Climate Change Strategy 2011

Council of the Isles of Scilly

….. a strong, sustainable and dynamic island community

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1. Introduction

Climate Change is an urgent global issue which has already begun to impact upon every nation on Earth, influence the way people live and threaten our very survival. This document explores what is meant by the term Climate Change, reviews the science of Climate Change and draws on the most recent research to present a consolidated picture to enable us to understand how it will most likely impact on the community of the Isles of Scilly.

Using the latest projections from the UK's Hadley Climate Research Centre (based at the Met Office in Exeter), this Climate Change Strategy will assess the risks (and opportunities) that UK residents and more specifically Islanders may potentially face as a result of a warming planet and quantify them at a regional and local level. The document will discuss how residents of the Isles of Scilly can adapt to Climate Change in a meaningful way and will seek to define a road map of practical actions, which will build resilience and sustainability into our local environment and community to enable us to face the future with confidence. Unlike many other Council strategy documents the Climate Change Strategy operates to a much larger time scale and therefore must not only fit with current Development Framework, Core Strategy and the management plans of key stakeholders such as the Duchy of Cornwall, Tresco Estate, Area of Outstanding Natural Beauty (AONB), English Heritage, Natural England and the Wildlife Trust, but also look ahead to the long term future of the islands. It must set the process of adaptation to Climate Change in motion, not only for our generation's welfare, but also for our children and future generations' welfare, helping them to develop the framework that will create a sustainable way of life on the Isles of Scilly.

Scilly has a unique environment and a unique microclimate compared to the rest of the UK Mainland. It will take unique solutions to adapt to the changes the islands will experience from rising sea level, hotter summers, wetter winters, more frequently occurring extreme weather events and increased energy costs. Island life has always had to respond to extreme weather events and we have a good record of dealing and adapting to unforeseen circumstances. We have already faced many changes in the long history of the islands, so if we start early enough and plan wisely we will be able to create a sustainable environment and a thriving community for future generations to enjoy despite or with the help of Climate Change.

2. Purpose and Scope of the Climate Strategy Document

Government policy on adapting to Climate Change, supported by the National Indicator 188 (now defunct) objectives and milestones, together with the Council's undertaking to produce this document as signatory to the Nottingham Declaration on Climate Change have provided the drivers for the development of this strategy. The key purposes of this document are:

- To provide the Council, public and other local strategic partners (both statutory and non-statutory) with information on Climate Change and its likely impacts on the islands and the community of the Isles of Scilly, which will assist them in making short, medium and long-term decisions on the best way to adapt to and manage both negative and positive aspects of Climate Change.
- To explain the need for action and identify specific threats and opportunities.
- To investigate what adaptive measures are currently in place to reduce threats and benefit from opportunities and identify what other steps need to be put in place where appropriate.
- To recommend adaptation strategies to minimise the risks to the community from Climate Change and embed these in Council operating procedures.
- To recommend adaptation strategies to protect and manage habitats and species for the benefit of wildlife and people.
- To relate response to Climate Change to the Council's overarching strategic documents.

3. The Isles of Scilly

3.1. Geography, Geology and Community

The Isles of Scilly is an archipelago of over 200 low-lying granite islands and rocks located some 28 miles south-west of Land's End. It is the most south-westerly part of Britain and is the only archipelago in England. The archipelago consists of five inhabited islands (St Mary's, St Martin's, Bryher, St Agnes and Tresco), several other uninhabited islands and numerous small rocky islets. The island community consists of a little over 2,000 inhabitants, concentrated on the main island of St Mary's (see table 1). St Mary's acts as the administrative and logistical hub of the islands.

The location of the archipelago presents islanders both with a unique environment and also unique challenges to maintain a sustainable community. All freight and passenger traffic must be transported to and from the islands either by air (helicopter, light aircraft) or by sea using the Isles of Scilly Steamship Company's passenger and freight service. The islands are special in many ways. They are designated as an Area of Outstanding Natural Beauty (AONB), have the highest density of Scheduled Monument sites in the UK, together with the highest percentage of land mass

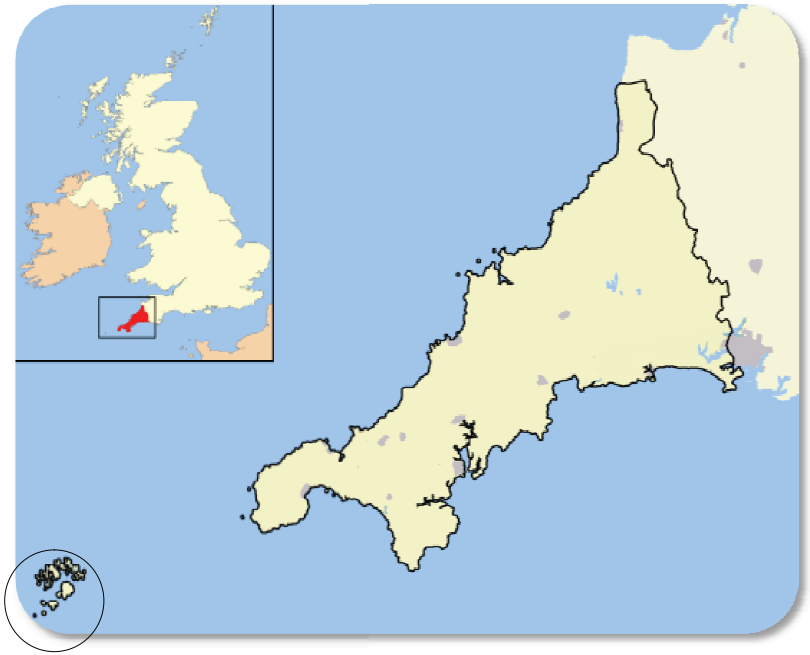

Figure 1: SW England and the Isles of Scilly

designated as Sites of Special Scientific Interest (SSSI) and internationally important wetland conservation sites (RAMSAR). The islands are also designated as a European Marine Site as they contain examples of some of the best marine habitats and unique collections of marine species in

Table 1: Population of the Isles of Scilly (census 2001)

Island (Census 2001)	Population	Area (km²)	Main settlement
St Mary's	1,666	6.29	Hugh Town
Tresco	180	2.97	New Grimsby
St Martin's (with White Island)	142	2.37	Higher Town
St Agnes (with Gugh)	73	1.48	Saint Agnes
Bryher (with Gweal)	92	1.32	Bryher
Samson	-	0.38	
Annet	-	0.21	
St. Helen's	-	0.2	
Teän	-	0.16	
Great Ganilly	-	0.13	
remaining 45 islets	-	0.5	
Isles of Scilly	2,153	16.03	Hugh Town

Europe; and also designated as a Special Protection Area (SPA) for breeding seabirds.

Economic sustainability on the islands is primarily supported by the tourism industry (accommodation providers and associated service businesses), together with a limited input from farming (mainly flower growing), fishing and general maintenance and supply businesses.
Sustainable economic development hinges on three factors:

- Continued prosperity of the tourism sector
- Enhancement and diversification of traditional activities such as farming
- Development of new businesses, especially those in knowledge based sectors or internet based businesses, where access to markets is not limited by the islands geographical location.

The Council of the Isles of Scilly has the status of a Unitary Authority. It is a major employer within the community, providing employment to over 10% of employment age residents. However, due to the small size of the Council Tax base over 2/3rds of the Council's income comes from external central Government and European grant funding. In addition the Council is unique in that it is one of the few remaining Councils in England to manage its own waste disposal, water provision and airport. This sometimes can

create special problems which require creative local solutions and make funding for any significant capital projects that might be required in response to the impacts of Climate Change (e.g. flood defences) a critical issue.

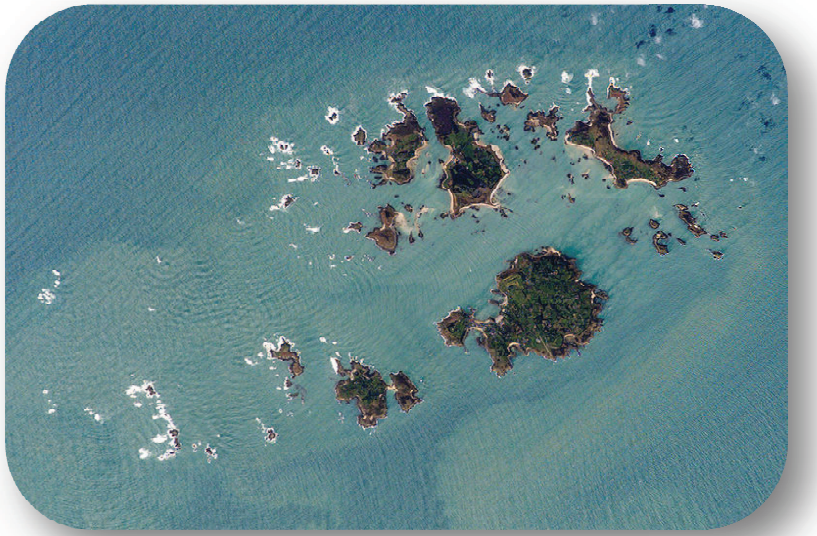

Figure 2: Aerial view of the Isles of Scilly

From a geological perspective, the islands solid geology is granite, formed around 290 million years ago. The granite is part of a huge subterranean batholith stretching from Dartmoor to the submarine outcrop of Haig Fras, some 100 km to the WNW of Scilly, but exposed only in places where the overlying cover rocks have been stripped from the domes by weathering and erosion. Slow cooling of the batholith during formation has given the granites a distinctive crystalline and coarse-grained texture. This is reflected in the poorly formed, acidic soils of the islands.

During the last Ice Age, 21,000 years ago, a large glacier flowed southwards down the Irish Sea Basin reaching down as far as the northern extremities of Bryher, Tresco and St Martin's. South of this ice limit, cold tundra conditions resulted in the accumulation of orange-brown slope and wind-blown deposits known locally as "ram", still visible in the cliffs around the islands. These relatively soft deposits are particularly susceptible to coastal erosion. However, the result of granite weathering and erosion of low cliffs and platforms takes two forms, an angular head and the production of much sand which is often blown up into small ridges and dunes, which with proper guardianship will provide long lasting natural barriers to the sea.

4. Climate Change

4.1. Climate Change - An Introduction

What do we mean by Climate Change? Climate is about long term trends in weather patterns, usually defined as average conditions over a 30 year period or longer. Climate describes a wide range of parameters such as temperature, rainfall, wind speeds, number of significant weather events etc. Weather is what is going on outside your window at any given point in time. It follows then that climate will follow distinct patterns of change over time, ranging from decades to millennia.

Global mean temperatures have risen about 0.6^{O}C since 1860 when systematic temperature records began. The 20th Century was probably the warmest in the past 1000 years. In the UK, eight of the last 10 years have been the warmest since records began, with 1990 and 1999 the two warmest years ever recorded. Globally, 2005 was one of the warmest years on record. As a result it is clear our climate is changing.

2003 saw the highest maximum temperature recorded in the UK since records began of 38.1^{O}C (100.6^{O}F) in Gravesend, Kent on 10th August 2003 (source Met Office).

There is evidence that rainfall patterns are changing, sea levels are rising, glaciers are retreating and Arctic sea-ice is thinning. The incidence of extreme weather is also increasing in some parts of the world.

Researchers are confident that most of the current phase of warming is due to increasing concentrations of so called greenhouse gases (such as CO^2, methane and CFCs) in the Earth's atmosphere. Concentrations of these gases have risen by some 50% in less than 200 years, largely through the burning of carbon rich fossil fuels and deforestation.

The science behind Climate Change is complex. The following sections will, for the sake of brevity, summarise the current scientific understanding of the impacts of Climate Change. The reader is referred to Appendix 1 for a more detailed discussion of the scientific arguments.

Many factors seem to play a role in changing our climate and indeed climate must be considered from a regional and in the case of the Isles of Scilly a local micro-climate perspective. The history of our planet shows that in the distance past there have been huge changes to the global climate. During the last two billion years the Earth's climate has alternated

between a frigid "Ice House" and a steaming "Hot House", like the world of the dinosaurs.

Climate Change is driven by both so called internal and external factors. Internal factors include the production of gases from both human and environmental sources (such as volcanoes) which may be either warming (e.g. CO^2 and other greenhouse gases) or cooling (sulphates from volcanic eruptions). External factors include variation in solar output due to sunspot activity or variations in the Earth's orbital characteristics. The Earth would be about 30^OC colder if it was not surrounded by our atmosphere.

All these factors act together to create our climate. But it now seems likely that the *current* phase of global warming is being caused by the increase in greenhouse gasses, produced by mankind since the early days of the industrial revolution. Concentrations of these gases have risen by 50% in less than 200 years. Concentrations of CO^2 (in particular from the burning of fossil fuels, required to meet our rising energy needs), has increased significantly since the 1800s. Climate driven by mans influence is termed anthropogenic Climate Change.

There is now a general consensus amongst Climate Change Scientists that global warming is occurring and that man is responsible for the current phase of warming or at least accelerating the current warming trend. The rate and duration of warming during the 20th century has been much greater than in any of the previous nine centuries.

However, the Earth's climate like all natural systems exhibits a high degree of variability and whilst global climate is relatively easy to model, local and regional climates are more complex.

An example of this is the recent relatively cold winters seen over the UK (see Fig: 3). Despite the UK experiencing exceptionally cold weather, the rest of the Northern Hemisphere as a whole has actually seen relatively mild weather and measurements indicate that 2010 will be another of the warmest years on record. The cause of the cold winters over the UK was a movement in the Jet Stream, so that cold air was sucked down from higher latitudes. The Jet Stream is one of several high-speed, meandering wind currents, generally moving from a westerly direction around the globe at altitudes of between six to nine miles.

We should therefore expect extremes of weather to occur above and below the trends predicted for long term Climate Change, but over time it is reasonable to make predictions as to the direction of Climate Change, which is for an increase in global temperatures.

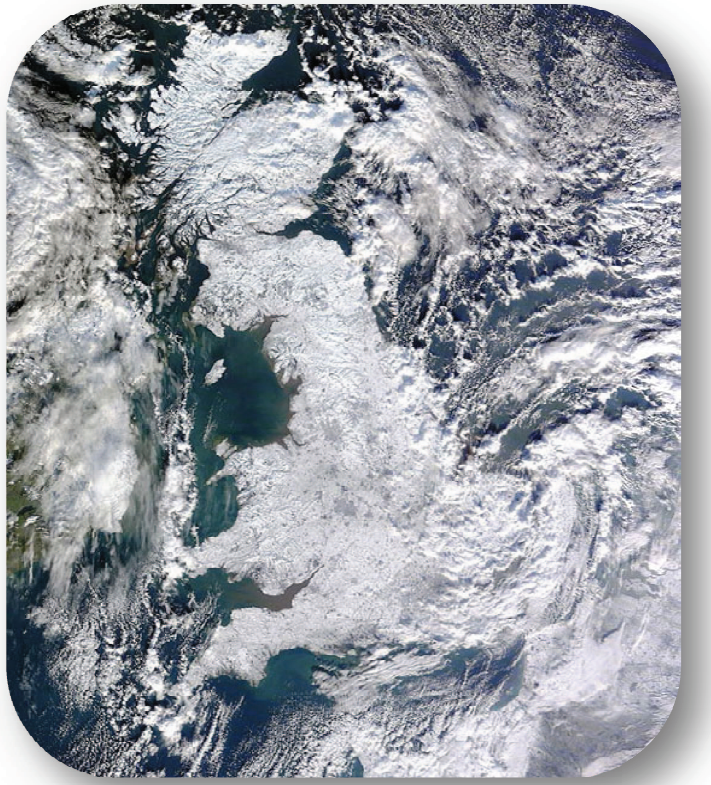

Figure 3: An historic snowfall blanketed Great Britain on January 7th 2010. A strong high-pressure event pushed the jet stream south and allowed Arctic air masses to invade Northern Europe in December and January, creating an unusually cold winter.

One year (or even a run of cold or hot years) of unusual weather does not prove or disprove what is happening to the climate. Global warming theory does not project a linear, year-to-year increase in temperatures. What it does say is that increasing concentrations of gases such as carbon dioxide and methane, with unchecked growth, will contribute an increasingly greater warming influence on the world's climate.

4.2. Understanding Climate Projections

Climate scientists know that there is plenty they don't know about the way the Earth system works. Some of the physical processes that models describe are thoroughly well-established - the melting point of ice, for example and the law of gravity. Other physical processes are less well understood. For example, when the air temperature is not far below 0^{O} Celsius, will water vapour condense into liquid or ice? Either is possible, depending on atmospheric conditions. To understand how uncertainty about the underlying physics of the climate system affects climate predictions, scientists have a common test: They use a model to predict what the average surface temperature would be if carbon dioxide concentrations were to double from pre-industrial levels. They run this simulation thousands of times, each time changing the starting assumptions of one or more processes.

When they put all the predictions from all of these simulations onto a single graph, what they get is a picture of the most likely outcomes and least likely outcomes.

Data is collected from many different sources and analysed by different groups of scientists around the world. Three of the key groups are NASA's Goddard Institute for Space Studies (GISS) in the USA, the UK's Met Office Hadley Climate Research Centre and the National Climatic Data Centre (NCDC), which is part of the US National Oceanic and Atmospheric Administration (NOAA-USA). Data is collected from 1000s of weather stations, floating buoys and survey ships. Around 1.5 million observations each month are taken around the world. The key here is that *all* analyses show warming of the globe has accelerated in the last 150 years. All show a marked warming trend, particularly over the past three decades.

Climate projections are made using theoretical models derived from our understanding of past & present climate. Projections are made from a consensus of the output from different models (which are tested against historical data) in order to minimise variability and uncertainty. Whilst any individual study may draw erroneous conclusions it is very unlikely that the consensus from all studies, which clearly show temperature rises, is incorrect. The Inter-Governmental Panel on Climate Change (IPCC) stated in their most recent report (2007)[1] that global surface temperature at the end of this century will probably be between 1.8 and 4^{O}C warmer than it was at the end of the last century.

Its natural to question whether we and future generations will regret our efforts to reduce greenhouse gas emissions if it turns out global warming isn't as bad as predicted. But the best science we have to guide us at this time indicates that the chance that warming will be much larger than the best estimate is greater than the chance that it will be much smaller.

4.3. Global Projections of Climate Change

What can we expect globally? Predicting global changes are mostly about modelling global increases in temperatures. A global increase of 4^{O}C will not mean that all regions of the globe will warm equally (See Fig.4). The IPCC predicts that increases in global mean temperature of less than one to three degrees centigrade above 1990 levels will produce beneficial impacts in some regions and harmful ones in others. Taken as a whole, the IPCC states, "the range of published evidence indicates that the net damage costs of Climate Change are likely to be significant and to increase over time." Below are detailed some of the

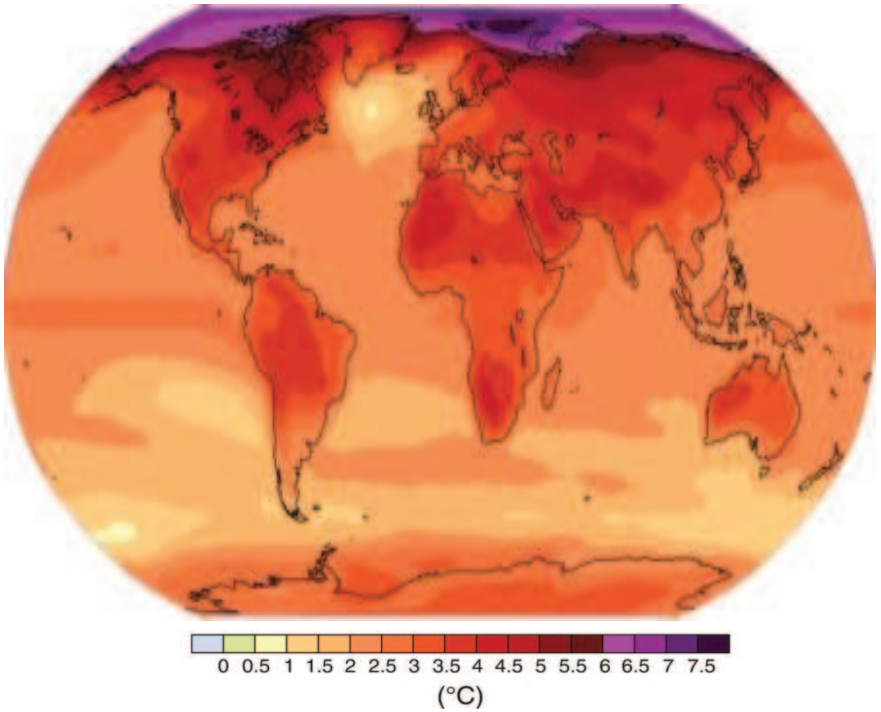

Figure 4: Regional variations in predicted global warming (IPCC AR4 multi-AOGCM average projection for the A1B Temperatures relative to 1980-1999) [1]

regional impacts of global change forecast by the IPCC:

1: North America: Decreasing snowpack in the western mountains; 5-20 percent increase in yields of rain-fed agriculture in some regions; increased frequency, intensity and duration of heat waves in cities that currently experience them.

2: Latin America: Gradual replacement of tropical forest by savannah in eastern Amazonia; risk of significant biodiversity loss through species extinction in many tropical areas; significant changes in water availability for human consumption, agriculture and energy generation.

3 Europe: Increased risk of inland flash floods; more frequent coastal flooding and increased erosion from storms and sea level rise; glacial retreat in mountainous areas; reduced snow cover and winter tourism; extensive species losses; reductions of crop productivity in Southern Europe.

4 Africa: By 2020, between 75 and 250 million people are projected to be exposed to increased water stress; yields from rain-fed agriculture could be reduced by up to 50% in some regions by 2020; agricultural production, including access to food, may be severely compromised.

5 Asia: Freshwater availability projected to decrease in

Central, South, East and South East Asia by the 2050s; coastal areas will be at risk due to increased flooding; death rates from disease associated with floods and droughts expected to rise in some regions.

Note that the projections shown in Fig: 4 indicate that warming at the North Pole will be substantially higher than more temperate latitudes, suggesting an increased probability of ice melt and sea level rise.

4.4. Regional Projections for Climate Change in the UK

The UK's Met Office Hadley Climate Research Centre has invested a significant amount of resources in analysing Climate Change projections for the UK over the next 100 years. The current set of projections is referred to as the UK Climate Projections 09 (UKCP09) and is the 5th set of projections from the Met Office replacing the last official set of projections (UKCP02).

Recognised as a world leader in climate science, the centre has developed a range of tools which can be accessed on line to explore the consequences of Climate Change across the UK. Climate projections are based on a range of different models and a consensus view used to output different Climate Change scenarios. This allows scientists to assign a level of probability to projections and helps decision makers to understand the risks we are likely to face.

Climate models are a mathematical description of our understanding of the processes in the Earth's climate system; atmosphere, ocean, land. The Met Office evaluates their reliability in a number of ways, testing multiple models against historical data. Validation exercises such as these provide compelling evidence that, at least in terms of gross temperature response, the model is effectively reproducing what has been observed and this gives us confidence that the models are adequate tools for the prediction of future climate in the UK.

Within any given range of plausible Climate Changes, one cannot talk about the absolute probability of climate changing by some exact value — for example a temperature rise of exactly 6.0^{O}C. Instead scientists talk about the probability of Climate Change being less than or greater than a certain value, using the Cumulative Distribution Function (CDF). This is defined as the probability of a Climate Change being less than a given amount. The Climate Change at the 50% probability level is that which is as likely to be exceeded as not; in UKCP09 it called the central estimate. In Fig. 5, the CDF (a hypothetical example for a given location, at a certain future time period, for a given month of the year, under a particular emissions scenario) shows that there is a 10%

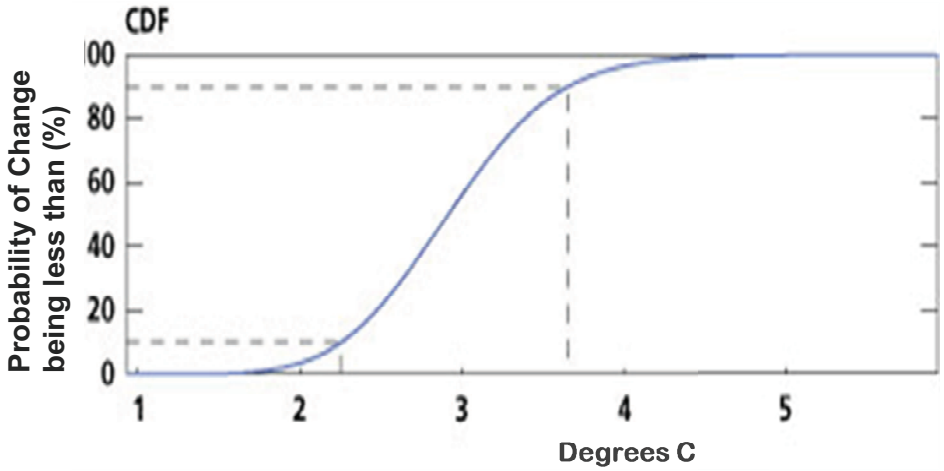

Figure 5: Example of a Cumulative Distribution Function (CDF)

probability of temperature change being less than about 2.3ºC and a 90% probability of temperature change being less than about 3.6^{O}C. The 50% probability suggests a temperature change around 3^{O}C. In line with IPCC terminology, this means that it is very unlikely that the temperature rise will be less than 2.3^{O}C and very likely that the rise will be less than 3.6^{O}C and unlikely it will be greater than 3.6 ^{O}C.

All projections quoted in this document use the 50% probability value for simplicities sake. To develop regional projections (e.g. for the South West) the whole of the UK is divided up into 25 sqKm grids and climate projections modelled for each square. This allows generalised key findings to be made for the UK regions.

The South West Regional Climate Change Impacts Group (SWCCIP) - now South West Climate - was set up to provide best guidance to the South West Region on the impacts of Climate Change and works in conjunction with the Met Office and Department of Energy & Climate Change (DECC) to develop a set of guidelines for local authorities and communities, based on the UKCP09 projections. The headline impacts for the predicted changes are shown in section 4.5 onwards.

4.5. SW UK: Headline Climate Change Scenarios

The data below is extracted from UK Climate Projections Briefing Reports (2009) [3, 4] and summarises projections for the South West region of the UK.

Long term seasonal averages versus 1961–1990 baseline

- Warmer drier Summers
- Milder wetter Winters
- Rising sea levels
- Reduced soil moisture content during summer / autumn.

Extremes

- More very hot days – more frequent high temperature days and higher extremes.
- More intense downpours of rain – both volume and frequency of extreme precipitation events.
- Shorter return periods for high water levels at coast.

4.6. Detailed Climate Projections for the SW for 2080s versus 1961–1990 baseline

Taken from the projections published by the Met Office Hadley Centre for Climate Change [3,4]:

Temperature

Summer

- Increase in mean temperature of 3.1 ^{O}C.
- Increase in maximum daily temperature of 5.4 ^{O}C.
- No of days likely to exceed 28 ^{O}C : 4/year.

Winter

- Increase in mean temperature of 2.7^{O}C.

Precipitation (Rain snow etc)

- Annual mean precipitation reduced by 0- 5%.
- Winter mean precipitation increased by 10-20%.
- Summer mean precipitation decreased by 15-25%.
- Annual number of dry day periods > 10 days between 4-7days.

Storm Tracks Wind and anticyclones

- By 2080s models predict slight weakening in storm tracks and tracks moving further south.
- The frequency duration or intensity of anticyclones is unlikely to change.
- There is little consistent evidence of a projected systematic change in wind speed.
- A high degree of uncertainty underlies the anticyclone and wind projections; there is no compelling evidence to suggest a marked change is likely to occur. This suggests storm intensity and frequency are not likely to increase or decrease significantly.

Relative Sea Level Rise (baseline 1990)

- 8 inch (19cm) by 2040.
- 16 inch (40cm) by 2080.
- 21 inch (52cm) by 2100.

This represents an increase in current mean high water tide levels and excludes any storm surge element.

Storm Surge (defined as "skew surge": the difference between expected tide and observed tide)

- Surge levels, predicted to exceed current levels at a one in 2, 10, 20, or 50 year events are not projected to increase by more than 9cm (3.5 inch) in the SW and uncertainty in projections suggests this is within the normal variability seen from historic data.

Offshore waves relative mean annual wave height

- Predicted to increase by 1 meter or 39 inches by 2080.

Seasonal Mean Sea Temperatures

- Projections show wide variability but we may see a shift to higher seasonal mean sea temperatures by 1-3 ^{O}C in summer and autumn.

Sea shelf conditions

- Predictions whilst uncertain suggest an increase of 0.2 practical salinity units leading to increased and longer stratification of overlying fresh water layers.

4.7. Local Climate projections for the Isles of Scilly

The Isles of Scilly have a unique sub-tropical microclimate, which both because of our position, surrounded by the Atlantic to the west of the UK mainland and the influence of the Gulf Stream, means we generally do not experience the extremes of weather seen in the rest of the UK. For example the highest recorded temperature on Scilly in the last 30 years (direct measurements from local weather stations) was 29.5^{O}C on 20th June 2003, whereas the highest mainland recorded temperature was 38.1^{O}C (100.6^{O}F) in Gravesend, Kent on 10th August 2003 (source Met Office).

In making regional projections for the UK the UKCP09 models use 25 sqKm grids. These are then classified as marine or land grid squares based on the percentage of sea or land within each square. Each type of square is modelled slightly differently and outputs different climate variables. Whilst this works well for the South West in general, the Isles of Scilly do not fit this classification scheme exactly and there are therefore no specific output predictions for the islands. For example, we are less likely to experience extreme temperature highs of greater than 35^{O}C, assuming a 5.4^{O}C warming by 2080. It may well be that the islands will benefit from relatively mild increases in temperature (particularly our tourism industry) as the hotter parts of Southern Europe and North Africa become too hot for holiday makers.

To plan and adapt to Climate Change for the islands is complicated because of the lack of hard data available at the scale of the Isles of Scilly. However, historical data has been collected for daily weather parameters for the last 23 years and mean high water level and surge data from St Mary's harbour records back to 1994 and from Newlyn records back to 1910 are available. Whilst 20 years of data certainly does not prove a Climate Change trend, it is interesting to note that the collected data (see Figs.6 & 7), does follow the expected and observed trends for both sea level rise and temperature for the South West. It is recommended as an action arising from this document that these data are collected on a regular basis and made available for general use to improve our understanding of changes in our local climate. This is key to understanding and planning for both long-term trends as well as responding to extreme weather events in the future.

Of all the parameters of Climate Change that have been modelled, the most certain is the change in sea level. Sea level rise is probably the single most predictable outcome of Climate Change – changes already observable in our oceans are slow processes, which once initiated are difficult to reverse. Should the melting of ice at the poles be somehow

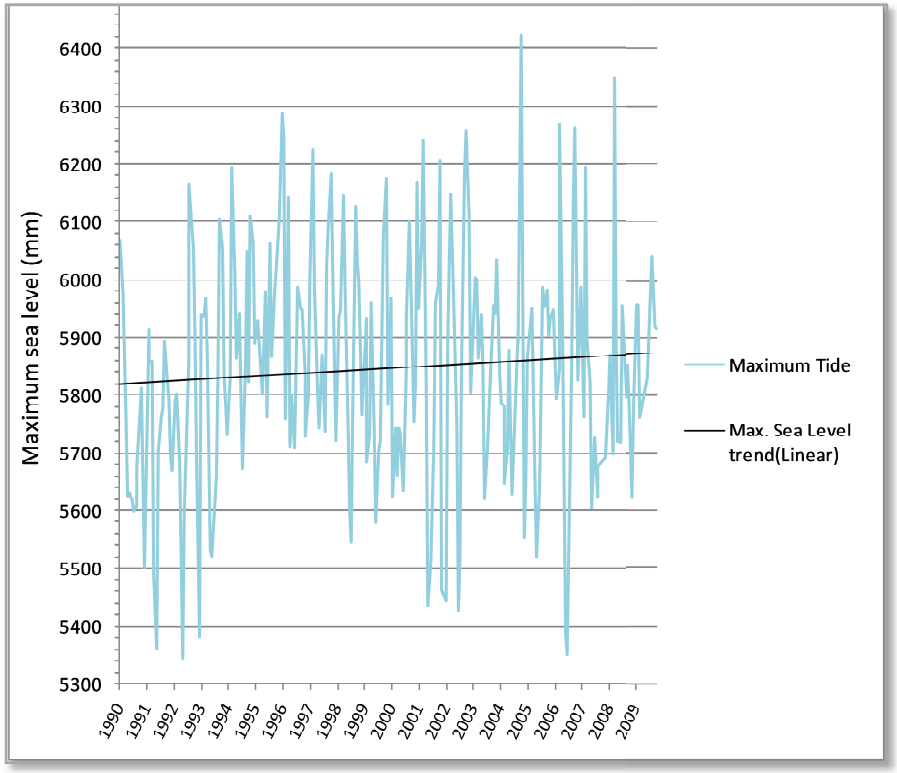

Figure 6: Trends in Mean High Water Level at Newlyn 1990 – 2010.

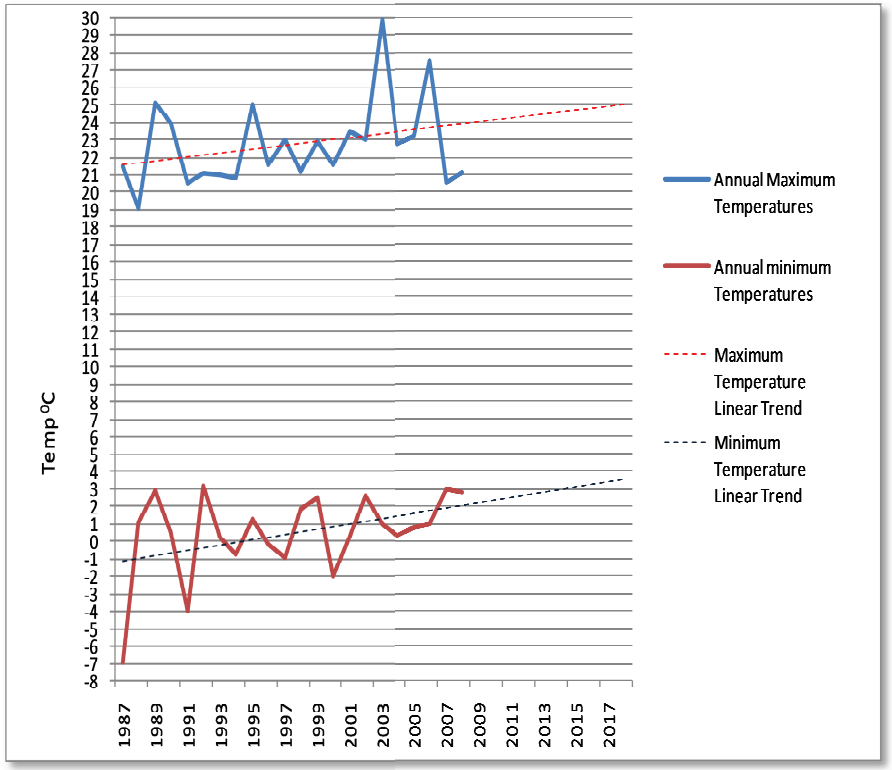

Figure 7: Annual maximum and minimum temperature and trends - St Mary's (local data) 1987-2017.

halted, expansion of the water in our oceans as thermal mixing and stabilisation continues will, due to the inherent heat capacity of water, lag behind any stabilisation of global temperatures. Sea level rise will continue for some time irrespective of global warming. In simple terms this means that some further expansion of water in our oceans is already locked in and will continue to create a rise in sea level, whether or not atmospheric greenhouse gases are stabilised.

In addition, sea level rise will be increased in the South West due to glacial isostatic adjustment (GIA). As the ice sheets covering the Northern Hemisphere melted after the last Ice Age the landmasses above, relieved of the weight of ice, have been gradually rebounding – a process which continues today. Other factors also come into play, but the end result is that the UK is tilting down to the SW and rising in the NE. This is projected to add around 0.6 mm/year to the rise caused by hydrostatic factors in the South West (Shennan et al 2009)[5]

It should be noted however that the Met office projections for sea level rise around the UK are based around the IPCC's projections which are generally considered somewhat conservative by many scientists. In 2007, the IPCC stated that sea-levels would rise by between 18 and 59 cm by 2100. The Panel underlined that this estimate only included rises caused by the expansion of sea water due to a warming climate and excluded the water contributed by the disintegration of Greenland and Antarctica ice sheets.

The science behind sea level rise is incomplete. In particular there is a paucity of hard data on what is currently happening to ice sheets in the Arctic and Antarctic. New models are being developed which suggest there could be relative sea level increases in the order of 1-2 M by 2100 [21], although this is not yet the consensus.

It is clear that the single biggest threat to our community and environment (including the integrity of the AONB) is coastal erosion caused by storm damage and sea level rise. This is addressed in more detail in section 7.1, but means that coastal erosion and flood inundation is linked to the coincidence of several factors – mean high water, low pressure events, wind direction and velocity, wave height and storm surges. When these factors come together they have an added effect which significantly increases the risk of overtopping and flood inundation. Historical data on these event coincidences is insufficient to make predictions – but do suggest that inundation forecasts based on mean high water projections alone, are very conservative in quantifying risk.

In summary the consensus from most scientific studies iss that global Climate Change will have a major impact on the

Earth. Understanding of what will have a major impact on the UK as a whole is reasonably predictable. Predicting how Climate Change will impact on The Isles of Scilly (with the exception of sea level rise) is much more of a challenge. We can protect our way of life for as long as feasible by careful risk assessment and planning.

The remainder of this document outlines the strategy of how we should prepare to minimise the impacts that we and future generations will face.

5. Assessing and adapting to the impacts of Climate Change

To properly prepare to face the challenges of Climate Change we must understand the range of risks we are likely to need to assess and then lead the community in addressing these risks by building resilience into our community fabric.

Climate Change will impact on virtually all aspects of island life (Fig. 8). Where particular areas of island life overlap, the effects are likely to be multiplied. For example, Climate

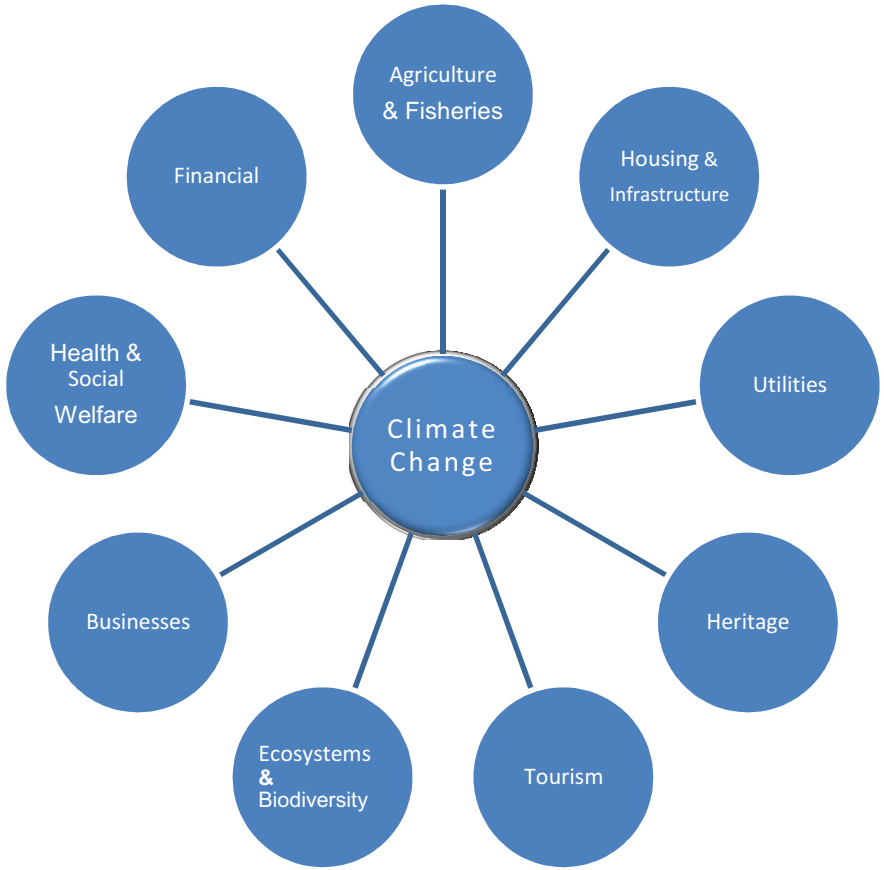

Figure 8: The impacts of Climate Change

Change will directly affect our eco-systems which in turn will have an indirect impact on our tourist industry and agriculture.

5.1. National Indicator 188

To guide the Council in preparing for Climate Change a decision was ratified by Members in 2008 to sign up to National Indicator 188 (Adapting to Climate Change). Until their recent abolition, National Indicators were Local Government targets on which the Council and its Local

Strategic Partners (LSP) agree to work jointly. NI 188 defined a self-assessment framework to ensure that the relevant issues were explored and addressed. Level 0 & 1 covered the initial project scoping, the collection of environmental data, the carrying out of preliminary research on the impact of extreme weather events and top level identification of potential risks to the community. Level 1 was achieved in May 2009 and the output from these preliminary studies published on the Council of the Isles of Scilly's website. Level 2 self assessment was submitted in May 2010. Level 2 required the following goals to be achieved:

"*The Authority has undertaken a comprehensive risk based assessment of vulnerabilities to weather and climate, both now and in the future and has identified priority risks for its services. It has identified the most effective adaptive responses and has started incorporating these in Council strategies, plans, partnerships and operations (such as planning, flood management, economic development, social care, services for children, transport etc). It has begun implementing appropriate adaptive responses in some priority areas. In its role as a community leader the Council has started working with its LSP encouraging identification of major weather and climate vulnerabilities and opportunities that affect the delivery of the LSP's objectives*."

To meet this target, the key was to carry out a comprehensive risk assessment to identify and quantify risks arising from Climate Change. To facilitate understanding of the impact of the identified risks, an assessment of existing or required adaptation responses formed part of the exercise. Comprehensive in this context is defined as wide ranging, rather than in depth analysis of specific risks.

Many of the risks identified will require integrating into long term planning strategies such as the Local Development Framework and the Core Strategy. Solutions (e.g. for flood and coastal erosion) may take several years to develop and implement and require ongoing updating and review. Risk management is a continuous cycle, whereby assessing situations enables evaluation of risk and guides implementation of management actions. The impacts of

Figure 9: The Cycle of Risk Management

these actions are then measured, followed by reassessment of the situation so as to continuously monitor risk (Fig: 9).

The risk assessment was carried out by circulating a briefing document and questionnaire to senior Council department heads and members of the LSP with follow up interviews.

5.2. Climate Change Risk and Adaptation Assessment Methodology

Over 50 risks were identified and the detailed output of the risk assessment is summarised in Appendix 1. A summary of the five most significant risk categories is shown in section 6. Risks were grouped by environmental variable (e.g. increased temperature) and the impact area and likely consequence identified. Additionally, current Climate Change related adaptive measures already in place were captured and gaps in adaptive processes identified. Risk impacts were assessed qualitatively by a scoring method based on a simplified version of the Council's risk assessment procedures which inform the Community and Corporate Risk Registers. Risks were assessed taking into account mitigating adaptive procedures *already* in place and scored high, medium or low for financial and community impact. Likelihood of risk occurring was scored high, medium and low and a timescale score factored into the calculation (short (high), medium or long term (low) risk). Risks were assessed using the above scoring method by a

panel of Planning and Economic Development staff (including input from the AONB officer). Finally, the risk was given a standardised overall score taking into account impacts, timescale and likelihood of occurrence.

Relevant documents from the Council's strategic plans were referenced for each risk to show where risks should be addressed in Council policies.

However, it should be noted that whilst Section 6 details the critical risks which threaten the very cohesion and sustainability of the island community itself, there are significant other risks which will impact on our ability to maintain our way of life: for example risks to both natural and heritage environments listed in the main risk register database.

These are also considered important and will be included in the management plan for Climate Change in the sections following. A compilation of all risks identified in the Climate Change risk assessment process is detailed in Appendix 1 for completeness sake.

6. Summary tables of Major Risks & Opportunities

Environmental Variable	Risk / Opportunity	Impact Area	Consequence
Sea Level Rise and Storms	Threat to infrastructure and administration e.g.Town hall / roads / sewers & drains, septic tank drainage systems waterlogged	Finance function and all Council services	Damage to key administration buildings and central services / infrastructure - Server Room flooded, Council Tax, benefits, accounts, planning, accommodation lists, payroll services lost - cost of disruption high Inability to pay staff, creditors and collect revenue Loss of financial control (inability to monitor expenditure or prepare accounts) Impact on clients (Council Tax and housing benefits) Loss of organizations data due to servers being lost and backup data being lost (stored in TIC) Budgetary implications for repairs and maintenance, clearing drains , minor localized flooding etc) Damage to residential and business property Major impact on key industries - tourism / agriculture Higher insurance premiums - possibly no insurance Loss of permissive access routes to conservation areas through erosion. Buildings left in poor state of repair or abandoned
Sea Level Rise and Storms	Transport links at risk	Council Services Tourism Health All Business sectors Supply chain import / export	Wear and tear on vessels increased Travel becomes difficult from mainland and inter-island Decreased productivity / unable to meet performance targets Service Clients (eg children and vulnerable adults at risk. Medical needs / treatment not met - potential for avoidable deaths Longer periods without freight leads to: Economic impact on businesses Community may become unsustainable Loss of essential and non essential supplies Off Island links may be reduced - medical issues / quality of life reduced

Adaptation process in hand or needed	£ con-sequence (1-3)	Impact (score 1-3)	Likely - hood (score 1-3)	Time frame	Reference Documents / organizational structures	Overall score
Implementation of Shoreline Management Plan rev. 2 (SMP2) Implementation of Porthcressa plan Ensure adequate insurance and contingency/disaster recovery planning. Reviewing Disaster Recovery (DR) plan in Finance and Resources service plan. Consider moving server room above sea level when reallocating office space Investigate outsourcing transactional processing functions to a safer location on the islands, or on the mainland Emergency Planning early warning systems in place - event database created Review locations of essential Council services and back-up data plans Recognition that budgets need to be permanently increased in budget planning process Sea level Rise database monitors trends Weather database monitors trends Need to review domestic & business flood defence technologies (eg door protectors, socket positioning) Need to address climate channge issues in policy documents and planning decisions in accordance with PPS 25 and new PPS documents in draft which replace PPS25 & PPS1 All new building / developments need to have flood risk assessments done Monitor access routes and open new ones	3	3	3	Short-Medium	SMP2 Porthcressa masterplan Flood Inundation Modelling IOS Flooding (M.Thomas) CIOS Flood Plan Sea level rise and weather databases	83%
Improve facilities for remote access to IT systems More robust transport links to mainland - Sustainable Transport Strategy ongoing Strengthen harbour (planning assessment done) Implement SMP2 Capacity for Change consultation identifies ways to build resilience Harbour plans assessed against Climate Change and environmental impacts Discussions ongoing to maintain BIH helicopter link	3	3	3	Short-Medium	Sustainable Energy Strategy Sustainable Transport Strategy Route Partnership Capacity for Change	83%

Environmental Variable	Risk / Opportunity	Impact Area	Consequence
Sea Level Rise and Storms	Threat to infrastructure e.g. roads / sewers & drains, septic tank drainage systems waterlogged	Highways Technical Services Tourism health heritage agriculture logistics	Damage/loss of infrastructure including main and off island quays requiring rerouting/repair vehicular & pedestrian access to properties reduced or removed. Dwellings uninhabitable, tourist accommodation affected, sewage effluent above ground. Temporary evacuation of vulnerable people.
Sea Level Rise and Storms	Current housing and business accommodation vulnerable to sea level rise and storm surges	Planning Tourism Business	Property flooded/ damaged and services disrupted – Loss of revenue
Increasing energy costs and more demanding CO2 regulatory environment	Energy Costs predicted to rise 20% by 2020 Increasing regulatory pressure from UK and EU to minimise energy wastage and develop renewable energy sources Public interesrt in renewable microgeneration will increase rapidly	All areas impacted Council services / reputation Council Finances Business sector Tourism Residents Agriculture Transport	Financial burden on businesses, Council, schools and homes significant Reduced cash for other services Fuel poverty will increase Opportunity to gain significant financial benefit through FITs for Council, schools and residents Possible conflict with biodiversity and landscape Sustainable provision of self sufficient energy Businesses struggle to compete due to direct energy costs and increased export/import cost. Cost to visitors may become unsustainable

Adaptation process in hand or needed	£ con-sequence (1-3)	Impact (score 1-3)	Likely - hood (score 1-3)	Time frame	Reference Documents / organizational structures	Overall score
Implementation of Sustainable Transport Strategy Implementation of SMP2 Hospital & Health Centre are in elevated positions. SLR Waste Management Report implementation Vulnerable persons assessment required, evacuation plans Sea-level rise database monitors trends	3	3	3	Med-long	SLR Waste Management SMP2 CIOS Flood Plan Flood Inundation Modelling IOS (M.Thomas) Sea level Rise database	50%
Sea level Rise database monitors trends Implement SMP2 Planning to consider impacts on future proposals for development Flood Planning (CIOS flood plan - reviewd annually) Business Continuity Planning	3	3	3	Med-long	CIOS Flood Plan SMP2 Flood Inundation Modelling IOS (M.Thomas) Business Continuity Plan	50%
Investment in renewable energy initiatives that are appropriate and proportionate to the context of Scilly, including the AONB and Conservation Area designations - (sustainable energy policy). Wave power project (Sustainable energy policy) Planning to encourage microgeneration - education / business case studies promoted Council to support promotions on insulation / efficient energy use Council to promote energy efficent transport (Sustainable transport policy - boat calendar system) New school has alternative energy sources built in to reduce these effects. (ground source heat pumps and solar PV) Consultants review of Councils carbon footprint and energy efficiency project IT review, upgrade of software / hardeware to allow power management of desktops. Use of virtualization technology to make utilization of server resources more efficient. Destination management strategy needs to identify compensating best value solutions and Sustainable Transport Strategy needs to address sustainability issues Capacity for change consultancy to address improved local sourcing and diversification to ensure community sustainable	2	2	3	Short	Sustainable Energy Strategy LDF including Core strategy Climate Change Strategic Plan Make our energy work project	44%

Environmental Variable	Risk / Opportunity	Impact Area	Consequence
Increasing energy costs and more demanding CO2 regulatory environment	Increased fuel / electricity costs for running desalination plant and incinerator etc	Council services / reputation Council Finances Business sector Tourism	Economic impact on residents, businesses and Council finances of increased water and waste processing costs. Damage to Council reputation Planning/B Reg requirement for new higher u value properties increases - All new builds zero carbon by 2015 All Council new builds zero carbon by 2017 Most Council buildings will need DEC certification and development plans in response to DECC and Climate Change directives Cost of energy impacts on Council finances
Increased heavy winter rainfall and higher wind speeds	Flooding will contaminate mains water supply and overburden drainage system (already under pressure on St. Mary's)	Tech. Serv. Public Health Tourism & other Business sectors Health Residents	Contamination of water supply, flooding Back up of raw sewage into properties in Hugh town Implications for health, property, business continuity Contamination of beaches impact on tourism
Reduced Summer Rainfall & Drought	Greater volume of water needed to irrigate crops, available water in soil for crop growth could be diminished	Agriculture Tech Services Planning	Depletion of water table Negative inpact on crop yield - financial impact

Adaptation process in hand or needed	£ con-sequence (1-3)	Impact (score 1-3)	Likely - hood (score 1-3)	Time frame	Reference Documents / organizational structures	Overall score
Need to explore opportunities for renewable energy systems to offset rising energy costs under new Government financial packages (eg use PV panels to offset electricity use by desal plant; possible energy from waste plant etc.) . Project proposal for study being worked up. PV Panels installed on island schools and Children's Services offices Project to assess and improve Council buildings to minimise carbon footprints initiated Ensure policy documents & planning decisions take into account new technologies Ensure Climate Change impacts assessments built into Core Strategy and Climate Change Strategy documents Review Sustainable Energy Strategy Encourage renewable energy initiatives that are appropriate and proportionate to the context of Scilly	2	2	3	Short	LDF including Core Strategy Climate Change Strategic Plan AONB management plan Make our energy work project Sustainable Energy Strategy	44%
Water quality monitoring & treatment Urgent need to revamp drainage system particularly Hugh Town although some drainage adapted for rising sea-level Educational programme to prevent residents from routing surface water to foul drains. Programme to raise & refurbish manhole covers on Town Beach to address sea level rise implemented. Need for renewal of main drain & sewer system in Hugh town – funding being sort in conjunction with Environment Agency	2	2	3	Short-Medium	Water business plan Climate Change Strategy (initiated)	37%
Water use campaign & rainwater storage Grey water useage considered in all new planning applications Evaluate alternative irrigation systems Water extraction licensing needs investigation Water quality monitoring in place	2	2	3	Medium	Capacity for Change Tourism Strategy (initiated) Climate Change strategic plan (initiated) LDF including Core Strategy	30%

7. Adaptation Processes to Risks and Opportunities

To develop the output of the risk assessment into a meaningful action plan and long term strategy, the risks identified in Section 6 are broken down into themes and within each theme, the risks explored in more detail leading to the development of a specific action plan. Further work is required to grade all risks identified with the more detailed approach used in the Council's Risk Register.

At the top level, reaction to Climate Change is often broken into two primary themes: adaptation and mitigation. Adaptation looks at ways to build resilience into our environment, changing how we do things to make our community and natural landscape more resistant and more resilient to Climate Change. Mitigation specifically focuses on how to reduce energy demand and as a result, greenhouse gas emissions, with the intention of stabilising global warming. Whilst working on the NI 188 submissions this difference was explored with the SW Regional Climate Impacts group and for Scilly it was concluded that energy is a key factor influencing the sustainability of our community. Energy issues are therefore included in the sections on adaptation.

Climate Change will impact on nearly all aspects of island life and specific threats will have multiple areas of impact. Analysis of threats and detailed implementation of adaptation is dealt with below.

7.1. Coastal Erosion & Shoreline management

As previously discussed, it is clear that the biggest threat to the islands will come from rising sea levels coupled with a combination of exacerbating factors such as storm surge, wind and weather conditions. Shoreline management is generally defined as:

"..a long term, strategic approach to managing risk from land instability, coastal erosion and tidal flooding."

It is generally taken to include non-statutory policy, guidance and planning efforts at national and sub-national levels. The 1st shore line management plan for the Isles of Scilly was published in 1997, has now been updated, taking into account the latest data on rising sea levels and detailing where probable inundation will occur between now and 2100. The Shoreline Management Plan revision 2 (SMP2) formally adopted by the Council in October 2010 has been used to inform this discussion.

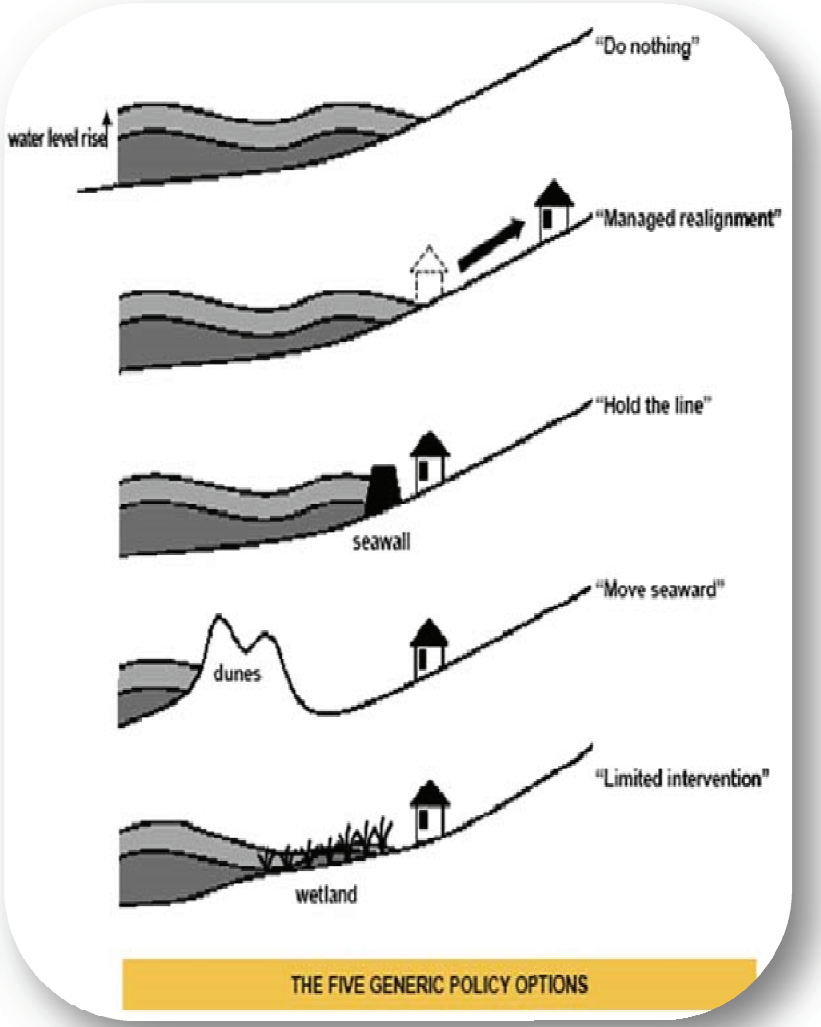

Figure 10: The five options for managing the shoreline from erosion and flooding

Historically sea levels have risen significantly over the last tens of thousands of years. The Lyonesse research project (co-ordinated by Historic Environment Projects, Cornwall Council and funded by English Heritage) is re-investigating the intertidal peat deposits and preliminary data (unpublished) suggests that the islands may have been joined into a single land mass as recently as a few thousand years BC. Study of the inundation of low lying areas may give some indication of the potential threat to modern day Scilly and should be supported by the Council.

Global average sea level has risen since 1961 at an average rate of 1.8 mm/yr and since 1993 at an average rate of 3.1 mm/yr, with contributions from thermal expansion, melting glaciers and ice caps, together with the polar ice sheets. Whether the faster rate for 1993 to 2003 reflects decadal variation, or an increase in the longer-term trend is unclear (IPCC AR4, 2007)[1]. Data from the tidal gauges at Newquay support these projections (see fig: 7). Although the observed increases in sea level rise around the UK are not in themselves sufficient to argue that sea level rise is accelerating, this does fit the consensus scientific projections of an increase in the rate of rise in sea level. In addition sea level rise is exacerbated in the South West due to isostatic

factors causing the SW to sink by an additional 0.6mm/year (see sections 4.6 and 9.1 for further information)

Flooding and inundation will most likely occur as a result of overtopping of sea defences during a storm at a spring or autumn high tide, rather than as a result of a high equinox tide alone. Such an event, once defences are breached, may then lead to permanent flooding of low lying areas such as the Lower Moors on St Mary's. It needs to be recognised that by 2100 inundation from increases in mean high water levels alone are projected to result in such flooding. The SMP2 document identifies areas likely to be at risk and proposes one of the following 5 possible strategies for each area of the islands at risk (Fig.10):

- Inaction leading to eventual abandonment - No Active Intervention (NAI).
- Managed Realignment or Retreat (MR), which plans for retreat and adopts engineering solutions that recognise natural processes of adjustment and identifies possible new lines of defence.
- Hold the Line (HTL) - shoreline protection, e.g. seawalls are constructed around the coastlines.
- Move Seawards, by constructing new defences seaward of the original ones.
- Limited Intervention, by which adjustments are made to be able to cope with inundation, e.g. raising coastal land or buildings vertically.

A description of these five generic approaches follows:

Inaction (No Active Intervention - NAI)

The "do nothing" option, involving no protection, is a cheap and expedient way to let the coast take care of itself. It involves the abandonment of coastal facilities when they are subject to coastal erosion and either gradual landward retreat or evacuation and resettlement elsewhere. This option is environmentally friendly and the only pollution produced is from the resettlement process. However, it does mean potentially losing land and property to the sea.

Managed Realignment or Retreat (MR)

MR is an alternative to constructing or maintaining coastal structures. It allows an area that was not previously exposed to flooding by the sea to become flooded and is often a response to a change in sediment budget or to sea level rise. The technique is used when the land adjacent to the sea is low in value. However, in areas of conservation or Sites of Special Scientific Interest it may be that managed retreat can be used to create new habitat such as new sea, inter-tidal and salt-marsh to compensate for the loss of habitat elsewhere.

In some cases, a retaining wall (or bund) must be constructed inland in order to protect land beyond the area to be flooded, although such structures can generally be lower than would be needed on the existing coast. Costs may be lowest if existing defences are left to fail naturally, but often the realignment project will need to be more actively managed, for example, by creating an artificial breach in existing defences to allow the sea in at a particular place in a controlled fashion or by pre-forming drainage channels and creating salt-marsh. This process may continue over many years and natural stabilization will occur. The earliest managed retreat in the UK was an area of 0.8 ha at Northey Island in Essex, flooded in 1991. This was followed by Tollesbury and Orplands in Essex, where sea walls were breached in 1995.

Hold The Line

Until recently strategies for the UK coast have been heavily based on a static engineered response, i.e. using concrete and rock constructions such as seawalls, groynes, detached breakwaters and revetments to "fix" the coastline and protect the assets located behind. These techniques permanently fix the coastal structure, whereas normally the coast is in, or strives towards, a dynamic equilibrium. Solid coastal structures may be built and persist because they protect expensive properties or infrastructures, but they often relocate the problem to another part of the coast. Arguably the erosion of the shoreline to the east of Porthcressa beach is the result of energy being displaced by the concrete sea wall along the beach. Hard engineering solutions are generally very expensive. Soft options such as building with natural processes and relying on natural elements such as sands, dunes and vegetation to prevent erosive forces from reaching the backshore where possible (for example Porthmellon Beach) are likely to be more appropriate in an Area of Outstanding Natural Beauty and will go some way to restoring the natural dynamism of the shoreline.

Move seaward (Advance The Line)

This is about creating new habitats seaward of the current shoreline by building dunes or expanding salt marshes. It is unlikely that this will be appropriate for the Isles of Scilly's shoreline and is likely to be expensive as a process.

Limited Intervention

Limited intervention is an action taken whereby the management only solves the problem to some extent, usually in areas of low economic significance. Measures taken using limited intervention often encourage the development of salt water habitats, including salt marshes and sand dunes. This will normally result in the land shorewards being more sufficiently protected, as wave energy will be dissipated by the accumulated sediment and additional vegetation residing in the newly formed habitat. Although not strictly man-made, as

many natural processes will contribute to the development or succession of the habitat, anthropogenic factors will be partially responsible for the formation of such features because an initial factor would have been needed to help start the process of succession.

Recommendations

It is not the purpose of this document to define which parts of the shoreline should be protected from coastal erosion, rather to define the adaptation process which should be followed to arrive at a suitable conclusion. The Shoreline Management Plan 2nd Revision (SMP2), which was approved by Members in October 2010, identifies and discusses in detail those areas of the shoreline which require protection and the preferred options which should be considered. The SMP2 Action Plan lists details of both the preferred actions as well as identifying partners and sources of funding. It also details, on a site by site basis, the ongoing studies (such as monitoring of sand dunes and sand deposition / erosion) required to both understand coastal erosion processes better and monitor the amount of erosion taking place.

From an environmental perspective it would be appropriate for the Council to support investment of resources by the AONB / IOS Wildlife Trust in managing natural defences, both to minimise the visual impact on our landscape but also to create new habitats to support biodiversity and where possible protect or create replacement sites of special ecological value through managed realignment, thus supporting the objectives of the AONB Management Plan and the objectives of the Isles of Scilly Wildlife Trust.

The sand dunes on Porthmellon beach, Port Hellick and St Martin's are good examples of natural defences which could be improved by ensuring access to the beach is carefully managed to prevent erosion from tourist and local traffic. It is noted that a drainage channel was partially cut through the dunes on Porthmellon recently, potentially compromising the structure. A significant storm / high tide event could breach this weakness and lead to flooding of the industrial estate. As sea levels rise, the risk of inundation of the Lower Moors, flooding of the refuse dump, damage to the incinerator and contamination of aquifers will be significantly increased if natural defences are compromised. The buildings on the east side of Porthmellon beach (I.E. the gig sheds and Boatshed Restaurant) may in the long term need to be relocated as they compromise the natural strength of the dune.

Local strategic partners such as the AONB, the Isles of Scilly Wildlife Trust and the Duchy of Cornwall should be encouraged to work together to strengthen existing natural defences and develop strategies for managed retreat where this is impossible.

At a local level, many of the actions specified in the SMP2,

relate to the monitoring of cliffs, dunes and beaches, in order to provide ongoing surveillance of the actual nature of morphological change at individual sites. However, a decision about exactly what can be done will need to be based on a detailed engineering solutions analysis. This will need to take into account practicality and cost as well as environmental impacts, balanced against the value of land, habitat and properties at risk.

Obviously funding for any proposals will need to be identified and it is clear that this will be a significant issue. Realistically, asking for significant amounts of funding from the Department for Environment, Food and Rural Affairs (DEFRA) for the Isles of Scilly in competition against other authorities such as London (the Thames estuary alone is home to 1.25 million people with 1.5 million commuters and assets worth up to £100 billion), will becoming increasing difficult as sea levels rise around the UK.

The Climate Change Strategy agrees with the SMP2 output which recommends that such an analysis is carried out as a matter of some urgency. The output will need to be debated by island residents and Local Strategic Partners so the community is clearly aware of the options which lead to both desirable and practical actions. The SMP2 also alludes to the longer term effects of sea level rise and coastal erosion, which will have a significant impact on subsequent revisions of the Council's Local Development Framework and Core Strategy as time progresses and may at some point in the future require relocation of key settlements to higher ground. Because it is clear that sea level will not stop rising in 2100 and may continue for several centuries after this time point, the sustainability of the islands in next few hundred years will depend on how we manage the risks of Climate Change over the next 50 years or so.

However, well before the turn of the next century it is likely that a significant number of sites (including Hugh Town on St Mary's – see fig: 11) will be at risk from flooding as a result of a combination of sea level rise and coastal erosion caused by adverse storm, wave & tide conditions. In addition there is the potential for climatic events to significantly increase the speed of sea level rise [1,3,21], (e.g. by accelerated melting of the ice caps – a process not well understood), although a catastrophic rise in sea level is not something for which we could easily plan to adapt to.

It is recommended that faced with uncertainty a pragmatic approach to adapting to flood risk as a result of Climate Change is adopted, with small steps to build resilience into the local community, so that as flood risk increases impacts can be minimised. Examples of this approach are to provide encouragement and support for practical flood defence measures on existing buildings at risk:

- Fitting removable doorway flood barriers
- Raising the height of electrical circuits and outlets above the traditional floor level
- Raising kitchen work units on to legs to protect carcases
- Fitting water resistant floor coverings such as stone /slate tiles on at risk floors
- Providing pathways for water to leave a building if water breaches flood barriers.
- Assessing the impact of Climate Change associated flood risk on any new developments.
- Ensuring that new domestic and commercial drainage systems do not overload the existing sewage and drain infrastructure.

Whilst these are not solutions which the planning systems can enforce, unless the statutory framework changes, the Council's Planning Department with the support of the Technical Services department should take the lead in promoting good practice through education and example. This has begun through the recent business workshop on the impacts of Climate Change held in October 2010. Whilst a small step it is recommended that more awareness events are planned over time to increase local understanding of the risk faced by residents and businesses. It is a statutory duty that all major developments have an assessment of the impacts of Climate Change carried out as part of the planning application process, as has been done with the new school build and the Porthcressa Regeneration Project, as is required under Planning Policy Statement 25 (PPS25) - Development and Flood Risk.

The Government's "Big Society" vision, localism agenda together with the drafts of the new Climate Change Planning Policy Statement (PPS) mean that local Councils will be expected to lead change. The intent of the Climate Change PPS is to set out a planning framework for:

- Driving progress against the UK's targets to cut greenhouse gas emissions.
- Using more renewable and low carbon energy.
- Planning for the effects of Climate Change.

The draft PPS on Climate Change combines and updates the policy set out in the existing PPS1- Planning for Sustainable Development and PPS22 Renewable Energy into a consolidated planning policy document.

Implementing adaptation measures may well have benefits for

residents and businesses. On the mainland, insurance companies will be looking at offering policy discounts or conversely charging higher premiums for those properties which have or have not taken adaptive flood defence measures. Devon County Council has worked with a number of insurance companies to explore this issue and raise public awareness through a series of workshops.

7.2. Summary of Shoreline Management Plan v.2

For detailed analysis the reader is referred to the Shoreline Management Plan v.2 (SMP2) document itself. However, it is appropriate for the Climate Change Strategy to summarise a number of key findings.

The SMP2 covers the Policy Development Zone (PDZ 18) – the Isles of Scilly. PDZ18 is then broken down into management areas (MAs) which are further broken down into sub areas for specific management strategies and action plans.

Across the whole of the PDZ18 policy unit a number of actions are proposed for implementation:

Wave studies are critical to understand the long term implications of wave height and direction on flood inundation modelling and its implications for the built environment and the natural and heritage environments

Wave study monitoring requires two different study areas - deep sea wave height monitoring to the west of the archipelago and on shore monitoring, notably:

- St Mary's for Porthcressa, Porthhellick, Porthmellon and harbour frontage.
- St Agnes for Big Pool defences.
- Tresco for the Island Hotel.

The SMP2 also specifies that a Flood and Coastal Risk Management (FCRM) strategy should be developed to inform spatial planning and a Coastal Change Management Area (CCMA) should be defined for key areas such as Porthcressa, Porthmellon and Porthhellick as a minimum. This may need to take in the whole of St Mary's in order to be effective and used to develop the evidence base for incorporating into the Local Development Framework (LDF). it will be a major challenge to balance the interests of residents, environmental custodians and landlords, but it is clear from any perspective, that rising sea level will eventually in the longer term have a major impact on the built environment and particularly for Hugh Town.

Either significant changes to the existing built environment or relocation of properties at risk will be necessary.

In addition whilst the SMP 2 identifies significant risks to water supplies, further work is necessary to understand the impacts of flooding on ground water and aquifers used for extraction of fresh water. The SMP2 does not take into account saline intrusion through the ground which may become an increasing problem as sea level rises and if extraction of water increases over time, causing salt water to intrude into aquifers filling voids left by extraction.

Water supplies and adaption to meet the risk of saline intrusion are discussed further in section 7.5.

More specifically, the SMP2 defines for given areas of the islands what type of holding action over what timeframe should be considered. In general holding the line is only feasible at many sites for a limited period. After this managed retreat is probably the only practical solution and for some key sites such as Port Hellick by epoch 3 no active intervention is likely to be the only practical approach. Rerouting of roads and footpaths may be necessary as time progresses and these issues should be identified and options evaluated to inform spatial planning decisions.

From a Climate Change adaptation perspective the key will be to put in place, working with local strategic partners, formal monitoring programmes to inform decisions on coastal management based on good evidence.

St Mary's

Over the short term (0-20 years) the preferred options are:

- Take no active intervention for the undefended cliffs and coves but where appropriate defend by holding the line at key frontages and monitor cliff recession rates and beaches (widths and slopes).

In the medium term (20-50 years) the preferred options are:

- Continue with a policy of no active intervention along undefended cliffs and coves and hold the line specifically around the quay and Town Beach. Old Town, Porthcressa, Porthmellon and Porthloo frontages will need to be adapted and realigned.

In the long term (50 -100 years) the preferred options are:

- Continue with a policy of no active intervention along undefended cliffs and coves and continue to hold the line along the quay, but realign and adapt the Town Beach frontage from the quay to Thomas Porth and continue to adapt and realign the Old Town, Porthcressa and Porthmellon and Porthloo frontages.

More specifically the Quay, the wall by the Mermaid Inn and the Quay to Custom House is integral to the continued shelter of the remainder of the Town Beach frontage and require a policy of holding the line. However, managed realignment may be necessary from the Custom House to Carn Thomas in the latter half of the 21st century, dependant on sea level rise. Realignment in the medium term may be needed at Porthmellon to manage the increasing flood risk and in particular inundation risks to Lower Moors area and the fresh water supply.

Beyond Porthmellon with the exception of Porthloo all the way around the coast to Porthhellick Point, a policy of no active intervention is recommended up to the end of the 21st century, which would satisfy objectives relating to the AONB and Heritage Coast designations. At Porthloo no active intervention until 2055 is recommended with some managed retreat including the realignment of the roadway likely in the medium to long term.

At Porthhellick, it is recommended that consideration should be given to realignment of the embankment to provide improved, robust natural defence to the Higher Moors area, with a policy of hold the line for the short term followed by managed retreat over 20-50 year timescale and finally no active intervention towards the latter half of the 21st century. Since the embankment is a good example of a natural mobile sea defence this needs to be explored further in the next stage of the SMP2

At Porthminnack, the preferred option would be to hold the line for the first 20 years, then move to a policy of managed retreat in the medium to long term, specifically undertaking some realignment of the defence to prevent excessive coastal squeeze developing and minimizing inundation risks to the Lower Moors area and fresh water supply.

From Tolman Point to Old Town Slip a policy of no active intervention is proposed, which would satisfy objectives relating to the AONB. From Old Town slip to Old Town Church, it is recommended to hold the line in the short term and consider the controlled roll back of the defences over longer term, taking into account the inundation risks to Lower Moors area and the possibility of saline intrusion into our fresh water supply.

From Old Town Church to Carn Leh and Carn Leh to the playground, no active intervention is proposed throughout the 21st century, accepting the loss of some land as a result of coastal erosion along the coastal strip between Old Town Church and Carn Leh which would satisfy objectives relating to the AONB and Heritage Coast designations.

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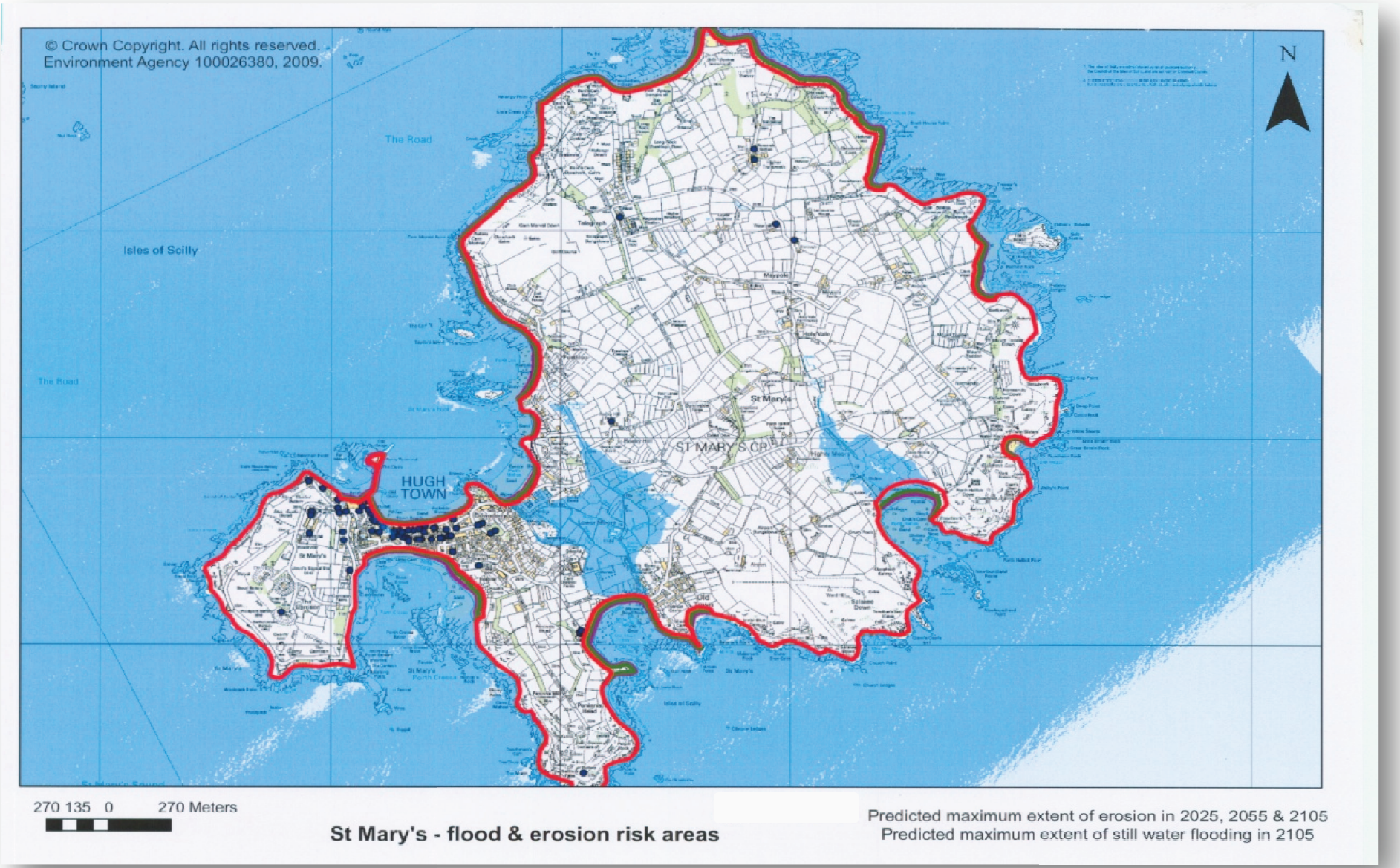

Figure 11: St Marys - Flood & Erosion Risk Areas

Porthcressa Bay recommendations include initially HTL in the first 20 years followed by NAI with some localised managed retreat zones. The overriding strategy will be not to lose any width of the isthmus, whilst monitoring the coastal squeeze impacts, particularly in terms of beach levels and changes in the beach slope and width and recognising the very significant risks posed by potential occurrence of an extreme storm event.

Finally, a policy of NAI is proposed for the Garrison, although this should not preclude localised management taking place (defined as localised Hold the Line) around all sections of the Garrison frontage to address ongoing stability issues along the cliff line to protect the internationally significant historic coastal defences and the Garrison Walls.

St Martin's

No active intervention for Tean Sound, St Martin's Bay, St Martin's Sound or Middle Town, here the key will be to monitor beach erosion and carry out post storm surveys to develop a better understanding of coastal processes. Again the natural structures such as the dunes along Higher Town beach should be supported by looking at ways to strengthen their structure by encouraging plant succession without damaging existing or protected ecosystems and minimising trans-dune erosion damage from visitors and other traffic through carefully controlled access ways to the beach. The AONB and Isles of Scilly Wildlife Trust are key to implementing these changes.

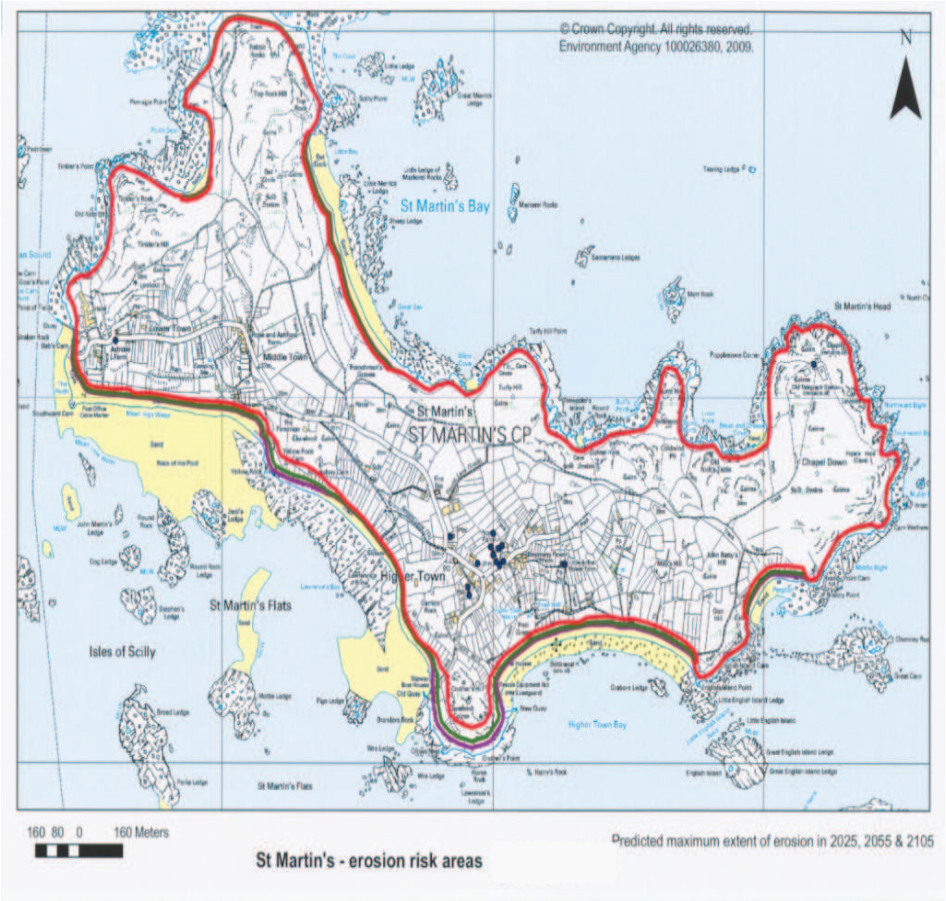

Figure 12: St Martin's showing Erosion Risk Areas

The AONB has already built into its management plan a number of monitoring actions (including fixed photo points) which will record changes to the landscape, ecosystems and geology of the islands. This will be invaluable in informing policy as coastal erosion become more of an issue over time.

Tresco

With the exception of New Grimsby (for all three epochs) and the Island Hotel coastal stretches (epoch one & two), the remainder of Tresco is designated NAI. Current recommendations for the Island Hotel zone indicate it may not be practical to maintain an HTL approach into the third epoch and therefore this zone will revert to NAI. The key actions here will be to monitor beach erosion and carry out post storm damage surveys to document and inform decisions on land and asset management.

Bryher

For Bryher the majority of the shoreline has been designated as NAI zones. However, two key areas are designated as HTL in the first epoch – Great Porth North and Popplestones where breaches of the sea defences threaten the hotel grounds and key water resources.

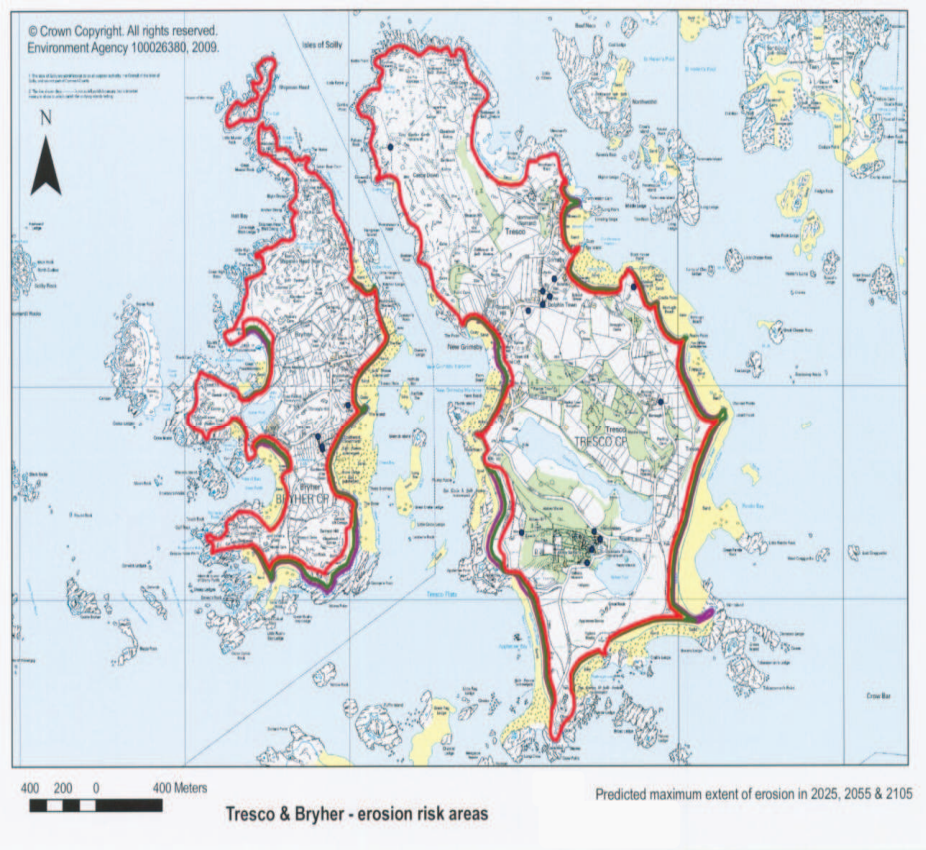

Figure 13: Tresco and Bryher Flooding & Erosion Risks

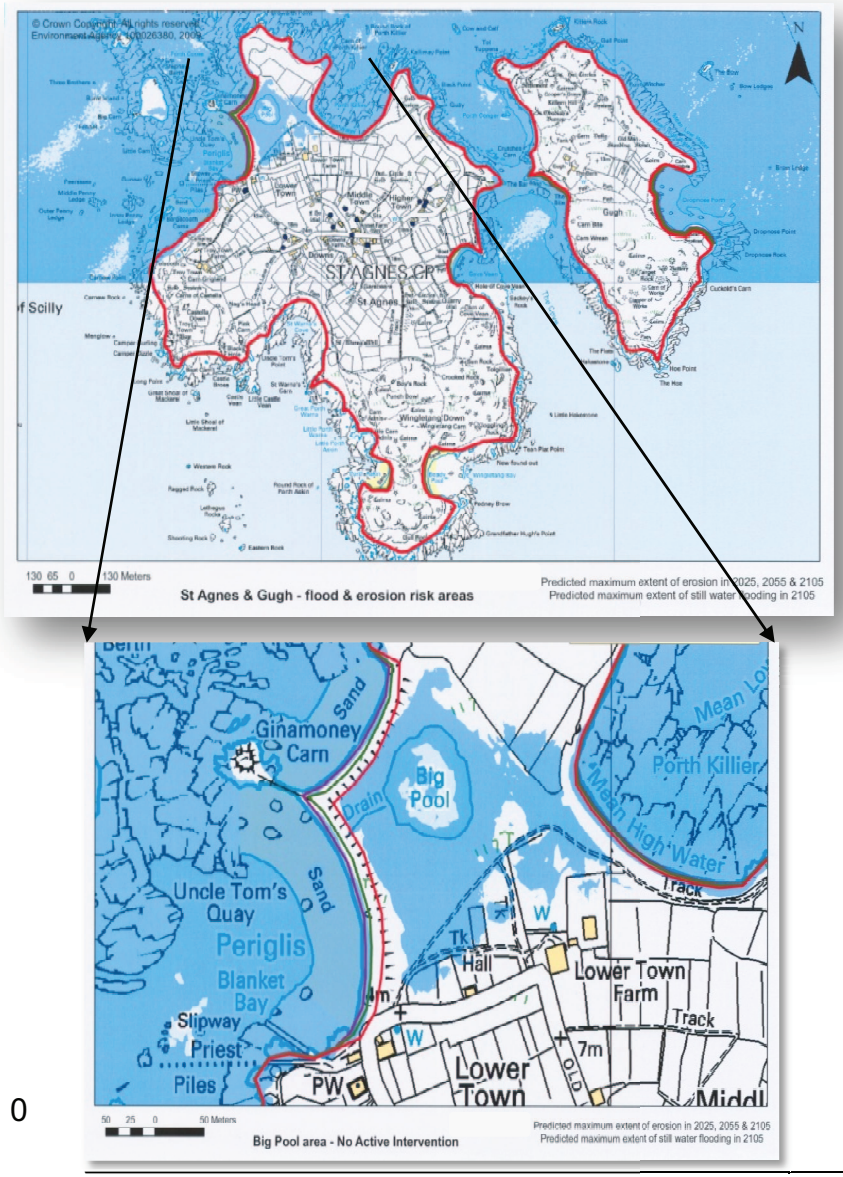

Figure 14: St Agnes Flooding & Erosion Risks

Beyond the first Epoch it may be impracticable to intervene and NAI is the recommended option.

St Agnes

The majority of St Agnes and Gugh have been designated as NAI zones. However two key zones are identified as HTL zones, Pereglis slips to Ginamoney Carn and Ginamoney Carn to Browarth Point. Coastal erosion threatens Big Pool and the island's fresh water supplies and requires urgent action in the next 5 years.

Care must be taken so that any works do not damage intertidal habitats or bird roosting sites or have any adverse effects on the Isles of Scilly SPA & RAMSAR sites. As with other sites monitoring of erosion and storm damage will provide the evidence base to inform strategies to minimise impacts and develop adaptation strategies for St Agnes residents.

In summary, there is much work to do monitoring the impact of coastal erosion and sea level rise which needs to involve key strategic partners and will need funding to provide the evidence base that guides future adaptive responses to Climate Change.

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7.3. Transport

One of the key risks identified in the Climate Change risk assessment is the impact on both inter-island and island to mainland transport links.

Links to the mainland by both land and sea are fundamental to the sustainability of our way of life on the islands. Our tourist industry (responsible for some 75-85% of the island's economy) is entirely dependent on air and sea transport to bring visitors and supplies to the islands. Flower farmers, livestock farmers and fishermen also rely on the existing sea and air links to transport produce to the mainland, either for further processing or onward sale. Inter-island transport supports the tourism industry as well as providing transport and freight links to and from St Mary's, delivering key services to maintain the sustainability of off island resident populations.

Climate Change will potentially threaten transport links as a result of increased frequency of adverse weather events and rising sea levels, which are likely to threaten infrastructure, such as St Mary's harbour, Penzance harbour and off-island quays. In addition, the increased cost of fuel supply for both marine and aviation transport will add additional burdens to the cost of transport, as a result of both regulatory pressures (as Governments strive to meet emissions targets) and increasing imbalance in supply and demand as demand for energy in new economies such as China and India increases.

Sustainable Transport Strategy

WSP Development and Transportation was appointed by the Council of the Isles of Scilly in November 2009, to develop a Sustainable Transport Strategy for the islands. The purpose of the study is to update and replace the existing Transport Strategy 'Moving On' adopted in 2003. Its objectives are to:

- Address travel and transport issues on the islands, between the islands and between the islands and mainland in a comprehensive, creative and sustainable manner to the benefit of the community, the environment and the economy. Following a rejection of the Route Partnership Project by the Department of Transport a key objective will be to ensure the continuity and long term sustainability of the life line sea link to the islands, including improvements to St Mary's Quay

- To tackle Climate Change (reducing transport's emissions of carbon dioxide and other greenhouse gases).

- To contribute to better safety, security and health.

- To promote greater equality; and to improve quality of life and promote a healthy natural environment.
- To reduce / minimise the impact of cars on the islands' community by:
    - Reducing the amount of travel required, especially by private car
    - Where travel is required, minimising the fossil fuel energy used
    - Providing year round, reliable transport services at an acceptable cost.
- To encourage transport which respects the environmental credentials of the islands.
- To provide transport that supports tourism and the economy of the islands.
- To develop transport of freight, goods and people at a sustainable cost.

All of these objectives contribute to adaptation of our community to Climate Change and in particular to reduce reliance on fossil fuels, whilst providing inclusive travel arrangements for disadvantaged sectors of the population and incentives for promoting healthy living. This plan supports the development of sustainable transport solutions, but actions need to be taken by all parties to ensure that where "green" solutions, such as electric vehicles are proposed, they are encouraged, and that the energy used to charge vehicles is sourced from renewables where possible. An example of a successful sustainable transport action developed with LAG funding is the purchase of the Dial-a-Ride scheme's electric bus for over sixties or anyone with a disability. The scheme has a condition to ensure that the energy used will be derived from a genuine renewable energy supplier.

Electrical vehicles offer a number of advantages:

- As fuel costs rise there will be an impact on local business overheads.
- Whilst in general the islands have good quality air the exhaust from diesel engines in particular is a nuisance and possibly health damaging, particularly on St Mary's.
- Today our electricity supply is mostly from fossil fuels, but as renewables become a larger part of the supply mix it will becomes less acceptable to continue to use fossil fuels.
- Electric vehicles are quieter and therefore have the benefit of reducing noise pollution – if cars and vans etc cannot be discouraged for practical reasons at least we can minimise their impact on the environment.

However, not all people accept these arguments and it would be worth carrying out a short study to assess the whole life carbon footprint of electric vehicles versus fossil fuel vehicles.

7.4. Energy

One of the key risks identified in the risk assessment is security of our energy supply. Not necessarily from the point of view of our infrastructure which relies on a single cable to the mainland and which it is a statutory duty of the local infrastructure provider to maintain. The main issue here is one of the cost of energy. Energy is a significant percentage of the cost of running a small business and the costs of energy, whether electricity, oil or natural gas will rise. This will have an impact on the sustainability of island businesses from tourism to farming and in addition it is likely that an increasing number of people will fall under the definition of "Fuel Poverty" as fuel prices increase.

Why are fuel prices likely to increase significantly?

The price of energy will increase significantly over the next 10 - 20 years, whether Peak Oil (extraction of oil will hit a peak leading to demand outstripping supply) is a real threat or not (and the recent environmental disaster in the Gulf of Mexico hasn't helped). UK energy generation capacity is severely stretched – many power stations will reach the end of their working lives in the next 5-10 years and will need to be replaced. Replacements will be required under EU legislation to be carbon efficient and this means investing large sums of money into our generating and distribution networks. The Government has said it expects the private sector to fund this development and inevitably that means consumers will pay.

We are importing increasing amounts of our energy feedstocks as our North Sea gas and oil stocks decline. Russia is now one of the key providers of Natural Gas to Europe and hence to the UK, bringing possible security risks to the safety of supply. Insecure supply of a commodity usually means unstable prices. Iran will assume the presidency of the Organization of Petroleum Exporting Countries (Opec) for the first time in 36 years in January 2011 and is hardly a friend of the West.

Rapidly increasing demand from developing economies such as China and India will start to squeeze global supplies with the inevitable consequences of rising prices.

In response to Climate Change much political time and effort has been invested in trying to get the world's major economic blocks to reduce the emissions of "greenhouse" gases created by the burning of fossil fuels. For example, the EU has set a target of reducing emissions by 20% of their 1990 levels by

2020. To meet the EU's 15% renewable energy target for the UK, it is expected that 40% of electricity must come from renewables by 2020. Currently, the figure is just 5%, so an eight-fold increase is required (see Carbon Trust website), requiring huge amounts of investment.

The new incentives (see below for more detail) created by the previous and current Governments, notably the Feed in Tariffs (FITs) and the proposed Renewable Heat Incentive (RHI) are designed to stimulate microgeneration (i.e. domestic scale generation of electricity or heat on site) using renewable sources. The FITs incentive scheme will not be paid for from central Government funds, but are legally binding obligations on utility companies to meet these costs. Inevitably consumers will end up paying more for electricity to cover this extra burden on supply and generating companies.

In its drive to meet EU emissions targets for 2020 the UK Climate Change Act 2008 has resulted in a number of regulatory requirements and targets being implemented.

The UK has set a target of 80% reduction in carbon emissions by 2050. This will drive incentive and penalty schemes to accelerate a reduction in energy use from non-renewable sources. To put this into perspective, a 2050 ration of carbon would be enough for you to do just *one* of the following each day (assuming no technological change):

- Drive 15 miles.
- Buy two cotton t-shirts.
- Eat a cheeseburger and fries.
- Heat and power a bedsit.

(Cornwall Sustainable Energy Partnership website 2009)

Display Energy Certificates (DECs) - an EU directive - are now required for every public building over 1000sqM. Fines are payable if certificates are not displayed. DECs show the carbon footprint of a building and rate its energy efficiency., They are required to be displayed in a manner accessible to the general public.

Associated with the certificate itself is a requirement for an improvement plan which outlines the steps that will be taken to improve the efficiency rating of the building. DECs must be reviewed annually. Currently the EU is debating how quickly these certificates can be introduced for smaller buildings. This would potentially have a big impact on management of public buildings on the islands such as the Town Hall, which at the moment (with the exception of the Five Islands School) fall under the current size cut-off.

Since 2000 residential electricity charges have increased by

20% spiking in 2008 by a huge 40% on 2000 prices (Government statistics: the Department of Energy and Climate Change 2010).

The Department of Energy and Climate Change (DECC) already forecasts energy prices to rise by 30% on average by 2020 and this excludes any spikes in oil and gas prices on the commodity markets.

It is clear therefore that the islands need a sustainable energy policy which actively seeks to address the twin issues of minimising fossil fuel use and ensuring we have a programme aimed at increasing the percentage of energy derived from renewable sources. Ideally we should set targets to strive towards that are in line with the rest of the South West. Central Government targets were being devolved to the regions towards the end of the last parliament and it is likely that as the current Government starts to refocus on Climate Change and achieving mitigation targets, that regional and eventually local targets will be set. The Council prepared a Sustainable Energy Strategy (SES) for the Isles of Scilly in 2007 which included a number of targets. Whilst significant positive progress on many of the targets has been achieved with, for example, all new social housing and Council developments (e.g. Normandy swimming pool refurbishment) requiring renewable energy sources and a high level of insulation, more needs to be done to decrease our reliance on fossil fuels.

There is little recent data on the level of fuel poverty on the islands – in the 2001 census (now nearly 10 years old) an estimated 60% of homes had central heating compared to 92% of homes nationally. However, many island houses are second homes or holiday accommodation, with low demand for winter heating. Cornwall Energy Efficiency Advice Centre ran a major insulation project on the Isles of Scilly in 2008. Around 80 customers applied for partial grants to have their homes insulated and 25 social houses and all 300 of the Duchy of Cornwall homes on the islands were planned to be insulated. There are no up-to-date statistics to measure the success of these programmes and which could inform energy efficiency planning.

It was originally proposed that the SES be reviewed on a biannual basis and the document itself is 3 years old – in a rapidly evolving (technically, economically and at national policy level) market place it is recommended that the SES is reviewed in 2011 and a new strategy building on the original, developed as a matter of some urgency.

Development of renewable energy resources is both a requirement and an opportunity for sustaining the island's community.

Currently all major developments require a sustainability assessment as part of the planning process. In line with PPS1

they should:

"…take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption, including maximising cooling and avoiding solar gain in the summer; and, overall, be planned so as to minimise carbon dioxide emissions through giving careful consideration to how all aspects of development form, together with the proposed density and mix of development, support opportunities for decentralised and renewable or low carbon energy supply"

As described previously, a new planning policy statement is at draft stage which combines and updates the policy set out in the existing PPS1- Planning for Sustainable Development and PPS22 - Renewable Energy into a consolidated planning policy document. This is likely to recommend Councils lead on renewable energy.

Renewable Energy

To date the Council has backed plans to develop wave power as the best solution to meeting renewable energy needs on the islands and talks have been held with a number of companies. However, whilst wave power will provide a year round relatively stable energy resource and will provide an excellent renewables solution, it is likely to be some years before a commercially viable operating system could be put into operation. Technology for tidal and wave renewables is generally considered to be at the pre-commercial phase of it's development with significant hurdles to overcome in terms of its long term reliability. In the meantime small scale microgeneration should be encouraged and indeed provides a not insubstantial financial opportunity for investors and businesses across the islands. This has the multiple benefits of reducing the island's carbon footprint, promoting the islands as a green tourist destination, generating income for small business and residents to offset increasing energy costs and ensuring that any financial gain from the wave power project is maximised – more energy can be exported rather than used on the archipelago.

Feed In Tariffs (FITs) are a new Government-backed measure to incentivise the installation of renewable electricity generation systems. They replace the grant systems that have been used until now to incentivise renewables. Most grant schemes have now been withdrawn and will be mutually incompatible with FITs. If grants have been used to fund installations, FITs will either not be payable or will be paid at a reduced rate. FITs are an obligation on utility companies to pay for every unit of "Green" electricity generated by small scale microgeneration installations such as photovoltaic (PV) panels on house roofs.

This obligation is enshrined in the Climate Change Act of 2008. It is not funded by Government money, but by a small increase in everyone's electricity bills, so installing small scale renewables means a potential to earn money on investment

capital, offset increasing electricity and fuel bills and help meet carbon footprint reduction targets. Renewable generation systems up to a capacity of five megawatts are eligible under the new Feed-In Tariffs scheme.

There are three separate ways that FITs generate income or reduced costs:

The Generation Tariff – a fixed income for ***every*** kilowatt hour of electricity generated, whether used or not.

Export Tariff - an additional fixed income for every kilowatt hour of electricity generated that is not used and sold back to the grid.

Reduced consumption from the grid - When electricity is being generated it can be used as a free source of power replacing consumption from the grid.

The Government calculated its return on investment for FITs payments on the basis of payback of capital in 8-10 years and an annual return of around 7% per annum over the investment lifetime of 25 years.

Different technologies can be used for microgeneration of electrical renewable energy, but on a general basis:

Wind turbines are not generally seen as acceptable due to the intimate landscape and environment quality of the islands, although one-off small scale developments may be acceptable on a case-by-case basis.

Photovoltaic (PV) panels are a more acceptable technology, provided they are appropriately sited and scaled to match conservation guidelines. New designs (such as PV tiles integrated into the roofs of buildings) have appeared in the last year which are now more acceptable for listed buildings and have minimal visual impact. The National Trust, for example, has recently refurbished Kynance Cove cottage and café with PV tiles.

Because the Isles of Scilly receives more sunshine on average each year than the rest of the UK mainland, investment in PV will actually provide a bigger return on investment here than elsewhere. When calculating FITs for PV panels, the Government assumed that for every KWhr of PV panels installed, 800KWhr of electricity per annum would be produced on average across the UK. The Isles of Scilly receive far more sunshine than the rest of the UK and limited data from our existing installations on the off island schools, suggests we may be able to generate as much as 1300KWhr per annum per KWhr installed. That increases green energy production by approximately 60% compared to the average for the UK and means a significant increase in FIT payments, with payback times reduced to seven to eight years and a return of 10-12% per annum over 25 years. More information is available from the Council's web site on FITs.

The Renewable Heat Incentive, which is currently under review, will implement a similar incentivisation scheme to the FITs. This is designed to encourage the retro and new build fitting of renewal heat systems such as biomass burners, solar thermal and heat pumps.

Scilly is quite well suited to heat pumps with modest minimum temperatures during the winter months where temperatures rarely fall below freezing in an average year. In addition solar thermal benefits from our increased levels of sunshine compared to the mainland. A ground source heat pump has already been installed in the medical centre and several of the newly built social housing units are similarly equipped. The new Five Islands School build will be equipped with air source heat pumps. Retrofitting of ground source heat pumps is relatively expensive and not straight forward, due to the problems of bringing drilling equipment into the islands for vertical boreholes or digging out gardens for horizontal loops.

Even air source heat pumps are not without problems caused by the salt driven corrosion of our maritime environment. However, the technology is improving every year and heat pumps seem to be the way forward in replacing fossil fuel burners.

True geothermal energy from deep wells (>1-2 Km deep), such as those used at the Eden Project could provide us with all the energy we need, but the expense of drilling and building such installations is prohibitive.

To demonstrate the Council's commitment and show leadership by reducing its carbon footprint, it is recommended that a number of actions should be implemented:

The Council is required by DECC to carbon footprint its activities annually. A system should be designed to automate the collection of statistics on fuel use within the Council. This will inform the Council and provide monitoring capabilities to assess any future improvements.

A programme of actions to reduce energy waste within the Council should be developed and implemented. We have achieved some steps toward this in 2010:

- In October 2010 the Council signed up to the 10:10 movement pledging to reduce energy use by 10% by October 2011. This action demonstrates the commitment from the Council to lead the community in seeking ways to reduce the islands carbon footprint and reduce energy costs – particularly in the current financial climate faced by public service organisations.

- In 2008 the AONB sponsored a project called "Making our Energy Work" to stimulate change in the way

Council staff operate to save energy and resources. This should be reinvigorated.

- The Carbon Trust has agreed to provide free consultancy to analyse some of the Council's key buildings and recommend ways their carbon footprint could be reduced.

- The Climate Change and Energy Fair held in October 2010 has taken the first steps to informing island residents of the new technologies and incentive schemes available.

- Renewable energy sources such as photovoltaic panels should be evaluated and novel funding approaches sourced to cover the capital cost of materials and installation. The Government Feed in Tariffs have changed the economics of installing renewables and this together with investment capital schemes should be assessed as possible solutions to funding projects where public money cannot be found.

- In response to the new PPS, a baseline energy survey and renewable resource assessment should be carried out (an action rated as a high priority in the SES). This has already been done by other Councils in the SW.

- The Council should invest in promoting renewable energy where appropriate across the islands and as part of the revised SES and set targets for achieving this

- The Council should promote energy efficiency through behavioural changes (i.e. switch off campaigns) and new technologies (such as LED lighting).

- An effective way to do this would be the creation of new Climate Change and renewable energy pages on the Council's web site as well as running an annual energy efficiency event.

- With the opening of the new school, comes a significant positive PR opportunity for the Council to co-promote an energy efficiency and renewables event in 2011. Rapid advancements in technology, changes in FITs and the RHI could make this a very interesting event and a stimulus to increasing energy efficiency and renewable energy uptake.

7.5 The Historic Environment

Coastal erosion is already obvious on St Mary's and elsewhere in the archipelago. With rising sea level and the likelihood of more severe rainfall in the winters causing soil erosion, coastal erosion is likely to accelerate over the coming decades. Whilst the Shoreline Management Plan in general takes the view that no active intervention is appropriate for the majority of the islands' coastline, Scilly has more heritage sites of national importance than any other parts of the UK. Because of the conservation status of the islands, the pressure of development ever present on the mainland is much reduced within the archipelago, providing a rare opportunity to preserve the historic environment for the enjoyment of residents, future visitors and researchers.

Figure 15: Nornour Island showing ruins of Bronze Age Settlement, threatened by coastal erosion and rising sea levels

Historic buildings such as those that make up the military defences of the islands and other public and domestic Listed Buildings together with monuments such as prehistoric entrance graves represent an important record of the islands' historical and archaeological heritage. A significant percentage of the historic environment exists in the form of buried archaeological remains and field monuments. These sites will become more vulnerable to Climate Change as time progresses (see fig. 15), both from coastal erosion and flooding as well as from potential storm damage. This may negatively impact on tourism and on the special qualities of the AONB designation as well as result in the loss of a valuable historical resource.

In the recent publication "Defending Scilly" (2011) [25], Bowden & Brodie recognise that the coast can only be defended where it is sustainable and affordable and that national priorities will

focus on the areas of the UK where significant assets and infrastructure are at risk. There will be little possibility of protecting our entire heritage, but where possible much can be achieved even with limited resources. It is unlikely that relocation of important heritage assets will be practical on Scilly as has happened elsewhere in the UK (e.g. Clavell Tower in Dorset).

The most appropriate response to the threat of coastal erosion and storm damage will be to record the currently observable historical and archaeological remains. Importantly, as coastal erosion accelerates a number of new finds are likely to be exposed. At Halangy Porth on St Mary's, erosion continues to reveal and destroy a prehistoric settlement site as the soft coastline crumbles. The Isles of Scilly Museum has a growing collection of material coming from these sources. This emphasises that great care must be taken to preserve heritage sites where possible and where natural forces cannot be prevented from damaging sites or expose new sites, recording and monitoring programmes should be put in place. This is underpinned by the following policies:

- Implementation of policies in Historic Environment Research Framework (HERF).
- English Heritage monitoring, especially of Scheduled Monuments at Risk.
- Ensure sites are adequately documented and recorded.

Where the Shoreline Management Plan calls for holding the line (for example, it is proposed that the stretch of Hugh Town from the quay to the Custom House will be held until 2055 after which there may be a need for some managed realignment) or where listed buildings are at risk, the Council should provide in conjunction with English Heritage, advice to residents and businesses on how to minimise risks from storm and flood damage. This should also show how to protect buildings sympathetically by the use of appropriate high quality materials English Heritage should also be consulted on any impacts of proposed maintenance or modifications to sea defences . A useful resource for protecting and dealing with flooding of heritage buildings is available from English Heritage at this web address:

http://www.climatechangeandyourhome.org.uk/live/content_pdfs/80.pdf

It is worth noting that the IoS Wildlife Trust (to which English Heritage provides key financial support) operates a grazing strategy which is also of benefit to the historic environment it is supported by English Heritage because it clears historic sites of invasive vegetation and allows them to be appreciated more by visitors. Invasive vegetation such as bracken and gorse can cause damage to buried archaeological features through root

and rhizome growth. Grazing has even uncovered new sites of historical interest. It is important that the IOS Wildlife Trust continues, with the Council's support, to identify and manage new sites exposed by the grazing programme. As was previously stated, sea level rise will continue long into the future and there will inevitably be loss of historic assets on Scilly, which makes the process of recording these assets more important. Fortunately we have time to manage this process, provided finance can be sourced.

7.6 The Built Environment

The biggest threat to the built environment (buildings and assets) is likely to arise from sea level rise and coastal erosion. Adaptive measures to protect these have been partially addressed in the section on shoreline management.

However, a number of other risks and adaptive responses were identified in the risk assessment

Water harvesting and management of sustainable drainage systems:

These are discussed in the water and drainage section

Residential and public buildings:

Key Climate Change adaptive steps for the built environment are:

- Every building owner/tenant and land tenant to be encouraged to:
    - Critically assess their buildings' ability to withstand high winds and storm damage particularly in any new build at planning stage
    - Select correct trees and hedges for withstanding high winds and maintain good structure
- Planning policy and decisions to encourage design of new buildings to be both robust to minimise wind damage and maximise resistance to flooding and should require sustainable drainage and sewerage options. Much of this has already been adopted in the Isle of Scilly Design Guide and the Local Plan: a 2020 Vision.
- Emergency planning early warning systems are already in place to warn of adverse weather events. These should be logged to help understand the likelihood of return events occurring and help predict the impact of future events.

7.7 Water & Drainage Management

Water Resources:

The Council is responsible for providing water supplies to island residents on the main island of St Mary's and managing the boreholes supplying water from underground aquifers on Bryher.

Climate Change will bring increasing pressure on our water supplies. Following a drought which stretched the islands water supplies to the limit, a small-scale reverse osmosis plant was installed on St Mary's to top up public supply in 1992. This plant was acquired from Gulf War army surplus supplies and has been providing an invaluable resource ever since. It is currently able to cope with required capacity (175K gals/day). It is unlikely that the maximum daily tourist numbers will increase significantly as most accommodation operates at close to maximum capacity during the high season.

However, demand currently peaking at 20-24,000 cu M/month in the high season, is increasing, probably as a result of several factors - although there is no hard evidence base to support these assumptions:

- Increasing use of power showers in guest houses and hotels.
- General increase in water useage as more properties are fitted with automatic washing machines and dishwashers.

The Climate Change risk assessment identifies additional risks to the water supplies on both St Mary's and the off-islands:

- Hotter dryer summers are forecast, which will increase demand for both irrigation and potable water.
- Increased rainfall in the autumn is likely to be heavier, resulting in more water running off into the sea and less water available to replenish aquifers.
- Annually (as opposed to peak demand in the high season), the islands can expect an increase in tourist numbers as our climate becomes more Southern European allowing the tourist season to extend into the shoulder periods. This will create increased pressure on water aquifers.

- Saline intrusion from both overtopping of sea defences and penetration through the bedrock caused by sea level rise and probably more importantly potential over-abstraction of water may contaminate aquifers rendering them unusable. This may be a particular problem on the off-islands.

- The desalination pump on St Mary's is both expensive to run and has a limited working life. It may need replacing in 10-15 years.

However, a number of adaptive measures are currently in place and need to be built on to safeguard our water supplies:

- Our water pipe infrastructure assessment carried out by the Technical Service Department shows the network to be in excellent condition with minimal leakage loss. This should be monitored at regular intervals.

- Grey water recycling is already considered at the planning stage for new applications and encouraged as part of the local design guide. Public buildings design already specifies water capture where appropriate.

- The number of boreholes is being extended to allow for resting of aquifers, so as to prevent saline intrusion due to over extraction.

- Off-islands have local water extraction management procedures.

- Boreholes are monitored for conductivity and evaluated with pumping tests.

- The Business Continuity Plan defines responsibilities and risks in the event of a water shortage.

- A water business plan should be developed to include a strategy for replacing / upgrading the existing desalination plant and minimising water useage.

- Water useage statistics should continue to be monitored & recorded annually.

- It is recommended that the Council in partnership with its LSP members promotes efficient water useage in the community with educational material. This could include help in reducing demand and include information on water

efficiency products such as Water Hippos for old style toilets and tap aerators as well as promoting the use of rainwater capture and storage systems.

- The Council should limit new water hungry planning applications such as pools or insist on salt water swimming pools and have procedures in place to implement hose pipe bans.

- More drought resistant plants and crops should be investigated which require less irrigation. Regrettably the Trenoweth Agricultural Research Station has now been closed and is unlikely to be reopened in the current economic climate. However, its reinstatement or the creation of a new Centre of Land Management Excellence should be reconsidered in future years, if the economic climate improves. This would provide a useful focus for the different environmental management plans being developed.

Drainage Systems:

With increasing likelihood of higher volumes of autumn rainfall and more intense precipitation events, the drainage systems across the islands may need to be reassessed and managed carefully.

Land Drainage:

Agricultural land will need to be managed so precious top soil is not washed away to sea. Heath land will need to be monitored and managed to avoid erosion destroying habitats. Marshland will need to be monitored to ensure that drainage can cope with sudden increases in water flow from high volume precipitation events.

The IoS Wildlife Trust draft Habitat Management Plan addresses the issues of drainage at Lower and Higher Moors, but these issues should also be considered within any general land management plan.

Urban drainage:

Increased levels of rainfall particularly in sudden down pours will put great pressure on our already overloaded drainage system in Hugh Town. Rising sea levels will create further issues for drain outfalls, potentially causing drains to overflow and foul water to back up in the system, causing flooding in properties. The Council recognises that the drainage system is in urgent need of refurbishment but at present no funds are available to deal with this situation, ongoing discussions are in place with various bodies (including the Environment Agency) to try and find a satisfactory solution.

However, some steps have been implemented such as the

raising of storm drain outlets on Town Beach, to prevent extreme high tide water levels from backing up into the drainage system and causing foul water to overflow into properties at the west end of Town Beach. In addition H_2O Consultants Ltd have drafted a drainage management plan for Hugh Town which proposes solutions to ensure the gravity drainage flows from Church Street and the Strand can be managed to reduce the pressure on drains that run down to the Mermaid Inn, by building holding tanks under the car park at "Ingrams Opening" to manage the surge of water during periods of high flow.

The Council must continue to research cost effective and practical solutions to the drainage problems in Hugh Town .

Planning applications for new developments should consider the impact on the main drains in the centre of Hugh town taking into account changes in loading particularly along the High Street down to the Mermaid Inn. Major developments such as the Porthcressa Regeneration Project should consider the drainage structure outside the development area, in order to minimise the burden on vulnerable drains.

It would be helpful to implement an educational programme to encourage residents and businesses from routing surface water to foul drains to minimise risk of foul water flooding in the short term until a solution can be found.

7.8 Waste management

Whilst at first analysis, waste management might not be considered as a risk arising from the impacts of Climate Change; there are a number of issues which should be taken into consideration.

Waste is a major issue for the Isles of Scilly. It is not easy to recycle waste because of the small volumes available and the small local market for recycled goods, compared to mainland. Waste is therefore mostly incinerated, temporarily stored prior to being transported back to the mainland for recycling. In the past widespread open burning of domestic and business waste took place and occasionally this still occurs on some off-islands. However, under EU and UK regulations open burning of waste is no longer acceptable due to the environmental and health issues.

Waste management breaks down into two functions:

- Management of the amount of waste created.
- Management of the disposal of waste.

Both these issues are addressed in the Waste Management consultancy report commissioned with SLR by Department for Environment, Food and Rural Affairs (DEFRA) in conjunction

with the Council of the Isles of Scilly. This report has now been approved by DEFRA for release.

Risks arising from Climate Change to the management of waste processing are as follows:

- The most obvious is the threat of flooding to the Lower Moors and from breaches of the sea defences at Porthmellon. Both these are identified in the SMP2 as possible events by 2100 and will need to be addressed in any proposals which are made in the next phase of the SMP.

- There is the possibility of an increasing demand for waste disposal over the tourist season if warmer summers encourage more tourists to choose Scilly as a preferred destination, in response to Southern European destinations becoming too hot. Whilst significant increases in peak season tourism are unlikely without additional accommodation development, which is not the strategy proposed within the Local Plan, Core Strategy and Local Development Framework for the islands, it is possible that the shoulder seasons may become more attractive to tourists, increasing overall the annual levels of waste, which will need to be processed.

- Increases in sudden rainfall and rising sea level does pose a risk of ground and water reservoir contamination from toxins in the waste dump on St Mary's, but monitoring of levels of contamination from the main site has been carried out and no contamination has been observed so far. Monitoring should continue to be done on a regular basis.

- Increasingly warmer summers and milder winters will increase the risk of public health issues due to the likely increase in pests and vermin populations based around the dump.

In order to mitigate the potential risk from Climate Change the proposals in the SLR report should be supported – essentially to:

- Minimise waste generated.

- Recycle where possible.

- Ship back to the mainland for recycling, where impracticable to do this locally.

- Incinerate the remainder in order to minimise the requirements for landfill.

A number of steps to minimise waste are already identified as

actions within the AONB's management plan (working in partnership with the Council), but some significant hurdles remain. The SLR report identifies sourcing finance to replace the existing incinerator (which will increasingly struggle to meet existing and future regulations) as a major issue. Ongoing negotiations between DEFRA and the Council of the Isles of Scilly will address this.

Coordinating a replacement incinerator with a power and heat from waste plant installation, would present an opportunity to generate power as well as dispose of waste.

Projects to minimise waste bought onto the islands, to recycle where practicable and to minimise landfill should be encouraged. This needs to be addressed by working in partnership with local organisations such as the AONB, Transition Scilly, the Duchy of Cornwall and Tresco Estate.

7.9 Biodiversity

The rich diversity of flora and fauna on the islands is one of our greatest assets in attracting visitors, supporting our tourist and agricultural industries and underpinning the whole of the islands sustainability as a viable community. Changing Climate will have an impact on the natural environment of Scilly. However the direction and magnitude of this is not easily predictable.

In addition to site designations, many of the habitats on the

Isles of Scilly are of importance at an international level, appearing on Annex I of the European Habitats Directive (CEC, 1992). Although there is a certain degree of overlap, the principal Annex I habitats on the Isles of Scilly include:

- Vegetated sea cliffs of the Atlantic and Baltic Coast,
- Annual vegetation of drift lines,
- Embryonic shifting dunes,
- Shifting dunes along the shoreline with *Ammophila arenaria (*Marram Grass),
- Fixed dunes with herbaceous vegetation (grey dunes).

Sand beds supporting eel grass (*Zostera maritimum*) in the shallow waters around many of the islands of the archipelago represent the Annex I habitat sandbanks that are slightly covered by seawater all the time.

All of the Annex I habitats listed above are also included as priority habitats in the UK Biodiversity Action Plan (2010) [27], though there are sometimes minor changes in name. A full list

of UKBAP priority habitats occurring in the Isles of Scilly, including those that are not Annex I habitats is:

- Coastal sand dune
- Coastal vegetated shingle
- Maritime cliff and slope
- Intertidal boulder communities
- Saline lagoons
- Lowland heath
- Lowland meadows
- Lowland fens
- Reed beds
- Ponds

The potential impact of invasive non-native species at sea may also be significant, with both biodiversity and economic implications. Away from their native habitats, invasive species can become the most dominant species in an area and some can smother other flora or fauna. They can alter community structure and restrict light in aquatic and marine environments Invasive species can also decrease the amount of dissolved oxygen in the water and change soil chemistry and its structure. One example is Pacific oysters (Crassostrea gigas) which form large reefs of razor sharp shells, smothering inter-tidal areas, impacting upon native species and making beaches inaccessible to the public.

Invasive species can have impacts on our marine industries. For example, invasive seaweeds can grow on structures such as piers, slipways and fish-farm cages and can become entangled in boat propellers. Other species can kill or compete with species used for aquaculture and can spread disease. For example our lobster fishing industry (currently part of a seeding programme in conjunction with the lobster hatchery at Padstow in Cornwall), could be threatened by invasive species.

DEFRA's report The Invasive Non-Native Species Framework Strategy 2008) [18] provides a useful summary of current strategies to manage the issues associated with the invasive species which pose the biggest threat to our natural environment. Over the millennia, many non-native species have been deliberately introduced into Great Britain where they contribute to economic and social well-being through, agriculture, forestry, horticulture, fisheries and the pet sector.

Many other species have been introduced accidentally. Audits conducted by Scottish Natural Heritage and the former English Nature [18] identified 988 and 2,271 non-native species present in Scotland and England respectively. Most, such as Horse

Chestnut or Little Owl, are benign or have contributed to Britain's natural heritage. On Scilly, Agapanthus and Hottentot Fig have become accepted as a normal part of our flora. However unless managed, Hottentot Fig may become invasive. This highlights the balance that needs to be struck between invasive species which are perceived to be part of our natural environment's offering to the tourist and the potential damage such plants may cause to conservation sites.

A minority of non-native species can become dominant in the environment where they may impact on native species, transform ecosystems and cause environmental harm. Invasive non-native species of flora and fauna are considered the second biggest threat after habitat loss and destruction to biodiversity worldwide and the greatest threat to fragile ecosystems like islands.

Control or eradication of an invasive species once it is established is often extremely difficult and costly, while prevention and early intervention have been shown to be more successful and cost-effective.

Climate Change will have a substantial impact on biodiversity over the next century by:

- Affecting the distribution of our native species
- Enabling some non-native species to become more common.

Increasingly we could also see more non-native species that are currently benign become invasive as the Climate Changes. Already we are seeing some evidence of animals occurring outside their usual or expected ranges. Recent research also shows that the (generally northerly) expanding range of some species including butterflies, marine molluscs, migratory birds and plants are consistent with patterns of Climate Change seen in the UK over the past 30 years.

For example Pittosporum – long used as an effective wind break around the typical small fields used for flower farming, is not a native of Scilly and in more Mediterranean type climates is generally regarded as an aggressive coloniser. As our climate becomes more Mediterranean, Pittosporum and related shrubs may become difficult to control and impact significantly on our heathland.

The impact of Climate Change on biodiversity may be both positive and negative depending on species and location. Stress on ecosystems may reduce biodiversity but, there is also the possibility of more diverse plant & animal communities developing as wetlands cycle between high salinity at lower water levels in summer and lower salinity as water level increases in winter.

Apart from the cost in biodiversity terms, invasive non-native species can also create a huge economic cost to a very wide range of sectors, probably of the order of several billion pounds annually in Britain. For example, it is expected to cost many millions of pounds to deal with invasive weeds such as Japanese knotweed on land destined to host the infrastructure of the 2012 London Olympics.

Figure 16: *Undaria pinnatifida* (Wakame Kelp). Monterey Bay Sanctuary: Rocky Shores Monitoring Project 2002 [15]

Invasive species are already a major threat to the unique conservation designated areas of Scilly. The Common Standards Monitoring programme (CSM) for the Isles of Scilly, identified during 2009 and 2010, 15 out of 23 Biological SSSIs had issues with non-native invasive species. This is over 65% of biological SSSIs under potential threat from non-native invasive species. This includes species such as Phormiums on Plains and Great Bay SSSI (St Martins), Pittosporum on Gugh SSSI and recent invasions of Samson SSSI by *Senecio minutus*.

It is possible that aggressive invasive marine species such as *Undaria pinnatifida* (Wakame Kelp, Fig: 13), recently spotted on the hull of a boat in the Fal and Helford Special Area of Conservation, may damage our local marine ecosystems. Undaria pinnatifida has been nominated as among 100 of the world's worst invasive species according to the Global Invasive Species Database [15]. It forms dense underwater forests, resulting in competition for light and space which may lead to the exclusion or displacement of native plant and animal species.

Rats also threaten our breeding colonies of sea birds and are a

classic example of the introduction of a non-native species into an ecosystem, where there are no native predators and as a result they have spread widely through the islands

Supporting our valuable marine and terrestrial ecosystems by encouraging good land management, preventing monocultures developing, monitoring and taken action against invading species and increasing biodiversity is key to building resilience into the natural environment and protecting our unique ecosystems from the impacts of Climate Change. The more diverse our ecosystems, the more resilient they will be to the impacts of Climate Change.

Projects such as the IOS Wildlife Trust's grazing programme, Natural England's Higher Level Stewardship options for Scilly (including Landscape Management payments and conservation grazing options) the Capacity for Change in Agriculture study and the Duchy of Cornwall's Woodland Management Plan should continue to be supported by the Council. These documents should be considered together as an integrated land management strategy and will provide a useful guide to building resilience into our natural environment and protecting one of our most important assets.

Large stands of unbroken gorse or bracken scrub, rank grassland, unmanaged / dead pine wind breaks, sand dunes, waved heath and heather areas, unmanaged reed and rush beds all present significant fire hazards. Unplanned fires can lead to extensive habitat loss and particularly during bird breeding seasons, loss of species. Integrated land management will help strengthen resilience of habitats and species against the effects of Climate Change.

Technically, most of our terrestrial habitats are "semi-natural habitats" that require "management" to maintain them in good ecological condition.

The programme to eradicate rats, where feasible, from the islands, because of their impact on sea bird colonies, should continue to be supported by the Council. Local initiatives such as planting apple trees and supporting local bee keepers should be encouraged.

In summary there are three key issues:

1. Controlling established non-native invasive species in important natural habitats.
2. Monitoring for new non-native species.
3. Restoring and maintaining habitats in sound ecological condition.

Recommendations include:

- Collating a species list of non-native invasive species in Scilly.

- Producing a non-native species risk assessment for Scilly.

- Production of management recommendations for non-native species in Scilly.

- Increasing awareness amongst residents of the importance of managing residential and ornamental gardens and farm land to prevent the spread of imported species into the wider environment, for example by proper disposal of garden waste and prevention of import of barked wood.

The monitoring of tree health may become more important. Recent studies in the UK (Brasier and Scott, 1994)[10] suggest that Climate Change is likely to be at least partly responsible for the recent increase of serious tree infections in the UK. Whilst we are isolated from the mainland, disease may be spread by importation of diseased nursery plants or importation of barked wood as a fuel source.

Projects to monitor both marine and terrestrial flora and fauna populations should continue to be supported where possible, to enable us to understand the impacts of Climate Change:

- Monitoring of Scilly's 26 Sites of Special Scientific Interest (SSSI) is now complete (6 year cycle) and it was found that many heathland sites have issues, primarily due to insufficient grazing, with over 65% threatened by invasive non-native species.

- Seagrass mapping in Scilly has been carried out by the Marine Biological Association (MBA) for Natural England. The final report will be available shortly as a Natural England Commissioned Report (NECR).

- Reefs are a feature of the Isles of Scilly European Marine Site (EMS) and as such are monitored. Cornwall Inshore Fisheries and Conservation Authority carried out work recently on Scilly's reefs in 2010 and 2011, in conjunction with the Isles of Scilly IFCA.

- Cornwall Seal Group and Exeter University have been commissioned by Natural England and are carrying out pup surveys for Grey Seals around Scilly.

7.10 Health

Climate Change will impact on the health of tourists and residents of Scilly as summers become hotter with more extreme temperature events. However, as discussed earlier the Isles of Scilly is likely to escape the worst of the effect of climate warming and impacts similar to those seen in the 2003 heat wave that affected France may not be so severe (14,800

excess deaths were recorded with emergency admissions peaking at temperatures above 40^{O}C [13]), because of our unique position surrounded by the Atlantic. Whilst we may still expect to see average temperatures in the summer time rise by three to four °C by the second half of this century, compared to the 1990's, this will mean average temperatures increasing into the mid 20s on Scilly, with extreme temperatures possibly reaching the low to mid 30s. Of more importance may be the increase in UV radiation leading to sunburn and increased risk of skin cancer.

The Cornwall and Isles of Scilly Primary Care Trust (CIOSPCT) has already circulated information describing how to take precautions to alleviate the effect of excessive temperature and minimise sun exposure. The NHS also publishes several documents on line under its Livewell programme [11]. Monitoring of people's health by the local health services will become important to enable targeted educational programmes to be implemented as required. Education of school children is also seen as a key tool in protecting young people and educating residents about the dangers of heat stroke and sun burn.

There are other issues which potentially will impact residents and tourists as warmer dryer summers and milder wetter winters become more common. As with so much of Climate Change, impacts will affect many different aspects of the ecology of our environment. It is likely that the milder winters will encourage more pests, particularly insect vectors of disease. As the climate warms, many vectors—not just those that transmit malaria — are likely to expand their ranges within Europe and new vector species may be introduced from the tropics. A major vector of dengue fever, Aedes albopictus, has spread to 22 northern provinces in Italy since being introduced eight years ago. Arboviruses transmitted by mosquitoes can cause significant morbidity and mortality in Europe. West Nile virus affected France in the 1960s and Romania in 1996. There have also been outbreaks of Sindbis virus disease in northern Europe over the past two decades and numerous other viral infections have been reported [12].

Since it is not possible to predict with any degree of certainty what threats from disease carrying insects we may be exposed to in future, the best approach is to monitor using the national notifiable disease reporting mechanisms which already exist and consider taking action when appropriate. This might include educational programmes to reduce the amount of stagnant water in domestic environments such as ponds and water butts.

In addition to insect vectors of transmissible diseases, there is also a potential risk to the public from increased levels of fly infestations caused by rotting perishable waste in higher summer temperatures. The waste strategy recognises that care needs to be taken to ensure that the management of perishable waste minimises the risk of encouraging fly and

rodent populations and proper recycling of biological waste is encouraged. Support for the eradication of rats programme as previously discussed, will also help minimise risk to public health.

Warmer winters should generally reduce the risks to the elderly and other at risk sectors of the community. They could help to reduce fuel poverty, meaning those less well off should be able to maintain a better quality of life.

7.11 Tourism

The tourist sector represents some 75-85% of the island's industry. However, its actual value is probably higher and is vital to the sustainability of the whole community on the Isles of Scilly. The quality of the Scillonian landscape and marine environment is fundamental to the distinctiveness and character of the islands. It is this distinctiveness and character that is the primary appeal to visitors, making up the islands' "sense of place" through a combination of landscape, biodiversity, tranquillity, island character and custom and air and sea quality. This strong "sense of place" differentiates Scilly from other holiday destinations and is essential to its continuing success as a tourism based economy.

Climate Change will have both positive and negative impacts on our landscape, biodiversity, tranquillity, island character and customs, our air and sea quality and our ability to maintain that sense of space and support this important industry sector.

Negative impacts on tourism will include:

- Issues relating to the development of affordable and sustainable transport links to the mainland and inter-island travel.
- Cost of fossils fuels likely to increase.
- Cost of regulations (both in response to carbon strategies as well as safety regulations in response to more extreme weather events).
- More stormy weather interrupting transport links.
- Potential interruption to supply chains for goods and services. Including medical support for visitors.
- Possible loss of holiday accommodation if dwellings become un-inhabitable.
- Negative press associated with loss of services.
- Reduction in repeat bookings (around 60% of

current business), resulting from increased dissatisfaction due to bad experiences caused by interruptions to travel/restriction of other services etc.

- Reduction in infrastructure capacity leading to a "cap" on visitor numbers and gradually reducing islands ability to cope with a population influx at specific times, e.g. times of flood and drought as discussed in the water and waste sections.

Positive impacts of Climate Change on tourism include:

- Extension of the tourist season, particularly in shoulder periods, as temperatures rise.
    - More Mediterranean style climate - encouraging visitors to holiday in the UK rather than in Southern Europe where temperatures may become too hot.
- Increased awareness of Climate Change and environmental issues may increase potential for green tourism.
- Alteration in climate patterns and increased storms could re-invigorate the bird watching community and other wildlife groups as ecological and biodiversity changes take place.

The Isles Of Scilly Tourism & Destination Management Study, commissioned by Island Marketing and undertaken

by Blue Sail Destination Management Consultants, develops a strategy that aims to secure the sustainable future of tourism on the islands. Part of this study includes the development of a Green Tourism Framework to assist in the process of mitigating against the possible future changes associated with Climate Change.

7.12 Food Security and Agriculture

Industry on the Isles of Scilly, as described elsewhere in this document, is primarily focussed on tourism. However, both the sustainability of the tourism industry and the community as a whole relies on our ability to import supplies, particularly food and other perishables.

The Isles of Scilly are at the end of many long food supply chains, originating in the UK, Europe and other parts of the world. Along the way are processing units, complex distribution systems and finally a sea journey from Penzance. At every

stage of the journey to Scilly, food supply is vulnerable to impacts caused by Climate Change, amplifying commodity market fluctuations and increasing energy costs.

Agriculture everywhere in the world will be affected by Climate Change. In the UK changes in weather patterns will affect all farms and some coastal areas may experience serious flooding. 57% of grade 1 farmland in South East England [27] is below sea level and is the land responsible for providing significant amounts of vegetables and cereals.

Cost of food production and supply is already soaring due to a number of failed harvests and the impact of higher oil prices.

In many parts of the world Climate Change will increase tensions over food security, potentially creating a situation whereby food exports become not just undesirable, but impossible for those countries worst affected. Combine this trend with rising costs and decreased availability of oil and a reliance on food imports is extremely inadvisable as a policy for both countries and individual communities alike [19].

In the UK food price inflation was forecast to peak early in 2011 at around 6-7% and then decline slowly, according to European Food and Farming Partnerships (EFFP)[26]. This is unprecedented considering we have become used to deflationary prices over the last decade or so.

Food miles represent an important but sometimes relatively minor part of the carbon footprint and energy intensity of food production. Even if food is sourced relatively locally, from the South West of England, industrial agriculture itself is highly carbon intensive and vulnerable to increasing energy costs and Climate Change. Food processing is both centralised and relies on road transport, making it also highly vulnerable to oil prices and availability.

The UK is not self sufficient in food, producing around only 60% of the food we eat. It would be prudent to plan and develop a food system on Scilly that is resilient, adaptable to Climate Change and provides an appropriate level of local food security. This will require a shift in thinking both from local growers and local businesses to create a flexible and robust supply chain which can both meet some of the local demand and also focus on developing products to export back to the mainland with added value.

Whilst we will never be able to supply all our food requirements (e.g. cereals are unlikely ever to be grown commercially on Scilly) we should be aiming to significantly increase the amount of locally grown and produced supplies to reduce our dependence on imported goods and help local businesses become more sustainable by exporting higher value added branded products such as organic meat etc. These will however, only ever be aimed at niche markets because of the scale of farming possible on the islands.

Climate Change impacts on our local agriculture and horticulture [3,4,17] fall in to several categories; some potential opportunities; others challenges.

Opportunities

Crop production

- Longer growing seasons allow earlier maturity and harvesting.
- Improved crop growth due to warmer weather (assuming adequate water supplies).
- Opportunity to introduce new or novel crops (e.g. peaches, grapes).
- Reduced frost damage as frosts become milder and less frequent.
- Rising carbon dioxide levels may encourage photosynthesis and increase yields (dependent on water and nutrient availability).

Markets

- Opportunity to supply new markets e.g. new/different food crops.
- Longer growing seasons allow longer supply and greater availability of local produce.

Challenges

Productivity - crops

- Reduced soil moisture in the growing season may affect growth.
- Timing of maturity, crop uniformity and produce quality may be affected by temperature change.
- Potential for reduction in soil quality due to top soil loss from run off.
- Greater yield variability due to increasingly unpredictable weather.
- Increases in 'very windy' days could cause problems with crop spraying, spring crop establishment and lodging of mature crops.
- Extreme events may lead to more yield variability, increasing the need to plan, extending the range of crops and potentially increasing 'speculative' planting.

- Reduced summer rainfall will increase water stress on crops (especially at crop establishment and maturity) requiring increased irrigation and need for increased efficiency in water usage, such as new soil management practices to avoid evaporation and water runoff.

- Increased autumn rainfall and increased precipitation rates will require better soil management techniques to avoid erosion, with improved drainage, reduced soil compaction and better year round cover.

Productivity – livestock

- Livestock will require extra water and shade for summer heat.

- Sward diversity will be important to reduce effects of water and temperature variations.

- There may be a need to grow more winter forage for wet winters with waterlogged soils.

- Higher summer temperatures could affect ability to produce forage.

Costs

- Increasing costs for livestock housing from ventilation.

- Autumn cultivations may be threatened by wetter winters and autumns.

- Glasshouses, poly-tunnels and cold stores in summer will require extra cooling.

Pests/diseases

- Temperatures may not be cold enough to reduce pests, diseases and weeds, leading to larger surviving and breeding populations, creating more resilient populations and more of a management concern for farmers.

- The current geographic range of pests and diseases could change significantly, including novel species more adapted to a more Mediterranean style climate.

- Greater problems with pesticide resistance.

- Changing composition of weed communities.

Land and biomass

- Whilst it is uncertain whether we will experience increased frequency or strength of storms[4], it would be prudent to consider the impact of high winds and salt spray (increased plant burn during winter storms) on crops, windbreaks, trees and buildings as a matter of routine practise.

- Farm land very close to sea could face severe erosion and even inundation in the medium term– this should be considered when balancing current and future need for agricultural land against other pressures such as the need to relocate buildings and services in response to rising sea levels.

- Borehole water for irrigation could be affected by saline intrusion, requiring better aquifer management practices (see section 7.6).

- Beach erosion could impact on ability of farmers to haul seaweed.

- Warming seas are likely to have an impact on seaweed growth, affecting species mix and growth rates. This could affect seaweed resource available to farmers.

General principles

It should be noted that summer temperatures are unlikely to reach the peaks seen on the mainland so the severity of heat effects on Scilly will not be as significant . However, it remains good practice to build resilience into our environment to minimise any impact of extreme weather events, the frequency of which is likely to increase.

Whilst it is not within the scope of this document to advise farmers and land owners on specific actions to increase resilience to Climate Change, consideration of some general principles to increase resilience include the following:

- Improve soil structure and management.

- Increase organic matter levels in soils.

- Minimise cultivations and avoid bare soil where possible.

- Develop healthy and well managed windbreaks.

- Increase crop diversity over time and space.

- Efficient and timely irrigation and significant water storage ability.

- Timeliness of operations to make use of weather windows.
- Consider novel crops and different ways of doing things.
- Ensure all ventilation, heating and cooling equipment is correctly specified for its role, clean and working efficiently.
- Investigate drought resistant varieties of crops or alternative livestock breeds.
- Observe short and long term weather forecasts closely to enable forward planning. Be flexible and adapt plans as conditions dictate.

A number of ongoing initiatives such as the Capacity for Change study, the development of local abattoir facilities and local food market projects, seek to understand the opportunities and issues that moving towards a more sustainable and resilient food supply chain entail. These projects look at marketing opportunities for both supply to local consumers as well as building marketable brands which can be promoted off island. These initiatives must also consider the impacts of Climate Change both at the production and the distribution phases.

It is recommended that the Council and its LSP members continue to support research and development projects into alternative industries to the tourist trade and encourage the development of sustainable agriculture and sustainable local supplies of food, wherever practicable, in order to build resilience into our communities and way of life and reduce the risks from the impacts of Climate Change.

8. Implementation and monitoring adaptation Processes

8.1 Processes

The Climate Change Strategy looks ahead to the long term future and as such is quite different from most other strategy documents published by the Council.

In addition it describes scenarios which by their very nature are subject to a high degree of uncertainty, both in their likelihood of occurrence and the magnitude of their impact on the island community.

In the short term the strategy can be implemented and reviewed as part of the Council's commitment to NI 188. However, with the abolition of top down National Indicators, under the coalition's push to decentralise Government, the

long term monitoring of the recommended actions arising from this strategy document will need to be addressed separately.

The Climate Change Strategy should be reviewed on a regular basis – it is suggested on a timescale of 3-5 years with a major review every 10 years. This timescale allows implementation of recommendations to be measured whilst also allowing for a change in direction as impacts become clearer should this be necessary in the longer term. It should also tie in with the revision cycles of other key strategy documents. Clearly responses to the risks identified in the Climate Change Risk Assessment need to be integrated into the day to day operating processes of the Council:

- Planning permissions for new developments should be reviewed for environmental footprint and also assessed against any climate risks such as flooding and storm damage.

- All new strategy documents such as waste management proposals and output from Shoreline Management Plans must be scrutinised for issues which will arise in response to Climate Change.

- The risks identified by the Climate Risk Assessment in 2009/10 should be rerated and incorporated in the Council's Corporate And Community Risk Registers.

In this way risks are continuously assessed and response to Climate Change threats and opportunities are embedded in Council practices.

One issue which will require resourcing is the maintenance of weather and tidal databases and recording of adverse weather events. This is key to understanding developing climate impacts and assessing risk over the medium to long term. In the current economic climate it is less likely that funding will be available from central Government to support the ongoing management of Climate Change risks and therefore it is important to ensure that integration of risk assessment as outlined above is completed as soon as possible.

Detailed below is a summary of the actions arising from this strategic plan. This is designed to capture the key points raised in the discussion on Climate Change and should be read in conjunction with the sections which cover each issue.

A number of other actions will arise as various projects and strategies are developed and published and as previously stated this document should be seen as a living and evolving blue print which must be regularly reviewed.

8.2 Table 3: Climate Change Strategy Action Plan

Threat	Action	Suggested Key Responsible Partners	Time frame	Milestones	Priority
Maintain weather and tide databases and log adverse weather events and impacts	Ongoing logging activity. Develop user friendly front end	Council of The Isles of Scilly	2011	Monthly updates	Medium
Drainage	Improve drainage in Hugh Town	Council of The Isles of Scilly	Ongoing	Seek funding for recommended drainage improvements in Hugh Town	Medium
Energy Issues	Review the Sustainable Energy Strategy	Council of the Isles of Scilly, AONB, Duchy of Cornwall	2011-12	Initial review 2011, implement energy saving & renewables objectives by 2012	Medium
Energy Issues	Encourage and support renewable energy initiatives	Council of the Isles of Scilly, Transition Scilly, Isles of Scilly Renewable Energy Cooperative, Duchy of Cornwall	20011/12	Identify Council sites suitable for renewables Support the creation of Isles of Scilly Renewable Energy Cooperative Create guidance notes for householders	Medium
Energy Issues	Support energy efficiency in home and at work	Council of the Isles of Scilly Transition, Isles of Scilly Renewable Energy Cooperative, AONB, Duchy of Cornwall	2011/12	Provide annual carbon footprint data to DECC Compile fuel poverty survey Implement Council wide energy efficiency plan	Medium
Food & Agriculture	Continue to support the Capacity for Change research project, local food market initiatives and the local abattoir programme	Council of the Isles of Scilly, Transition Scilly, AONB, Duchy of Cornwall, Natural England	Ongoing		Medium
Habitat & Species protection	Rat eradication programme	IoS WildLife Trust, Natural England, RSPB, AONB, Duchy of Cornwall	Ongoing	Establish feasibility of rat eradication on Off-islands	Medium
Habitat & Species protection	Implement IoS WildLife Trust Land Management Plan	IoS WildLife Trust, Natural England, RSPB, Duchy of Cornwall	2015	Create non native species list & complete risk assessment and integrated land management plan	Medium

Threat	Action	Suggested Key Responsible Partners	Time frame	Milestones	Priority
Health & Animal Health	Monitor incidence of exotic infectious diseases and heat / UV related disease	CIOS PCT, Council of the Isles of Scilly	Ongoing	Set up or utilise existing databases Public health awareness programmes	Medium
Heritage and Biodiversity Threats	Support IoS WildLife Trust Land Management Plan	Council of the Isles of Scilly, Ios WLT, AONB, Natural England, English Heritage	Ongoing	Log all finds Monitor biodiversity and SSSI and other conservation sites	High
Invasive species, loss of biodiversity, destruction of habitat	Maintain Biodiversity & Conservation zone logs	AONB, IoSWLT, Natural England, RSPB,	Ongoing	Database creation	High
Sea Level Rise / Coastal Erosion / Flood defence	Collect Weather and sea level data and log impacts	Council of the Isles of Scilly	Ongoing	Publish annually	High
Sea Level Rise / Coastal Erosion / Flood defence	Manage coastal erosion and flood risk through the SMP2 process. Ensure coastal monitoring of cliff recession rates and beaches is implemented for all islands. Carry out repairs to sea defences at risk. Log all post storm damage.	Council of the Isles of Scilly, CISCAG, DEFRA, AONB, IOSWLT, Duchy of Cornwall, English Heritage	Ongoing	Identification of key flood risks by 2011 Source funding (see below) Participate in coastline monitoring project island monitoring databases set up by 2012 Implement Lower Strand, Porthcressa and 5 island school flood defence proposals	High
Sea Level Rise / Coastal Erosion / Flood defence	Complete DEFRA / EU Preliminary Flood Risk Assessment	Council of the Isles of Scilly Technical Services Dept.	30/6/11 2013	Submit draft by June 30th 2011 Define Coastal Change Management Areas	Medium
Sea Level Rise / Coastal Erosion / Flood defence	Encourage and support practical flood risk measures, particularly for historic buildings	Council of the Isles of Scilly, AONB, Duchy of Cornwall, English Heritage	Short term	Flood awareness programme	Medium
Sea Level Rise / Coastal Erosion / Flood defence	Ensure appropriate developments are assessed for potential flood impacts	Council of the Isles of Scilly Planning Dept	Short term	Review procedures	Medium
Sea Level Rise / Coastal Erosion / Flood defence	Support wave studies both to west of archipelago and at key points identified from SMP2 on shore	Council of the Isles of Scilly, CISCAG, Channel Coast Observatory (CCO)	Ongoing	Establish wave buoys at key locations	High

Threat	Action	Suggested Key Responsible Partners	Time frame	Milestones	Priority
Sea Level Rise / Coastal Erosion / Flood defence	Develop localised Hold the Line plan for the Garrison	Duchy of Cornwall, English Heritage, Council of the Isles of Scilly	2013	Preliminary consultation with English Heritage / Duchy / EA by end 2011	Medium
Sea Level Rise / Coastal Erosion / Flood defence	Create asset register of property and assets at risk as part of Preliminary Flood Risk Assessment	Council of the Isles of Scilly Planning & Technical Services	20011/12	Database creation end 2012	medium
Sustainable transport	Implement Sustainable Transport Policy	Council of the Isles of Scilly, Duchy of Cornwall, IOS Steamship Company	2011/12	Implement specific actions from Sustainable Transport Policy	High
Tourism	Implement the Isles Of Scilly Future of Tourism Report recommendations	Council of the Isles of Scilly, Island Marketing, Island Tourism	2011/12	Implement specific actions from The Isles Of Scilly Future of Tourism Report recommendations	Medium
Waste Management	Implement SLR waste report	Council of the Isles of Scilly, AONB, Environment Agency, DEFRA	Ongoing	Compact waste mountain Burn excess rubbish Improve recycling processes Seek funding to replace incinerator and review options for heat to energy plant	High
Water Management	Develop cohesive water plan for St Mary's / Bryher	Council of the Isles of Scilly Planning & Technical Services	2013	Desalination plant upgrade and energy efficiency programme Collect water useage statistics Assess threat from saline intrusion	high
Water Management	Develop cohesive water plans for St Agnes / St Martin's / Tresco	Tresco Estates, Duchy of Cornwall, Duchy of Cornwall Tenants Association	2013	Asses threats from saline intrusion	Medium
Strategy	Review Climate Change Strategy on regular basis	Council of the Isles of Scilly, LSP partners	2015 2020	Minor review Major review	Medium

9. Appendix 1: Climate Change: Understanding the Science

What do we mean by Climate Change? Climate is about long term trends in weather patterns, usually defined as average conditions over a 30 year period or longer. Climate describes a wide range of parameters such as temperature, rainfall, wind speeds and various other significant weather events. Weather is what is going on outside your window at any given point in time. It follows then that climate will follow distinct patterns of change over time ranging from decades to millennia.

Many factors seem to play a role in changing our climate and indeed climate must be considered from a regional and in the case of the Isles of Scilly a local micro-climate perspective. The history of our planet shows that in the distant past there have been huge changes to the planet's global climate. During the last two billion years the Earth's climate has alternated between a frigid "Ice House", like today's world and a steaming "Hot House", like the world of the dinosaurs.

Fig. 17 shows how global climate has changed through time. Looking at the swings in climate emphasises how complex our climate is. Climate Changes are driven by many different

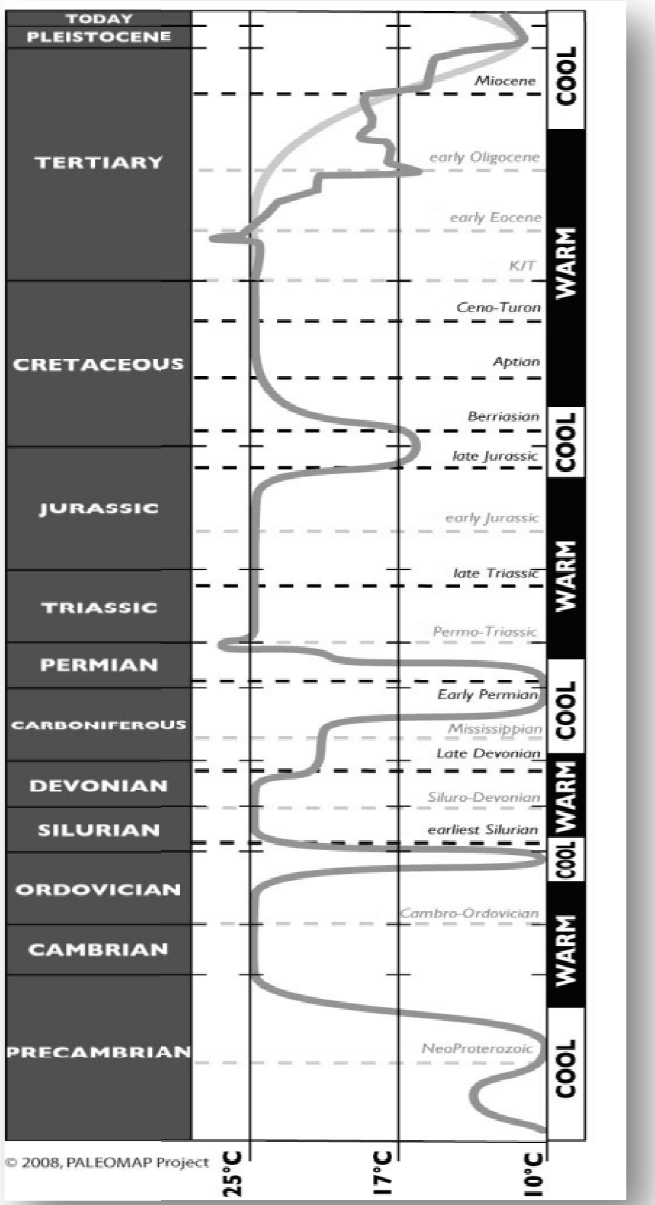

Figure 17: PaleoMap, showing climate cycles since the Precambrian era.
© Scotese, C.R., (2002) [2]

factors. Science is still trying to unravel exactly what causes shifts in climate but reasonably well understood drivers include external factors (from extraterrestrial systems) or internal factors (from ocean, atmosphere and land systems). For example, an external change may involve a variation in the Sun's output, which would externally vary the amount of solar radiation received by the Earth's atmosphere and surface. Internal variations in the Earth's climatic system may be caused by changes in the concentrations of atmospheric gases, mountain building, volcanic activity and changes in surface or atmospheric albedo (reflectivity). Ice fields reflect more solar radiation than the sea. To further complicate matters different factors may coincide to cause major changes in the climate. For example, the variations in the Earth's orbital characteristics (the distance of the Earth from the Sun and the tilt of the Earth on its axis) known as Milankovich cycles, affect the amount of sunlight falling on the Earth's poles. These interact with sunspot activity cycles causing peaks and troughs in the amount of energy reaching us from the Sun and therefore warming or cooling the Earth.

All these factors act together to create our climate, but it now seems likely that the *current* phase of global warming is being caused by the increase in so called Greenhouse Gases (such as CO^2 , methane and CFCs), produced by mankind since the early days of the industrial revolution. This is called anthropogenic Climate Change. CO^2, in particular from the

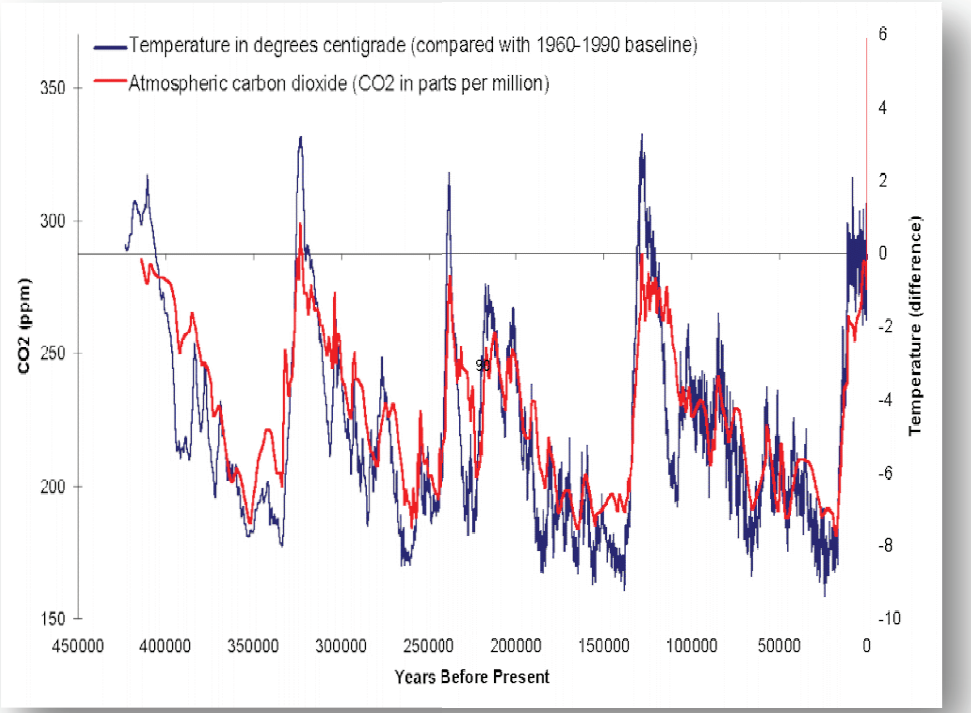

Figure 18: The Correlation between Co2 levels and global temperature Compiled from the Vostok ice core temperature record (dark blue), together with CO2 (red) from the Vostok ice core, the Law Dome ice core and from the Mauna Loa monitoring station in Hawaii. NOAA (2010)[21, 22]

burning of fossil fuels to provide us with our increasing energy needs, has increased significantly since the 1800s. Fig.18 illustrates the increase in concentration of CO^2 in the atmosphere from 400,000 years ago to the present. The physics of greenhouse gases and their impact on global warming is well understood. These gases absorb energy from the sun and re-emit it as heat and therefore it is not surprising that CO^2 levels match global temperature changes. However, close inspection of the correlation data of CO^2 levels with global temperature suggests that the levels of CO^2 seem to lag behind temperature rises. Most recent research suggests that the ends of an ice age were probably triggered by orbital and sunspot activity but that initial warming is then accelerated by the release of CO^2 from ocean reservoirs, which then causes accelerated warming [21, 22].

The majority of climate scientists agree that global warming is taking place. The rate and duration of warming of the 20th century has been much greater than in any of the previous nine centuries. Similarly, it is likely that the 1990s have been the warmest decade and 1998 the warmest year of the last 1000 years.

There has also been some discussion in the scientific literature about how much ice is actually melting, particularly in

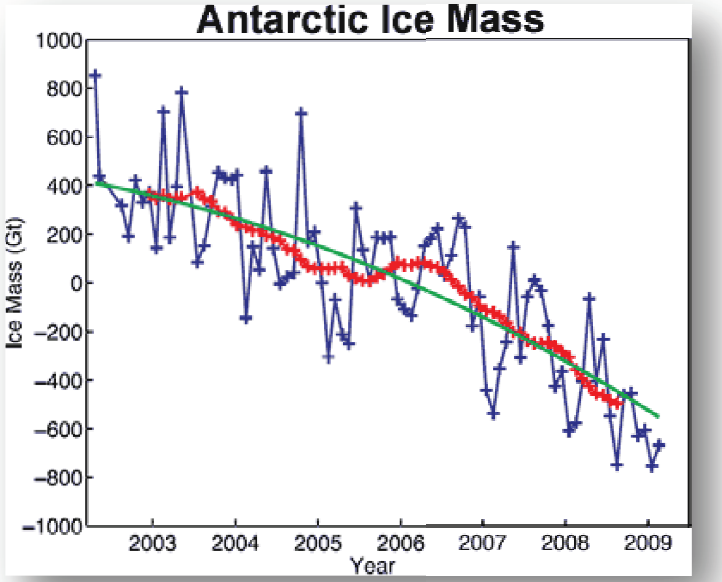

Figure 19: Ice mass changes for the Antarctic ice sheet from April 2002 to February 2009. Unfiltered data are blue crosses. Data filtered for the seasonal dependence are red crosses (Velicogna, 2009)[14]

Antarctica, where there was recently reported that the some of the ice sheets were actually expanding. However, Velicogna (2009)[14] established that overall the Antarctic ice sheet is

shrinking at an increasing rate (See Fig. 19).

It should be noted that the Earth's climate like all natural systems exhibits a high degree of variability and whilst global climate is relatively easy to model, local and regional climates are more complex. An example of this is the recent relatively cold winters seen over the UK (Fig. 20). Despite the UK experiencing exceptionally cold weather the rest of the Northern Hemisphere as a whole has actually seen relatively mild weather and measurements indicate that 2010 was another of the warmest years on record.

The cause of the cold winters over the UK was a movement in the jet stream so that cold air was sucked down from higher latitudes. Jet streams are fast flowing, narrow air currents found in the upper atmosphere (7 kilometres or 4.3 miles to 12 kilometres or 7.5 miles above sea level). The major jet streams on Earth are westerly winds (flowing west to east). Their paths typically have a meandering shape. Jet streams may start, stop, split into two or more parts, combine into one stream or flow in various directions including the opposite direction of most of the jet.

Meteorologists now understand that the path of jet streams steers cyclonic storm systems at lower levels in the atmosphere and so knowledge of their course has become an important part of weather forecasting.

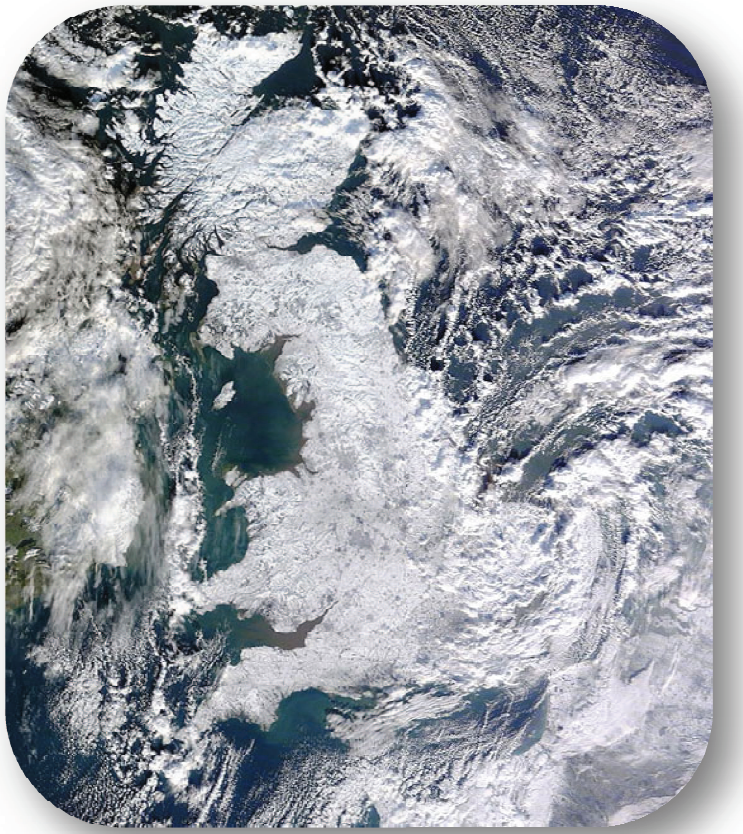

Figure 20: A historic snowfall blanketed Great Britain on Jan. 7th 2010. A strong high-pressure mode of a pattern called the Arctic Oscillation pushed the jet stream south and allowed Arctic air masses to invade Northern Europe in December and January, creating an unusually cold winter

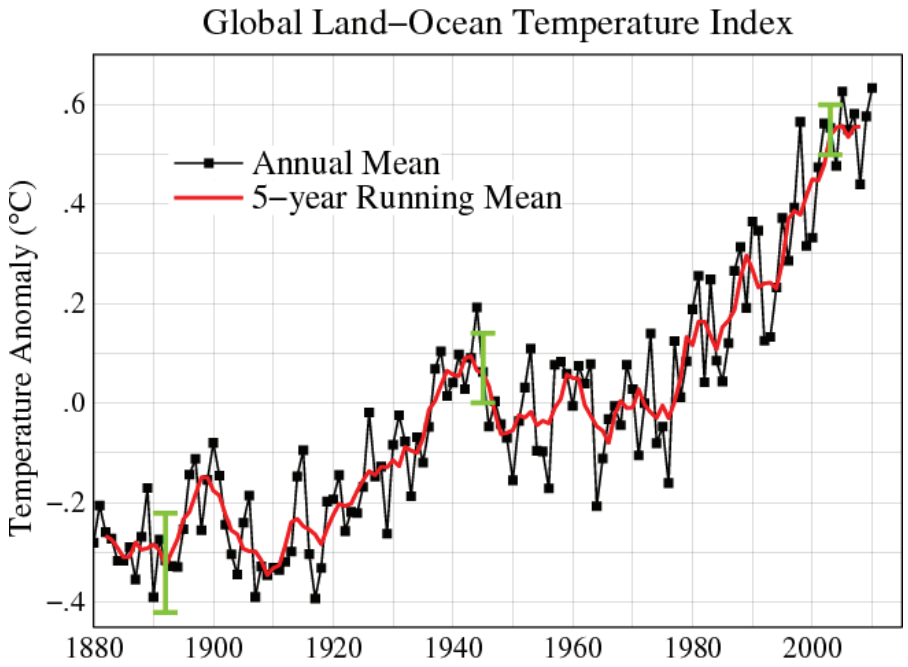

Figure 21: Global temperatures from multiple measurements compared to long term averages (red line). IPCC 2007[1]

Five year and 11 year temperature averages (i.e. the planet's annual mean temperature, averaged over 5 or 11 years), are valuable because they place less emphasis on single-year variability. These running averages show a consistent rise in the Earth's temperature over the past 30 years (See Fig. 21).

Further, if the El Niño effect (when unusually warm ocean temperatures occur in the tropical Pacific Ocean) is as strong in 2010 as expected, there is a greater than 50 percent chance that it could be the warmest year since instrumental data records began. But even if it is, like the recent harsh weather, one year or one particular spell of weather will never alone prove or disprove what is happening to the climate. Even as man-made greenhouse gases exert a consistent pressure on the climate, trapping more heat close to the surface of our planet, surface temperatures from year to year will fluctuate depending on the naturally variable forces at work around the globe. In the early 1990s, the mass of sulphates blasted into the atmosphere by the eruption of the Mt. Pinatubo volcano (in the Philippines) reflected sunlight and counteracted much of the man-made warming effect for several years. In 1998 El Niño combined with man-made warming to give us one of the warmest years ever recorded. Allowing for this variability, global warming theory does not project a linear, year-to-year increase in temperatures. Nor does it say that harsh winter weather will simply end. What it does say is that increasing concentrations of gases such as carbon dioxide and methane, with unchecked growth, will contribute a greater and greater warming influence on the world's climate.

Fig.22, based on Meehl et al. (2004)[24], shows the ability with which a global climate model (the DOE PCM [1]) is able to reconstruct the historical temperature record and the degree to which the associated temperature changes can be attributed to various influencing (or forcing) factors. The top part of the figure compares a five year average of global temperature observations (Jones and Moberg 2001) to the Meehl et al. theoretical model incorporating the effects of five predetermined forcing factors: greenhouse gases, man-made sulphate emissions, solar variability, ozone changes (both stratospheric and tropospheric) and volcanic emissions (including natural sulphates). The temperature change is shown on the left axis. Grey bands indicate the 68% and 95% probability range for natural variability in temperature relative to the climatic expectation modelled in multiple simulations. In other words, they indicate the estimated size of variations that are expected to occur due to fluctuation in weather rather than changes in climate.

In the lower portion of the figure are the results of additional simulations in which the model was operated with only one forcing factor used at a time. Temperature change modelled is shown on the right axis. A key conclusion of the Meehl et al. (2004) work is that the model response to all factors *combined* is, to a good approximation, equal to the sum of the responses to each factor taken individually. This means it is reasonable

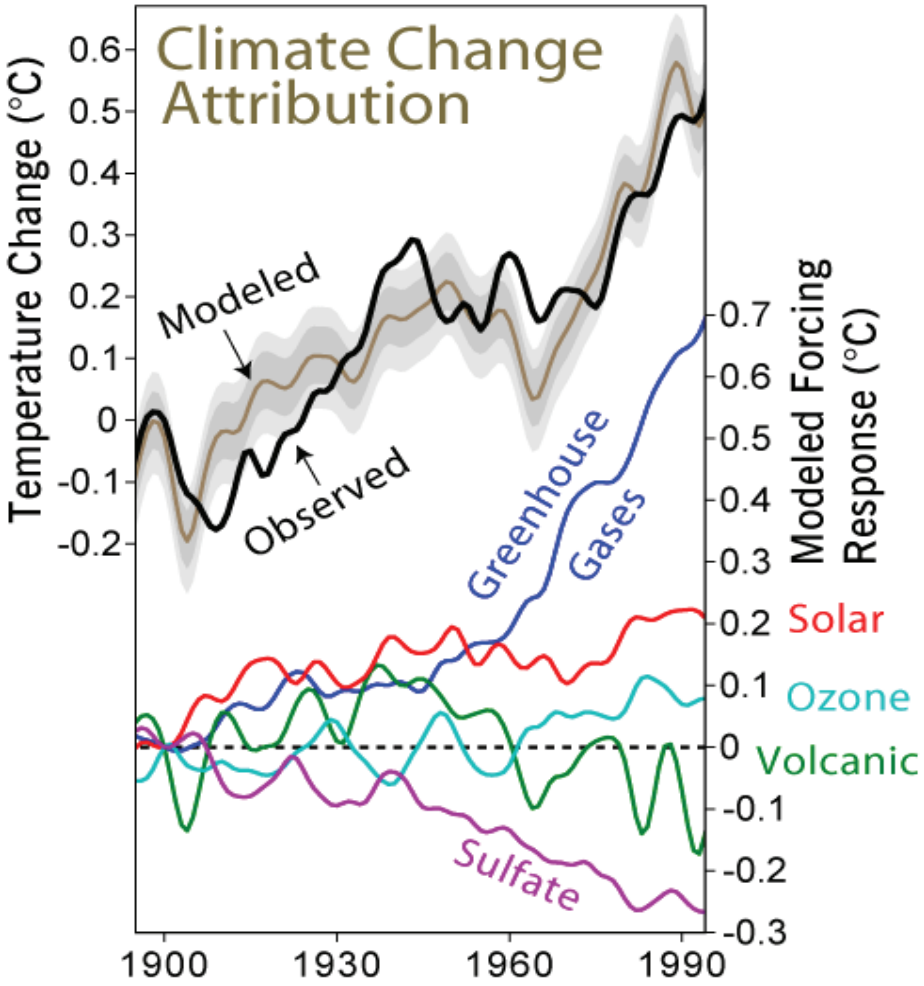

Figure 22: Relationship between different climate factors and modelled and observed Climate Changes (Meehl et al 2004)

to talk about the temperature change due to individual aspects of the evolving man-made and natural influences on climate.

The zeros on both plots are set equal to 1900 temperatures. The graph shows that most of the 0.52 °C global warming between 1900 and 1994 should be attributed to a 0.69 °C temperature forcing from greenhouse gases, partially offset by a 0.27 °C cooling due to man-made sulphate emissions and with other factors contributing the balance.

Similar studies have been done, modelling sea level rise against global temperature, to understand how increases in temperatures lead to rises in sea level due both to thermal expansion and ice melt.

Rahmsdorf et al [20] used two models to compare theoretical sea level rise with actual observed data in an effort to validate the models which can then be used to predict future sea level rises. Although a complex study the graph (Fig: 23) can be summarised as follows:

Upper plots

Observations-based rate of sea-level rise (red) compared with that predicted by model 1 (gray) and model 2 (blue with uncertainty estimate) using observed global mean temperature data. The light blue and light

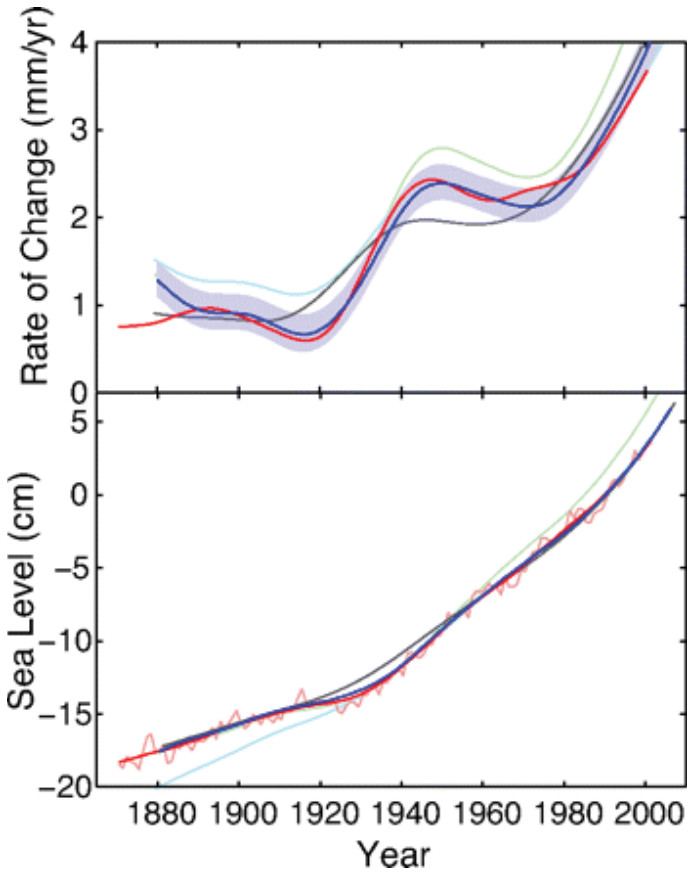

Figure. 23: Two models of sea level rise compared against observations over the last 30 years (Rahmsdorf et al, 2009)[20]

green curves utilise part data sets, but still correlate well.

Lower Plots

Show the integral of the curves in the upper plot, i.e., sea-level proper. In addition to the smoothed sea level (red line) used in the calculations, the annual sea-level values (thin red line) are also shown. The dark blue prediction by model 2 almost obscures the observed sea level because of the close match.

Clearly the models match observed data quite closely. However the variability exhibited here, with periods of accelerating and decelerating sea level rise, suggests other factors come into play and indeed Woodworth et al 2009 [21] proposed that changes in sea level air pressure systems have a significant impact on sea level measurements, influencing localised readings (i.e. for the UK and Eastern Atlantic) as water volumes are moved around the globe. This highlights the fact that quantifying the rate of sea level rise is still an inexact and poorly understood science. As always science advances by testing and refining arguments, but usually moves forward towards a better understanding of the world we live in.

In conclusion it can be seen that many different studies support the view that global warming is occurring. Both direct observations as well as theoretical models (which can be used to project future trends) show that the current warming trend is more than likely to be caused by the rapid increase in CO^2 as a result of mankind's use of fossil fuels to provide energy for our industrial age.

9.2. Detailed Risk Assessment tables

The tables following are summarized from the raw outputs generated by the NI 188 risk assessment (2010) with revised risk weightings based on impact on assets and time frame.

Environmental Variable	Risk / Opportunity	Impact Area	Consequence
Sea Level Rise and Storms	Transport links at risk	Council Services Tourism Health All Business sectors Supply chain import / export	Travel becomes difficult from mainland and inter-island Decreased productivity / unable to meet performance targets Service Clients (e.g. children and vulnerable adults at risk). Medical needs / treatment not met - potential for avoidable deaths Economic impact to businesses Community may become unsustainable Loss of essential and non-essential supplies Off Island links may be reduced - medical issues / quality of life reduced Wear and tear on vessels Longer periods without freight Discussions ongoing to maintain BIH helicopter link
Sea Level Rise and Storms	Flooding of Town Hall putting IT and finance systems out of action for extended period.	Finance function and all Council services	Cost of disruption Inability to pay staff, creditors and collect revenue Loss of financial control (inability to monitor expenditure or prepare accounts) Impact on clients (Council Tax and housing benefits) Loss of organizations data due to servers being lost and backup data being lost (stored
Sea Level Rise and Storms	Threat to infrastructure e.g. roads / sewers & drains, septic tank drainage systems waterlogged	Highways Technical Services Tourism health heritage agriculture logistics	Damage/loss of infrastructure including main and off island quays requiring rerouting/repair vehicular & pedestrian access to properties reduced or removed. Dwellings uninhabitable, tourist accommodation effected, sewage effluent above ground Temporary evacuation of vulnerable people.
Sea Level Rise and Storms	Current housing and business accommodation vulnerable to sea level rise and storm surges	Planning Tourism Business	Property flooded/ damaged and services disrupted – Loss of revenue
Sea Level Rise and Storms	Increased coastal erosion leading to flood inundation Storms causes damage to property and infrastructure	Services Residential property Tourism Economy Heritage and conservation	Damage to key administration buildings and central services / infrastructure - Server Room flooded, Council tax, benefits, accounts, planning, accommodation lists, payroll services lost Damage to residential and business property Major impact on key industries - tourism / agriculture Higher insurance premiums - possibly no insurance Loss of permissive access routes to conservation and tourist areas through erosion. Buildings left in poor state of repair or abandoned

Adaptation process in hand or needed	£ con-sequence (1-3)	Impact (1-3)	Likely-hood (1-3)	Time frame	Overall Risk score
Improve facilities for remote access to IT systems More robust transport links to mainland - Sustainable Transport Strategy review ongoing Capacity for Change consultation identifies ways to build resilience Harbour plans assessed against Climate Change and environmental impacts	3	3	3	Short-Medium	83%
Ensure adequate insurance and contingency/disaster recovery planning. Investigate outsourcing transactional processing functions to a safer location on the islands, or on the mainland Review locations of essential Council services and back up data plans Recognition that budgets need to be permanently increased in budget planning process	3	3	3	Short-Medium	83%
Implementation of Sustainable Transport Strategy Implementation of SMP2 Hospital & Health Centre are in elevated positions. SMP2 output to quantify risks Vulnerable persons assessment required, evacuation plans	3	3	3	Med-long	50%
Planning to consider impacts on future proposals for development Flood Planning (CIOS flood plan - reviewed annually) Business Continuity Planning	3	3	3	Med-long	50%
SMP2 addresses practical engineering solutions Need to review domestic & business flood defence technologies (e.g. door protectors, socket positioning) Reviewing Disaster Recovery (DR) plan in Finance and Resources service plan. Consider moving server room to above sea level when reallocating office space Emergency Planning early warning systems in place - event database created Need to address Climate Change issues in policy documents and planning decisions in accordance with PPS 25 and new PPS documents in draft which replace PPS25 & PPS1 All new building / developments need to have flood risk assessments done Monitor access routes and open new ones as appropriate	3	3	3	Med-long	50%

Environmental Variable	Risk / Opportunity	Impact Area	Consequence
Increasing energy costs and more demanding CO2 regulatory environment	Energy Costs predicted to rise by 20% by 2020 Increasing regulatory pressure from UK and EU to minimise energy wastage and develop renewable energy sources Public interest in renewable microgeneration will increase rapidly	All areas impacted Council services / reputation Council Finances Business sector Tourism Residents Agriculture Transport	Financial burden on businesses, Council, schools and homes significant Reduced cash for other services Fuel poverty will increase Opportunity to gain significant financial benefit through FITs for Council, schools and residents Possible conflict with biodiversity and landscape Sustainable provision of self sufficient energy Businesses struggle to compete due to direct energy costs and increased export/import cost. Cost to visitors may become unsustainable
Increasing energy costs and more demanding CO2 regulatory environment	Increased fuel / electricity costs for running desalination plant and incinerator etc	Council services / reputation Council Finances Business sector Tourism	Economic impact on residents, businesses and Council finances of increased water and waste processing costs. Damage to Council reputation Planning/Building Regs requirement for new higher u value properties increases - All new builds zero carbon by 2015 All Council new builds zero carbon by 2017 Most Council buildings will need DEC certification and development plans in response to DECC and Climate Change directives Cost of energy impacts on Council finances
Increased heavy winter rainfall and higher wind speeds	Flooding will contaminate mains water supply and overburden drainage system (already under pressure on St. Mary's)	Tech. Serv. Public Health Tourism & other Business sectors Health Residents	Contamination of water supply, flooding Back up of raw sewage into properties in Hugh Town Implications for health, property, business continuity Contamination of beaches impact on tourism

Adaptation process in hand or needed	£ con-sequence (1-3)	Impact (1-3)	Likely-hood (1-3)	Time frame	Overall Risk score
Investment in renewable energy initiatives that are appropriate and proportionate to the context of Scilly, including the AONB and Conservation Area designations - (Sustainable Energy Strategy). Wave power project (Sustainable Energy Strategy) Planning to encourage microgeneration - education / business case studies promoted Council to support promotions on insulation / efficient energy use Council to promote energy efficient transport (Sustainable Transport Policy - boat calendar system) New school has alternative energy sources built in to reduce these effects. (ground source heat pumps and solar PV) Consultants review of Council's carbon footprint and energy efficiency project IT review, upgrade of software / hardware to allow power management of desktops. Use of virtualization technology to make utilization of server resources more efficient. Destination Management Strategy needs to identify compensating best value solutions and Sustainable Transport Strategy needs to address sustainability issues. Capacity for change consultancy to address improved local sourcing and diversification to ensure community sustainable	2	2	3	Short	44%
See above ref CHP from waste. Need to explore opportunities for renewable energy systems to offset rising energy costs under new Government financial packages (e.g. use PV panels to offset electricity use by desalination plant etc.) . Project proposal for study being worked up. PV Panels installed on island schools and children's services offices Project to assess and improve Council buildings to minimise carbon footprints initiated Ensure policy documents & planning decisions take into account new technologies Ensure Climate Change impacts assessments built into Core Strategy and Climate Change strategy documents Review Sustainable Energy Strategy Encourage renewable energy initiatives that are appropriate and proportionate to the context of Scilly	2	2	3	Short	44%
Water quality monitoring & treatment Urgent need to revamp drainage system particularly Hugh Town although some drainage adapted for rising sea level Educational programme to prevent residents from routing surface water to foul drains. Programme to raise & refurbish manhole covers on Town Beach to address sea level rise implemented. Note: on inspection the sea valve on the drain under the Atlantic Inn has corroded & fallen off. Need for renewal of main drain & sewer system in Hugh Town – funding being sort in conjunction with Environment Agency	2	2	3	Short-Medium	37%

Environmental Variable	Risk / Opportunity	Impact Area	Consequence
Reduced Summer Rainfall & Drought	Greater volume of water needed to irrigate crops, available water in soil for crop growth could be diminished	Agriculture Tech Services Planning	Depletion of water table Negative impact on crop yield - financial impact
Sea Level Rise and Storms	Loss/transformation of recreational amenities, especially beaches and rocky foreshores	Tourism sector	Potential loss of sandy beaches- negative impact on tourism
Increased Heavy Winter rainfall and higher wind speeds	Risk of contamination of aquifers from waste facility	Tourism Health Residents Business sector Council services / reputation	Risk to health and water supply
Reduced Summer Rainfall & Drought	Insufficient fresh water to meet off-island community needs	Council Services Tourism Duchy Tresco Estate	Communities unsustainable
Sea Level Rise and Storms	Threat to water supplies on St Mary's and off-islands through saline intrusion and/or flooding of existing boreholes	Householders Duchy Tresco Estate Tourism Health Agriculture Council reputation & services	Impact on tourism Inability to sustain island communities Problems / conflicts with irrigation requirements and other water users
Sea Level Rise and Storms	Loss of agricultural land	Agriculture Built environment transport	Loss of farmland / farms become unprofitable unsustainable Soil fertility compromised by saline intrusion
Increased heavy Winter Rainfall and higher wind speeds	Soil erosion	Agriculture Accelerated coastal erosion	Significant risk of losing soil organic matter from bare soils

Adaptation process in hand or needed	£ con-sequence (1-3)	Impact (1-3)	Likely-hood (1-3)	Time frame	Overall Risk score
Water use campaign & rainwater storage Grey water usage considered in all new planning applications Evaluate alternative irrigation systems Water extraction licensing needs investigation Water quality monitoring in place	2	2	3	Medium	30%
Implementation of Sustainable Tourism Strategy	2	2	2	Medium	20%
SLR & DEFRA consultancy reports on waste management details recommendations to address waste issue on Scilly – funding being sought. Need to ensure Climate Change risk assessment carried out on final proposals for replacement of incinerator and other waste flow management plans. Monitoring of levels of contamination from main site carried out - should be done on regular basis. No risk observed so far.	2	2	2	Medium	20%
Minimise water use in homes and holiday lets. Water use campaign Use grey water recycling - must be considered at planning stage New public buildings design will use water capture for some processes Water business plan Monitor & record water usage statistics annually Implement hosepipe bans	2	1	3	Short-Medium	19%
Risk assessed in SMP2 & Water business plan Desalination plant installed as a result of past water shortages - can cope with required capacity (175Kgals/day) - unlikely to increase maximum daily tourist numbers significantly (managed increase in accommodation capacity) Water pipe work assessment shows network in excellent condition – minimal leakage loss. Number of boreholes extended to provide resting of aquifers – prevents saline intrusion due to over extraction. Off-islands have local water extraction management procedures. Boreholes monitored for conductivity and evaluated with pumping tests. Business continuity plan defines responsibilities and risks. Need to promote efficient water usage in the community with educational material. (Should be addressed via an LSP project). Consider limiting new water hungry planning applications such as swimming pools.	1.5	2	3	Long	11%
Detailed analysis of vulnerable areas, improved sea defences (man-made or natural) where appropriate and accepting natural processes will occur in others Diversification of agricultural businesses where possible	1	2	2	Medium	10%
Maximise cover of ground by crops, green manures or natural plant cover over winter months	1	2	2	Medium	10%

Environmental Variable	Risk / Opportunity	Impact Area	Consequence
Increased Heavy Winter rainfall and higher wind speeds	Wind damage to hedges / trees and buildings	Built environment Agriculture Council Residents Businesses Tourism Landlords (Duchy, Tresco Estate)	Loss of trees may reduce crop protection Insurance costs for property likely to rise Repair / maintenance costs will rise
Increased Mean Summer Temperatures & increased number of very hot days	Heat stress causes loss of IT in Hospital / medical centre Increased pressure on limited health systems / impact on tourist sector Increased risk of food poisoning Tick-borne encephalitis Increased risk of melanoma Increased risk of insect vector transmitted diseases (malaria etc)	Resident and tourist population Health	Loss of IT systems and disruption to and potential loss of diagnostic equipment in hospital or primary care settings. Loss of access to patient records and test results Additional diagnostic and treatment burden
Sea Level Rise and Storms	Increased frequency and strength of storms	Built Environment Transport Services Environment	Damage to buildings, infrastructure, trees, hedges, crops, salt burn
Increased Mean Summer Temperatures & increased number of very hot days	Increased agricultural insects pests, diseases and establishment of non-native species; increased rate of infection in animals and bacteria in animal feed, heat stress on animals and crops	Animal Health Agriculture	Loss of revenue when crop or livestock diseased
Increased Mean Summer Temperatures & increased number of very hot days	Reduced grass feedstock; need for more shelter in heat; increased tick density	Animal Health Public Health	Feedstock shortage, heat stressed animals, possible increase in Lyme's disease
Increased Mean Summer Temperatures & increased number of very hot days	Longer growing season	Farming community	Bulb-growers' seasonal advantage may be eroded
Increased Mean Summer Temperatures & increased number of very hot days	New crops grown due to longer hotter growing seasons (i.e. grapes)	Wildlife Farming Landscape	New market opportunities through diversification Possible landscape conflicts with changes in land use
Increased Heavy Winter Rainfall and higher wind speeds	Standing water provides mosquito breeding sites	Public Health Animal Health Tourism Tech Services	Vectors of West Nile Virus – affects some mammals particularly horses, can also affect humans

Adaptation process in hand or needed	£ con-sequence (1-3)	Impact (1-3)	Likely-hood (1-3)	Time frame	Overall Risk score
Every building owner/tenant and land tenant must critically assess their buildings' ability to withstand high winds and must be considered in any new build at planning stage Select correct trees and hedges for withstanding high winds and maintain good structure Contingency funds (Council, Duchy, Tresco Estate), Public information, advice on remedial action and guidance on financial support (if any). Planning policy and decisions encourage design of new buildings to be both robust to minimise wind damage and maximise resistance to flooding and will require sustainable drainage and sewerage options . SMP2 addresses practical engineering solutions. Emergency Planning early warning systems in place - event database created.	1	2	2	Medium	10%
Check resilience of IT systems evaluate the need for a secondary 'paper' system (if not already in place). Ensure robust business continuity arrangements for islands – mainland communications systems. Contingency plan for islands Education systems to limit exposure. NHS Heat wave and supporting documents Education of domestic and business sectors to limit disease - environmental health training and inspection programmes National and local education systems to limit exposure and monitor new disease developments	1	2	2	Medium	10%
Careful siting and construction of new buildings, analysis of vulnerability of buildings and infrastructure to storm damage, careful selection of plant species that are salt and wind resistant	1	1	3	Medium	7%
Animal Health Disease Contingency Plans; Monitoring of hygiene regulations Farmers supported to identify and plant drought resistant crops Integrated Land Management Control existing non-native invasive species in areas of high/important	1	1	3	Medium	7%
Could grow other crops (e.g. maize) for feedstock; Lyme's disease awareness programme	1	1	3	Medium	7%
Research required to monitor changing circumstances and to underpin the modelling of solutions (Agricultural RC Trenoweth now closed) - weather and tidal databases created	1	1	3	Medium	7%
Integrated Land Management Research/trial new crops	1	1	3	Medium	7%
Efficient drainage system & Flood Plan (SMP2) Animal Health Disease Contingency Plan Monitoring of transmitted diseases	1	1	2	Short-Medium	6%

Environmental Variable	Risk / Opportunity	Impact Area	Consequence
Sea Level Rise and Storms	Internationally important seabird breeding sites at risk	Environment Biodiversity	Nests on low-lying islands inundated and breeding success reduced. Loss of habitat.
Sea Level Rise and Storms	Loss/transformation of biodiversity value e.g. habitat within designations such as SSSI, SPA, Ramsar	Natural England, Wildlife Trust, tourism sector	Loss of existing habitat may negatively impact tourism, though new habitats may enhance environmental quality and diversity. Potential +/- impacts on biodiversity & AONB designation
Sea Level Rise and Storms	Threat to historic environment	English Heritage, Council, tourism sector	Loss of heritage sites (especially through coastline retreat) may negatively impact on tourism Negative impact on special qualities of the AONB designation
Sea Level Rise and Storms	Loss of sub-tidal and inter-tidal habitat & species i.e. Rumex rupestris	Wildlife Fishing Tourism Landscape	Decline in populations of seabirds. Decline in area of eelgrass beds and associated marine biodiversity. Extinction of species from archipelago.
Sea Level Rise and Storms	Salt water incursions into freshwater habitats	Wildlife	Loss of freshwater species, increase in brackish species.
Sea Level Rise and Storms	Erection of sea defences - both approved and informal	Wildlife Landscape	Sea defences can prevent natural coastal processes from occurring and exacerbate erosion elsewhere. Informal sea defence introduces non-native exotic species into vulnerable habitats i.e. Hottentot fig.
Sea Level Rise and Storms	Power supplies from mainland interrupted	Public tourism health Services All business sectors	Dwellings uninhabitable, tourist accommodation effected, businesses unable to operate, communications lost
Increased heavy winter rainfall and higher wind speeds	Storm damage to vulnerable flowers crops (e.g. narcissi and other crops grown during the autumn and winter periods) and greenhouses, potential delay in transportation to mainland markets Greater incidence of rot and disease in crops; soil erosion and crop damage, milder winters increased pest survival	Agriculture Transport	Unable to fulfill orders/ meet demand Crops become undeliverable and agriculture sector produces too little to sustain itself
Increased heavy winter rainfall and higher wind speeds	Short Rotation Coppice (SRC) opportunities	Wildlife Farming Landscape	Growing SRC crops (i.e. Willow) in low lying frequently flooded farmland could provide new market opportunities and windbreaks.
Increased heavy winter rainfall and higher wind speeds	Wireless aerials - wind damage	Council Internal/External services	No connectivity for phones and data between Council offices – no service provision

Adaptation process in hand or needed	£ con-sequence (1-3)	Impact (1-3)	Likely-hood (1-3)	Time frame	Overall Risk score
IOS Joint Seabird Strategy (Natural England, RSPB, Wildlife Trust, IOS Bird Group) – Plan to relieve other pressures e.g. Rat Abatement and Eradication Programme Marine Conservation Zones project	1	2	1	Medium	5%
Implementation of SMP2 Implementation of Sustainable Tourism Strategy Natural England designation monitoring Implementation of AONB Management plan	1	1	2	Medium	5%
Implementation of SMP2 Implementation of policies in Historic Environment Research Framework English Heritage monitoring, especially of Scheduled Monuments at Risk Ensure sites are adequately documented and recorded	1	1	2	Medium	5%
Managed realignment (opportunities very limited on Scilly - need to identify where and if this can be achieved) SSSI/SAC/SPA monitoring (5 year cycle)	1	1	2	Medium	5%
SSSI condition monitoring (5 year monitoring)	1	1	2	Medium	5%
Shoreline Management Plan Public communication / explanation	1	1	2	Medium	5%
Back up generator provides emergency power Increased use of renewables to reduce demand (solar heat) Energy efficiency programmes to reduce demand	1	1	2	Medium	5%
Alternative farming practices / diversification required Every building owner/tenant and land tenant must critically assess their buildings' ability to withstand high winds and must be considered in any new build at planning stage Select correct trees and hedges for withstanding high winds and maintain good structure Trenoweth agricultural centre (closed 2009) - evaluating opportunities Capacity for Change research undertaken Need sustainable drainage strategy	1	1	2	Medium	5%
Integrated Land Management	1	1	2	Medium	5%
Replacement units already available. Other means of communication and network setup in process this year as part of Data Resilience review	1	1	2	Medium	5%

Environmental Variable	Risk / Opportunity	Impact Area	Consequence
Increased Heavy Winter Rainfall and higher wind speeds	Drainage from flood risk areas (e.g.: Lower Moors) insufficient to cope with run off or marine overtopping Increased risk of local flooding of low lying areas	Technical Services Tourism Health Residents Farming sector	Saline contamination of aquifers. Unable to meet water demands Low-lying land becomes waterlogged all year round reduces available framing land
Increased Mean Summer Temperatures & increased number of very hot days	Increased pollen discharge and ground level ozone affecting air quality; increased melanoma from sun exposure, heat stress on people. Offices and schools overheat	Public Health Education Businesses Council	Problems for hay fever sufferers, asthmatics and increased deaths and hospital admissions for respiratory diseases / heat stroke in vulnerable groups (very young and elderly) IT servers in Council at risk
Increased Mean Summer Temperatures & increased number of very hot days	Increased risk of gorse fires	Fire Brigade Technical Services Medical Services	Heat exhaustion for fire-fighters Impact on businesses with time lost from retained staff responding impacts on water supply Loss of important habitats and impacts on wildlife
Increased Mean Summer Temperatures & increased number of very hot days	Mixing of seawater column reduced affecting plankton distribution and sand eel availability	Environment / Biodiversity / fishing	Reduced food availability for internationally important seabirds; deterioration of Special Protection Area condition
Increased Mean Summer Temperatures & increased number of very hot days	New terrestrial & marine species	Wildlife Tourism Fishing	Increase in wildlife tourism. New markets for fish Loss of native species and possible loss of biodiversity.
Increased Mean Summer Temperatures & increased number of very hot days	Risk to health from unprocessed waste in landfill and increased unsavoury smells	Tourism Health Residents Business sector Council services / reputation	Encouragement of vermin population and resultant increase in vector transmission of disease Negative impact on tourism
Increased Mean Summer Temperatures & increased number of very hot days	Potential Increase in tourism as Southern Mediterranean destinations become too hot	Council Services Health services Tourism Duchy	Tourism industry growth will put pressure on infrastructure

Adaptation process in hand or needed	£ con-sequence (1-3)	Impact (1-3)	Likely-hood (1-3)	Time frame	Overall Risk score
IOS WLT management plans to ensure natural sustainable drainage strategies in place – needs review Land management plan required for Duchy land	1	1	2	Medium	5%
Tighter controls on pollution - maintain current air quality? Surveillance & early warning systems for vulnerable groups. PCT Plans. Public Health awareness plans. School education programmes / restriction on outdoor activities. Provide shade where practical. Design of new builds to include passive cooling systems (carbon neutral) - as per new school build. Contingency planning/funding in health service provision Investigate passive cooling systems when building allocation is next reviewed Planning to upgrade server to high efficiency low power units as funds / life cycle permit	1	1	2	Medium	5%
Fire Brigade training & exercise Wildlife Trust Habitat Management Plan (controlled burning and grazing of heaths) Duchy Woodland Management plan Duchy Higher Level Stewardship Award scheme Contingency plans for water extraction	1	1	2	Medium	5%
IOS Joint Seabird Strategy Rat Abatement and Eradication Programme Marine Act Marine Conservation Zones working groups & IFCA	1	1	2	Medium	5%
SSSI/SPA & SAC Monitoring (5 year cycle) Marine Conservation Zones working groups	1	1	2	Medium	5%
SLR & DEFRA consultancy reports on waste management details recommendations to address waste issue on Scilly – funding being sought to upgrade incinerator (possibly to CHP plant) Need to ensure Climate Change risk assessment carried out on final proposals. Report to members 2009. Already encourage high levels of recycling through AONB community wet / bio waste project and glass recycling. Waste flow data reports routinely carried out Recommend re-engage with Resolve Kernow to drive better waste handling / recycling.	1	1	2	Medium	5%
Local Design Guide promotes building and development designs to promote passive cooling. Planning of new developments to encourage both energy efficiency and green / shady spaces. Tourism strategic plan will consider Climate Change	1	1	2	Medium	5%

Environmental Variable	Risk / Opportunity	Impact Area	Consequence
Increased heavy winter rainfall and higher wind speeds	Drainage from flood risk areas (e.g.: lower moors) insufficient to cope with run off OR marine overtopping Increased risk of local flooding of low lying areas	Technical Services Tourism Health Residents Farming sector	Saline contamination of aquifers –unable to meet water demands Low lying land becomes waterlogged all year round reduces available framing land
Increased Mean Summer Temperatures & increased number of very hot days	Increased pollen discharge and ground level ozone affecting air quality; increased melanoma from sun exposure, heat stress on people. Offices and schools overheat	Public Health Education Businesses Council	Problems for hay fever sufferers, asthmatics and increased deaths and hospital admissions for respiratory diseases / heat stroke in vulnerable groups (very young and elderly) IT servers in council at risk
Increased Mean Summer Temperatures & increased number of very hot days	Increased risk of gorse fires	Fire Brigade Technical Services Medical Services	Heat exhaustion for fire-fighters Impact on businesses with time lost from retained staff responding impacts on water supply Loss of important habitats and impacts on wildlife
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Increased Mean Summer Temperatures & increased number of very hot days	Risk to health from unprocessed waste in landfill and increased unsavoury smells	Tourism Health Residents Business sector Council services / reputation	Encouragement of vermin population and resultant increase in vector transmission of disease Negative impact on tourism
Increased Mean Summer Temperatures & increased number of very hot days	Potential Increase in tourism as southern med destinations become too hot	Council Services Health services Tourism Duchy	Tourism industry growth will put pressure on infrastructure

Adaptation process in hand or needed	£ con-sequence (1-3)	Impact (1-3)	Likely-hood (1-3)	Time frame	Overall Risk score
WLT management plans to ensure natural sustainable drainage strategies in place – needs review Land management plan required for Duchy land	1	1	2	Medium	5%
Tighter controls on pollution - maintain current air quality? Surveillance & early warning systems for vulnerable groups. PCT Plans. Public Health awareness plans. School education programmes / restriction on outdoor activities. Provide shade where practical. Design of new builds to include passive cooling systems (carbon neutral) - as per new school build. Contingency planning/funding in health service provision Investigate passive cooling systems when building allocation is next reviewed Planning to upgrade server to high efficiency low power units as funds / life cycle permit	1	1	2	Medium	5%
Fire Brigade training & exercise Wildlife Trust Habitat Management Plan (controlled burning and grazing of heaths) Duchy woodland management plan Duchy higher level stewardship award scheme Contingency plans for water extraction	1	1	2	Medium	5%
IOS Joint Seabird Strategy Rat abatement and Eradication Programme Marine Bill Marine Conservation Zones working groups	1	1	2	Medium	5%
SSSI/SPA & SAC Monitoring (5 year cycle) Marine Conservation Zones working groups	1	1	2	Medium	5%
SLR & DEFRA consultancy reports on waste management details recommendations to address waste issue on Scilly – funding being sought to upgrade incinerator (possibly to CHP plant) Need to ensure climate change risk assessment carried out on final proposals. Report to members 2009. Already encourage high levels of recycling through AONB community wet / bio waste project and glass recycling. Waste flow data reports routinely carried out Recommend re-engage with Resolve Kernow to drive better waste handling / recycling.	1	1	2	Medium	5%
Local design guide promotes building and development designs to promote passive cooling. Planning of new developments to encourage both energy efficiency and green / shady spaces. Tourism strategic plan will consider Climate change	1	1	2	Medium	5%

Environmental Variable	Risk / Opportunity	Impact Area	Consequence
Reduced Summer Rainfall & Drought	More domestic water use in gardens	Tech. Services Planning?	Depletion of water table
Warmer Sea Temperatures	Increase in non-native invasive species and changes in species distribution i.e. sand eels	Tourism Wildlife Fishing	Loss of biodiversity including marine and seabirds Reduced/new opportunities for fish markets as species ranges change
Increased heavy winter rainfall and higher wind speeds	Flooding leads to increase in surface rat infestations	Public Health Tourism	Negative publicity. Public Health risks – Weil's disease, Salmonella, E. coli etc
Sea Level Rise and Storms	School grounds flooding, school unable to be used, pitches unusable etc	Education	Have to build a new school in a new location
Increased heavy winter rainfall and higher wind speeds	Potential for storing water	Services Environment	May need to build reservoirs
Increased heavy winter rainfall and higher wind speeds	Travel to and from school for pupils will be harder	Education Technical services (Highways, e. Planning) transport	Curriculum delivery Risk to pupils and staff health & wellbeing
Increased heavy winter rainfall and higher wind speeds	Recharge of freshwater wetlands	wildlife	Possibility of more diverse plant & animal communities as wetlands cycle between high salinity at lower water levels in summer, and lower salinity as water level increases in winter. Possible impact to biodiversity both +ve and -ve depending on species and location
Increased heavy winter rainfall and higher wind speeds	Opportunity for more renewable energy resources from wind turbines	Public tourism	Acceptance of best possible resource for renewable energy on islands
Increased Mean Summer Temperatures & increased number of very hot days	Increase applications for swimming pools; more domestic heat exchangers	Technical Services Planning	Water table depletion & increased energy demands
Increased Mean Summer Temperatures & increased number of very hot days	Improved UK climate could challenge IOS as a destination; sub-tropical gardens developed on mainland	Tourism Transport	Possible reduction in visitor numbers/ revenue, transport disruption
Increased Mean Summer Temperatures & increased number of very hot days	Impacts (negative and positive) on tourism	Tourism sector	Attraction of sun-worshippers? Inability to compete with established sunny destinations?
Reduced Summer Rainfall & Drought	Water Shortage causes dehydration Contamination water supplies or storage tanks	Vulnerable people (elderly infirm etc) Increased risk of water supply contamination	Dehydration & inability of vulnerable people to access contingency arrangements Outbreaks of water borne contamination affecting vulnerable people Increased hospital admissions or GP consultations
Reduced Summer Rainfall & Drought	Freshwater wetlands dry up	Wildlife Tourism	Loss of habitat

Adaptation process in hand or needed	£ con-sequence (1-3)	Impact (1-3)	Likely-hood (1-3)	Time frame	Overall Risk score
Water use campaign More drought resistant garden plants encouraged Increase householders understanding of Climate Change Consider installing water meters	1	1	2	Medium	5%
Marine Conservation Zones & IFCA SPA and SAC monitoring (5 year cycle) Further research	1	1	2	Medium	5%
Rat Abatement & Eradication programme (IOS WLT, RSPCB) Efficient waste disposal and recycling of biological waste	1	1	1	Short-Medium	3%
New school designed & being built for September 2011 - takes into account Climate Change impacts from marine flooding, incl. sustainable drainage / sea defences	1	1	1	Medium	2%
Maximise rainwater harvesting and storage from buildings in planning process	1	1	1	Medium	2%
Develop school transport strategy with climate risks assessed	1	1	1	Medium	2%
Sustainable abstraction of water for human consumption SSSI Condition Monitoring (5 year cycle	1	1	1	Medium	2%
Services infra structure developed in line with wind energy, local plan positively encourages all types of renewable energy at whatever cost (Duchy comment)	1	1	1	Medium	2%
Water use campaign Planning to consider impacts of development in applications	1	1	1	Medium	2%
Tourism Marketing Plans – e.g. to promote shoulder season visits	1	1	1	Medium	2%
Tourism Strategic Plan promotion of shoulder visitors	1	1	1	Medium	2%
Contingency planning required NHS Heat wave and supporting documents Monitoring of water quality / management plan for existing water supplies & contingency planning	1	1	1	Medium	2%
Sustainable abstraction of water for human consumption, monitoring of boreholes and water usage	1	1	1	medium	2%

9.3 Bibliography.

1. InterGovernmental Panel on Climate Change, Core Writing Team. (2007). Chapter 3: Climate Change and its impacts in the near and long term under different scenarios., *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the InterGovernmental Panel on Climate Change.* Geneva, Switzerland: IPCC.

2. Scotese, C.R. (2002), *www.scotese.com*, (PALEOMAP website). Accessed 2010

3. Murphy et al (2009), UK Climate Projections Science Report: Climate Change projections. Met Office Hadley Centre, Exeter.

4. Lowe et al, (2009), UK Climate Projections science report: Marine and coastal projections. Met Office Hadley Centre, Exeter, UK.

5. Shennan et al (2009), Late Holocene relative land- and sea-level changes: Providing information for stakeholders., GSA today. Vol. 19, Issue 9.

6. Ramanathan, V., & Xu, Y. (2010). The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues. Proceedings of the National Academy of Sciences, 107(18), 8055.

7. www.Realclimate.org. (2007). The certainty of uncertainty. Accessed June 21, 2010.

8. Roe, G. H., & Baker, M. B. (2007). Why Is Climate Sensitivity So Unpredictable? Science, 318(5850), 629-632.

9. Stainforth, D. A., Aina, T., Christensen, C., Collins, M., Faull, N., Frame, D. J., Kettleborough, J. A., et al. (2005). Uncertainty in predictions of the climate response to rising levels of greenhouse gases.UK Climate Projections Briefing Report ISBN 978-1-90630-04-7 Crown copyright June 2009.

10. Brasier CM and Scott JK (1994). European oak declines and global warming: a theoretical assessment with special reference to the activity of Phytophthora cinnamomi. Bulletin OEPP/EPPO Bulletin 24, 221–234.

11. *http://www.nhs.uk/Livewell/Summerhealth/Documents/Heatwave%20looking%20after%20yourself%20and%20others.pdf* (2010)

12. Githeko et Al (2000), Climate Change and vector-borne diseases: a regional analysis. Bull. World Health Organ. vol.78 no.9. Genebra

13. Dhainaut et al (2004), Unprecedented heat-related deaths during the 2003 heat wave in Paris: consequences on emergency departments. Crit Care.; 8(1): 1–2.

14. Velicogna I (2009), Geophysical Research Letters, Vol. 36, L19503, 4 PP, doi:10.1029/2009GL040222

15. Lowe S., et al. (2000). 100 of the World's Worst Invasive Alien Species - A selection from the Global Invasive Species Database. Updated: November 2004. *http://www.issg.org/database/species/reference_files/100English.pdf*

16. Sanctuary Integrated Monitoring Network: *http://www.sanctuarysimon.org/index.php , accessed 2010.*

17. Cornwall and the Isles of Scilly SMP2, 2010

18. The Invasive Non-Native Species Framework Strategy for Great Britain. Department for Environment, Food and Rural Affairs. © Crown copyright 2008.

19. *http://www.soilassociation.org/Whyorganic/Climatefriendlyfoodandfarming/Asecurefoodfuture/tabid/345/Default.aspx*, accessed 2010

20. Vermeer M , Rahmstorf S (2009), PNAS;106:21527-21532

21. Woodworth, P.L., Teferle, N., Bingley, R., Shennan, I. and Williams, S.D.P. 2009. Trends in UK mean sea level revisited. Geophysical Journal International, 176, 19-30, doi:10.1111/j.1365-246X.2008.03942.x.

22. *http://www.ngdc.noaa.gov/paleo/icecore/antArctica/law/law.html* (accessed 2010).

23. *http://www.brighton73.freeserve.co.uk/gw/paleo/400000yrfig.htm*.

24. Meehl et al (2004), Combinations of Natural and Anthropogenic Forcings in Twentieth-Century Climate., Journal of Climate, vol.17, 3721.

25. Bowden, M., Brodie, A. Defending Scilly, ISBN 978 1 84802 043 6 © English Heritage 2011

26. European Food and Farming Partnership website (2011): http://www.effp.com/knowledge-bank/price-forecast-analysis/EFFP_latest_forecast.aspx

27. An inconvenient truth about food –Neither secure nor resilient ©Soil Association 2008 SA0461.1208

28. Natural England UK Biodiversity Action Plan (2007): *http://www.naturalengland.org.uk/ourwork/conservation/biodiversity/protectandmanage/ukactionplan.aspx . Accessed 2011.*