CCDeW:

Climate Change and Demand for Water

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Final Report

Executive Summary

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Executive Summary

The Climate Change and Demand for Water Revisited project (CCDeW) revisits and updates the benchmark study by Herrington (1996) and takes advantage of new data sets, regional coverage of demand projections and new methodologies for climate impact assessment. Domestic demand, industrial and commercial water use and irrigated agriculture and horticulture are included in the CCDeW study. Leakage was excluded from the CCDeW study.

This report presents the outcome of an extensive UK research programme concerning: demand forecasting; demand management; sensitivity of demand to climatic variations; and sources of risk and uncertainty.

While the CCDeW study focuses on demand, climate change uncertainties feed into supply side and demand estimates of water requirements. Therefore, the report's conclusions should be seen as one element in the dynamic management of the supply/demand balance over the course of the next twenty years and beyond (see Section 9). Clearly, the extent to which water consumption will be influenced by climate change depends upon the sensitivity of different sectors to specific aspects of climate change as well as potential behavioural and regulatory changes, in part related to different socio-economic and climatic futures.

Methods

In determining the potential impact of climate on demand a range of models were employed. Models were selected variously for their ability to provide insights into the relevant aspects of water demand in a specific sector and their compatibility with available data. The models include statistical analysis for domestic demand (see Chapter 3), expert judgement combined with statistical models (for industrial and commercial demand, see Chapter 4), dynamic simulation (including domestic water use in Chapter 3 and crop water requirements in Chapter 5), dynamic optimisation (for land use, see Chapter 5) and agent-based social simulation (to explore behavioural changes, in Chapter 7).

Common to the assessment in each sector is the use of current UK Climate Impacts Programme's climate scenarios (UKCIP, 2002) and the Environment Agency water demand scenarios (Environment Agency, 2001a, b) based on the socio-economic reference scenarios developed under the Foresight "Environmental Futures" framework (DTI, 1999).

The UKCIP climate scenarios are based on a range of global greenhouse emission scenarios. The four scenarios are developed from the Hadley Centre's global climate model, utilising the high-resolution regional climate model runs for the 2080s. Four scenarios are presented representing Low, Medium-Low, Medium-High and High global emissions of greenhouse gases.

The science behind climate change is developing rapidly and the Intergovernmental Panel on Climate Change conclusion that anthropogenic climate change is inevitable appears increasingly robust (IPCC, 2001). However, the available climate change scenarios do not provide probabilistic projections of the future climate of the UK and

many uncertainties remain as to the timing and extent of climate change. Deficiencies remain in understanding likely changes in the frequency of extended periods of high temperatures and droughts, which are the major concern of the water industry. The projections made in the CCDeW assessment are likely to prove relatively robust for gradual mean changes. However, they do not adequately capture the risks and uncertainties associated with extreme events (see Chapter 8).

The potential impacts of climate change have been reported relative to the EA reference scenarios of future water demand. The four EA scenarios detail how plausible socio-economic conditions (described in the Foresight scenarios) could result in plausible, increasing and decreasing, outcomes for water demand over time (see Section 2.1). For all sectors, the 'choice' of reference socio-economic scenario has a larger impact on the forecasted results for the 2020s than the direct impact of climate change. This suggests that innate uncertainty in future climate and socio-economic conditions remains a constraint on more precise projections.

Results

The results of the study are presented for each Environment Agency Region. The results are expressed as a percentage changes from a "without climate change" demand scenario that allows water resource practitioners to apply the results to their own projections of demand. The results apply to average demands only (with the exception of agricultural demand which are for design dry year), although some comments on the potential impacts on peak demands are included in the report. A summary of the results across the regions is shown below.

Domestic demand

For domestic demand, the socio-economic reference scenarios indicate a range of future demand in 2024/25 between 118 to 203 l/h/d, compared to 162 l/h/d in 1997/98. The additional impact of mean climate change on domestic demand is a modest increase in average annual demand, up to 1.8% by the 2020s. For the 2050s, the climate scenarios indicate an increase of 1.8%–3.7% above the socio-economic scenarios (see Section 3.4).

The effect of climate change on domestic demand is not appreciably different across the eight regions of England and Wales. However, in water resource zones where the micro-component composition of water demand is markedly different, the impact of climate change will differ. See for example, Table 3-9.

The study suggests that domestic demand will be sensitive to the interplay of warmer climates, household choices regarding water-using technologies and the regulatory environment. The CCDeW project developed an agent based social simulation model to explore these interactions. The model revealed that an increased frequency of drought could provide the catalyst for the adoption of water saving technologies and associated reductions in demand, or alternatively if the presumption of entitlement to a private good were to exceed the willingness to conserve water during periods of drought, increased frequency of drought could lead to consumers increasing their demand beyond the high reference scenarios. Critically the model identifies the extent of community interaction and particularly the mimicking of neighbour behaviour as a key determinant of the uptake of new water saving technologies. Neighbourly

interaction also determines the extent to which households are influenced by policy agent exhortations to use less water in times of drought – closely knit communities appear to be less impressionable. The findings, although purely qualitative, suggest key social determinants of future water demand (see Chapter 8).

Impacts of Climate Change by Component of Water Demand
For Selected Marker Scenarios

Domestic demand

	2020s	2020s	2050s
	Low	Medium-High	Medium-High
Alpha	0.9-1.2%	1.4-1.8%	2.7-3.7%
Beta			
Gamma		1.0-1.3%	
Delta			

Industrial/commercial demand

	2020s	2020s	2050s
	Low	Medium-High	Medium-High
Alpha	1.8-2.9%	1.7-2.7%	3.6-6.1%
Beta		1.8-3.0%	
Gamma		2.0-3.1%	
Delta		1.7-2.7%	

Agricultural demand

	2020s	2020s	2050s
	Low	Medium-High	Medium-High
Alpha	18%	19%	26%
Beta		19%	
Gamma		19%	
Delta		20%	

Industrial and commercial demand
Among the industrial/commercial sectors sensitive to climatic variations, soft drinks, brewing and leisure are likely to have the greatest impact on the overall requirements for public water supply. Climate change impacts in industry and commerce are likely to be higher in percentage terms – up to 2.8% in the 2020s – than the impacts on domestic consumption (see Chapter 4). The impacts do not appear notably different across the scenarios. In contrast to domestic demand, there do appear to be differences between the regions, attributable to the different mix of industrial/commercial sectors in each region (see Tables 4-3 and 4-9).

Agricultural and horticultural demand
Climate change could affect irrigation water use via changes in plant physiology, altered soil water balances, cropping mixes, cropping patterns that take advantage of longer growing seasons, and changes in demand for different foods (see Chapter 5). The survey of irrigation of outdoor crops in 2001 confirmed that water use for

irrigation is currently growing at 2%-3% per annum, and provided a new baseline for the demand modelling (see Section 5.3).

Agroclimatic zones defined by soil-moisture-deficits will move northwards and westwards in the UK as a result of climate change. By the 2020s, central England will experience conditions similar to those currently typical of eastern England, and by the 2050s eastern, southern and central England will have irrigation needs higher than those currently experienced anywhere in England (see Section 5.5).

The climate change impacts (including changes in demand for water by crops, effects of CO_2 enrichment, and expected irrigation use) modelled in this study indicate increases in irrigation use of around 20% by the 2020s and around 30% by the 2050s (see Section 5.7). The impacts are region specific, with expected changes relative to the baseline, ranging from a decrease of 4% in the North West to an increase of 24%-25% in the Thames region.

Leisure sector demand

The analysis of potential impacts of climate change on the leisure sector has been limited by the paucity of historic data from which to establish relationships between climate variables and consumption (see Chapter 6).

Summary: England and Wales

The total impacts for England and Wales appears to be on the order of 2% for 2024/25, based on the Beta reference scenario and Medium-High climate scenario (see Section 9.2). The regional impacts vary from 1.3% in the North West to 3.9% in the Anglian region, where spray irrigation is a major factor. By the 2050s, increased climate change leads to greater impacts—perhaps a further increase of 1-2% in the regional impact of climate change.

Impacts of Climate Change on Demand for Water in England and Wales For the Selected Marker Scenarios

	Climate change		
EA Reference	**Low**	**Med High**	**Med High(2050s)**
Alpha		1.4%	
Beta		2.0%	3.8%
Gamma	1.8%	2.0%	
Delta		1.8%	

Note: The shading in the 2050s cell indicates a rough estimate of the total regional effect of climate change on water demand. The EA reference scenarios are limited to 2024/25 and the CCDeW project did not project all components of demand to the 2050s.

Guidance and further assessment

The simplest guidance for using the CCDeW results is to apply the regional impacts reported here to the entire water company area. For example, the impact in the 2020s for domestic demand is between 0.9 and 1.8%, depending on region and scenario. An additional factor in headroom of, say, 1.5% would be justified. More detailed calculations are possible, based on the micro-components of demand, but may not be justified by the relatively modest climate impacts shown above. In the case of

irrigated agriculture, the relatively larger impacts (on the order of 20%) may justify additional estimates at the water resource zone level.

Improved understanding of climate change impacts on demand is as important as for groundwater and hydrology. A continuation of present monitoring systems, especially for a sample of households, key industries and irrigation, is essential. The lack of data on industrial and commercial use is a major constraint. Detailed studies of specific dynamics are warranted, in particular the willingness and ability to reduce demand during periods of water shortage. The next major assessment should adopt a risk methodology employing probabilistic scenarios of climate change, including climatic variability and extremes, and linking climatic episodes to realistic responses by key users.