



A framework for adapting to climate change in the water and sanitation sector: The case of Wales

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A framework for adapting to climate change in the water and sanitation sector: The case of Wales

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Author(s)

Emma Westling, Liz Sharp, Richard Ashley, Simon Tait

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Executive summary

- This report presents outcomes from an intense research phase in which our partner utility in the Prepared project, Dwr Cymru Welsh Water (DCWW), and other organisations with some role in water management in Wales have been examined in terms of their work towards climate change adaptation
- Climate change adaptation may involve using new technologies, but may equally involve new ways of working within and between organisations, or between organisations and the public. This report focuses on the organisational and social processes through which adaptation occurs in the water sector
- Climate change adaptation is underpinned by how the issue is perceived and based on how the current and future water management practices are envisioned across actors. In this research our aim is not to identify the optimum climate change adaptation strategy for Wales, but rather to bring light to the diversity of ways that adaptation is understood, and hence to enable collective negotiation about developing a forward strategy
- Drawing on four different case studies covering Wales in general and three specific cases, four distinctive *frames* which illustrate contrasting ways in which water management actions are discussed, judged and planned in Wales are identified.
- These frames are referred to as *Market; Environment; People of Wales; and Technocracy*. Depending on the current balance of the frames water management strategies and actions will proceed in a certain direction.
- We seek to use the frames to facilitate conversations within teams or water management organisations about what they are doing at present and raising questions about what they want to do in the future. These conversations may include questions such as: what is the current balance of frames? Is this the right balance? Does it address adaptation to climate change in Wales? What is the right balance to support climate change adaptation in Wales?
- Once the current external and internal balance of the frames has been identified a specific action plan supporting water management organisations to move towards the perceived right balance can be developed. These actions may include both organisational and technological actions. The current and aspired balance should not be perceived as static but rather as progressively changing. These conversations therefore must be iterated in moving towards a balance that aids in facilitating organisations' adaptivity to climate change.

Glossary

Adaptive co-management: form of adaptive management with an additional focus on the role of collaboration, rights and responsibilities.

Adaptive governance: form of adaptive management developed to deal with diversity and reconciling conflict among people and groups who differ in values, interests, perspectives, power.

Adaptive management: approach to govern ecosystems or social systems that are highly uncertain, complex and unpredictable aiming for such systems to become resilient, i.e. the capacity of a system to undergo disturbance and restructure and undergo change whilst still retaining essentially the same function.

Countryside Council for Wales: the Government's statutory advisor on sustaining natural beauty, wildlife and the opportunity for outdoor enjoyment in Wales and its inshore waters.

CSO: combined sewer overflow.

DCWW: Dwr Cymru Welsh Water, water and sewage company a partner in Prepared.

DEFRA: UK Government's Department of Environment, Food and Rural Affairs it ensures that EU and UK legislation are complied with for water companies serving England.

Drinking Water Inspectorate (DWI): a regulatory that ensures that water supplied water is safe to drink and meets standards set out in Water Quality Regulations. It also investigates consumer complaints and incidents that affect, or could affect, drinking water quality.

Environment Agency Wales: monitors and enforces compliance with environmental water quality standards. It also ensures the proper use and management of water resources.

Frame: way in which water management actions are discussed, judged and planned.

Framework: the set of frames through which current actions and future choices can be considered.

Interpretive research: focuses on the meaning of a particular context and acknowledges the subjective nature of real world problems. Rejects the idea of the researcher as being objective and standing outside of the subject being researched.

OFWAT: the economic regulator of the water and sewerage sectors in England and Wales. It ensures that a defined quality of service is provided at a fair price.

Positivist research: characterised by a belief in an independent and objectively accessible world and by the pursuit of explanation through general laws describing regularities in nature and/or society.

Serviceability: the capability of a system of assets to deliver a reference level of service to customers and to the environment now and into the future.

SuDS: sustainable drainage systems.

SuDS Approval Bodies (SAB): responsible for approving, adopting and maintaining drainage plans and SuDS schemes that meet the National Standards for sustainable drainage.

SWMS: The Surface Water Management Strategy, a current strategy of DCWW to manage storm water.

Welsh Government: ensures that EU and UK legislation are complied with for water companies serving Wales.

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1 Introduction

Climate change impacts pose fundamental challenges to water policy makers as they imply non-linearity, complexity (Hall, 2003 in Duit and Galaz 2008) and scientific and policy uncertainties (Galaz, 2007). However, adapting water organisations and processes to meet these changes is also a significant challenge, which may involve using new technologies, but may equally involve new ways of working within and between organisations, or between organisations and the public. This report focuses on the organisational and social processes through which adaptation occurs in the water sector. Institutional factors, such as fragmented water management organisations and technocratic management ideals are increasingly believed to post the main barriers to climate change adaptation in the water sector (Ellis and Revitt, 2010). However, the way in which organisations or individuals seek to adapt to climate change pressures is largely underpinned by how the issue in itself is perceived and also based on how the current and future water management practices are envisioned across actors. Hence, in order to identify current and future processes seeking to achieve climate change adaptation, and to understand why institutions behave in a certain way, the subjective interpretation of the actor needs to be considered (Scott, 1995, Gonzales and Healey, 2005). Only with an in-depth understanding of the current situation can recommendations underpinning a shift in water management structures to more adaptive approaches be identified.

In this report we aim to identify the dominant frames, which organisations or individuals draw on to make sense of water management policy and practice. These frames will influence how climate change adaptation is defined and acted upon. Frames are defined by Rein as ‘structures of thought, of evidence, of action, and hence of values and of actions’ (Rein, 1983:96). A particular framing of water management and adaptation is therefore not only underpinned by scientific evidence, but also includes tacit knowledge, perceptions and aspirations. This report provides the initial outcomes from an intense research phase in which our partner utility in the Prepared project, Dwr Cymru Welsh Water (DCWW), and other organisations with some role in water management in Wales have been examined in terms of their work to prepare Wales for climate change impacts. Our contribution is the identification of four different frames which together describe four contrasting ways in which water management actions are discussed, judged and planned; together these form a ‘framework’, through which current actions and future choices can be considered. Hence, our aim is not to identify the optimum climate change adaptation strategy, but rather to bring light to the diversity of frames that may exist in order to enable an open dialogue about these and for organisations to use the analytical framework to collectively negotiate a strategy forward. The geographical focus of this research is Wales in the UK and within this broad case (henceforth ‘the big case’) we draw on three specific cases within the case (henceforth strategic and implementation cases) to illustrate the framework and investigate adaptation to climate change within the water and sanitation sector. In this report we refer to Wales in terms of areas served by DCWW, which also includes bordering regions in England. In total, DCWW serves three million people in Wales and England.

2 Climate change adaptation in the water sector

The concept of adaptive management derives from ecosystem management (Holling 1978 in Pahl-Wostl, 2007) as an approach to govern ecosystems that are highly uncertain, complex and unpredictable (Pahl-Wostl, 2007). In the more recent literature, adaptive management is primarily concerned with social - ecological systems and has a normative agenda in aiming for such systems to become resilient, i.e. the capacity of a system to undergo disturbance and restructure and undergo change whilst still retaining essentially the same function (Walker et al., 2004). In the context of climate change, the Intergovernmental Panel on Climate Change (IPCC) defines adaptation as 'adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities' (IPCC, 2001:982). This definition provides two important contributions for adaptation within the water cycle. First, it highlights the fact that institutions within the water cycle must build adaptive capacity to cope with potentially increased numbers of critical events such as floods or droughts, but also for strategic longer term changes due to climate change impacts. Second, adaptation or adaptive capacity is not only concerned with dealing with or coping with change, but also with identifying opportunities to benefit from the changing environment (e.g. Folke, 2006; Gupta et al., 2010) provides a useful addition to adaptive capacity in not only focusing upon the characteristics that build an adaptive institution, but also including the 'degree to which such institutions allow and encourage actors to change these institutions to cope with climate change' (2010:461).

The key components in adaptive management are learning and experimentation (Duit and Galaz, 2008; Huitema et al., 2009; Gupta et al., 2010). Traditionally experimentation within adaptive management has been applied in a strict positivist fashion where experimentation has been used as a methodology with the purpose of testing hypotheses on ecosystem response to different management interventions to provide a scientific basis for management (e.g., Lee 1999; Richter et al. 2003). However, more recent contributions from the literature are concerned with experimentation as a management approach that creates arenas for learning across different perspectives and interests and have the potential for trust building between actors (Lejano and Ingram 2009 in Huitema et al 2009). This in turn may increase their capacity to cope with uncertainty and future change (e.g., Moberg and Galaz 2005). These later contributions to adaptive management have developed to include a number of new insights. Firstly, consideration of social-ecological systems in the literature has triggered new analytical frameworks for adaptive management (Olsson et al., 2007). *Adaptive co- management* has been suggested as an important addition to the original form, in that it not only focuses on learning and experimentation but also emphasises the role of collaboration, rights and responsibilities (Huitema et al 2009). However, Olsson et al. (2007) argue that adaptive co-management fails in terms of understanding the governance component of complex systems, and how to deal with uncertainties and complexities within these. Hence, *adaptive governance* has been introduced as a form of management that is able to cope with uncertainty, deal with diversity, and reconciling conflict among people and groups who differ in values, interests, perspectives, power, and the kinds of information they bring to situations (Dietz et al.2003, 2007). Adaptive governance is therefore argued to be suitable to deal with complex systems, and to provide the fit between institutions and ecosystems dynamics (Olsson et al., 2007). However, challenges for adaptive governance in addressing complex and uncertain environmental issues is to be prepared for incremental, rather slow moving change as well as rapid, unpredictable events (Gupta et al., 2010). Non-hierarchical, polycentric, and multi-level decision making including local, regional,

national and global powers, are often highlighted as crucial characteristics for addressing unpredictable and fast moving critical changes such as floods or droughts. Here power and authority moves upwards, downwards and sideways, away from the central power (Olsson et al., 2007). Hence the role of networks and their ability to enable interaction between individuals, organisations, agencies and institutions at multiple organisational levels is crucial for adaptive governance (Rijke, unpublished manuscript). At the same time, institutions must be robust enough to deal with strategic long-term management in relation to slower moving more predictable change (Olsson et al., 2007), such as the impact of temperature changes on the water cycle. In order to organise for both types of event, the institutional dynamics within the water cycle must balance centralised and decentralised control (Hatfield-Dodds et al., 2007; Duit and Galaz, 2008). Finally, the role of a leader has been identified as central for adaptive governance, in that a leader has the role of securing resources, driving for change, showing a direction and encouraging others to follow (Gupta et al., 2010). Within the literature, the leader is often referred to as a champion which can be both an individual and an institution that works across multiple sectors to initiate change (Brown and Clarke, 2007). However, Brown and Clark (2007) highlight the fact that it is not the champion in isolation that fosters change, but rather the interplay between the enabling contexts, which has shaped, constrained and enabled change and the champion.

Although it has achieved recognition in the academic literature, adaptive management and adaptive governance have frequently been criticised for being too detached from 'real-life' problems and consequently face a range of barriers in terms of implementation (Medema et al., 2008). For clarity, the term adaptive management will be used for the rest of the document to cover both adaptive management and adaptive governance. First, management frameworks are often designed within a scientific discourse, meaning that the designer and the local implementer of the framework are rarely the same. Though rarely developed without practice in mind, such separation of science and practice can be problematic because adaptive management as often portrayed in the literature seeks to produce generalisations rather than alternatives fit for the local context (Bosch et al., 2003 in Medema et al., 2008). Second, adaptive management primarily draws on rational choice theory in understanding institutional dynamics (Hatfield-Dodds et al., 2007). A collective approach of rational choice, defined as 'institutional choice' by Ostrom (1990:192), relies on individuals or institutions to act in a rational manner. According to Galaz, (2005:569) rational choice is based on the idea that 'each actor has a set of preferences and is engaged in a 'game' defined in terms of the relationship of their preference orderings. This 'game' describes the structure in which each individual finds him- or herself. The expected result occurs because rational actors, knowing their own ordering of preferences and the structure of the game, will play to achieve the best payoff given these circumstances'. However, rational choice theories have been profoundly criticised because they assume that the individual will make a rational, deliberate decision based on self-interest, which neglects decisions made out of habit and routine, and leaves out other types of motivation for action such as altruism (Knamiller and Sharp, 2009). Further, people are not completely free to choose, rather it is institutional dynamics that enable and constrain action (Shove, 2010). Consequently, the adaptive management literature provides insights into characteristics, but offer little insight into the role played by institutional dynamics in the process of becoming more adaptive to climate change within the water sector. Third, adaptive management frameworks fail to deal with value plurality of stakeholders (Walker 1997 in Medema et al., 2008). Adaptive management make claims about the most appropriate way to organise for sustainable management of water and highlight key characteristics such as learning, experimentation and certain structures described above. Although, the governance element as a concept has been introduced to deal with conflicts

due to value differences amongst individuals and/or organisations it does not suggest how these differences are manifested and play out and how they influence strategies put forward for climate change adaptation. Further, the approach is normative in assuming that a common vision and shared interest with regards to an envisioned water future exists (Berkhout et al, 2004). Rather it is crucial to be open to a diversity of futures and the different values, interests and problem framings that exist within and between institutions in the process of moving towards a more adaptive water future. However, these different visions of the future in turn influence how adaptive strategies of response to climate change are coordinated and justified (Smith et al., 2005). Thus, the adaptive capacity within the water sector to respond to climate change impacts will depend upon the different assumptions underpinning climate change threats (and opportunities) across and within institutional arrangements.

Hence, in this report we do not seek to define *the* adaptive management framework for Wales, but the aim is rather to identify dominating frames underpinning how water ideally *should* be managed in Wales according to a range of organisations. Drawing on a number of cases, the report investigates how these frames play out in policy and practice, and how they may influence adaptation to climate change in Wales. Once the major frames are recognised water management institutions can then collectively identify conflicts, discuss the appropriate balance of frames and identify strategies for Wales in order to cope with current and future climate change impacts.

3 Methodology

3.1 Interpretive research

The research presented as part of this report is underpinned by an *interpretive* understanding of knowledge, focusing ‘on meaning that is situated in a particular context’ (Yanow, 2003: 228) and acknowledges the subjective nature of real world problems (Davenport and Anderson, 2005). This approach differs from and is argued to be incompatible with traditional, so called *positivist* science (Sharp, 2011). A positivist approach is “characterised by a belief in an independent and objectively accessible world and by the pursuit of explanation through general laws describing regularities in nature and/or society” (Connelly and Anderson, 2007: 213). In contrast, interpretive research examines how phenomena are understood by relevant actors, and how these different understandings and values play out in terms of policy and practice to produce ‘rich’ and ‘situated’ narrative accounts. Interpretive approaches challenge positivism in arguing that the researcher-narrator can never stand completely outside the story they are representing, hence emphasising how our research too is part of the process of system reproduction and change. Interpretive research may generalise through theorising rather than through quantification and predictions; however, such generalisations are not the primary aim. Rather, its rich narratives are valuable because they ‘clarify and deliberate about the problems and risks we face and (...) outline how things may be done differently, in full knowledge that we cannot find ultimate answers to these questions or even a single version of what the questions are’ (Flyvbjerg, 2001: 140). Because interpretive approaches do not offer predictions they leave decisions open to debate among politicians and decision-makers according to their values. The stories they tell help everyone consider which values are reproduced by which policy practices and this is the key area of their contribution.

3.2 Case study approach

Case studies are often used to produce knowledge as part of interpretive research. Case studies offer ‘concrete context-dependent knowledge’ (Flyvbjerg, 2006:224) and are useful for capturing complexities and contradictions that happen ‘on the ground’. Hence, qualitative methods as applied in this report rarely aim to quantify findings in a generalised, statistical way, but rather allow for the development of a deeper understanding of climate change adaptation in a particular context. In using case studies, they not only illustrate what happened, but also why and how it happened and why alternatives failed to happen and for what reasons. The case studies drawn on in this report are ‘exemplifying’ (Bryman, 2008) with ‘the objective [...] to capture the circumstances and conditions of an everyday or commonplace situation’ (Yin 2003:41). Hence, the cases do not seek to illustrate typical cases that can be generalised, but seek to illustrate examples of water management actions or strategies from which we analyse adaptation to climate change in Wales.

Our case study investigation of adaptation focuses on water management in Wales, and in particular, that occurring within the geographical area served by DCWW. The scope and range of water management activities within the DCWW area, however, clearly meant that it was impractical to carry out a comprehensive study of all relevant activities. Instead, we sought to ‘drill down’ in specific policy and practice areas and hence to undertake a number of ‘cases within a case’. These ‘case studies’ were selected from a long list of potential cases, which were

initially identified by DCWW in dialogue with the research team. This process was iterative and new cases were added to the list over time. The list was then tested against a set of criteria defined by the research team and DCWW. For example, each case was expected to give insights into climate change adaptation, while the set of cases as a whole needed to include some in which DCWW interacted with other important stakeholder organisations. Details of the case study selection process are available in Appendix 1.

As a result of the selection process seven different cases covering longer-term water management strategies, innovative initiatives and critical events were identified. By covering a range of water management activities, which spans a variety of time scales and involves multiple organisations, the set of selected case studies is believed to aid our understanding of climate change adaptation in Wales. Figure 1 illustrates the case studies including the ‘big case’, which investigates overall strategies and structures in place for climate change adaptation in Wales, and the six specific strategy and implementation cases.

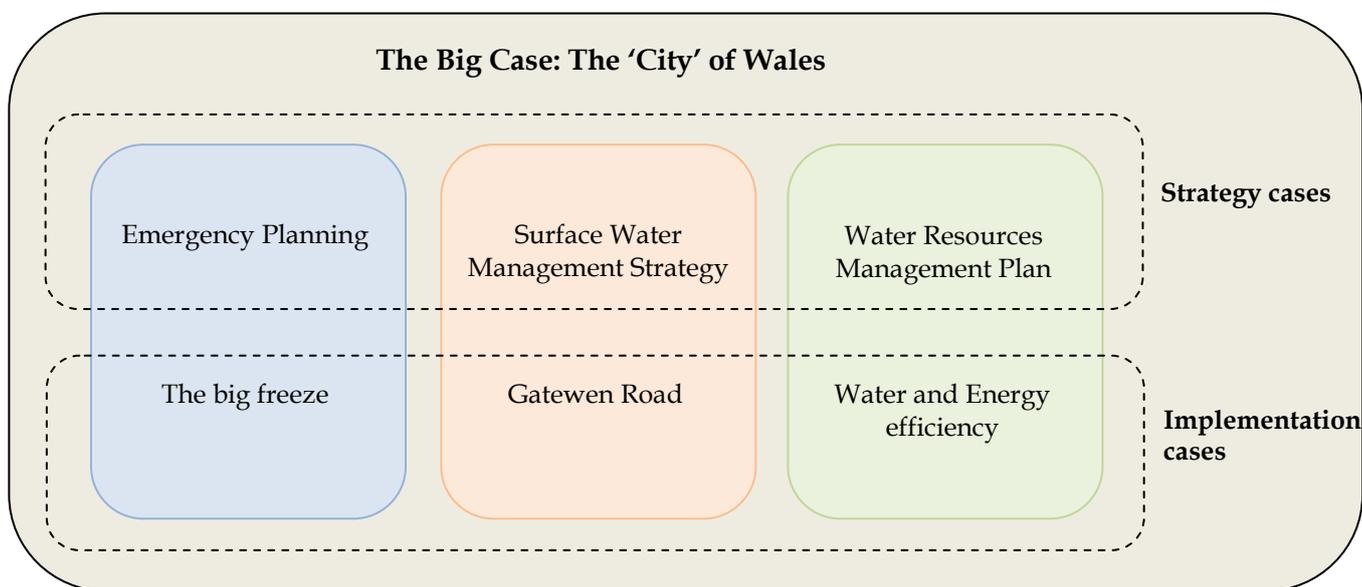


Figure 1. The seven case studies selected to aid our understanding of climate change adaptation in Wales

However, in this report we draw on four different cases to identify and illustrate the framework influencing climate change adaptation in Wales. The first case refers to Wales in general (the big case). The three other cases discussed in this report cover the Surface Water Management Strategy (SWMS) accompanied by the implementation case of Gatewen Road, and the Big Freeze (implementation case only). The specific cases are introduced in the results and analysis section (section 5) of this report and the interviewees and document reviews carried out as part of each case study are described in the section below. Case study interviews for other case studies which had been completed before the 1 September 2011 have been included in this write up as part of the analysis of the ‘big case’, but the individual cases are not discussed in detail here.

3.3 Data collection and analysis

In order to develop the framework and gain a deeper understanding of how Wales is preparing for climate change, semi-structured interviews were carried out with respondents holding key roles within organisations with an interest in water management. Semi-structured interviews are designed to aid an understanding of the respondent's perspectives, rather than to make generalisations about behaviour. Such a method follows an interpretive approach in seeking to unpack different concepts that underpin perceptions and values. The technique is based on open-ended questions and the interview is structured as a conversation, allowing for additional questions or subjects to be discussed (Denscombe, 2007). In this sense, what is and what is not important information is not pre-determined by the interviewer, but becomes apparent as part of the interview. In addition to the interviews a number of key documents from a range of water related organisations were reviewed. The aim of these reviews was to gain insight into how water management and adaptation to climate change are communicated and prioritised within organisations or in the public domain. However, like interviews, documents do not objectively represent the organisation, but rather presents a position for how some people perceive the world. Hence, documents are not a representation of an organisation's routine, negotiations and decision making process (Denzin and Lincoln 2003) but could reveal new insights about the organisation (Coffey, 2011) not gained from the interviews. Table 1 details the data collection methods which have contributed to the analysis reported below.

Table 1. Summary of the case studies, interviews conducted, organisations represented and documents reviewed.

Case study	No of interviews & interviewees	Represented organisations and interviewees	Documents reviewed
The big case: the 'City' of Wales (and total)	29/33	DCWW (20), Welsh Government (2), Environment Agency Wales (1), ENTEC consultancy (1) MWH consultancy (2), COSTAIN consultancy (1), AECOM consultancy (1), Landowner (1), BSP Consulting (1), Bloor Homes developer (2), Wrexham County Borough Council (1)	DCWW (2007) Our Sustainable Future DCWW (2010) Adaptation to Climate Change. Draft report DCWW (year) Draft Water Resources Management Plan DCWW (year) Surface Water Management Strategy - Phase 2 Welsh Government (2010) Climate Change Strategy in Wales. Welsh Government (2006) Environment Strategy in Wales Environment Agency (2010) Managing the environment in a changing climate OFWAT (2006) Preparing for the future - Ofwat's climate change policy statement
The Big Freeze	5/5	DCWW (5)	Response to Severe Weather - December 2010 (Final Draft) Update on the Response to Severe Weather - December 2010
The Surface Water Management Strategy	4/5	DCWW (4)	DCWW (2010) Surface Water Management Strategy - Phase 2 DCWW (2007) Our Sustainable Future
Gatewen Road	9/8	DCWW (4), BSP Consulting (1), Bloor Homes, developer (2), Wrexham County Borough Council (1)	Specific scheme documents

The interviews were primarily conducted with one interviewer and one interviewee and lasted between one and two hours. In some interviews more than one interviewer or interviewee was present. All interviews were recorded, fully transcribed and coded using the software NVivo 9 to underpin an iterative thematic analysis based on the overall aim of the research. The same coding structure and iterative analysis process was applied to the document reviews. The coding of the data emerging from the interviews and documents enabled different themes and subcategories underpinning water management ideals in Wales to be identified. These themes formed the *frames* underpinning water management and adaptation aspirations, which will be described later. The subcategories represent *characteristics* typical for each frame. These themes (frames) and subcategories (characteristics) are constructed 'interpreted abstractions' (Strauss and Corbin, 1990: 145), which 'reduces data from many cases into concepts and sets of relational

statements that can be used to explain, in a general sense, what is going on' (145). The coding process of defining the themes and categories was highly iterative in removing repetition, or filling in thinly developed themes or categories through further 'theoretical sampling' (Strauss and Corbin, 1990: 161).

The analysis was validated by comparing it to the interview transcripts and through extensive discussions within the research team. In addition, the analysis and results were validated through follow up discussions with interviewees and other individuals representing organisations with an interest in climate change adaptation in Wales. These discussions were structured around a workshop held in September 2011 with the aim to discuss and reflect upon the analysis and results of the research leading to the initial framework. All interviewees were invited to the workshop and invitees were also encouraged to circulate the invitation to colleagues they believed could be interested in contributing to the discussions. In total 65 people were invited and 25 people attended. 17 of the attendees represented DCWW and the remaining attendees represented the Welsh Government (3), Environment Agency Wales (2), The Consumer Council for Water (1), MWH engineering consultancy (1) and AECOM engineering consultancy (1). The discussions during the day have influenced and slightly modified the initial framework in terms of definitions used and key characteristics underpinning each frame identified. For example, the frames were initially referred to as 'visions', which was changed because this was perceived as something aspirational and not something underpinning decisions regarding water management today. What is later described as the 'market frame' was originally referred to as 'competition'. However, this definition was proved to be too narrow because it was used interchangeably with OFWAT's plans of increasing competition in the water industry in England and Wales, which only refers to parts of the frame. The way in which certain aspects or frames were referred to caused confusion and highlighted the importance of language in the way in which people make sense of the world. In general the view was that the four frames underpinning water management are represented in Wales and that no frames were missing. Although validated through an iterative analytical process and through extensive discussions between academics, practitioners and policy makers, further validation in terms of the wider academic literature forms an important next step of the research, potentially supporting the application of the framework beyond the DCWW area in which it was developed.

4 Framework to aid understanding of climate change adaptation in Wales

In the next section the frames underpinning water management and climate change adaptation in Wales are introduced. These frames are empirically grounded, meaning that they emerged from the analysis of the conducted interviews and reviewed documents. Hence, they were not theoretically predefined and tested through the interviews, but followed an inductive approach of generating theory from empirical findings. Frames or 'ideal types' are constructed to understand what is going on and to create meaning to what other people do. These constructions emerge from everyday experience, knowledge and common sense understandings and are used to structure our everyday reality (Burrell and Morgan, 2001:245).

Below, the frames of water management in Wales are introduced. A reflection, in terms of adaptation mechanisms that each frame is likely to promote and prioritise, is also included. In the second part of the result section, we draw on the 'big case' and the three specific case studies to illustrate the framework. As a result of the case study research four distinctive frames regarding how water ideally would be managed in Wales emerged. These frames are referred to as: *Market*, *Environment*, *People of Wales* and *Technocracy*. The frames are described in more detail below, firstly in terms of their main characteristics, and secondly in terms of adaptation mechanisms promoted by each frame.

It should be noted that there is a significant strand of research which looks at different future scenarios in order to check whether policies are resilient to different futures (e.g. Ashley and Tait 2011; Leach, 2011; SPRU, 2002). On a superficial level, the set of frames in the framework below appears similar to a set of future scenarios. Two crucial differences should be noted, however. First, whereas scenarios are different possible futures, the frames are observable and present in water management today. Second, whereas scenarios refer exclusively to changes in the external social, economic and physical environment, frames are concerned what is going on within DCWW and their stakeholders as well as the external drivers of change, they therefore describe what is occurring internally as well as externally.

4.1 Market

The Market frame argues that a free market, which enables the customer to choose freely where and by whom they wish to buy their water services from, will result in a better management of the resource. Water and drainage services are seen as tradable commodities which through competition will result in a service of higher quality at a lower price. The customer is only using as much water as they wish to pay for. The belief is that only a strong economy can provide social and environmental improvements. The Market frame is characterised by being highly target-driven and seeks defensible and cost-effective solutions to water management issues based on robust evidence. Water companies should provide the customer with the level of service that they need and should fulfil expectations. Such an approach would therefore produce new resources in case of deficit, rather than use demand management to safeguard current resources. Water services should however be used efficiently and this is to be incentivised by economic measures. What customers need and want is defined through the concept of serviceability.

As the name implies, the Market frame relies on the market for successful climate change adaptation. One example of such market approach is carbon-trading with the aim to reduce carbon emissions and climate change impacts. Companies can then trade carbon quotas within a limited system. The Market frame is based on a rational-choice model where it is believed that individuals act according to economic incentives. In a drought situation for instance the frame may push for compulsory metering to save water. The logic is that if individuals pay for what they use, they will be incentivised to save water through lower bills.

4.2 Environment

The Environment frame argues that water is a precious resource and part of our natural capital, which we have a responsibility to protect and improve as part of the ecosystem for its intrinsic values. Hence, the activities of water management should not only seek to minimise the environmental impacts, but strive to improve the environment in which it operates. It is believed that social well-being and economic development is only possible within a sustainable environmental framework. The frame advocates the precautionary principle in that measures that cannot be proven to have no adverse effect on the ecosystem should not be implemented. Like the Market frame, the Environment frame is underpinned by an evidence approach, but evidence is sought about how to protect ecosystems rather than in order to identifying the most cost-effective solution. A better understanding of impacts from water management practices on ecosystems is aspired for. The frame takes a strong holistic approach in that water management cannot be separated from other socio-technical systems such as energy.

Climate change adaptation is at the heart of the Environment frame. Climate change poses severe threats to ecosystems and must therefore be addressed through adequate adaptation measures. It is the responsibility of all water users to protect the environment and become more adaptive. However, the water industry's role of supplying people with water services has particular responsibilities in assuring that their activities do not harm the environment and addresses future climate change threats. Water demand initiatives and enhanced environmental protection measures are advocated to prevent damage to natural water resource. However, although water and the environment is everyone's responsibility to protect and improve, the frame trusts 'experts' to identify the best actions to be taken, and then to educate the public with the aim of changing their behaviour. The environment frame advocates stricter regulation to ensure that ecosystems are not declining in the face of climate change.

4.3 People of Wales

The People of Wales frame would argue that water is a human right, which should be safe and reliable for people regardless of socio-economic circumstances. Delivering this public service characterised by good quality, fairness, and water services to an affordable price is therefore central. It is believed that Wales has a great environment and creates a special sense of place that everyone, as a community, should (and will) respect and protect. Water efficiency is promoted in order to free up more water for Wales as a whole. However, in contrast to the previous frames, such approaches are community orientated instead of encouraging individual consumers to save water. Rather it is the responsibility of the people of Wales together to protect and maintain the water environment. The water industry and associated institutions represent

the people of Wales and aspire to policies and practices that provide well-being for Welsh communities, now and for future generations.

Adaptation to climate change is a shared responsibility where organisations work collectively to address challenges caused by climate change. Rather than educating the public about how to act, the frame encourages transparent and more involved water management by all participants. Members of the public are perceived as an equally important institution compared with other organisations with a stake in water management and are empowered to take action for the collective.

4.4 Technocracy

In the Technocracy frame water is an asset to be managed to secure human demands for water supply and drainage. The frame is supply orientated, in terms of both the provision of potable water and of drainage capacity, and it is the responsibility of the technical experts to make sure that these supplies are continuously provided with minimum interruption. Technical solutions are used to address potential issues such as flooding or potable water shortages. The water industry's highest priority is to respond to the customers' needs in terms of water supply and drainage.

In terms of adaption, climate change impacts are believed to be predictable. They may be uncertain, but this uncertainty is taken into account as part of the predictive models. Once the future is known, appropriate technology and technical innovation can be identified and applied. The role of the public is limited because with new techniques there is no need to change behaviour. Consumer orientated 'fix and forget' technology is applicable such as low flush toilets or more energy efficient dishwashers. In contrast to the Environment frame, Technocracy seeks to adapt to climate change through efficiency to secure a constant supply, not necessarily to protect the natural environment or consider socio-economic needs.

4.1 Frames influencing water management and climate change adaptation in Wales

Emerging from the empirical study of water management in Wales, this section has introduced a set of frames underpinning the overall framework, which are summarised in table 2. However, these frames are 'ideal types' and one frame or type does not represent the situation in Wales. Rather, these frames are all represented in current water management policies and practices in Wales and will constantly be negotiated and renegotiated. Hence, the balance of these frames is constantly changing. In turn, this negotiation of balance will influence how the water sector in Wales is currently adapting to climate change and how strategies for the future are defined. Below, the framework is applied to the four case studies to illustrate how the frames play out in policy and practice influencing climate change adaptation.

Table 2. The set of frames constituting the framework, their main characteristics and primary adaptation mechanisms

FRAME	SUSTAINABLE	WATER AND DRAINAGE	PUBLIC	NATURE	RESPONSIBLE	PRIMARY ADAPTATION MECHANISMS
MARKET	Economic driven	Commodity	Customer	Nature for people to exploit	Market through the individual	Economic incentives for behaviour change
ENVIRONMENT	Environment driven	Natural capital	Exploiter	People are stewards of nature	Everyone using water	Regulation to ensure no adverse effect on the environment
PEOPLE OF WALES	Social driven	Human right	Citizen	People are part of nature	Everyone collectively	Collective inclusive action for the benefit of people in Wales
TECHNOCRACY	System driven	Source of demand	Demander	Nature as an asset to fulfil demand	Experts	Prediction and technical innovation to address anticipated impacts

5 The framework illustrated through four case studies

In the following section the framework is illustrated through the four case studies drawn on in this report (The big case; the Big Freeze; the Surface Water Management Plan and Gatewen Road). The cases described below will be discussed in relation to the frames and how they influence motivation and decisions as part of the process. How motivations and decisions underpinned by the frames enable and hinder adaptation to climate change in Wales will also be discussed in the three specific cases.

5.1 The big case: The 'City' of Wales

Rather than referring to a specific strategy, initiative or place, the big case investigates overall management structures currently existing in Wales. Hence, these strategies and structures include internal DCWW information and interviews as well as external information influencing DCWW provided by for instance the Welsh Government, Environment Agency Wales and OFWAT.

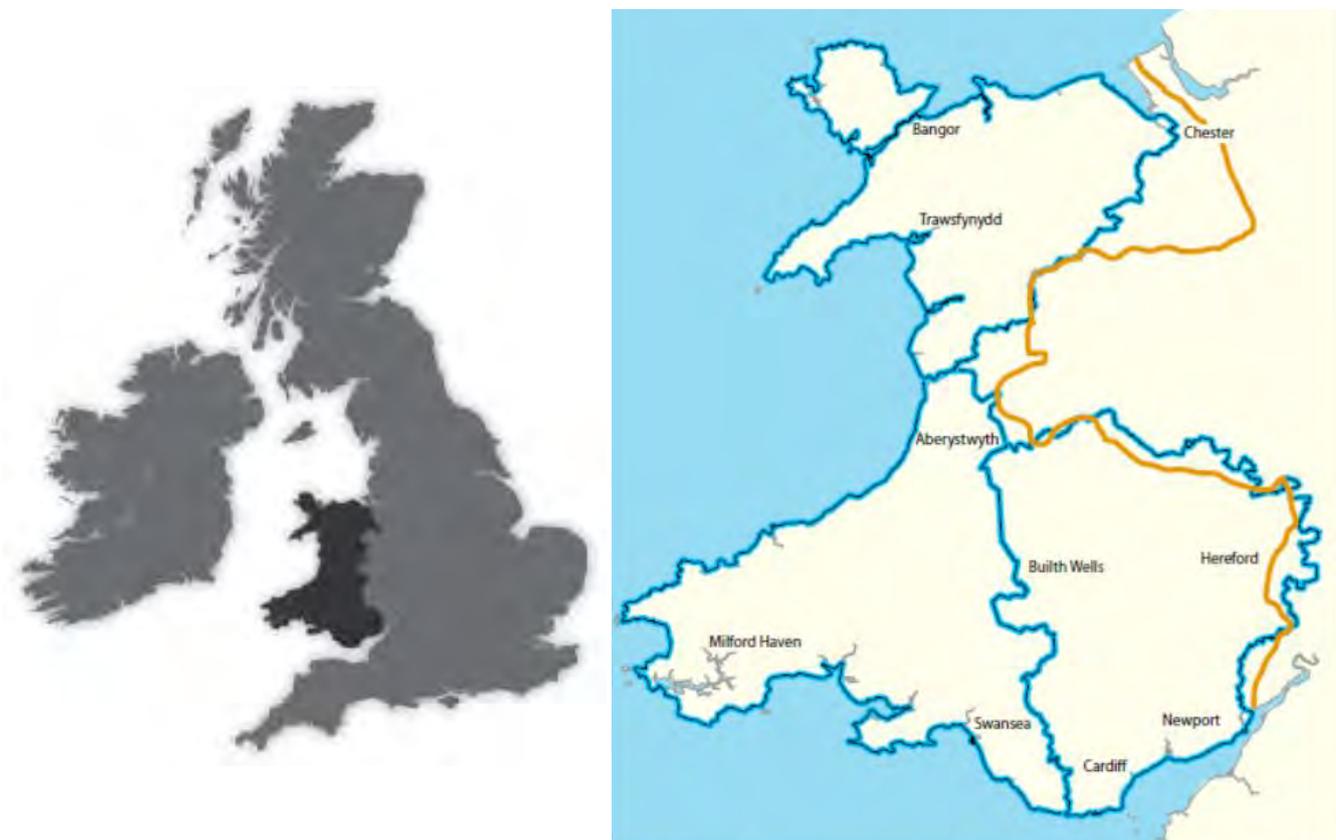


Figure 2. Maps of the UK and DCWW's service areas in Wales and England. Blue lines refer to water operating boundaries and orange lines to waste water operating boundaries.

The water and sewerage authorities were privatised in Wales and England in 1989 as part of the UK Government's 'privatisation programme' (Bakker: 2003:8) of national utilities such as gas, electricity and telecommunications. The rationale for water privatisation was the perceived 'state failure' (Bakker, 2003: 6) in which an inefficient public sector had been unable or unwilling to finance necessary infrastructure investment. The privatisation of the water and sanitation sector meant that an earlier focus on social equity diminished, while new priority was given to achieving efficiency (Bakker, 2003).

The newly formed water companies were and still are subject to a stringent central government economic and environmental regulatory framework, however. The water companies do not own the water or the infrastructure to supply and remove water but they hold 25 year licences to supply water services within specified spatial boundaries. There are three main authorities regulating the water industry in England and Wales, focused on the environment (the Environment Agency and the Environment Agency Wales (EAW)), economics (OFWAT), and the quality of drinking water (the Drinking Water Inspectorate (DWI)). In addition statutory legislation requirements are set by the Welsh Government in Wales and by DEFRA in England. In 2000 DCWW sought and gained permission to transfer their operations into a not-for-profit company owned by the customers rather than by shareholders. DCWW is the only not-for-profit company in England and Wales but currently remain subject to a similar regulatory framework as the other water companies.

5.1.1 The big case illustrated through the framework

Although all of the four frames are present in current water management structures in Wales, particular internal and external pressures pulling water management in different directions have been identified. For instance, the People of Wales frame is particularly encouraged both in terms of Welsh government policies and within DCWW structures. In their current water policies (e.g. Welsh Assembly Government, 2006) the Welsh Government for example seek to move away from the Market frame in considering not only cost-effective initiatives to climate change adaptation in monetary terms, but highlights the importance to also consider wider environmental and social benefits not easily measured and how Welsh communities can become more involved in and benefit from particular decisions. In the interviews with government employees it became clear that the currently promoted increased competition in the water industry in the UK, meaning more freedom for the individual customer to choose from which company to buy their water services from, with the purpose to reduce bills, were not perceived to be beneficial to Welsh communities. This market driven approach is hence not considered with the same enthusiasm in Wales as it currently is in England. Support for the people of Wales frame was also found internally within the organisation of DCWW. For instance, the importance of delivering a good service to people in Wales is very much ingrained in the DCWW culture. This importance became particularly clear through analysing the Big Freeze case introduced below. Likewise, the Technocracy frame can be seen as firmly embedded within the organisation and procedures of DCWW, this is apparent for example in the approach to water resource management which has tended to focus on the identification of more sources of water rather than processes of demand management.

Although the culture of DCWW and employees of the water and sewerage company have some (albeit constrained) ability to influence the balance of frames through the activities they

undertake, there are external pressures present, which to a large extent determine this balance and hence influence the environment within which DCWW is working. The Market frame has a current strong influence on the water industry in the UK as a whole requiring water management initiatives to be cost-efficient and valuable for the individual customer in monetary terms. These approaches make innovative initiatives such as encouraging communities to collectively be more involved in water management activities, often difficult to quantify in strict monetary terms, challenging to justify. An example of such innovative approach that failed to move forward due to insufficient evidence of the benefits is addressed in the case considering the Surface Water Management Strategy below. At the same time, the Environment frame is of strong influence in a European context where more stringent regulation (e.g. the Water Framework Directive, the Habitats Directive) in order to protect and improve water resources clearly influence water management in Wales as a whole and DCWW as a water and sewerage company. In the three cases below we seek to analyse the balance of these frames and how they influence adaptation to climate change in more detail.

5.2 The Big Freeze

According to Meteorological Office data, December 2010 was the coldest December on record in the UK. The temperature fell to minus 17.5°C in parts of Wales on the 20th of December, this event had considerable impacts on water and wastewater networks. However, the most severe impact took place over Christmas when temperatures went from minus 10°C to plus 10°C in the space of 24 hours resulting in five times the quantity of normal bursts and leaks on the water mains and peak demand for water resulting in increased works throughput. Due to network issues and consequently loss of water, DCWW could not meet the current demand. However, the problem for people's own pipe-work and plumbing was worse. Many properties were unoccupied over Christmas and New Year which meant that many were unaware of burst pipes on their properties. During the holiday period Welsh Water customer households were affected by loss of supply, the most significant local event being loss of water to 3700 properties due to the distribution service reservoir. One of the largest lessons learnt identified by DCWW was the inability to answer telephone calls from customers in relation to the freeze. During some days as many as 9,000 customer calls were unable to get through to customer services and those who did often had a long wait (Perry, 2011).

Although the Big Freeze caused disruption to the networks and posed a major challenge for the water and sewerage company, less than 0.01% of the customers were affected by failures from DCWW. According to one of the managers interviewed DCWW coped with the situation due to decisions taken early on in the process that in retrospect proved to be decisions which avoided a much more serious situation developing. One major decision taken early in the process, was to move into 'Gold' (the highest level of emergency status) from the very start of the process. Mobilising to Gold meant that the Operation Director took part in conference calls twice a day. This close communication enabled the director and his management team to recognise quickly that their problems had a common cause and consequently ensuring that remedial strategies were co-ordinated and consistent between regions. The recent reorganisation of DCWW where a high proportion of operational resources were brought back into the water & sewerage company from a previously outsourced business model is also believed to have contributed to the successful management of the emergency events. Having core business functions in-house aided quick responses and mobilisation. In addition, the experience and knowledge of the

DCWW staff and available short-term capital were other critical factors, mentioned during interviews to have influenced the responses to the Big Freeze.

The 'Big Freeze' case offers a good example of a weather related emergency, which are believed to be likely to increase in Wales due to climate change impacts in the future. Hence, learning to adapt to these types of critical events is crucial for overall adaptation to climate change in Wales. Through the case of the Big Freeze we examine the interactions and decisions that allowed DCWW to emerge from the events without major impacts on its operations or on the service it provides. How DCWW has applied lessons learned from the events to future planning for climate change adaptation and the limitations that may prevent them from doing so is also investigated. Finally, the underlying assumptions in terms of the frames introduced as part of our framework relating to how decisions were made are considered.

5.2.1 The Big Freeze illustrated through the framework

A key priority for DCWW during the Big Freeze events was to keep the perceived good relationship with their customers and to ensure the best possible outcome for those affected. According to one manager, the water and sewerage company has a legal duty to provide safe drinking water to the taps of its customer 24 hours a day, seven days a week without interruptions. If the provision of water fails, it is publicised and means that the reputation of DCWW is at risk. However, the drive for satisfying its customers could be underpinned by a number of frames. In terms of Technocracy as part of a traditional view of the roles of technical experts and lay people in perceiving the water and sewerage company as experts responsible to provide services to less skilled and knowledgeable people. Or underpinned by a Market frame to satisfy the economic regulator OFWAT and ensure a 'good' score in their assessment of water companies based on customer satisfaction underpinned by the concept of serviceability. Although other frames did influence the decisions taken regarding customer satisfaction, the most dominant was the People of Wales frame. During the event there was a general feeling of wanting to do their absolute best to ensure minimum disruption to people. One manager mentioned that DCWW employees felt personally responsible for fixing the problems and worked very long hours during the Christmas holidays to achieve the best possible outcomes for the customers. In addition, the drive to do a good job was underpinned by the need to deliver a public service rather than to fulfil a paying customer's demands, which is in line with the frame of People of Wales. Although a too strong focus on reputational factors risk outweighing long-term concerns such as climate change (Berkhout, 2006), a good relationship to the customer or members of the public in general could build a platform for a more inclusive role of members of the public in working collectively for adaptation to climate change in the long run. The People of Wales frame advocates that everyone, experts and lay people collectively need to meet the challenges of climate change and become more adaptive.

During the emergency events and as a result of the evaluation post the event, the value of DCWW's human capital was well recognised within the organisation and should not be underestimated in favour of technical infrastructure. Institutional barriers to the efficient management of emergencies frequently occur in all organisations (Hersh and Wernstedt 2002); they can therefore be partially addressed through the knowledge and commitment of DCWW employees. It is also generally believed that since the big freeze DCWW has become better in learning from emergencies and incorporated more training events to prepare for future critical events such as freezing conditions, flooding or dry periods. For instance by increasing their

incident preparation exercises conducted in a year. However, whilst institutional factors were highlighted as key component to managing the Big Freeze effectively and with relatively few incidents given the circumstances, the learning incorporated from these events were primarily focused on technical solutions. Hence, DCWW appear to follow the People of Wales frame in valuing human capital, cooperation and a closer engagement with the public to cope with emergencies such as the Big Freeze, but at the same time believing that technical fixes alone such as addressing leaks and bursts and broken equipment alongside buying more cold-weather-appropriate vehicles are adequate adaption measures. These findings support the view that in terms of climate change adaptation DCWW are highly influenced by the Technocracy frame underpinned by traditional engineering ideas of responding to customer's needs in terms of water supply and drainage through technical solutions. The technical solutions were also put in place to fix specific issues related to the Big Freeze rather than seeking to address long-term climate change impacts. This is not surprising given that past strategies to improve environmental performance in systems have been heavily influenced by technological efficiency and innovation (Guy et al., 2001) not least in the water industry (Ellis and Revitt, 2010). However, from an adaptation perspective short-term fixes restricted by technological innovation could pose constraints on future adaption since they usually fails to recognise social and environmental factors.

The findings from the research also indicated that measures to tackle future emergencies and adapting to challenges such as climate change are influenced by frames not necessarily drawn on within the organisation. For instance the requirement to produce a 5 year business plan from the economic regulator OFWAT is believed to hinder long-term adaptation measures. One interviewee highlighted the contradiction of on the one hand being encouraged to produce a 25 year long-term plan, but only being allowed to implement initiatives that can be funded and delivered within the 5 year business plan timescale. These deliverables draw on narrowly defined cost-benefit analyses, which are problematic to apply to less certain longer-terms adaptation strategies. In this case, the regulator is underpinned by the Market frame where water is a tradable product of high quality at a low price with very tightly defined bounds on expenditure and charging within each 5 year period. The price is often defined as a tangible factor in monetary terms, which risks hindering the full potential of adaptation measures to be considered within DCWW.

If not incorporated into future emergency strategies, key learning from the event also included institutional rather than technical barriers. The relatively low public awareness of their roles and responsibilities in the event of burst pipes was identified. As mentioned above very few of the incidents were caused by faults from DCWW, but occurred on people's private systems, which is the responsibility of that individual. However, the public awareness of the individual responsibilities for water infrastructure such as pipes was low and the problems were perceived by the customers to be the role of the water and sewerage company to fix. Hence, adapting to more frequent events such as the Big Freeze should not only be the responsibility of DCWW, but customers need to be made aware of their responsibilities when emergencies occur. A bigger push must be made to encourage homeowners and businesses to address and take care of their own pipes in terms of pipe protection and appropriate depth of lay. Being a not-for profit company, DCWW could take advantage of their strong customer focus and draw more firmly on the People of Wales frame in including members of the public into adaptation measures. The engagement could be extended to broader adaptation initiatives not only related to weather emergencies but also include longer term strategies for climate change adaptation in Wales as a collective responsibility.

In terms of motivation DCWW are strongly underpinned by the People of Wales frame. The water and sewerage company is not for profit and strive to do what they believe is best for their customers and for Wales as a whole. A strongly committed workforce during the emergency event witnessed a great concern for the customers. Wanting to maintain good relations with their customers provides opportunities for a more inclusive water management approach, where experts and lay together tackle climate change impacts. Such approach could partly help to address the often perceived and encountered institutional barriers to climate change adaptation. However, according to Ellis and Revitt (2010) the water industry is predominantly emphasising technological issues rather than institutional barriers. This was also found in the study of the Big Freeze. The response to the key learning from the events primarily followed the Technocracy frame. In terms of adaptation, these responses risk to increase the vulnerability to climate change for DCWW. The technocracy frame relies on the fact that climate change impacts are predictable within definable bounds of uncertainty, which is a dangerous simplification. To become more adaptive to climate change, DCWW need to invest in long-term strategies and not solely respond to past experiences. A more holistic approach is also required, rather than focus on freezing conditions in isolation from other potential emergencies. However, long-term adaptive often uncertain approaches are difficult to justify financially. Regulators primarily supporting the Market or Environment frame require cost-effective solutions proving no adverse effect on the environment, which rarely goes hand in hand with innovative adaptation strategies. The fixed five year investment plan was also identified as a barrier to climate change adaptation amongst the interviewees. Hence, regulators need to work closer with the water companies to better understand their needs in terms of adaptation, whilst at the same time protecting the customers and the environment.

5.3 The Surface Water Management Strategy

In contrast to the Big Freeze case study, the Surface Water Management Strategy (SWMS) does not cover a particular event, but is an example of a longer-term strategic case study. In terms of this case, we have firstly analysed the strategy through the framework and secondly through a site-specific case illustrating a mechanism through which the strategy may be implemented.

The SWMS was developed to address the increasing flows of surface water into the foul and combined sewer network. When the capacity of the sewerage network is exceeded this can lead to flooding of properties and pollution occurring to rivers and streams.. The key aim of the strategy is to ‘raise awareness of the issue and enable engagement with interested bodies, in order to work together to deliver a solution’ (DCWW, no year: 2). Initially, the strategy sought to introduce four pilot study areas in partnership with local authorities with the purpose of implementing different sustainable drainage techniques. The pilots were supported by the Welsh Government and intended to be part funded through European Grants. However, the remaining funding for the four pilot areas and associated initiatives was not approved by the economic regulator, Ofwat, because they were perceived not to provide clear quantitative benefits for customers. Instead, Ofwat agreed to allow Welsh Water funding to remove a set number of properties (133 properties) from the existing (once in five years) flooding register using Surface Water Elimination and Reduction (SWEAR) techniques¹ over a five-year period. In

¹In this report we refer to sustainable drainage systems or ‘SuDs’ defined by the UK National Standards for sustainable drainage as ‘an approach to managing rainwater falling on roofs and other surfaces through a sequence of actions. The key objectives are to manage the flow rate and volume of surface runoff to reduce the risk of flooding

this sense it was possible to quantify the benefits that customers would receive in return for the required investment.

5.3.1 *The Surface Water Management Strategy illustrated through the framework*

The driver for the emergence of the SWMS was primarily justified by the interviewees and document reviews through the Environment and the People of Wales frame. Due to stricter environmental regulation from the mid nineties and onwards in the UK and the EU as a whole, water companies were no longer entitled to discharge the same amount of surface water runoff into rivers and streams in order to provide better environmental protection. Hence, the strategy partly emerged to address new regulatory demands. The strategy was also believed to provide wider environmental benefits than reduced pollution such as reduction in potable water use, energy consumption and, in turn, a smaller carbon footprint. However, the main aim of the strategy is to increase the awareness of surface water runoff and its associated problems and the strategy and its implementation is believed to highlight an often forgotten part of the business². Instead of being perceived as something unpleasant, surface water runoff and drainage could if managed on the surface provide an amenity to communities, for instance in terms of ponds and increased green space. Such features provide a clearer picture of what is going on with drainage in contrast to pipes under the ground where water is discharged and forgotten about.

The idea of engaging organisations with a role in water management and members of the public in surface water drainage follows the People of Wales frame, which would promote a more active engagement role in water management. Initiatives such as collecting rain water or reusing grey water could be promoted as part of the strategy and increases the involvement of households in managing their own water. However, the people of Wales frame would encourage such initiatives if they were motivated through a collective belief that this will benefit the environment and Welsh communities, rather than promoting individualistic measures to reduce surface water runoff.

An additional motivation to develop the SWMS according to the interviewees was to move away from the Technocratic frame, which has historically dominated, and to some extent still dominates, the water industry. In this sense, the strategy emerged from the perceived increase in uncertainties surrounding future weather conditions and climate change impacts in particular. Because the future capacity needed is impossible to predict, traditional solutions such as larger pipes and tanks to store water are not perceived to be appropriate and would potentially be too costly in the long term. In contrast, if surface water was instead removed from the system, determining future capacity requirements would be done in a different way. However, removing surface water has its own issues including where to store and discharge the removed runoff and infrastructure issues such as how to maintain and clean the pipes when a reduced amount of water is flushed through the systems. It also transfers more direct responsibility to individual property and house owners. Issues aside, the SWMS provides an alternative to purely

and water pollution. SuDS also reduce pressure on the sewerage network and can improve biodiversity and local amenity' (Defra, 2011:4). Hence these systems are not necessarily sustainable in scientific terms and are not subject to sustainability assessments. See Defra (2011) National Standards for sustainable drainage systems – Designing, constructing, operating and maintaining drainage for surface runoff at <http://www.defra.gov.uk/consult/files/suds-consult-annexa-national-standards-111221.pdf>

² See for example: NAO (2004) Out of sight - not out of mind. Ofwat and the public sewer network in England and Wales. National Audit Office. Report By The Comptroller And Auditor General. HC 161 Session 2003-2004: 16 January 2004 Ofwat (2011) < <http://www.ofwat.gov.uk/future/sustainable/drainage> > accessed November 2011

technocratic solutions and recognises that technology alone cannot provide climate change adaptation in Wales.

Although the strategy primarily draws on the environment and people of Wales frames, there is an apparent gap between vision and implementation of the strategy. The original idea of introducing four pilot studies failed to get funding approved by OFWAT in the Price Review process 2009. In this sense the strongly evidence-based market frame which encourages cost-efficiency hindered the full potential of the strategy to be realised. However, here costs and benefits are narrowly defined in monetary terms by the regulator which traditionally has failed to fully include wider social and environmental costs and benefits. The rejection of the original pilot studies replaced by a much more target driven and quantifiable approach could potentially hinder long term adaptation to climate change. However, a number of interviewees did indicate that OFWAT has somewhat softened in their views and is now requiring similar approaches by other water companies to the one DCWW originally proposed to go forward. This means that the dominating market frame may have weakened in terms of the management of surface water.

The gap between strategy and implementation is also nourished by a dominating Technocracy frame. Despite a belief amongst the interviewees that technical solutions alone will not help Wales to adapt to climate change, there are few examples in Wales where alternatives to traditional technical solutions have been exercised. Below a specific case study which did implement an alternative SuDS scheme is introduced. As part of this case the main barriers in relation to the framework to implement such schemes more effectively will be discussed.

Moving away from approaches underpinned by a technocratic frame in recognising that technical solutions are not the answer to addressing future issues such as climate change has the potential to strengthen adaptation in Wales. However, for the strategy to become realised and to benefit from its full potential there is a need for a re-balancing in terms of the currently dominating frames. For instance a strong technocracy frame or inflexible cost-benefit analyses underpinned by the market frame would potentially fail to recognise the wider benefits of alternative more flexible techniques compared to traditional pipes and infrastructure, and hence risk hindering adaptation to climate change. At the same time the implementation of schemes to realise the strategy must become more efficient in the way in which they help prepare for future climate change impacts. As one interviewee put it 'we are not designing for climate change, we are making the system climate change-proof'. However, for this ambition to be realised on the ground the People of Wales and Environment frame need to become more dominant. The People of Wales frame supports fewer and lower technical solutions and more active involvement of the public and other organisations, which are both perceived to be elements required if climate change adaptation were to be acted upon in relation to surface water management in Wales. The Environment frame would highlight wider benefits of sustainable drainage initiatives in terms of environmental quality and also act as an aid to achieve statutory environmental targets.

Although SuDS are infrequently implemented in Wales today the next section draws on a specific case study where a sustainable drainage system is currently being implemented as part of a housing development in North Wales. This case study 'Gatewen Road' provides a good example of a mechanism through which the SWMS is being implemented.

5.4 Gatewen Road

The Gatewen Road scheme is a private housing development consisting of 236 homes on a brown field site in Wrexham, north Wales that was a former colliery. The development faced issues in relation to surface water drainage from the site. The main issues relate to the local public combined sewer, which lacks capacity during heavy rainfall events leading to flooding. Due to planning conditions attached to the development's planning permission the developer needed to ensure necessary upgrades to the sewer network to accommodate the additional foul flows emanating from this development. There is a watercourse bordering the site but it is not possible to dispose all of the surface water to this receiving body due to the difficult topography and the potential disruption to a nearby sensitive environmental area. Rather than connecting to the public sewer, the alternative was to implement a sustainable drainage system (SuDS) for the disposal of surface water, with only minimal flows being discharged to the local watercourse. The disposal of surface water from the fully developed site will be provided by a combination of SuDS and other techniques which include house soakaways, a retention pond and a detention basin. In addition, rain water harvesting units will be fitted to 10% of the developments properties. Further, 'low flow' water efficient fittings will be built into each of the properties within this development.

In addition to all organisations being in favour of the site drainage scheme, the water and sewerage company (DCWW) agreed to take ownership of SuDS components after the construction. Ownership post implementation is a common issue in promoting sustainable drainage techniques, with no single authority being responsible for their adoption and maintenance. Traditionally SuDS solutions have been considered to be outside the remit of a water and sewerage company, with maintenance responsibility often falling to a private management company, which the residents would pay for. As a result of these adoption arrangements the SuDS at Gatewen Road is seen as a unique and relatively rare project of its kind. The adoption of SuDS components on this site served as a valuable demonstration of how a water and sewerage company can facilitate a more sustainable drainage approach. However, DCWW has yet to repeat this adoption on other development sites.

The Gatewen Road scheme represents an example where a range of organisations worked collaboratively to support and implement a sustainable drainage system on the site. The scheme was also overseen by organisations such as the Environment Agency Wales and the Country Council for Wales. The organisations may have had different motivations and aspirations for the site drainage, but what they had in common was that this alternative served to be the most suitable approach for the disposal of surface water from the site. Drawing on this case we explore the main enablers and barriers to implementation of sustainable techniques such as those implemented as part of the Gatewen Road development. In addition, we investigate what frames are dominating in terms of enabling and hindering SuDS schemes and what this means for adaptation to climate change.

5.4.1 Gatewen Road illustrated through the framework

The Gatewen Road case study including the SuDS implementation is a collaborative scheme between DCWW, Wrexham County Borough Council, Bloor Homes Developer and BSP consulting. A key reason for the implementation of the scheme was a common belief that a SuDS

system was the most appropriate solution for the particular development. However, the motivations for the project varied and were underpinned by different frames described as part of the framework. DCWW welcomed the scheme because it was seen as a good practice example in implementing their Surface Water Management Strategy (SWMS) and to illustrate a more sustainable approach to its customers and regulators. As part of their current business plan commitment DCWW are required to demonstrate 133 cases where surface water elimination and reduction solutions are used to alleviate sewer flooding. It also offered a good opportunity to increase other organisations' awareness of sustainable drainage. From a customer point of view, it illustrated that the water and sewerage company was putting words into action and translating the strategy into practice. DCWW also had a more practical motivation for supporting the scheme in preventing more surface water runoff into the public sewer. Hence, their motivation for the project was underpinned by a combination of the Market, People of Wales and Technocracy frames. The developer from Bloor Homes however had a purely economic motivation for the scheme to go ahead. In line with the Market frame the developer agreed to the implementation of the scheme because it was believed to be the most cost-efficient solution for this particular development. Any developer is also required to consider sustainable drainage alternatives in line with UK planning policy, which would primarily be promoted by the Environment Frame. However, drainage was seen as an insignificant aspect of the development and SuDS could potentially be a risk if it impaired the saleability of the properties. Wrexham County Borough Council on the other hand followed an Environmental frame and supported the scheme as being in line with the priorities of the Environment Agency Wales and the Countryside Council for Wales. The main motivations for the Council were to follow regulation in terms of local sustainable development objectives and protection of the watercourse from flooding and pollution. In addition Wrexham County Borough Council sought to enhance biodiversity by creating new habitats as part of the scheme. BMP Consulting's interest drew on the Technocracy frame in arguing that the scheme was physically and financially viable and on the People of Wales frame in seeking to provide added amenity benefits for the community.

However, given that schemes such as the Gatewen Road case are rare the next section introduces a number of key barriers identified through the interviews as part of this case as to the more frequent uptake of SuDS in Wales for increased adaptation to climate change. First, the roles and responsibilities of agencies towards adopting SuDS are unclear. There is no organisation that has a statutory requirement to own and maintain sustainable drainage schemes. Although these responsibilities could fall on local authorities or water and sewerage companies, there are no financial incentives to undertake such a commitment. However, SuDS Approval Bodies (SAB) are expected to be introduced under 2012 legislation, which makes the Lead Local Flood Authorities accountable for SuDS and their maintenance. However, the question remains with regards to how this new role for Local Authorities is to be funded and how to make sure that adequate expertise is in place. Resource issues aside, the SABs would provide one statutorily responsible body which would address the current uncertain authority for SuDS adoption and maintenance. Second, SuDS are believed to be less predictable in terms of their long-term performance, which makes traditional techniques such as pipes, and responses underpinned by a Technocracy frame perceived to be a more reliable option. However, climate change impacts are also uncertain and difficult to predict (Hall, 2003 in Duit and Galaz 2008), which make current technological solutions not as reliable as presumed and generally less adaptive to future scenarios. Third, all interviewees perceived cost-efficiency as one of the greatest barriers to the implementation of sustainable drainage techniques. This concern follows the Market frame in defining costs in tangible monetary terms. Costs in this sense are often short-sighted and

potential future cost to the environment or society is rarely incorporated in the concerns. The developer expressed concerns about the SuDS and how they are perceived by the residents. SuDS were also believed to take up valuable space where another property could have been developed. As a result, the SuDS were not promoted as a benefit in the local area. In contrast, DCWW believe that SuDS can have a positive impact on the saleability of the properties. According to the interviewees, people are becoming more aware of climate change impacts and want to act environmentally so there is an opportunity to use sustainable drainage techniques as a positive aspect of a housing development.

Through this case it has been illustrated that despite that the collaborating organisations drawing on different frames, the shared goal of implementing the SuDS realised the scheme. In other cases, the incompatibility of the frames may not reach such a favourable outcome and may suggest that the differences in frames hinder such projects to be consistently rolled out. It has also highlighted key barriers to implementation of SuDS in other cases underpinned by the frames. For instance, if the Market frame is too dominant, it is challenging to prove the tangible benefits of sustainable drainage. On the other hand, if the Technocracy frame is primarily drawn upon, it may hinder innovation and alternative techniques to be considered. In contrast, the frame of People of Wales and Environment could enable alternative drainage techniques to become the norm rather than a rarity. Although if the anticipated roll-out of the new Water Management Act is delivered as expected, this will in any case, become mandatory³. In drawing on People of Wales, any organisation involved in water management needs to communicate the wider benefits of sustainable drainage techniques and encourage the more active involvement of local residents and communities. Regarding the Environment frame, more stringent environmental legislation may constrain traditional techniques by demonstrating that in whole life performance and benefit terms they are too costly.

³ Defra (2011) National standards for sustainable drainage systems. <http://www.defra.gov.uk/consult/files/suds-consult-annexa-national-standards-111221.pdf>

6 Implications and conclusion

This report has demonstrated that the way in which water management is framed in Wales and how these frames are played out and influence climate change adaptation. In most cases, a combination of frames is drawn on in particular situations or points in time. Hence, the balance of frames can both hinder and enable climate change adaptation responses over short or long time scales. The balance of frames appropriate in one context or at a specific point of time may not be suitable in other contexts. Although this research and the development of the framework presented in this report has drawn on Wales as its geographical focus and DCWW as its context, similar frames are likely to be found in other countries and contexts. Frames presented in this report may not be applicable in all cases, and there may be other frames more appropriate for other particular cases. What the cases have in common however is that one single shared framing of adaptive water management rarely exists, rather a range of different rationalities are continuously being negotiated, renegotiated and played out in policy and practice. The contribution of this research is therefore not to define the right balance of frames for a particular context, for which policy makers and practitioners collectively are better placed to work out. Rather, the key message is that these frames must be articulated and made explicit, instead of remaining implicit parts of the processes of water management and adaptation to climate change. When organised within an over-arching framework, these frames define an analytical tool through which contradictions and alignments can be identified as part of collectively negotiating a strategy for climate change adaptation in any given context.

In this report we have introduced four contrasting frames that have been found to drive water management and consequently climate change adaptation strategies in Wales by DCWW and a wider group of stakeholders. These have been illustrated through a range of case studies, covering different scales, types and areas of the water sector addressed by DCWW. However, an important contribution of such a framework is to reflect upon how such an analytical tool can be used in practice by water management organisations to support their work in becoming more adaptive to climate change. Therefore we end this report with setting out our future work within the Prepared project and the implications for adaptive water management as a consequence.

Although we have identified the four frames and through the different case studies reflected upon how the balance of these frames play out in different contexts, we have not entered into extensive discussions about whether the current balance between these frames is the right one in terms of climate change adaptation in Wales. We have avoided this because our interpretive research approach is one which says that academics do not necessarily know best, but that water management organisations are in the best position to determine the balance appropriate for the specific contexts. However, we think our insights can help organisations to make the appropriate judgements. Therefore, we seek to use the frames as a means to, within teams based on our case studies, facilitate conversations about what water management organisations are doing at present and raising questions about what they want to do in the future. These conversations may include questions such as: what is the current balance for this context? Is this the right balance? Does it address adaptation to climate change in Wales? How can the frames be re-balanced to better address climate change adaptation in Wales?

An output from such a process could be a figure identifying the different weights of the individual frames and how these weights are represented externally to the case and internally within the case. Figure 3 gives an example of how such a figure of the weighted frames may be

designed and provides a visual means of communicating the findings of a case study to the team concerned. A workshop with the team could be used both to confirm that the understandings conveyed are a good depiction of the current state of play within the case, and to facilitate discussion of whether the current balance of frames is appropriate. However, such figures are not intended to demonstrate an absolute balance in quantitative terms but give an indication of the relative balance between the contrasting frames.

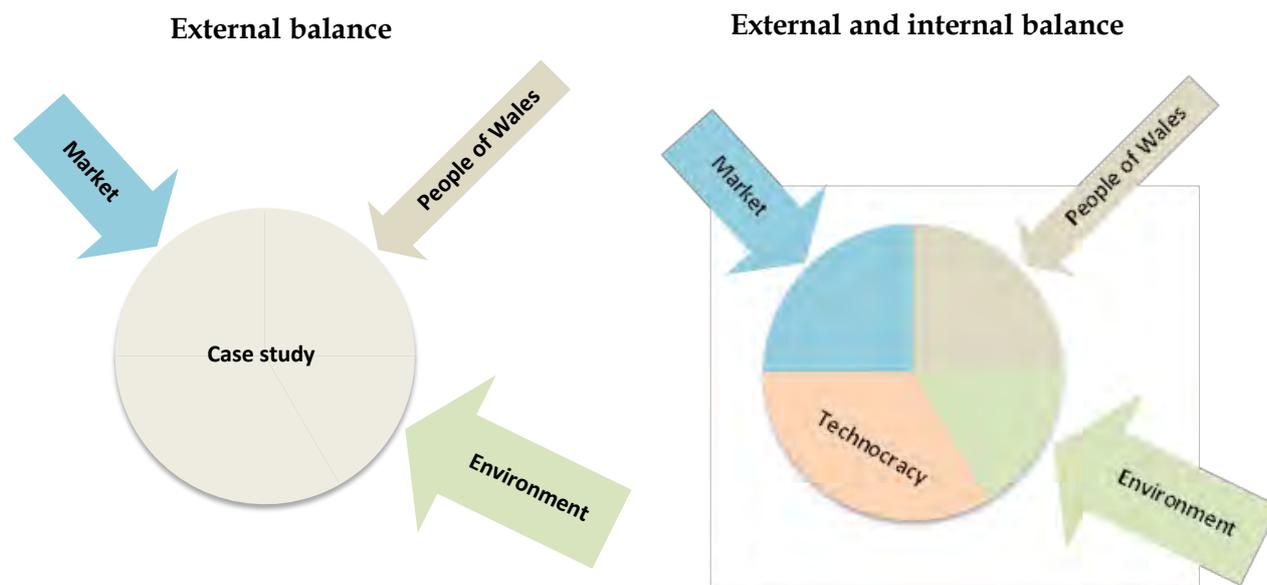


Figure 3. Visual representation of external and internal balance of frames for an example case

The above figure illustrates that the relative balance of the frames may be different depending on whether the pressures are external to or internal within the case. In the example above the external pressures from the Market and Environment frame is dominating. However, due to the internal culture of the organisations influencing the example case, the technocracy frame is dominant within the case although not apparent as an external pressure. In identifying the external and internal pressures and balances, organisations can establish what pressures that can be tackled in order to move towards a different balance and areas which are more difficult to influence upon as an individual organisation. Once the current external and internal balance has been identified a specific action plan supporting organisations to move towards the perceived right balance can be developed. The perceived 'right balance' will depend on both what the team regard as a necessary balance to address the external pressures, and the actions and emphasis which they would like to embrace collectively as a guide to their route forward. The actions identified to move towards this 'right balance' are also determined by the specific case and the scale of the case and can include both organisational and technical actions. For example an action could be to develop a common adaptation strategy for Wales across water management organisations, or using technologies in a different way. Likewise it may include establishing new partnerships to address external pressures in order to become better at adapting to climate change. However, it is important that the current and aspired balance is not perceived as a static process but these conversations need be iterated into the process of moving

towards a balance that aid adaptation to climate change. In figure 4, the identification of the balance of frames and its application is summarised.

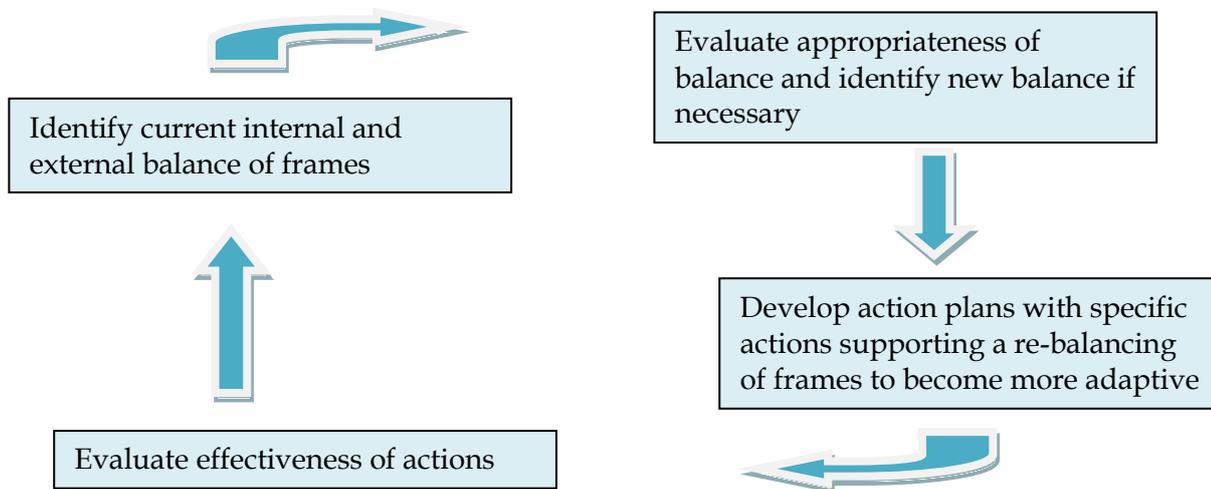


Figure 4. Summary of the iterated process of moving towards a balance that aid adaption to climate change

The PREPARED project expects to support water organisations in Wales in a first iteration of all the steps shown on Figure 4. If the project is successful, the same organisations may wish to develop further iterations of the same processes as they develop specific strategies and working practices to adapt to the impacts of climate change.

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8 Appendix A: Case study selection process

Case study research is a useful approach for capturing complexities and contradictions that happen 'on the ground'. It does not only answer the question of what happened, but also why it happened and how and why alternatives did not occur. A central question to any case study research is what the case seeks to represent. In our work we will draw on a range of cases that will help us tell a narrative about structures and processes that are in place to enable adaptation to climate change and other challenges. From our perspective a case is anything that can help us build up a picture of how water management is currently perceived to deal with stressors such as climate change and how it can be managed differently in the future. A case can therefore represent: i) a specific location in Wales where the water cycle is believed to be particularly impacted by climate change impacts or other stressors; ii) a specific initiative taken to respond to an unforeseen critical event, such as a flood (short-term response); iii) a specific initiative taken that seeks to manage water differently in order to address future stressors such as climate change (long-term influence); iv) a policy that seeks to influence practice with regards to how water could be managed differently in order to address future stressors to the water cycle.

Case study criteria

In order to cover a full range of aspects to inform our understanding of adaptation in Wales the set of cases must:

1. Tell us something about adaptation in Wales (existing or non-existing, effective or non-effective)
2. Cover different aspects of the business
3. Involve a range of different stakeholders
4. Include a degree of external stakeholder input
5. Be planned interventions or an intervention in process
6. Cover a range of types in terms of:
 - a. Locations
 - b. Initiatives (planned internal initiatives and external events that are non-controllable)
 - c. Timings of initiatives
7. Provide accessible information (documents, people)
8. Include opportunities potentially arising from climate change
9. Address interdependency issues

Case study long list

Through discussions with a range of employees from DCWW the following case studies were originally identified:

<ul style="list-style-type: none"> • SWMS – focus on history and process • SWMS – focus on planning processes and engagement / change in local councils • Water resource management plan (Draft version coming out March- April) • Deep freeze over Christmas and its impact • Cefni Anglesey ('doing' catchment activity in very small catchment on Anglesey. Project Countryside Council for Wales) • Drought plan • Consultation on the 'Living Wales: A natural environment framework' • Adaptation report 	<ul style="list-style-type: none"> • SWMS – specific location • SWMS – catchment focus • SWMS – charging strategies • Above/below ground assets • Adoption of private sewers • Sewer abuse project • The Sustainable Land Management Scheme Glas tir
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Selection process

1. A number of likely cases from the long-list to be studied as part of PREPARED based on the interests of Bradford, INSA and DCWW were first identified. Institution responsible for each case in brackets.

The Water Resource Management Plan (Bradford)

Surface Water Management (INSA) including:

- Surface Water Management Strategy: History and process
- Development control
- DG5 process

Emergency planning through the 'Big freeze' case (Cardiff MA(s) and Bradford)

2. The criteria identified by Bradford and DCWW were grouped into individual case criteria (i.e. criteria that every case need to fulfil) and group criteria (i.e. criteria that the set of case studies need to fulfil). A number of criteria originally identified by Bradford

and DCWW were believed to be more applicable for the 'big picture' case study and therefore not included in the first case study selection process.

Individual case criteria	Group criteria	Big picture case criteria
<ol style="list-style-type: none"> 1. Inform on adaptation in Wales 2. Accessible information 3. Likely to have impact on current management 4. Applicable to other cases 5. Present anticipation of change - (cases where there is a wish to/need to do things differently) 	<ol style="list-style-type: none"> 1. Cover different aspects of the business 2. Involve a range of different stakeholders 3. Include planned or in process interventions 4. Cover range of strategic and operational perspectives - short-medium-long term 5. Address interdependencies issues (tactical) 	<ol style="list-style-type: none"> 1. Include future challenges and opportunities from CC 2. Cross over adaptation work in different sectors of the business 3. Address interdependency issues (strategic)

3. The identified case studies were firstly tested against the individual criteria with the result that each case successfully fulfilled the criteria.
4. The set of cases were tested against the group criteria with the result that all the criteria to a certain degree were met. The selected cases cover different aspects of the business in terms of water supply and drainage (criterion 1), include a range of stakeholders throughout (criterion 2) and cover both strategy and operational cases (criterion 4). However, the one aspect in particular missing from the selected cases is water treatment. As a consequence, particular stakeholders might be excluded from the research. Hence, to fulfil criterion 1, treatment will be investigated to some extent in relation to the 'big picture' case study concerning adaptation in Wales, and might lead to an additional case study.
5. As a result of the Bradford selection process the following case studies were selected:
 - Surface Water Management Strategy
 - Water resource Management Plan
 - Emergency planning

6. A separate selection process through which each listed case were assessed against each of the criterion were undertaken by DCWW resulting in the selection of the following cases:
 - Surface Water Management Strategy
 - Private sewer transfer
 - Water Resource Management Plan
 - Drought Plan
 - Emergency planning

7. Although the case of private sewer transfer did obtain a high score in the selection process, it was decided not to be considered in the first case study phase due to not fulfilling the overall criterion of contributing *to the understanding of adaptation in Wales*. The drought plan will be covered to a certain degree in the water resource management plan case study and will not be considered as an individual case study. The result from the combined selection processes results in the following cases to be considered:
 - Surface Water Management Strategy
 - Water resource Management Plan
 - Emergency planning

8. Once the overall case studies were selected and agreed upon, more detailed cases within each of the areas were identified. This process was led by Bradford, but DCWW provided crucial input throughout the process. The final case study areas and specific cases selected are as follows:
 - Surface water management
 - Surface Water Management Strategy: History and process
 - Development control process
 - Water resource management
 - Water Resource Management Plan: History and process
 - Water efficiency case
 - Emergency planning
 - The big freeze