Technical Annex 7

Implications of Climate Change

Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Signed
1	0	Draft to Coastal Group for comment	20 May 03	LSBanyard
2	0	Final	31 Jan 04	LSBanyard

Contents

Figures

Tables

1 Introduction

Climate change is expected to affect the management of flood and coast defences in a number of ways, of which the main factors are:

- changes in sea level, incorporating global (eustatic) sea level rise and land-level (isostatic) change
- changes in storm surge, due to changes in extremes of barometric pressure and wind stress caused by changing weather patterns
- changes in wind climate affecting the height, periods and directions of wave conditions
- changes in rainfall intensities, durations, and event frequencies, particularly affecting cliff slippage and run-off flooding

The inter-relationships between these factors are complex, but are represented in a simplified form in **Figure 1.1**. The negative effects of these factors will be evident through changes in flooding, erosion and accretion. Various data from the South Coast of England has been used in the assessments of climate change. The locations of the data sources are shown in **Figure 1.2**.

1.1 UK Climate Impacts Programme

The latest guidance on future climate change, including temperature, precipitation, snowfall, wind speeds, relative humidity and fog, seasonality, soil moisture as well as sea levels is provided in the UK Climate Impacts Programme "Climate Change Scenarios for the United Kingdom" (UKCIP 2002), which updates the previous UKCIP 1998 scenarios (UKCIP 1998). This guidance provides four scenarios based on future emissions of Carbon Dioxide (CO_2) which are: Low Emissions, Medium-Low Emissions, Medium-High Emissions and High Emissions (the precise definition of each is provided within the reference).

1.2 SCOPAC Study – Preparing for the Impacts of Climate Change

A comprehensive study "Preparing for the Impacts of Climate Change" was recently prepared for the Standing Conference on Problems Associated with the Coast (Halcrow et al, 2001). For detailed information on past change and future predictions, the reader is referred to this document, but a brief summary of the implications of climate change for Poole Bay & Harbour is provided here. In particular the study incorporated a categorisation of the future behaviour of shorelines in the whole SCOPAC area (from Lyme Regis to Shoreham). Within the Poole Bay and Harbour area the shoreline was categorised into 3 types as shown in **Table 1.1**. All three forms of shoreline behaviour will respond in different ways to climate change, with differing shoreline management outcomes, consequences and economic implications. These factors are all presented in **Figure 1.2.**

Behaviour	**Shoreline Processes & Landform Change**
Static Declining	Net decline with a negative sediment budget and a static or restrained shoreline eg (i) to erosion of a relict cliff prior to reactivation of landsliding, (ii) erosion of the beach in front of stabilisation structures that nevertheless "hold" the shoreline (iii) a saltmarsh undergoing coastal squeeze due to a constraining backshore topography or a defence.
Net Retreat	Eroding shoreline migrating landward, but maintaining characteristic form and function of landforms eg a retreating cliff coast, barrier beach or spit, or a landward migrating saltmarsh or tidal flat. Includes reactivation of landsliding on a relic cliff (eg Black Ven or Blackgang model).
New Form	Establishment of a new characteristic form eg (i) breaching and/or fragmentation of a barrier or spit, (ii) replacement of saltmarsh by a tidal flat (iii) deterioration or removal of a defence leading to permanent tidal inundation of the backshore (managed retreat/realignment) model.

Table 1.1 Shoreline Processes & Landform Change

2 Changes in Mean Sea Level

The UKCIP 2002 summary report states that "As global climate warms, the world's oceans will expand, causing a rise in the average level of the sea. Many land glaciers will continue to melt, adding to this rise in sea level. Changes will occur to the ice sheets of Greenland and Antartica, although over the coming 100 years they are unlikely to contribute much to changes in sea level. If climate continues to warm in the longer term, however, both these ice sheets may contribute enough melt water over the next 1000 years to raise global sea level by several metres….The change in the level of the sea relative to the land will not be the same everywhere, because of natural land movement; much of southern Britain is sinking at between 1 and 1.5mm per year, and much of northern Britain is rising at between 0.5 and 1 mm per year relative to the sea."

2.1 Past Sea Level Change

The SCOPAC (2001) climate change report advises that the most reliable sources of long term water level data are the 'A' Class gauges, the data from which is collated and verified by the Proudman Oceanographic Laboratory. The changes in recorded sea level at the 'A' Class gauges in the vicinity of Poole Bay & Harbour are given in **Table 2.1.**

Station Name	Start Date	End Date	No of years of Data	Linear Trend & Standard Error (mm/yr)
Newhaven	1993	1997	4	2.51 ± 5.07
Portsmouth	1962	1997	29	1.30 ± 0.56
Bournemouth	1997	1999	3	7.5 ± 5.48
Weymouth	1992	1999	7	7.36 ± 2.23

Table 2.1 Changes in Mean Sea Level at 'A' Class gauges

source: http://www.pol.ac.uk/psmsl/datainfo/rlr.trends last updated 23 Feb 2001

Of the four data sets in the vicinity, only one, at Portsmouth has a duration suitable for providing a reliable representation of sea level rise. There is a harmonic tidal constituent of periodicity of 18.4 years and an amplitude in the range of 100mm. Where data sets are shorter than this duration, as at Newhaven, Bournemouth and Weymouth, the variation in level due to this harmonic constituent can be more significant than the relative sea level rise. Even when this source of uncertainty is disregarded, the values of standard error (being a measure of the scatter of the data either side of the trend-line) for these shorter data sets is 5-10 times higher than for the longer data set at Portsmouth.

The most reliable estimate of past sea level rise from 1960s to 1990s for Poole Bay & Harbour is 1.30 ± 0.56 mm/yr.

2.2 Future Sea Level Change

There is considerable uncertainty regarding future sea level rise, as with all of the other climate change factors, which has lead to the approach adopted by UKCIP described in Section 1.1.

The figures for sea level rise in UKCIP 2002 provide high and low scenarios for the increase from the 1960s-90s average to the 2080s; the values for the South West and South East of England are presented in **Table 2.2**

	Vertical Land Change (mm/yr)	Sea Level Rise by 2080	
		Low Emissions (mm)	High Emissions (mm)
SE England	-0.9	190	790
SW England	-0.6	160	760

Table 2.2 Sea Level Rise Scenarios from UKCIP 2002 from 1960s-90s to 2080s

The figures provide a useful guide as to the range in current estimates of the future change. However, for the purpose of this study the rate of future sea level rise that has been assumed is taken from the DEFRA Flood and Coast Defence Project Appraisal Guidance - Economic Appraisal (MAFF, 1999), as presented in **Table 2.3.** This guidance is understood to have been derived prior to UKCIP 1998 but it is not believed to have been revised by DEFRA.

	Sea Level Rise by 2050	
	Rate of Sea Level Rise (mm/yr)	Sea Level Rise (mm)
South West and Wales	5	250

Table 2.3. DEFRA Guidance values for future sea level rise

The rate of future mean sea level rise assumed for Poole Bay and Harbour is 5mm/year. In accordance with DEFRA guidance contained in FCDPAG3, no sensitivity testing of this particular factor was carried out in the study, but the range of potential change by 2080 given in Table 2.3 was noted.

2.3 Reduced Wave Attenuation

The general increase in water levels will result in reduced attenuation of waves as they approach the shoreline, in particular through reduction in the loss of wave energy due to refraction, bed friction and wave breaking.

The change in the inshore wave extreme conditions over a 50year period is, however, likely to be small, being of the order of magnitude of the uncertainty inherent in wave modelling. For example, the bathymetries that are used in the wave modelling are based on historical measurements of the sea bed level, the accuracy of which will be of the order of 200-300mm.

Assuming a 250mm increase in water depth, the increase in maximum unbroken wave height will be approximately 150mm. This amounts to a 2-4% increase in wave heights in the range of H_s=4-6m, which are typical values for the 1:100yr wave conditions. This is small compared to the expected changes in wave energy due to increased wind speeds at offshore locations (as described in Section 4.1)

The reduction in wave attenuation may also influence more frequent wave conditions, particularly through reduced refraction, resulting in waves approaching the shoreline at more oblique wave angles. Again the effect is expected to be relatively small, when compared with the expected future variability of offshore wave conditions (Section 4.2).

The effect of reduced wave attenuation due to higher sea levels is likely to be small, of the order of 2-4% for typical day to day conditions. Under more extreme water level and wave conditions the effect may be slightly greater, but still small when compared to the other climate change factors, such as the expected future variability of offshore wave conditions

2.4 Summary of Effects of Change to Mean Sea Level

As shown in **Figure 1.1**, sea level rise may have an effect on:

- flooding through increased overtopping/overflow
- flooding and erosion/accretion through increasing inshore wave conditions caused by reduced wave attenuation
- erosion/accretion through increased tidal flows into estuaries

The implications for consideration when identifying the preferred strategy for each of the Management Units are outlined in **Table 2.4**.

<table>
<tr><th>management unit</th><th>flooding through increased overtopping/ overflow</th><th>flooding and erosion/accretion through increasing inshore wave conditions caused by reduced wave attenuation</th><th>erosion/accretion through increased tidal flows into estuaries</th></tr>
<tr><td>DUR1</td><td rowspan="3">✗ no flood risk on cliff frontage</td><td rowspan="32">✗ modelling of wave conditions at 2053 water levels shows little change in inshore wave climates</td><td rowspan="8">✗ influence of Poole Harbour and Western Solent considered to be insignificant at this location</td></tr>
<tr><td>DUR2</td></tr>
<tr><td>DUR3</td></tr>
<tr><td>SWA1</td><td rowspan="3">✓ potential for increased flood risk</td></tr>
<tr><td>SWA2</td></tr>
<tr><td>SWA3</td></tr>
<tr><td>SWA4</td><td rowspan="2">✗ no flood risk on cliff frontage</td></tr>
<tr><td>SWA5</td></tr>
<tr><td>STU1</td><td rowspan="4">✓ potential for increased flood risk</td><td rowspan="4">✓ ebb/flow from Poole Harbour influential to sediment transport</td></tr>
<tr><td>STU2a & 2b</td></tr>
<tr><td>STU3</td></tr>
<tr><td>STU4</td></tr>
<tr><td>PHB1</td><td rowspan="17">✓ Potential increase – to be identified in flood risk mapping by Posford</td><td rowspan="17">✓ ebb/flow from Poole Harbour influential to sediment transport</td></tr>
<tr><td>PHB2</td></tr>
<tr><td>PHB3a, 3b & 3c</td></tr>
<tr><td>PHB4</td></tr>
<tr><td>PHB5a, 5b & 5c</td></tr>
<tr><td>PHB6</td></tr>
<tr><td>PHB7</td></tr>
<tr><td>PHB8</td></tr>
<tr><td>PHB9</td></tr>
<tr><td>PHB10</td></tr>
<tr><td>PHB11</td></tr>
<tr><td>PHB12</td></tr>
<tr><td>PHB13</td></tr>
<tr><td>PHB14</td></tr>
<tr><td>PHB15</td></tr>
<tr><td>PHB16</td></tr>
<tr><td>PHB17</td></tr>
<tr><td>PBY1</td><td>✓ potential for increased flood risk (at west end of PBY1)</td><td>✓ ebb/flow from Poole Harbour influential to sediment transport – west-end of PBY1</td></tr>
<tr><td>PBY2</td><td rowspan="2">✗ no flood risk on cliff frontage</td><td rowspan="2">✗ influence of Poole Harbour and Western Solent considered to be insignificant at this location</td></tr>
<tr><td>PBY3</td></tr>
</table>

Table 2.4 Effects of Changes in Mean Sea Level on Management Units

3 Changes in Storm Surge

Changes in extreme sea levels caused by storm surge have been modelled using the POL 35km model, the results of which are presented in UKCIP 2002. The assessment was made by modelling the sea level that has a 2% probability of occurrence in any year (the 1:50 year event), assuming a Medium-High Emissions scenario, with a mid range estimate of 300mm of global sea level rise. The estimates take into account local land movement.

The largest increase in extreme sea level may occur around the southeast coast of England, which experiences both the largest changes in winds and storms and also the greatest fall in height of the land. Under the Medium-High Emissions Scenario, the increase in the 2% occurrence water level event is up to 1m higher in 2080 than in the present day, compared with the rise in mean sea level under the same scenario of 190mm.

In the scenarios that are illustrated, the Poole Bay and Harbour area appears to experience a mid-range change (not as severe as in the Thames Estuary, but more severe that much of the west coast of England and Wales). The values of mean sea level rise lie within the range of the 2% occurrence water level increases (**Table 3.1**). This indicates that the modelling shows that there is no clear tendency for extreme sea levels to rise more than mean sea levels in this area.

	Sea Level Rise by 2080	
	Low Emissions (mm)	**High Emissions (mm)**
SE England (mean sea level)	190	790
SW England (mean sea level)	160	760
Poole Bay area (2% occurrence) (1)	c100 ~ 300	c600~900

Table 3.1. Potential increases in Extreme Sea Levels

note: (1) values estimated from graphical model output provided in Figures on page 76 of UKCIP (2002).

It is noted that UKCIP (2002) states that the confidence in the results of the extreme water level modelling is less than in the assessment of future rise of mean sea level (Section 1.1). It is anticipated that further research on this item will be included in the next UKCIP assessment.

In the absence of definitive guidance at this time it is considered that there is no evidence for a separate allowance for the increase in storm surge in additional to the increase in mean sea level within Poole Bay & Harbour.

4 Changes in Wind / Offshore Wave Climate

4.1 Changes in Extreme Wave Conditions

As part of the SCOPAC Climate Change study (Halcrow, 2001) modelling of two comparable 10 year wave climates, one being representative of the present day and the other being representative of 2080, was completed at four locations along the south coast of England, namely: Lyme Bay, Christchurch Bay, Lee-on-the-Solent and Shoreham. The values of extreme wave conditions of both the control results and the 2080 results are not an accurate prediction of the actual values. However, the comparison of the two demonstrates the potential for magnitude of change.

The study was carried out using daily wind speed data from the Hadley Regional Climate Model, which is run by the Met Office Hadley Centre for each period and hindcasting the wave conditions that would result from each wind timeseries. The resulting offshore wave conditions were transformed inshore using a wave propagation model MWAVE. The extreme wave conditions at each inshore location were calculated for each 10 year period using standard statistical analysis methods.

The analysis at Lyme Bay shows an *increase* in the values of extreme wave conditions of the order of up to 40% (**Table 4.1 and Figure 4.1**). At Lee-on-the-Solent and Shoreham there is an apparent *reduction* in extreme conditions of up to 15%. At Christchurch Bay the *increase* was of the order of 15% at extreme values (**Figure 4.2**).

It was concluded by Halcrow (2001) that the exposure of the site within the English Channel is critical in determining the increase/decrease in the extreme conditions. This was supported by the inspection of the wave climate which showed an increase in wave conditions from the west and a decrease in conditions from the east.

	Lyme Bay		Christchurch Bay		Lee-on-the-Solent		Shoreham	
return period	**control**	**2080**	**control**	**2080**	**control**	**2080**	**control**	**2080**
1:1 yr	5.8	7.2	5.7	5.9	3.1	2.7	5.5	5.3
1:10 yr	7.1	9.6	7.4	8.6	4.2	3.5	7.1	6.8
1:50 yr	8.1	11.3	8.6	10.1	5.0	4.2	8.2	7.9

Table 4.1 Extreme wave conditions derived from hindcasting of current and future wind conditions

Note: for comparative purposes only – not for design

A review of the wave climate data in the course of this Strategy study supports this finding, but also shows that the changes in all four sets of wave data show a consistent pattern of (i) a marked reduction in the number of days of calms, (ii) a marked increase in the frequency of day-to-day conditions up to $H_s = 3.5$m, (iii) a decrease in the wave heights between $H_s = 3 – 6$m and (iv) an increase in the wave heights in excess of $H_s = 6$m. It is likely that this pattern is a feature of the data set and may be due to the particular climate change scenario that was assumed, rather than a generic factor in future climate change.

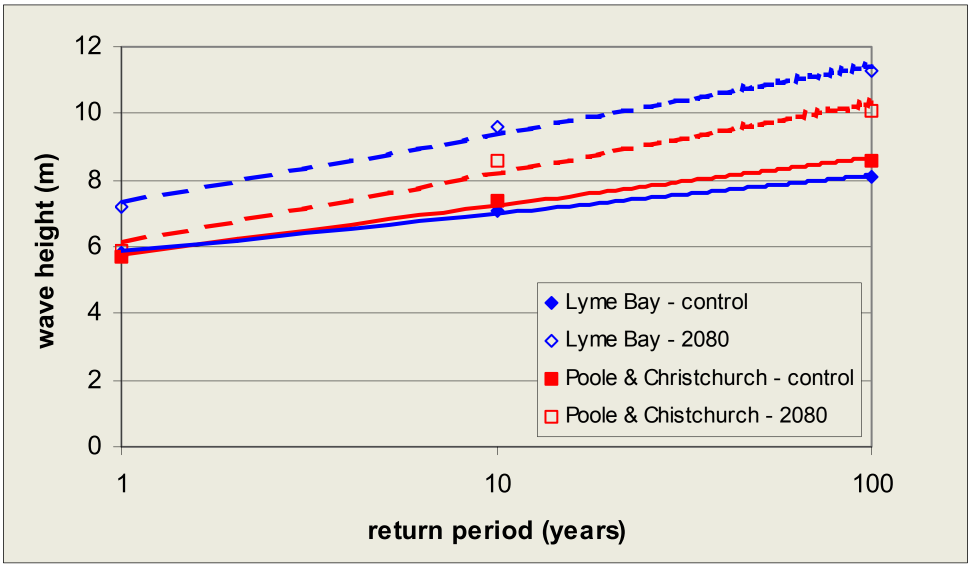


Figure 4.1 Potential change in extreme wave conditions – Lyme bay & Poole & Christchurch Bays

The reduction in wave climate may therefore be due to the sheltering in the Lee-on-the-Solent and Shoreham areas, but may also be due to the length of the sets of wind data, which were 10 years. A longer data set, may, particularly at Shoreham have included data in excess of $H_s = 6$m, which may have resulted in a greater upward trend in the extreme values arising from the statistical analysis.

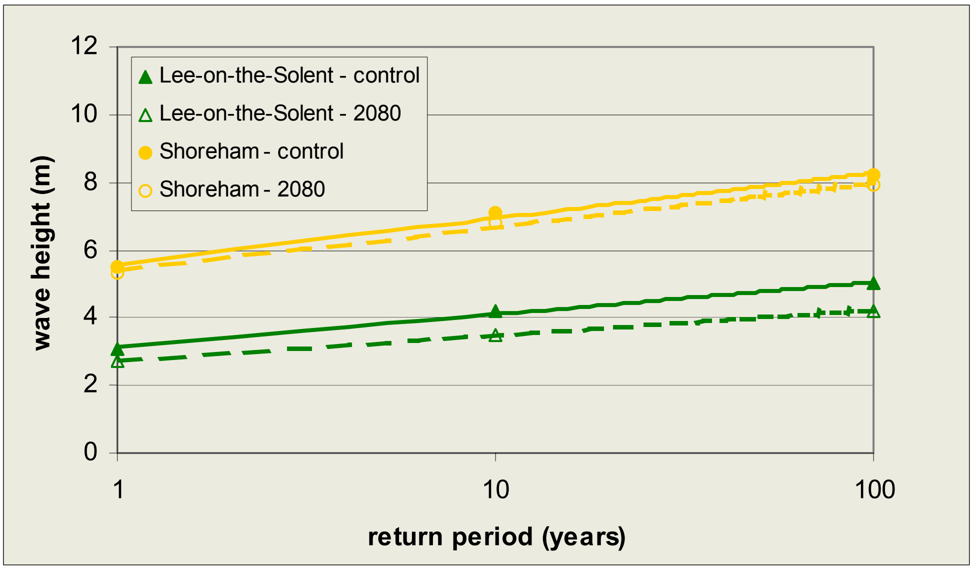


Figure 4.2 Potential change in extreme wave conditions – Lee-on-the-Solent and Shoreham

This area of uncertainty does not alter the overall conclusion of the work presented in the Halcrow et al (2001) report, which is that an increase in the wave climate at exposed sites is to be expected. A change of 15% in the area of Poole Bay & Harbour is a reasonable first estimate. This increase should be applied as a sensitivity test to the predictions of extreme wave conditions contained in Technical Annex 1, rather than the values provided in **Table 4.1.**

A sensitivity test of an increase of 15% in extreme wave conditions in the next 50 years provides a reasonable allowance for climate change due to changes in wind and wave climate in Poole Bay & Harbour

As shown in **Figure 1.1**, increases in extreme wave conditions may have an effect on:

- inshore wave conditions
- flooding and erosion/accretion through increasing inshore extreme wave conditions

4.2 *Changes in the Overall Wave Climates (Affecting Longshore Sediment Transport)*

The offshore hindcast waves were also used by Halcrow et al (2001) to study the predicted differences in longshore sediment transport under the Medium-High UKCIP 1998 future climate change scenario. The offshore waves conditions were first transformed to a number of inshore locations and then the longshore transport rates were calculated using the Kamphuis (1991) equation.

The calculations were carried out at West Bexington (Lyme Bay), Chesil Beach, Milford-on-Sea and Shoreham. It was found that at all locations the gross drift rates in both directions increased, in response to the increase in the wave conditions and the reduction in the total duration of calms.

At Shoreham and Milford-on-Sea, the existing wave conditions cause a strong predominant net drift in one direction (at both locations the net drift is around 85-90% of the larger gross drift rate). The change in the net drift rates between the control period and the 2080s data set is small at these 2 locations, being less than 20%. In these two cases the affect of the changing wave climate was judged to be small when compared with natural variability of longshore transport.

At Chesil Beach and West Bexington, the existing longshore transport regime is finely balanced between easterly and westerly gross drift rates and the resulting net drift is small, being less than 5% compared to the larger gross drift rate. As a result, the change in the net drift rates between the control period and the 2080s data set is large, resulting in an increase from c1,000m^3/yr to c16,000m^3/yr at Chesil Beach and a switch in the net drift direction from c1,000m^3/yr (eastwards) to c8,000m^3/yr (westwards) at West Bexington. Changes of this scale would have considerable implications for coastal management.

At locations where the longshore drift is found to be predominantly from one direction (the ratio of net drift : larger gross drift is high) there is no evidence for the need for a particular allowance for climate change due to changes in the overall wave climate.

At locations where the longshore drift is found to be finely balanced between the two directions (the ratio of net drift : larger gross drift is low) allowance needs to be made for a considerable change in the regime, possibly involving a switch in net drift direction and/or a manifold increase in the net drift rate.

4.3 Summary of Effects of Change to Wind / Offshore Wave Climates

As shown in **Figure 1.1**, increases in overall wave conditions may have an effect on:

- erosion/accretion through changes in inshore wave conditions

The implications for consideration when identifying the preferred strategy for each of the Management Units are outlined in **Table 4.2**.

management unit	flooding and erosion/accretion through increasing inshore extreme wave conditions		erosion/accretion through changes in inshore wave conditions	
DUR1	✗	link between extreme wave conditions and cliff erosion not possible to consider	✗	strong predominant net longshore transport direction
DUR2	✔	may be relevant to defence maintenance/overtopping/ beach draw-down		
DUR3	✗	link between extreme wave conditions and cliff erosion not possible to consider		
SWA1	✔	may be relevant to defence maintenance/overtopping/ beach draw-down	✗	strong predominant net longshore transport direction
SWA2				
SWA3				
SWA4	✗	SMP policy is Do Nothing		
SWA5				
STU1	✗	SMP policy is Do Nothing	✗	strong predominant net longshore transport direction
STU2a & 2b	✔	may be relevant to future beach evolution		
STU3				
STU4				
PHB1	✔	potential effect to be identified for each management unit	✗	existing longshore transport due to wave action is minor
PHB2				
PHB3a, 3b & 3c				
PHB4				
PHB5a, 5b & 5c				
PHB6				
PHB7				
PHB8				
PHB9			✗	balanced gross drift rates, but directions controlled by fetch, rather than wind climate
PHB10			✗	existing longshore transport due to wave action is minor
PHB11				
PHB12				
PHB13				
PHB14				
PHB15				
PHB16				
PHB17				
PBY1	✔	may be relevant to defence maintenance/overtopping/ beach draw-down	✔	balanced gross drift rates
PBY2			✗	strong predominant net longshore transport direction
PBY3				

Table 4.2 Effects of Changes in Wind / Offshore Wave Conditions on Management Units

5 Changes in Rainfall

In Halcrow et al (2001), the UKCIP 98 Emissions scenarios were applied to rainfall data from Ventor. The estimates indicate a 5-6% increase in mean monthly effective rainfall under the Low Emissions scenario and 12-25% increase for the High Emissions scenario (**Table 5.1**). It was noted that these estimates are comparable with the historic trend of increasing annual rainfall at Pinhay of 10% in the period 1868-1998 and at Ventnor of 20% in the period 1839-2000.

	Sep – Nov		**Dec - Feb**	
	mm	**% change**	**mm**	**% change**
Effective Rainfall $_{mean}$ 2000	76.4	0	67.4	0
Low 2080	80.2	5	71.7	6
Medium-Low 2080	84.4	11	74.6	11
Medium-High 2080	82.7	8	81.8	21
High 2080	85.2	12	84.0	25

Table 5.1 Change Scenarios of Monthly Effective Rainfall at Ventnor for 2080

Source: Halcrow et al (2001)

On the basis of the assessment at Ventnor, a sensitivity test of an increase of 15% in effective rainfall in the next 50 years provides a reasonable allowance for climate change due to this factor in Poole Bay & Harbour

5.1 *Summary of Effects of Change to Rainfall*

As shown in **Figure 1.1**, increases in rainfall may have an effect on:

- erosion/accretion through increased risk of cliff slippage

The implications for consideration when identifying the preferred strategy for each of the Management Units are outlined in **Table 5.2**.

management unit		erosion/accretion through increased risk of cliff slippage
DUR1	✔	response of cliffs in Management Unit DUR2 and adjacent units likely to be sensitive to variation in ground water
DUR2		
DUR3		
SWA1	✗	no cliffs
SWA2		
SWA3	✔	response of cliffs likely to be sensitive to variation in ground water
SWA4	✗	SMP policy for cliffs is Do Nothing (although more frequent cliff falls to be expected)
SWA5		
STU1	✗	SMP policy for cliffs is Do Nothing (although more frequent cliff falls to be expected)
STU2a & 2b	✗	no cliffs
STU3		
STU4		
PHB1	✗	SMP policy for cliffs is Do Nothing (although more frequent cliff falls to be expected)
PHB2		
PHB3a, 3b & 3c	✔	response of cliffs in 3c likely to be sensitive to variation in ground water
PHB4	✗	SMP policy for cliffs is Do Nothing (although more frequent cliff falls to be expected)
PHB5a, 5b & 5c	✗	no cliffs
PHB6		
PHB7	✔	response of cliffs likely to be sensitive to variation in ground water
PHB8	✗	no cliffs
PHB9		
PHB10		
PHB11		
PHB12		
PHB13		
PHB14	✔	response of cliffs likely to be sensitive to variation in ground water
PHB15	✗	no cliffs
PHB16		
PHB17		
PBY1	✔	response of cliffs likely to be sensitive to variation in ground water
PBY2		
PBY3		

Table 5.2 Effects of Changes in Rainfall on Management Units

6 References

Kamphuis (1991) Alongshore Sediment Transport Rate, Journal of Waterway, Coastal and Oceanographic Engineering, Vol117, No 6 ASCE

Halcrow, University of Portsmouth, University of Newcastle and The Met Office (2001) Preparing for the Impacts of Climate Change, Standing Conference on Problems Associated with the Coastline.

UKCIP (1998) Climate Change Scenarios for the United Kingdom: Scientific Report. UKCIP Technical Report no 1. Climate Change Unit, Norwich, UK

UKCIP (2002) Climate Change Scenarios for the United Kingdom: The UKCIP02 Scientific Report. Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East Anglia, Norwich, UK

MAFF (1999) Flood and Coast Defence Project Appraisal Guidance – Economic Appraisal (FCDPAG3)

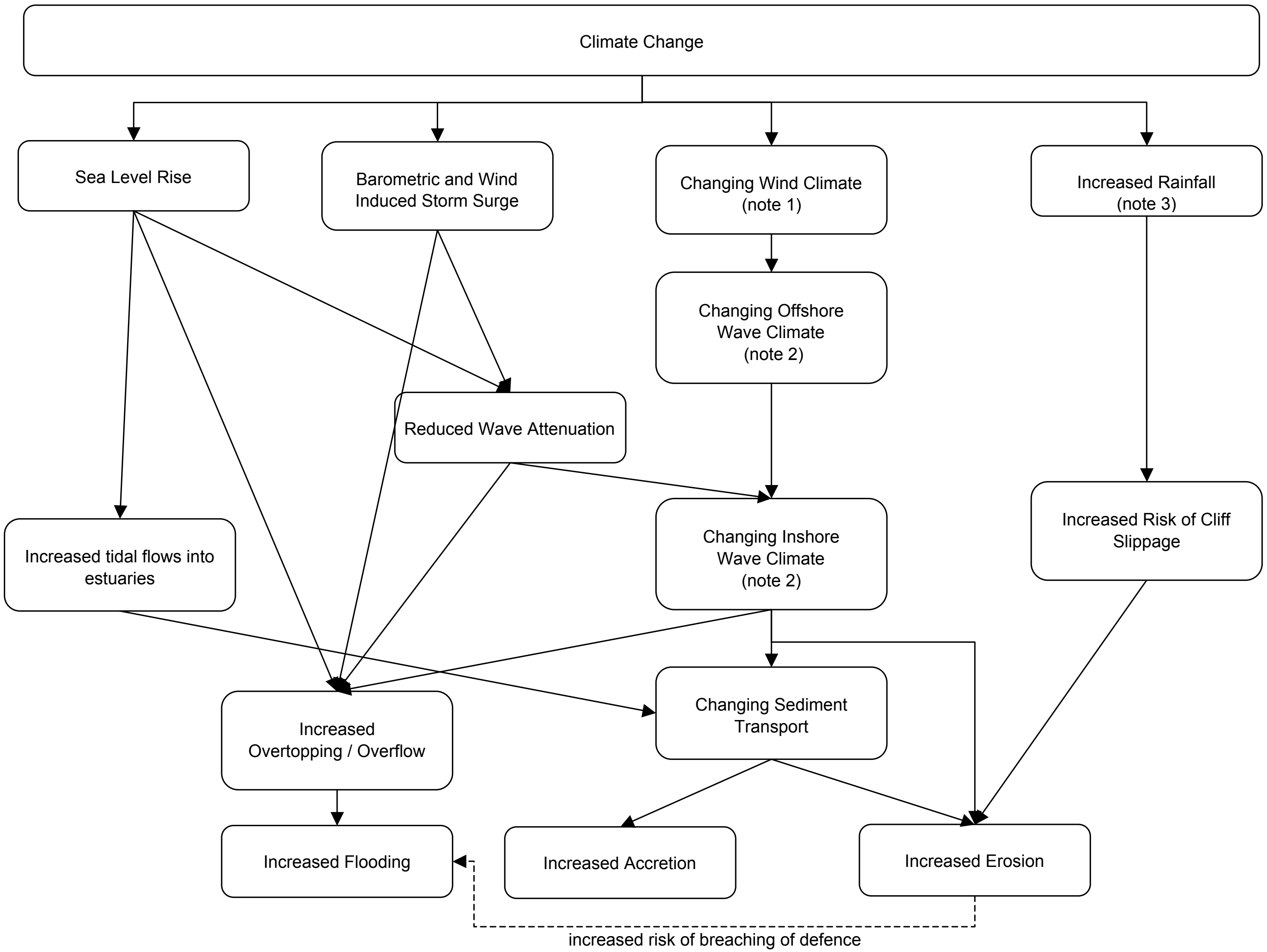


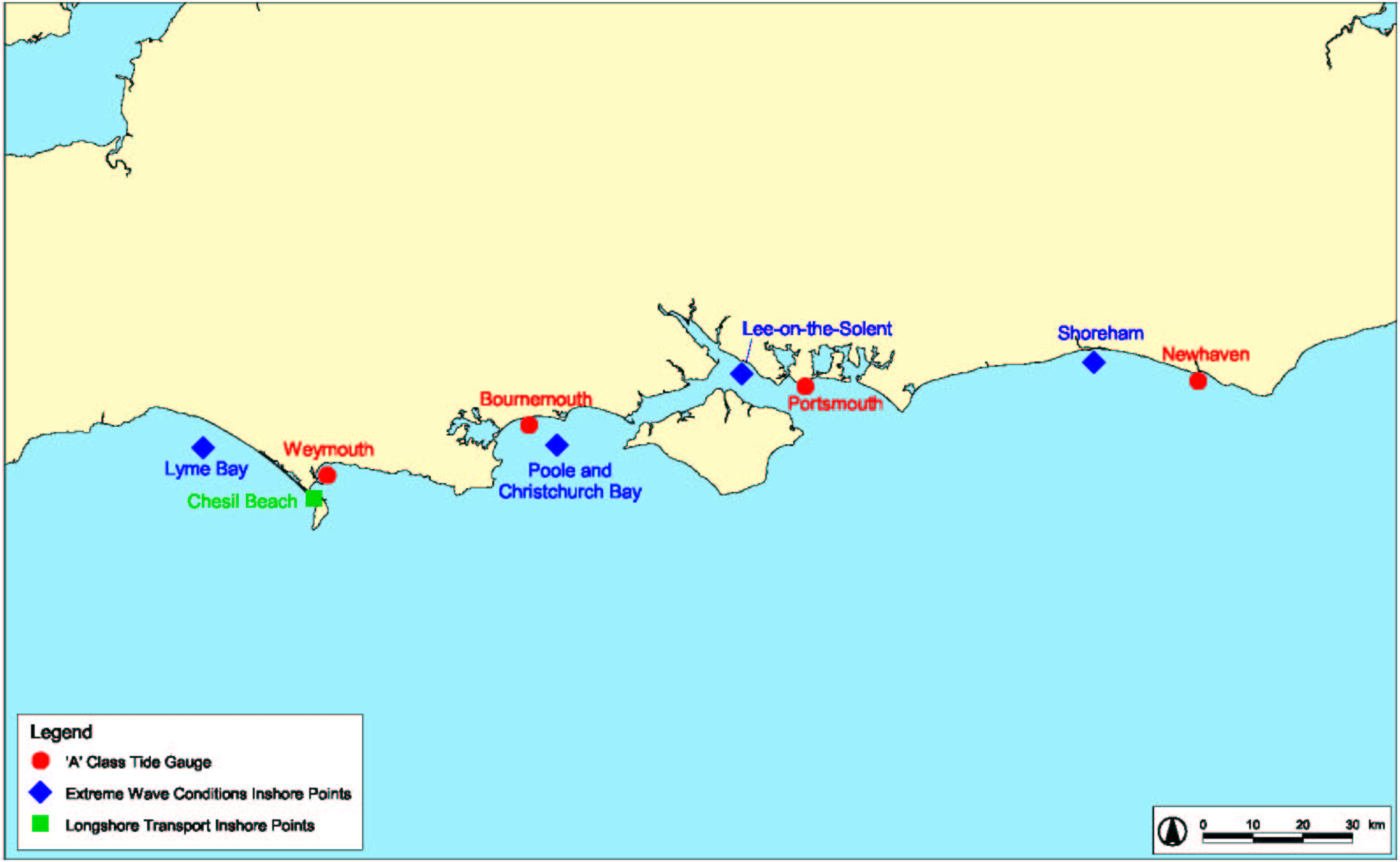
Diagram shows linkages through which increased flooding and increased erosion could, but not necessarily will, occur

Changes to ecological habitats will be influenced by all of the outcomes shown in this diagram, but also by the direct influence of climatic change (particularly temperature and rainfall change)

Note 1 - Wind Climate includes: wind speed, wind direction and frequency of occurrence

Note 2 - Wave Climate includes: wave height, wave period, wave direction and frequency of occurrence (therefore includes increased "storminess")

Note 3 - Increased Rainfall may also result in increased run-off flooding, which is not addressed in this diagram



M:\Projects\Coasts\WCPBHS\GIS\climatechangedata.apr

Halcrow

Halcrow Group Ltd
Burderop Park, Swindon, Wiltshire SN4 0QD
Tel 01793 812479 Fax 01793 812089
www.halcrow.com

PROJECT	DATE
POOLE BAY AND HARBOUR STRATEGY STUDY	Apr 2003
TITLE	
Locations of Climate Change Analysis Data	Figure 1.2

Map Symbol	Future Behaviour Category	Landform	Landform Response to Climate Change	Shorline Management Outcome	Consequence	Economic Implications
	1: Static Resistants	Cliffs	No Significant Change	No Significant Change	No Significant Change	No Significant Change
	2: Static Dynamic	Barrier Beaches & Lowlands	Increased Overtopping/Overflow & Storm Damage	Increased Defence Failure. Decreased Residual Life & Standard of Protection of Defences	Increased Risk of Flooding & Saltwater Contamination	Increasing beach recharge costs. Increased Flood Risk area.
	3: Static Declining	Cliffs	Increased Slope failure, defence Overtopping/Undermining & Storm damage. Increased beach Lowering	Increased Defence Failure. Decreased Residual Life & Slope Stabilisation Measures.	Increased Risk of Cliff top Recession & Ground Movement	Increased defence costs. Loss of cliff tops assets.
		Barrier Beaches & Lowlands	Increased beach face or crest erosion, overtopping, undermining, storm damage & barrier breakdown	Increased defence failure, decreased Residual life & standard of Protection of defences	Increased Risk of Flooding, Saltwater Contamination & Shorline Erosion	Increased Defence costs. Increased flooding/contamination damages
		Estuaries & Inlets	Increased Overtopping/Overflow, undermining & storm damage. Increased beach Lowering	Increased Defence Failure. Decreased Residual Life & Standard of Protection of Defences	Increased Risk of Flooding & Saltwater Contamination	Increased defence costs. Increased flooding/contamination damages
	4: Barrier beaches & Lowlands	Barrier Beaches & Lowlands	Beach Accretion. Decreased wave energy.	Shoreline Advance. No Significant change in standard of protection.	No Significant Change	No Increase in defence costs
		Estuaries & Inlets	Decreased wave energy	Shoreline Advance. No Significant change in standard of protection.	No Significant Change	No Increase in defence costs
	5: Retreat	Cliffs	Increased cliff failure/reactivation & toe erosion. Accelerated cliff top recession	Accelerated Shoreline retreat. Increased Coastal Landsliding & Ground Movement	Increased Risk of Cliff top Recession & Ground Movement	Loss of cliff top assets. Damage to structures on slope.
		Barrier Beaches & Lowlands	Increased beach face/crest erosion, barrier Overtopping/breach/breakdown.	Accelerated Shoreline retreat. Increased Barrier failure. Decreased natural standard of Protection	Increased Risk of Flooding, Saltwater Contamination & Shorline Erosion	Increased Flooding damages. Possible write-off of low lying assets.
		Estuaries & Inlets	Increased Overtopping/Overflow accelerated foreshore/beach lowering	Accelerated Shoreline Retreat. Decreased natural Standard of protection.	Increasd Risk of Flooding, Saltwater Contamination & Shoreline Erosion	Increased Flooding damages. Possible write-off of low lying assets.
	6: New Form	Barrier Beaches & Lowlands	Barrier Breakdown. Tidal Incursion.	Defence failure/barrier breakdown, dramatic reduction in standard of Protection. Possible sub cell-wide changes.	Flooding, Saltwater Cortamination. Flooding/Erosion elsewhere in Sub Cell.	Loss of all Low lying assets
		Estuaries & Inlets	Loss of Saltmarsh/mudflat. Breach of defences	Defence Failure. Dramatic reduction in standard of Protection. Probable changes to Estuary Dynamics.	Flooding, Saltwater Cortamination. Flooding/Erosion elsewhere in Estuary.	Loss of all Low lying assets

M:\Projects\Coastal\WCPBHS\Scopac_Climate_Change\CoastalRisks.apr

Halcrow 2003

0 1 2 3 4 5 Kilometers

Scale 1:100,000

N

Legend:

Indicative Floodplains (Data supplied by EA)

Urban Areas (Data Supplied by EA)

Figure 1.3 Coastal Risks in Poole Bay