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Can resilience framing enable adaptation to a changing climate? Insights from the UK water sector

Paola Sakai and Suraje Dessai

August 2015

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1. Understanding green growth and climate-compatible development
2. Advancing climate finance and investment
3. Evaluating the performance of climate policies
4. Managing climate risks and uncertainties and strengthening climate services
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Its five inter-linked research themes are:

Theme 1: Understanding green growth and climate-compatible development

Theme 2: Advancing climate finance and investment

Theme 3: Evaluating the performance of climate policies

Theme 4: Managing climate risks and uncertainties and strengthening climate services

Theme 5: Enabling rapid transitions in mitigation and adaptation

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ICAD Project, Informing Climate Adaptation Decision Making is funded by the ERC and began April 2012. Adaptation to climate variability and change represents an important challenge for the sustainable development of society. Informing climate - related decisions will require new kinds of information and new ways of thinking and learning to function effectively in a changing climate. Adaptation research requires integration across disciplines and across research methodologies. Currently, we lack the critical understanding of which kinds of knowledge systems can most effectively harness science and technology for long - term sustainable adaptation. This interdisciplinary research programme aims to significantly advance knowledge systems to enable society to adapt effectively to an uncertain climate. The programme is divided into two domains:

1. Understanding climate information needs across society and
2. The social status of techno-scientific knowledge in adaptation to climate change.

The whole programme will be applied to the UK context given the sophistication of existing knowledge systems (such as probabilistic climate scenarios) and the progressive climate policy landscape (that requires public authorities to regularly report on adaptation activities).

Disclaimer

The opinions presented are those of the author(s) and should not be regarded as the views of SRI, CCCEP, ICAD, or The University of Leeds.

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Abstract

The concept of resilience has been increasingly gaining relevance in the climate change policy arena as a compelling discourse for adaptation to climate change. The UK provides an important case study as the water sector has faced top-down steering from the government and regulators to ensure resilience. This paper investigates what resilience means in practice, which forces are driving the framing of resilience and, more importantly, what resilience means for adaptation to a changing climate. Data was collected through semi-structured interviews and document analysis covering 95% of UK water companies. We take adaptation as a process where responses precede frames which, in turn, are shaped by internal and external factors. Results reveal that resilience is understood as the ability to withstand impacts and continue providing a reliable service. It usually takes a stability connotation and tends to be associated with "low regret solutions" to deal with today´s weather. Framing resilience in this way accommodates the UK sector's adaptation agenda by building flexibility that will allow water companies to wait and be able to change in a 'more certain future'. The analysis identifies internal and external factors that are shaping the current framing, e.g. high self-efficacy, uncertainty, regulatory framework, which are influencing actions on the ground. In light of future climate challenges, if resilience, as it currently stands, is seen as an end in itself, there is a risk that it could lead to insufficient actions or ill fated outcomes. Innovation is missing in the sector, as well as a stimulus that influences transformational adaptation. Overall, by critically examining how the concept of resilience is being used, this paper contributes to the debate that adaptation is a process in which frames catalyse or inhibit action. It stresses the importance of setting clear heuristics when communicating climate change adaptation to help crucial sectors to face short and long-term challenges.

Key words: Resilience; adaptation; water; climate change; framing; transformation

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Highlights:

- The dominant framing is the engineering resilience framework
- Resilience is associated with low-regret solutions that enables flexibility to adapt to a 'more certain future'
- Internal and external factors are driving the resilience framing
- Resilience is helping short-term but not long-term adaptation
- Resilience represents only one step in the continuous process of adapting to climate change

About the Authors

Paola Sakai is a research fellow, specialising in climate resilience, adaptation in organisations, and mitigation at the University of Leeds, where she also was awarded her doctorate. Before this, she obtained a BSc in Business Administration in ITESM (Mexico) and second BSc in Economics in UNAM (Mexico). She also has a Diploma in Stock Finance (ITAM) and another one in Budget and Planning (UNAM). Paola's PhD investigated the extent to which small and medium size enterprises (SMEs) are able to face climate change in a developing country context. In assessing the vulnerability and resilience of these types of organisations, she combined a mixture of quantitative and qualitative methods. Since completing her PhD in April 2013, Paola has been involved in the ICAD project, lead by Prof. Suraje Dessai, leading a case study of the use of climate information for adaptation in the UK water sector. In addition, she is part of the Climate Smart Cities team, led by Prof. Andy Gouldson, where she was a contributor of the study the economics of climate change for Lima, Peru. Paola has been a teaching fellow at the Faculty of Economics in the National Autonomous University of Mexico since 2004, where she currently teaches Financial Mathematics on a distance learning system. E-mail: P.H.M.D.Oca@leeds.ac.uk

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1. Introduction

Climate change is one of the main challenges that water systems face around the world. Recent evidence acknowledges that sustained adaptation efforts are necessary across every nation (IPCC, 2014). However, adaptation is difficult to grasp. The invisibility of climate impacts, its abstract meaning, the lack of feedback i.e. indication about how successful someone's adaptations are, among other issues, have induced the use of various terms (e.g. 'climate-proof' or mainstreaming) to make adaptation more accessible (Moser, 2014). Actors in several spheres, from policy makers, private equity companies, and international aid organisations, have turned to the term 'resilience' as a compelling discourse for adaptation (Davoudi et al., 2012). The word has a more positive connotation. As O'Hare and White (2013:275) explain, it "seems counter-intuitive to argue that we should not become more resilient". In the UK, for instance, resilience is embodied in government policy. As such, the National Adaptation Programme is titled "Making the country resilient to a changing climate" (Defra, 2013a) and focuses on strengthening the resilience of the country. What resilience implies for adaptation, however, remains unclear.

Resilience can be understood from a linear short-term perspective, oriented towards preserving the status-quo, or from a long-term systems view, in which change is managed and encouraged. Instead of being a property of the system, like resilience, adaptation implies actions taken to fit within the surrounding environment. Adaptation is a continuous process that aligns with a set of ideas (framings). The way concepts are negotiated and communicated in public discourses influences strategies on the ground (Wise et al., 2014; Moser, 2014; O'Brien et al., 2007). Thus, framing is crucial in climate change adaptation. The increasing notoriety of the 'resilience' word, its striking practical relevance and poor conceptual clarity pose a warning for any program directed to address problems with longer term horizons. Here we examine what resilience means in practice and what it implies for adaptation. Thus, we tackle three research questions: *1) What does resilience mean in practice? 2) Which factors are driving the framing of resilience?* And *3) What does resilience mean for adaptation to a changing climate?*

To answer these steering questions, semi-structured interviews and document analysis were conducted on the UK water sector. We focus on the UK as it has been a leader in climate change adaptation (See: (Massey and Huitema, 2013; Massey et al., 2014) . Moreover, as water is crucial to the functioning of society and the economy, numerous efforts have been made towards adapting this sector to climate change. In addition, recently there has been top-down pressure to build resilience and encourage water companies to undertake a longer-term perspective on climate change (See: DEFRA 2013b). The water sector is ahead of the curve in adaptation compared to other sectors within the UK (Arnell and Delaney, 2006; Arnell, 2011); thus, by analysing its adaptation agenda, lessons can be learnt, which are relevant for policy makers, water companies, governments and practitioners across the globe. Overall, this paper contributes to the understanding of what could a resilience

agenda mean in practice and what it may add –or not– towards climate change adaptation.

Since we are examining what resilience means in practice and how it is influencing adaptation on the ground, we first review its two main meanings, as well as the literature around its practical implementation. We then review why it is important to examine framings in climate change adaptation. The UK water sector is presented in section 3, followed by the methods section (4) which introduces the framework used in this paper. Results are presented in section 5 and discussed in the following section where the research questions are answered. The paper finishes by offering some conclusions.

2. Theoretical background

The resilience concept has ventured in different fields of knowledge, such as political ecology (Turner, 2013), disaster risk reduction (Manyena, 2006), development (Béné et al., 2014), business (Linnenluecke et al., 2012), planning (Wilkinson, 2012), and adaptation is no exception (Berkes and Jolly, 2002; Davoudi et al., 2012). The conflicts and contradictions in the way the term resilience has been used and the gaps it entails have led to several ongoing debates.

The current debates around resilience can be classified around 10 aspects. The first conversation at the centre of resilience is its conceptual over-streching and ambiguity of the term (See the Table 1 column (1) for authors in this stream). The two predominant meanings above reviewed, one around a single equilibrium, or around multiple equilibria. Another current debate is the conservative usage of the term. A number of authors are concerned about the predominance use of resilience as a form of keeping the status quo, i.e. perpetuating same strategies to conserve what you have (2). It has also been argued that resilience parallels neoliberal ideas. There is a common understanding in the neoliberal world about how society responds and resilience is being used to reinforce those ideas. For instance, the utility maximising approach is an example of how efficiency works in society (3). Another idea is that resilience has been related as governance instrument. Authors argue that resilience characteristics such as self-organisation fit well with the idea of having a society with more independent agents able to look after their own risks and safety (4). Several academics have highlighted that resilience is limited in the scope of incorporating the human science domain in terms of issues of fairness, power, ethics, equity, social justice (5). Reliance on external stimulus is another criticism of resilience. Some authors argue that the '*lazy 8*' (the adaptive cycle of growth) portrays a dynamism that relies much on the external stimulus to have the cycle started, and that the transformation aspect cannot really be seen if the system self-organise around its previous state (6). There have also been conversations about the normative aspect of resilience (7). Another argument around resilience is the difficulties to operationalise and put system ideas into practice (8). Different ontologies, historical and disciplinary origins that clashes have been pinpointed as

flaws in resilience thinking. The SES has its roots in ecology where systems behave in a certain way, and even though social systems share similarities, they are understood around equilibrium ideas and have different dynamics (9). The extent to which resilience can exert transformation is also a debate in the literature (10). For a review of the critiques see: Jassanoff, 2008; Leach, 2008; Morrow, 2008; Rose, 2007; Shaw and Maythorn, 2012; Cote and Nightingale, 2012; Welsh, 2013; Brown, 2014.

Table 1. Current debates around resilience and relevant literature

Examples of relevant literature	Ambiguity of the term	Conservative approach	Parallels neoliberalism	Helpful for tranformation?	Resilience in practice	Governance instrument	Limited in social dimension	Reliance on external stimulus	Normativism	Difficult to operationalise	Different ontologies
Davidson, 2010;	■										
Brown, 2012		■									
McKinnon & Derickson, 2012		■	■								■
Watts, 2011			■								
Jerneck & Olsson, 2008				■							
O'Hare and White, 2013				■							
Shaw , 2011				■							
Benè et al., 2014				■							
Pelling, 2010				■							
O'Brien, 2012				■							
Shaw & Maythorne, 2012		■			■						
Shaw & Theobald, 2011		■			■						
Klein et al., 2003	■									■	
Beymer-Farris et al., 2012							■				
Cannon and Muller-Mahn, 2010							■				
Brown et al., 2013									■		
Nasdasdy, 2007							■				
Hatt, 2013											■
Nightingale, 2012											■
Brand and Jax, 2007									■		
Kirchhoff et al., 2010											■
Porter and Davoudi, 2012	■				■						
Cote and Nightingale, 2012											■
Joseph, 2013			■			■	■				
Jasanoff, 2008			■			■	■				
Morrow , 2008			■			■	■				
Rose, 2007			■			■	■				
Welsh, 2014			■			■	■				
Handmer and Dovers, 1996			■								
Chandler, 2014			■								
Andreas et al, 2010			■								
Leitch and Bohensky, 2014								■			
Leach, 2008	■	■				■	■	■	■		

2.1 Resilience an elusive meaning

The term ‘resilience’ is in vogue (Brown, 2014), with two main conceptualisations of resilience vying for attention. The first corresponds to the engineering resilience framework (ERF). From this view, resilience refers to the ability of a system to return to normality after a shock. It focuses on reducing the risk of failure and returning to an initial state, emphasising a problem-solving perspective by improving reliability (Pelling et al., 2008). This idea has been widely used in mechanics; for example, considering the resistance of steel (Alexander, 2013). In the management and planning literatures it is used to describe systems confronting risk, avoiding failure and resuming normal functioning quickly (Lekka, 2011). This connotation has been highly used by the disaster risk reduction community (Manyena et al., 2011), where resilience has been mainly conceptualised as the ability to recover after a shock, and has had a strong influence in climate change adaptation (IPCC, 2012). The ERF’s attraction emerges from its focus of maintaining the status quo.

The second stream is the resilience of social-ecological systems (SES). This approach is understood as the ability of a system to cope with a shock and exert change to move towards a different stage, i.e. the shock triggers a significantly change response and the system is able to maintain its functions. Academics of global environmental change started to embrace SES, being Folke, Walker and colleagues among the first to pick up the ideas from Holling’s work (Folke, 2006; Folke et al., 2002; Walker et al., 2004). Trying to understand the characteristics and behaviour of ecosystems, Holling (1973) challenged the notion of stability. He proved that a system that has been through a shock is capable of changing and shifting towards a new stage, constituting a new equilibrium. His seminal work on the adaptive cycle portrays this dynamism, where four phases interact in a constant flow: once a system is disturbed it enters a reorganisation phase, then an exploitation one –characterised by extreme changes–, followed by growth, and then by a state of conservation where the system settles until it is disturbed again. Gunderson & Holling (2002) developed the panarchy model, in which the adaptive-cycle phases operate at multiple scales and speeds, interacting in several nested cycles. SES refers to that ability to manage and influence change either to one or to multiple states (Walker et al., 2004), whereas ERF resists disturbances and change to conserve what you have (Folke, 2006, p.356). In this sense, SES focuses on the ability of not only withstanding a shock, but also on the opportunities emerging from the shock. This implies the system is able to rethink paths, learn, reorganise and even thrive (Berkes et al., 2003).

2.2 Framing informs action: the ongoing problem in climate change adaptation

The recent 5th Assessment Report of the IPCC defines adaptation as: “*the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities. In natural systems, human interventions may facilitate adjustments to expected climate and its*

effects (Agard et al., 2014). Adaptation then is conceptualised here a process. This process comprises adjustments made to fit within the surrounding environment. A crucial aspect often neglected is that these adaptation responses are based on the way decision makers frame their environment. A 'frame', in simple terms, is a set of ideas that allows understanding of a phenomenon[1]. These ideas are formed by a myriad of factors: internal (e.g. experiences) and external (e.g. rules) (Hrebiniak and Joyce, 2010). Frames can be conceived in the language or reflected in it (Fillmore and Atkins, 1992). Some frames resonate with some people and not with others, and there is even domination of certain framings (Moser, 2010). We adapt –or not– because there is a frame guiding us to do it. As will be discussed later, frames act as roadmaps facilitating decision making. Climate change represents an abstract concept and its nature makes it particularly prone to be framed in different ways (de Boer et al., 2010; Moser, 2014; Nisbet, 2009). Adaptation responses will be enacted depending on factors such as: how risky the situation is, the likelihood of the phenomenon, the time horizon of threats (distant, proximal), the uncertainty about science and politics, salience in the source of information, the strength of the signals, the resources available, etc. All these issues highlight the ambiguity of the climate change challenge, and stress the importance of examining the framings behind adaptation programmes.

2.3 Action after framing

Depending on how the situation is framed, will affect how its detected, evaluated, enacted and monitored, and the different paths chosen (Berkhout, 2012). The well-known framework of single-loop, double-loop and triple-loop learning (Argyris and Schön, 1996, 1978; Pelling and High, 2005; Pelling et al., 2008) is useful to explain the process that takes place once any situation comes to the scene. When facing a difficulty or a new problem, people tend to use short-cuts (Kahneman, 2011). If the situation or problem is familiar and does not seem to represent a big challenge, it will be solved by following the known patterns that have worked well in the past –those are short-cuts, or single-loop. Alternatively, if a situation cannot be solved in a business-as-usual manner, double-loop will follow. This process will involve searching for alternatives and experimenting new ways of doing things that fit with the new situation at hand. This process will challenge mental models, involving generally larger adjustments in routines. Routines are difficult to change as they represent ways of doing things that have worked in the past (Levitt and March, 1988; Zollo and Winter, 2002). Triple-loop will emerge in situations where problems cannot be solved without a deeper questioning of underlying principles. Here again, change will not always be easy to acknowledge, to introduce and follow (Weick and Quinn, 1999). Once a path is taken, it will give way to a process of assessing if ones' response was enough –or not. In the adaptation process this is called feedback

[1] cf. Barsalou, 1999; Chong and Druckman, 2007; Goffman, 1974; Lehrer and Kittay, 1992; Schön and Rein, 1994

(Berkhout, 2012; Risbey et al., 1999). If the feedback is perceived as successful (even it is not) the frame will be reinforced and new routines will be developed. If the response is perceived as not being adequate enough, the process of searching will start again.

Framing is decisive for adaptation. Since resilience has been increasingly used as part of the adaptation discourse, it is crucial to investigate how this word is influencing adaptation responses. If change is needed in the way adaptation is taking place, it is paramount to identify which internal and external driving forces act upon this framing, so efforts can be redirected.

3. Adaptation in the UK water sector

The UK water sector is comprised of water and sewage companies, water-only companies, as well as regulators, government departments, research centres, trade associations and consumer councils. There is an economic regulator (Ofwat[2]), which aims to ensure that water companies can fund their activities at a competitive and fair price for customers. There is also an environmental regulator, which seeks to ensure environmental sustainability. The health and safety regulators deal with drinking water and safety standards (Drinking Water Inspectorate and the H&S executive). The consumer's watchdog (Consumer Council for Water) also acts in customer challenges. Water companies coexist in a highly regulated monopoly. That is, they control specific areas of the country without competition. They do compete, however, for prestige, since the sector is compact and the companies are well-connected. They have a highly collaborative approach, and have created spaces for networking and benchmarking, in which they learn, reflect, and agree about common interests (e.g. Water UK, a forum where companies get together every 3 months and concur on common practices). Furthermore, the sector is tightly regulated.

Adaptation has been incorporated into the water sector since the late 1990s. For instance, the Water Industry Act of 1991 (sections 27(3) and 192B) states that Ofwat has the statutory duty of reporting on a yearly basis to the Secretary of State the work that has been done to ensure that water and sewerage companies are prepared for long-term challenges. In turn, companies are required by law to assess the future balance between water supply and demand considering the risks and ways to secure the needs of the population and the environment. The so-called periodic review is a 5 year process in which each water company has to produce a Water Resources Management Plan (WRMP). These plans take into account changes in the supply and demand balance for the next 25 years. Another example is the Water Act of 2003 which, among other things, imposed a legal requirement on

[2] Economic regulator is Ofwat in England and Wales, Water Industry Commission in Scotland, and Utility Regulator in Northern Ireland. The Environmental regulator – in England is the Environment Agency, in Scotland is the Scottish Environment Protection Agency (SEPA), and in Northern Ireland is the Northern Ireland Environment Agency (NIEA), in Wales is Natural Resources Wales since April 2013; before then the Environment Agency was also the environmental regulator in Wales.

water companies to publish their WRMPs so they can be scrutinised by the public. The act also gives companies the task to report how they would meet their duties in case of a drought and adapt their practices accordingly. In this sense, companies have to prepare a 'drought plan' every 3 years and a half. Overall, the water sector represents an opportunity, as many lessons can be learnt for adaptation to climate change (Arnell and Delaney, 2006; Arnell, 2011; Dessai and Darch, 2014).

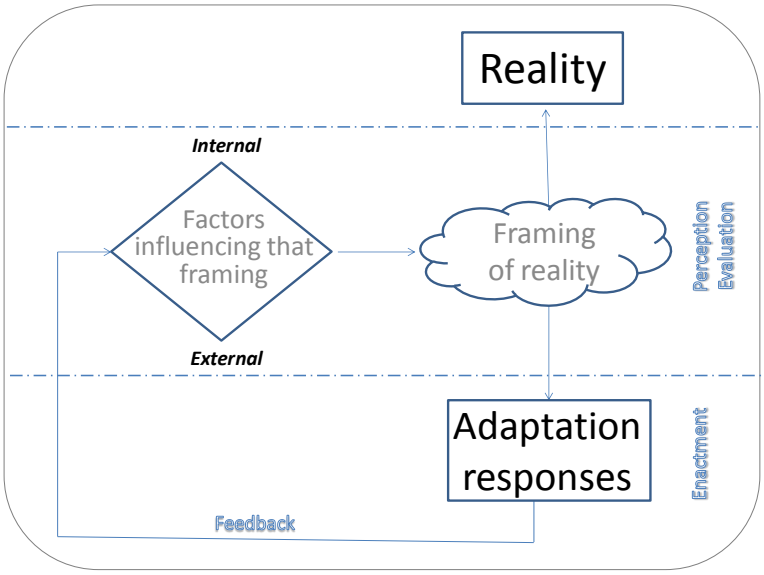
4. Methods

Semi-structured interviews and document analysis were used to investigate what resilience means in practice and what it means for adaptation. 24 interviews were conducted during May-July 2013 and then in April 2014. Climate change managers and water resource managers from 21 organisations were interviewed, covering 95% of all UK water companies. In addition, 3 more persons from the official regulators and related institutions were interviewed. Textual analysis of policy documents was also undertaken[3]. These documents, as well as the interview' transcripts, were coded and analysed using NVivo software.

The analysis involved identifying large thematic groups related to the analytical framework used in this paper, which is portrayed in Figure 1. As has been said, adaptation to climate change will depend on how 'reality' is framed. Framing of reality, portrayed at the centre of the diagram, is a cloudy process where people's perceptions and interpretations of 'reality' are influenced by internal and external factors, which lead to certain actions (adaptation responses). These adaptation responses are contrasted (feedback) against the perceived 'reality'. If they seem to be a good fit, the frame will be reinforced and incorporated as routines. If not, the framing of reality will be modified, and new adaptation responses will follow. Although decision-making is rarely linear, by following these aspects we are able to deconstruct the process and understand how adaptation responses are conceived. We focused on the middle of the diagram to answer our first and second research questions, i.e. how water companies are framing the problem (which set of ideas are in place when they think about: climate change, resilience and adaptation); and which internal and external factors are driving sense-making. The results are presented in section 5.1 and 5.2, respectively. The feedback mechanisms that reinforce the current sense-making are discussed in section 5.3. The bottom part of the diagram constitutes our final enquiry: what does framing the problem as building resilience mean for adaptation to climate change? It is important to note that since climate change effects are not evident yet, it is impossible to appraise if adaptation responses have been enough. We attempt to evaluate this in light of what the literature suggests, though. This analysis is presented in section 6.

[3] Publications by Defra, Environment Agency, Cabinet Office, Ofwat, among others related to the subject.

Figure 1. Conceptual framework of the adaptation process



The figure shows that adaptation responses are taken (bottom box) after a frame is in place, i.e. a cloudy process (middle) of sense-making regarding the need to respond. Internal and external factors (middle diamond) influence the interpretation of reality. When adaptation responses are contrasted with reality (bottom part), this provides a feedback that reinforces or not the current framing of reality.

5. Results

5.1. Resilience meaning on the ground

5.1.1 What is meant by resilience?

The interviews show that resilience is commonly framed around five ideas. The most common way of thinking about resilience is 1) as business continuity or the capacity to continue providing the service, i.e. customers need to be able to turn the tap on whenever they want without any restriction: *"to be able to continue to provide a service in all scenario"'* (WC9[4]). Another way resilience was conceptualised was as being flexible (2), which interviewees relate also with the ability to respond more quickly: *"it means that we're not reliant on one source, that we have the ability to adapt and change to a situation quite rapidly, so that we have the ability to move water around our network to ensure that our customers' demand and supply is not in any way interrupted due to a number of events"* (WC2). 3) Buffering disturbance and recovering is another common idea provided by interviewees when they refer to resilience, as they argued that resilience gives the ability to cope with a wide range of disturbances: *"This means that if you have a failure within the system at some point, then you are able to accommodate that failure and deal with it"* (WC16). A

[4] WC= interview of a water company, IS= interview of a person from the water institutional setting. The numbers reflect an internal code to identify the interviews.

trend was also found where water managers conceptualise resilience as a way of managing risks (4): *"is a form of risk management because you are looking at an asset and you are saying what are the failure notes... then investigate the avenues to reduce that risk to a level that you are comfortable with"* (WC8). Finally, resilience is a mix of different options (5) that companies can do to protect and respond to a weather or climate event: *"Is a suite of things you could do"* (WC12).

5.1.2 What builds resilience? How is resilience built?

To have a better understanding of what resilience means in practice, we enquired about specific actions or strategies to build resilience. Resilience actions tend to be associated with less risky options, which require less investment, efforts and tend to be focused on the short-term – the so called "low regret solutions". Some of the examples provided by interviewees refer to simple technical preparedness measures, such as backwashing filters more often or even having an additional spare pump "sitting in the corner of a pumping station". Others relate to strategic actions, like linking distribution networks and planning in general. For instance, having good emergency plans with sufficient headroom and schemes for an efficient recovery process. Several measures from the demand side were also mentioned, like promoting water efficiency among customers. However, long-term measures, such as building a flood barrier or putting an extra borehole to get more water from a site, were pinpointed as implying larger investments. Some interviewees consider that these measures could constrain future flexibility, while others argued that those were the only measures that could truly secure water in the future. Despite these opposing opinions, there was a general agreement that these types of measures would be only considered if the need was evident and a convincing case could be made to the regulators.

5.1.3 Resilience and adaptation, how are they framed?

Interviewees acknowledged that the concepts around climate change have evolved, and that the terminology used among the sector at the moment is more about resilience than adaptation. Resilience emerged as a more attractive and easy-to-grasp concept than adaptation. First, it implies responding to a more tangible and evident need, as it is generally associated to today's weather. As a result, resilience tends to be easier to communicate across the organisation. "*if you talk about extreme weather and resilience it sits more comfortably with them* [people in the business]*, than talking about adaptation and climate change because it is more immediate and it is something that they can really latch onto and understand*" (WC1). Second, water companies consider that flexibility is crucial for them to adapt in the future. Since adaptation to climate change is associated to uncertainty, and there is a risk of becoming locked-in to long-term investments, water managers preferred

actions (“low regret solutions”) that allowed them the flexibility to deal with a wide range of future circumstances (cf. Dessai et al. 2009; Hallegate 2009; Wilby and Dessai 2010). In this sense, it was more convenient to build resilience than adaptation. Actually, water managers found it difficult to distinguish both concepts. Nevertheless, resilience seems to be a step towards adaptation:

“*our adaptation is really about how we think about when we are delivering schemes that we have secured funding for, how we might build more flexibility and resilience, into them. That is how we are adapting*”. (WC12).

5.2. Internal and external factors driving the current resilience framing

As Fig.1 shows, adaptation responses are enacted based on internal and external factors influencing how reality is framed. We identified several of these aspects and present them next.

5.2.1. Internal factors

Confidence and capacity: Water companies are confident that they are at the forefront of planning for climate change. The water sector is sensitive not only to the weather, but also to population and other factors that can put pressure on water supply. In this sense, since privatisation of the UK water industry in 1989, water companies have been required to address all those factors every 5 years contemplating a 25-year planning horizon. In those plans, they have to come up with solutions in the event that deficits appear during that period of time. This process has provided them with skills, and they are confident that adaptation is already integrated into their planning. “*In many cases what we see is that we have already planned for whatever will happen*” (WC9). Several interviewees mentioned that climate change is not a new problem, but that it is just a risk modifier, i.e. one of the many things that could affect the water balance in the future. They feel that throughout the years they have learned how to manage their risks effectively, and consequently there is no need to do things differently: “*If everything we do in the business is a risk based approach of it and therefore climate change and our adaptation to it wouldn’t follow any other pattern would it.*” (WC16).

Caution and responsibility: Another factor that is ingrained is the fear to fail. Failing to supply water is perceived as a significant social, political and economic problem. The analysis reveals that interviewees have embraced the responsibility that water is part of public health, which depends on their performance. Reputation also plays an important role. Failing to provide water to an international financial centre, such as London, would be unacceptable politically and economically. In this manner, the possibility of failure is almost a taboo in the water sector. As discussed in some interviews, no actor, from ministers, OFWAT, the EA, and water companies, wants to be the one blamed for failing. This risk-averse behaviour is also undermining innovation: “*We are all so concerned about the risk of the innovation being in the wrong direction that we’re reasonably happy to live with slower collective innovation*

across the whole sector than we are with individual innovation that might go horribly wrong" (IS19). Water companies are used to deal with risks, but with comfortable levels of risk.

Resonance: 98% of our interviewees have an engineering background. For them, like for risk managers (O'Hare & White 2013), the ERF has a great appeal. Concepts such as resilience and adaptation can be transmitted through actors and its acceptance is influenced by a shared language (Davoudi et al., 2012; Spence and Pidgeon, 2010). If our interviewees were ecologists, SES might resonate instead. However, since at the heart of their everyday activities there is a problem solving perspective, the word resilience automatically activates the ERF in them.

5.2.2 External factors

There are various external factors that drive the prevalent framing and thus adaptation responses. One of them is the lack of clear signals and another is the uncertainty in climate scenarios. The interviews and document analysis show that direct climate damages are not significant drivers to modify existing practices. In the last periodic review (PR09), just half of the companies reported deficits in their balances by 2035 (CCC, 2013). In the current periodic review (PR15), interviewees mentioned that according to their initial exploration, the yields in many of their sites do not show a decline by 2040 because of climate change.

On the other hand, the analysis highlights that the uncertainty about the magnitude of future impacts continues to be an issue in decision making. Interviewees argue that even the latest climate change scenarios (UKCP09) have not eliminated the uncertainty as the ranges of impact ranges are still large. This has led to the common decision-making problem of having to decide the level of impact (low, medium, high) and the solutions to be implemented around a certain level of risk. Water companies do not perceive yet a clear climate signal (impact), so they are focusing on building flexibility and waiting until more robust evidence compels them to respond in the future. The document analysis also reveals that Ofwat has been encouraging companies to build interconnections (OFWAT, 2013), and this is what water companies proposed to do in PR15. Interconnectivity is a clear way to build flexibility to respond to an uncertain future, as the following quote exemplifies: "*...you have maybe taken another approach which is to interconnected to assist next door to each other. And maybe what that gives you is a lower level of protection at each asset, but you have spent less money and effort to do it. [...] And you have also not prejudiced any future investment because it may be that in time to come the flood risk may get so big that that asset-you just abandon it and build a new one somewhere else. Whereas if you put a £30 million flood defence around it, you might be more reluctant to abandon it*" (WC8).

Another external factor that is driving the current sense-making and thus adaptation pathways is the framework set by the regulators. A cascade of documents has

recently poured down pushing the resilience agenda. For instance, 'Water for life' (Defra, 2011), the precedent of the Water Act 2014, identified water scarcity as a challenge and pins down the need for securing the 'resilience' of water supplies in the longer term. Then, the Department for Environment, Food and Rural Affairs (Defra) issued a guide to help the economic regulator, Ofwat, in its role of ensuring a sustainable and 'resilient' water sector. That guide aimed to *"identify Government priorities clearly and to provide a strong steer on the outcomes Government wishes Ofwat's activity to contribute to delivering"* (Defra, 2013c, p. 2). (Defra, 2013c; MP Benyon, 2012). 'Resilience' then is at the centre of the UK water sector as portrayed in the document titled: "Updating the general duties with respect to the water industry to reflect the UK Government's *resilience* priorities" (Defra, 2013b). Here resilience refers to *"the ability of a system to withstand shocks and continue to function"* (p.2). This is clearly referring to ERF, in the same way that past documents have framed it (See Table-1, quotes A-C). However, even at this high policy spheres confusion exists on what 'resilience' means, like the NAP which refers to SES framing (Table 2, D). Nonetheless, since framing in the water sector follows a top-down approach, water companies' idea of resilience is closer to Ofwat's, i.e. continue providing a reliable service. This evidences that companies follow the frames set by their regulators, which is crucial as this influences decision-making on the ground.

Table 2. Examples of resilience conceptualisations in policy documents

Resilience is defined as:
A) Keeping the Country Running: Natural Hazards and Infrastructure. A Guide to improving the resilience of critical infrastructure and essential services, **Cabinet Office**, **2011**:14: *"is the ability of assets, networks and systems to anticipate, absorb, adapt to and / or rapidly recover from a disruptive event".*
B) Climate Resilient Infrastructure: Preparing for a Changing Climate, **Defra, 2011**:69: *"Climate resilience: The ability of a system to absorb climate-related disturbances while retaining the same basic structure and ways of functioning."*
C) Resilience -outcomes focused regulation. Principles for resilience planning, **OFWAT, 2012**:11: *"resilience is focused on services for customers and the environment, rather than on the resilience of assets, or even networks and systems [...]The approach to resilience set out in this report recognises that there are different components of resilience that need to be considered for understanding the resilience of services. The four components of resilience identified in "Keeping the Country Running" have been adopted here".*
D) National Adaptation Programme, **Defra, 2013**:13: *"the ability of a social or ecological system to absorb disturbance while retaining the same basic ways of functioning, and a capacity to adapt to stress and change".*

5.3 Feedback

Interviews reveal that adaptation responses are mainly assessed against the eyes of the economic regulator. Ofwat is one of the closest regulators working with the water companies, as it is the one who authorises the tariffs to be charged during the the PR period. This means that all the financial investments proposed by the water companies, even for climate change adaptation, need to be authorised by Ofwat. In

this way, Ofwat plays a crucial role in terms of steering priorities and even framing the urgency of the climate change challenge. In order to obtain investment authorisation to undertake adaptation actions, companies need to develop a strong case using the latest climate models to clearly show the future negative effects. In addition, the analysis confirmed that Ofwat's framing has effects on the ground. For instance, this regulator has encouraged companies to increase their network connectivity in order to facilitate future market competition (OFWAT, 2013). The analysis of the water companies draft plans for PR15 and the interviews reveal that many of the proposed actions are precisely focused towards having more network connectivity.

Some interviewees applauded Ofwat's conservative approach, arguing that it does not constraint their capacity to be innovative and adapt. In contrast, some interviewees maintained that Ofwat represents a barrier to adaptation, since investments need to be done today, even if the impacts are expected in the long-term. However, Ofwat assesses the deliveries of the company's 'outcomes' in the short-term (5-year intervals). The government (DEFRA and the EA) are pushing a long-term perspective, but the path set out by Ofwat, and the adaptation actions followed by companies, seem to be in conflict to that. Important is to note that Ofwat is changing the way water companies are assessed to promote long-term planning. The idea is that at the end of the current PR (in 2019) companies will be evaluated through outcomes instead of measuring their outputs. '*Climate change adaptation strategies allow a service to be resilient. And that's the outcome. The outcome of good adaptation is a resilient service.*" (IS13). Water managers have seen this as a positive change that might give them more flexibility in the way they manage their operations. However, companies are not yet certain about Ofwat's real intentions, are not sure how this will work and cast doubts about the effectiveness of this approach in terms of pushing long-term thinking.

6. Discussion

6.1 What does resilient mean in practice? ERF as the dominant framing

We found that the dominant framing of resilience was the ERF heuristic. That is, when experiencing weather or climate impacts, water companies believe themselves to be resilient when they are able to provide the agreed level of service whatever the circumstances. It is a form of flexible risk management in which causal knowledge of the system is applied to identify potential risks and establish adaptation responses. As problem framing influences adaptation responses (de Boer et al., 2010), the solutions implemented have a functional goal, i.e. providing flexibility in the short-term, so failures are avoided and the system can continue functioning. Although the meaning of resilience has been evolving and some government documents seem to be adopting a SES perspective (e.g. Table 2, quote D), in practice the focus is around the stability of the water service.

6.2 Which factors are driving the framing of resilience? ERF fitting the mould

Four interlinked factors are pushing the engineering-resilience framing: lack of clear signals, perception of high-self efficacy, risk-averse behaviour, and the regulators agenda.

Water companies do not perceive a clear signal indicating them to do things differently. For instance, there have been few droughts in recent years. Signals are perceived or ignored depending on their strength, past experiences or recollections of similar situations (Berkhout, 2012). Results reveal that water companies have not yet experienced significant climate-induced damages and climate projections up to 2040 do not indicate a sense of urgency either. Adaptation to climate change is just another risk that needs to be incorporated into their normal planning activities. There is a sense of self-efficacy, in the sense that enough experience and understanding has been gained on how to manage risks. Self-efficacy (i.e. the sense that one is able to achieve something through one's own actions) can both hinder and enable proactive behaviour (Chapman et al., 2009; Morton et al., 2011) . In the case of water companies, feeling certain about their own capacities in the face of impacts inhibits going beyond of what is just necessary, because things appear to be under control. If a problem is not detected as a new problem, the process of searching for new solutions will not start and new routines will not be developed (Zollo and Winter, 2002). Indeed, firms often repeat past responses (Kelly and Amburgey, 1991) This means that their history and previous experiences shape subsequent paths of behaviour. The current routine is that of securing stability in the water supply. And stability fits with the ERF framing.

Results show that the water sector is risk-averse. Arnell and Delaney (2006) found that water companies embraced a *wait-and-see* approach to adaptation. Here we argue that their strategy is a *proactive-wait-and-see* stance, because efforts are still being made, i.e. building flexibility to buy time until climate change unfolds. However, they are not searching for radical changes. As a highly regulated sector, adaptation is a mix between public and private decisions (Mendelsohn, 2006; Naess et al., 2005).The analysis reveals that companies are exploiting low-hanging fruits from the demand side, since uncertainty still exists regarding a move towards larger actions (e.g. reservoirs). The literature suggests that some institutional arrangements may hinder proactive approaches (Naess et al., 2005). In the water sector this is clearly portrayed. Regulators are not willing to authorise massive investments under the current circumstances. As companies are receiving risk-averse signals, they avoid risks so mistakes are diminished. In a similar vein, Rayner et al. (2005) found that water companies in the US tend to avoid doing something different (in that case using new climate information) than what the regulator has stipulated as that puts them at risk of not fitting with the standard. Water companies, then, are oriented towards what De Boer et al. (2010) calls '*prevention orientation*', pinpointing behaviours sensitive to negative outcomes. Governments, generally, intervene in the normative appreciation (what is expected to be correct) and respond accordingly to

climate change (Berkhout, 2012; Garschagen, 2013; Keskitalo, 2010). This is clearly happening in the UK. Water companies assess their performance to a great extent on the feedback provided by their regulators. Despite climate change uncertainty, by following and accomplishing the standards of the regulators, water companies are confident about the possible outcomes of their actions.

Many policy interventions are only incremental modifications of the status quo (Hayes, 2002; Howlett and Migone, 2011; Howlett, 2014). Resilience interventions in the UK have been pinpointed as having a short-term, conservative flavour (Davoudi et al., 2012; Shaw and Theobald, 2011) with some arguing that ERF is the most appropriate measure in a period marked by austerity (Davoudi et al., 2012), to conserve the power structures (Watts, 2011), and to encourage the big society (Joseph, 2013). This constitutes the current governmental agenda and we argue here that it is also the one embedded in the UK water sector. The government priority lies on securing water supply (Cabinet Office 2011). Our results show that failing to provide the agreed level of service is considered to be a catastrophe. To avoid failure, decision makers do not tend to engage in risky situations (Hood, 2010; Tversky and Kahneman, 1992). In relation particularly to climate change, policy (in)action follows a blame-avoidance approach (Howlett, 2014). That is, when failure has the potential to reach the larger public, programmes are unlikely to be approved or put forward (Cobb and Primo, 2003). In this manner, ERF fits with the current framing of the UK water sector. As other conceptualisations require challenging routines and developing new paths, policy makers and water companies prefer incremental rather than radical strategies to avoid the threat of being blamed for a failure in the system.

Efforts have been made to promote a long-term perspective by introducing resilience, but our results show that confusion exists about what resilience implies. The regulatory framework sends mixed messages about what is needed thus reinforcing the risk averse behaviour. When talking about larger investments in the water sector, there is a temporal distinction between resilience and adaptation. The different spaces they have to discuss and reflect provide them the opportunity to start a reflection process. The water sector has started to question what resilience implies (Water UK, 2014). But it is early stages and more work needs to be done to avoid confusion in the goal the sector wants to achieve.

6.3. What resilience framing is doing for adaptation to a changing climate?

Defining successful adaptation is a challenging endeavour (Adger et al 2005; Ekstrom & Moser 2014; Moser & Boykoff 2013). Uncertainty exists around the extent of climate impacts, and responses are context dependent, which is also contested from many fronts (Dessai and Hulme, 2007). We acknowledge here that it is impossible to ascertain if current adaptation responses will address –or not– future climate change impacts satisfactorily in the UK. Nevertheless, based on the literature and on our results, we argue that the current ERF framing is helping the water sector

adapt to near term climate variability and change, but it is unlikely to help with long-term adaptation (cf. Dilling et al. 2015; Hernández Montes de Oca 2013).

Numerous authors have suggested that planning to minimise risks and seeking stability or returning to pre-disaster levels of functioning is essential, but an 'increasingly insufficient goal' to manage climate events (IPCC 2012:34). In fact, one of the most prominent debates around climate change adaptation in the last decade was the insufficiency of the risk hazard approach. The classic risk thinking has been widely criticised arguing that it conceals root problems, since it just focuses on the effects of the perturbations (Eakin & Luers 2006; O'Brien et al. 2004; O'Brien et al. 2007; Kelly & Adger 2000). The risk management approach has strong similarities with ERF, in the sense that they focus on minimising the risks to continue functioning, leaving apart underlying problems that might be causing or increasing the risks. This not only might represent an inadequate adaptation response in the face of uncertainty, but in some cases, may constitute mal-adaptation (Barnett and O'Neill, 2010; McGray et al., 2007).

Adopting ERF, however, has been a crucial step. First, ERF has been easier to absorb and accommodate into the people's frames and practices. Most people in the sector have an engineering background, making it easier for resilience to be understood from an engineering perspective. In addition, engineering-resilience framing has helped water companies to continue functioning, to communicate climate change within their organisations, and it has encouraged them to build flexibility and comply with regulations. ERF represents single-loop learning where, following the known patterns that have worked in the past, water companies have been successful in coping with current weather conditions. They have learned and gradually adjusted some practices to be prepared when the time comes. ERF represents a way to deal with uncertainty because you can be flexible and focus on immediate benefits.

Relying solely on ERF could be problematic as it has a strong short-term focus. Water companies have been successful in coping with current weather conditions. Nonetheless, climate change is a long-term problem. Time is needed to develop adequate adjustments for rapid and abrupt climate change -or other surprises. The process of implementing large water structures requires decades of preparatory studies, several years of constructing infrastructure and a large sum of money, making the planning horizon of water companies a long-term issue (Rayner et al., 2005). For example, to build a reservoir, the natural system of the site must be understood and feasibility studies need to be conducted. Costs and benefits during a period of 50 or 100 years need to be calculated, while construction and implementation is carried out. All these actions require long lead in time for implementation.

ERF implies a *ceteris paribus* future and adaptation is a dynamic process. So far, water companies have made a judgement call by choosing a certain degree of risk (i.e. an "x" or "y" level of service) that they are willing to bear –and regulators are

able to authorise. The current resilience framing not only fits with this conservative agenda, but reinforces it. There is no sense of wanting to change, reinvent or transform the current norm. Challenging the status-quo puts at risk current systems and power structures (Pelling, 2010). This risk-averse strategy is at the expense of opening opportunities for innovation, because at the end the solutions will be influenced on goals, values and concerns (O'Brien et al., 2007) implicitly involving social contracts (O'Brien et al., 2009). Concern seems to centre on securing a reliable service, which of course is in everyone's interest. However, as climate change unveils, social and natural systems will need to enhance their coping thresholds and introduce a double/triple-loop, which can push to incorporate profound changes into adaptation strategies (Pelling et al., 2008; Yohe and Tol, 2002). Some authors have argued that these two learning loops are closer to the term 'transformation'[5] as question the underlying values of social structures that have created the current routines (Pelling 2010; IPCC 2012:66). Few signals of transformation are evident in the UK water sector. Some changes are being implemented, but none that question the dominant social, cultural and value structures and norms. Studies on the pathways to sustainability have informed the need of transformational approaches (Westley et al., 2011). Some authors have suggested that a holistic adaptation agenda would require an alignment with sustainable development goals. This would imply that responses should not only be viewed as a way of getting out of trouble, but as ways to provide broader benefits in the development process. The UK government has been reluctant to link the 'resilience' concept with 'sustainable development' (See DEFRA 2013c). In this way, a more proactive behaviour that challenges water companies (for instance to improve the lives of people by increasing every PR the committed level of service), is not yet present in the UK water sector.

7. Conclusion

Can resilience framing enable adaptation to a changing climate? It might, but the UK water sector should do more to steer its practices towards a long-term perspective and an innovative approach. The analysis of the interviews with water managers, regulators, and several policy documents show that resilience is associated with current weather and low-regret solutions. It is oriented towards supporting stability and providing a continuous and reliable service. This ERF framing is being pushed on internal and external fronts: a sense of confidence and self-efficacy, lack of direct damages, uncertainty in future scenarios, risk-averse behaviour and responsibility, and mainly by the regulatory framework. Our results show that the Government sets up the framing and it is mainstreaming adaptation on the ground.

[5] A change in the fundamental attributes of natural and human systems. Within this summary, transformation could reflect strengthened, altered, or aligned paradigms, goals, or values towards promoting adaptation for sustainable development, including poverty reduction (Agard et al., 2014)

The UK water sector has been evolving and adaptation to climate change has been progressing. Water companies have learned to manage contingencies, plan ahead and significant advances have been made to prepare for weather-related impacts. In spite of a strong focus on incremental adaptation, other sectors can learn from the UK water sector as it is at the forefront of adaptation. This is manifested in actions driven by plausible statutory periodic processes of planning and reflecting about their current and future circumstances. The tight regulation and solid collaborative partnership has given this sector a cohesive structure, and the different spaces they have to discuss, provide them with the opportunity to reflect, share knowledge and set up strategies to create progress towards common goals. Nevertheless, their *proactive-wait-and-see* approach is closing up opportunities to rethink pathways and improve.

This paper adds to the debate about the relationship between resilience and adaptation as a transformational change by showing that ERF represents only one step in the continuous process of adapting to climate change. Adaptation is a dynamic process highly intertwined in processes of change and learning. The uncertainty associated with the future climate asks for anticipatory transformative change (Kates et al., 2012). In the UK water sector, ERF is helping to adapt in the short-term, but is not pushing adaptation boundaries. If ERF is seen as an end in itself, there is a risk that it could lead to insufficient adaptation actions or ill fated outcomes. Clear strategic heuristics are needed as well as challenging narratives that steer innovation. The competing idea of resilience, SES, might be more suitable to keep up with adaptation as it can function as a metaphor that centres the attention on change, on evolving and renewal. Although tensions exist about its usefulness (Olsson et al., 2015). Other reflexive approaches have moved purposely away from the ambiguity of resilience to explicitly differentiate what needs to be achieved (e.g. adaptive resilience vs. transformative resilience) (Bahadur and Tanner, 2014; Christmann et al., 2012; Pelling, 2010; Wilson et al., 2013). Others, such as the adaptive pathways, have also tried to inform the ways to open up opportunities avoiding conservative framings driven by power dynamics and unsustainable paths (Leach et al., 2010; Maru and Stafford Smith, 2014; Wise et al., 2014). There are multiple ways to design the future, but *who decides on the magnitude to adapt to environmental change and what the alternatives are*? (O'Brien, 2012, p. 669) The depth of change required to face climate-related events will be unknown for now, but it is now when debates need to be raised on the depth of change society is willing to make.

Under the current challenges and future uncertainties, it is desirable to learn to change, routinely modify to learn and be prepared for small and big changes so as to be adapted. If it is recognised that change is needed in relation to how the water sector is enabling adaptation, this is a judgement call that companies, regulators, government and customers have to make. Decision makers should not take for granted that their decisions are based on their conception of reality (De Boer et al., 2010). Framings have the power to catalyse adaptation as they push individuals to

action or inaction. The depth of action not only depends on resources and impacts, but also on how the problem is framed and communicated (Moser, 2014). Framing is often neglected and under-researched in climate change adaptation. The insights offered in this paper call for further research, not only to discern framings and the underlying factors underpinning adaptation actions, but also to understand how they are co-constructed and the channels that facilitate them.

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