water management' case study (3). Thirdly, the main results are presented with profiles founded, consensus and disagreements between participants (4). These results open a next part of discussion with intervention scenarios on water governance through public policies (5). Concluding comments on the empowerment of discourses with Q methodology for environmental economics and results on water governance are then summarized (6).

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Usefulness of Q Methodology in environmental economic policies

This part details first the theoretical framework (2A) of the use of Q methodology in environmental economic policies and questions advantages and limits of the method (2B). It introduces also a discussion on the role for Q methodology on interactions and power of stakeholders (2C), before ending with a presentation of empirical evidence in the environmental field (2D).

A) Conceptual background

Many authors already questioned the use of Q methodology as a complementary actor-based method that can enrich research in economics and policy analysis (Durning, 1999).

Recently, Baker et al. (2006) discussed the use of Q methodology in health economics with arguments that are also relevant for environmental economics. They show that Q methodology is a reliable supplementary method as it combines both a profound subjectivity with factor analysis and correlations but also mathematics and statistics in the foundations. According to them, this dual approach with mathematical transparency and qualitative aspects enriches economic tools without the usual critic on data analysis of the mystery of classification. Thus, the method presents many advantages that can support the development of economics in general but also in more specific fields (health economics, environmental economics and so).

Indeed, Q methodology completes environmental economic tools providing an actor based method on commonality of perceptions. According to Hermans and Thissen (2009), actor-analysis methods rely on five main components. It should provide a comparative overview for the multiple actors invested. It should also focus on one or several dimensions of multi-factors political process. For them, methods or past applications should also be described with enough details to rebuild their uses. Moreover, such a method should have proven its utility in practice to analyze the role of actors in the elaboration of real politics. Lastly, it should have been subject to scientific examination with publications on its developments and uses. These five elements pointed out by Hermans et al. (2009) reflect that we can identify Q methodology as an actor based analysis method. In a context of environmental economics, it can be useful to understand the perceptions of all stakeholders and all dimensions of an issue. As policies deal with environmental questions nowadays, it contributes also to have a robust and scientific trustful method to elaborate a state of play on such a question.

Additionally, Raadgever et al. (2008) brighten this idea, saying "An overview of stakeholders' perspectives can be useful in natural resource management" for many reasons. Indeed, it helps to set the research agenda and to identify differences between interests that need to be discussed. It is also interesting to create awareness among a broad range of stakeholders. Finally, this overview of stakeholders' perspectives is a way to develop scenarios. This last reason will be exploited in our own study to better know which means and economic tools as quotas, taxes and subventions should be implemented and accepted regarding water governance. Construction of interventional scenarios can thus take roots in expectations of stakeholders about important means to preserve water resources.

B) When advantages surpass limits

Generally in economics but more specifically in the environmental field, Q methodology represents a good tool to enrich analysis of a situation, based on discourses of participants. Thus even if there are some disadvantages of the method, they can be exceeded by all advantages. As Baker et al. (2006) show, Q methodology relies on subjectivity of

individuals, which can be subject to critics. However, this subjectivity is coupled with mathematical transparency and does not suffer from the limit of data analysis and biases of classification.

Therefore, as Barry et al. (1999) underline, Q methodology is time consuming with face-to-face interview and the choice of the Q set (set of items ordered by participants in the grid). The selection of appropriate participants also takes time to prepare a pertinent study. However, these authors also emphasize the necessity of a small number of participants to obtain a statistical significance because each Q-sort filled (result of the sorting process in the participant's grid) provides an important information on ordered statements. This second technical advantage on a small number of participants can mitigate the time spent on interviews. As Baker et al. (2006) show, Q methodology does not allow a generalizable research at a large scale. The results obtained concern only the sample of participants. However we can say that thanks to the hypothesis of "finite diversity" (Barry, 1999), which says that there are not as many discourses as participants, this limit can be surpassed and Q methodology is still interesting to catch a large variety of perceptions.

Moreover, for Barry et al. (1999), Q methodology can improve public acceptance through the implementation of pertinent public policy in adequacy with participants' expectations. According to them, Q methodology helps to implement a policy depending on the group concerned and to adapt policies at a local scale with more adequacy to public expectations. Thus, Q methodology is made to catch the local context and needs of stakeholders in order to assist environmental policies in two ways. First, it helps to understand perceptions of environmental problems by different groups with consensus areas and adherence to each type of discourse is thus better known. Second, if groups have two radically opposed perceptions, it helps policy makers to know on which support and on which group they can rely on to implement their policy. In this context, one major advantage of Q methodology is to correlate and gather individual answers (Barry,1999). For environmental policy analysis, it is a crucial argument because areas of consensus and agreements are often needed. For example, we need it in treaties on the sharing of a common pool like a river or a lake.

One other advantage of Q methodology is the diversity of fields and infinity of topics that we can study. Thanks to various supports like pictures, statements, videos, sounds, objects, it is possible also to awake senses and ideas. It breaks the barriers of language with images, sounds for example, or it can be very precise with statements. It is even possible as Baker et al. (2006) say to conduct intensive studies with a small sample but several Q sorts under various conditions of instructions. We also see in the literature some longitudinal studies over time to understand evolutions of perceptions on a given topic, conserving the same Q sort process and participants. As an example of longitudinal study, Davies and al. (2012) made this kind of Q methodology with two Q-sorting, one in 2008 and another in 2011 to understand changes in agriculture over time.

C) Q methodology to understand power in negotiations and interactions between stakeholders

At a reduced scale, in environmental policy analysis, Q methodology represents a good measurement of interactions and power of stakeholders in negotiations on the sharing of a common environmental pool.

In that way, Frantzi et al. (2009) show that efficiency of a policy relies on various ingredients that depend on the plurality of visions. They underline also that only a few studies deal with efficiency of policy implementation while many studies focus on environmental diplomacy, treaties and agreements. It is not hard to understand the link between the two as a public acceptance is necessary to conduct an efficient policy (Barry, 1999 ; Wards, 2013 ; Iribarnegaray, 2014). Then, Q methodology underlines views and expectations of stakeholders on a topic: a necessity to build an efficient policy.

Another idea is the importance of cooperation to create a dialogue between all actors and to find a consensus. Frantzi and al. (2009) show that cooperation can lead to multilateral agreement on environmental issues. The importance of cooperation between actors is also underlined by the Q-study of Stevenson (2019) on green political economy, conducted on a large P sample, that is to say the set of participants (civil society, nongovernmental organizations, academics…). One profile of this study is called "Cooperative reformism", underlining the need to cooperate on implemented reforms in the economic system in order to improve their sustainability over time. Even if this profile is one between others ("Radical transformationism", "Statist progressivism") it appears as a good option that we should not evince to favor cooperation on green policies.

Following this idea of negotiation and cooperation on a common environmental pool, the study of Forouzani (2013) illustrates how Q methodology can underline conflicts of use and helps to implement good policies in order to create an agreement between stakeholders. Their study is based on two groups of stakeholders (farmers and agriculture specialists) on the notion of "Agricultural water poverty" is a context of scarcity and conflicts. One interesting point of this study is the caesura between the two groups of profiles revealed by the study. A first group composed by three profiles is clearly dominated by specialists and the 4 other profiles of the second group are dominated by farmers but none of them are clearly equiponderant. It reveals the divergence of interests between farmers and specialists and the gap that water allocation policy have to face. Thus, their Q study provides information on power and opinions of each kind of actors to create an agreement.

As Cuppen et al. (2010) notice, it is often difficult to find an agreement between stakeholders because all actors are often discrepant on policies. However, Q method can be seen as an introductory method to understand all the points of view so that the stakeholders can know their vision and the other participants' one. It is useful to have an overview of all perceptions on a topic before the introduction of a dialogue. Indeed, in their study, Cuppen et al. (2010) use Q methodology as a complement to introduce and to understand all the perceptions of individuals on biomass use in Energy in Netherlands. Then Q methodology was the first step to select participants of a final dialogue to represent all knowledge, past influences, functions and expectations of stakeholders that should be defended in the final discussion. Q methodology refined the selection of stakeholders in order to co-construct policies. This example in environmental economics shows that Q methodology is a good complement to other methods in order to apply efficient environmental policies and to consider each vision. It is a path from discrepant to co-construction and cooperation on a consensus.

D) Empirical evidence: An overview of Q methodology in environmental issues and policies

More than the interesting conceptual framework for environmental economists, Q methodology have proven its empirical reliability to catch discourses on a public and environmental issue. The following Table 1 gives an overview of diverse applications in the field of environmental issues and policies regarding consumer behaviors, conflicts of use or even policies and regulations. This table also underlines adaptability and pertinence of the method in environmental economic policy.

Authors and year	Context and place studied	Main topic	Selection of statements and Q sorting	Number of participants and functions	Profiles and results
Barry et al. (1999) *Ecological economics*	United Kingdom, on participants of the Local Employment Trading Systems (LETS)	The theme of the Q sort is "Environmental concern, awareness and Sustainability", to understand the vision of individuals on environmental policies, their public acceptation and their implementation	36 statements kept after a concourse on medias and interviews with studied populations	25 participants related to the LETS, individuals of a common group	4 profiles : -Techno-sceptical and non-green holism ; Anti-capitalism, techno-skepticism and non-green ecologism ; Political ecologism ; Pro-technologism, acquisitiveness
Raadgever et al. (2008) *Hydrology and hearth system sciences*	Rhine bassin between Germany and Netherlands	Study different perspectives on management of future water flood in the downstream part of the Rhine basin and define a common vision on it by 2050	Literature review and 23 semi-structured interviews led to 46 statements on 4 themes (actual situation, autonomous developments, management strategies and future desired situation).	22% answers on 200 interviewed by mail, well balanced between German and Dutch. Larger representation of governmental organization, academics than NGO, citizens and scientific entrepreneurs from Germany.	3 profiles : anticipation et institution ; Space for floods ; Engineering knowledge. Common vision of the actors on the provision of security in front of flood and the future vision allows to consider scenarios of intervention.
Frantzi et al. (2009) *Journal of environmental management*	Territory of the Mediterranean action plan to understand the efficiency	Extension of research on environmental diplomacy, international treaties and agreements. It	25 semi-structured interviews, concourse of 294 statements, sorted by topics and selected to have as much negative and	25 Q sorts filled by a huge variety of stakeholders (academicians, external consultants, NGOs, center of	4 profiles on regime efficiency : international political cooperation ; legal implementation and environmental performance ; Practical VS political effectiveness; governance through participation.

	of the implementation of international cooperation policies	focuses on efficiency of regimes already implemented.	positive arguments. Final total of 44 statements for the Q sort.	research, ministry of environment, …)	It shows that efficiency relies on different elements depending on perception of participants: role of institutions, legal measures, cultural, scientific and environmental aspects. This diversity of opinions underlines the hardness of consultation to defend different interests and conduct an efficient policy
Cuppen et al. (2010) *Ecological economics*	Netherlands, during a dialogue on energy options from biomass.	This study should help all actors to know the visions and perceptions of others, to get a mapping of all the perspectives before the dialogue and reflects each view equally.	Concourse built with discussions, reports, public debates, articles and so. 62 statements selected and 60 kept after 5 pre-tests to catch the amplitude of the perspectives	75 participants in total from various institutions: institutes, academics, NGOs, big/ medium and small firms, local/regional/national instance of the government. 30 participants over 75 participated at the final dialogue representing the different views, interests and expectations.	6 profiles: Keep all options open; Hit the brakes; support small-scale innovation initiatives; security of supply with global, certified, 2nd generation biomass; efficiency the goal, biomass a mean? ; Just do it, step by step.
Davies et al. (2012) *Ecological economics*	United Kingdom, comparative study conducted both in 2001 and 2008 on	Study focuses on changes of environmental perception frameworks of individuals over a long period with a	Use of the same Q set in the two studies to have a perfect comparison of the results	102 face-to-face interviews in 2001 and a re-test of 34 completed studies by post box in 2008.	4 evolutions between the two studies: Increasing reluctance to endorse environmentalism, surge of support for technological stability, decline in enthusiasm for payments for service, increasing concern with farming communities. These results show the

	agricultural changes	longitudinal approach			evolutions over time and not the profiles because the longitudinal approach allows us to show the structural stability of some agricultural perspectives or on the contrary the evolving elements in perceptions of respondents.
Forouzani et al. (2013) *Journal of arid environments*	Province of Harvdasht Couty of Fars in Iran during the development of « water agricultural poverty » (AWP) on the territory , confronted to the insufficiency of qualitative water for agriculture production, overexploitation and climate change.	This study wants to understand what is the «Agricultural water poverty » for farmers and specialists of the agricultural world and their different interpretations between the two groups. It is even more interesting that agriculture is one of the main activities on the territory and all the population faces a deterioration of underground water	Transcript of semi-structured interviews (6 farmers, and 9 focus group with farmers and specialists), literature review. Initially, 750 statements collected and at the end, 54 statements were selected to develop all the main themes.	75 participants (50 Farmers and 25 specialists).	7 profiles : 4 dominated by farmers (Management-adherents , adaptative adherents, Fatalists, Support seekers) and 3 dominated by specialists (Farmer-blamer pessimists, technocratic realists, Optimists). Generally, the results question the sustainability of the actual model : Access to water, reasonable use, availability of the resource, means of extraction, vision of the AWP, future, and optimization.
Lucas Ward (2013) *Geoforum*	Paraguay	The goal of this study is to understand the	24 semi structured interviews on the actors invested in the		3 factors with a mitigated vision on adoption and implementation of the program: IRWN Acolytes in favor of

		implementation of the “Integrated Water Resource Management” (IWRM) and its approval	IWRM (civils, NGO, government of Paraguay, …). 50 statements on 4 topics : Local management and development conditions, the role of science in governance, politics of the IWRM model , values of environment and development		the adoption of program rules; Centralized IRWM who represent three high level governmental persons in favor of the central role for government agencies in managing civil society participation; selective IRWM represented by the public sector and NGOs who are opposed to the acolytes vision on the market and think that power over water should not be diminished.
Asquer (2014) *Water*	Italy, a territory with a furniture of water partly private since a reform of 1994 but 2/3 of the distribution network stays public.	Study of the perceptions of water services on a territory shared between public and private sectors. They are all regulated by norms on quality of water and a limit of prices for water.	A concourse of 150 statements on water services regulation for local water services was built on documentaries, 20 interviews with public officers at a governmental, local and national scale with water regulators, managers, laws and reforms on water in Italy. The final Q sample counts 30 statements.	This study asked 481 elected members of 19 municipalities and 5% answered at the end, so a total of 24 participants The elected members of the public service of local governments have a role to play in water regulation and legal conception of pricing rules and supervision of distribution firms of water.	5 factors identified: interventionists of public sector; pessimists ; pragmatists ; prudent privatizers and fatalists privatizers. These 5 profiles show distortions on the importance of public and private sectors in the furniture service of water. A majority of profiles say that principles of solidarity and accessibility for the poorest should be applied while the last profile emphasizes more protection for firms than for users with a recover of engaged costs. This heterogeneity is linked to the historical concept and the recent implementation of the private sector in services of distribution of water.

Iribarnegaray et al. (2014) *Water policy*	City of Salta (Northwestern Argentina) with a really huge water consumption about 600 liters per person per day, due both to over-consumption, leaks and so.	Efficiency of means to reduce water consumption (awareness campaigns, mass-media advertisement, leaks of the distribution system) and to test their public acceptance.	Concourse was obtained from analysis of the local media, conference proceedings, scientific articles, interviews and experience of authors. They found more than 150 potential statements and kept between 13 and 20 on the four following themes: service provider, water rights, public participation and water availability.	Total of 29 persons interviewed from diverse horizons (water company managers, technical staff, public relations representatives, government officials, NGOs, water users, environmental engineers …) in 2011 and a post-Q semi-structured interview was conducted in 2013 with the more representatives of each profile to confirm the results obtained.	4 main profiles : "Right based consumption advocate" composed by 6 participants and mainly customers who think that water is a human right and the inefficiency is due to lack of management capacity of water companies and inadequate control by state ; "proponent of market based and technical water management" composed by 6 participants whose 3 members of water company) ; "Participatory governance advocate" in favor of a more participatory and environmentally friendly water governance composed by 4 participants mainly engineers and student in environmental sciences ; "State-led governance supporter" with three participants (university professors and a philosopher invested in NGO) in favor of a relatively hierarchical, state-led, needs-oriented governance.
Forrester et al. (2015) *Applied geography*	Cross-border regions between Scotland and England	Study of social commitment on the problem of flood management and ability of risks, adaptability of the population	Huge literature review and informal interviews.	Participative cartography with 3 communities (2 in Scotland and 1 in England) with a global study of stakeholders in the citizen population, GIS study	Coupling Q methodology with a participatory mapping construction and GIS allows to combine spatial data to promote the consideration of all stakeholders and to put forward the "cooperative policy action" (Bischof, 2010) on cross-border management of floods.

				on a public with all actor types.	
Strickert et al. (2015) *Water policy*	This study takes place in the South Saskatchewan river basin, in western Canada.	It questions the concept of water security and its many definitions, linked with flooding, pollution, drought, lack of access.	Statements are collected in workshops on water and gave a concourse with 57 statements, reduced into 40 for the Q sample to suppress redundancy.	37 respondents, including 13 headwaters, 14 midstream and 10 downstream and also various types of citizens (ranchers, water managers, Scientifics, municipalities, agricultural producers , urban planners, …)	5 main profiles: idealistic sustainability with the need to protect environment by managing growth ; Pragmatic sustainability which supports intergeneration progress ; reliability which emphasizes reliability and recognize there will be some shortages ; social and ecological justice which supports basic needs for all humans and limited resources with a sustainable use of water.
Bischoff et al. (2018) *Water policy*	Murray Darling Basin in Australia	Discussion on the concept of cultural water for indigenous and debates / conflicts around its use.	31 selected statements from a public speech of the culture of water indigenous and on the study of 130 documents in newspaper, scientific reviews, and governmental papers. They are selected from an initial concourse of 350 initial statements.	A sampling method semi targeted used to choose the participants with a final number of 51 (22 in face to face), all concerned by proximity or work around the Murray Darling's basin.	4 profiles: Structural barriers and restitution (ask justice to give back to indigenous their right to water; scope and routing of water resource (the role of experts and science); a common ground and collaboration (the role of water in an environmental point of view) ; collaboration and restitution (Both the environmental and cultural views). This study presents the base to build a new constitutive reform to allocate power of decision and intervention and to respect the interests of each.
Levesque et al. (2019) *Journal of environmental*	Saint Pierre's Lake in Québec (Canada)	This territory is at the heart of interest divergences between agriculture,	Medias review over 25 years of the uses and problems on the lake (814 articles),	4 sectors are represented by elective represented, farmers, agronomists,	3 profiles: Proconservation (mainly represented by conservation associations, researchers, governmental agencies, elected

planning and Management		conservation and development around the water resource threatened by climate change and ecosystem's disruption. A consensus is needed. .	reports, meetings and conferences with organizations which work on the lake to find at the end 19 statements on the coexistence of uses, collective actions for the ecosystem, agricultural and agro environmental practices, regulation policies of agriculture and resource conservation	and government employees, members of associations and conservation organizations, fishing and hunting sectors. Participants have been divided in 4 sectors: Agriculture, governmental and municipal, conservation, Hunting/fishing sector; with approximately 15 persons in each. A total of 57 participants finished the completed Q study.	members), pro-agriculture (farmers, agronomists, one fisherman, one elected member and one environmentalist), farmers in the heart of the lake (Only farmers). The profiles of this study shows the existence of conflictual interests with different opinion groups. They agree on a few things but it is still hard to find an agreement on the activities around the lake. This study underlines the different levels of conflicts and a better comprehension of all social perspectives.
Ormerod (2019) *Journal of political ecology*	South western United states	This paper aims to understand viewpoints on potable water reuse and its planning	30 recommendations on the possible potable water reuse , for example in the case of toilets	176 key actors asked by mail to answer but 41 completed the study. The sample was diverse to consider all views with city planners, water managers, operators, activists, administrations, engineers, Scientifics, elected representatives	2 main profiles and 6 unique views not considered as Q methodology catches commonality: The neo-sanitarian which includes a lot of participants and the rest in the eco-sanitarian view. Neo-sanitarian trust in water treatment, recycling actions, modern industry and progress of technologies while eco-sanitarian view promotes holistic and ecological approaches like with dry toilets

Table 1 : Applications of Q methodology in the field of water and environment

Our own Q methodology on water provides new insights than the previous examples in the Table 1. First, our study mobilize all varieties of actors around water resources. We do not focus only on one use as it is often the case in papers behind, that focus more on agriculture (Davies et al., 2012 ; Forouzani et al., 2013) or on domestic water (Asquer, 2014; Ormerod, 2019). We decided to study water as a whole because it is a good way to evaluate conflicts of uses at a large scale and to understand the prior uses in a case of water scarcity. The goal of our study is to see the repartition of a water pool on a territory so that cooperation and negotiation between all actors is necessary.

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An applied case study on water management in France

A concrete application of Q methodology on water management in France is useful to understand all the implications of discourses on environmental policies. It is accentuated when resources are facing scarcity issues, which is the case of water here in both quantity and quality. The following part details the context of the study, research method and data collection.

A) Context and issues

The region Pays de la Loire is located in western part of France over 32 082 km squared that houses more than 3.7 million of inhabitants. It is facing a huge annual population growth, which questions the sustainability of actual water consumption and retreatment. Moreover, the territory suffers from heterogeneity on the allocation of water. While the Eastern part benefits from huge quantity of groundwater, the western part is deprived of it and relies mainly on polluted surface water resources. The disparities in both quality and quantity between departments are even accentuated by the strong extraction of the west on the river la Loire. This resource is flooding from the East of the region to the West, creating an interdependency between all departments of the region because the upstream part can influence quantity and pollution of the resource on the downstream one.

Thus, the studied territory contains many inequalities in terms of water allocation. In order to avoid any conflicts of use both between territories and between types of consumers (industries, farmers, domestic consumers,…) it is crucial to find agreements on the way to allocate, to preserve and to manage water in this region. For that reason we decided to use Q methodology in all departments of the region and with different kind of stakeholders to “give a voice to the voiceless” (Gauzente et al., 2019) and to consider all discourses. One of the advantages described upper is the possibility to find consensus statements and ideas between participants. This study wants to rely on these elements to create a common agreement on the way to preserve the scarce water available on the territory. Indeed, Q methodology allows us to let each stakeholder express himself for a better and cooperative action to manage water in an optimal way.

More concretely, our study was conducted in the region Pays de la Loire (France), including participants from all departments of the region (Sarthe, Mayenne, Loire Atlantique, Vendée, Maine et Loire) between November 2019 and February 2020. To understand all the perceptions and discourses of stakeholders we contacted a large variety of actors to catch the complexity of water management in France. We tried to consider finite diversity of all views and interests of the multiplicity of actors presented in the following Figure 1. As all of these actors have a role to play to preserve water, recommendation’s scenarios of intervention for

policy makers in the long term should be in adequacy with the actual and concrete situation around this vital good of the region.

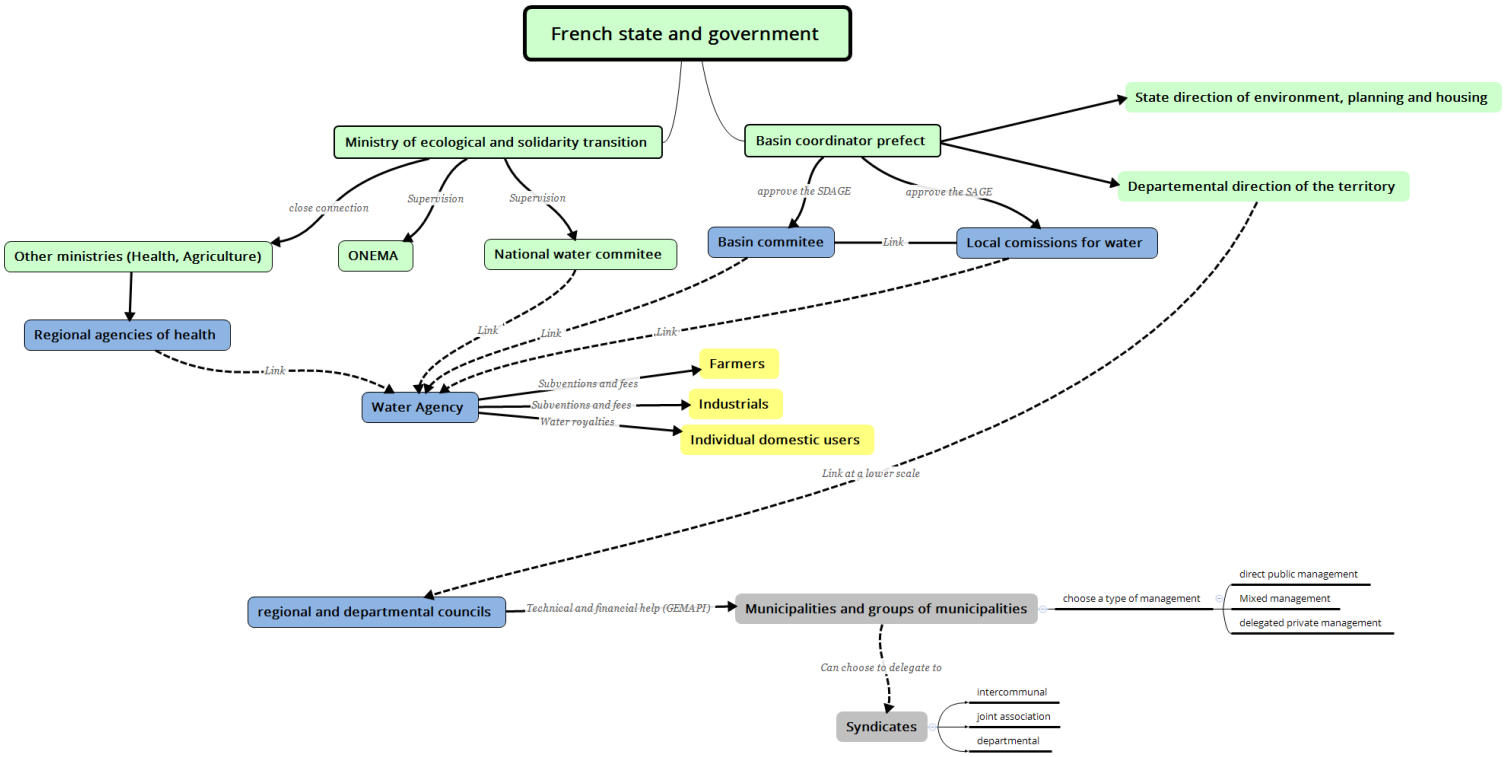

Figure 1: Map of stakeholders around water in the region

B) Research method and data collection

Our study follows the common steps of Q methodology. Firstly, the concourse (set of all items and ideas to preserve water in the region) was obtained on the following thematic universe: water management and preservation. We gathered statements in websites of water actors, newspapers, literature on water and interviews and we got at the end a total of 155 statements on various themes. The topics included were Reduction of domestic consumption, Reduction of industrial and farming consumption of water, Preservation of water in quantity and quality, City planning and innovation, Water governance and information, Solidarity and intergenerational issues, Cooperation and shared initiatives. After grouping common statements, deleting the less important ones, choosing the central sentences we conserved 33 statements in the Q-set (list of conserved statements for the sort in the grid). They are presented in the Annex 1.

Then potential participants were contacted by mail. Face-to-face interviews were conducted with those who accepted to be involved in the study. As shown before, the multiplicity of actors around water management and consumption is really expanded. However we really tried to have a sample with all kind of actors at all scales (delegated power from state, regional actors, departmental ones and individual consumers) to catch all views and interests. Participants were from distinctive groups as presented in Figure 2, which maps all the participants. What is interesting to notice is the diversity of uses represented here, sometimes at the origin of conflicts between farmers, industrials, and domestic consumers, associations

and collectivities or public and private sectors. We also tried to have participants from each departments and from the region in its entirety to represent local specificities and spatial heterogeneity of the resource. It is generally equilibrated in four departments of the region but we do not have participants from Mayenne, only regional views to represent them, which is not surprising as its population is less important than in other departments and suffers less from water conflicts and tensions.

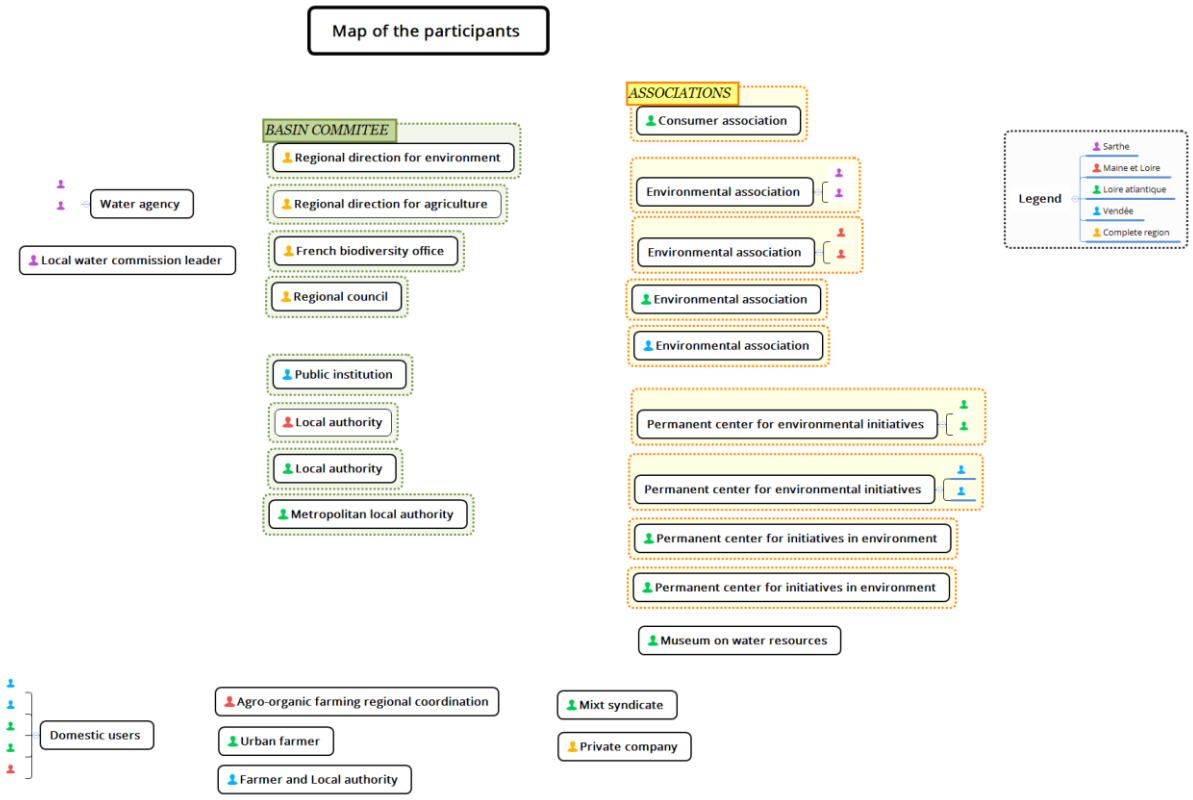

Figure 2 : Map of the participants of the Q study

Actually, we conducted 35 Q-sorting and semi structured interviews divided in two parts. First we asked participants to sort in a grid the 33 statements of the Q-set according to the instruction "What means do you consider as important to manage and preserve water in a better way ?" On one side of the grid they putted the statements that they consider crucial and on the other one the statements which are really not important. The grid was distributed between -3 and 3 with 7 columns, as follows in Figure 3.

Really not important -3	-2	-1	Neutral/ Do not know 0	+1	+2	Very important +3

Figure 3: Representation of the grid

Then we asked participants to explain their choices in the extreme parts of the grid in order to consider their perception and their vision about water preservation in a better way. Then a second part follows the Q sort, with semi-structured interviews to understand more the role and the interactions of each actor with water and other stakeholders. We asked them to describe their activities in relation with water management but also the interactions, conflicts, actions they have in common with other actors. Finally, some additional questions were asked about their visions of water as a common or a merchandised good and the private or public management. To conclude we asked them if in their mind people take care of the others when they consume water and if they try to reduce their own consumption to let the resource for others in a way to avoid conflicts of use. This last question wants to understand if there is a social norm on water consumption or not. All these additional questions contributes to a better interpretation and contextualization of participants' answers.

After the interviews, we interpreted the results obtained using the software *Ken Q* which provides a full amount of data both on correlations, on factors characteristics, on consensus and disagreement areas. Regarding the results obtained, it is important to note that Q methodology relies on factor analysis and the study of correlations. The first step to define profiles, based on participants' subjectivity, is to calculate the correlation matrix to understand degrees of similarities between participants. As given by Baker et al. (2006) the correlation matrix is constructed between participants using the following formula:

$$R = 1 - \left(\frac{\sum Diff^2}{\sum Indiv^2} \right)$$

Where *Diff* is the difference of rank score between two participants concerned given to each statement and *Indiv* is the rank score given by each participant to the statement. This matrix is built repeating this formula for each participants of the study. A correlation of one indicates the perfect similarity of answers between participants while a negative correlation between individuals indicates strong disparities in perceptions.

After that, we made Varimax rotation based on level of explained variance and similarities between participants but also a judgmental analysis, based among others on eigenvalues above one. These two complementary analysis permit the selection of the number of factors (views) as we will see in the following part. To each factor, a grid is associated, relying on the subjectivity of a group of participants, who are flagged for their commonality in answers. In our case only seven participants were not flagged because they were non-loaders and to much divided between views as detailed in Annex 3. After choosing the number of factors and the flagging, Ken-Q provides results depending on the statements and their sort value in the grid. The results also provide the Z-score of statements for participants in terms of standard deviation from the mean. Consensus and disagreements on statements are also ranked to understand the common answers or on the contrary, the diverging views. Based on this method, the following part consists in the interpretation of the results

- 4 -

Empirical results

Empirical results of our study on water management in France are provided in the following part. It highlights the factors obtained in the analysis and the areas of consensus and disagreements between views.

A) Factors

The factor extraction conducts to the following results in Table 2 on eigenvalues of factors and explained variance percentages.

Factor	1	2	3	4	5	6	7	8
Eigenvalues	11,135	3,1465	2,5529	2,2474	2,1715	1,8967	1,6218	1,3641
% of Explained Variance	32	9	7	6	6	5	5	4
Cumulative % of explained Variance	32	41	48	54	60	65	70	74

Table 2 : Results of eigenvalues and explained variance for factors

Usually, we conserve factors with an eigenvalue superior to 1 to consider them independents, which represent 8 factors in our case. However, regarding the local context and the results of the flagging we decided to keep only 5 factors to distinguish and interpret them clearly. Indeed, with 8 factors, factors 5 and 6 were composed only by one participants and 17 individuals were not flagged with a p value < 0.05. Q methodology bases its force one commonality between agents to produce factors. In that way, regarding the local conflictual context, our five factors already represent an accumulative variance of 60% and catches the main diversity of perceptions. However, it is still interesting to consider that our topic divides participants, and it is not surprising as water governance in the region creates conflicts of use. This study helps to show that only one statement of consensus does not distinguish any pair of factors (#15) a positive consensus on “Restrict/ Ban pesticides, fertilizers, phytosanitary products …”. It shows the representativeness of scattered views of stakeholders on water governance. The repartition of participants between factors is given as follows in Table 3.

FACTOR	NUMBER OF PARTICIPANTS	CATEGORIES OF PARTICIPANTS
1	8	Environmental associations and permanent center for initiatives in environment (4), water agency (2), Regional direction for environment, Local authority of a huge city
2	6	Environmental association and permanent center for initiatives in environment (3), water local commission leader, mixt syndicate, regional council
3	8	Domestic consumer, permanent center for initiatives in environment, Urban agriculture, farmer in basin committee, museum, public institution, regional direction for agriculture, local authority
4	8	Domestic users (4), environmental and consumers associations (3), French biodiversity office

5	5	Environmental association, permanent center for initiatives in environment, agro-organic coordination of the region, local authority in basin committee

Table 3 : Repartition of participants in factors

Factor 1 : Active management guided by the trade-off between quantity and quality

Common of these participants was the importance of concrete actions to preserve the resource. While other factors put the statement “guaranty the access to drinking water for present and future generations” (#32) in the most important things, it is not the case for this factor which consider this statement more as a declaration of intent rather than a real improvement. According to this factor, it is necessary to secure the distribution and to restore the resource (#23 / #19) actively. This factor does not tolerate that some individuals and the farming sector pollute water and affect others without retribution, even more when it can induce sanitary problems. Thus, agricultural practices are a crucial lever to improve water management for this factor in both quality and quantity. Indeed, this factor thinks that "restrictions on pesticides and fertilizers” (#15) and “favor an organic production” (#14) are necessary to preserve water in quality. Regarding quantity used by agricultural sector, this factor also thinks that favor crops that consume little water (#8) and quotas on m^3 consumed by industries or farmers (#12) are important. These actions are necessary to preserve and restore watercourses and wetlands (#21). Conversely, for this factor we must stop “bandage” actions such as recycling urban water for agriculture and industry (#9) or eco-friendly household products (#4) because they do not tackle the problem at source. For this factor, water storage (#12) is not a good solution contrary to factors 3 and 4, because the problem is elsewhere. If we implement crops that consume little water and organic production, agriculture will need less inputs of water and so storage is consequently not necessary. Moreover, stakeholders around water have to be invested in the preservation of water and then subventions for water saving installations (#3) is a wrong solution because it relieve consumers of their economic responsibility. Thus, for this factor, water management should be guided by concrete and large-scale actions to solve both quantity and quality issues through the main levers as agricultural production.

Factor 2: Everyone’s involvement for a sustainable management of water

This factor is characterized by the desire of a systemic evolution in the use and preservation of water resources, considering the challenges of climate change (#28 in +3 of the grid while for other factors it is less important) to guaranty an access to water for future generations (#30). This factor is in favor of a long run, forward looking and transversal approach of water governance, which requires many changes in practice. Thus, it is crucial to restore the quality of aquatic environments and wetlands (# 19) and to prevent the degradation of watercourses (# 23). It is therefore necessary to improve the resource in the gross state which, among other things, involves restrictions on the use of pesticides and pollutants (#15). Water management also needs a transition towards organic farming (#14) which requires fewer water inputs, placed in +2 by the factor while it is generally less important for other factors. This factor highlights the importance of user practices (#4) both in the domestic sphere with a distinguishing statement : promote the use of eco-friendly and natural household putted in +2 while it is neutral or even very not important for other factors , but also in the agricultural sphere

favoring crops that consume little water (#8). Thus water management is a shared concern between all users and actors and everyone's involvement is needed to preserve the resource. This factor think that accountability of polluters and huge consumers of the resource cannot be done by costs because they are not dissuasive and high enough. Thus, this factor thinks that an increase of fees (#27), taxes on m^3 of water consumed in drought (#11) and increasing prices (#13) are not efficient means to improve water management. For this factor, cost is not a good lever because huge consumers are not dissuaded to overconsume economically and do not really care about the resource because the price is very low in the region. The most important is to empower users and make them aware of the problems. To conclude, this factor is in favor of everyone's involvement in a long run perspective but prices are not the good lever to manage water in a better way.

Factor 3 : Tackle local issues thanks to knowledge

This last factor is quite particular in that it brings together a majority of the respondents from one department of the region (Vendée) and the agricultural sector (farmers, regional direction for agriculture, …). It marks orientations on local problematics regarding water. For this factor, as for many others, restoring wetlands and aquatic environments (#19) and prevention of degradation of watercourses (#23) are essential for the preservation of the resource. However, for this factor, we should take care of indicators of the degradation of watercourses but these indicators should be adapted to contextual specificities and local parameters to be relevant. On this lineage, the statement on transparency and access to good data (#25) is placed in +3 while it is neutral or very not important in other perceptions. For this factor, conversely to the others, it is very important to take into account risks of flood (#24), because it is a local concern on the territory with significant risks. It is a huge problem linked to waterproofing of the lands and roads, which prevent resource to return to earth in departments on the coastline of western France (Vendée and Loire Atlantique). However, for this actor, beyond the technical aspects of flood, it is necessary to provide psycho-socio supports for the inhabitants concerned and to create withdrawal zones. Moreover, water storage (#12) is also essential because many participants live in a department with little supply of quantity and consequently bad quality water while there is a huge necessity of water furniture for agriculture in summer. For this factor, storage is a solution to anticipate challenges of climate change (#28) and to support future droughts. Conversely, some statements for this factor do not make sense in the regional context like "modernization of sanitation station and supply factories" (#20) placed in -3 because they are already efficient enough. It is the same idea for neutrality on water leaks (#21) as they are low in the department of Vendée and even at a regional scale in this factor's mind. Moreover, subventions of domestic installations (#3) do not represent an important mean to preserve water, as it is only a gain for the person who install it but not for the resource. To resume, important actions and infrastructures should be adapted to the local context and specificities of the territory and agricultural needs to manage water in a better way and preserve the resource. It goes regionally with knowledge of the issues to improve the restoration of aquatic environments, prevention against flood and security on access to water in the long term with storage.

Factor 4: Technological optimization to compensate lack of citizen engagement

This factor is characterized by the notion of efficiency regarding water management. For this factor, important means to preserve water involve a technically efficient approach with the modernization of sanitation stations and water supply factories (#20) but also agricultural water-saving technologies for one of the largest consumer of water (#6). Preservation of water needs also improvement of the distribution networks to repair leaks (#21) placed in +2 while it is neutral or not important for other factors. Unlike other factors except the fifth one, it places the statement "Use good quality water only for uses that really need it, or otherwise lower quality water" (#16) as an important one. This statement indicates the distinction of uses, which should not be suboptimal at the risk of wasting the resource. Unlike other factors, while optimization of the resource is crucial, citizen investment is not the good lever to preserve and manage water according to this factor. Indeed, for this factor, individual actions are not efficient enough so that inform and educate consumers about eco-friendly actions (#4), domestic water saving installations (#3) are not important. Moreover, for this factor, empowerment of citizen does not have a real impact, then mission actors to help public services and citizen consultations and co-construction programs are not important to preserve water. This factor thinks that habits will always underpass the rest and set up social pricing will encourage this population not to take care of the resource. To conclude, this factor favors progress regarding water preservation with the modernization and optimization of the allocation of the resource rather than investment of domestic users.

Factor 5: Pricing and regulation to support water preservation

For this factor, water preservation and distribution requires adapted pricing tools, which take into account the scarce aspect of the resource and its fair value. Indeed this factor places an increase of water fees (#27) in the neutral area while for some other factors it is not important at all. Moreover, this factor considers that increasing prices to discourage overconsumption (#13) are very important conversely to other factors, in order to adjust the amount consumed to the real value of water and to optimize water consumption choices of consumers. While taxes are also a good mean to regulate water consumption in periods of drought and summer, according to this factor, quotas (#10) and water storage are not important because the regulation of the quantity can go through the price. Moreover, for this factor, regulation and control of quality of wastewater treatment (#17) is very important to fight against pollution and to restrict pesticides and fertilizers. Thus to achieve the objectives of access to drinking water for future generations and consider the challenges of climate change, prices is the most direct mean as pricing is efficient to alert on the scarce state of the resource. Moreover, these prices should be adapted to financial resources of the population with the implementation of a social pricing (#31). Thus, this factor highlights the fact that laws, regulation and prices are the most efficient way to control and preserve the quantity and the quality of the resource, restricting sources of pollutions and dissuading overconsumption.

B) Areas of distortion and consensus

1. Disagreements

A crucial advantage of Q methodology is the construction of consensus areas between profiles and on the contrary areas of divergence. In policy decisions, disagreements can lead to no public acceptance and consequently a fail in the implementation. In this study, the correlation

matrix in Table 4 between factors shows that the factors 1, 3 and 4 have a relatively high correlation, higher than 0,4 which means that they have a common view on some statements. However, the distinguishing views on some sentences are high enough to consider them independents. One other thing to underline is that factor 5 seems very different from the four others with a low correlation with others except the second one, which underlines its complete independence.

	factor 1	factor 2	factor 3	factor 4	factor 5
factor 1	1	0,386	0,4199	0,4759	0,3687
factor 2	0,386	1	0,4145	0,3379	0,4257
factor 3	0,4199	0,4145	1	0,4313	0,2577
factor 4	0,4759	0,3379	0,4313	1	0,2414
factor 5	0,3687	0,4257	0,2577	0,2414	1

Table 4 : Table of independency of factors and factor score correlations

We even constructed a graph with disagreement statements between actors as follow with a difference in the Z-score in absolute value higher than 2. It consolidates the fact that factor 5 have many strong disagreements with other factors such as factor 3 and 4 with three strong disagreements on statements 25, 12, and 19 and 20, 19, 12 respectively. However, some other factors as 1 and 3 do not have strong disagreements like that, which can explain a higher score correlation between them. This graph also highlights many disagreements between factor 5 and some others like the 1, the 3 and the 4. These disagreements statements highlight regional debates such as statement 12 (“Improve water storage”) at the hearth of controversial ideas on water.

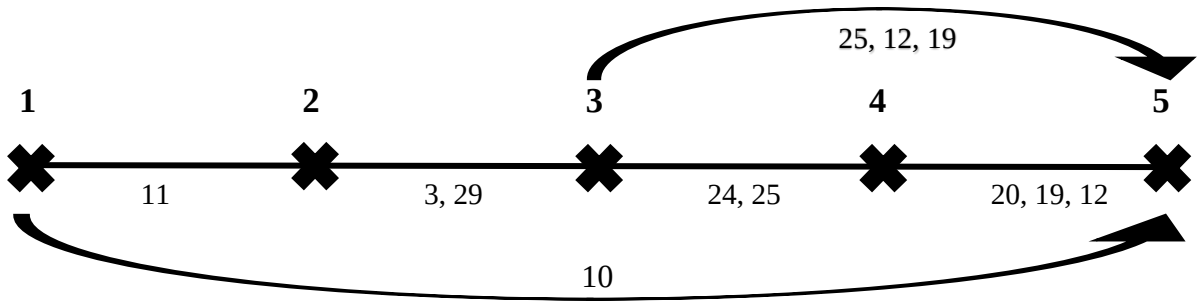

Figure 4: Network of disagreements between factors

Even if we selected only 5 factors, 8 had an eigenvalue higher than one which means, not surprisingly, that water management and governance in this French region is at the source of conflicts of use and debates between stakeholders and users. It explains the multiplicity of views on a controversial topic like water. However, our five factors were representing commonality, without any factor constructed by only one participant, but also variety of perspectives as a majority of the participants is flagged. The only participants not flagged 7 over 35) were non loaders as they were divided between many factors and were not associated

to a unique view. For instance, respondent 32 is divided between all factors excepting the fifth one (Annex 3).

Contradictory views are indeed existent on many statements. For instance, modernization of sanitation stations and water supply factories (#20) is not considered as important for factor 2, 3 and 5 while it is the case for the 4. Similarly, the question of water storage (#12) is not important for many factors, while it is for factor 3 which consider it as a good local solution to face the lack on water. Factors 1 and 5 also do not agree on taxes over m^3 consumed in periods of drought and summer (#25) because they think that it is important, while others think that it is not. Furthermore, increasing prices represent a good way to preserve and manage water for factors 3, 4 and 5 while it is not the case for the first and the second ones.

2. Consensus

On the contrary, some statements find a common tendency between all factors. It is the case for instance for statements "Inform on good daily habits" (#5) and "Restrict watering schedules for agricultural activities" (#7) which are considered as not really important by all. It is not surprising as in complementary interviews and commentaries on domestic water, many participants said that it is not the good lever because domestic consumers do not represent a huge volume of consumption comparing to industries or agriculture, and because domestic users are already informed enough. Moreover, for people, restrict water schedule is not important if we implement other alternatives such as crops that consume little water or quotas on m^3 consumed. Moreover, water is a necessity for farmers to product vital food.

Another consensus shows the strong importance of systemic shifts in agriculture towards an organic production (#14) and all factors placed "restrict and/or ban pesticides and fertilizers" in + 3 (#15), which reveals the strong importance of this measure for all because it is at the source of water pollution in the region. It can be a solution to accomplish a positive consensus and to consider the challenges of climate change regarding water management. Consensus statements are interesting and highlight strong consensus on a less polluting agriculture. Additionally, in complementary interviews, one main idea is to stop stigmatization of the agricultural world but accompany this profession in a virtuous transition. Other forms of pollutions are also at the heart of consensus areas like facilities to trap pollutants in order to decrease water pollution, which is problematic in the region with a low quality water.

More generally, we can notice that exact similarity in priorities of all factors are scarce. It is not surprising when we know the context of conflicts of use between agents and variety of expectations of stakeholders which stand out from this study. However, some huge consensus on agricultural shifts, non-point pollutions and climate change issues appears and are fully in line with regional problems on water.

Even if the results of this study show many disagreements, it is a good help for policy makers. They know in a better way the different types of profiles and behaviors they can face when they are implementing a policy. It is also encouraging to see that they are consensus areas on certain priorities (systemic shifts in agriculture towards more organic and non-polluting cultures) which can be the foundation of a common and accepted policy to favor actions on agricultural and industrial uses of water for instance.

General discussion

According to Baker et al. (2006), Q methodology find three areas of application in Economics: Preference elicitation, Economic evaluation using case study methods and Behavioral economics. This study gathers partially these three areas by a concrete example on water governance. Regarding the type of profiles and the level of their associated intensity with a given viewpoint, we know that domestic consumers included in this study prefer technological optimization, as they are mainly included in factor 4. It reveals at least partly their preferences on the way to deal with water issues. Moreover, case study methods with local factors and contextual economic valuation appear through Q study. In our case, we use instruments as taxes, quotas, subventions and price of water to understand determinants of economic valuation of water at a small scale. Finally, with Q methodology we consider human actions and behaviors, which are relying on their perceptions and expectations. For instance in our study, if someone find that a statement and a mean to act is not important, he will probably not want to invest time and money on it.

As showed by the previous link between areas of application of Q methodology in economics, our study appears as a good way to imagine and apply an efficient water management based on people's perspectives. Indeed, thanks to profiles it is possible to build scenarios of intervention for policy makers, following means that are important for stakeholders to preserve water as follows.

- A scenario in factor 1's place :

In the context of interdependency between departments on water around the watercourse la Loire that crosses the entire region, the question of the security for the access to water downstream depends on cooperation with departments located upstream. This induces a pressure on water availability in quantity in Loire Atlantique and Maine et Loire for example. Moreover, while east of the region benefits from huge underground resource of high quality, it is not the case for western part of the territory, which extracts mainly on low quality surface water. In the region, nine water masses over ten do not reach a good ecological state so water quality is also a crucial concern. In this context, factor one promotes the guaranty of access to drinking water for future generations because it is aware of the danger on the resource. This scenario of intervention to fight for preservation in both quality and quantity can thus be done by the implementation of restrictions on fertilizers and pesticides to promote a better quality. It can also go through a general restoration of wetlands and quality of watercourses. Regarding quantity issues, in this region with a high density of population and consequently important agriculture, it can be interesting to favor crops that consume little water to economize water in quantity. To do so, we can thus imagine a scenario adapted from this view with regulation on fertilizers, direct actions on watercourses and means in favor of a less intensive agriculture.

- A scenario in Factor 2's place :

For factor 2, there is a need for a systemic evolution of water management, and then in the process of production and consumption by all stakeholders. As agriculture production is a huge consumer of water we can suggest to implement actions on this sector in order to act on this important lever thanks to crops that consume little water, restrictions on pesticides and organic production. There is already an increasing regional tendency of shifts towards organic production. According to the report of regional chamber of agriculture, in 2017 the part of

organic farms and production represented already 9.2 % of the total farming activity and is still increasing. We can thus imagine a scenario with subventions for organic shifting producers and farmers to promote a more global systemic evolution as a scenario of intervention. We took the example of agricultural evolution, but for this factor, it is one among others because it also favors use of eco-friendly household products for domestic users. Everyone have to be invested at his scale into the preservation of water

- A scenario in Factor 3's place :

This scenario considers more local specificities and participants from Vendée are overrepresented. The water deficit weighing on this department with a high population and especially in the touristic season of summer when watercourses are at their lower level does not facilitate water management. Thus, specific alternatives as water storage are important for this factor while it is not the case for others. Risks of flood are also important in this coastline of the region. We can thus imagine various scenarios of evolution for this department. A first one can be to adapt city planning to problems of quality and to plan the territory creating facilities to trap pollutants. Dams and storage can be also envisaged regarding quantity to have the necessary amount of water all year, even if it is controversial between some regional actors. Thus, this factor underlines a variety of possible scenarios to fight for a better water preservation but to do so, knowledge on the topic for all stakeholders is crucial to measure the scale of local necessary actions.

- A scenario in Factor 4's place :

This scenario is based on technological optimization to allocate water in the most efficient way. Based on technical progress in both agriculture with the use of water saving technologies, and in domestic distribution with modernization of sanitation stations and water supply factories, it is possible to improve water availability. This scenario can also promote investment to repair leaks as in France more than 20% of water is wasted in leaks. In this scenario, we can thus imagine a higher budget allocated to renewal and repairing actions for the networks of distribution. More generally, individual actions are not the solution in this scenario. Indeed, progress and new technologies are the answer to save water and preserve its quality.

- A scenario in Factor 5's place :

According to the Water Agency, in 2018, domestic consumers paid more than 70% of water fees. For this factor, to preserve the resource it is necessary to pay the fair price of water to be aware of its scarcity and its real value. This would imply a scenario where huge consumers pay more and small consumers pay less. This scenario would include for instance an implementation of an increasing price scheme. For this factor, preservation of the resource goes through a regulated allocation of water in quality with control on retreatment and restrictions on pesticides. Then pricing and regulations are efficient and direct means to affect all users and alert them. It is a strong lever to change behaviors towards a reduction of waste.

These scenarios relies on both the contextual issues of the region on diverse topics but also on the importance that people give to means of preservation defined in the Q sorts. One interest of Q methodology as underlined before is that it helps to raise consensus. In this study they are also areas of agreements between participants which can constitute the roots of a co-construction for a program to use water in a better way. To generalize, for us Q method offers an exploratory method for other economic tools.

To go further in that way, we do think that scenarios guided by the expectations of stakeholders on policy recommendations obtained by Q methodology can inspire calibration of scenarios explored in agent-based models. Indeed, in these kind of simulations it is possible to represent real stakeholders by agents with various characteristics (the quantity of water they consume, the territory where they live, their interactions with others and some other characteristics) and parameters. It is also possible to calibrate the environment where agents are acting on real data like water resources in the region Pays de la Loire, depending on seasons for example with cases of drought in summer. Thanks to agent-based modeling, it is possible to see the evolution of agents in such an environment and potential impacts of scenarios described before. For example if we implement quotas on domestic consumers, we can imagine that it will favor a decrease of global domestic water consumption and conversely for other actors that benefit from more availability. Thus, Q methodology can help to calibrate good scenarios of interventions for policy makers and to model them with other economic tools.

-5-

Concluding comments

This paper presents a Q method study conducted in the region Pays de la Loire (France) between November 2019 and February 2020. It involves 35 participants from different groups of interests (collectivities, state directions, water consumers, associations, museum …) around a common issue: Preservation and management of water. Participant sorted 33 statements organized around several main topics like preservation of water in domestic/ agricultural/ industrial uses, trade-off between quality and quantity, city planning, water governance, shared initiatives and solidarity. They finally compose five main social perspectives in the results. Factor 1 exhibits an active management with means to preserve both quality and quantity of water. Factor 2 gathers regional institutions and associations and offers a holistic view of water governance towards a sustainable systemic evolution that guaranty access to water in the future. The third factor is composed mainly by agriculture representatives and an over-representation of respondents from the department of Vendée and is characterized by local issues regarding water management. Factor 4 is represented mainly by consumers and environmental associations, and promotes an optimal use of water through technological advances. The last factor is subject to pricing and regulation recommendations as it is a direct lever to support water preservation in both quality with control of the retreatment and increasing prices to discourage quantitative over-consumption. Our case study on water preservation stirs up an interesting point: it helps to raise regional disagreements and consensus. More than the state of play of visions, it provides statistical measures of conflicts, which are notable in water governance bodies but not observed through the scientific prism. It highlights also consensus areas on climate change issues, agricultural systemic shifts towards organic and sustainable ways of production, and fight against increasing non-point pollutions.

In a context of conflicts of use and water scarcity, Q methodology is a good complementary tool in environmental economics to catch diversity of social perspectives induced by subjectivity. Thus, this study helps to build intervention scenarios regarding water management for regional policy makers in adequacy with actual tensions on the resource. More generally, it shows the powerful aspect of such a method, both theoretically and empirically in

environmental economic valuation and policy analysis to provide a panorama of thought and to explain why some policy can fail. Thanks to Q methodology, misunderstandings and diverging views can be highlighted to promote comprehension between actors on a common issue. It underlines consensus areas on the path of coordination and agreements over the resource. Thus, Q methodology can be easily considered as an alternative mean to complete traditional tools from environmental economics in public policy analysis.

If this paper illustrates concretely this idea, it could be improved. First, we want to conduct other Q-sort interviews to increase the number of participants and have at least the 40 recommended for more relevance regarding the qualification of an extensive study (Brown, 1980). In a long run perspective, we would also propose new insights on centrality of stakeholders in networks and influences of agents on the Q-sorting process. Regarding links between agents, depending on tensions or peaceful relationships, we see that participants pertains or not to the same factor, they agree or not on the way to manage water. Then networks, relations and centrality of participants represent a good perspective for future research in the interpretation of Q methodology. For instance, it can go with results from Q methodology to calibrate interactions in a game theoretical network or to build scenarios of interventions that we can try through Agent-based modeling simulations.

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Annexes:

Annex 1 : Q-set

Reduce domestic consumption

1. Drink tap water rather than bottled water
2. Install water saving equipment (double flow flush, aerators, tap timers, …)
3. Subsidize domestic water-saving installations (water collector …)
4. Promote the use of eco-friendly and natural household products (washing powder, …)
5. Inform on good daily habits (more shower than baths, wash the car in the station, …)

Reduce agricultural and industrial consumption

6. Use water-saving technologies for agriculture
7. Restrict watering schedules for agricultural activities
8. Favor crops that consume little water
9. Recycle municipal wastewater for agriculture and /or industry use
10. Set up quotas on the m^3 consumed by the farmers and/or industries
11. Tax the m^3 consumed in summer or periods of drought

Preservation of the resource in quality and quantity

12. Improve water storage
13. Implement increasing prices to discourage overconsumption (The more I consume, the more expensive is the water units)
14. Encourage organic agricultural production
15. Restrict/ Ban pesticides, fertilizers, phytosanitary products, …
16. Use good quality water only for uses that really need it, or otherwise lower quality water
17. Regulate and control the quality of wastewater treatment
18. Create natural facilities to trap pollutants (hedges, …)

City planning and innovation

19. Restore and manage wetlands and aquatic environments
20. Modernize sanitation stations and water supply factories
21. Improve water distribution networks and repair leaks
22. Include the economy/ecology trade-off in the urban planning tools (like the SAGE)
23. Prevent degradation and improve watercourses quality (biodiversity, …)
24. Develop the territory but taking into account the risk of flood

Water governance and information

25. Pursue the acquisition and transparency of data on water, make it accessible and usable
26. Inform and educate consumers about eco-friendly actions at school or at work (awareness campaigns, billboards
27. Increase water fees

Solidarity and shared initiatives

28. Consider the challenges of climate change in water management (drought, …)
29. Foster solidarity between territories (for example between rural and urban ones,…)
30. Guaranty the access to drinking water for present and future generations
31. Set up social pricing for water for the most disadvantaged consumers
32. Set up citizen consultations and co-construction programs on water conservation
33. Mission actors to help the public service on awareness programs for water (NGOs, environmental associations, …)

Annex 2 : Consensus and disagreement statements

Statement Number	Statement	factor 1	factor 2	factor 3	factor 4	factor 5	Z-Score variance
15	Restrict/ Ban pesticides, fertilizers, phytosanitary products, …	3	3	3	3	3	0.041
5	Inform on good daily habits	-2	0	-1	-1	-1	0.124
7	Restrict watering schedules for agricultural activities	-1	-2	-2	0	-1	0.152
28	Consider the challenges of climate change in water management	3	3	1	1	3	0.214
14	Encourage organic agricultural production	2	2	1	0	1	0.253
21	Improve water distribution networks and repair leaks	0	-1	0	2	-1	0.259
22	Include the economy/ecology trade-off in the urban planning tools	1	-1	1	0	-2	0.261
18	Create natural facilities to trap pollutants	1	-1	2	1	1	0.265
33	Mission actors to help the public service on awareness programs for water	0	-1	0	-3	0	0.294
9	Recycle municipal wastewater for agriculture and /or industry use	-3	0	0	0	0	0.308
2	Install water saving equipment	-2	0	-1	0	-2	0.33
6	Use water-saving technologies for agriculture	0	1	0	1	-1	0.345
26	Inform and educate consumers about eco-friendly actions at school or at work	-1	1	-1	-2	0	0.348
17	Regulate and control the quality of wastewater treatment	1	0	-1	1	2	0.351
23	Prevent degradation and improve watercourses quality	2	1	2	2	0	0.355
8	Favor crops that consume little water	2	2	1	3	2	0.4

31	Set up social pricing for water for the most disadvantaged consumers	-1	-1	-1	-3	1	0.402
1	Drink tap water rather than bottled water	-2	1	0	-1	1	0.413
32	Set up citizen consultations and co-construction programs on water conservation	0	0	-1	-3	-1	0.421
16	Use good quality water only for uses that really need it, or otherwise lower quality	-1	-2	-2	1	1	0.465
30	Guaranty the access to drinking water for present and future generations	1	3	2	2	3	0.473
27	Increase water fees	0	-3	-3	-2	0	0.523
10	Set up quotas on the m3 consumed by the farmers and/or industries	2	0	0	1	-3	0.526
3	Subsidize domestic water-saving installations	-2	0	-3	-2	-1	0.527
19	Restore and manage wetlands and aquatic environments	3	1	3	3	0	0.659
4	Promote the use of eco-friendly and natural household	-3	2	0	-1	0	0.674
24	Develop the territory considering the risk of flood	-1	1	2	-1	1	0.675
29	Foster solidarity between territories	1	2	-2	-1	-2	0.809
11	Tax the m3 consumed in summer or periods of drought	1	-2	-2	-2	2	0.827
25	Pursue the acquisition and transparency of data on water, make it accessible and usable	0	-1	3	-1	-3	0.982
20	Modernize sanitation stations and water supply factories	0	-2	-3	2	-2	1.047
13	Implement increasing prices to discourage overconsumption	-1	-3	1	0	2	1.076
12	Improve water storage	-3	-3	1	0	-3	1.18

Table 5 : Scores of consensus and disagreements

Annex 3 : Flagging of participants

Q sort	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Rep1	0,0185	0,0519	0,6894 F	-0,0943	0,0356
Rep2	0,1656	0,1891	0,2224	0,4486 F	0,1022
Rep3	0,1802	0,2899	0,1056	0,5401 F	0,0956
Rep4	0,2966	-0,3133	-0,0747	0,5749 F	-0,04
Rep5	-0,1336	-0,0707	-0,1949	0,6106 F	-0,378
Rep6	0,5188	0,0135	0,2592	0,4946	0,2138
Rep7	-0,0813	0,7446 F	0,3494	0,0464	0,115
Rep8	0,6687 F	0,0175	0,024	0,1804	0,0333
Rep9	0,1323	0,1886	0,4586	0,7244 F	0,1168
Rep10	0,2511	0,0752	0,0691	0,7595 F	0,0547
Rep11	0,3894	-0,3513	0,4143	0,2216	0,4798
Rep12	0,0685	0,3016	0,3937	0,7062 F	0,104
Rep13	0,6357 F	0,1168	0,1269	0,2643	0,377
Rep14	0,6671 F	0,3253	0,2086	0,0249	0,0306
Rep15	0,3335	0,3812	0,6627 F	0,0838	0,0362
Rep16	-0,0915	0,6491 F	0,5037	-0,0088	0,2376
Rep17	0,2844	-0,1163	0,2177	0,21	0,5191 F
Rep18	0,2861	0,3252	0,1559	-0,1005	0,7255 F
Rep19	-0,0816	0,4319	0,5093	0,4421	0,3461
Rep20	-0,0354	0,2928	-0,115	0,2119	0,6587 F
Rep21	0,7529 F	0,2342	0,0396	0,2922	0,1354
Rep22	0,5117 F	0,292	-0,0707	0,1484	0,1379
Rep23	0,1517	0,0777	0,6069 F	0,3072	0,0984
Rep24	0,3702	0,7138 F	-0,0481	0,1108	0,0275
Rep25	0,273	0,391	0,2345	0,2277	-0,4469
Rep26	0,5021	0,0792	0,527 F	0,0272	-0,0944
Rep27	0,8005 F	-0,0953	0,2782	-0,0517	0,034
Rep28	0,2869	0,683 F	-0,0998	0,1278	-0,1457
Rep29	0,3329	-0,033	0,5175	0,1779	-0,4326
Rep30	0,23	0,318	0,5714	0,4251	0,0687
Rep31	0,0792	0,0465	0,73 F	0,292	0,0232
Rep32	0,384	0,4577	0,3193	0,3131	0,2555
Rep33	0,658 F	0,1932	0,1332	0,2677	-0,1353
Rep34	0,5083	0,0875	0,1776	0,6312 F	0,0797
Rep35	0,197	0,5462 F	0,1902	0,1632	0,2078

Annex 4 : Q sort grids of factors

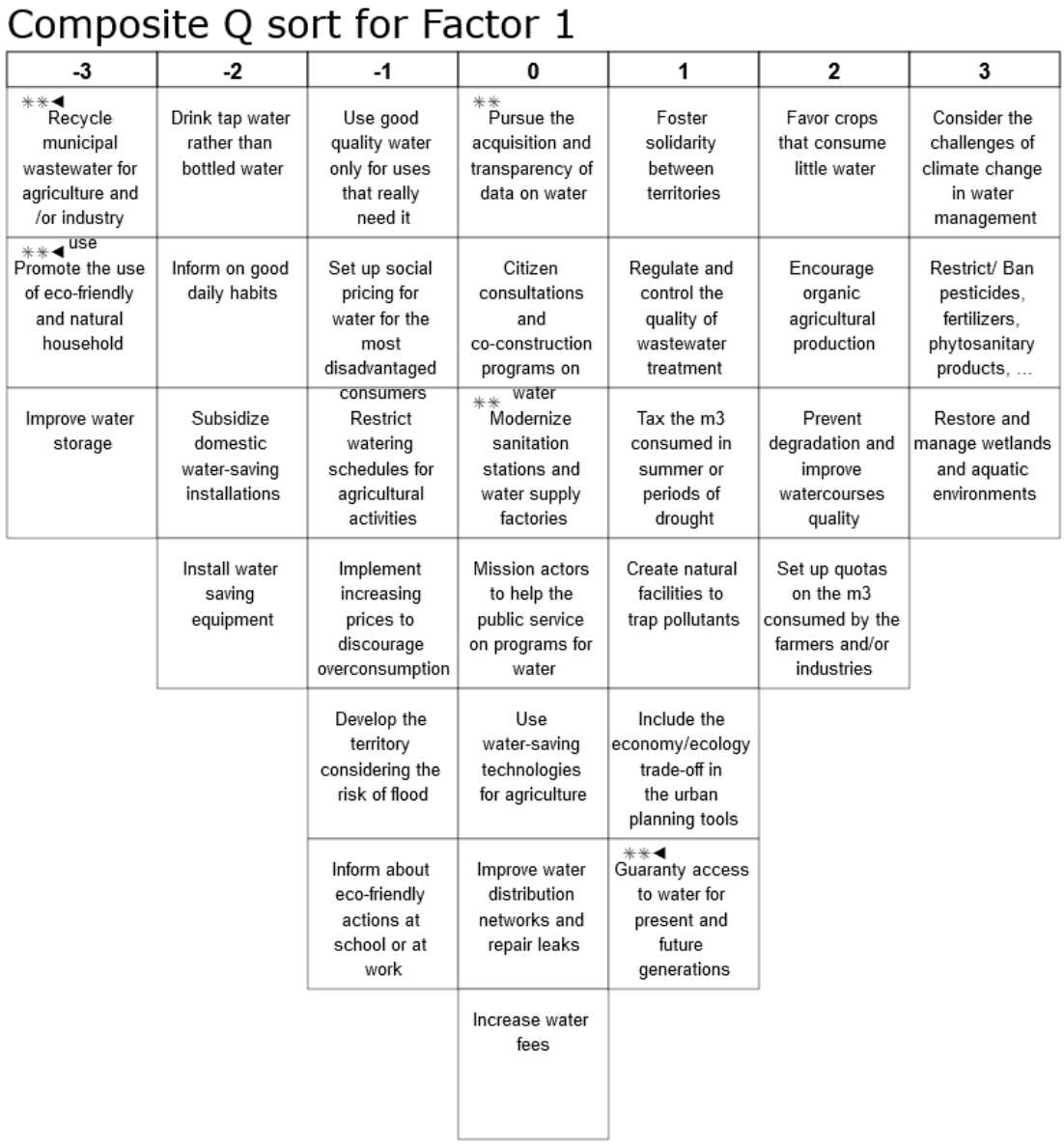

Figure 5 : Q sort of factor 1

Composite Q sort for Factor 2

-3	-2	-1	0	1	2	3
Increase water fees	Use good quality water only for uses that really need it	Create natural facilities to trap pollutants	Install water saving equipment	✳ Restore and manage wetlands and aquatic environments	Encourage organic agricultural production	Guaranty access to water for present and future generations
Improve water storage	Restrict watering schedules for agricultural activities	Improve water distribution networks and repair leaks	Subsidize domestic water-saving installations	Use water-saving technologies for agriculture	✳✳► Promote the use of eco-friendly and natural household	Restrict/ Ban pesticides, fertilizers, phytosanitary products, ...
✳✳◄ Implement increasing prices to discourage overconsumption	Modernize sanitation stations and water supply factories	Include the economy/ecology trade-off in the urban planning tools	Citizen consultations and co-construction programs on water	Develop the territory considering the risk of flood	Foster solidarity between territories	Consider the challenges of climate change in water management
	Tax the m3 consumed in summer or periods of drought	Mission actors to help the public service on programs for water	Set up quotas on the m3 consumed by the farmers and/or industries	Inform about eco-friendly actions at school or at work	Favor crops that consume little water	
		Set up social pricing for water for the most disadvantaged consumers	Regulate and control the quality of wastewater treatment	Drink tap water rather than bottled water		
		Pursue the acquisition and transparency of data on water	Inform on good daily habits	Prevent degradation and improve watercourses quality		
			Recycle municipal wastewater for agriculture and /or industry use			

Legend

✳ Distinguishing statement at P< 0.05

✳✳ Distinguishing statement at P< 0.01

► z-Score for the statement is higher than in all other factors

◄ z-Score for the statement is lower than in all other factors

Figure 6 : Q sort of factor 2

Composite Q sort for Factor 3

-3	-2	-1	0	1	2	3
Modernize sanitation stations and water supply factories	Restrict watering schedules for agricultural activities	Inform about eco-friendly actions at school or at work	Mission actors to help the public service on programs for water	Consider the challenges of climate change in water management	Prevent degradation and improve watercourses quality	Restore and manage wetlands and aquatic environments
Increase water fees	Tax the m3 consumed in summer or periods of drought	Citizen consultations and co-construction programs on water	Improve water distribution networks and repair leaks	✳► Improve water storage	✳► Develop the territory considering the risk of flood	Restrict/ Ban pesticides, fertilizers, phytosanitary products, …
✳✳◄ Subsidize domestic water-saving installations	Foster solidarity between territories	Inform on good daily habits	Recycle municipal wastewater for agriculture and /or industry use	Encourage organic agricultural production	✳► Create natural facilities to trap pollutants	✳✳► Pursue the acquisition and transparency of data on water
	Use good quality water only for uses that really need it	Regulate and control the quality of wastewater treatment	Set up quotas on the m3 consumed by the farmers and/or industries	Include the economy/ecology trade-off in the urban planning tools	Guaranty access to water for present and future generations	
		Install water saving equipment	Use water-saving technologies for agriculture	Implement increasing prices to discourage overconsumption		
		Set up social pricing for water for the most disadvantaged consumers	Promote the use of eco-friendly and natural household	✳◄ Favor crops that consume little water		
			Drink tap water rather than bottled water			

Legend

✳ Distinguishing statement at P< 0.05

✳✳ Distinguishing statement at P< 0.01

► z-Score for the statement is higher than in all other factors

◄ z-Score for the statement is lower than in all other factors

Figure 7 : Q sort of factor 3

Composite Q sort for Factor 4

-3	-2	-1	0	1	2	3
✳✳◄ Mission actors to help the public service on programs for water	Inform about eco-friendly actions at school or at work	Promote the use of eco-friendly and natural household	✳ Improve water storage	✳► Use water-saving technologies for agriculture	✳✳► Modernize sanitation stations and water supply factories	Favor crops that consume little water
✳✳◄ Citizen consultations and co-construction programs on water	Subsidize domestic water-saving installations	Develop the territory considering the risk of flood	Restrict watering schedules for agricultural activities	Create natural facilities to trap pollutants	Prevent degradation and improve watercourses quality	Restrict/ Ban pesticides, fertilizers, phytosanitary products, …
✳✳◄ Set up social pricing for water for the most disadvantaged consumers	Tax the m3 consumed in summer or periods of drought	Pursue the acquisition and transparency of data on water	Install water saving equipment	Use good quality water only for uses that really need it	Guaranty access to water for present and future generations	Restore and manage wetlands and aquatic environments
	Increase water fees	Foster solidarity between territories	Encourage organic agricultural production	Consider the challenges of climate change in water management	✳✳► Improve water distribution networks and repair leaks	
		Inform on good daily habits	Implement increasing prices to discourage overconsumption	Set up quotas on the m3 consumed by the farmers and/or industries		
		Drink tap water rather than bottled water	Recycle municipal wastewater for agriculture and /or industry use	Regulate and control the quality of wastewater treatment		
			Include the economy/ecology trade-off in the urban planning tools			

Legend

✳ Distinguishing statement at P< 0.05

✳✳ Distinguishing statement at P< 0.01

► z-Score for the statement is higher than in all other factors

◄ z-Score for the statement is lower than in all other factors

Figure 8 : Q sort of factor 4

Composite Q sort for Factor 5

-3	-2	-1	0	1	2	3
✳✳◄ Set up quotas on the m3 consumed by the farmers and/or industries	Include the economy/ecology trade-off in the urban planning tools	Restrict watering schedules for agricultural activities	Recycle municipal wastewater for agriculture and /or industry use	Develop the territory considering the risk of flood	Favor crops that consume little water	Guaranty access to water for present and future generations
Pursue the acquisition and transparency of data on water	Install water saving equipment	Improve water distribution networks and repair leaks	Inform about eco-friendly actions at school or at work	Drink tap water rather than bottled water	✳► Regulate and control the quality of wastewater treatment	Restrict/ Ban pesticides, fertilizers, phytosanitary products, …
Improve water storage	Foster solidarity between territories	Subsidize domestic water-saving installations	Increase water fees	Encourage organic agricultural production	✳✳► Implement increasing prices to discourage overconsumption	Consider the challenges of climate change in water management
	Modernize sanitation stations and water supply factories	Use water-saving technologies for agriculture	Prevent degradation and improve watercourses quality	✳► Set up social pricing for water for the most disadvantaged consumers	Tax the m3 consumed in summer or periods of drought	
		Citizen consultations and co-construction programs on water	Mission actors to help the public service on programs for water	Create natural facilities to trap pollutants		
		Inform on good daily habits	✳◄ Restore and manage wetlands and aquatic environments	Use good quality water only for uses that really need it		
			Promote the use of eco-friendly and natural household			

Legend

✳ Distinguishing statement at P< 0.05

✳✳ Distinguishing statement at P< 0.01

► z-Score for the statement is higher than in all other factors

◄ z-Score for the statement is lower than in all other factors

Figure 9 : Q sort of factor 5