MaRIUS

Managing the risks, impacts and uncertainties of droughts and water scarcity

Workshop documentation

15 September 2016

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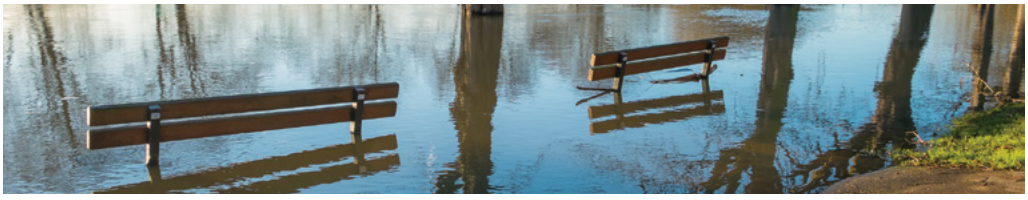
Scenario workshop:

Resilient drought and water scarcity management in England and Wales in 2065



UNIVERSITY OF OXFORD

CSLS

Contents

1 Introduction and background

One element of the MaRIUS project is to explore and review options for drought management practice in England & Wales beyond the existing regulatory framework and to discuss qualitatively the potential effectiveness of and constraints upon these options with stakeholders. For this purpose, an explorative scenario building workshop was chosen. This is based on the assumption that it benefits the whole project to have different scenarios for drought and water scarcity management available. The explorative scenario building method offers:

- the possibility to develop explorative scenarios for drought management
- the opportunity for unconstrained blue sky thinking about drought management options based on the question What can happen?
- to be useful in cases where there is fairly good knowledge regarding how the system works at present, but one is interested in exploring the consequences of alternative developments in drought management

In order to include and reflect the results of other MaRIUS workstreams about half of the workshop participants were researchers from the project. The other half of the participants was represented by water companies, water consultancies, the energy sector and representatives from the regulatory bodies DEFRA, EA and Ofwat. To a large extent the participants were recruited from the MaRIUS Stakeholder Advisory Group. The diversity of participants guaranteed that a comprehensive water expertise, ranging from policy, economic aspects, to modelling and water quality, was represented. The workshop took place on 15th September 2016 at the Centre for Socio-Legal Studies, University of Oxford.

Table 1. List of participants	
Name	**Institution/Organisation**
Gemma Coxon	University of Bristol / MaRIUS
Catharina Landstrom	University of Oxford / MaRIUS
Lola Rey	Cranfield University / MaRIUS
Mohammed Mortazavi-Naeini	University of Oxford / MaRIUS
Jianjun Yu	University of Oxford / MaRIUS
Kevin Grecksch	University of Oxford / MaRIUS
Ian Pemberton	Ofwat
Ben Piper	Atkins
Meyrick Gough	Southern Water
Neil Edwards	RWE Generation UK
Bill Baker	NERA
Sarah Heinemann	DEFRA
Victoria Williams	Environment Agency
Paul Crockett	Environment Agency

2 Method

Generally speaking, there are three different types of scenarios and scenario building methods that all try to think about the future in a structured way – prognostic, explorative and normative (cf. Börjeson *et al*., 2006). In this case an explorative scenario building workshop was chosen. Here the aim is to develop scenarios for possible trajectories and thinkable future situation. At the centre is the question "What can happen?" As opposed to prognostic scenario building exercises that try to map the future in a narrow corridor ("What will happen?"), in this case the future "space" is deliberately wide to allow for eliciting different thinkable futures. Normative specifications ("What should happen?") do not play a role or if at all only a minor role (Börjeson *et al*., 2006). In order to open up the currently constrained set of drought and water scarcity management options, thus being as explorative as possible, they were not suitable.

A precondition for the development of explorative scenarios is a fairly good knowledge of the subject – drought and water scarcity management. All participants fulfilled this condition by either being engaged in research on drought and water scarcity or by working on drought and water scarcity issues as a consultant, regulator or for a water company. There are other methods to develop scenarios, for example surveys or Delphi-methods. Yet, due to staff and time constraints these methods were not feasible. In addition, the workshop was conducted in a reduced timeframe. While usually two to three days are allocated to run the workshop, this workshop was completed within one day. This however implicated some methodological adjustments. The central steps of the workshop were as follows:

- definition of problem frame
- identification and grouping of influencing factors ("drivers") for future development
- selection of relevant drivers for scenario development
- scenario development
- scenario description

The last step, the scenario description, could only be touched upon during the workshop and was further elaborated in the aftermath of the workshop by the author.

Definition of problem frame

The first step defined the problem frame. The spatial dimension, “England & Wales”, was easily agreed upon, yet the temporal and topical dimension sparked some discussion. The decision to have 2065 as temporal dimension was based on water industry decision-making procedures around future planning and risk management. Some participants suggested two dates, for example 2040 and 2065. The first date would be about what needs to be put in place and the second would be about testing the legacy of what has been done against what has been expected over the longer time frame. However, having two dates as temporal dimension would have harmed the methodological feasibility of the workshop and was subsequently discarded. With regard to the topical dimension, the original proposition of “Resilient Drought Management” was amended to “Resilient Drought and Water Scarcity Management”. Water scarcity management was seen as broader and more complex than just focussing on responses to drought events, especially with regard to the long term perspective of the workshop. Eventually, the problem frame was also deliberately chosen as wide as possible to reflect future exploration, thereby including as many potential influencing factors as possible.

Table 2: Problem frame	
Dimension	Institution
Temporal	2065
Spatial	England & Wales
Topical	Resilient drought and water scarcity management

Identification of drivers and grouping

After defining the problem frame, the next step was to identify key influencing factors or drivers for resilient drought and water scarcity management. Participants were handed out five index cards each and were asked to write down, based on their knowledge and background, what they thought are the most important influencing factors or drivers with reference to the problem frame. Subsequently, each card was briefly discussed among all participants and thematically grouped. Ambiguous drivers were further differentiated or assigned to more than one thematic group. The following group headings emerged from the exercise:

- Policy
- Weather / climate
- Economic development
- Behaviour
- Environmental needs
- Intervention

All thematic groups and their assigned influencing factors can be found in Figures 1 to 6 in the next chapter.

Selection of relevant drivers

Four breakout groups were formed in next step and each group was assigned one or two thematic groups of drivers. At this stage of the workshop, the aim was to identify those drivers that are of a high importance for resilient drought and water scarcity management in England and Wales in 2065 and at the same time are characterised by high uncertainty with regard to them becoming effective or actually happening. The focus on important and uncertain drivers is made to satisfy the objective of developing explorative scenarios: generating a wide spectrum of thinkable and potentially highly relevant futures.

The influencing factors were placed on a two dimensional coordination system showing importance on the y-axis and uncertainty on the x-axis. At this stage participants were also free to add further influencing factors or differentiate existing drivers further. The total number of drivers was 59. Each breakout group presented its results to the audience. Based on that all participants decided upon which factors to take to the next stage of the workshop. This meant selecting the top right quadrant in each case as this reflects the factors that are potentially of high importance but also highly uncertain. Figures 1 to 6 show the selection for each thematic group. Table 3 lists all thematic groups and drivers. The drivers in the shaded areas are the drivers from the top right quadrant.

Noteworthy about the discussion are two points. First, the breakout group “Weather/ Climate” added arrows to its coordination system (fig. 2) to point out that some aspects, such as science, regional differences or changes in water quality were difficult to pin down to a certain point on the coordination system. The second discussion arose around the issue of “Funding for infrastructure”. While the “Policy” breakout group placed it as relative highly important and highly uncertain, others argued that the funding as such will not be uncertain but it is rather the source of funding that is uncertain. Another aspect that was discussed is that the intergenerational dimension of funding creates uncertainty. One participant however maintained the position that the cost of funding is of high impact but of low uncertainty (see Box 1).

A satellite image of a rare cloudless day across the UK

Box 1: Statement – Ian Pemberton (Ofwat) regarding funding of costs

I maintain my position that we are in danger of confusing between price caps being set below that required for efficient companies to meet statuary minimum levels of service (or more accurately customers being unwilling to pay for the enhanced levels of service proposed) and the item that card was put inside the high-high box which I believe was 'lack of availability of finance for infrastructure'.

For the avoidance of any doubt I am happy to agree that it has a high impact on drought resilience and whether the investment comes from todays or inter-generational customers, investors or government is uncertain – but I maintain my position that the overall availability of finance for continued supply of a fundamental resource cannot be uncertain. As a developed economy we will finance water infrastructure investment one way or another.

Let's consider a range of how the world might look in 2065 and why, in my opinion, availability of finance for infrastructure is low uncertainty:

Current position

Ensuring the finance ability of the industry is one of the fundamental rules of Ofwat. As long as we exist in our current form we would be failing in our duty if availability of funds for infrastructure prevented companies meeting the levels of service that we expect from them. In the status quo it is our responsibility to ensure that availability for finance for infrastructure is not a constraint.

One extreme

At one extreme it is re-nationalised. Bills will then be set by central government and the financeability of any investment is subject to normal Treasury pressures. In this case funding for infrastructure is limited by government policy – not availability of finance.

The other extreme

The other end of the spectrum they industry could radically evolve to become a free-market economy – supply and demand dictating price. In this world customers set the price point of the level of service they're willing to pay for. This has he potentially for neighbouring customers to receive different levels of service depending on their willingness and ability to pay. In this case infrastructure investment will be limited by customer willingness to pay, – again not availability of finance.

In truth, the most likely scenario will be a further development of opening the source to tap to source model – water resources, wholesale, retail, sludge with competition in each price control business unit. Something akin to the Rail industry – albeit I hope better than that model. This will still be regulated and we remain responsible for ensuring that availability of finance for infrastructure projects is not a constraint.

Figure 1: Matrix of influencing factors – policy

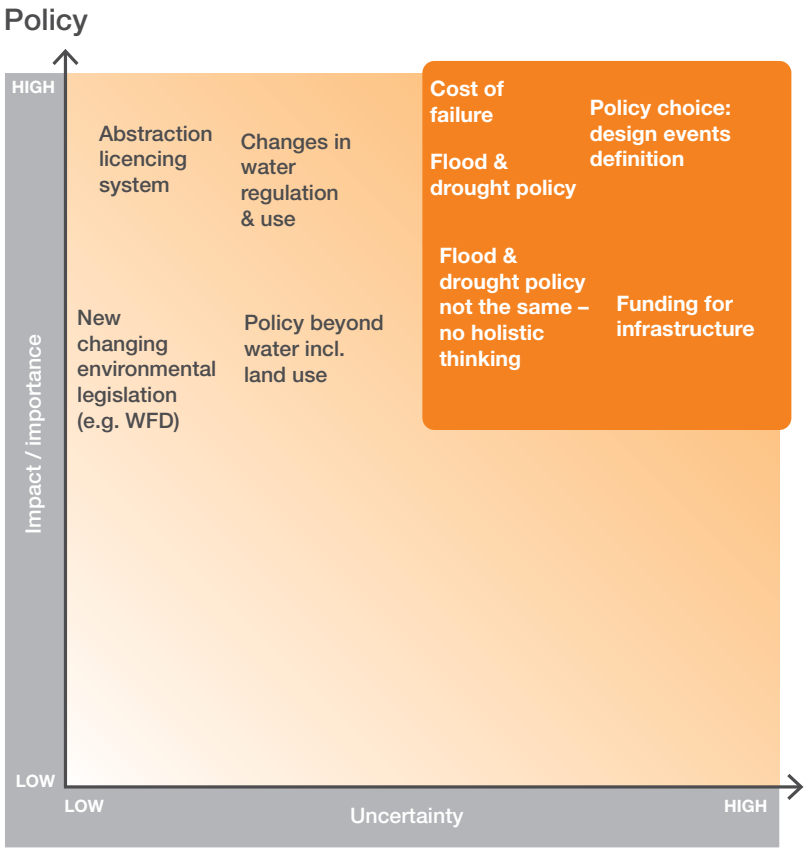


Figure 2: Matrix of influencing factors – weather / climate

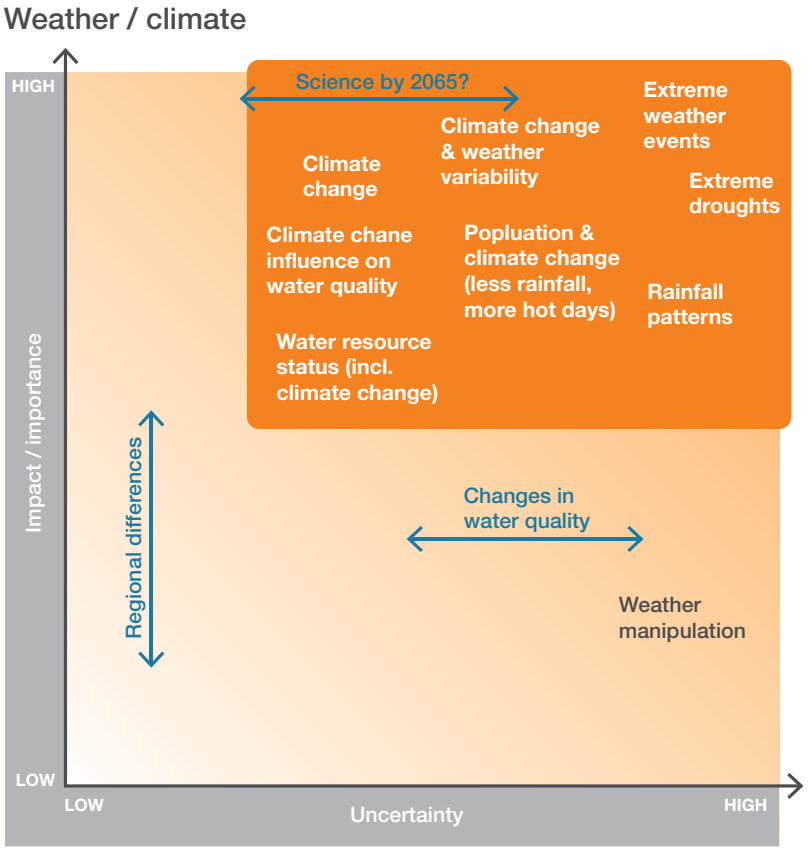


Figure 3: Matrix of influencing factors – intervention

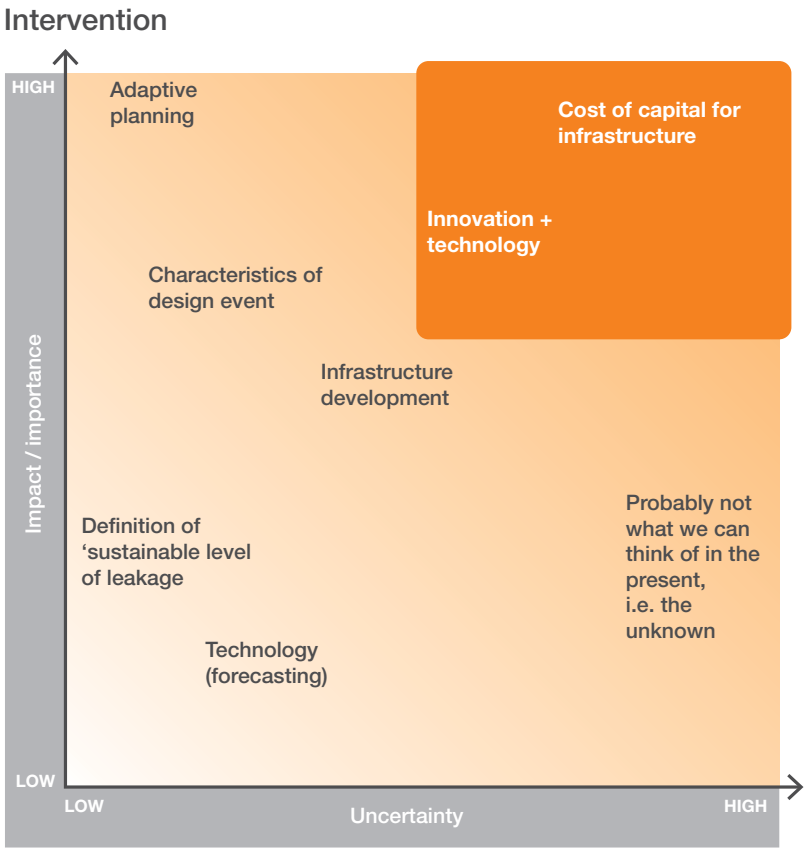


Figure 4: Matrix of influencing factors – economic development

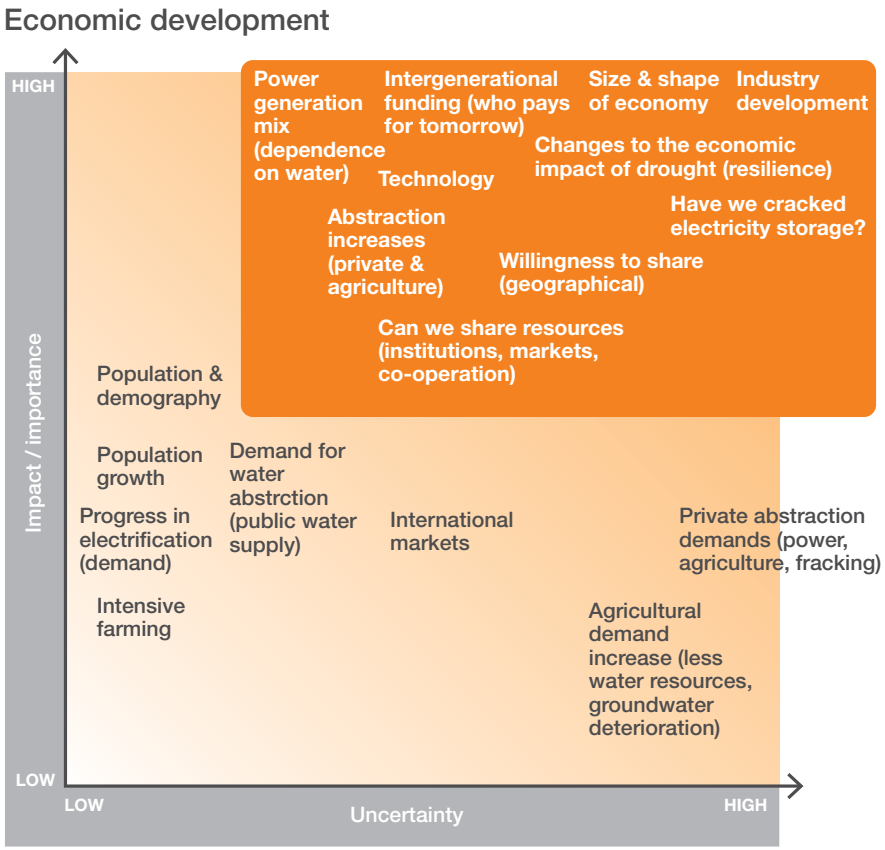


Figure 5: Matrix of influencing factors – environmental needs

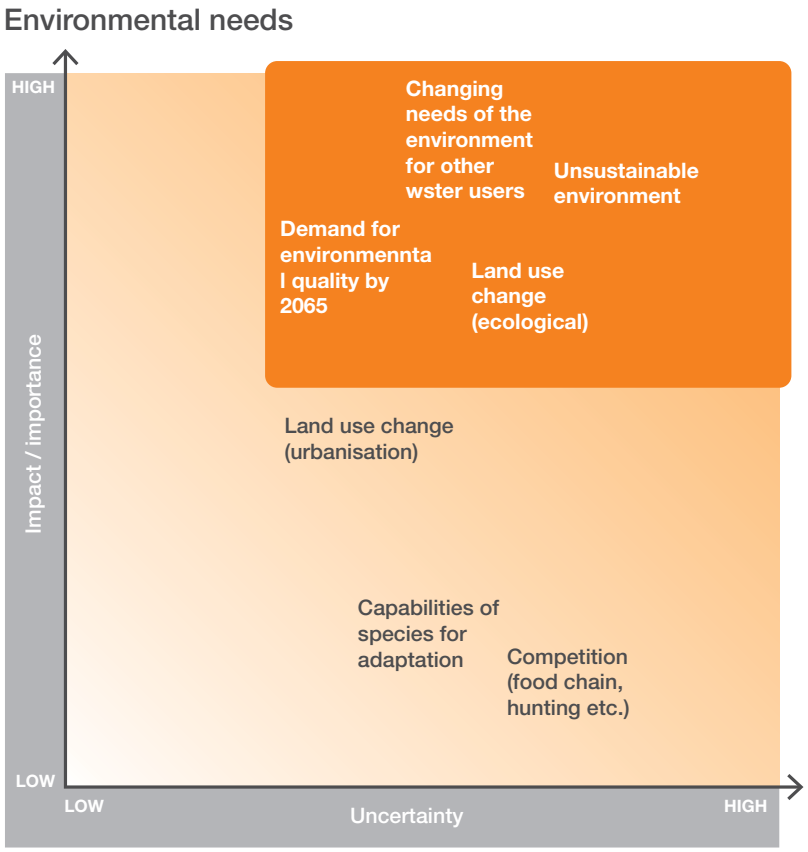


Figure 6: Matrix of influencing factors – behaviour

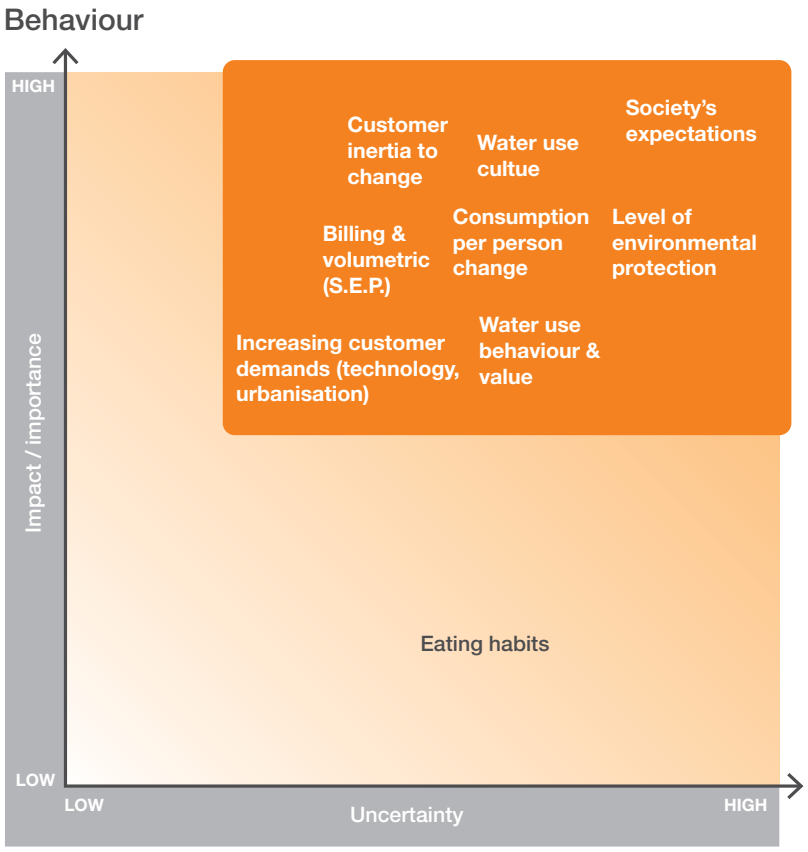


Table 3. Drivers and influencing factors	
Policy	Policy choice: Design event definition
	Flood and drought policy
	Flood and drought policy not seen as the same cycle (no wholistic thinking)
	Cost of failure
	Changes in water regulation and use
	Abstraction licencing system
	New/changing environmental legislation (e.g. WFD)
	Policy beyond water (incl. land use)
Weather / Climate	Extreme weather events
	Extreme droughts
	Rainfall Patterns
	Climate change and weather variability
	Climate change
	Knowledge of water resources status (incl. climate change)
	Climate change – influence on water availability
	Population and climate change (less rainfall, more hot days)
	Weather manipulation
	Changes in water quality
Economic Development	Industry development
	Have we cracked electricity storage?
	Size and shape of economy
	Changes to the economic impact of drought (resilience)
	Intergenerational funding (who pays for tomorrow)
	Abstraction increases (private and agriculture)
	Technology
	Can we share resources (institutions, markets, co-operation)
	Willingness to share (geographical)
	Power generation mix (dependency on water)
	Population and demography
	Population growth
	Demand for water abstraction (public water supply)

Table 3. Drivers and influencing factors *continued…*	
Economic Development *continued…*	Progress in Electrification (Demand)
	Intensive farming
	Private abstraction demands (power, agriculture, fracking)
	Agricultural demand increase (less water resources, groundwater deterioration)
Behaviour	Society's expectations
	Level of environmental protection by society
	Water use culture
	Consumption per person change
	Water use behaviour and value
	Customer inertia to change ("water is free" & "it rains all the time")
	Billing and volumetric (S.E.P.)
	Increasing customer demands (technology, urbanisation)
	Eating habits
Environmental Needs	Unsustainable environment
	Land use change (ecological)
	Demand for environmental quality by 2065
	Changing needs of the environment for other water users
	Land uses changes (urbanisation)
	Capability of species for adaptation
	Competition (food chain, hunting, etc.)
Intervention	Cost of capital for infrastructure
	Innovation and technology
	Adaptive Planning
	Characteristic of design events
	Definition of "Sustainable" Level of Leakage
	Technology – forecasting
	Infrastructure development
	Probably not what we can think of in the present, i.e. the unknown

The 36 drivers identified as highly important and highly uncertain were further weighted among each other. The core question was, which of these drivers are the most important for resilient drought and water scarcity management in England and Wales in 2065. Therefore, each participant had four votes, whereby more than one vote could be given to a driver. Voting was made using sticky dots, which participants put on the driver(s) of their choice. Table 4 presents the "ranking" of the drivers. This step is a methodological simplification of the scenario building method. Usually this step is followed by a cross-impact analysis, where all highly uncertain and highly important drivers would be juxtaposed and their reciprocal influence assessed. Due to time constraints, this step was not taken during this workshop. Instead, the participants engaged in an open discussion about which drivers could be used to develop scenarios.

Table 4. List of drivers and their importance as assessed by the participants

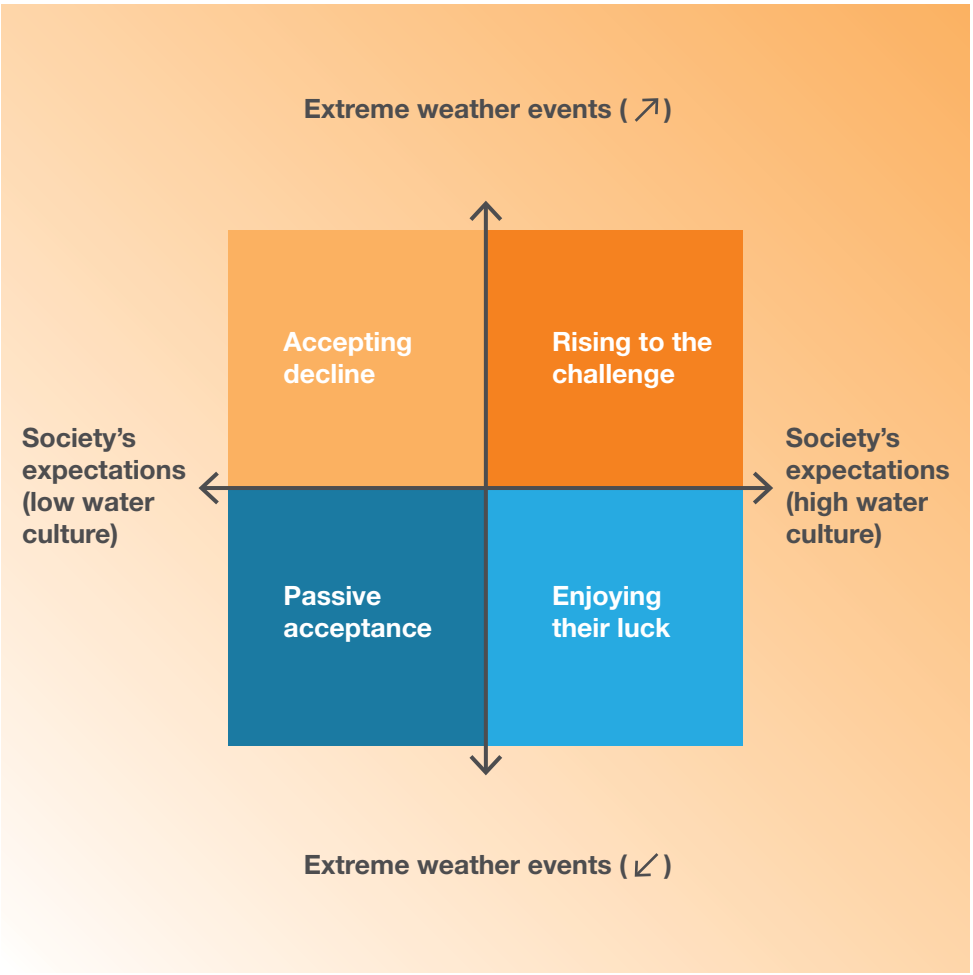
Driver	Point based assessment
Society's expectations / Water use culture	9
Extreme weather events (droughts)	8
Flood and drought policy	6
Willingness to share water	5
Cost of failure	5
Policy choice: design event definition	4
Unsustainable environment	3
Billing and volumetric	2
Demand for environmental quality	2
Abstraction increases	1
Intergenerational funding	1
Innovation and technology	1
Knowledge of water resources status	1
Electricity storage	0
Customer inertia to change	0
Water use behaviour	0
Economic impact of drought	0
Rainfall patterns	0
Size and shape of economy	0
Changing needs of the environment	0
Land use change (ecological)	0
Cost of capital for infrastructure	0
Industry development	0
Funding for infrastructure	0
Climate change and water	0

The list is reduced to 25 drivers because some drivers were seen as representing and meaning the same as another driver and were subsequently discarded.

Scenario development

The drivers with the highest number of points awarded were juxtaposed in different combinations. Therefore, they were placed on a two-dimensional matrix, where the axes represent the different developments of the driver. The combination of 'Extreme weather events' and 'Society's expectations' (figure 7) was selected by the participants as the most feasible, i.e. they evoked the clearest idea about the future of drought and water scarcity management in England and Wales.

Figure 7: Scenarios – resilient drought and water scarcity management in England and Wales by 2065

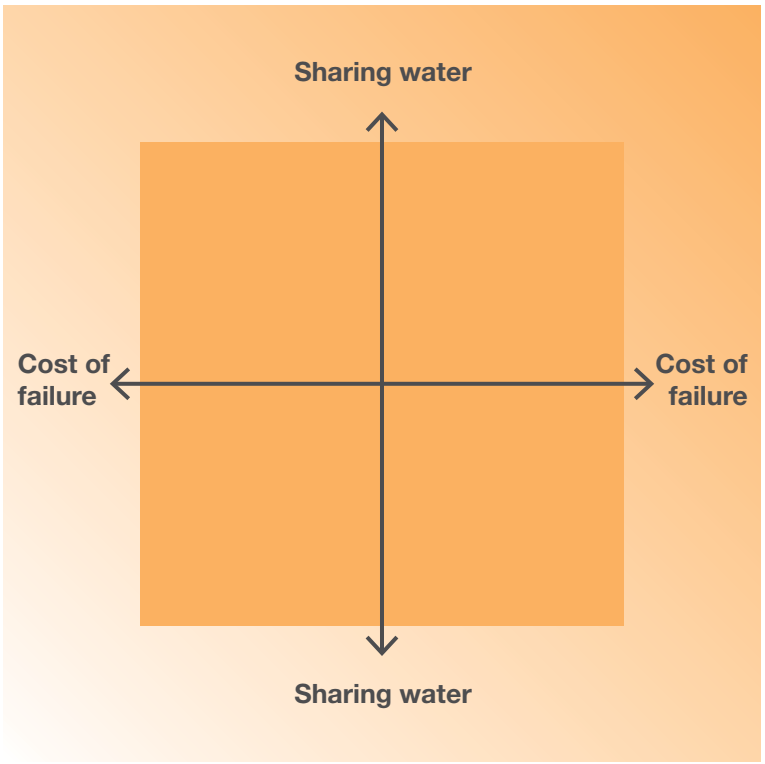


Each matrix quadrant generated a scenario and the following scenario titles were selected:

- Scenario 1: **Accepting decline**
- Scenario 2: **Rising to the challenge**
- Scenario 3: **Enjoying their luck**
- Scenario 4: **Passive acceptance**

Other combinations were not able to elicit comparable concrete and consistent ideas about the future of drought and water scarcity management. Figure 8 shows the discussed yet discarded option.

Figure 8: Discarded scenarios



These rather rough four scenario sketches are now elaborated. This included the list of highly important and highly uncertain drivers. Yet, the focus of this step is not their possible exploration or different development. Instead the focus is on developing four self-consistent and per se plausible scenarios that are different and interesting enough to act as generators of further processes. A first draft of these explorative scenarios is presented in the next chapter.

3 Scenario description

Scenario 1: Accepting decline

General characterisation

In the year 2065 England and Wales are more frequently hit by extreme weather events. River flooding, coastal storm surges and frequent drought events have become a common phenomenon. At the same time society's expectations towards water are very low. People expect public water supply to deliver water to their households without interruption and regardless of any environmental implications.

Droughts and other extreme weather events frequently occur in England and Wales as a result of climatic changes. The regions of England and Wales are affected differently though. Worst affected is the Southeast, which has seen a growing water demand due to a rising population. A growing wine, fruit and vegetable business in the region has put further stress on the available water resources. Londoners frequently queue for water after extreme events as the city is low on drinking water availability. Plans for new reservoirs and an inter-basin water transfer scheme had been dropped due to high costs and the unwillingness of both responsible water companies to reach an agreement on sharing water. The desalination plant at Beckton, once built as a backup facility, is now operating 365 days a year to supply the capital with water. The energy costs outweigh the costs for repairing leakages as public support for water supply disruption to carry out the necessary leakage repairs is low.

In the north, the people of West Cumbria are completely cut off public water supply after plans to build a pipeline from an adjacent water resource zone had to be dropped. Public pressure from customers to prioritise them over West Cumbrian customers led to this decision. The people of West Cumbria now rely on the few remaining local sources and tankering by lorries after extreme weather events.

Society's expectations towards water are very low. People see water as a commodity they pay for and hence one that has to be delivered to their households. This results from a general decline in environmental standards and low demands for environmental quality. The increased frequency of extreme events and its consequences have shifted public attention towards restoring vital infrastructure and creating jobs. Environmental aspects only play a minor role in these policies. Water companies are struggling between providing customers with water they paid for and sourcing that water, and are thus unwilling to share any water with other companies. This cannot be justified against their customer's expectations.

Society lacks a general understanding and interest on the interconnectedness of extreme weather events and integrated water resources management. Integrating drought and flood policies, or mitigating and adapting to climate change rank low on the political agenda. People accept a decline in extreme weather event protection as the rising costs of protection and disaster reduction can no longer be justified.

Developments with regard to drivers and tendencies

Flood and drought policy: Floods and droughts have hit England and Wales frequently over the last decades. Yet, flood and drought policy are treated as separate entities. Flood policy is based on dredging rivers to alleviate those affected quicker. Drought policy relies on emergency measures such as standpipes and rota cuts.

Willingness to share water: The willingness to share water has strongly decreased. Water companies struggle to meet demand within their water resources zones and hence only reluctantly share water. Adding to that are customer expectations to be supplied with the water they pay for, high leakage and a deteriorated infrastructure.

Cost of failure: The frequency of extreme events has increased. Given the public's lack of interest in water related issues public spending for further new and innovative flood defences and drought prevention measures could not be justified. However due to the increased frequency of extreme events the costs for the current flood and drought policies increase to uphold and restore the existing housing stock and infrastructure.

Policy choice: design event definition: The drought event that is being planned for and its probability of actually happening have not changed much over the decades. It follows traditional standards to determine the probability of extreme events using statistical analysis based on historical observations and regardless of coping with potential climatic changes. The policy choice made is to save vital infrastructure and secure drinking water supply even if it means tankering by lorries or stand pipes.

Unsustainable environment: The general state of the environment has deteriorated. Environmental issues are low on the policy agenda and due to a lack of public interest in environmental issues. Policies focus on engineering based solutions following an extreme event neglecting environmental issues for the benefit of creating jobs.

Billing and volumetric: Metering has not made many advances over the decades and millions of households are still unmetered. Public awareness of the benefits of metering is low and unmetered households emphasise and defend their right to water without being metered.

Demand for environmental quality: The demand for environmental quality has strongly decreased. People accept an unsustainable environment and the deterioration of ecosystem services over the creation of jobs after frequent extreme events. The awareness of the interconnectedness of environmental issues, the water-energy-food-nexus, is almost non-existent. People expect public water supply at all (environmental) costs. The use of household water filters has strongly increased due to the low drinking water quality.

Scenario 2: Rising to the challenge

General characterisation

England and Wales are frequently hit by extreme weather events among them droughts. Yet, society's expectations towards water are very high. People are aware of increased extreme weather events and they are well prepared. This reduces the costs of extreme weather events. People actively engage in environmental protection and are water aware. They make use of the latest water saving technology at home and at their workplaces.

Droughts and other extreme weather events occur more frequently in England and Wales and have different consequences in the different regions. However, a national inter-basin transfer scheme and cooperation among water companies ensure a continuous water supply across the island. Floods are also among the increased extreme weather events but instead of dredging rivers, the policy is to store water where possible and make it available when needed. The government has anticipated that environmental challenges such as climate change are interlinked with other societal challenges such as migration, population growth and economic prosperity. All policies have to undergo a climate change test. This ensures for example that floodplains are not available as land for housing or business use. New legislation also introduced the rule that whenever a property has been flooded it cannot be rebuilt at the same spot. However, compensation is paid to the property owner, yet the compensation costs outweigh the cost of restoring the property after each extreme weather event. A side effect of this policy is the increasing availability of land for floodplains, which also helps to hold water back.

The society is very water aware and is able to rise to the challenge of increasing extreme weather events. The link between water, energy and food is at the core of school and university curricula. New housing estates automatically require the installation of a grey water reuse scheme to save water. Businesses in industrial estates actively engage in collaboration with their business neighbours to assess the potential of saving water through grey water reuse schemes. Increasing extreme weather events have made people aware about the fragility of nature and the precious resource water. Reducing water consumption and mitigating the consequences of future extreme weather events is therefore high on the agenda. A whole new business sector has developed around making more water available either through technological measures or education.

Developments with regard to drivers and tendencies

Flood and drought policy: Flood and drought policy are integrated and subject to long term planning, monitoring and frequent review. Floodplains have been restored where possible and allow to hold back water for water scarce times. This also reduces the impacts of extreme weather events. Drought policy is characterised by a mixture of supply and demand measures and puts emphasis on the value of water and on measures for specific abstractor groups such as farmers or large industrial water consumers.

Willingness to share water: The willingness to share water is very high. The government, the public and water companies acknowledge the need to share water across water resources zones in order to alleviate areas affected by drought. Sharing water is seen as a key drought management option.

Cost of failure: Although the frequency of extreme events increases, the costs of failure decrease. The society is well prepared for extreme weather events and major disruptions of for example productions processes are kept to a minimum. Water saving devices are widespread as are grey water reuse schemes. People are willing to proactively save water thereby helping to keep the costs of extreme weather events down.

Policy choice: design event definition: Each extreme weather event triggers a review of current drought policies. Hence, the probability and the consequences of the drought event that is planned for is always state of the art and anticipating the latest research on droughts. Therefore, by recognising the increased frequency of extreme weather events and its implications, an alliance of government, science and water companies ensures the highest standards in the design event definition that also tackle uncertainties.

Unsustainable environment: England and Wales have turned into a sustainable and green society. People cherish nature and value natural resources. Being water aware, i.e. knowing about the linkages between water, energy and food, using water saving devices and integrating environmental protection and nature-based solutions into other policies, is an essential part of school and university curricula. People anticipated the link of proactively preventing drought and being prepared for the next extreme weather event.

Billing and volumetric: Every household and every business customer is metered in England and Wales. The water consumption behaviour of households is investigated for better pricing strategies and water use efficiency. This allows water companies to better plan their supply and demand balance and customers have a much better overview over the costs of water and how much water they use. This also enables them to appreciate water far better.

Demand for environmental quality: The demand for environmental quality has strongly increased. Society is willing to save water to ensure its quality. Greywater reuse schemes and water saving devices are actively promoted and accepted by customers and help protecting the environment.

Scenario 3: Enjoying their luck

General characterisation

The number of extreme weather events in England and Wales has decreased. Despite this trend, society's expectations towards water are very high. People are well prepared for drought periods and proactively engage in drought prevention measures. They save water and they are well prepared for the rare extreme weather events.

Droughts and other extreme weather events occur less frequently in England and Wales. In case of an extreme weather event water companies, authorities and society are well prepared. For example, those regions that could be affected by drought the most are connected to other water resource zones to quickly transfer water when needed. In addition, floodplains have been restored where it was possible, yet especially in areas with a large share of environmentally active people. They demanded measures although the frequency of extreme weather events has decreased. Overall, society is enjoying its luck that government policy is environmentally friendly and benefits from less frequent extreme weather events.

People are water aware and acknowledge the water-energy-food-nexus. Both are an essential part of education although due to the reduced number of extreme weather events environmental protection goals are frequently put into question. Water companies have to actively promote water saving devices and metering although people quickly enjoy the benefits of both.

Developments with regard to drivers and tendencies

Flood and drought policy: There is recognition that flood and drought policy should be integrated. People are aware of the link between the two policies and demand a better integration of both. As the number of extreme weather events has decreased plans for large infrastructure projects such as flood alleviation schemes were dropped. Drought management has been reduced to a core set of necessary measures (permits, orders), which are only used in very rare events.

Willingness to share water: The willingness to share water has strongly increased though the actual need for water transfers is low. However, the government, the public and water companies acknowledge the need to share water across water resources zones in order to alleviate areas affected by the rare drought events.

Cost of failure: As England and Wales do not suffer from a lot of extreme weather events, the cost of failure has been reduced to almost zero. Society demanded better protection from extreme weather events such as droughts and due to the low frequency of extreme weather events the government was willing to spend it on proactive and preventative measures thereby reducing the cost of failure.

Policy choice: design event definition: As the occasional extreme weather event still hits England and Wales, the design event definition has been upgraded to meet these events and to mitigate the consequences. One of the consequences is that the investment for water infrastructure is increased. However, because there are only occasional extreme weather events such a design only makes a marginal contribution.

Unsustainable environment: England and Wales have kept a good level of sustainability and environmental protection over the decades, yet as extreme weather events have decreased, popular demand for further environmental protection and higher sustainability standards have also decreased. However, people are actively engaged in environmental protection and water saving.

Billing and volumetric: The number of metered households has remained relatively constant and water saving, the decreased number of extreme weather events and a good level of environmental protection, led water companies to the decision to not actively push for increased metering. Customers can demand it though.

Demand for environmental quality: The demand for environmental quality has increased. People are expecting a good water quality and are doing their fair share to save water from overabstraction. Water saving devices are widely used although water companies have actively promoted them.

Scenario 4: Passive acceptance

General characterisation

The number of extreme weather events has decreased in England & Wales. However, this led to a decrease in public interest in environmental issues and environmental awareness. Water companies have to deal less with emergency measures and focus on meeting supply and demand. As long as they meet both, customers are satisfied and show no further interest in saving water.

Droughts hit England and Wales only occasionally and affect only certain regions. Although the consequences after each event are devastating for the affected regions, planning for future drought events does not change. The low number of extreme drought events does not justify any measures beyond restoring the supply and demand balance. Government priorities have shifted away from environmental issues to economic growth. In addition, society lacks a general understanding and interest on the interconnectedness of extreme weather events and integrated water resources management. Integrating drought and flood policies, or mitigating and adapting to climate change rank low on the political agenda.

People are passively accepting the fact that extreme weather events rarely occur, are being dealt with and hence they do not demand any improved water supply infrastructure, leakage repair or water saving education.

Developments with regard to drivers and tendencies

Flood and drought policy: Floods and droughts have hit England and Wales less frequently over the last decades. Yet, flood and drought policy are treated as separate entities. Flood policy is based on dredging rivers and rebuilding destroyed infrastructure. However, both measures need to be within the current government's budget. Drought policy relies on temporary use bans, drought orders and permits, though the latter ones are hardly applied.

Willingness to share water: The willingness to share water is low. Although water companies meet demands within their water resources zones they only reluctantly share water. Customers expect to be delivered with the water they pay for which water companies interpret as a duty to keep water within a water resource zone.

Cost of failure: Extreme weather events have decreased but as society's expectations towards water are low, the costs of failure have remained at a steady level. People do not expect government to spend more on effective drought management but simply to alleviate the worst effects of a drought.

Policy choice: design event definition: The design event definition has not been updated or changed over the decades because there was no necessity to do so since the number of extreme weather events went down. However, this means that society suffers from high costs of failure after occasional extreme weather events. Also, there is no expectation from society to do so, as allocating more funds into the prevention of extreme weather events is hardly justifiable.

Unsustainable environment: The general state of the environment has slightly deteriorated. Environmental issues are low on the political agenda and due to a lack of public interest in environmental issues. The low frequency of extreme weather events has decreased demands in sustainable living and national or regional sustainability strategies.

Billing and volumetric: The number of metred households has not changed much over the decades. For an industrialised country numbers are very low. Water companies do not actively encourage customers to switch over to meters.

Demand for environmental quality: The demand for environmental quality has strongly decreased. The low number of extreme weather events has decreased the awareness of the interconnectedness of environmental issues. Water supply is usually met but any further efforts to save water are low. Water companies have stopped funding water education programmes as the public response has slowed down.

4 Summary and next steps

This report documents the results of a one-day workshop aimed at generating explorative scenarios for resilient drought and water scarcity management in England and Wales in 2065. The key critical drivers, which were developed and assessed by the workshop participants cover aspects such as changing attitudes towards water use, extreme weather events, integrating flood and drought policy, the willingness to share water or the state of the environment. These drivers have been mapped in the framework of four scenarios and Table 5 summarises the development of each driver under each scenario again. Due to time constraints a cross impact analysis was not feasible.

The question remains in how far these scenarios are daring enough to look beyond one's own nose? Some participants struggled with the idea of explorative thinking in the sense that normative issues of drought and water scarcity frequently emerged during the discussions. However, making claims about future developments are even more difficult when they do not relate to technological options but relate to complex societal or political conditions a few decades ahead. Developments that strongly differ from current situations, breaks, are less seldom conceived. Instead current "trends" are continued because they are in a way "inspiring". In other words, our thinking about the future is influenced by current events and developments. The futurologist De Jouvenel pointed out that our view of reality is often blurred by: "(1) means of observations, or even more rudimentary, our sources of information: (2) means of measurement or quantification, for example, the GNP per capita, which tends to favour whatever is expensive over that which is not, and which occasionally overestimates what could be seen as accessory while underestimating the essential; (3) weight of the theories that we use to explain phenomena; theories that often lag behind reality." (De Jouvenel, 2000, p.39).

However, there are three possible uses for these scenarios within and beyond the context of MaRIUS. First of all, with regard to decision-making the scenarios present four alternative developments for drought and water scarcity management in England and Wales in 2065. This could be useful for water companies and regulatory bodies when developing strategies for future water resources management.

Other research within the MaRIUS project has shown that currently applied drought management options in England and Wales present a rather restrained set of options while the available array of options is much larger. The list of key drivers developed during the workshop thereby represents a list that reflects current developments in drought management – putting emphasis on water education, integrating drought and water policies or ideas of sharing water. Hence, key stakeholders acknowledge the need for further and a broader array of options and measures. Second, the results of the workshop could be the basis for a further exercise – backcasting. The idea behind backcasting would be to select one of the scenarios as the most desirable one to reach in the future. A backcasting workshop then tries to identify options to connect the future to the present and establishes what actions must be taken to attain a certain goal, i.e. scenario. Ideally, this results in a programme of measures that would be implemented at certain times along the time frame, in this case 2065. A third possible use of the scenarios would be to use them in modelling exercises and to test how each scenario would influence the different parameters in a model and to see the impacts under the various scenarios.

Table 5: Development of critical drivers in each scenario

	Scenario			
Critical driver	**Accepting decline**	**Rising to the challenge**	**Enjoying their luck**	**Passive acceptance**
Society's expectations / water use culture				
Extreme weather events				
Flood & drought policy				
Willingness to share water				
Cost of failure				
Policy choice: design event definition				
Unsustainable environment				
Biling & volumetric				
Demand for environmental quality				

 Strong increase / strongly agree

 Strong decrease / strongly disagree

 Increase / agree

 Neither increase or decrease / no opinion / not applicable

 Decrease / disagree

5 References

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