2. Climate Change

Image 2a: **Sunset at Topsham**
Source: Exe Estuary Management Partnership

Long term changes in the climate as a result of the redistribution of the continents around the globe, and changes in the Earth's orbit and the Sun's output have shaped the landscape we know today. The Exe Estuary is a drowned river valley or ria inundated by a sea level rise of 120 metres that took place from the end of last Ice Age 18,000 years ago to about 4,000 B.C. Whilst we do not expect changes of that magnitude to take place in the coming century as a consequence of human-induced climate change caused by greenhouse gas emissions, some of the physical attributes of the Exe Estuary will be affected during our lifetimes.

This section will describe both the climate change that has already taken place in Devon and that which is projected to occur, making specific reference to the Exe where possible. The information and figures in this Section are taken from Devon County Council's Climate Change Strategy (2005).

The Climate of the South West

The South West peninsula is the mildest area in Britain because it takes the full force of the mild, rain-bearing winds of the Atlantic. This oceanic location produces a warm temperate humid climate with only occasional frost that is tempered throughout the year by the influence of the sea. Devon is typical of such extreme Atlantic coastal areas, which are defined as having 'low summer and high winter temperatures, moderate precipitation and below average sunshine for their latitude' (Tansley, 1939).

The Climate Change Experienced to Date

Climate change is often thought of as a future issue but it has been established that most of the warming observed over the last 50 years is attributable to human activity. This means that we are already experiencing its effects which can be seen in the temperature and rainfall records of Devon.

Temperature

Using data supplied by the Met Office it is now possible to assess the temperature rise associated with climate change over the 20th century at most locations across the county. The mean annual temperature in Devon has increased since the cooler period of the 1950s and 1960s in line with both global and UK warming trends (see Figure 2a). Exeter has recorded a rise of 0.9°C since 1900 (Figure 2b).

Whilst some warming occurred during the first half of the century most of the warming has been since the mid 1960s. There has also been an unusual sequence of warm summers during this post 1960s period with summer 2003 now being acknowledged as a climate change event. The warmest decade has been the 10 year period since 1995

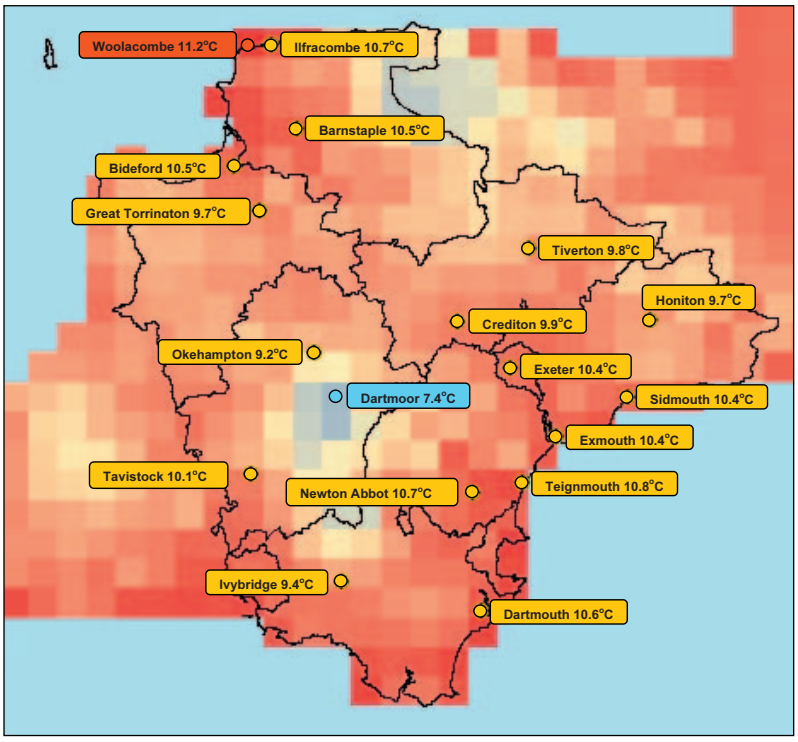


Figure 2a: **Long-term average annual temperature in Devon (1961 – 1990)**
Source: Devon County Council Climate Change Strategy (2005)

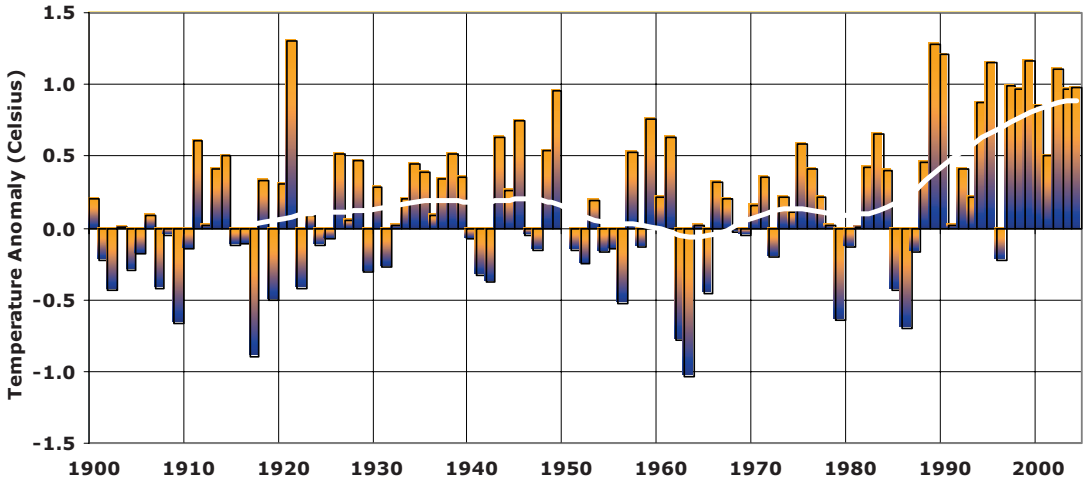


Figure 2b: **Trend in mean annual temperature for Exeter (1900 – 2004)**
Source: Devon County Council Climate Change Strategy (2005)

Rainfall

Analysis of these records shows some statistically significant trends in the annual amount of precipitation (see Figures 2c and 2d). Across Devon there have been changes in annual rainfall, both increases and decreases, but Exeter has experienced significant drying. There are also some important changes taking place in the seasonality of rainfall as measured by the changing ratio of winter to summer rainfall. This ratio implies that there are significant differences between the periods before and after 1976, with summers getting drier and winters wetter. This is largely due to the unusual sequence of hot summers experienced across the UK.

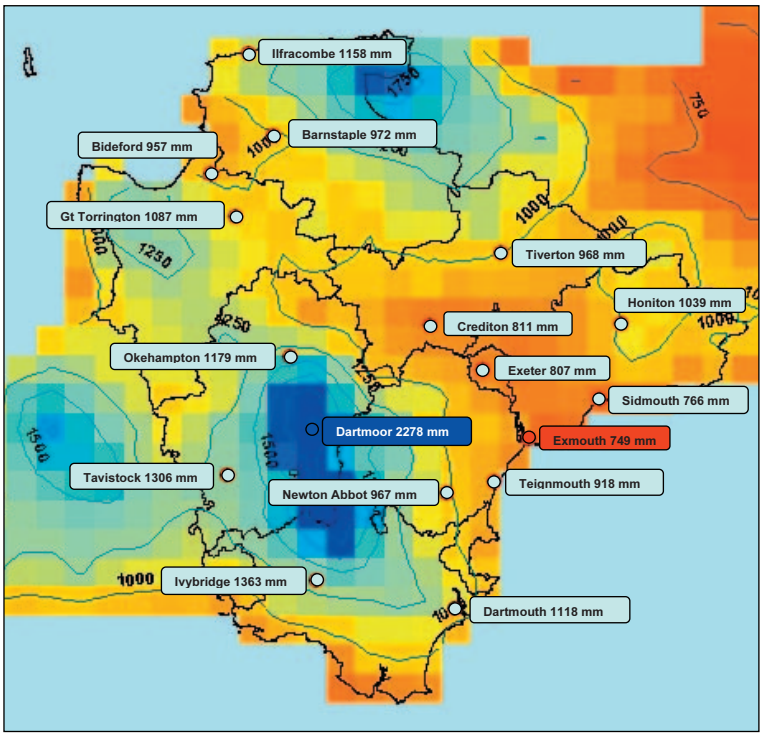


Figure 2c: **Long term average annual precipitation in Devon (1961 – 1990)**
Source: Devon County Council Climate Change Strategy (2005)

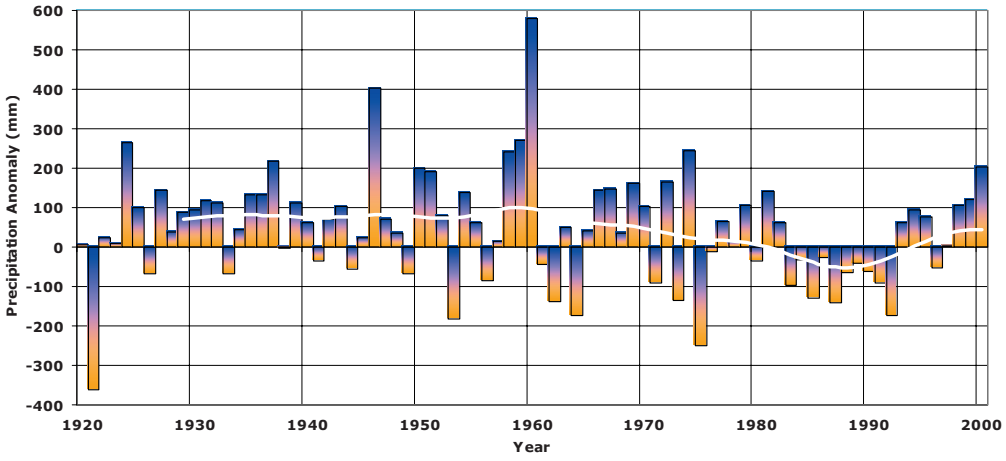


Figure 2d: **Annual precipitation for Exeter (1920 – 2000)**
Source: UKCIP in Devon County Council Climate Change Strategy (2005)

Sea Level

Sea level rise has two important components which in the South West act together to make it a more significant impact than for most other coastal regions of the UK. The first component is the on-going isostatic adjustment caused by deglaciation at the end of the last Ice Age. Whilst much of northern Britain is rebounding now that the weight of ice sheets up to 1.5km thick has been removed, much of southern Britain is still sinking. For the South West the present rate of subsidence is about 1mm per year. The second component is the increase in the volume of the oceans as they heat up due to global warming. Add to this thermal expansion process the melt water from valley glaciers, and total sea level rise in the South West is proceeding at about 2mm per year. Whilst this is a slow process, it does mean that sea level has risen by about one foot (30cm) since the construction of the Exeter to Newton Abbot rail link in the 1840s.

Image 2b: **Stormy sea at Dawlish**
Source: Exe Estuary Management Partnership

Image 2c: **View from Dawlish Warren**
Source: Exe Estuary Management Partnership

Projection for Future Climate Change

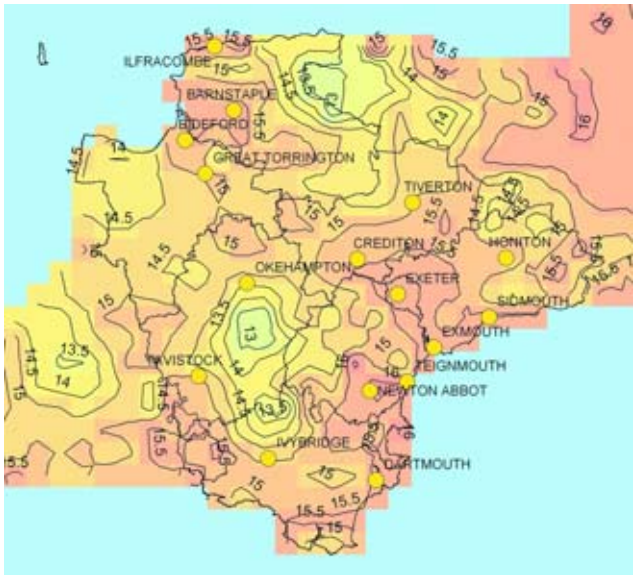
Simulating Future Climate and Emissions Scenarios

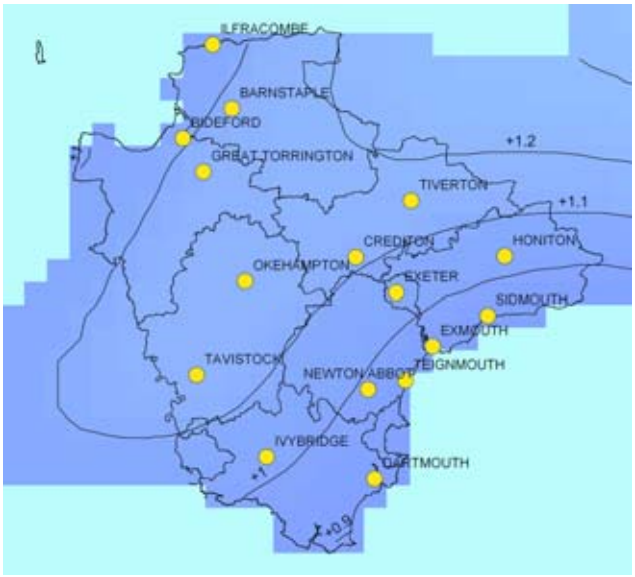
Whilst there remains considerable uncertainty over future projections, climate change scenarios have been created by the UK Climate Impacts Programme (UKCIP) to help us understand the evolution of our climate over the next 100 years. At one end of the scale is a business-as-usual view of the world which has the highest greenhouse gas emissions total. This is designated the "high emissions" scenario. At the other end is a scenario in which clean and efficient technologies are adopted, material use is reduced, population size is under control and global solutions to sustainability are widely implemented. This is designated as the "low emissions" scenario. The following Figures all use the high emissions projections.

Temperature

On an annual basis the rise in Devon's average temperature is likely to be less than 1°C by the 2020s regardless of scenario. The temperature rise by the 2050s may be between 1.4 and 2.3°C accelerating thereafter to up to 4.0°C by the 2080s. Seasonally, there may be greater warming in summer than winter. Spatially, there may be more warming in the north and east of the county than in the south and west reflecting the moderating influence of the sea around the coast and a marginal increase in continentality further inland.

Figure 2e: Change in mean summer temperature (°C) in Devon





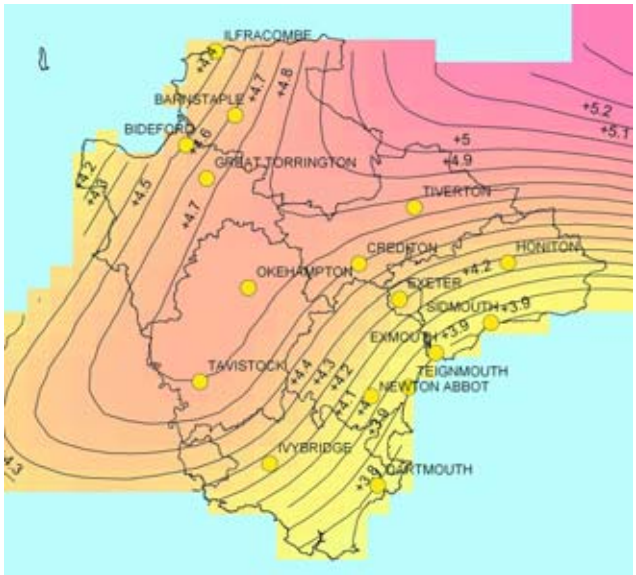


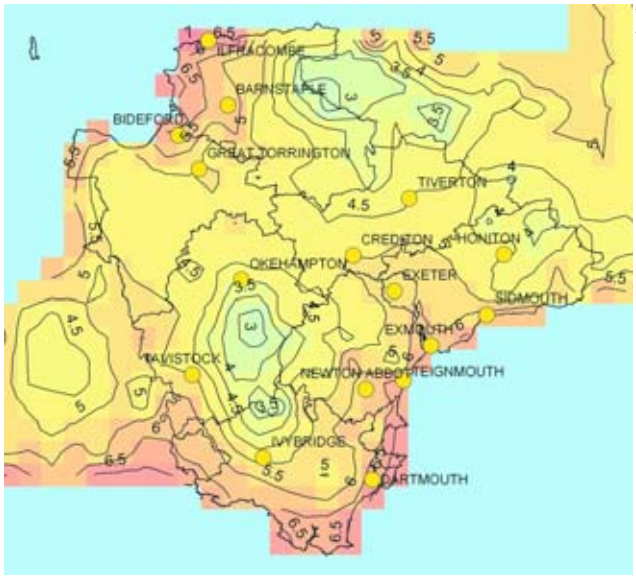
Figure 2ei: **Baseline mean summer temperature (°C) (1961 – 1990)**

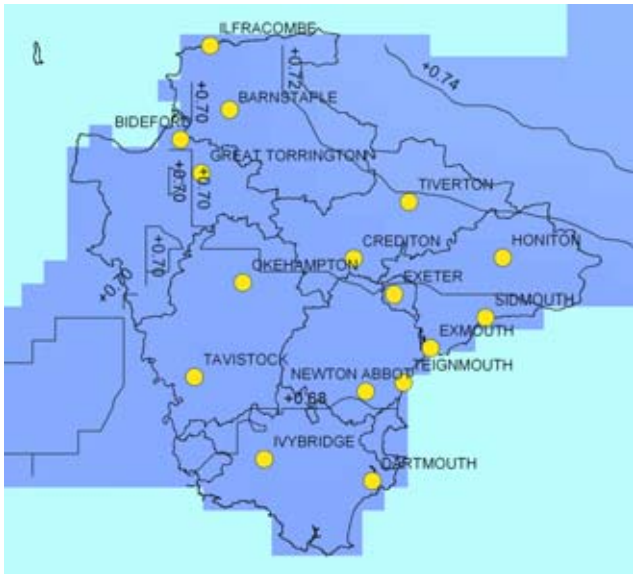
Figure 2eii: **Change in mean summer temperature (°C) by the 2020s for the high emissions scenario**

Figure 2eiii: **Change in mean summer temperature (°C) by the 2080s for the high emissions scenario**

Source: Devon County Council Climate Change Strategy (2005)

Figure 2f: Change in mean winter temperature (°C) in Devon





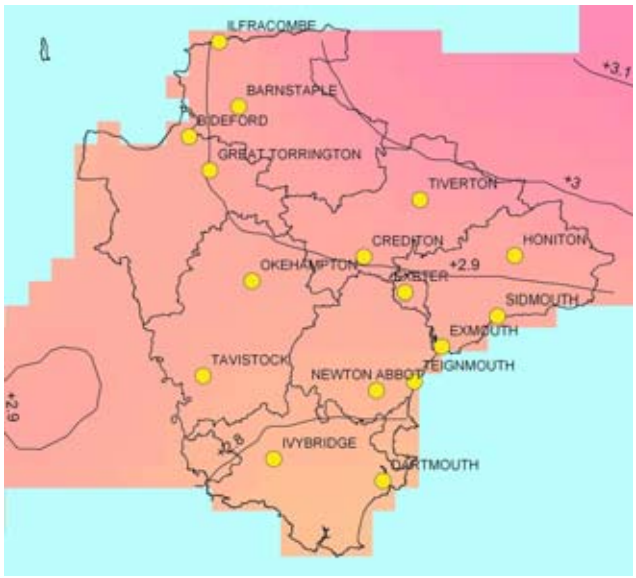


Figure 2fi: **Baseline mean winter temperature (°C) (1961 – 1990)**

Figure 2fii: **Change in mean winter temperature (°C) by the 2020s for the high emissions scenario**

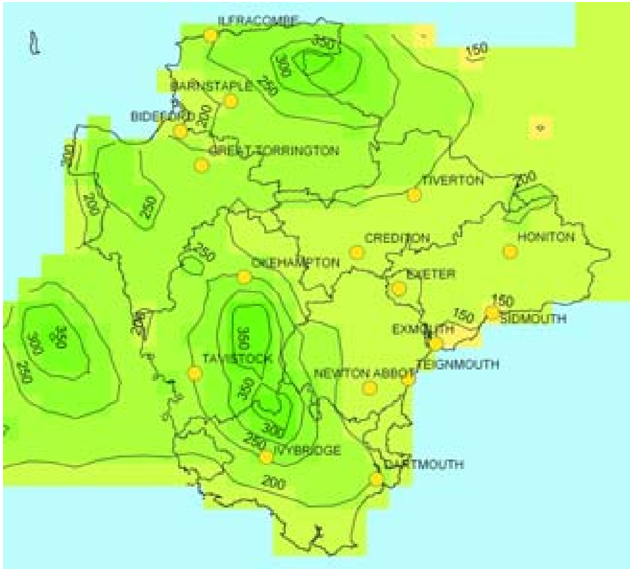
Figure 2fiii: **Change in mean winter temperature (°C) by the 2080s for the high emissions scenario**

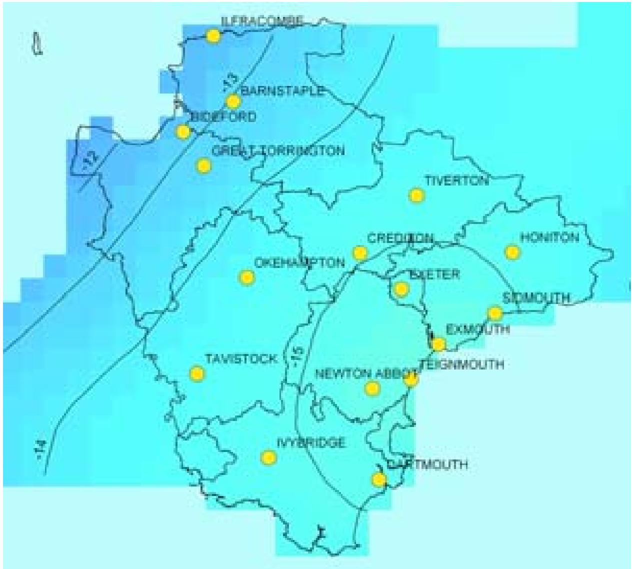
Source: Devon County Council Climate Change Strategy (2005)

Rainfall

On an annual basis the precipitation total for Devon shows a marginal decrease by the 2020s reducing further by up to 8% by the 2080s. All of these changes are within the current annual variability of ± 30%. Seasonally, winters may become up to 30% wetter in coastal regions by the 2080s. In the same time frame summers may become up to 55% drier; the epicentre of this drying is the Exmouth/Teignmouth/Newton Abbot area. There is already evidence that this trend is established.

Figure 2g: Percentage change in mean summer precipitation in Devon





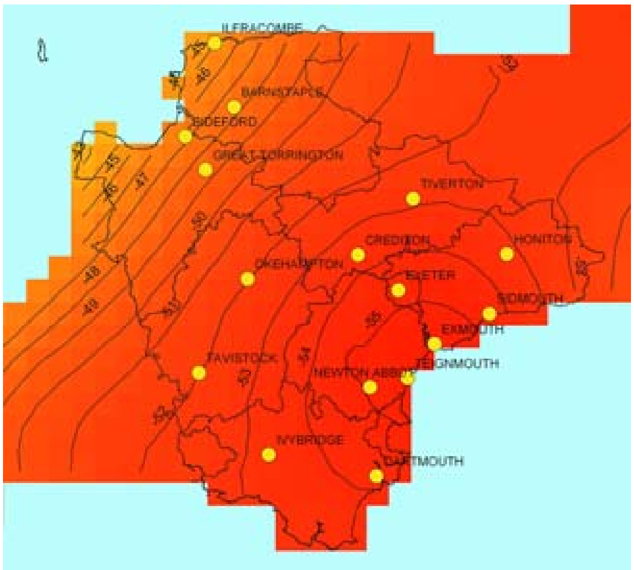


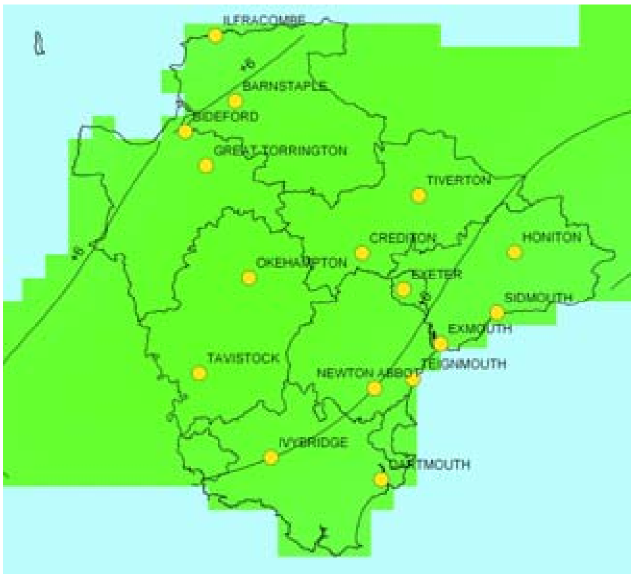
Figure gi: **Baseline mean summer precipitation (mm) (1961 – 1990)**

Figure gii: **Percentage change in mean summer precipitation by the 2020s for the high emissions scenario**

Figure giii: **Percentage change in mean summer precipitation by the 2080s for the high emissions scenario**

Source: Devon County Council Climate Change Strategy (2005)

Figure 2h: Percentage change in mean winter precipitation in Devon



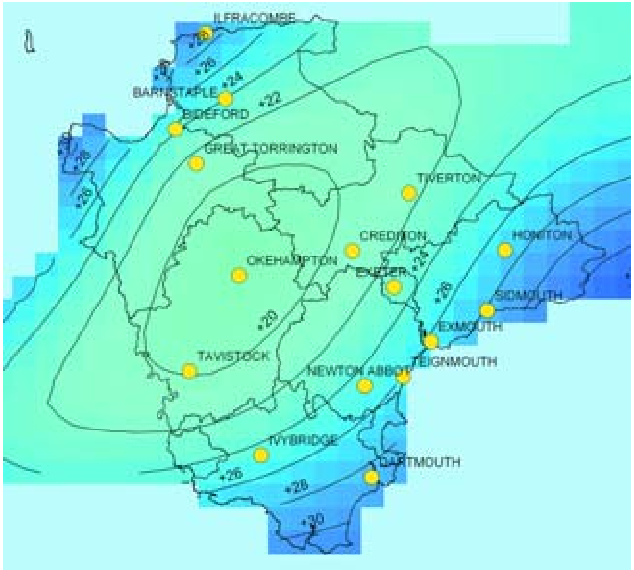


Figure 2hi: **Baseline mean winter precipitation (mm) (1961 – 1990)**

Figure 2hii: **Percentage change in mean winter precipitation by the 2020s for the high emissions scenario**

Figure 2hiii: **Percentage change in mean winter precipitation by the 2080s for the high emissions scenario**

Source: Devon County Council Climate Change Strategy (2005)

Sea Level

Relative sea level will rise around the coasts of the South West by between 20 and 80 cms over the course of this century. If we take a mid point in this range that means that over the next 75 years we can expect twice the rise experienced over the past 150 years. However, this in itself is not the real problem. On a calm day another couple of feet of water in the sea will not cause a flooding hazard to our coastal infrastructure but in storm conditions the situation could be grave. Storms are caused by areas of low pressure at the centre of which sea level can be up to 1 metre higher than normal. Moreover, storms crossing the South West peninsularhave very strong onshore southerly then easterly winds on their leading edge. This combination of low pressure and onshore winds generates a storm surge like that of October 2004. As climate change progresses we can expect an increase in the number of very deep lows transitting the South West delivering larger storm surges on top of a sea level already half a metre or so higher. The implications are that a 1 in 200 year storm today will become a 1 in 20 year event by the end of the century. This change in magnitude is the rule of thumb.

Climate Change Timings

Whilst climate change is a very slow process in human terms there are two important timing issues that need to be considered by decision makers. Firstly, as a consequence of the significant time lag in the climate system between cause and effect, the climate change that is occurring today is a consequence of global emissions released during the 1960s and 1970s. This means that there is already 30 to 40 years of climate change in the system about which we can do very little except adapt. Moreover, any action taken today to reduce emissions will not have an impact on climate until the 2040s and beyond. Therefore, the longer the shift to a low carbon economy is delayed, the more likely it is that future generations will experience the more extreme and potentially dangerous scenarios of the 2080s. Secondly, the climate change journey on which we are embarked has a one-way ticket. We cannot put the climate back to what it was nor can we expect to stabilise it for many hundreds of years given the long life of carbon dioxide in the atmosphere and the very long time it takes for the oceans to heat up and the ice sheets to melt.

Image 2d: **Storm at Dawlish**
Source: Exe Estuary Management Partnership

What are we already doing?

At a national level there are many policies and measures already being implemented that contribute to emissions reduction and climate change adaptation. These include the European level agreements to improve fuel efficiency of new cars, a number of schemes to improve energy efficiency in the residential sector, a shift in the Common Agriculture Policy from production-related subsidies to an environmental focus and the EU Landfill Directive and landfill tax.

In Devon the initiatives underway to prepare for and minimise the impact of climate change include a range of policies and proposals to

- reduce emissions of carbon dioxide
- minimise energy consumption
- increase use of renewable energy
- support development of sustainable transport plans
- prepare a number of local scale risk assessments
- put in place flood management strategies

In terms of coastal management, Devon County Council promotes the prioritisation of essential coastal defence works and the value of favouring natural processes where these can be accommodated. To prepare for the impact of climate change on biodiversity Devon's present approach is towards landscape-scale conservation which seeks to influence land management practices over large areas, in particular concentrations of important sites and in areas with good opportunities for enhancement. This approach will maximise the potential for ecological adaptation, by providing the widest possible range of niche sites. For example, butterflies currently associated with warm, south-facing bracken-covered hillsides might, in the future, require less warm locations and so revert to cooler north-facing hillsides. This will only work if suitable sites are available for them to move to, even though such areas are currently not considered to be so important for their wildlife interest.

Implications for the Exe Estuary

Image 2e: **View across the mouth of the Estuary**
Source: Exe Estuary Management Partnership

Image 2f: **Aerial of the mouth of the Estuary**
Source: Exe Estuary Management Partnership

As perhaps the most important scientific challenge of our time, climate change must be addressed when describing the current state of the environment. It is a cross cutting issue which will affect the physical character of the Exe Estuary, and therefore has implications for the human populations and wildlife that live on and use the Estuary. The following sections of this report must be read bearing in mind that in the long term preservation of the Exe and its Estuary as it is today will not be possible. A flexible, well-planned approach to management of the Estuary resource is needed, now and in the future. This report provides a snapshot of the state of the Estuary, but in the context of an ever changing environment.

On the Exe Estuary specific action could be taken to raise awareness of the causes of climate change and its impacts on the Estuary, and to monitor the slow changes that are taking place. In addition, the vulnerability of sites, habitats and processes operating within the Estuary need to be identified and assessed so that appropriate management strategies can be agreed.

Ian Bateman, Climate Change Officer, Devon County Council, 2006