

Climate Change in Essex - The evidence base and priorities for a county-wide action plan

Part 2 – Recommendations for Climate Change Action in Essex




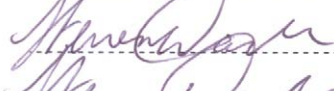

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Summary

Climate Change in Essex – The evidence base and priorities for a county-wide action plan

Part 2 - Recommendations for Climate Change Action in Essex

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HR Wallingford Ltd and AEA Technology plc.

Essex is vulnerable to a number of natural hazards, in particular flooding and drought, because of its low-lying topography and geographical location on the Thames Estuary and in one of the driest parts of the UK. Climate change will increase Essex's vulnerability to these hazards. Major development schemes within Essex, most notably the Thames Gateway, if left unchecked could exacerbate these problems. In addition, the proximity of Essex to London brings its own challenges with respect to infrastructure pressures and likely future life-style changes in the southeast, including migrating populations.

There is also an underlying need for Essex to take on its fair share of responsibility in limiting the escalation of global warming by addressing its contribution to national and global greenhouse gas emissions. Without such action, the East of England and the UK as a whole will fail to meet its targets laid down by the Kyoto Agreement.

Therefore, actions are needed as soon as possible to:

- Minimise the potential risks to people, property, businesses (including agriculture and tourism) and the environment caused by climate change.
- Minimise the impacts that Essex has on global warming.
- Plan for and take advantage of opportunities presented by a warmer climate (without causing negative impacts on others).

The effectiveness of these actions will depend on the:

- Integration of actions as part of the UK's and East of England's targets, policies and aspirations, as described in the East of England Regional Assembly's *Integrated Regional Strategy* (EERA, 2005).
- Co-ordination of actions across the county between local government, emergency services, businesses, farmers and landowners, transport and utility providers, non-governmental organisations and the general public.

The Essex Partnership

The Essex Partnership comprises approximately 120 organisations representing the interests of the people of Essex, including county, district, borough and parish councils, the police and fire authorities, health trusts, businesses and voluntary sector organisations. The purpose of the partnership is to provide a unified voice for Essex people on issues of key concern to the county.

The partnership's first task was to set out the agreed vision for Essex in *Shaping the Future of Essex – A Community Strategy 2004-2024* (Essex Partnership, 2004). Under the theme of "Conserving our Environment", it was identified that there was a need to plan and prepare for likely climate changes and to develop strategies to deal with the impacts and causes of climate change.

Project aim

The Essex Partnership, via the Environment Task Group, commissioned HR Wallingford Ltd with support from AEA Technology plc to determine a set of priorities to shape the delivery of action on climate change in Essex, drawing on a range of evidence that currently exists across a breadth of organisations within Essex and beyond.

This study provides recommendations regarding potential actions and how they might be implemented and monitored. It does not actually undertake the final decision-making regarding which actions will be implemented, nor does it provide detailed planning for these actions. It will be the responsibility of the Essex Partnership under the recommendations of the Environment Task Group to take the recommendations forward.

Climate change in Essex

Relative to the baseline period of 1961 to 1990, the main climate changes projected for Essex by the 2080s are listed below. All results are derived from the UKCIP02 Climate Change Scenarios as presented in Hulme *et al.* (2002).

- Winter temperatures will increase by 2-3°C
- Summer temperatures will increase by 3-5°C
- Winter precipitation will increase by 13-25%
- Summer precipitation will decrease by 24-47%
- Average sea levels will increase by 26-86cm*
- Extreme sea levels will increase by 80-140cm*

*including regional isostatic subsidence as well as climate change

What would happen if we did nothing?

Urgent action is needed to adapt to and to mitigate for climate change. The consequences of doing nothing or delaying action would include, but not be limited to:

- **Increases** in risks to public health and safety;
- **Increases** in economic damages (domestic, commercial, industrial and agricultural);
- **Reduced** economic potential for existing commercial, industrial and agricultural practices;
- **Damage** to or reduction in wildlife habitats;
- **Failure** to implement policies in the East of England Plan;
- **Failure** to meet government targets for greenhouse gas emissions;
- **Increased** climate change in the future, due to lack of immediate mitigation actions.

Top five threats from climate change

The following is a list of the most significant threats to Essex from climate change as identified by this study (in no particular order):

- Decrease in water resources exacerbated by a potential increase in demand
- Increase in risk to people, property and the environment from flooding
- Hotter and sunnier summers putting public health and safety at greater risk
- Hotter summers causing greater “heat stress” to buildings, utilities and the transport system
- Decrease in soil moisture (particularly during summer and autumn) affecting agriculture, the natural environment and landscape

Top five opportunities from climate change

The following is a list of the most promising opportunities for Essex from climate change as identified by this study (in no particular order):

- Increased tourism and leisure activities
- Reduction on cold weather related illnesses and accidents
- Reduction in heating bills, which would result in a reduction in domestic carbon emissions
- Increased demand for summer leisure products and fresh fruit and vegetables
- Opportunities for renewable energy and innovative construction/building service companies

The study identified more threats than opportunities, but it is recognised that opportunities provide valuable incentives for action, as long as actions do not have negative impacts on others.

Types of actions proposed

Both mitigation and adaptation actions are being considered. In both cases, the actions generally fall into the following six categories:

- **Awareness and education** - Increasing awareness and providing education for the public and businesses about climate change and how to mitigate its causes and adapt to its impacts.
- **Policies and plans** - Ensuring both mitigation and adaptation to climate change are addressed by all relevant policies and plans produced by authorities, agencies and non-governmental organisations in an integrated way.
- **Design for sustainability** – Encouraging businesses and other organisations (in particular local authorities, the construction industry and utility providers) to design infrastructure, buildings, etc. that will be resilient to climate change impacts (including flooding, heat stress, high winds and subsidence), whilst at the same time considering efficiencies in water consumption, energy consumption, reduction of greenhouse gas emissions and responsible usage of natural resources.
- **Funding and legislation** - Finding funding for initiatives aimed at reducing greenhouse gas emissions and dealing with the impacts of climate change and lobbying for changes in legislation to support such initiatives.
- **Leading by example and sharing expertise** - Encouraging authorities and businesses in Essex to lead by example in taking actions to reduce greenhouse gas emissions and in adapting to climate change and share their expertise both in terms of actions to reduce emissions and actions to adapt to climate change impacts.
- **Monitoring and review** – Undertaking monitoring exercises or more detailed risk assessments specific to the particular needs of the individual, business or organisation, prior to undertaking further actions.

Key actions proposed

The following is a list of the main themes behind the actions proposed by this study.

- **Improve water conservation** and match demand to resources through sustainable water resources and development planning;
- **Protect people and property from the consequences of flooding** without detriment to the environment and with appropriate consideration of the proposed government strategy in *Making space for water* (Defra, 2005);

- **Reduce carbon emissions** by increasing the use of renewable energy sources and by improving energy conservation, in particular related to buildings, transport and production;
- **Protect people and property from the effects of heat and UV radiation**, such as the development of cooling systems, changes in working practices and provision of shade in public green spaces;
- **Promote sustainable tourism**, recognising the potential demands that tourism makes on the county as well as the potential benefits.

Current actions

This study has identified that there are many and varied actions and initiatives already taking place in Essex that are broadly addressing these issues. These include the Greener Essex campaign, the Essex Development and Regeneration Agency (ExDRA), the Essex Design Initiative, the Abbots Hall Farm project by the Essex Wildlife Trust and information on the Essex County Council and Environment Agency websites. Further details of these and other actions and initiatives are provided in *Part 1 – Project Report*.

Next steps

It is not possible to do everything immediately and actions should be managed in a co-ordinated manner to ensure consistency of message and to prevent duplication of effort. However, a number of measured steps forward are proposed by this study and are summarised below. It is the responsibility of the Essex Partnership to review these proposed steps and take them forward as appropriate.

1. Encourage all Local Authorities in Essex to sign up to the Nottingham Declaration on Climate Change.
2. Encourage all Local Authorities to lead by example regarding energy conservation and the use of renewable energy. This should include Essex County Council reviewing its Renewable Energy Strategy (Essex County Council, 2003).
3. Encourage all Local Planning Authorities to promote the sustainable planning and design of new development, with particular regard to both climate change adaptation and mitigation measures. This needs to include appropriate support at the county and regional strategic planning levels. At all levels of planning there should be greater emphasis of water resource management, flood risk reduction and management, resilience of buildings and infrastructure to climate change and low/no net increase in greenhouse gas emissions.
4. Encourage closer co-ordination between organisations and individuals that play a part in flood and coastal erosion risk management (including Local Planning Authorities, Emergency Services, community groups and landowners, as well as flood and coastal defence authorities) to increase the sustainability of flood and coastal erosion risk management in conjunction with ensuring sustainable development for effected areas of Essex.
5. Promote the importance of action on climate change, in particular with the general public and private sector, through the Essex Partnership website and other communication channels used by the Partnership, with cross-references to the network of related initiatives in Essex, such as *A Greener Essex* campaign. This should include the provision of both reports from this study on the website.
6. Get sign-up from both public and private sector members of the Essex Partnership to take forward the identified actions through collaborative task groups, as appropriate (building on the guidance provided in this report regarding implementation, monitoring and review).

7. Collate information from ongoing schemes, initiatives and pilot sites to better inform the detailed scoping of actions and to act as “flagships” for future initiatives.
8. Consider the continuing role of the Environment Task Group to champion climate change issues in Essex, or the creation of a specific climate change group, to push forward these next steps.

These steps are described in more detail in Section 15 of this report.

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Photograph courtesy of Essex County Council

1. Introduction

1.1 PURPOSE OF THIS STUDY

The Essex Partnership requires a set of priorities to shape the delivery of action on climate change in Essex, drawing on a range of evidence that currently exists across a breadth of organisations within Essex and beyond.

This evidence base includes:

- Climate Change Scenarios for the United Kingdom: The UKCIP02 Scientific Report (Hulme, M. et al., 2002)
- Living with Climate Change in the East of England, Stage 1 Report: Guidance on Spatial Issues Living with Climate Change in the East of England and Stage 2 Report: Draft Guidance for Local Service Provision (Land Use Consultants, CAG Consultants and SQW Limited, 2003a and 2003b)
- Results from the Chelmsford climate change conference in March 2004
- A range of research projects and area specific studies in individual sectors, such as flood risk and water resources. References are provided at the end of this report and an Appendix is also provided with details of additional supporting material.

Further details regarding study objectives are provided in *Part 1 – Project Report*.

1.2 STUDY REPORTS

This study has produced two reports. These being:

Part 1 - Project Report, which provides a detailed record of the tasks undertaken during this study and the resultant recommendations, following the decision-making framework described in Willows, R.I. and Connell, R.L. (Eds.) (2003) *Climate adaptation: Risk, uncertainty and decision-making*, UKCIP Technical Report, UK Climate Impacts Programme, Oxford.

Part 2 - Recommendations for Climate Change Action in Essex (this report), which summarises the climate change impacts for Essex identified by this study and presents the recommended actions.

1.3 REPORT STRUCTURE

Actions have been proposed in this report covering each of the following topics:

- **People** (including health and social care, employment, education and training, community facilities/benefits, culture)
- **Domestic properties**
- **Businesses**
- **New development**
- **Agriculture** (including forestry and fishing)
- **Transport** (e.g. rail, road, air and maritime)
- **Utilities** (e.g. water supply, sewerage, waste and recycling, electricity, gas, telecommunications)

- **Emergency services** (including fire, police, health service, coast guards and lifeboat services)
- **Natural environment**
- **Landscape, heritage and archaeological sites**

1.4 HOW ACTIONS HAVE BEEN ASSESSED

Actions have given a relative significance, identified as being H-High, M-Medium and L-Low. This relative significance is a qualitative assessment of the relative change in probability of the hazard and the spatial extent of the impact.

No regret and low regret actions have been identified:

- ✓ **No regret** actions have clear benefits (especially for public health and safety, the environment or economically) under present-day climate conditions as well as all plausible future climate change scenarios. No regret actions have also been identified as those that are already underway and this study confirms their value in tackling climate change for Essex.
- ✓ **Low regret** actions have been identified as those that have some degree of uncertainty regarding future scenarios or the extent of the benefits. It is advisable that these actions are not undertaken until appropriate feasibility studies have been carried out to understand the specific issues associated with the action on a case by case basis.

Only no regret and low regret actions have been presented in this report. Other actions can be found in *Part 1 – Project Report* along with more detailed descriptions of both positive and negative consequences of individual actions. Appendix B in *Part 1 – Project Report* provides details of adaptation actions and Appendix C provides details of mitigation actions.

Both adaptation and mitigation actions have also been identified as falling into one of the following timescales:

- **Act now** and aim to have full implementation within the short-term, say 2-5 years;
- **Plan ahead** for implementation within 5-10 years; or
- **Monitor** situation and review action plan or implement actions as required.

2. *A summary of Essex*

The county of Essex, including the unitary authorities of Thurrock and Southend-on-Sea, has a population of over 1.61 million, based on the 2002 census.

Essex is subject to significant development pressure and includes parts of two of the four nationally identified Growth Areas: the Thames Gateway (with the area within Essex being referred to as Thames Gateway South Essex) and the London-Stansted-Cambridge-Peterborough corridor (which consists of the Harlow-Stansted-M11 corridor within Essex). A major programme of housing and commercial development with associated transport links and services is planned over the next 11 years (with approximately 40,000 new homes and 55,000 new jobs created by 2016). This is in addition to development planned in existing Local Plans/Local Development Frameworks.

Essex contains important transport links, notably the international port of Harwich (with expansion proposed in Bathside Bay) and Stansted Airport (where major expansion is proposed¹). There is an extensive road network, much of which serves a commuting London workforce. All these different transport links would be affected by extreme weather conditions, predicted to become more frequent with climate change.

Essex is an important agricultural region with farmland covering more than half of the county. Therefore, agriculture has become a major influence in the County's landscape. In the south of the County there is a high concentration of automotive manufacturing activities and West Essex has large pharmaceutical companies.

The County has a high quality landscape and important inland and coastal environmental areas, many of which are protected by national and international environmental designations. Essex saltmarshes account for one tenth of the national resource. Essex also has an extensive network of inland waterways, as well as 350 miles of coastline, mostly very low-lying, with numerous seaside resorts. Historically there has been considerable development along the coastline including Harwich Port, Clacton and Maldon and on Thames side. Coastal development in these areas is vulnerable to flooding, requiring extensive flood defences.

Various studies have been undertaken or are ongoing looking particularly at present and future flood risks (with climate change) in particular in the Thames Gateway Growth Area. These include the Thames Gateway South Essex Strategic Flood Risk Assessment, the Thames Estuary 2100 study and the Association of British Insurers (ABI) Making Communities Sustainable study (Entec *et al.*, 2005).

Because of its topography and geographical location much of Essex is vulnerable to a number of natural hazards including high winds and gales, coastal and river flooding, subsidence and drought.

¹ National government policy sets out a strategic framework for the development of airport capacity in the UK over the next 30 years and has earmarked Stansted for an additional runway to enable 80 million passengers to use the airport every year (Department for Transport, 2003).

3. Climate change in Essex

3.1 SUMMARY OF CLIMATE CHANGE SCENARIOS FOR ESSEX

Relative to the baseline period of 1961 to 1990 the projections for the primary climate change variables for Essex are the following:

Table 3.1 Summary of climate change projections for Essex

Climate Variable	UKCIP02 Time-slices		
	2020s	2050s	2080s
Precipitation			
Annual	↓ 2%	↓ 4-6%	↓ 5-10%
Winter	↑ 5-6%	↑ 9-15%	↑ 13-25%
Summer	↓ 10-11%	↓ 17-27%	↓ 24-47%
Temperature (daily mean)			
Annual	↑ 1°C	↑ 2°C	↑ 2-4°C
Winter	↑ 1°C	↑ 1-2°C	↑ 2-3°C
Summer	↑ 1°C	↑ 2-3°C	↑ 3-5°C
Sea Level (average)*			
Annual	↑ 12-22cm	↑ 19-48cm	↑ 26-86cm
Wind speed (average)			
Annual	Unchanged	↑ 0-1m/s	↑ 1m/s
Winter	↑ 1-2m/s	↑ 3-4m/s	↑ 4-7m/s
Summer	Unchanged	↓ 1m/s	↓ 2-3m/s
Cloud cover			
Annual	↓ 1-3%	↓ 3-6%	↓ 3-9%
Winter	Unchanged	Unchanged	↑ 0-3%
Summer	↓ 3-4%	↓ 5-10%	↓ 6-15%+

* Net sea-level change for Essex includes regional isostatic subsidence as well as climate change.

Winter refers to the months of December, January and February.

Summer refers to the months of June, July and August.

3.2 PRECIPITATION

Flooding caused by increases in winter rainfall is a potential hazard. The consequences to public health and safety, domestic properties, businesses, agriculture, transport and utilities are well known. This could be fluvial, pluvial or sewerage flooding.

Fluvial (river) flooding

Due to the characteristics of the main rivers in Essex, the increase in spatial extent of flooding would be relatively small. However, the frequency of flooding for those already at risk could increase noticeably.

Pluvial (overland) flooding

Pluvial flooding or overland runoff, which is sometimes referred to as flash flooding, is a very localised phenomenon and dependent on a number of other factors including local topography, soil moisture and land use practices. For this scale of assessment the significance of this type of flooding cannot be determined, although this is likely to increase.

Sewerage flooding

Sewerage flooding, sometimes referred to as artificial drainage flooding as it covers foul, combined or surface water drainage, is likely to be more significant than pluvial flooding. However, this is very much dependent on the current hydraulic performance of the sewers. This type of flooding may occur more regularly than fluvial flooding (depending on future investment in drainage improvements undertaken by the Water Companies), but only in localised areas. Again, for this scale of assessment the significance of this type of flooding for Essex as a whole cannot be determined.

Decrease in water resources versus demand

The most significant hazard caused by the change in precipitation is the lack of annual replenishment of water resources as a result of the decrease in annual rainfall.

The consequences of this are potentially severe, especially when combined with:

- The limited water resources available at present in Essex (Environment Agency, 2001a, 2001b, 2004)
- The likely increase in demand (particularly during the summer months) resulting from other climate change variables in particular temperature, and
- The anticipated increase in demand resulting from the substantial amount of development planned for Essex (East of England Plan Sustainability Appraisal Report, 2004).

The potential consequences are far reaching, impacting on domestic properties, businesses (including tourism, manufacturing and service industries), agriculture and the natural environment.

There are potential opportunities to enhance water capture during the winter months² in new or expanded reservoirs, but the effectiveness of this needs to be determined on a site by site basis. In general, water supply companies currently believe that the yield from current reservoirs is likely to decrease.

Water transfer from outside Essex is likely to become less sustainable in the future, especially if served by rivers rather than reservoirs, as rainfall (and hence river flows) will also be decreasing in the surrounding counties and demand in these counties will also be increasing.

3.3 TEMPERATURE

The projected increase in year-round mean temperatures, increase in “extremely” warm days in the summer, decrease in heating degree days and increase in cooling degree days all generate different hazards and consequences.

Extremely warm days in summer

The projected increase in extremely warm days during the summer is likely to be highly significant. Public health and safety, whether related to tourism or employment by businesses or agriculture, could be affected significantly, which in turn puts pressure on the emergency and healthcare services. Heat stress to buildings, transport infrastructure, utilities and livestock is also likely to be significant and high temperatures increase peak

² Although it should be noted that spring and autumn rainfall is also projected to decrease in Essex (see Section A.2.1.1 in Appendix A).

demands for water (as discussed earlier under precipitation). The risk of fires is also a potential concern for agriculture, the natural environment and landscape.

Year-round temperatures

The projected increase in year-round temperatures is also likely to have significant consequences, particularly for the natural environment where the pressure on river and wetland ecologies are of greatest concern. It is also possible that there would be increases in pests and diseases, which would affect agriculture, the general public, businesses and waste facilities, particularly landfill sites.

Heating degree days

The consequences of fewer heating degree days tend to be opportunities rather than threats and should be taken as an opportunity to offset the consequences of more cooling degree days.

Cooling degree days

The projected increase in cooling degree days would have a noticeable impact on businesses and agriculture that will be faced with the requirement to provide an increase in cooling and refrigeration facilities. Without this, there would be secondary consequences for the workforce, livestock and productivity. In turn, provision of such facilities will put greater pressure on water resources and energy generation.

The number of cooling degree days is one of the easiest indicators to define “summer conditions” for predicting social behaviour. Therefore, the increase in cooling degree days is likely to result in an increase in tourism and use of the leisure industry, changes in demands for food and drink, increases in demand for particular products, etc. This in turn will have impacts on businesses, agriculture, landscape, heritage and archaeology.

3.4 SEA LEVEL

There are hazards associated with the increase in mean sea level and extreme sea level. There is much greater confidence in the projects for mean sea level changes than extreme sea levels. However, as the two are related some of the consequences (and to a greater extent the potential responses) are similar.

Mean sea level

The projected increase in mean sea level is likely to have greatest significance on the natural environment due to the landward transgression of the estuaries resulting in coastal squeeze. This would affect a very significant proportion of existing saltmarsh. Mudflats, however, would increase and a suitable trade-off should be established. Inland and inshore fisheries could also be affected (Posford Haskoning, 2002).

The projected increase in mean sea level (in combination with extreme surges) may also result in loss of beaches, which have consequences for protection of natural habitats and sea defences (causing an increase in flood risk for defended properties, both business and domestic).

Extreme sea level

The most significant hazard caused by the projected increase in extreme sea level is the increase in risk of tidal and coastal flooding based on current levels of defence along the whole of the Essex coast. This will have significant consequences for public health and safety (with knock-on effects for the emergency services), domestic properties, businesses, agriculture, transport, utilities and landscape, heritage and archaeology. The

increased risk to the public and properties will be compounded by new development in these areas.

There would probably also be an increase in coastal erosion, which would also affect agriculture, landscape, heritage and archaeology, transport, domestic properties and businesses. However, the significance of this is likely to be much smaller than flooding.

3.5 WIND SPEEDS

The projected increase in average winter and spring wind speeds has a low level of confidence associated with it and the change is relatively small. Therefore, potential consequences are considered relatively insignificant.

It is not unreasonable to assume that there will be gales and high winds associated with increased storminess, but again there is a low level of confidence in modelling the extent of the storminess. Therefore, potential consequences are considered relatively insignificant compared to the consequences described above.

3.6 CLOUD COVER

The projected reduction in spring, summer and autumn cloud cover would result in an increase in UV radiation, which could have consequences for public health (whether associated with leisure activities or outdoor employment). However, due to the relatively low confidence in the projections, this consequence has been given a lower relative significance score compared to consequences to other more certain climate change variables. This is reflected in the risk prioritisation summarised below.

3.7 OCEAN CLIMATOLOGY

Projections of ocean climatology are currently limited to sea surface temperatures, which are projected to rise. This may have consequences for the fishing industry, but the scale of this is unknown, especially as the non-climate related factors of over-fishing and fishing quotas also play a major role.

3.8 GROWING SEASON

The projected increase in thermal growing season could have significant consequences for agriculture, forestry, parks and gardens. However, this would in turn have secondary consequences in increasing demands for water and energy, associated with sprinklers and irrigation.

It should be noted that the actual growing season is also dependent on soil moisture, cloud cover, day-length and land use practices.

3.9 SOIL MOISTURE

The projected reduction in summer and autumn soil moisture would have significant impacts on agriculture, increasing needs for irrigation and putting additional pressure on water resources and energy generation. To a less extent it will also have an impact on gardens, parks, sports grounds, trees and archaeological sites, which all have consequences on tourist and leisure activities. There is also a potential impact on landfill sites, suffering from failure of clay seals.

Soil moisture also has an impact on the risk of subsidence, although this is very much dependent on local soil conditions. In localised areas this could have consequences for domestic, business and heritage properties and on transport assets, such as roads, embankments, rails, bridge foundations and underpasses.

3.10 OTHER CLIMATE VARIABLES

Due to Essex's geographical location and climate, it is not possible to rule out any climatic variables at this stage from the analysis. However, there are a few climate variables that we do not understand sufficiently to determine whether or not they are significant. These are:

- Weather types
- Pressure gradient
- Storm tracks
- Ocean climatology (other than sea surface temperature)
- Lightning

This study does not consider the potential impact on the UK of changes in the Gulf Stream. Further information regarding this can be found in Part 1 – Project Report.



Clacton sea defences © Dr Chris Gibson/English Nature

4. *Actions for ensuring public health and safety*

4.1 ADAPTATION ACTIONS

Public health and safety is anticipated to be put at greater risk primarily as a result of high temperatures and increased flooding.

Hot weather

High temperatures will increase mortality of the vulnerable (including the elderly, the very young and the long-term sick) and increase cases of heat stroke and other illnesses triggered by hot weather. Alongside this, due to the reduction in cloud cover and the increased likelihood of outdoor activities, exposure to UV radiation will increase, increasing the number of cases of skin cancer, cataracts and severe sunburn.

Since the heat wave of August 2003 many studies have been undertaken regarding the impact of this event on public health and as a result more information is now available for both the public and professionals regarding how to manage these conditions. However, there are a number of inter-related actions that can still be undertaken to help improve safety of the public.

Flood risk

Due to increased sea levels, potentially compounded by greater surge heights, and to a lesser extent increased river flooding, flood risks to people will increase in Essex. Several studies are currently underway or planned for the near future to look at this issue in much greater detail than this study and it is recommended that these are referred to in due course.

Clearly the protection of public health and safety sits side by side with protection of property and further recommendations regarding this are provided in the following sections.

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale		
				No regret	Low regret
<div style="background-color: #fce4d6; padding: 2px;">Threats</div> <div style="background-color: #e8f5e9; padding: 2px;">Opportunities</div>					
Increase in mortality during extremely hot weather, increase in cases of heat stroke and other hot weather illnesses	H	Increase dissemination of currently available information on public health and safety in hot weather	Act now	✓	
		Look for funding for additional healthcare visits for the vulnerable in hot weather (such as the elderly and long-term sick)	Plan ahead		✓
		Encourage voluntary groups and individuals to check on the vulnerable in hot weather (as currently encouraged in cold weather)	Act now	✓	

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale	No regret	Low regret
Threats					
Opportunities					
Increased UV radiation and risk of sunburn, skin cancer and cataracts	H	Adopt cover-up policies for nurseries and schools	Act now		✓
		Support the national Sun Safe and Sun Smart campaigns locally	Act now	✓	
Increases in risks to people (including drownings, injuries, water borne diseases and mental stress) due to flooding	H	Encourage greater integration of flood forecasting, flood warning and emergency planning across organisations, including the lessons learnt from Exercise TRITON '04	Act now	✓	
		Undertake a watching brief of ongoing EA and Defra research and initiatives, including Making space for water and the joint R&D programme	Monitor	✓	
		Review success of “Borrowed Land” for schools and “Fragile Land” for professionals and look at the potential for providing similar educational material for inland flood risks	Act now	✓	
Increased cases of drowning and water borne diseases due to leisure activities	H	Monitor the need for improved signage and public information regarding water safety	Monitor	✓	
		Monitor the need for more lifeguards and coast guard services	Monitor	✓	
Increased cases of food poisoning	H	Encourage greater emphasis in the media of food hygiene in the home	Act now		✓
Increased risk of vector-borne diseases	H	Monitor and plan for arrival of vector-borne diseases	Monitor		✓
Reduction in cold weather illnesses (particularly amongst the elderly)	H	Monitor reductions in cold weather illnesses and consider the redirection of resources to be redirected to hot weather healthcare	Monitor		✓

4.2 MITIGATION ACTIONS

There are no mitigation actions identified by the study that can be considered as the direct responsibility of those responsible for ensuring public health and safety. However, mitigation actions identified under other topics will have secondary benefits for public health and safety, for example the reduction of carbon emissions would improve air quality.

5. Actions for domestic properties

5.1 ADAPTATION ACTIONS

The most significant climate change impacts likely to be experienced by those owning and/or living in existing domestic properties are water supply problems and property damage due to flooding. Issues related to new development are discussed separately in Section 7.

Water supply and demand

Essex already suffers from limited available water resources and is considered one of the driest counties in the UK. Climate change projections indicate a substantial decrease in annual rainfall, which will put increased pressure on these limited resources. In addition to this, the lifestyle adopted during hot weather, including the use of swimming or paddling pools, garden watering, more frequent showers, etc. will increase demand.

The Water Companies and the EA have been undertaking water conservation campaigns for a number of years and Essex County Council is also promoting water conservation through the Green Essex campaign. In addition to this, various initiatives are underway to design new houses to be more water efficient as part of the overall campaign to provide sustainable development in the light of climate change, such as *Adapting to Climate Change: A Checklist for Development* (Three Regions Climate Change Group, 2005). However, despite all of these efforts the message of water conservation has not significantly altered the behaviour of the public to date. Therefore, there remain actions that can be undertaken.

Flood risk

As stated earlier flood risk will increase in Essex and several studies are currently underway or planned for the near future to look at this issue in much greater detail. However, these studies are primarily concerned with flood risk management at a relatively large scale and as with all risk management it is impossible to prevent flooding entirely. Therefore, there are actions that can be undertaken by individual property owners or communities to protect themselves from the consequences of flooding.

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale	Regret	
				No regret	Low regret
<div style="background-color: #fce4d6; padding: 2px;">Threats</div> <div style="background-color: #e2efda; padding: 2px;">Opportunities</div>					
Water supply shortages and increased demand of water supply	H	Increase the number of properties with water-meters (ongoing initiatives by Water Companies)	Act now		✓
		Increase public education on water conservation, by expanding the information already available on the Greener Essex website, by supporting the ongoing initiatives by Water Companies and the EA and, in particular,	Act now	✓	

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale	No regret / Low regret	
				No regret	Low regret
<p style="background-color: #f4a460; padding: 2px;">Threats</p> <p style="background-color: #90ee90; padding: 2px;">Opportunities</p>		<p>Look at the possibility of producing educational material for schools and colleges identifying the specific challenges facing Essex and use the schools themselves as a means of demonstrating water efficient practices</p> <p>Further encourage the use of water efficient appliances and fittings by supporting the ongoing initiatives by Water Companies and promoting water efficient design of new developments</p> <p>Look at the feasibility of banning non-efficient appliances from the market or charging increased rates for users</p> <p>Further promote dry gardens and rainwater collection by supporting ongoing initiatives by Water Companies and the EA and providing demonstration projects in public parks and gardens</p>	<p>Act now</p> <p>Act now</p> <p>Plan ahead</p> <p>Act now</p>	<p>✓</p> <p>✓</p> <p></p> <p>✓</p>	<p></p> <p></p> <p>✓</p> <p></p>
Increased property damage due to flooding	H	Provide wider publicity of information about flood risk already available to the public through existing initiatives by the EA, ABI, WaterVoice and ECC website	Act now		✓
		Provide wider promotion of flood protection products, such as the BSI Kitemark Scheme, currently promoted via the EA website	Act now		✓
		Continue to encourage community involvement in local strategy planning, etc. building on the Community Strategies and the increasing requirement for stakeholder engagement in other strategies as part of Sustainability Appraisals	Act now	✓	
		Use the outputs from CFMPs, fluvial flood risk studies, the Estuary Studies (including Thames Estuary 2100), the CHaMP and SMP2 to better inform other strategies and plans regarding flood risk management	Plan ahead	✓	

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale	No regret	Low regret
Threats					
Opportunities					
Increased summer energy requirements for air conditioning, refrigeration, etc.	H	Continue to promote energy saving initiatives, energy efficient appliances and alternative natural cooling methods	Act now	✓	
Reduced heating bills	H	Encourage diversion of spending on house cooling techniques, whilst promoting energy saving measures for both domestic heating and cooling	Plan ahead	✓	
Increased property damage due to coastal erosion	L	Continue to encourage community involvement in coastal erosion risk management, building on the Community Strategies and the increasing requirement for stakeholder engagement in other strategies as part of Sustainability Appraisals	Act now	✓	
Increased property damage due to gales and high winds	L	Ensure insurance is available through collaboration with the ABI	Monitor		✓
Increased property damage due to subsidence	L	Ensure insurance is available through collaboration with the ABI	Monitor		✓



Photograph courtesy of Essex County Council

5.2 MITIGATION ACTIONS

Actions taken by individual house owners and occupiers can contribute significantly to the overall reduction in greenhouse gas emissions for Essex. These are primarily in the form of either conserving energy or using renewable energy sources. Proposed no regret and low regret actions are presented in the table below.

Conserving energy

All energy conservation actions for domestic properties have been identified as “Act now”. These actions will require a campaign for increasing public awareness. By identifying the immediate benefits to energy bills, this may act as a relatively strong incentive for action by the public. However, the encouragement of a behavioural change is not an instantaneous process. Therefore, a series of public campaigns are likely to be more effective, rather than a one off action. The use of grants to support campaigns to install insulation, etc. should also be taken into consideration.

Low energy bills for rented properties also offer a potential market edge for landlords. In addition, local authorities could lead the way by installing energy efficiency measures in council owned homes.

Renewable energy

The use of renewable energy in the form of direct action by house owners (as opposed to energy providers) is likely to require more detailed consideration of financial incentives, such as the provision of grants, and the relative benefits of renewable energy generation at the individual property scale compared to the community or county scales. Therefore, these actions have been identified as “Plan ahead” actions.

Mitigation Approach	Proposed Action	Timescale	No regret	Low regret
			✓	✓
Conserving energy to reduce greenhouse gas emissions	Promoting a “switch off or turn down” campaign for lighting, other electrical appliances and central heating	Act now	✓	
	Retrofitting insulation to walls and lofts	Act now	✓	
	Retrofitting double, triple and krypton/argon filled low e glazing	Act now	✓	
	Use low energy light bulbs and appliances	Act now	✓	
Using carbon neutral fuels/energy sources to generate energy without producing carbon emissions	Increase the use of solar electric (PV) to generate electricity and active solar water heating (ASWH) to generate hot water	Plan ahead	✓	
	Increase the use of building mounted wind turbines	Plan ahead		✓

6. *Actions for businesses*

6.1 ADAPTATION ACTIONS

Businesses have the potential to be affected by a very wide range of climate change impacts, providing both threats and opportunities for businesses. Therefore, the need for businesses to plan for the impacts of climate change is clear. Useful information is available in a new UKCIP document called *A changing climate for business – business planning for the impacts of climate change* (Metcalf and Jenkinson (Eds.), 2005).

6.1.1 *Threats*

The three principle threats for Essex businesses identified by this study are related to hot weather conditions, water supply and flooding.

Hot weather

The climate change projections of an increase in the number of extremely warm summer days would result in increased heat stress for building services and the workforce (leading to absenteeism). The health and safety of those working out of doors is a particular consideration due to exposure to UV radiation, as well as high temperatures. In addition to the extremely warm days, the increase in the number of warm days in general would result in an increased need for air conditioning and refrigeration. However, the hot weather does present opportunities in tourism, sales and building services.

Water supply and demand

As stated earlier, with Essex's limited available water resources, climate change will put increased pressure on these limited resources. In addition to this, the increased need for air conditioning, refrigeration, potentially increased tourism and use of leisure facilities will all put additional demands on this limited resource.

Flood risk

As stated earlier, flood risk will increase in Essex and several studies are currently underway or planned for the near future to look at this issue in much greater detail. However, these studies are primarily concerned with flood risk management at a relatively large scale and as with all risk management it is impossible to prevent flooding entirely. Therefore, there are actions that can be undertaken by individual businesses to protect themselves from the consequences of flooding.

6.1.2 *Opportunities*

Businesses have been identified as having the greatest number of opportunities arising from climate change. These are predominantly associated with innovative building service and renewable energy businesses: increased tourism and leisure industries; and producers and suppliers of fine/hot weather food, drink and leisure goods.

The Essex Development and Regeneration Agency (ExDRA) may prove to be a valuable vehicle for promoting future initiatives, in particular in relation to sustainable tourism and innovative businesses.³

³ Further information can be found at <http://www.exdra.co.uk/>.

Innovative building service and renewable energy businesses

Innovative building services and renewable energy businesses are linked, as both contribute to adaptation and mitigation actions. Both types of businesses are likely to have increasing opportunities in the future, if they are able to promote the savings they can offer other businesses and if they are able to take advantage of new initiatives to improve green credentials of businesses, such as the procurement practices currently being reviewed by Essex County Council. The benefits to the environment are clear, with or without climate change. Therefore, the proposed actions have been categorised as “Act now” and “No regret”. However, it is still likely to be beneficial to review how Essex might develop the local market in this area.

Increased Tourism

Finer weather could provide greater opportunities for tourism in the county, which could significantly benefit local businesses. Based on the assumption that most of the tourists would be from within the UK, this could also present opportunities to reduce greenhouse gas emissions associated with air travel and other means of transport used for long distance travel (see mitigation actions for transport in Section 9.2).

Tourists effectively make all of the same demands on services as residents. Impacts on transport and water resources have been highlighted by this study as being the most significant. However, all other services will also be affected by tourism and these need to be planned for accordingly.

Fine/hot weather products

The majority of the remaining opportunities are related to increasing markets in fine/hot weather food, drink and leisure goods. However, there are two important issues that should be considered in regard to these opportunities:

- To what extent is this increasing market to the detriment of other markets?
- How can these business opportunities be exploited in a sustainable manner, i.e. with due consideration of water consumption, energy consumption, reduction of greenhouse gas emissions, responsible usage of natural resources and impact on the environment?

Answering these questions is beyond the scope of this project and they need to be taken forward by the relevant parties.

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale	No regret	Low regret
Threats					
Opportunities					
Water supply shortages and increased demand of water supply	H	Businesses should seek efficiencies in water reliant processes, including recovery/reuse of “grey water”	Act now	✓	
		Encourage businesses to undertake risk assessments and plan to mitigate such risks	Act now		✓
		Water Companies and EA should look at the possibility of using tighter discharge consents to act as a means to regulate water usage	Plan ahead		✓

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale	No regret	Low regret
Threats					
Opportunities					
		Encourage the use of innovative building services (see building service opportunities below)	Plan ahead		✓
		Encourage improved water efficiency in hotels, sports clubs, etc.	Act now	✓	
Increased property damage and business disruption due to flooding	H	Encourage businesses to devise emergency flood plans to protect property and to limit the impact on the business services	Act now		✓
		Provide wider promotion of flood protection products, such as the BSI Kitemark Scheme, currently promoted via the EA website	Act now		✓
		Provide support to businesses for considering sustainable solutions for the whole community (e.g. consider sustainable alternatives for businesses that are considering moving away from flood risk areas)	Act now		✓
Increased heat stress to building services	H	Businesses should undertake risk assessments and determine the need for retrofitting more resilient assets	Act now		✓
Increased workforce absenteeism and stress due to high temperatures	H	Review and upgrade air conditioning and natural ventilation systems (see below regarding energy requirements)	Act now	✓	
		Undertake risk assessments to determine benefits of changing working practices, such as allow siestas, have fewer working hours in the summer or have longer summer breaks	Plan ahead		✓
Increased risks to outdoor workforce (e.g. construction industry) due to heat and UV radiation	H	Undertake risk assessments for workforce to determine need for modified working practices, such as early and late working patterns, afternoon siestas, regular rest breaks, provision of shade and drinks	Plan ahead	✓	
		Look at the possibility of lobbying for legislation on working practices	Plan ahead	✓	✓
Increased summer energy requirements for air conditioning, refrigeration, etc.	H	Encourage investment in innovative building services (see below)	Plan ahead	✓	
		Encourage investment in business owned renewable energy schemes (see below)	Act now	✓	

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale	No regret / Low regret	
				No regret	Low regret
Threats					
Opportunities					
Increased building construction costs to accommodate cooling systems and energy efficiencies	H	Promote findings of demonstration projects amongst the business community, identifying energy cost-savings to compensate for construction costs, etc.	Act now	✓	
Increased cases of food poisoning in the catering industries	H	Identify changes in practices required for continued adherence to hygiene standards	Plan ahead	✓	
Deterioration of golf courses, sports grounds, etc. due to soil moisture	H	Monitor and review cost-effectiveness of changing surfaces where possible (e.g. adopt more Mediterranean style grounds)	Monitor		✓
Fewer construction delays due to cold weather	H	Monitor and consider the need for changes in contingency planning to hot weather impacts	Monitor		✓
Lower heating bills	H	Encourage diversion of spending on cooling techniques, whilst promoting energy saving measures for both heating and cooling	Plan ahead	✓	
Increased opportunities for innovative building service businesses	H	Promote best practice through the planning and building control processes (linking to currently available guidance, the Carbon Trust, the Energy Saving Trust and other initiatives)	Act now	✓	
Increased opportunities for renewable energy businesses and businesses choosing to use renewable energy	H	Encourage involvement in current initiatives and take advantage of available advice (such as Renewables East, GreenEnergy, Community Renewables Initiative, CRed, Essex Energy Efficiency Advice Centre, etc.) via the Greener Essex campaign	Act now	✓	
		Encourage businesses to develop green credentials (ECC is already looking to adopt a green procurement strategy)	Act now	✓	
Increase in tourism and use of leisure industry	H	Monitor through market research	Plan ahead		✓
Increased sales of fans and air-conditioning units, summer leisure products (e.g. BBQs, paddling pools) and warm weather food and drink (e.g. ice-cream, beer, fruit, salads, etc.)	H	Monitor through market research	Plan ahead		✓

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale	No regret	Low regret
Threats					
Opportunities					
Increased business for garden centres and nurseries	H	Monitor through market research	Plan ahead		✓
Increased use of outdoor recreational activities (e.g. street cafes, outdoor swimming pools, etc.)	H	Monitor through market research	Plan ahead		✓
Loss of beach frontage for tourist and leisure industry	M	Undertake beach protection or regeneration as appropriate based on SMP2	Plan ahead		✓
Increased property damage due to coastal erosion	L	Continue to encourage community involvement in coastal erosion risk management, building on the Community Strategies and the increasing requirement for stakeholder engagement in other strategies as part of Sustainability Appraisals	Act now	✓	
Increased property damage due to gales and high winds	L	Ensure insurance is available through collaboration with the ABI	Monitor		✓
Increased property damage due to subsidence	L	Encourage best practices for planning applications and in building controls	Act now	✓	
		Ensure insurance is available through collaboration with the ABI	Monitor		✓



Photograph courtesy of Essex County Council

6.2 MITIGATION ACTIONS

Actions taken by businesses can contribute significantly to the overall reduction in greenhouse gas emissions for Essex. These are primarily in the form of conserving energy, using renewable energy sources and promoting more sustainable transport policies. Proposed no regret and low regret actions are presented in the table below.

Conserving energy

All energy conservation actions for businesses have been identified as “Act now”. These may only require a campaign for increasing awareness, as the immediate benefits to energy bills are a relatively strong incentive for action. These actions are also closely related to changing energy needs identified above under adaptation actions.

Renewable energy

The use of renewable energy in the form of direct action by businesses (as opposed to energy providers) is likely to require more detailed consideration of financial incentives and the relative benefits of renewable energy generation at the individual business scale compared to the community or county scales. Therefore, these actions have been identified as “Plan ahead” actions. Again, these actions are closely related to changing energy needs identified under adaptation actions.

Sustainable transport

Transport needs of businesses, either due to the travel of the workforce or due to the supply of materials and the delivery of products, are significant. Therefore, the contribution that businesses can make to reduce the demand for fossil energy is substantial.

It should be borne in mind, however, that the issue of centralised distribution networks for businesses that operate beyond the boundaries of Essex means that there will always be pressures outside of the county’s control.

Mitigation Approach	Proposed Action	Timescale	No regret	Low regret
			✓	✓
Conserving energy to reduce greenhouse gas emissions	Promoting a “switch off or turn down” campaign for lighting, other electrical appliances and central heating	Act now	✓	
	Retrofitting insulation to walls and lofts	Act now	✓	
	Retrofitting double, triple and krypton/argon filled low e glazing	Act now	✓	
	Use low energy light bulbs and appliances	Act now	✓	
	Developing more energy efficient production methods	Act now		✓
	Providing shade for buildings to reduce energy requirements for cooling	Act now		✓

Mitigation Approach	Proposed Action	Timescale	No regret	Low regret
	Incorporate more reuse and recycling of products and/or packaging (as long as the overall energy consumption compared to existing practices can be identified as reducing)	Plan ahead		✓
Using carbon neutral fuels/energy sources to generate energy without producing carbon emissions	Increase the use of solar electric (PV) to generate electricity and active solar water heating (ASWH) to generate hot water	Plan ahead	✓	
	Increase the use of building mounted wind turbines	Plan ahead		✓
	Increase the use of heat pumps	Plan ahead		✓
Reduced demand for fossil fuels from transport	Promote the use of public transport, cycling, walking or car-sharing schemes within the workforce	Act now	✓	
	Locate businesses where there is a good choice of “green” transport options for the workforce	Act now	✓	
	Locate businesses where there is a reduced need for transport to supply materials and to deliver products to customers	Act now	✓	
	Avoid travel by the workforce, by looking at options to work at home and reducing business travel (particularly air travel) by looking at cheaper technological alternatives (e.g. video conferencing)	Act now		✓
	Use alternative means of transporting freight other than by lorry, such as water or rail	Plan ahead		✓
	Avoid travel for customers, by providing delivery services	Plan ahead		✓
	Promote the use of low-energy or non-fossil energy vehicles (such as electric, biodiesel, waste vegetable oil vehicles) where feasible either on site or for delivery services	Plan ahead		✓

7. *Actions for new development*

The Essex Design Initiative (EDI) provides a valuable step forward in the design quality of the built environment (particularly with regard to high density developments) and the creation of sustainable communities. This includes consideration of the reduction in greenhouse gas emissions.^{4, 5} However, genuine sustainability must include appropriate consideration of adaptation to climate change.

Various initiatives are underway to design new houses to be more sustainable in the light of climate change, such as *Adapting to Climate Change: A Checklist for Development* (Three Regions Climate Change Group, 2005). However, efforts are still required at a more strategic level to determine a sustainable approach to development planning in the light of climate change. This includes (but is not limited to) understanding the implications for transport and other infrastructure, flood risk and water resources. Flood risk and water resources need to be managed through adaptation actions, whilst transport and other infrastructure should be considered from the perspective of both adaptation and mitigation actions.

The East of England Regional Assembly's *Integrated Regional Strategy* (EERA, 2005) recognises that major developments are planned in areas that will be affected by climate change and the Region must respond creatively to the pressures and opportunities associated with climate change. This builds on the draft *East of England Plan* (EERA, 2004), which recognises that climate change must be taken into consideration when locating new development. In addition to this, the *Regional Environment Strategy* (EERA and EEEF, 2003) sets out a strategic aim to reduce the vulnerability of the Region to climate change and the *Regional Sustainable Development Framework* (EERA and EESDRT, 2001) states that there should be a commitment to making decisions now that will reduce the impact of climate change in the future, such as not developing in areas at risk from flooding. These documents, however, only provide policy statements regarding climate change and do not provide guidance on how these policies will be reconciled with the major developments proposed in the Region. Recommended actions for Essex are presented below.

7.1 ADAPTATION ACTIONS

The issues of primary concern for new development in Essex in adapting to climate change have been identified by this study as being water supply and demand and flood risk.

Water supply and demand

There is the large amount of development proposed for Essex, increasing domestic, commercial and service industry water supply needs.

Flood risk

Increased development also increases flood risk, especially in Essex where a large proportion of proposed development will be in flood risk areas. Several studies are

⁴ Further details can be found at <http://www.the-edi.co.uk/>.

⁵ An example of a valuable “flagship” initiative for sustainable building design is Notley Green Primary School. This was the result of a competition run jointly by the Design Council and Essex County Council to produce a prototype for a sustainable school.

Further information can be found at <http://www.cabe.org.uk/library/casestudy.asp?id=167>

currently underway or planned for the near future to look at this issue in much greater detail than this study and it is recommended that these are referred to in due course. However, actions are still recommended in support of these studies in order to improve integration between flood risk management and development planning.

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale	No regret	Low regret
<p>Threats</p> <p>Opportunities</p>					
Water supply shortages and increased demand of water supply	H	Limit development to levels consistent with water resources. This is currently being reviewed as part of the examination of RSS14, but requires subsequent implementation by the Local Planning Authorities	Act now	✓	
		Encourage the use of innovative building services (see building service opportunities below), including recovery/reuse of “grey water”	Act now	✓	
Property damage and business disruption due to flooding	H	Use the outputs from CFMPs, fluvial flood risk studies, the Estuary Strategies (including Thames Estuary 2100), the CHaMP and SMP2 to better inform other strategies and plans regarding flood risk management	Plan ahead	✓	
		Develop all Local Development Frameworks with full consideration of climate change and flood risk via the use of SFRAs (Thames Gateway South Essex SFRA is already underway)	Act now	✓	
		Apply PPG25 (DTLR, 2001) and its future successor PPS25 more robustly, including the undertaking and review of flood risk assessments	Act now	✓	
		Encourage the resilient design of buildings (recognising that the avoidance of property in areas of flooding should take priority and resilient design should only be considered as a means to manage residual risk)	Act now	✓	
Higher summer energy requirements for air conditioning, refrigeration, etc.	H	Encourage investment in innovative building services (see below)	Plan ahead	✓	
		Encourage investment in business owned renewable energy schemes (see below)	Act now	✓	

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale	No regret	Low regret
Increased building construction costs to accommodate cooling systems and energy efficiencies	H	Promote findings of demonstration projects amongst the business community, identifying energy cost-savings to compensate for construction costs, etc.	Act now	✓	
Heat stress for people	H	Promote the use of green spaces, tree planting, etc. to enhance developments and protect people from heat and UV radiation	Act now	✓	
Increased opportunities for innovative building service businesses	H	Promote best practice through the planning and building control processes (linking to currently available guidance, the Carbon Trust, the Energy Saving Trust and other initiatives)	Act now	✓	
Increased opportunities for renewable energy businesses and businesses choosing to use renewable energy	H	Encourage involvement in current initiatives and take advantage of available advice (such as Renewables East, GreenEnergy, Community Renewables Initiative, CRed, Essex Energy Efficiency Advice Centre, etc.) via the Greener Essex campaign	Act now	✓	
Property damage due to subsidence	L	Encourage best practices for planning applications and in building controls	Act now	✓	



Example of SuDS in a new development, photograph by HR Wallingford

7.2 MITIGATION ACTIONS

New developments should lead the way in promoting improved building design and usage. Leading by this example, improvements to existing buildings should then become more popular. To this end, strict sustainability standards should be applied to all new development.

Mitigation actions are primarily in the form of conserving energy, using renewable energy sources and provision of a sustainable transport strategy. Proposed no regret and low regret actions are presented in the table below.

Conserving energy

All energy conservation actions have been identified as “Act now”. These could be readily implemented through development control and building regulations. An example of this might be to make it a requirement of all new developments to meet the Energy Saving Trust (EST) Energy Efficiency Best Practice standards.

Renewable energy

The use of renewable energy in the form of individual units for properties should first be compared with the relative benefits of providing a community scale facility or the use of renewable energy by the power generating companies. Therefore, these actions have been identified as “Plan ahead” actions.

Sustainable transport

A sequential approach should be applied to planning sustainable transport for new development. In the first instance new development should be sited to reduce the need for transportation at all. Subsequent to this, the provision of public transport and transport with reduced need for fossil fuels and reduced greenhouse gas emissions should be considered.

Mitigation Approach	Proposed Action	Timescale	No regret	Low regret
			✓	✓
Conserving energy to reduce greenhouse gas emissions	Provide insulation in walls and lofts	Act now	✓	
	Provide double, triple and krypton/argon filled low e glazing	Act now	✓	
	Install low energy light bulbs and appliances	Act now	✓	
	Use passive solar design to maximise the light and heat gains from the sun and promote natural ventilation by stack effect	Act now	✓	
	Provide shade for buildings to reduce energy requirements for cooling	Act now		✓
Using carbon neutral fuels/energy sources to generate energy without producing carbon emissions	Increase the use of solar electric (PV) to generate electricity and active solar water heating (ASWH) to generate hot water	Plan ahead	✓	
	Increase the use of building mounted wind turbines	Plan ahead		✓

Mitigation Approach	Proposed Action	Timescale	No regret	Low regret
	Increase the use of biomass for small scale/community based power and heat generation	Plan ahead		✓
Reduced demand for fossil fuels from transport	Increase avoidance of transport needs by ensuring provision of employment, education, local services, shopping and leisure opportunities either within or in close proximity to new residential developments	Act now		✓
	Reduce reliance on cars by providing an integrated public transport system	Act now		✓
	Reduce the transportation of construction materials to site by promoting the use of locally available materials	Act now		✓



Train line between Southend and Leigh-on-Sea, photograph by HR Wallingford.

8. *Actions for agriculture, fishing and forestry*

8.1 ADAPTATION ACTIONS

Agriculture, fishing and forestry have the potential to be affected by a wide range of climate change impacts, providing both threats and opportunities. Useful information is available in a new UKCIP document called *A changing climate for business – business planning for the impacts of climate change* (Metcalf and Jenkinson (Eds.), 2005).

8.1.1 *Threats*

The three principle threats identified by this study for Essex's agriculture are related to water conservation, soil moisture and heat stress (to both livestock and workforce).

Water conservation and soil moisture

As discussed previously, water resources are scarce in Essex and supply problems will be exacerbated with climate change. Agriculture will be particularly affected by the drop in soil moisture, which will have direct consequences for crops and indirect consequences of soil erosion and poorer conditioning. Therefore, the potential increase in demand for irrigation could put additional pressures on the available water resources. Demands for water could also increase to prevent heat stress for livestock (see below).

Hot weather

The increase in the number of extremely warm summer days will result in heat stress for both livestock and workforce. The health and safety of those working out of doors is a particular consideration due to exposure to UV radiation, as well as high temperatures. Hot weather (in combination with less rainfall) can also lead to an increased fire risk and more warm weather in general puts greater demands on refrigerated storage and distribution.

8.1.2 *Opportunities*

Similarly to the potential climate change impacts identified for businesses described in Section 6, climate change has the potential to offer a number of benefits to local agriculture. However, these are complex issues that also have secondary consequences that need to be weighed up against the benefits.

- To what extent is the potential increase in certain markets to the detriment of other markets?
- How can these opportunities be exploited in a sustainable manner, i.e. with due consideration of water consumption, energy consumption and impact on the environment?
- Will the projected changes in growing conditions provide only short-term gains leading to long-term blight and, therefore, be unsustainable?

Answering these questions is beyond the scope of this project and they need to be taken forward by the relevant parties.

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale	No regret	Low regret
<p style="background-color: #fce4d6; padding: 2px;">Threats</p> <p style="background-color: #e2efda; padding: 2px;">Opportunities</p>					
Water supply shortages and increased demand of water supply	H	Encourage businesses to accept less washing of fruit and vegetables and devise more water efficient processes	Act now		✓
		Encourage alternative means of managing livestock to prevent heat stress rather than just rely on water (see below)	Plan ahead	✓	
		Look at opportunities for increasing storage of winter rainfall and water reuse, including collaboration with Water Companies	Act now	✓	
		Encourage the selection of crops with reduced or limited irrigation needs	Act now	✓	
		Encourage sustainable farming practices (including water conservation, energy generation, less intensive farming) through increased promotion of existing initiatives by Defra, the CLA, etc.	Act now	✓	
Increased heat stress for livestock	H	Provide greater shade protection for livestock	Plan ahead	✓	
		Monitor implications of heat stress and plan ahead for changes in farming practices (including less intensive farming)	Plan ahead	✓	
		Limit distances travelled for sale or slaughter and plan for periods without transportation	Plan ahead		✓
Increased risks to outdoor workforce due to heat and UV radiation	H	Undertake risk assessments for workforce to determine need for modified working practices, such as early and late working patterns, afternoon siestas, regular rest breaks, provision of shade and drinks	Plan ahead	✓	
		Look at the possibility of lobbying for legislation on working practices	Plan ahead	✓	✓
Reduced soil conditioning and reduced kill-off of pests and disease; increased soil drying and erosion	H	Monitor effects and plan ahead for changes in farming practices to ensure long-term sustainability	Plan ahead	✓	
Increased fire risk	H	Encourage farmers to undertake risk assessments and produce emergency plans, including the provision of fire fighting equipment if appropriate	Plan ahead		✓

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale	No regret / Low regret	
				No regret	Low regret
<p>Threats</p> <p>Opportunities</p>					
Greater need for refrigerated storage and distribution	H	Provide support and information for on-site energy generation through existing initiatives, such as the CLA's Renewable Energy Policy and Community Renewables Initiative	Plan ahead	✓	
Increased property damage, crop damage and livestock health/mortality problems due to flooding	H	Encourage farmers to devise emergency flood plans to protect property, crops and livestock	Act now		✓
Loss of land due to coastal erosion	H	Continue to encourage involvement in coastal erosion risk management, building on the Community Strategies and the increasing requirement for stakeholder engagement in other strategies as part of Sustainability Appraisals	Act now	✓	
Land abandoned due to flood risk can be put to use as grazing marshes or change land use to biofuels	H	Encourage involvement in the Sustainability Appraisals for the Essex Estuarine Strategies	Act now	✓	
		Encourage diversification through appropriate incentives, including the Environmental Stewardship Scheme	Act now	✓	
Less frost damage of crops	H	Offset these benefits against disadvantages of less frosts (e.g. reduced soil conditioning and more pests and diseases) and hot weather problems	Monitor		✓
Increased demand for warm weather food and drink products (e.g. fresh fruit and salads)	H	Monitor through market research	Plan ahead		✓
Increase in crop yields and new or wider range of crops	H	Encourage the use of local suppliers in preference to imports	Act now	✓	
		Promote healthy eating	Act now	✓	
		Expand promotion of local farmers' markets, etc. already ongoing via the Greener Essex campaign	Act now	✓	
Water and temperature related stresses for tree growth	M	Monitor and undertake climate change assessments to determine the need for changes in forestry practices and use of different tree species	Plan ahead	✓	

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale	Regret Level	
				No regret	Low regret
Threats					
Opportunities					
Drop in supply of some fish species	M	Look at possibilities of further controls on diminishing species, whilst promoting the popularity of flourishing species	Monitor	✓	
Increase in supply of some fish species	M				
Reduction in productivity of inland (freshwater) and inshore fisheries (e.g. Blackwater Oyster beds) with increased flooding	L	Encourage involvement of fishing industry in the Sustainability Appraisals for the Essex Estuarine Strategies	Act now	✓	
Increased property and crop damage due to gales and high winds	L	Ensure insurance is available through collaboration with the ABI	Monitor		✓
		Undertake risk assessments and determine cost-benefit of providing wind breaks	Monitor		✓

8.2 MITIGATION ACTIONS

Many potential mitigation actions that can be undertaken by agriculture are similar to those identified for other businesses or domestic properties. Proposed no regret and low regret actions are summarised in the table over the page.

However, the exceptions to this are tree planting to capture carbon from the atmosphere and the growing of bio-fuels as a viable alternative to fossil fuels.⁶ In both cases, although the actual activities would be undertaken by the agricultural or forestry industries, these are not actions that would be undertaken independently by these industries. These actions would be undertaken based on the needs of other businesses (including power generation companies) and at least in the early stages would probably need to include financial incentives provided by government.

It should be borne in mind that tree planting is not a panacea as is the public perception, as there are consequences as well as benefits from such an action. Therefore, it has been categorised as a low regret rather than a no regret action. A feasibility study should be undertaken that considers the management of the trees and their subsequent use. This feasibility study would determine whether tree planting at a proposed location can be considered as a low regret or no regret action. Further details of the consequences of tree planting are presented in Appendix C of *Part 1 – Project Report*.

⁶ Useful information on bio-fuels relevant to Essex can be found in *Renewable Energy Strategy for Essex - Consultation Document* (Essex County Council, 2003).

Mitigation Approach	Proposed Action	Timescale	No regret	Low regret
Sequestering (removing/separating) greenhouse gas emissions	Tree planting	Act now		✓
Conserving energy to reduce greenhouse gas emissions	Undertake mitigation actions as for all other businesses (see Section 6.2)	Act now/ Plan ahead	✓	✓
Using carbon neutral fuels/energy sources to generate energy without producing carbon emissions	Increase the use of solar electric (PV) to generate electricity and active solar water heating (ASWH) to heat water	Plan ahead	✓	
	Increase the use of on-site wind turbines	Plan ahead		✓
	Increase the use of biomass for small scale power and heat generation	Plan ahead		✓
	Grow biofuels for use on-site or to supply businesses	Plan ahead		✓
	Incorporate more reuse and recycling of products and/or packaging (as long as the overall energy consumption compared to existing practices can be identified as reducing)	Plan ahead		✓
Reduced demand for fossil fuels from transport	Undertake mitigation actions as for all other businesses (see Section 6.2)	Act now/ Plan ahead	✓	✓



Photograph courtesy of Essex County Council

9. *Actions for highways and transport providers*

Essex County Council has recently submitted its second Local Transport Plan (Essex County Council, 2005). This takes into consideration emissions, congestion and air quality, all of which are issues that have been highlighted as being either a cause or an effect of climate change.

However, at present these issues are only tackled at the micro-climate scale rather than county-wide, which is likely to prove increasingly important in the future with climate change. Therefore, it is recommended that future Local Transport Plans have greater emphasis on climate change (identifying both adaptation and mitigation actions) and the integration of transport within sustainable development (as already discussed under the actions for new development in Section 7).

9.1 ADAPTATION ACTIONS

The consequences of climate change for highways and transport providers are likely to be most significant in relation to hot weather, either directly due to heat stress of infrastructure or indirectly due to greater demands created by tourism. However, there are a number of potential benefits in less severe winters (for example, less gritting, less accidents, less icing of rails, points and overhead cables, etc.), which may enable cost savings to be redirected to dealing with hot weather problems

Heat stress

There is significant potential for there to be disruption to services as a result of heat stress to infrastructure, such as tarmac melt on roads, buckling of rail tracks, damage to overhead cables, breakdowns, etc.). Heat stress can also be experienced by the workforce or travellers.

Tourism

The hot weather is also likely to show an increase in tourism, which will be capitalised on by businesses in the county. This will put additional pressures on the transport system.

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale		
				No regret	Low regret
Threats Opportunities					
Disruption to services due to heat stress of infrastructure (e.g. tarmac melt and rail buckling)	H	Undertake risk assessments to determine best adaptation strategies for high temperatures, which may include retrofitting more resilient assets, increase maintenance and provision of shade	Plan ahead		✓
Increased heat stress for public transport staff and travellers	H	Undertake review of frequency of problems at present during hot weather and likely increase in the future, in order to determine cost-effective investment in air conditioning, emergency backup, etc.	Plan ahead		✓

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale	No regret	Low regret
<p>Threats</p> <p>Opportunities</p>					
Increased demands on transport system due to increased tourism	H	Find additional methods of dissemination of the information already available (for example on the Greener Essex website) encouraging the use of public transport, walking and cycling to visit tourist locations	Act now		✓
		Provide more public transport to tourist locations, adopting similar initiatives for the rest of Essex as the Green Grid and Thames Gateway South Essex transport initiative	Plan ahead	✓	
Increased need for vegetation management on roadsides and railway embankments	H	Monitor and review need for changes to cutting times and frequencies (recognising there are also potential benefits in vegetation growth by providing stability and reducing the threat of landslip)	Monitor		✓
Less winter road gritting	H	Redirect any cost savings to hot weather operations	Monitor	✓	
Fewer road traffic accidents due to icy conditions	H	Redirect any cost savings to hot weather operations	Monitor	✓	
Reduced incidents of icing of rails, points and overhead cables, blockages due to snow and improved safety on platforms	H	Redirect any cost savings to hot weather operations	Monitor	✓	
Increased disruption to services due to flooding	M	Increase coordination between transport planning and flood risk management, which may include the use of flood risk studies undertaken for other purposes (such as development planning) but which still provide valuable information	Act now	✓	
Damage to roads, embankments, rails, bridge foundations, underpasses, etc. due to subsidence	L	Promote subsidence resilient construction of new assets	Act now		✓
		Undertake risk assessments for existing assets	Plan ahead		✓

9.2 MITIGATION ACTIONS

Transport is responsible for around 50% of all nitrous oxide emissions, 90% of carbon monoxide emissions and 21% of carbon dioxide emissions in Essex (Essex County Council, 2005). Highways and transport providers, however, can only go so far in undertaking mitigation actions to reduce these emissions. Significant actions are also required by businesses and the public. Actions that can be undertaken specifically by businesses are described in Section 6.2. The issue of educating the public to promote behavioural change is tackled in this section.

Mitigation Approach	Proposed Action	Timescale	No regret	Low regret
Conserving energy used to reduce greenhouse gas emissions	Undertake mitigation actions as for all other businesses (see Section 6.2)	Act now/ Plan ahead	✓	✓
Using carbon neutral fuels/energy sources to generate energy without producing carbon emissions	Increase use of renewable energy sources for electrical equipment	Plan ahead		✓
Reduced demand for fossil energy from transport	Promote the use of public transport, cycling, walking or car-sharing schemes to reduce reliance on car travel	Act now	✓	
	Improve access to public transport, the quality of the services and access to information of services to encourage the transfer from private transport	Act now	✓	
	Promote the avoidance of business travel needs (see actions for businesses)	Act now		✓
	Promote alternative means of transport for businesses (see actions for businesses)	Act now		✓
	Promote the use of low-energy or non-fossil energy vehicles (such as electric, biodiesel, waste vegetable oil vehicles) where feasible either on site or for delivery services	Plan ahead		✓
	Reduce public demand for air travel by promoting holidays at home	Plan ahead		✓

10. Actions for utility providers

10.1 ADAPTATION ACTIONS

The results of this study suggest that there are no highly significant risks to utilities resulting from climate change. The greatest concern is related to flood risk and this is already being addressed in best practices by the utilities companies.

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale		
				No regret	Low regret
Threats Opportunities					
Increased disruption to services due to flooding	M	Promote best practice with utilities companies regarding prevention and protection against flooding via relevant regulators such as OFWAT, Ofgem and Ofel	Act now	✓	
Poorer river water quality and less abstraction potential	M	Water Companies need to continue to work with the EA to monitor and control river water quality and sustainable abstraction levels	Monitor	✓	
Increase in pests and pollution breaching at landfill sites	M	Monitor increases in pests and review control methods as appropriate	Monitor	✓	
		Undertake risk assessments of pollution breaching, consider appropriate mitigation measures and monitor increases in pollution	Monitor	✓	
		Continue to encourage recycling and improve recycling facilities	Act now	✓	
		Encourage businesses to use less packaging	Act now	✓	

10.2 MITIGATION ACTIONS

Mitigation actions for utility providers are primarily split between the power generating and supply companies and all other utility providers. With regard to the latter, mitigation actions are the same as for all other businesses and reference should be made to Section 6.2. Power generating and supply companies, however, have additional mitigation actions that could be undertaken. The actions presented in this section have been identified as the most viable in Essex. Therefore, hydro-electric power, wave or tidal energy and geothermal energy capture have not been included in the proposed actions. Solar energy is a viable option in Essex, but this has been identified as a more suitable option for small scale installations. Further details of existing schemes and future potential for alternative energy generation can be found in Essex County Council's Renewable Energy Strategy (Essex County Council, 2003).

Sequestering of greenhouse gases

Power generating companies have particular issues associated with the emission of greenhouse gas emissions and they are probably the main organisations that should look

at the opportunities for sequestering these gases. Tree planting is the only action identified by this study as being low regret. Alternatives such as injecting greenhouse gases underground or under the sea have been identified as higher regret and, therefore, unlikely to be viable in the foreseeable future.

Mitigation Approach	Proposed Action	Timescale	No regret	Low regret
Sequestering (removing/separating) greenhouse gas emissions	Tree planting	Act now		✓
Conserving energy used to reduce greenhouse gas emissions	Provide guidance to domestic properties and businesses in improving energy conservation based on the actions for domestic properties (see Section 5.2) and businesses (see Section 6.2)	Act now		✓
	Undertake mitigation actions as for all other businesses (see Section 6.2)	Act now/ Plan ahead	✓	✓
Using carbon neutral fuels/energy sources to generate energy without producing carbon emissions	Increase use of large scale on and off shore wind power	Plan ahead		✓
	Increase use of biomass for large scale power and heat generation	Plan ahead		✓
Reduced demand for fossil energy from transport	Undertake mitigation actions as for all other businesses (see Section 6.2)	Act now/ Plan ahead	✓	✓



Images of wind turbines by HR Wallingford

11. Actions for protecting the natural environment

11.1 ADAPTATION ACTIONS

The most significant threats to the natural environment in Essex are the effects of coastal squeeze, caused by the increase in sea levels, the deterioration in river and wetland ecology due to low river flows and the potential extinction of drought sensitive species especially in saltmarshes. Several studies and initiatives are already underway looking at means to address these problems, details are provided in *Part 1 – Project Report*. However, there is still a number of activities that can be undertaken in support of these.

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale	No regret	Low regret	
Threats Opportunities	H	Deterioration in long-term river and wetland ecology due to low river flows and potential extinction of drought sensitive species especially in saltmarshes	EA should continue with the existing approach to monitoring and managing water levels in rivers (i.e. water resource strategies and catchment abstraction management plans) with increased emphasis on climate change (as planned with the next review) and in collaboration with local wildlife groups such as the Essex Wildlife Trust	Act now	✓	
		Undertake monitoring and research into the critical pressures for river and wetland ecology in Essex, in combination with other habitat activities (in particular those compensating for sea level rise)	Act now		✓	
Changes in biodiversity	H	Establish a co-ordinated system for recording and evaluating biodiversity within Essex, building on and lending support to existing initiatives	Act now	✓		
		Provide local promotion of the Environmental Stewardship Scheme for farmers, encouraging amongst other things wildlife corridors and sustainable land use practices	Act now	✓		
		Promote the involvement of the general public in providing habitat havens in their own gardens	Act now	✓		
		Promote the establishment of habitat havens within new developments (linking to the appropriate use of SUDS)	Act now	✓		

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale	Regret	
				No regret	Low regret
<div style="background-color: #f4a460; padding: 2px; margin-bottom: 2px;">Threats</div> <div style="background-color: #90ee90; padding: 2px;">Opportunities</div>		Monitor and review the need for measures to mitigate increases in invasive species	Monitor		✓
		Monitor and review the need for measures to stabilise indigenous species	Monitor		✓
		Consider opportunities for establishing key elements of our biodiversity (by assisted migration or translocation) in areas that offer suitable space under the relevant climate scenarios	Monitor		✓
Increased fire risk	H	Provide appropriate signage and information for the public regarding fire prevention and what to do should they spot a fire	Act now	✓	
		Monitor and undertake risk assessments to determine the need for increased surveillance or preventative measures	Plan ahead	✓	
Coastal squeeze leading to loss of saltmarsh habitat	H	Implement recommendations from the Essex CHaMP in conjunction with the Estuary Strategies and the SMP2, ensuring cross-community collaboration with other strategies and plans for the area (effectively providing integrated coastal zone management).	Plan ahead	✓	
Reduced protection of near coast habitats from coastal/tidal waters provided by beaches, especially saltmarshes	M				
Change in existing distribution and pattern of flora and fauna communities	M				
Deterioration in short-term river water quality due to intermittent discharges	M	Water Companies should continue to review drainage system performance and undertake programme of works, supported by increased recognition from OFWAT regarding the implications of climate change on performance targets	Act now	✓	
		Undertake research and development looking at the viability of retrofitting SUDS and continue to encourage the use of SUDS for new development	Act now		✓

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale	No regret	Low regret
Threats					
Opportunities					
Increased frequency of toxic algal blooms in freshwater and marine waters	M	Monitor and review the need for tighter controls on physical and biological components that contribute to the formation of algal blooms	Monitor		✓
Morphological changes to fluvial and intertidal areas	M	Use the outputs from the CFMPs and fluvial flood risk studies to better inform other strategies and plans regarding restoration work, etc.	Plan ahead	✓	
Increase in mudflat habitat on open coast	M	Offset the benefits to mudflats against the reduction in saltmarsh to provide a sustainable balance between the two, based on recommendations in the Essex CHaMP. However, the relative benefits versus threats associated with this can only be determined on a site by site basis.	Plan ahead		✓

11.2 MITIGATION ACTIONS

There are no mitigation actions identified by the study that can be considered as the direct responsibility of those with the role of protecting the environment, except that individuals and organisations should be continually reviewing and improving means of energy conservation and use of renewable energy.



Jacques Bay, Stour Estuary © Dr Chris Gibson/English Nature

12. Actions for protecting the landscape, heritage and archaeology

12.1 ADAPTATION ACTIONS

Many of the potential impacts to heritage sites and archaeology are very dependent on the individual characteristics of the particular sites. Therefore, this study is unable to quantify the risk in any meaningful way. However, there are two potentially county-wide impacts to the landscape and heritage or archaeological sites in general. These are related to tourism and tree damage.

Tourism

With increased warm weather and reduced rainfall, it is likely that there will be an increase in tourism, which could result in increased damage to sites. However, this has the potential to be offset against increased donations and entry charges at particular sites. It is therefore recommended that sites undertake risk assessments and modify access for visitors accordingly.

Tree damage

There are potentially a number of different consequences for tree due to the changes in climate. However, the most significant it likely to be damage to tree roots due to the wetting and drying cycles. Therefore, it is recommended that this is monitored and the benefits of compensatory tree planting are reviewed, whilst recognising the potential impact on Essex's indigenous species and species limitations due to both current and future conditions in the county.

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale	Regret	
				No regret	Low regret
Threats					
Opportunities					
Increased damage to sites due to increased tourism	H	Undertake risk assessments and modify access for visitors as appropriate	Plan ahead	✓	
Damage to tree roots due to wet/drying cycle	H	Monitor and consider risk/benefits of compensatory tree planting	Plan ahead	✓	
Increased donations and entry charges due to increased tourism	H	Offset increased maintenance costs with increased income from visitors	Plan ahead	✓	
Water and temperature related stresses on tree species, hedgerows, etc.	M	Monitor and continue to promote wildlife corridors and appropriate tree planting	Monitor	✓	
Increase damage to land and property due to flooding	L	Encourage the use of flood risk assessments to determine the need for localised flood protection for properties, the potential benefit of moving properties out of flood risk areas or to review insurance cover	Act now	✓	

Climate Change Impacts	Relative Significance	Proposed Actions	Timescale		
				No regret	Low regret
Threats					
Opportunities					
Deterioration of public parks due to soil moisture	L	Monitor and review the need to change planting schemes, maintenance practices, etc. for parks and gardens	Monitor		✓
Damage to buried sites caused by wet/drying cycle	L	Monitor and undertake risk assessments for buried sites and monuments prior to selection of mitigation measures	Monitor		✓
Increased property damage due to subsidence	L	Monitor and review the need for protection measures for properties or moving of property	Monitor		✓
Damage to footpaths due to subsidence	L	Monitor and review the need for increased maintenance, abandonment or replacement of foot paths	Monitor		✓

12.2 MITIGATION ACTIONS

There are no mitigation actions identified by the study that can be considered as the direct responsibility of those with the role of protecting the landscape, heritage and archaeology, except that organisations should be continually reviewing and improving means of energy conservation and use of renewable energy and encourage the same philosophy in businesses and the public that support these organisations.



Veteran English Oak, Hylands Park © Dr Chris Gibson/English Nature

13. *Implementation of actions*

In order to plan the implementation of actions, it is advisable to identify the key risks or uncertainties associated with each action and how they might affect the overall effectiveness of the decision. Knowledge of these factors enables decision-makers to have confidence in the proposed actions.

For example, it is desirable for actions that affect the public to be supported by the public. Therefore, to assist with this, as well as the implementation of the main action, supporting actions such as communication exercises with the public might help prevent misconceptions or misunderstandings.

13.1 ROLES AND RESPONSIBILITIES

The actions proposed by this study require input from each of the following organisations or groups of organisations:

- Essex County Council
- District and Borough Authorities
- Transport Providers
- Public Utility Providers
- Private Businesses
- Farmers and Landowners
- General Public
- Government Departments and Agencies (including Defra, EA, GO East)
- Non-governmental Organisations (wildlife, heritage, etc.)

In many cases these organisations will require to work in partnership to provide best value. For example, the promotion of public transport in support of tourism will require buy-in or actions to be undertaken by all of the above, either to provide direct input into existing or new transport schemes or to promote a change in behaviour of visitors. Further examples of cross-cutting activities involving a number of organisations are provided over the page.

13.2 TIMING

A number of proposed actions follow on from ongoing studies. Therefore, the programme of implementing “Act now” actions may need to stretch over the next 3 to 4 years. However, it is still recommended to “act now” by ensuring/planning for these actions within organisations’ work programmes, by formally recognising their linkage to these other studies.

Many of the actions proposed are also cross-cutting and, therefore, the timing of actions needs to take into consideration the implications of implementation across a number of stakeholders. This will need to include recognition of initiatives already being undertaken or planned by stakeholders, so that the timing can maximise benefits.

13.3 RESOURCES

As many of the actions proposed are cross-cutting, there will be opportunities to combine resources across a number of benefiting stakeholder groups. Examples of cross-cutting opportunities include the following:

Improving water conservation by the public and businesses – This will involve the EA, Water Companies, Essex County Council, Education Authorities, Local Planning Authorities, developers and others in coordinating and expanding existing education initiatives, linking into actions to promote the use of water efficient appliances and processes.

Protecting people and property from flooding – This will involve the EA and other flood defence authorities, Water Companies, the ABI, Emergency Services, Local Planning Authorities and others in coordinating and expanding existing education initiatives, linking into actions to increase integration across organisations involved in flood forecasting, flood warning, emergency planning, recovery planning and development planning, promote the use for flood protection products, guidance for businesses and farmers in undertaking their own risk assessments and developing emergency plans.

Improving energy conservation by the public and businesses – This will involve the EA, Essex County Council, energy providers, building service companies, building standards organisations, developers, public transport providers and others in coordinating and expanding existing education initiatives, linking to actions to promote the use of energy efficient appliances and processes, the use of renewable energy solutions for growing energy needs, the use of public transport, etc.

Protecting people and property from the effects of heat and UV radiation – This will involve local Health Authorities, Education Authorities, Emergency Services, employers, building service companies and others in coordinating and expanding existing education initiatives, linking into actions to promote voluntary care, cover-up policies in schools, review and address issues regarding working conditions, innovative building services to accommodate air conditioning or natural ventilation systems, etc.

Promotion of tourism – This will involve local businesses, wildlife trusts, heritage and archaeological groups, public transport providers and others in ensuring that the benefits of increased tourism do not have detrimental effects on demand for water, energy, transport or services or damage to wildlife, heritage or archaeological sites.

14. *Monitoring and review of actions*

The success or otherwise of the actions should be monitored. Quantified targets and indicators against which to monitor the performance of actions should be developed as part of the implementation planning.

Monitoring of the actual changes in climate and the associated hazards is also beneficial in providing additional information that can help reduce uncertainties in the decision-making behind an action or actions, which may in turn enable a revision to the actions.

Monitoring can be used as an ‘early warning’ system for the detection of trends, which require a new problem to be resolved and the decision-making process reinitiated. As part of this, updated knowledge or understanding of climate change projections and impacts should also be monitored to enable climate change risk assessments, such as this study, and decision can be revisited as appropriate.

Monitoring can also provide short-term forecasts, supporting emergency and other rapid adaptation responses.

Possible indicators fall into two categories: a) Detecting changes in climate and its impacts and b) Monitoring the success of actions

- **Detecting changes in climate and its impacts** – undertaken by monitoring climate change variables and pathways or hazards associated with these variables. The selection of indicators to be used will depend on those considered most significant, those that are already being collected for other purposes and available resources. Examples include:

Climate change variables

Temperature
Rainfall patterns
Sea level rise
Wind speeds
Hours/days of sunshine

Pathways or hazards

Flood levels in rivers
Minimum flows in rivers
Water quality
Sewerage flooding
Subsidence
Beach loss
Estuary morphology
Fish species
Bird species



Little Tern © Dr Chris Gibson/English Nature

- **Monitoring the success of actions** – undertaken by identifying changes in patterns of behaviour in order to adapt to or mitigate the impacts of climate change. The selection of indicators will depend on the actions that have been implemented. Examples include:

Adaptation

Changes in water demand
Changes in use of flood management systems (e.g. barrier closures)
Appropriate development planning decisions (e.g. High-Level Target 12)
Changes in biodiversity
Changes in habitat extent
Changes in working practices
Changes in farming practices
Frequency of transport delays
Frequency and extent of disruption to utilities
Number of businesses with risk assessments and emergency plans
Number of schools with climate change education programmes
Number of schools with cover-up policies
Number of homes with flood protection products

Mitigation

Greenhouse gas emissions
Changes in energy consumption
Use of renewable energy
Use of public transport versus private transport



Saltmarsh creek © Dr Chris Gibson/English Nature

15. Next steps

It is not possible to do everything immediately and actions should be managed in a co-ordinated manner to ensure consistency of message and to prevent duplication of effort. However, eight measured steps forward are proposed by this study and are listed below. It is the responsibility of the Essex Partnership to review these proposed steps and take them forward as appropriate.

1. It is beyond the scope of this project to set targets for reducing greenhouse gas emissions in Essex. However, actions towards identifying these targets should be taken forward by the Partnership. The first step towards this is to encourage all Local Authorities in Essex to sign up to the Nottingham Declaration on Climate Change⁷.
2. Encourage all Local Authorities to lead by example regarding energy conservation and the use of renewable energy.⁸ This should include Essex County Council reviewing its Renewable Energy Strategy (Essex County Council, 2003), which could provide a template for similar strategies for District and Borough Councils. This also includes a discussion of renewable energy targets for Essex.
3. Encourage all Local Planning Authorities to promote the sustainable planning and design of new development, with particular regard to both climate change adaptation and mitigation measures. This needs to include appropriate support at the county and regional strategic planning levels. At all levels of planning there should be greater emphasis of water resource management, flood risk reduction and management, resilience of buildings and infrastructure to climate change and low/no net increase in greenhouse gas emissions.⁹
4. Encourage closer co-ordination between organisations and individuals that play a part in flood and coastal erosion risk management (including Local Planning

⁷ The Nottingham Declaration on Climate Change was an initiative launched at a conference on climate change held in October 2000. Its purpose was to promote action by local authorities to tackle greenhouse gas emissions from transport, waste, energy, industry, etc in support of the Government's Climate Change Programme. The declaration commits local authorities not only to reduce their own emissions but to act as a catalyst to other organisations in their areas to promote awareness of climate change and reduction in overall emissions. A copy of the current declaration can be found at the following web address:

http://www.lga.gov.uk/Documents/Briefing/Our_Work/Environment/Nottdeclaration.pdf. As of September 2005, there were 87 signatories to the declaration. The declaration is due for review at the end of 2005.

⁸ Guidance is provided in the Local Government Association's document *Leading the way: how local authorities can meet the challenge of climate change*, (LGA et al., 2005), which can be found at the following website address

<http://www.lga.gov.uk/Documents/Publication/leadingthewayssummary.pdf>.

⁹ The Essex Design Initiative (EDI) provides a valuable step forward in the design quality of the built environment (particularly with regard to high density developments) and the creation of sustainable communities. This includes consideration of the reduction in greenhouse gas emissions. Further details can be found at <http://www.the-edi.co.uk/>. However, genuine sustainability must include appropriate consideration of adaptation to climate change. Various initiatives are underway to design new houses to be more sustainable in the light of climate change, such as *Adapting to Climate Change: A Checklist for Development* (Three Regions Climate Change Group, 2005). However, efforts are still required at a more strategic level to determine a sustainable approach to development planning in the light of climate change.

Authorities, Emergency Services, community groups and landowners, as well as flood and coastal defence authorities) to increase the sustainability of flood and coastal erosion risk management in conjunction with ensuring sustainable development for effected areas of Essex. This should build on the growing momentum generated by the large number of studies currently underway as described in *Part 1 – Project Report*.

5. Promote the importance of action on climate change, particularly with the general public and the private sector, through the Essex Partnership website and other communication channels used by the Partnership, with cross-references to the network of related initiatives in Essex, such as *A Greener Essex* campaign.¹⁰ This should include the provision of both reports from this study on the website, along with the presentations used at the Steering Group and Plenary meetings.
6. Get sign-up from both public and private sector members of the Essex Partnership to take forward the identified actions through collaborative task groups, as appropriate (building on the guidance provided in this report regarding implementation, monitoring and review).
7. Collate information from ongoing schemes, initiatives and pilot sites (some of which are listed in *Part 1 – Project Report*) to better inform the detailed scoping of actions and to act as “flagships” for future initiatives.^{11, 12}
8. Consider the continuing role of the Environment Task Group to champion climate change issues in Essex, or the creation of a specific climate change group, to push forward these next steps.

¹⁰ <http://www.agreeneressex.net/>

¹¹ Useful information on examples of renewable energy schemes in Essex can be found in *Renewable Energy Strategy for Essex - Consultation Document* (Essex County Council, 2003).

¹² The Essex Development and Regeneration Agency (ExDRA) may prove to be a valuable vehicle for future initiatives, in particular in relation to sustainable tourism and innovative businesses. Further information can be found at <http://www.exdra.co.uk/>.

16. References

1. Defra (2005) *Making space for water, Taking forward a new Government strategy for flood and coastal erosion risk management for England, First Government response to the autumn 2004 Making space for water consultation exercise*, Defra, March 2005.
2. Department for Transport (2003) Government White Paper: *The Future of Air Transport*, DfT, December 2003.
3. DTLR (2001) *Planning Policy Guidance Note 25: Development and Flood Risk*, HMSO, London.
4. *East of England Plan Sustainability Appraisal Report (incorporating the Report of the Strategic Environmental Assessment, known also as the Environmental Report)*, prepared on behalf of the East of England Regional Assembly by Levett-Therivel and Land Use Consultants, November 2004.
5. East of England Regional Assembly (2004) *East of England Plan, Draft revision to the Regional Spatial Strategy for the East of England*, November 2004, East of England Regional Assembly, Bury St Edmunds, UK.
6. East of England Regional Assembly (2005) *Sustainable Futures: The Integrated Regional Strategy for the East of England*, October 2005, East of England Regional Assembly, Bury St Edmunds, UK.
7. East of England Regional Assembly and East of England Environment Forum (2003) *Our Environment, Our Future: The Regional Environment Strategy for the East of England*, East of England Regional Assembly, July 2003.
8. East of England Regional Assembly and East of England Sustainable Development Round Table (2001) *A Sustainable Development Framework for the East of England*, East of England Regional Assembly, October 2001.
9. East of England Sustainable Development Round Table (2004) *Living with climate change in the East of England, Summary Report*, East of England Sustainable Development Round Table.
10. Entec, HR Wallingford and John Chatterton Associates (2005) *Making Communities Sustainable, Managing flood risks in the Government's growth areas, Summary Report*, Association of British Insurers, February 2005.
11. Environment Agency (2001a) *Water resources for the future, A summary of the strategy for Anglian Region*, March 2001, Environment Agency.
12. Environment Agency (2001b) *Water resources for the future, A summary of the strategy for Thames Region*, March 2001, Environment Agency.
13. Environment Agency (2004) *The South Essex Catchment Abstraction Management Strategy*, June 2004, Environment Agency.

14. Essex County Council (2002) *Report on the potential implications of Climate Change for Essex County Council, Consultation Draft*, Essex County Council, Chelmsford, Essex.
15. Essex County Council (2003) *Renewable Energy Strategy for Essex, Consultation Document*, Essex County Council, Chelmsford, Essex.
16. Essex County Council (2005) *Essex Local Transport Plan 2006/2011*, Essex County Council, Chelmsford, Essex.
17. Hulme, M. et al. (2002) *Climate Change Scenarios for the United Kingdom: The UKCIP02 Scientific Report*, Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East Anglia, Norwich, UK.
18. Land Use Consultants, CAG Consultants and SQW Limited (2003a) *Living with Climate Change in the East of England, Stage 1 Report: Guidance on Spatial Issues*, prepared for Hertfordshire County Council on behalf of the East of England Regional Assembly and East of England Sustainable Development Roundtable, February 2003.
19. Land Use Consultants, CAG Consultants and SQW Limited (2003b) *Living with Climate Change in the East of England, Stage 2 Report: Draft Guidance for Local Service Provision*, prepared for Hertfordshire County Council on behalf of the East of England Regional Assembly and East of England Sustainable Development Roundtable, September 2003.
20. Local Government Association, Energy Efficiency Partnership for Homes, Energy Saving Trust (2005) *Leading the way: how local authorities can meet the challenge of climate change*, LGA, June 2005.
21. Metcalf, G and Jenkinson, K (Eds.) (2005) *A changing climate for business – business planning for the impacts of climate change*, UK Climate Impacts Programme, Oxford, UK.
22. Office of the Deputy Prime Minister (2004) *The Planning Response to Climate Change, Advice on Better Practice*, HMSO, London.
23. Posford Haskoning (2002) *Essex Coast and Estuaries Coastal Habitat Management Plan (CHaMP), Final Report*, September 2002, English Nature.
24. Three Regions Climate Change Group (2005) *Adapting to Climate Change: A Checklist for Development, Guidance on designing developments in a changing climate*, Consultation Document February 2005, East of England Sustainable Development Roundtable, London Climate Change Partnership and South East Climate Change Partnership.
25. Willows, R.I. and Connell, R.L. (Eds.) (2003) *Climate adaptation: Risk, uncertainty and decision-making*, UKCIP Technical Report, UK Climate Impacts Programme, Oxford, UK.
26. Younge, P, Pettifer, D and Burton, R (2005) *Exercise Triton '04*, 40th Defra Flood and Coastal Management Conference 2005, University of York, 5-7 July 2005.