Coastal Futures 2001: Coastal Management for Sustainability - Review and Future Trends
2001, Volume 8, Paper No. 0103, pp.9-18 ,   ISBN 0 9522946 7 2

CLIMATE CHANGE: BRINGING HOME THE REALITIES

Colin Fenn
WS Atkins Consultants Limited, Woodcote Grove, Ashley Road, Epsom, Surrey, KT18 5BW

Summary

Most professionals are fully aware of the background to climate change, and of the various global climate change scenarios which have been produced; but most find them too far-off and too vague to be of concern, let alone use, in their working practice. But climate change is with us, here and now, and requires action, here and now. Just as mitigation of the problem has to have a global dimension to stand a chance, so adaptation to it must have a local one. '*Rising to the Challenge'* is the final report of a recent scoping study into climate change and its impacts in the South East of England. River and coastal flooding heads the list of predicted threats, and extreme events like those experienced in Autumn 2000 are forecast to be the norm in the not too distant future. The presentation given at Coastal Futures 2001 reviewed the nature and extent of these risks, and considered appropriate responses to them. This paper constitutes a note-form summary of that presentation.

Introduction - The reality of the risk of climate change

Evidence and consensus regarding climate change is mounting.

The rate, pace and scale of recently experienced changes in climate are unprecedented in the geological climatic record (insofar as we can determine it, from ice sheet cores, ocean sediment cores, tree cores, glacier fluctuations, rainfall time series, etc).

Most scientists agree that climate change is real. Virtually all agree that *the risk of it is real*. The Inter-Governmental Panel on Climate Change (IPCC) is now saying that there is a definite anthropogenic signal in the climatic record, and that the probability is
that the kinds of changes we are seeing in our climate are produced by man.

Reference for further details: http://www.ipcc.ch

Mainstream politicians are taking the matter, and the consequent risks, seriously:

"The science is no longer about whether but when" (John Prescott, November 1999)

"This is a wake up call" (John Prescott, November 2000, in response to the devastating floods of Autumn 2000, and reminding people of the connection to climate change).

Climate change is the quintessential case for the application of the precautionary approach, or, as I have previously advocated (ref. Hewett, Harries and Fenn, 1991) a "no regrets" approach:

Don't do anything which you would not otherwise do; but don't do anything without testing its' vulnerability to climate change.

The scope and content of this paper includes: -

- Climate futures and risks
- Mitigation and adaptation
- The local dimension
- Flood risks in the South-East of England
  - Present
  - Future
- Flood risk management – Strategies & Policies for Sustainable Coastal Flood Defence

Dealing with climate change

The response to climate change must incorporate both *mitigation* (of the causes of man-made climate change) and *adaptation* (to the effects and impacts of climate change).

Mitigation requires
- Assessment
- Agreement
- Global action

to minimise climate-changing emissions.

Adaptation is required, here and now, because of the survival life of previous emissions (e.g. 50~100 years), and the inertia in the climate system. Mitigation alone is insufficient. The impulse is in the system, and we need to respond to it. Just as mitigation requires global assent and action to succeed, so adaptation requires local assent and action.

The South East Study

The Government, through DETR, is rolling out a major programme of regional assessments in relation to climate change. The United Kingdom Climate Impacts Programme (UKCIP) is co-ordinating work, and disseminating findings:

Reference for further details: http://www.ukcip.org.uk

The South East Study was the second of the regional impacts and adaptations scoping studies to be undertaken in the UK (Wade, et al 1999). '*Rising to the Challenge*', the final report of this study, defined best available estimates of climate change in the region; identified the likely impacts of the predicted change in temperature, rainfall, evaporation etc. on key environmental, agricultural, industrial and commercial interests; and chartered the degree of awareness, the state of readiness and the adequacy of response of those sectors to the threats posed.

Climate futures in SE England

Rising to the Challenge contains the (at-the-time) best predictions of future (2020, 2050, 2080) climate in South East England, as produced by the UK Climate Change Impacts Programme (UKCIP). The following data are taken from the report:

Figure 1 shows how air temperature and rainfall are predicted to change from their present (1961~1990 period) mean values, in summer and in winter, by 2080, under the four (Low, Medium-Low, Medium-High and High) emission scenarios which have been used to produce estimates of change and consequent impacts. Temperature will rise, in both summer and winter, under all scenarios (the change is a matter of degree, not direction). Rainfall, on the other hand, will change to the drier in summer, and to the wetter in winter. The extent of change again differs according to the scenario, but – again – it is the degree but not the direction of the change which varies.

Table 1 shows the estimated change (present v 2080) in the mean value of a set of key climatic variables, under the Low and High scenarios. Significant as these are, it is the change in extreme values which are likely to be most significant.

Table 2 summarises the extent to which events which are considered extreme and infrequent under present conditions are likely to occur under a changed future climate. Reading across each of the rows shows the extent to which today's extremes (infrequents) may become tomorrow's norms. For example, (1) what is now a dry summer, with 50% of normal rainfall and likelihood of occurrence of once in a hundred years, will have become an event with a chance of occurring once in 14 years by 2020, and once in 8 years by 2050; (2) the chance of our experiencing a climatic anomaly of + 3.4 degrees C (as we did in August 1997) will change from 1 in 50 years to 1 in 7 years by 2020, and 1 in 3 years by 2050). 2020s etc.

Impacts of Climate Change

Rising to the Challenge charts the possible impacts of such climate changes on a range of environmental, social and economic activities. Some are challenging, and problematic. Some are challenging, and opportunity-filled. All are challenging.

None is more challenging than that of the possible impact of climate change on flooding, and flood management, and the rest of this paper will focus on this matter.

Flood risk

When *Rising to the Challenge* was launched at the Royal Geographical Society, in November 1999, permission to show the two diagrams given below in Figure 2 was granted for the first time, in public session.

Figure 2 shows areas in the South East of England which are deemed to be at risk of (upper map) river flooding in an event with a return period (recurrence interval) of 100 years, and (lower map) coastal flooding in an event with a return period (recurrence interval) of 200 years.

Little more than a year later, the Environment Agency had made equivalent information on flood risk throughout England and Wales available to all, via the internet: Reference for further details: http://www.environment-agency.gov.uk/flood/index.htm
and enter your postcode in the box

This site received 40 hits *per second* when it went on-line, on 8 December 2000. Figure 3 shows an extract of the flood risk information available for my own "back-yard", near Littlehampton, in West Sussex.

These sources show the risk of flooding under our current climate. But what of the risk under a changed future climate? Uncertainties abound: but I contend that in the presence of uncertainty, it behoves us to assess possibilities, and test impacts.

Changes in river flood risk under climate change – prospects

In the future, it seems likely that we will have:

- Wetter, and possibly stormier winters
- More rain, more rain days and more heavy rain days
- More saturated ground conditions, and for longer periods
- More run-off

More high flows and higher flow levels, in rivers, on floodplains

Figure 1. Predicted changes in summer and winter air temperature (upper plot) and rainfall (lower plot) in South East England, 2080s compared to the present, under the four UKCIP emission scenarios (Source: Wade et al 1999).

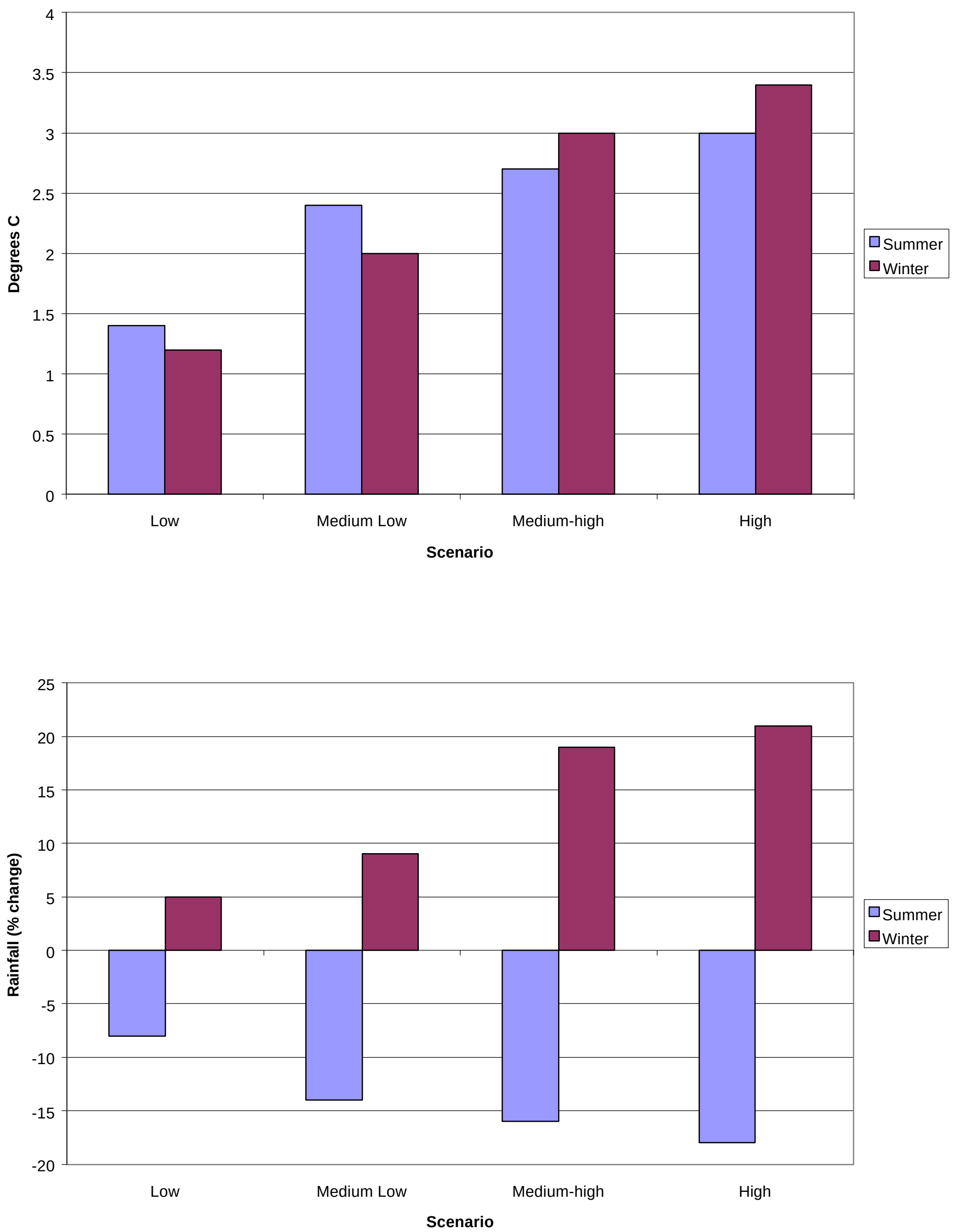


Table 1 Predicted changes in annual average climate, 2080s compared to the present. (Source: Wade <u>et al</u>. 1999)

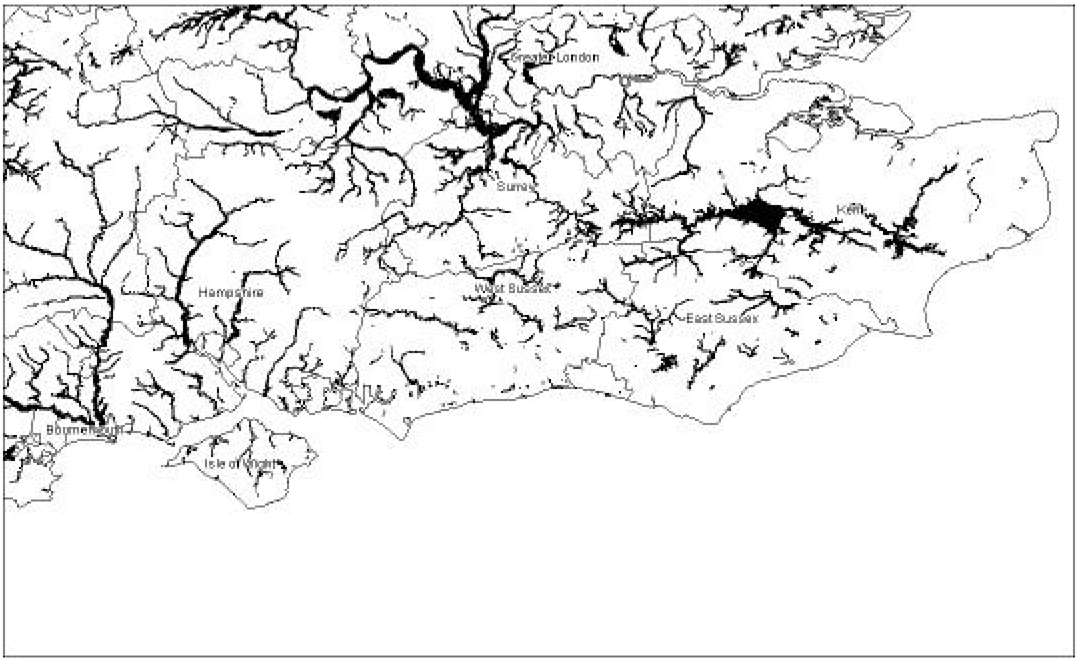
	L	H	Units
Mean annual temperature	+ 1.2	+ 3.4	°C
Mean annual rainfall	+ 1.0	+ 4.0	%
• **Winter rainfall**	+ 6.0	+ 22.0	%
• **Summer rainfall**	- 8.0	- 23.0	%
Summer cloud cover	- 3.0	- 4.0	%
Mean annual wind speed	-	+ 0.09	m/s
Summer evaporation	+ 0.45	+ 0.91	mm/d
Relative humidity	no change	no change	
Mean sea level	+ 54 cm (MH scenario)		

Notes: The column headed L shows predictions from the UKCIP low emissions scenario. That headed H shows predictions from the UKCIP high emissions scenario. All changes are against the mean of the standard 1961-90 period.

Table 2.
Estimated future return periods (years) [and probability, %] for temperature and rainfall values in South East England that are unusual in the present climate. The anomaly is relative to the present climate. (Source: Wade <u>et al</u>. 1999)

RETURN PERIOD (YEARS)	PRESENT CLIMATE	2020s	2050s	2080s
TEMPERATURE				
ANNUAL: Anomaly + 1.06°C as in 1997	17 [6%]	1.7 [59%]	ALMOST EVERY YEAR EXCEEDS [85%]	ALMOST EVERY YEAR EXCEEDS [99%]
SEASONAL: Anomaly + 2.0°C as in summer 1995	50 [2%]	3 [33%]	ALMOST EVERY YEAR EXCEEDS	ALMOST EVERY YEAR EXCEEDS
MONTHLY: Anomaly + 3.4°C as in August 1997	50 [2%]	7 [32%]	3 [32%]	2.5 [40%]
RAIN				
WINTER: 160% of normal	17 [6%]	4 [25%]	5 [20%]	3 [33%]
DRY SUMMER: 50% of normal	100 [1%]	14 [7%]	8 [12%]	10 [10%]

Figure 2 Areas at risk of river flooding in a 1 in 100 years event (upper map) and of coastal flooding in a 1 in 200 years event (lower map). Source: (Source: Wade et al. 1999)



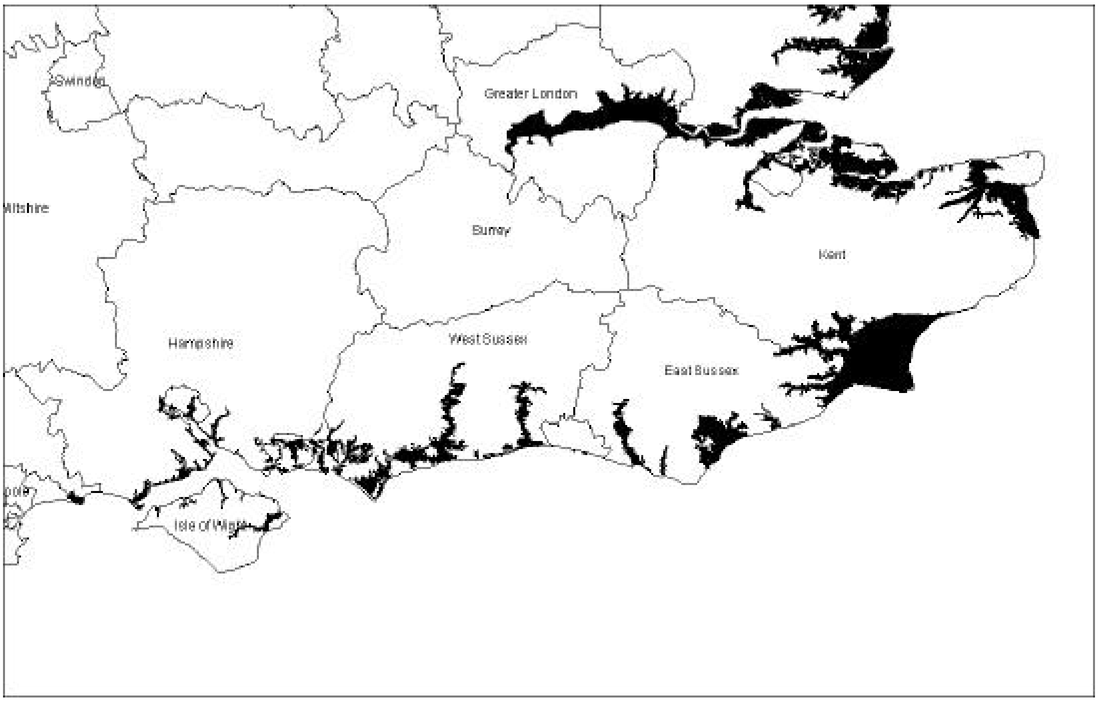


Figure 3 Extract from the Environment Agency's web-site, showing indicative flood risk areas around Littlehampton, West Sussex

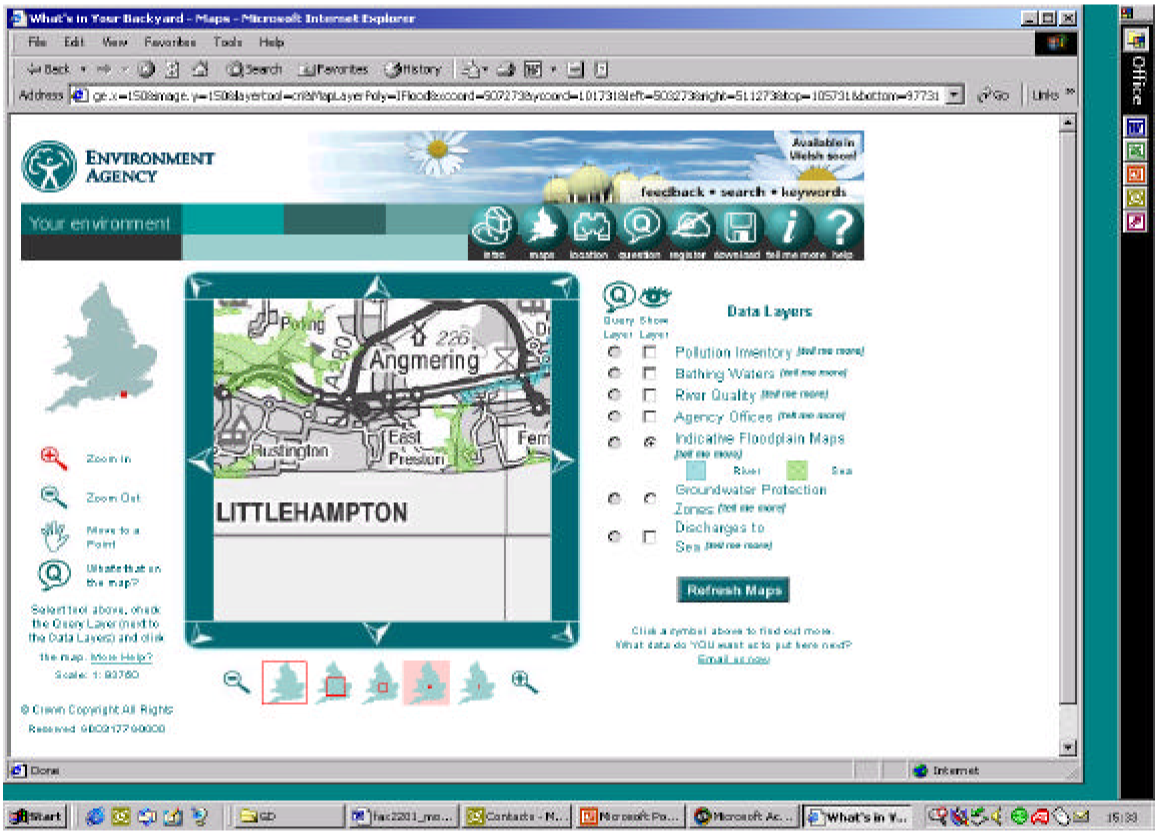
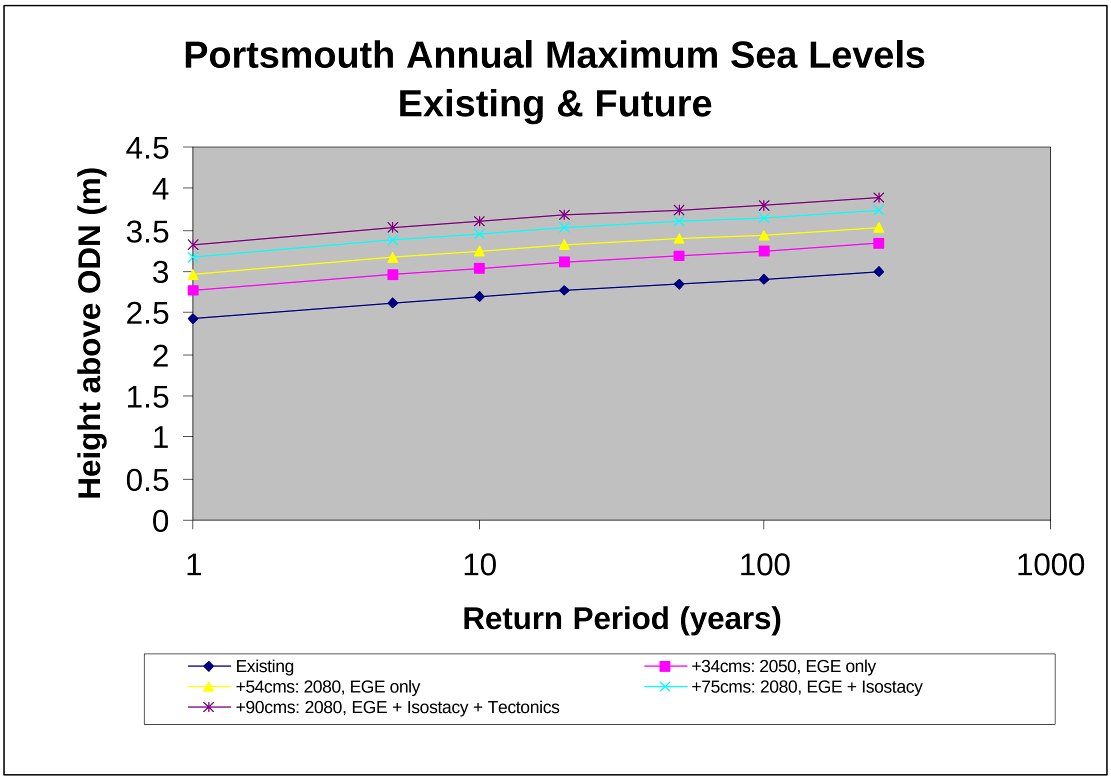


Figure 4 Existing and possible future level – frequency curves for annual maximum sea levels at Portsmouth



At the coast and in estuaries there will be higher sea level, and a greater tidal reach into river valleys; this will have a backwater effect, raising upstream river water levels. On the Sussex coast, the tidal reach along river valleys is up to 20km inland, and this extent will increase under climate change.

Changes in coastal water levels and flood risk under climate change - prospects

Mean sea water levels along the southern coast are rising, relative to the land, along the southern coast. Climate change is to blame. Some of it is ancient, some of it is modern.

We know that the south of England is sinking in isostatic response to the melting of the Scottish ice caps; Scotland is rebounding up and southern England is tilting down. Tectonic movements – faulting and land subsidence - are exacerbating the problem, locally. The historic rate of change in mean sea level over the last century has been around +1.5 mm/yr, along the southern coastline in general, but as much as another +5 mm/yr around Portsmouth.

The predicted rate of mean sea level rise due to climate change – attributable to thermal expansion of sea water (eustatic change) and the melting of land-based ice caps and glaciers is an additional 6 mm/yr. This is +34 cms by 2050, and +54 cms by 2080. Adding the isostatic and tectonic effects gives a total relative rise of mean sea level of 7.5 mm/yr in general, and as much as 11.0 mm/yr locally.

What the change in extreme sea water levels will be is less certain. But it seems reasonable to assume that the climate change effect on extreme sea water levels will be at least as much as that on mean sea water levels (since surge and wave heights as well as mean sea level are likely to increase under climate change). So today's extreme sea water levels mighty be tomorrow's frequent sea water levels.

Just how dramatic the impact might be depends upon the gradient of the existing water level vs return period (recurrence interval) chart, and the extent of local isostatic and tectonic influences. The potential situation at Portsmouth is shown in Figure 4 below.

Figure 4 shows the annual maximum sea water level at Portsmouth plotted against frequency of occurrence (return period, in years). The lowest line shows the existing relationship; note how small is the difference in sea water in 1 in 1 year, 1 in 10 year and 1 in 100 year events. The lines above the existing curve show the effect of climate change induced sea level rise by (respectively) 2050, and 2080; then those resulting from climate change by 2080 plus the local isostatic and tectonic effects. The indication is that today's 1 in 100 year extreme mean sea water level might become a 1 in 1 year event by the be 2080's, in this particular case. More generally, it does not seem unreasonable to conclude that there might be an order of magnitude increase in the probability of extreme sea water levels (i.e. what is now a 1% risk might become a 10% risk, by 2080).

Possible impacts of the increased flood risk

Allison, Fenn and Lane (2000) published data showing the change in the numbers of properties at risk of flooding (from fluvial, coastal and combined fluvial and coastal causes) arising from an order of magnitude increase in the risk of flooding in South East England. Figure 5 below shows some of the data presented by them.

Figure 5 shows the increase (and shift) in the number of properties vulnerable to flooding in South East England, under an order of magnitude increase in flood risk, with the current 1 in 1000 year event becoming a 1 in 100 year event. The risk category shown along the bottom axis defines the combination of chance of flooding (H, M, L); the size of the population affected (H, M, L); and the resultant impact of flooding (H, M, L) under existing circumstances (upper plot) and under the postulated future circumstances (lower plot). Note the shift of properties in higher risk categories, from the upper to the lower plot.

Management issues

Gary Lane, the then Regional Water Manager for the Southern region of the Environment Agency made the following comment in *Rising to the Challenge*:

" There is no doubt that many of the climate change scenarios are extremely challenging to our flood defence role. Southern Region is dominated by its coastline. Climate change will make it extremely difficult to maintain standards of defence against both flooding and erosion".

The House of Commons Agriculture Select Committee stated, in their 1998 report:

"*We are of the opinion that flood and coastal defence policy cannot be sustained in the long term if it continues to be founded on the practice of substantial human intervention in the natural processes of flooding and erosion*

Indeed, it is of great concern to us that the legacy of flooding and erosional problems arising from this practice….

.. and the likely increase in future of climatological and other environmental pressures on the UK's ageing flood and coastal defence infrastructure…

.. might combine to present flood and coastal defence authorities with insuperable difficulties."

This is strong language by any standard. The Government rejected the charge of *insuperable difficulties* but it has acknowledged that we will have to adopt less interventionist policies in future practice.

The Management Challenge

The main challenge can be summarised as follows:

Dense population + development pressure + climate change = ?

These issues combined are going to increase the likelihood and impact of flooding in the following ways:

- Floods of a given likelihood will be larger
- Floods of a given size will happen more often
- More places will be affected
- More people will be affected
- More assets, in all senses of the term, will be affected = economic, social, environmental (physical & ecological)

The management challenge will involve decision making involving:

- Defend all, or some? At all costs? Or not? What criteria do we use?
- The need to break the escalator effect (i.e.- as the quantum of assets behind a protection increases, its value is greater, and under MAFF flood appraisal guidelines it qualifies for protection to a higher level – so as the value at risk rises, the case for defending it increases)
- Softer, less interventionist management
- Do we 'preserve what is there' or do we take a more dynamic and less conservationist attitude to places and habitat?

Existing guidance

Key documents are:

- DoE Circular 30/92, 1992
- EA Policy & Practice, 1997
- DETR (draft) PP25, 2000; 2001

PPG25 proposes practical guidelines for controlling inappropriate development on floodplains, and advocates an explicit risk-based approach to development planning in flood risk situations.

As noted by Allison, Fenn and Lane (2000), flood management policy adopts the language of influence and persuasion, and confers only permissive powers on the Environment Agency (the lead authority in flood risk assessment matters),in comparison to the stronger language and directive powers conferred on the lead authority in PPG9, apropos environmental protection under the Habitats Directive.

Solutions

- Adopt a risk-based approach to flood defence
- Flood management = development control + forecasting + warning + response + recovery
- Flood defence needs to be integrated with the land use planning system and asset management
- Longer planning horizons – tomorrow's generations under tomorrows conditions
- Climate change factored in as one of the risks
- Precautionary principle – presumption against development in flood risk areas
- Technical, economic environment and social appraisal (Sustainability Appraisal) true sustainability
- Arrest the escalator – resist building defences only to build behind them

Conclusions - Key messages

To quote Allison, Fenn and Lane (2000):

"We need to shift our horizons and build up our knowledge of what we have considered extreme risks (i.e. presently around 0.1% in 1000 year likelihood)"

"We need to rethink our view of what is an acceptable development proposal, to reflect what will be the long term flood impacts within the risk area when climate change and cumulative development pressures are taken into account"

" We need a way to test the sustainability of our decision-making. A declaration of the burden imposed on future generations would help."

.. and if we are reckoning the case for future generations, we've no choice but to factor climate change into our thinking.

References

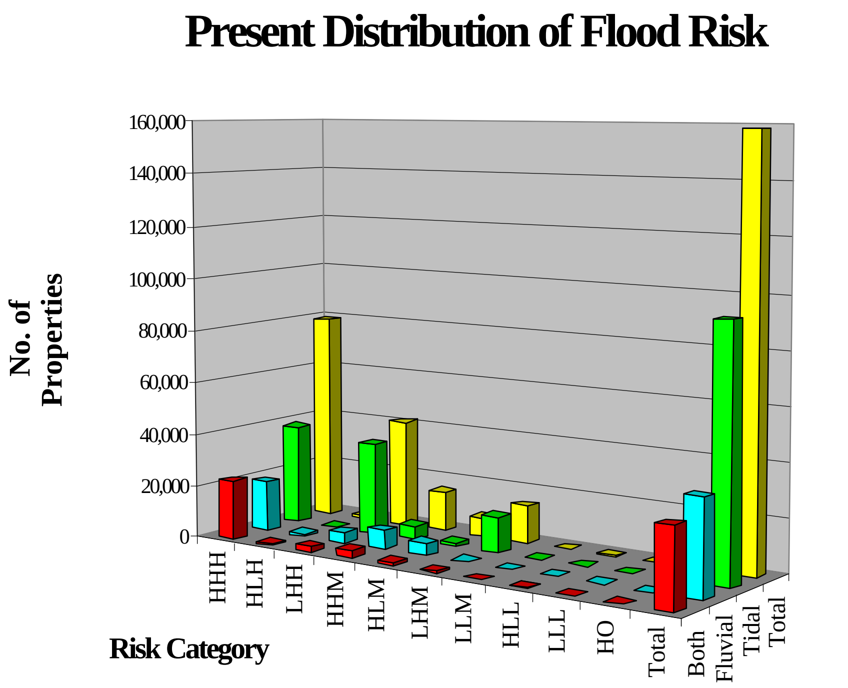
Allison, K., Fenn, C.R. and Lane, G. (2000) Strategic implications of climate change for coastal flood risk in the south east. *Flooding: risks and reactions, Proceedings of the CIWEM/ICE Water Environment Conference held on 5 October 2000*, ICE, London.Allison, K., Fenn, C.R. & Lane, G. (2000) Flooding, Risks and Reactions, CIWEM, 2000, 21-43.

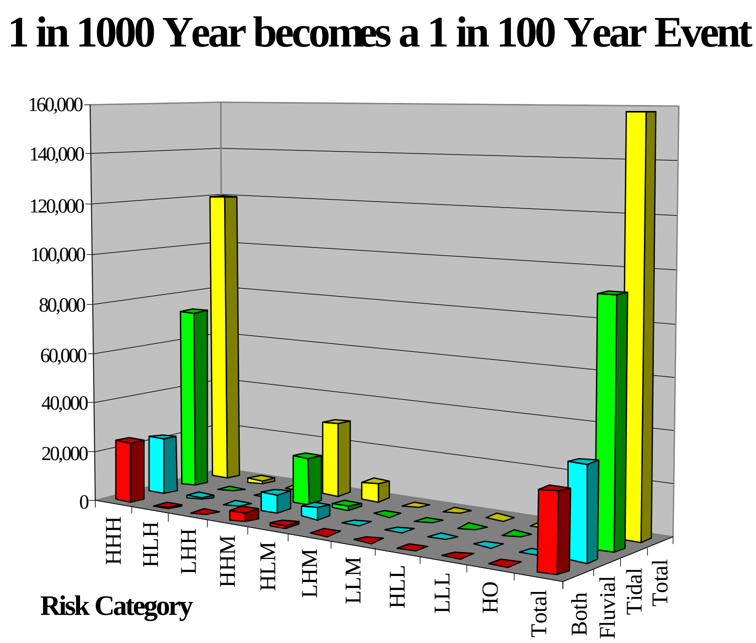
DoE Circular 30/92 (1992) Development and Flood Risk. HMSO 1992.

DETR (2001). Planning Policy Guidance. Development and Flood Risk. (PPG25), January 2001

Environment Agency (1997*). Policy and Practice for the Protection of Floodplains*, 1997.

Figure 5 Distribution of properties in South East England in flood risk categories, under existing risk/climate and under future risk/climate with a 1:in 1000 year risk becoming a 1 in 100 year risk (Source: Allison, Fenn and Lane, 2000).





Hewett B A O, Harries C D and Fenn C R (1993). Water resources planning in the uncertainty of climatic change: a Water Company Perspective. in White, R (ed.) *Engineering for Climatic Change*, Thomas Telford, London, 38-54.

House of Commons Agriculture Select Committee (1998). Flood and Coastal Defences, 30 July 1998.

Wade, S.D., Hossel, J., Hough M. and Fenn C.R. (1999). South East study - *Rising to the Challenge – Impacts of Climate Change in the South East in the 21st Century* (1999). Copies available c/o Phil Sivell, Surrey County Council.