Adaption and Climate Change Scenarios

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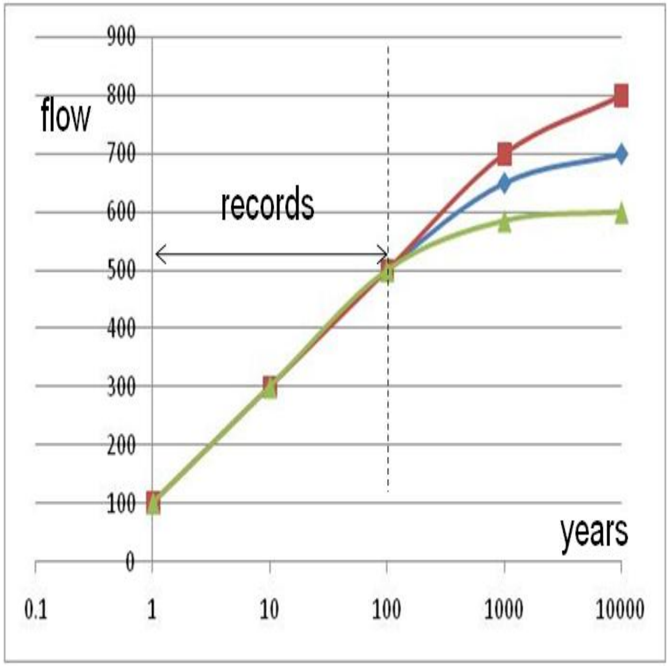
Presentation Structure

1. Uncertainty
2. Adaption
3. Scenarios

Recent and Future Challenges

Current challenge for Water Utility managers



Older design philosophies relied on the extrapolation of historical climate data

Current design processes for assets are based on an assumption of quasi-stationarity

Accepted that significant external driven climate changes can now be expected in the design life of a typical water infrastructure asset

Simple “multipliers” have been used to try and account for anticipated changes

Predictions of climate change are “uncertain” – difficult to account for such uncertainty

Climate Change Prediction

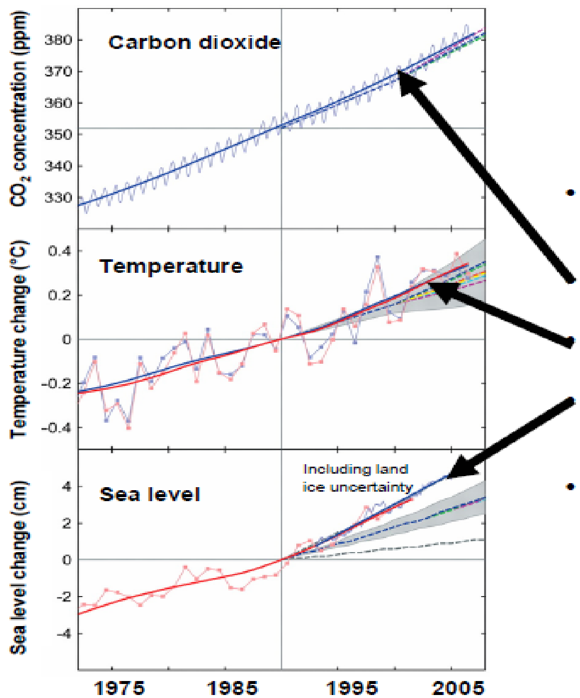
Future changes in climate are predictions

Quality of the predictions are continually improving

Improvements have focussed on spatial resolution and reliability

Key uncertainties: processes, input conditions, emissions

Always be uncertainties in these predictions – especially over the timescale of water assets



Underestimating the change?

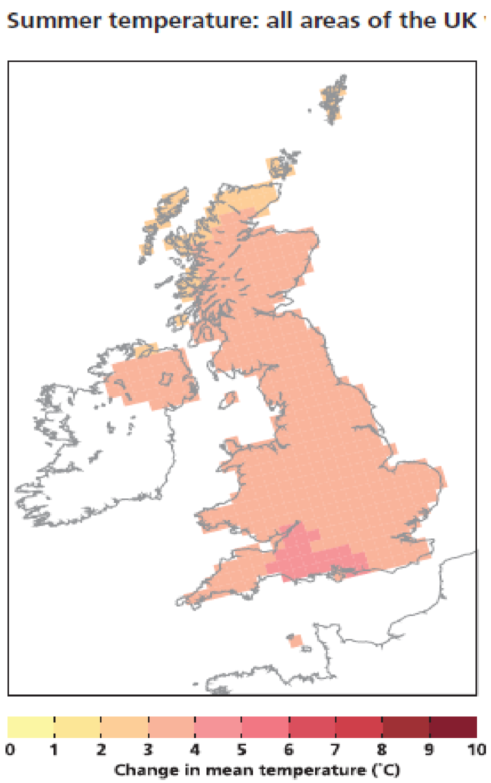
- A comparison of IPCC (2001) projections with observations from the year 1990
- **CO_2** observations follow the projections almost exactly
- **Temperature** is in the upper part of the projected range
- Observed **sea level** has been rising faster than the model projections
- IPCC have not exaggerated change and in some respects may have underestimated the change

Rahmstorf et al. 2007 Science

Direction of trend clear – but..

Recent CC Predictions - UK

UKCIP09 Programme



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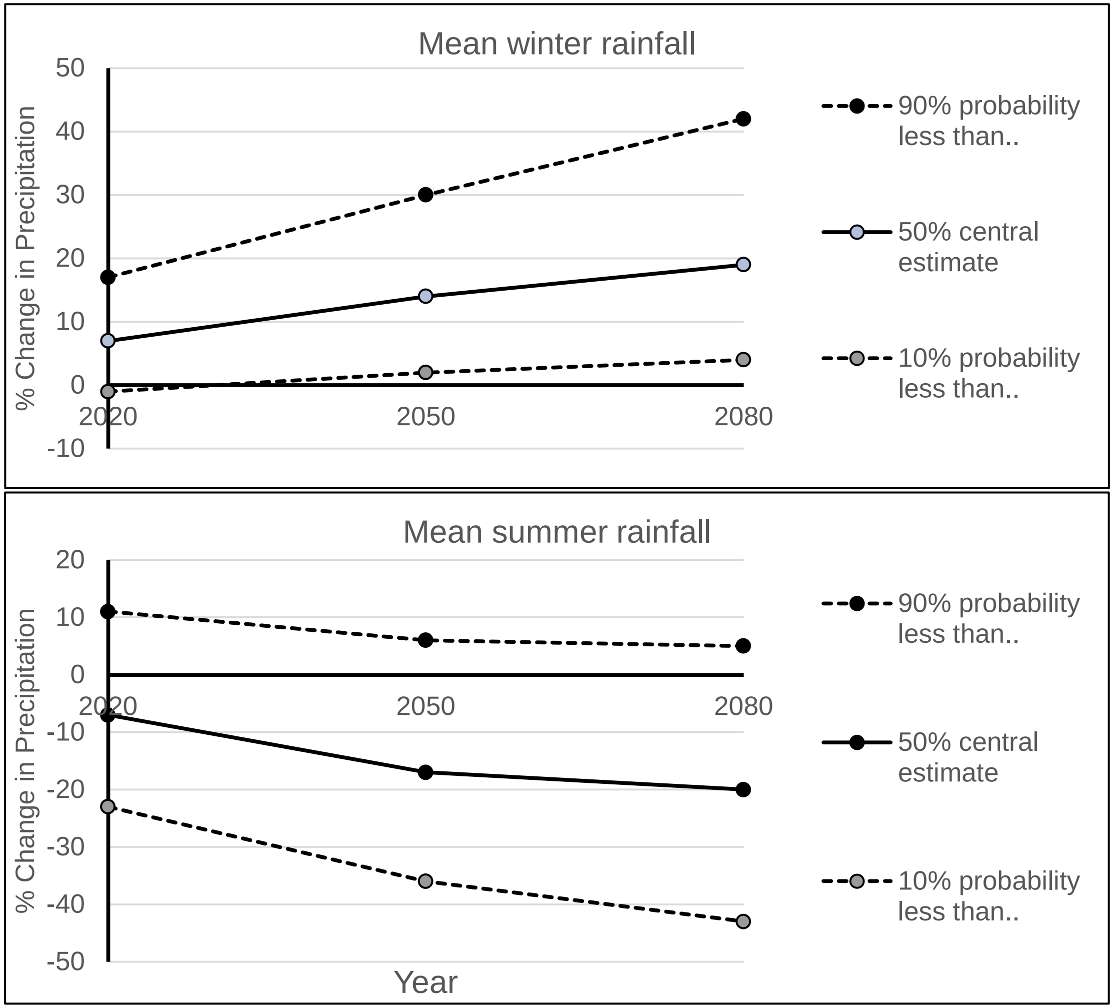
Wider range of analysis tools – data sets at national, regional and 25km x 25 km area

High number of individual model runs – likelihood of occurrence at different time periods

Three emission scenarios – does not include impact of mitigation measures but assumes a switch from fossil fuels to renewable energy sources

Water utilities can now get much more detailed climate change information

Recent CC Predictions – Wales UK



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Trends and uncertainty

By 2080 in Wales:

Mean Winter rainfall to change by +19% central estimate

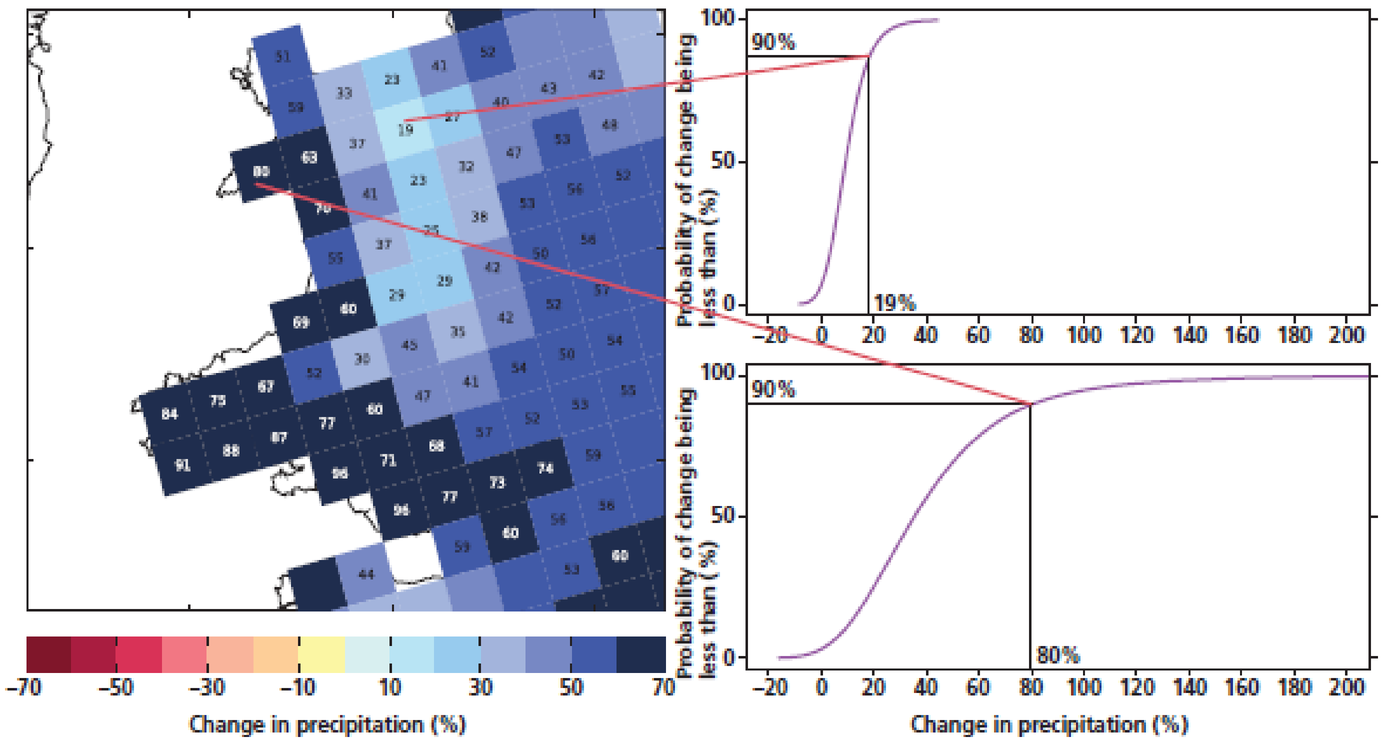
(+4%to 42% ↔ 10-90% likelihood range)

Mean Summer rainfall to change by -20% central estimate –

(-43%to +5% ↔ 10-90% likelihood range)

Recent CC Predictions – Wales UK

Prepared
enabling change



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Spatial Variation - relating a map of changes, at 90% probability level, to mean winter precipitation over Wales by the 2080s at two of the 25 km squares.

System Resilience

Resilience – ability of a system to function, or recover function in the face of change.

Ideas originated in ecological studies – the capacity of a system to cope with a disturbance and to re-organize whilst undergoing or experiencing change

Extended to include the concept of recovery of function as well

- Desirable in water infrastructure – ever present risk of failure – system therefore need the ability to recover
- Resilience may be a good *or* bad property in regard to water services, so we need to promote it only where it is beneficial

Adaptation – Water Systems

Adaptation

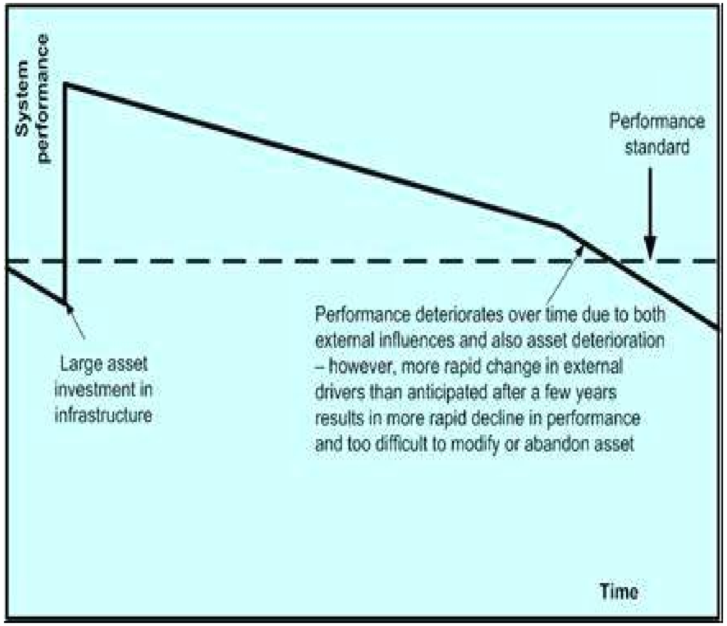
Adaptation is a method to deliver resilience

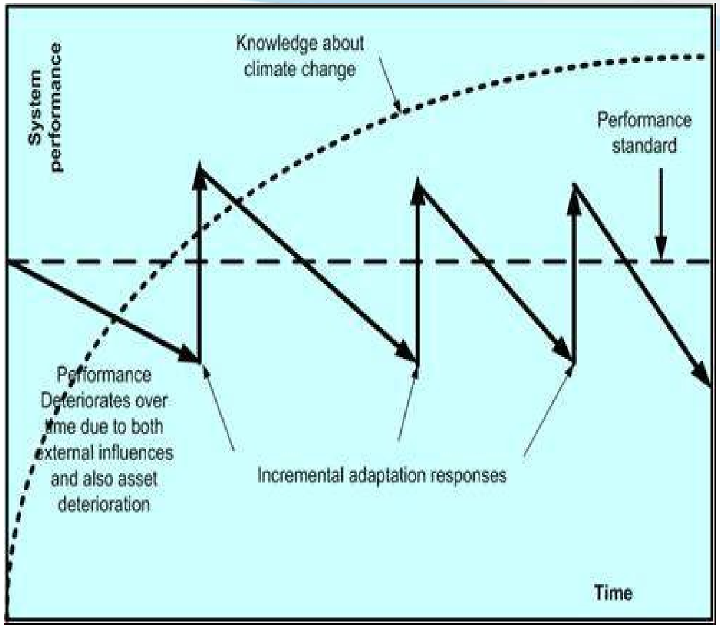
Key characteristics of adaptive systems:

- System operators or manager learn new strategies methods to deal with change – ability to learn, improve and act at the most appropriate time
- Identified timescale for which risks and responses will be re-assessed.
- Prediction of the future to identify and understand future change and their consequent pressures on the system

Adaptation is not about optimization

Adaptation – Water Systems



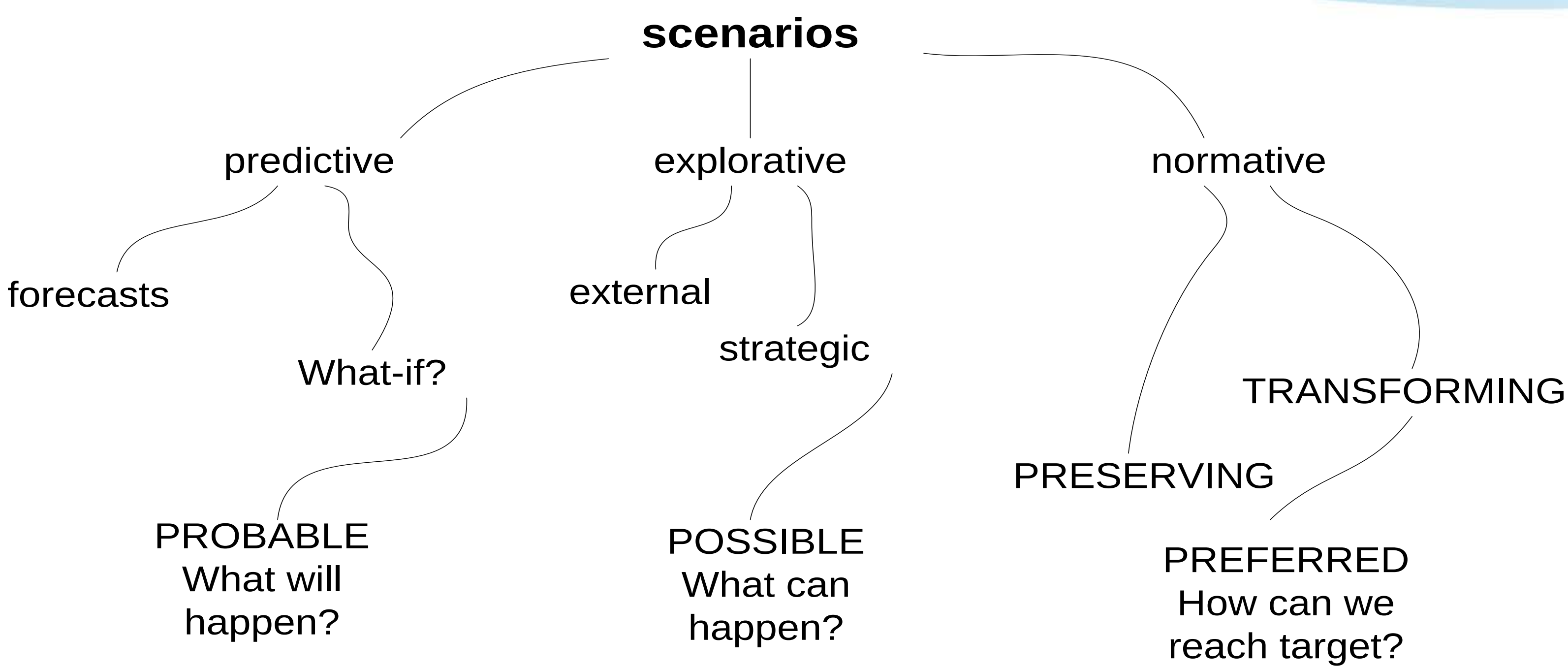


Repeated responses – when current knowledge allows for well informed intervention

Need to continually review system performance in light of current knowledge on climate change

Need to be willing to have repeated investment in change

Futures methods - concepts



1. Predictions – what will happen
2. Roadmapping – what we would like to happen
3. Scenarios – what may happen

How to deal with future uncertainties

Prepared
enabling change

Scenarios – what are they?

Coherent, internally consistent and plausible descriptions of possible futures;

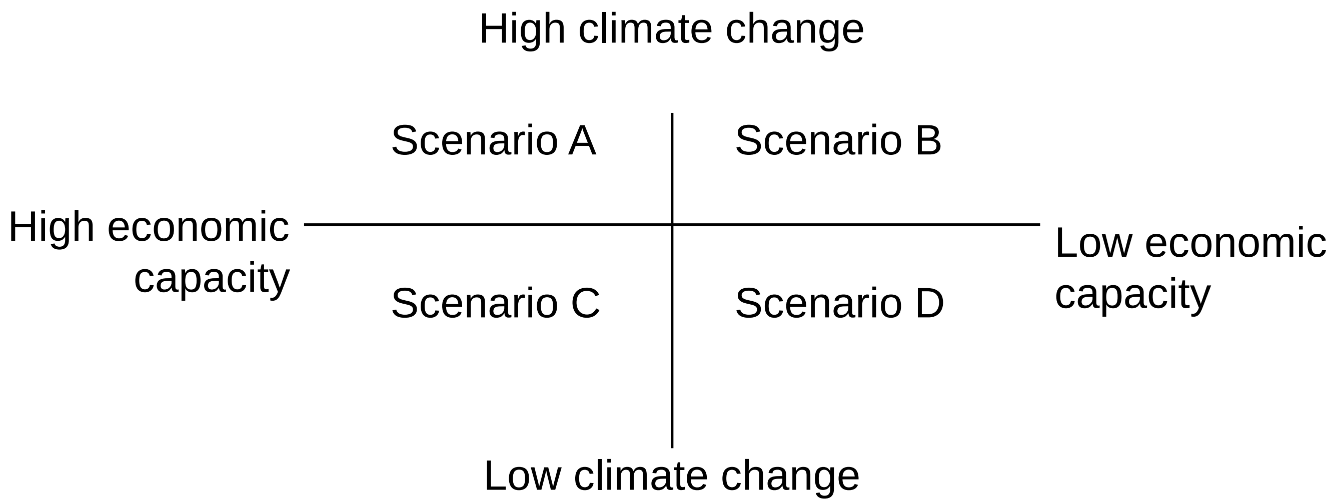
Tool for thinking about the future – and current actions to change the future:

1. The future is unlike the past; it is influenced by past trends but also by human choice and action.

2. There are many possible futures, scenarios map a ‘*possibility space*’

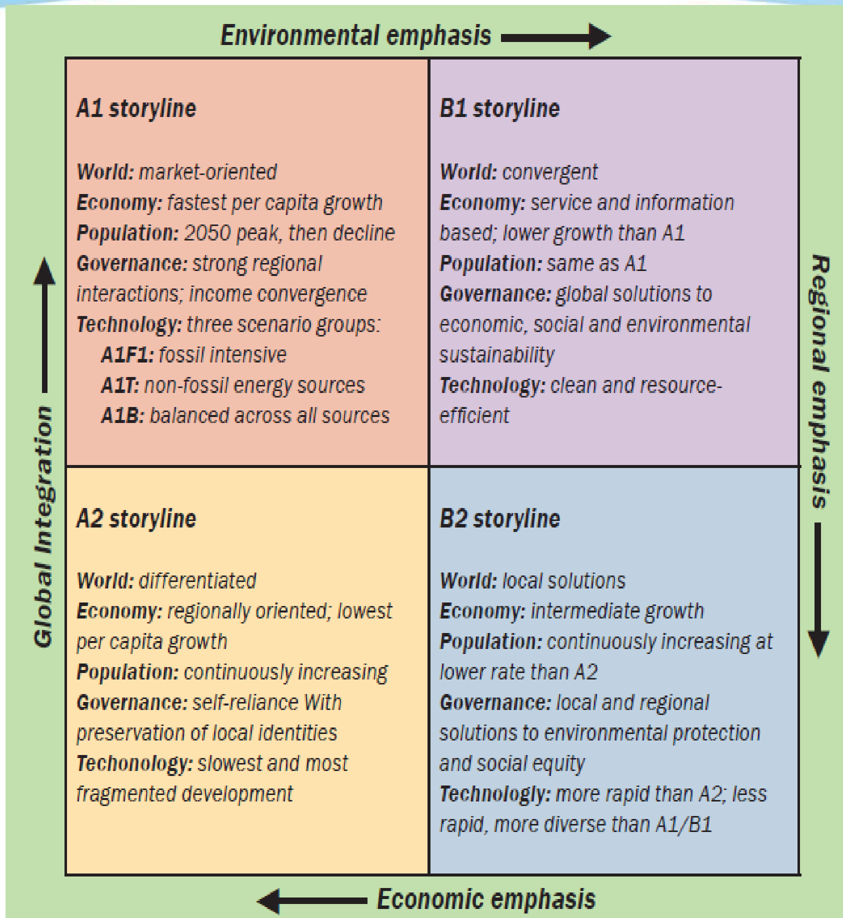
3. Scenario development involves rational analysis and *subjective* judgement

Scenarios – what should be included?



- Understand what are the drivers that can cause pressures on the systems to be studied
- For water, sanitation and drainage systems both climate and social-economic drivers
- Drivers: climate change, change in population, change in financial resource, changes in regulation

Socio-economic inputs



Special report on Emissions Scenarios (SRES): A special report of Working Group III of the intergovernmental panel on climate change. Cambridge University Press

Socio-economic criteria relevant to water management

- %GDP growth per year
- Investment in water and sanitation (%GDP)
- Primary energy consumption change per year from today (%)
- Population change from today
- Social Values, attitudes and capacity
- Governance Structures
- Equity

Need to be related to the most suitable spatial scale for any study

High level socio-economic data - UK

Scenario	Economic Growth Rate (%)	Population (million)	No. of Households (million)
National Enterprise	2.0	63	29
World Markets	3.5	70	35
Local Stewardship	2.0	61	23
Global Sustainability	2.75	68	29

Specific socio-economic attributes

Characteristics of Scenario	Examples of Attributes/Epoch (changes from today)			
	Criteria*	Today	E1 2020s	E2 2050s
High Socio-economic capacity	%GDP growth per year	0	3	3.5
	Investment in water and sanitation (%GDP)	0.8	0.8	0.10 High growth, high innovation, capital productivity
	Primary energy consumption change per year from today (%)	-	+1	+2
	Population change from today	-	+2%	+5%
	Social Values, attitudes and capacity	Nationalist, individualistic, gearing up capacity	Nationalist - Internationalist /entrepeneurial, high capacity	Internationalist, libertarian
	Governance Structures	Centralised; Declining Regulations	Deregulating and consultative	Weak, dispersed, Consultative, Minimal, enabling markets
	Equity	Apparently promoted	Strongly declining	Strongly declining

Specific climate change attributes

	Probability	Change in temperature °C			% change in precipitation		
Very unlikely to be less than	10%	0.6/1.1/1.6	0.5/1.2/1.9	0.9/1.3/1.9	-4/-6/-6	-1/+2/+4	-23/-36/-43
Central estimate	50%	1.3/2.0/2.8	1.4/2.5/3.5	1.9/3.4/4.8	0/0/0	+7/+14/+19	-7/-17/-20
Very unlikely to be more than	90%	2.0/3.1/4.2	2.5/4.1/5.8	3.66.1/8.6	5/5/6	+17/+30/+42	+11/+6/+5
		Winter Mean	Summer Mean	Summer Mean Daily Max	Annual Average	Winter Mean	Summer Mean
Low Emissions Scenario for 2020's					-4	-4	-21
					1	5	-6
					5	15	11
High Emissions Scenario for 2020's					-4	-3	-20
					0	5	-4
					5	14	14

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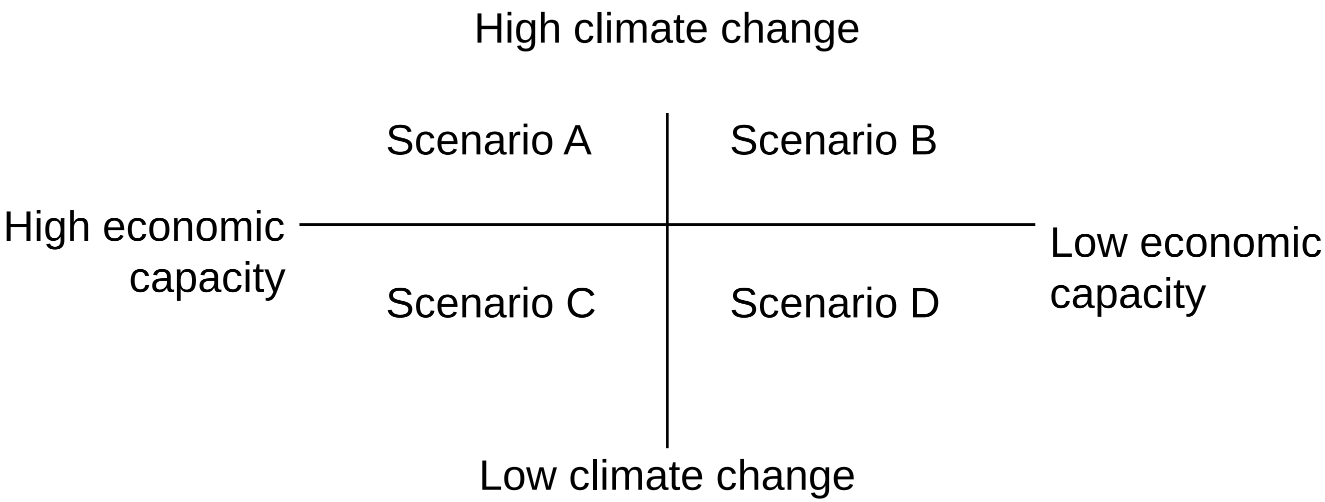
Scenarios – what should be included?



- Socio-economic parameters
- Climate change – region specific, specific for water management issue
- Description of potential range of futures and the parameters that can be used to estimate scale of drivers
- Drivers-Pressures-Imapct

Driver-Pressure-Impact Chains

Climate Change

↘

Precipitation

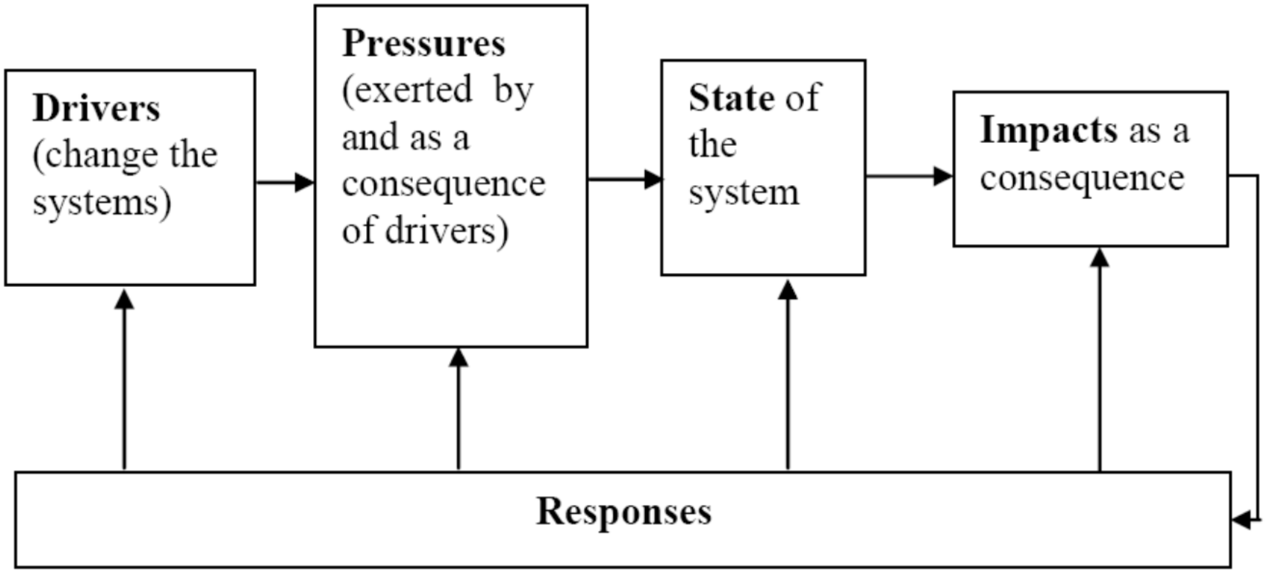
↘

More Intense Runoff

↘

More surcharged sewers – More Flooding

Driver-Pressure-Impact Chains



Need to identify drivers and describe them over a suitable time scale

Interventions and responses

Less control — *High control*

Global prosperity
Global greenhouse gas emissions

EU regulation
National prosperity
Public perceptions
Insurance industry

Building practices
New Technology

Design codes
Maintenance activities

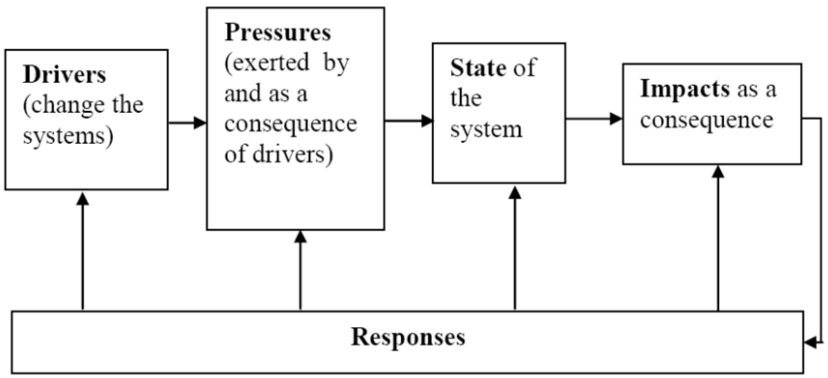
Responses – UK Perspective

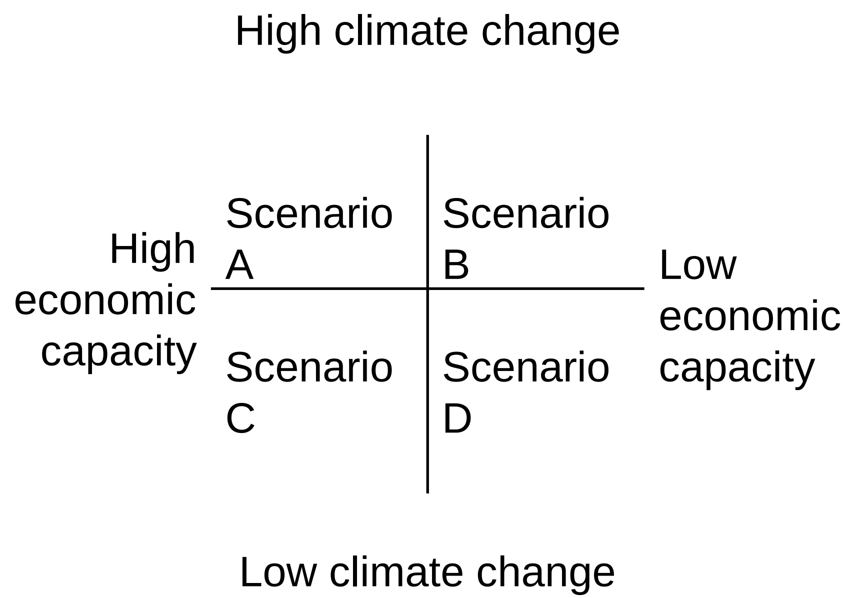
Study	No control		RESPONSES		High
	control potential				
Hall et al (2008) Flood risk and management (to 2080s)	Earth's orbit	Global values Global prosperity Global greenhouse gas emissions	EU policy and regulation National prosperity Public perceptions Insurance industry	Urban and rural land use Building practices	Flood defences Flood forecasting and warning
Ashley et al (2006) 21st Century sewerage (to 2080s)		1. Climate change	2. Environmental and other legislation 4. Energy and other resource use	3. Land use and urbanisation Demographics	5. Asset condition, performance and serviceability 6. Science, engineering and technology

Scenarios – Timescales – System Specific

1	Year 2020s	Climate changes are already in process (2014) and cannot be altered 2014-2025 Represents the typical lifetime of mechanical and electrical assets in water and wastewater systems.
2	2050s	Climate may change in ways not reliably predicted at the present time. 2011-2050 - is the lifetime of many water and wastewater assets; thus 2050 end of the 'design life' of many of the current infrastructure assets in European urban water systems. Major refurbishment or replacement would be considered.
3	2080s	Predicting climate change for this period is highly uncertain This period is probably the future limit of what can be reasonably imagined from a position in 2014. Current major infrastructure assets would be failing; replacement would be essential.

Scenario Process





Will a response work equally well under each scenario?

How do we value responses that work well under each response?

Is this of more value than a response that works extremely well under one scenario?

Examples of output of scenario based process

Prepared enabling change

Driver, Pressure, Impact	Rank	Response	Robustness		Now in application
			20's	50's	
Climate Change - Changing pattern of weather - Changes in land use	1	Legislation to control more land with the people/Education + capacity building	4	4	partially
Social - Greater imbalance of equity - Potential for 'poorest' to have more influence.	2	Work with and influence government, Local Authorities, firms and others	4	3	yes
Science & Technology - Limited funds - (Low cost technologies) More self reliance	3	More self reliance: Simple solutions based on historical knowledge. Low cost communal assets + infrastructure with capacity for change on a local level.	3	3	partially

Conclusions

- Significant climate change uncertainty – information on trend, spatial and modelling uncertainty.
- Uncertainty will reduce but will never be eliminated

- Water infrastructure systems complex and prone to failure
- Adaptive approaches – review/learning/repeated interventions

- Need a method to understand what the future will be
- Scenarios – method is understand a range of potential futures
- Need to include all significant aspects for water systems in scenarios
- Spatial and timescale are important – review and future responses
- Used to estimate future impacts of water systems
- Robust responses
- Responses may not be optimum in all scenarios