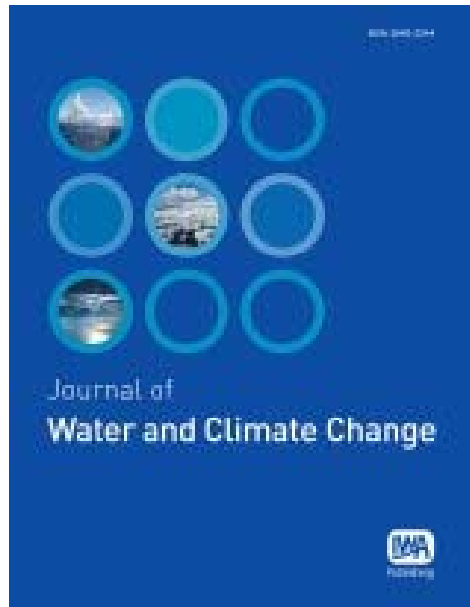


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# Water resources and climate change: water managers' perceptions of these related environmental issues

Elisabeth Michel-Guillou

## ABSTRACT

The present study focuses on climate change and water resources. Its objectives are: (i) to understand the perceptions of climate change by water managers responsible for the French Water Development and Management Schemes (SAGES); and (ii) to determine whether or not these managers consider this phenomenon in their management of water resources. The analysis is mainly based on interviewees' spatio-temporal evaluation of these two environmental issues. Semi-structured interviews were conducted with 49 people in France. The interviews were transcribed and analysed both manually and via a computer-assisted content analysis. The results show that for water, the major problem is 'quality', an issue that is known (i.e. defined by its social, spatial and temporal dimensions), whereas for climate change, this is defined by global warming, drought, or extreme events which are not regularly perceived or locally situated. This indicates that water managers recognize the existence of both issues and the relationships between them. However, because these problems are perceived at different temporal and spatial scales, it seems that these managers find it difficult to incorporate measures into their day-to-day decision-making that take into account the effects of climate change.

**Key words** | climate change, qualitative analysis, spatial dimension, temporal dimension, water resources

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## INTRODUCTION

Water and climate change are undeniably related. It has been scientifically proven (e.g. [IPCC 2007](#)) that climate change impacts both the quantity and quality of water resources. The link is obvious for the scientific community working on climate change issues, but what do people working on water resource issues think about this link? There is a consensus within the scientific community that the climate has been undergoing rapid change since the mid-20th century ([Liverman 2007](#); [Oreskes 2004](#)) and that this acceleration has an anthropogenic origin ([IPCC 2013](#)). However, despite scientific warnings, the gravity of the situation seems to be underestimated by non-specialists, particularly in relation to other issues whose local consequences are judged to be

more important ([Spence & Pidgeon 2009](#)). Water resource issues have significant local implications for managers who must identify and resolve them. But what about climate change? What link, if any, do managers make between the issues of water resources and climate change? This paper aims to answer these general questions. It concerns stakeholders responsible for the design and implementation of the French Water Development and Management Schemes (*Schéma d'Aménagement et de Gestion des Eaux*; SAGES) for sub-basins and adopts a psychosociological and environmental approach to analyze the representations or perceptions that these managers have about water resources and climate change.

## PERCEPTIONS OF ENVIRONMENTAL ISSUES

### Adopting a psychosociological and environmental approach

The Intergovernmental Panel on Climate Change (IPCC) defines climate change as:

*'[...] a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity' (IPCC 2007, p. 30).*

This report cites the main effects of climate change to be warming temperatures, ice melt and rising sea levels. Its position is clear from the opening pages of the report: 'Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level' (p. 2).

As stated above, the link between climate change and water resources has been scientifically proven (IPCC 2007). Variations in the global average surface temperature have an impact on water resource quantity and quality: scientists have observed sea-level rise as well as significant increases in precipitation in certain parts of the world (e.g. Northern Europe) and reductions in others (e.g. the Mediterranean region). The IPCC report presents an overview of potential impacts on water resources with varying degrees of probability for extreme climate change-related weather and climate events as follows: 'virtually certain' for snow melt to impact water resources, 'very likely' for water-quality related issues to arise (such as excessive algal bloom), and 'likely' for available fresh water to decrease due to saltwater intrusion.

Furthermore, climate change has been integrated into the Water Framework Directive (2000/60/EC) – which establishes a European Community-wide framework for the protection of water – since its latest version which was modified in 2009. All of these observations consequently prove the link between climate change and water resources.

Therefore, climate change experts believe that there is an obvious link between climate change and water, but what is the viewpoint of water resource experts? What do they think about climate change? In the human-climate change interrelationship, humans play two roles: contributor and victim. They are contributors insofar as human activities impact climate change, notably through the production of greenhouse gases (Dubreuil *et al.* 2010; IPCC 2013), and victims insofar as they suffer from the consequences of their actions (e.g. floods, drought, storms). However, individuals' perceptions of causes and consequences vary according to their values, beliefs, social position, the importance of the problem for themselves or their community and finally, their particular context, their reality. A psychosociological and environmental approach allows us to understand these different realities (Michel-Guillou 2012) and the climate change representations that people construct. This paper will focus in particular on the perceptions of water managers who manage an environmental issue affected by climate change.

### Understanding the human–environment relationship within the context of climate change

A psychosociological and environmental approach allows us to understand the relationships that the individual has with the physical and social environment and their underlying spatial, temporal, and cultural dimensions (Stokols & Altman 1987; Moser 2009). In other words, the social and physical characteristics of space, the individual and social factors (e.g. representations, values, attitudes, or behaviours determined by the social group) and temporality are all essential to explain the human–environment relationship (Canter & Craik 1981; Moser & Uzzell 2003). These dimensions highlight how it is sometimes difficult for individuals to define local and global environmental issues. In some ways, global issues are perceived as more serious than local ones, yet individuals feel less responsible for events at the global scale (Uzzell 2000; Bonnes & Bonaiuto 2002; Garcia-Mira *et al.* 2005). Besides, assessing issues as either 'local' or 'global' is related to the level of perceived control (Garcia-Mira *et al.* 2005; Moser 2009). As spatial distance increases (how far an individual considers the issues to be

from his or her territory), the level of perceived control over these issues decreases.

Uncertainty also adds to this local–global dichotomy, which prevents a complete understanding of the environmental phenomenon and therefore the commitments towards it (Michel-Guillou & Weiss 2007). Graumann & Kruse (1990) highlighted how it is difficult, even impossible, to directly perceive the state of the environment and its evolution, the latter being mostly characterized by uncertainty. Not only are individuals physiologically incapable of identifying certain types of pollution (e.g. radioactive or ozone), but the slowness of environmental transformations such as climate change makes them imperceptible at the human scale. Even at the proximal level, a lot of uncertainty surrounds the quantity and quality of available resources. Hence, individuals struggle to relate local and global scales and to evaluate the immediate and long-term consequences of their behaviour, especially with regard to shared resources. This means that individuals tend to make choices that are of immediate benefit to themselves, but which can be detrimental to the community in the long term. This is referred to as the ‘tragedy of the commons’ (Hardin 1968).

Thus, temporality also plays a role in perceptions of environmental issues. Individuals are more concerned with present problems than with those whose impact seems more important in the future (Garcia-Mira *et al.* 2005). Water resources research (De Vanssay *et al.* 1997; Moser *et al.* 2004) has shown that different temporal horizons will affect environmental conceptions that may be different and even contradictory according to the populations and their environmental management goals. For example, a fragmented vision of an environmental issue (e.g. local and sporadic events) supports behavioural stability in contrast to a ‘global ecological vision based on the perception of the interdependence between people and the environment’ (Moser *et al.* 2004, p.15). Finally, based on the construal level theory of psychological distance (Trope & Liberman 2003; Trope *et al.* 2007; Liberman & Trope 2008) and in relation to climate change, other studies (Milfont 2010; Spence *et al.* 2012) have highlighted the importance of spatial, social, and temporal dimensions in individuals’ perceptions of climate change. Thus, as temporal, spatial, social and hypothetical distance from the

problem increases, so does the level of abstraction of the perception of the phenomenon, which subsequently leads to a decrease in the level of involvement and behavioural intentions.

An individual’s attitude towards the environment will, therefore, be interpreted according to his or her representation of it. This representation, or subjective reconstruction of reality, varies according to individual factors (e.g. needs, aspirations, life experience) as well as sociocultural factors (Michel-Guillou & Weiss 2007). In this sense, human–environment relationships are also transmitted by culture, values and a particular identity – a shared position between individuals and their group or community; that is, the social dimension. Our understanding of the environment, our decisions and our habits are all explained through our personal representation of the world. This is a social representation as it refers to common ideas, to collective perceptions of the world. The purpose of Social Representation Theory (Moscovici 1976, 2001) is to understand and interpret this social construction of reality by focusing on how ideologies, belief systems, representations, evaluations and standards (i.e. regulatory systems) justify the relationships between groups and social practices. Therefore, it seeks to gain an understanding of how social knowledge is constructed and how scientific theory is integrated into common beliefs. Thus, social representations correspond to different forms of knowledge (e.g. beliefs, values, norms) transmitted by society. It is a form of social thought that allows individuals to comprehend their environment and provides them with a certain vision of the world. As such, these social representations are a social construction of reality – one that is practical and formulated and shared by a social group (Jodelet 1999) – aimed at making this reality meaningful (Abric 2001a, b). Such representations are highly contextualized and depend on the groups’ social anchoring (Doise 1992). In other words, individual positions on the object will vary according to what is at stake for individuals and their level of social inclusion (Doise 1985, 1993).

As regards climate change, insofar as it gives rise to debates, it can be considered as a social construction of reality specific to each group (Michel-Guillou 2012). As such, there are potentially just as many realities as there are communities affected by the phenomenon. Some research, based

on lay representations and social constructions of climate change, depicts a low level of knowledge (Lorenzoni *et al.* 2007; Cabecinhas *et al.* 2008). Several studies focusing on the perception of this phenomenon show that it is often associated with global warming, periods of drought, storms, glacier melt, or rising water levels (Lorenzoni *et al.* 2006; Bohn Bertoldo & Bousfield 2011), with the terms ‘change’ (i.e. climate change) and ‘warming’ (i.e. global warming) often being used interchangeably (Bohn Bertoldo & Bousfield 2011). Some of these studies also reveal the difficulty in engaging in climate change actions because the phenomenon is perceived as too ‘distant’ and ‘elsewhere’ in terms of time and space (Lorenzoni *et al.* 2007). Furthermore, when climate change is compared with other environmental issues, it tends to be considered as less important (Brenchin 2003; Lorenzoni *et al.* 2007; Spence & Pidgeon 2009).

As a result, when individuals are questioned about this issue, or must face up to it, they will activate their own representations according to their social anchoring (Doise 1992). Based on these theoretical viewpoints, the present study will focus on how water managers have appropriated climate change. What are their social representations of this phenomenon and how do they deal with it in their day-to-day management of water resources?

### Study context and objectives

This research was conducted in western France. The existence of climate change in this area has been identified in previous studies. In Dupont *et al.* (2001), the authors state that the use of long-term (around 50 years, sometimes more) climate observations shows that global warming is a reality and highly consistent across western France. More specifically, these studies highlight the local impact that various climatic changes can have on water resources (Merot *et al.* 2012). For example, climate change can impact coastal risks (e.g. erosion, marine floods) (Roussel *et al.* 2012), with sea level rise and changes in extreme events increasing such risks (Clus-Auby *et al.* 2006). It may also have an impact on hydrologic crises (e.g. drought, flooding, severe low water levels). A regional study conducted by Lamy *et al.* (2012), which sets out to model the water balance from 1950 to the end of the 21st century in different sites

across Brittany (Brest, Caen, Rennes), shows an increase in the frequency and intensity of droughts at the beginning of the 21st century. It predicts that increases will be moderate in the first part of this century and more intense in the second half. Finally, in terms of water quality (e.g. nitrate concentration in watercourses), even if climate change is not the main constraint, it does, nevertheless, have an effect on quality and can modulate the variability of nitrogen flows (Salmon-Monviola *et al.* 2012).

These studies show the impact of climate variability on water resources, especially at the local level in western France, and may provide relevant information for land management and planning. For this reason, the present study will focus on how individuals involved in water management apprehend climate change. It concerns water managers – the stakeholders responsible for drawing up and implementing the SAGEs in France (a SAGE is an official document defining strategies and practices to be implemented to protect local sub-basin water quality) – whose primary goal is to define local water-related issues in terms of quality and quantity and to propose actions to overcome them (Bommelaer *et al.* 2011). This is done collectively through meetings between the managers and local water commissions called CLEs (*Commission Locale de l'Eau*) consisting of elected councillors (50%) (e.g. presidents of regional councils, mayors), user representatives (25%) (e.g. user associations, environmental associations, fishing federations, farmers' unions), and government representatives (25%) (e.g. public institutions, local authorities). Therefore, their related actions mean that these people are consequently liable to be concerned with the issue of climate change.

Based on these observations and the aforementioned theory, this study will examine how water managers perceive and assess the environmental issues of water resources and climate change, and their knowledge and representations thereof. First, in line with Social Representation Theory, the study seeks to identify managers' social representations of water resources and climate change. Second, considering also the importance of the spatio-temporal dimension in explaining human–environment relationships, it will focus on how the stakeholders involved understand these issues in space and time. How do they set these issues at the global/local level? How do they perceive

the evolution of these phenomena (i.e. the temporal sequence of environmental issues)? Finally, the answers to these questions will enable us to gain an understanding of how decision makers in environmental management respond to and evaluate climate change issues, especially when compared with another environmental issue they face – namely that of water resources management.

## METHODOLOGY

### Survey population and data collection tools

This study was conducted in western France between 2009 and 2010. Semi-structured individual interviews were conducted with 49 participants. Amongst the interviewees, there were 26 elected councillors, 14 user representatives and 9 government representatives. The qualitative survey enables a more in-depth understanding of the water-related/climate change representations and attitudes of these managers. This technique is suitable for populations with low numbers since it provides insight into interviewees' personal viewpoints, and consequently, their related representations and practices. It also allows the identification of issues as perceived by individuals. The recorded interviews were verbatim transcribed to better grasp the entire discourse, which enabled the transcripts to undergo data processing via the Alceste textual analysis software. Semi-structured individual interviews (Wengraf 2004) were used for data collection. The aim and interest of this method is to encourage interviewees to talk about a particular theme whilst minimizing interviewer bias. It is called 'semi-structured' because it focuses on a specific theme and is based on a thematic guide containing the main themes to be discussed. Some questions are prepared in advance for each theme in the form of an interview guide, but the interviewer only asks them if they are not evoked spontaneously by the interviewee. As its name suggests, it is just a guide for the interviewer to help the interviewee to produce discourse. The semi-structured interview, conducted in an open framework, allows for in-depth examination of a phenomenon through people's representations, perceptions and attitudes (Johnson 2001). It provides the meaning that people give to the situation,

and as such, any related representations and practices. It also helps to identify the problems as they are perceived by individuals and understand the inter-individual relationships. Each interview is recorded and fully transcribed to keep a record of the discourse in its entirety.

Our interview guide focused on three main themes: water, climate change, and sustainable development. For water, interviewees were asked to raise and rank the issues covered within their SAGE, and to evaluate the temporal and spatial qualities of the resource and the causes and consequences of the identified issues. For climate change, interviewees first evoked their knowledge and perception of the topic, followed by the potential links between this phenomenon and water resources and more specifically, the issues dealt with in the SAGE scheme. Finally, for sustainable development, questions focused on the stakeholders' representations of this theme, its integration within the SAGE scheme and its links to the previously mentioned environmental issues. The present study will mainly focus on the themes of water and climate change.

### Analysis of the results

Interview transcripts were analysed using Alceste textual data analysis software (Reinert 1990; Kronberger & Wagner 2000), which enabled us to gain an understanding of the discourse in its entirety and to highlight the main themes. The software uses a descending hierarchical classification (HDC) method to carry out successive splits of the text in order to distinguish a limited number of word classes representative of the discourse. These classes are established according to the co-occurrences of words. Each term within a class is associated with a chi-square, which indicates, for the particular term, its degree of statistical link with the class. Once the software has established all of the classes, each one can then be interpreted and the main themes highlighted by the researcher.

Alceste is an exploratory method for discourse content analysis. To achieve a more comprehensive analysis, this method was supplemented by a manual thematic analysis, which is an essential technique for qualitative data analysis (Krippendorff 2004). In the early 20th century, Harold Lasswell was already using this technique to study propaganda in

mass media in the World War context (Lasswell 1927; Lasswell *et al.* 1949). Within this context, in the interest of methodological rigour, Berelson defined content analysis as ‘a research technique for the objective, systematic, and quantitative description of the manifest content of communication’ (Berelson 1952, p.18). Content analysis allows the inference of knowledge from the production of discourse in relation to specific research objectives. In other words, it makes explicit the meaning of the messages (interpretation) by reducing their quantity (summary). To do this, the researcher constructs a content analysis grid (categorization). For this study and in relation to our objectives, in the interviewees’ discourse, we searched for information on the description of the phenomena (characterization of climate change, problems of water quality or quantity) and elements situating these phenomena in space (here or elsewhere) and time (the past, present and future). For each interview abstract cited, the interview number and relevant body (elected councillor/user/government) to which the interviewee belongs appear in brackets.

## RESULTS

The results of the Alceste analysis are presented in Table 1. From all of the transcribed interviews (the corpus), 68% were analysed and the HDC highlighted six classes. The researcher then interpreted these classes and identified themes based on the coherence of the words they contain. Thus, ‘climate change’ and ‘water’ (quality and quantity issues) were two of the six of the major discourse themes distinguished, with 17.77% and 12.38% respectively. The other themes, which will not be discussed here, were: sustainable development (25.57%); water resources management and functioning of the SAGE scheme (23.51%); the role of agriculture (12.81%); the role of buffer zones (wet zones, grass strips, etc.) in the protection of water resources (7.97%).

Furthermore, it was observed that the HDC opposed two major questions in the discourse (see Figure 1): environmental issues (climate change and water resources) and the management of these issues (SAGE, sustainable development, the role of agriculture). This result, which brings

**Table 1** | Six major themes from the interviewees’ discourse and the representative words of each class

Themes of each classes	Representative words
Sustainable development 25.57%	Sustainable, development, child, economic, to live, energy, people, car, social, to do, life, generation, environment, to consume, awareness, ways, society, world, waste, human, planet, model, procedure, to develop
Water resource management 23.51%	SAGE, <sup>a</sup> CLE, <sup>b</sup> elected member, committee, federation, association, to represent, meeting, territory, objective, president, council, representative, document, member, SDAGE, <sup>c</sup> management, title, state, scope, agency, general, chamber, mayor
Climate change 17.77%	Climatic, to warm, phenomenon, change, hot, winter, temperature, cold, storm, sea, degree, species, year, climate, drought, wind, period, ice, South, cold, precipitation, thunder, melt, marked
Role of agriculture 12.81%	Product, agriculture, organic, to sell, pesticide, to pay, phytosanitary, expensive, dose, producer, effort, vendor, to buy, price, to encourage, pig, processing, slurry, milk, fertilizer, cooperative, sales, farm-produce, gardener
Water issues: quality and quantity 12.38%	Water, drinkable, dam, low water, Vilaine, catchment, cube, quality, issue, collection point, sample, Arzal, metre, quantity, groundwater, food, upstream, Elorn, to downgrade, underground, to pump, reservoir, ZRE, <sup>d</sup> severe
Buffer zones 7.97%	Wet, flow, zone, soil, slope, to drain, to filter, soil, water, to purify, rise, buffer, drain, erosion, pit, strip, river, flow, stream, hectare, grass, to evacuate, bank, to waterproof

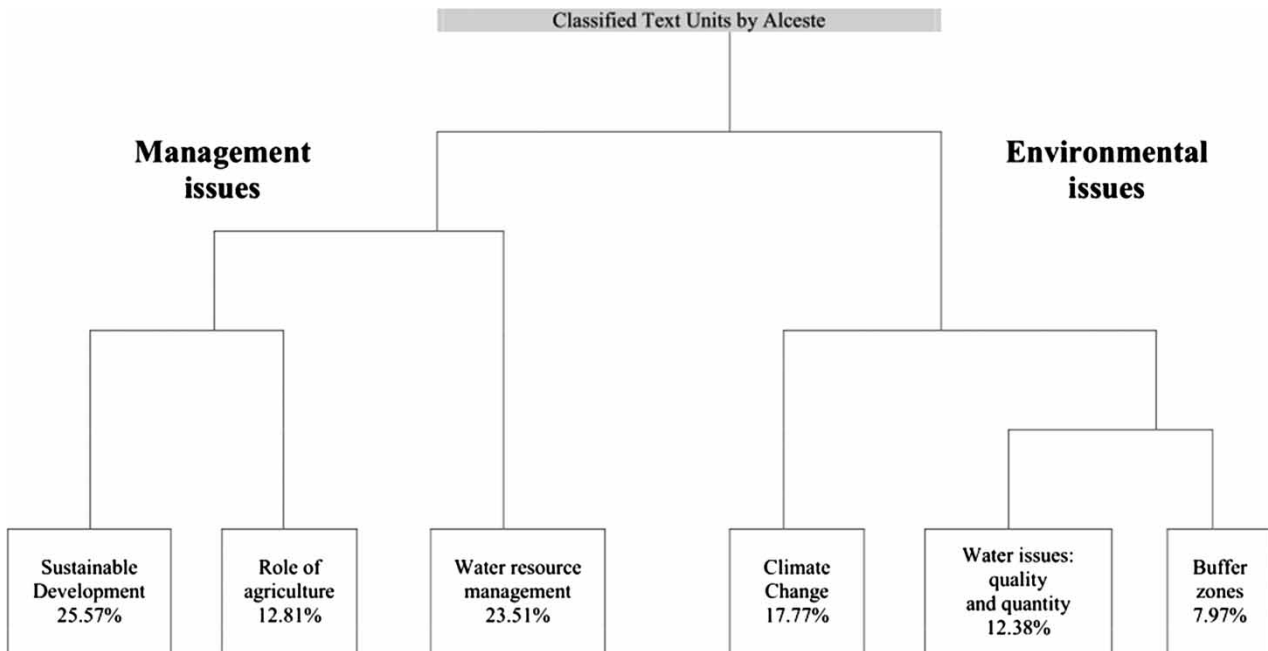
*Note:* The table represents the classes established by Alceste according to the co-occurrences of words. The words are presented in order of importance of their chi-square, that is to say, the first word has the strongest statistical link with the class (the most representative) and the last one has the weakest link. The chi-square varies between 600 and 300 for the strongest (first words of the classes), and between 40 and 90 for the lowest (last words of the classes). In the text, the chi-square ( $c^2$ ) of each word appears in brackets. The title of each Alceste class is its theme (left column) and percentage in relation to the entire corpus. This percentage represents the importance of each theme related to the other themes in the analyzed discourse.

<sup>a</sup>SAGE: French Water Development and Management Schemes (on a sub-basin scale) [Schéma d’aménagement et de gestion des eaux].

<sup>b</sup>CLE: local water commission [Commission Locale de l’Eau].

<sup>c</sup>SDAGE: Master Plans for Water Development and Management (on a river basin scale) [Schéma directeur d’aménagement et de gestion des eaux].

<sup>d</sup>ZRE: water distribution zones [Zones de Répartition des Eaux].



**Figure 1** | Results of the Alceste descending HDC and thematic interpretation of classes. *Note:* This figure shows the results of the Alceste descending HDC. The discourse is divided into six classes which are defined by their theme and their percentage (see Table 1). The first partition of the HDC divided the text in two parts: management issues and environmental issues.

together water and climate change in the different discourse, justifies the interest in comparing these issues. Therefore, the present study focuses on and compares these two environmental problems.

### Water resources: quality and quantity

Some of the different water issues mentioned by CLE members are as follows: quality ( $c^2 = 200$ ) (e.g. quality of drinking water,  $c^2 = 285$ , river pollution) and quantity ( $c^2 = 142$ ) (e.g. low water levels,  $c^2 = 270$ , watercourses, drinking water supply, flooding). The Alceste analysis, supported by the manual content analysis, highlights the recurrence of the discourse on water quality, irrespective of the SAGE scheme. This issue is systematically mentioned (either directly or indirectly) by all interviewees. Reference to quantity is not as systematic: over 50% of interviewees (25 out of 49, i.e. 51%) mentioned quantity as a problem in the SAGE schemes.

Thus, the main discourse is on water quality: major concerns are drinking water supply, and as a related issue, river pollution, especially by nitrates ( $c^2 = 72$ ). In Brittany there

are significant water pollution-related issues that are not simply related to intensive agricultural activity (problems with nitrates and pesticides). Water quality is a major issue in this region. In 2001, the Court of Justice of the European Union held that France had not complied with water quality requirements in terms of nitrates, in particular concerning nine catchments in Brittany. For such reasons, in terms of causes, the interviewees put forward the major role of agriculture and especially that of intensive agriculture. As a consequence, farmers are either directly or indirectly targeted (see Figure 1, 'Role of agriculture'), even though other causes such as private individuals or so-called 'Sunday gardeners', industries or communities are also mentioned. 'I don't need to spell it out for you, do I...? Of course they [farmers] are not the only ones to blame, but still, we have to be realistic, once again it's intensive agriculture' ( $n = 5$ , user). Besides, the discourse analysis on the causes of pollution, in conjunction with agriculture, clearly sets out the temporal dimension in the evaluation of the water quality issue. In fact, the interviewees commonly evoke the same time periods to historically date the water quality issue (see Figure 2).



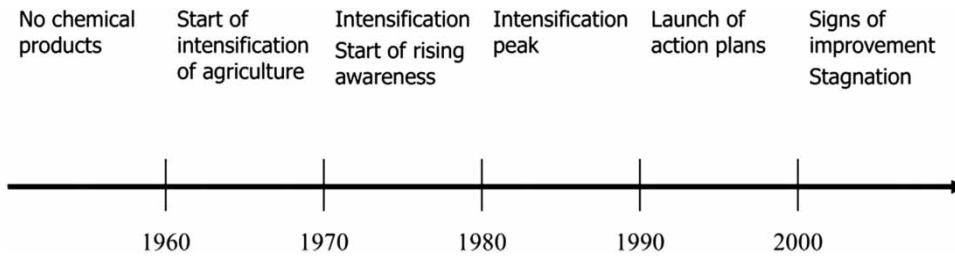


Figure 2 | Interviewees' descriptions of the temporal sequence of the water quality issue.

The general consensus amongst the interviewees (37 out of 49, i.e. 76%) is that before the 1960s, there was no pollution because there were no or very few brands of chemicals and as such, increasing production was not an objective. 'Looking back on things, we know that up until the 1960s, water belonged to everybody, it was pure, and everybody thought it was gonna last forever. There was no pollution then, we knew nothing, or very little, about chemicals' (n° 4, elected councillor). Intensive agriculture started in the early 1960s, a period referred to as the 'post-war years', and experienced a boom in the 1970s and 1980s. During the 1970s, an environmental awareness was also emerging that was inspired by green activists and associations who denounced disrespectful environmental practices. Interviewees date the debut of environmental programmes to be during the 1990s. We must bear in mind that during this period, the landmark Rio Conference was held (1992), which led to CAP (Common Agricultural Policy) reform, in particular on environmental issues: 'This period of intensive production between the 1970s and 1990s is over ... There was real change in the 1990s ... We no longer think in terms of development and intensification' (n° 25, user). In the 2000s, CLE members noticed another turning point. Although some believe that there is still a significant amount of work to be done in this regard, interviewees mostly agree that general awareness of water pollution issues and their consequences is on the increase. They note that the modified agricultural practices implemented in the 1990s have produced results. These have either led to static nitrate levels in the water, 'So what we notice is that there has been an improvement over recent years since, let's say, 2000, well, since the past two or three years or so. Now the situation is stagnant, especially in

terms of nitrate levels' (n° 7, elected councillor), or to a real improvement in water quality, 'And today, we are witnessing that deterioration [due to nitrates] has stopped and improvements in water quality have started' (n° 1, elected councillor).

In conclusion, the issue can be identified in the past, its evolution can be seen in the present and as a consequence, it is mostly perceived as solvable in the future, even though the environmental restoration process is considered to be slow. 'We also know that pollution, the deterioration of the water quality, all this didn't happen overnight. We also know that getting it pure again will not be an overnight process' (n° 4, elected councillor).

### Climate change

How do water managers perceive climate change? The Alceste analysis shows the use of descriptive vocabulary. Climate change is mainly associated with global warming and rising temperatures. Indeed, 'climate change' becomes 'climatic' ( $c^2 = 460$ ) 'warming' ( $c^2 = 375$ ) (*le réchauffement climatique*). This is supported by manual content analysis: 78% of interviewees evoked the 'warming', 69% 'droughts' and 41% emphasized 'extreme events'. People's awareness of climate change is derived from media coverage; they believe that it exists because scientists say so.

*'I believe that it has been scientifically proven that there is climate change at the level of ... in the past few years due to ... indeed, due to pollution ... But I'm not a scientist, so I can't really tell. I'm just like you, I listen to what I'm told but I have no proof whatsoever. But I believe that it does exist, I mean, of course I do, yes, it's true'* (n° 16, elected councillor).

Half of the interviewees (57%) trust scientists.

However, it is also a phenomenon which is difficult to perceive at the local scale and consequently, is defined as more global (76%) and located 'elsewhere' in space and time.

*'Concerning global warming, I'm more worried about the droughts in Africa, the disappearance of whole territories, populations affected by floods and so on. That is what worries me. Yet, concerning the quality of water in Brittany, well, it's true that at times we had water shortages in Belle-Île etc. But at the moment, I can't really imagine Brittany without water, for now...'* (n° 38, elected councillor).

Forty-nine per cent of interviewees believe that they cannot perceive changes of climate at the human time scale (life-span). This is because change takes place over several generations, which involves a minimum period of over 50 years, and therefore goes beyond a human lifespan.

This difficulty in perceiving the phenomenon reveals uncertainties. Interviewees speak of droughts ( $c^2=97$ ), changes in thunderstorms ( $c^2=65$ ), storms ( $c^2=166$ ) or other climate phenomena which could become more intense and/or more frequent. Interviewees speak about these phenomena in the conditional tense, as questions or doubts. And despite the fact that the interviewees state that they trust science, they express their doubts (e.g. 39% say 'I don't know'), sometimes by assertions based on scientific uncertainties. 'Scientists have to stand united, so to speak, in order to hold a coherent discourse' (n° 23, government). Claude Allègre, the French geochemist turned politician, thus becomes the opposition figure, the 'scientific detractor'.

Faced with these scientific uncertainties, interviewees construct their climate change representations according to their personal feelings on the topic. They research changes in meteorological events (e.g. 'more storms') or in seasonality (e.g. 'early flowering plants'). Thus, climate change becomes an objective issue with reference to past seasons. Some 'perceive' certain changes:

*'We can see that over the years, the temperature has been rising in comparison to what it was before. Seasons are*

*not as distinct as they used to be. There are also meteorological problems that we can't explain and that are due to global warming, yes indeed'* (n° 16, elected councillor).

Whereas others do not remember and put forward the 'shortcomings' of human memory:

*'Of course, personally, I don't remember, even if I'm not young, 50 years ago, I can't really remember what it was like in this area. It's true that when I hear older people say 'yes, in my day, summers were really dry, we knew what it was like, we had seasons' etc. I'm not convinced, I still believe that we embellish what we want to embellish'* (n° 29, elected councillor).

The discourse on the seasons highlights the search for experienced temporal landmarks and, unlike the issue of water quality, there is no general consensus, especially as climate change is imperceptible at the human scale and has an impact that lasts for centuries – both in the future as in the past: in the words of the interviewees, in the days of 'mammoths' and 'Diplodocuses', when 'the Sahara was full of hay' and when 'Greenland was green'. These comparisons allow the interviewees to reassure themselves or to protect themselves from uncomfortable feelings linked to the mediatized severity of the phenomenon; some even wonder about the natural cyclic evolution of the climate:

*'When you see everything that's going on, I don't know, it seems kind of hard to believe that it [the climate] can change overnight. Maybe in polar ice fields they witness things, I'm not denying anything, but in my opinion, it will happen somewhere far away from here, it did a thousand years ago; it seems that Greenland was once green... In my opinion, cycles might work that way, maybe people are making a fuss about it'* (n° 49, elected councillor).

The question of the natural origin of the phenomenon is evoked by 47% of the interviewees.

Therefore, the common viewpoint underlying the whole discourse is that climate changes are considered over very long periods of time, far beyond the human scale. The

difficulties involved in making projections in time and beyond the local space, limit the perspectives for action, particularly as regards water supply issues, even for the stakeholders who consider that these issues should be taken into account in the SAGE debates.

*‘So, it’s difficult to evaluate global warming because it’s something that we definitely have no control over. At least when it comes to the quality of water, we feel active; we feel that we are in control of the research, the implementation and realization of goals. With global warming, it’s a global matter, so I think that it’s definitely harder to feel able to commit to actions linked to global warming. Because some things are just beyond our understanding’ (n° 24, government).*

But even if climate change issues do not give rise to spontaneous and voluntary debate within the CLE, 59% of the interviewees believe they are indirectly referred to. And among the most frequently evoked climate change-induced impacts on water resources, we can mention the following: floods and sea level rise (61%), water quality and aquatic life changes (61%), drying rivers and important low flow (49%) and an impact on wetlands (41%).

## DISCUSSION AND CONCLUSIONS

This article set out to highlight how water managers understand the environmental issues of water resources and climate change. We focused on their perceptions of these issues, how they situated them in a spatial scale, how they perceived them in a temporal scale and what relationships, if any, they made between these two environmental problems.

Concerning the issue of water, results highlight the importance of water quality, which ties in with representations of water resource issues in Brittany (Michel-Guillou 2011). The issues of drinking water, river pollution and bacteriological quality are then discussed. This qualitative issue is clearly defined within various spheres: social (for farmers more than others), geographical (local issues), and temporal (identification of its origin in the past and a noticeable evolution). Thus, even if the passive (by natural processes) restoration of water quality appears to be a

relatively long course of action, the interviewees agree that there is a solution to this issue. As a result, contextualization of this water quality issue means that it can be overcome, managed and controlled (Garcia-Mira *et al.* 2005; Moser 2009).

Concerning climate change, water managers have some knowledge about this phenomenon and are clearly aware that it exists, but they know more about its effects than its causes (Cabecinhas *et al.* 2006). The issue is essentially defined by global warming, droughts and emphasis on extreme events. Managers are aware of it because they trust scientists who tell them that there is a change of climate. It must be underlined that water managers are strongly influenced by the media (Cabecinhas *et al.* 2008) and as a result, their social representations of climate change appear to be highly stereotypical and not really based on any personal experience. Yet, these changes are not perceived as a daily reality – the issue is perceived as a global rather than a local one and in the short term it seems to be imperceptible.

Therefore, there are separate, even mutually exclusive representations of these environmental issues. Some connections are made between water resources and climate change, but these are not explicitly debated in the CLE. Thus, although most water managers believe in the reality of climate change, comparing global and long-term consequences of this phenomenon with the immediate and salient water-resource consequences means that water-related problems are perceived as more serious than climate-related ones and, as such, climate change-related issues are not classed as a priority (Spence & Pidgeon 2009). As climate changes seem to be imperceptible, ambiguous and lacking in consensus, no decisions can be taken on this issue in the SAGE debates.

The lack of debate in the CLEs is unrelated to the non-recognition of the existence of climate change (i.e. most interviewees are aware that the phenomenon exists), or non-perception of relationships between water issues and climate change issues (most respondents believe that climate changes impact water resources, e.g. floods, low flows, aquatic life modifications). The lack of debate is linked to the perceived gap between these two issues in time and space. The water problems are clearly defined; they are closely located in space and time and, as such, as

Garcia-Mira *et al.* (2005) have shown, people are more concerned with problems perceived in the present. The climate change issue is barely perceptible at the local level and changes are only noticeable in the long term. Therefore, the effects are hardly visible and uncertain, like the fragmented vision highlighted by de Vanssay *et al.* (1997). Thus, this analysis underlines the importance of the temporal dimension in the evaluation of environmental issues. It seems difficult for individuals to reflect on issues that transcend the human scale due to their uncertainty (Graumann & Kruse 1990). Uncertainty is characterized both by the physiological incapacity of the individual to detect some contemporary pollution and the inability to perceive some environmental changes because of the persistence of other issues. This uncertainty generates inability to take action. For the effective management of environmental issues, it is important to adapt environmental information and communication strategies to the populations concerned. Therefore, setting the causes and consequences of climate change within a human time scale and a local space could be conducive to raising awareness about the issue and, consequently, to taking appropriate action.

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