PW Climate Change

CONFERENCE OF RIVER AND COASTAL ENGINEERS

1989

Loughborough 11th – 13th July

THE GREENHOUSE EFFECT
CONSEQUENCES FOR RIVERS AND COASTAL ZONES

Ministry of Agriculture Fisheries and Food
Flood Defence Division

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Conference of River and Coastal Engineers, Loughborough, 11-13 July 89

The Greenhouse Effect - Consequences for Rivers and Coastal Zones

EXECUTIVE SUMMARY

The scientific background to the greenhouse effect was reviewed and there was general agreement on the ranges for predicted global climate changes, particularly temperature, though regional effects cannot yet be defined.

The impacts of these changes for rivers and coastal zones will be the rise in sea level, expected to be in the range of 15cm to 30cm by 2030, possible increases in storm severity, and changes in weather patterns which could result in greater frequencies of inland flooding and droughts.

In response to these impacts the strategy should be to:

1. Refurbish defences to reduce existing risk;
2. Continue research into river and coastal processes;
3. Monitor trends in climate, sea level, waves, beaches and saline intrusion;
4. Utilise current predictions of sea level in a review of existing standards; and
5. Keep policy and 'best practice' under review as understanding develops of sea level trends, waves, surges and weather patterns.

Flood Defence Division
7 August 1989

Ministry of Agriculture, Fisheries and Food

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The Greenhouse Effect - Consequences for Rivers and Coastal Zones

1. Introduction

The Annual Conference of River and Coastal Engineers is organised by MAFF and was attended by over 200 leading practitioners in the field from Water Authorities, Central and Local Government, Drainage Boards, Universities, research organisations and Consultants. As part of this year's conference, a round table discussion on the Greenhouse effect took place on Wednesday 12th July. This was chaired by Professor Wolf, Professor Emeritus at City University, and led by the following panel of experts who each presented papers in their specialised fields.

Dr G J Jenkins	Meteorological Office
Dr R A Warrick	Climatic Research Unit, University of East Anglia
Dr A J Apling	Department of the Environment
Dr D T Pugh	Deacon Lab, Institute of Oceanographic Sciences
Mr I R Whittle	NRA (formerly Chief Engineer, MAFF)
Mr I H Townend	Sir William Halcrow and Partners
Mr F M Law	Institute of Hydrology

2. Science

The greenhouse effect may become one of the greatest issues of our age. There is a need to be clear about the current state of our knowledge and to work towards a better understanding of the many areas of uncertainty which exist.

Incoming short wave radiation from the sun reaches earth unattenuated. Outgoing radiation from the earth is of a longer wavelength and certain gases in the atmosphere absorb part of that radiation and re-emit it in all directions. The net effect is a warming of the earth's surface and lower atmosphere. This effect has become known as the greenhouse effect. Without the present level of natural 'greenhouse' gases average surface air temperatures would be some 38 degrees C less than they are today and thus they are essential for habitation in its current form. However the atmospheric concentration of greenhouse gases is increasing due to man's activities, with potentially large increases in global mean temperature. Records show an increase of about 0.5 degrees C in the last century in observed global mean surface air temperature. This warming cannot yet be attributed solely to the greenhouse effect since factors such as volcanic eruptions, solar variations, ocean current changes and the like also influence climate in the the medium and long term. It has not at present proved possible to separate out these influences unambiguously.

The gases which contribute most to global warming are carbon dioxide, methane and chlorofluorocarbons (CFC's). Nitrous oxide, ozone and other trace gases are also known to contribute.

Concentrations of carbon dioxide have increased by 25% since the mid 18th century, due largely to the burning of fossil fuels. Carbon dioxide accounts for approximately half the total change in global warming over the last decade. Over the same time period atmospheric carbon dioxide concentrations increased at the rate of 0.4%-0.5% per annum.

Methane concentrations have approximately doubled in the last 200 years and are currently rising at approximately 1% of current levels per annum. This methane probably comes largely from agriculture and fossil fuel extraction.

CFCs do not occur naturally. CFC concentrations have recently been rising at approximately 6% per annum and have a long atmospheric life (100 years). Although concentrations of methane and CFCs are much lower than that of carbon dioxide, molecule for molecule these gases are more powerful in their greenhouse effect, methane by 27 times and some CFCs by more than 10,000 times. These differences have led to the concept of 'equivalent' carbon dioxide concentrations (ie the combined radiative effect of all greenhouse gases expressed in carbon dioxide equivalence). The best estimate is that a doubling of carbon dioxide equivalent will occur around the year 2030.

A doubling of carbon dioxide is used in General Circulation Models (GCMs) to predict effects on equilibrium global climate. The UK Meteorological Office run one of the five leading GCMs in the world which have been used for such experiments. The technique is to run the model until equilibrium climatic conditions are achieved for both control and doubled levels of carbon dioxide concentration and then compute the changes in climatic variables. Good agreement between the five models has been found at the global scale but there is significant variation in regional predictions.

In summary, the "best guess" consequences derived from these GCMs and other climate models are as follows:

i. Global mean surface air temperatures will rise between 1.5 and 2.5 degrees C by 2050 with further increases to follow
ii. Global climate will change
iii. Global evaporation and precipitation will increase
iv. Global sea levels will rise
v. Regional and local effects are much more difficult to predict and may in some local areas be in directions which are the reverse of global trends.

3. Impacts

There is general agreement that the rise in global air temperature will lead to a rise in global sea levels due to thermal expansion of the oceans and to the melting of land based ice, though polar ice may increase due to increased precipitation at the poles. Best estimates indicate a range of increase of between 15cm and 30cm by 2030 and

between 25cm and 40cm by 2050. These should be considered in the light of increases of some 10cm to 15cm in the last 100 years.

As important as the global rise in sea level will be regional effects of changing ocean currents, tides and the frequency and magnitude of storms and surges. This is an area of much greater uncertainty as the global oceanic and meteorological models are not yet able to provide adequate predictions at a regional scale.

The best that can be achieved at present is to make broad assumptions of the changes likely to occur and to evaluate their regional and local effects. In the design of coastal defences it is generally the extremes of sea level and waves which are critical. Reference was made to one UK site for which it is estimated that levels, which at present might occur only once in 100 years, could occur every 5 years on average by 2050.

Local impacts will be highly dependent on the nature of the coastal zone. Some natural interfaces such as salt marshes and coastal wetlands can naturally adapt to change by build up of sediment and by migration inland provided that the rate of change is gradual and the process is not constrained, particularly by man made structures.

Other subsidiary effects include the need for increased pumping from low level areas and the increased intrusion of saline water into estuaries and coastal aquifers with consequences for agriculture and water supplies.

Inland changes in weather patterns will alter the character of river systems and could well lead to increased frequencies of both floods and droughts though prediction once again awaits more detailed regional models of the meteorological system.

4. Response strategy

4.1 International action

The Intergovernmental Panel on Climate Change (IPCC) established by the United Nations Environmental Programme (UNEP) and the World Meteorological Organisation (WMO) is undertaking a review of the science for improving predictions at global and regional levels, evaluating the environmental and socio-economic impacts and formulating response strategies. The UK is undertaking the first of these reviews of the science under the chairmanship of the Director General of the Met. Office. An interim report will be made to the World Climate Conference in 1990.

Programmes studying the role of oceans in climate change and the monitoring of earth crustal movements are in hand.

Procedures for controlling emissions are being discussed and the UK supports an Umbrella Convention leading to binding Protocols.

4.2 Local (UK) actions

The most pressing needs are to develop a response strategy to ensure that appropriate actions are taken and public money is used to best effect.

A number of existing defences are reaching the ends of their effective lives and a first priority should be to bring these to acceptable standards relative to current conditions so that there is a firm base for any necessary improvements in the future.

On the research side it is vital to continue and to increase the accuracy of the monitoring of sea levels and climate to provide indications of future change. In conjunction with this it is necessary to study other influences so that the effects of long term climate change can be identified. It is also necessary to identify earth crustal movements to obtain absolute sea level changes.

Other monitoring needs at a more local scale include the recording of changes in the coastal zone of levels, sediment transport, wave climate, ecosystems, saline intrusion etc. which will provide the basis for policy and design decisions.

Research should continue into river and coastal processes to assist in formulating effective strategies for coping with predicted changes as these become more clearly defined.

The design life of most sea defence works in relation to anticipated rates of sea level rise allows a flexible approach to be adopted. Design should be based on current predictions but should incorporate flexibility to allow future modifications when better predictions become available. In all cases the widest range options should be considered and these may include set back, retreat or advance from the present defence line.

There is a case for the continuing review and development of national policies including legislation in the light of future research results. This is particularly applicable to the development of appropriate links between planning and coastal management authorities within coastal cells.

Flood Defence Division
7 August 1989

HYTHE, KENT, MARINA BILL

REVISED NOTE FOR COUNSEL

GLOBAL WARMING / RISE IN SEA LEVEL

1.0 RECENT REPORTS

1.1 The "greenhouse effect" and the effects of consequential global warming on coastal zones were fully considered at a MAFF conference in July 1989. The report on this conference is attached.

1.2 The conference heard (in July 1989) that the best estimates of the global rise in sea level (due to thermal expansion of the seas and melting of land-based ice) were in the range of 15cm to 30cm by the year 2030 (i.e approximately 4mm to 7mm per annum), ASSUMING THAT THERE IS NO POLITICAL DRIVE TOWARDS REDUCING GREENHOUSE GAS EMISSIONS.

1.3 Subsequent to the MAFF conference, the Intergovernmental Panel on Climate Change (Working Group 1) has reported (in May 1990) that under the "business as usual" emissions scenario the predicted rise in global mean sea level is 20cm by 2030 (5mm per annum), BUT THERE WILL BE SIGNIFICANT LOCAL VARIATIONS. (N.B This report has not been widely circulated).

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2.0 MAFF POLICY

2.1 MAFF policy, given in ad hoc advice to coast protection authorities when applying for funding of new schemes, may be paraphrased as follows:

"Current accepted practice on the south-east coast of England is to design for a 3mm p.a rise in mean sea level with a design life of 30 to 50 years, depending on the type of scheme. In view of the current uncertainty in the predictions of global mean sea level rise and the unquantified regional variations, no variation in this practice has been advised"

2.2 The MAFF advice is derived from observed rises in sea level relative to the land mass at Sheerness over the period 1962 to 1980.

2.3 The strategy developed by MAFF at the 1989 conference is to:

(1) Refurbish defences to reduce existing risk;

(2) Continue research into river and coastal processes;

(3) Monitor trends in climate, sea level, waves and beaches;

(4) Utilise current predictions of sea level in a review of existing standards;

(5) Keep policy and "best practice" under review as understanding develops of sea level trends, waves, surges and weather patterns.

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3.0 STATEMENTS MADE IN EVIDENCE TO HYTHE BILL COMMITTEE

3.1 Dr Cox stated in giving evidence (Day 3, p 54/4) that the figure of "4mm a year has been widely used". This figure has been advised by Anglian Water for some years, in that Anglian Water have been concerned about the effects of mean sea level rise for rather longer than Southern Water and I (NJC) have used this figure in sea defence design for other marinas. It results in a more conservative design than would have been the case if using MAFF's 3mm p.a. However, we would not apply this figure over the 120-year design life of the project. I would expect to design for, say, 40 years at 4mm p.a (= 16cm) and review the situation in 2030 when repairs to the structures will probably be required in the natural course of events.

3.2 Mr Binns' Document 5 :

This suggests a 100cm rise by 2030 (40mm p.a) and is an (alarmist) worst case, derived from his Document 6.

3.3 Mr Binns' Document 6 :

The report by the University of East Anglia, aimed specifically at the Thames Barrier, gives a range of 14cm to

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90cms for "rise in high water level in the Thames Estuary between 1990 and 2030" (Fig 4). These are derived from Fig 2 which quotes global **mean** sea level rises by 2030 of 5cm to 41cm (with a best estimate range of 17cm to 26cm).

The justification of the regional applicability is not given but it does allow for sinking of the land mass.

3.4 Mr Binns' Document 10 :

The letter from the Institute of Oceanographic Science to Mr Binns (dated April 1987) does not give firm advice but quotes world-wide drops in MSL (para 1), rises of "several metres" by 2100 (para 2), and the past trend of 1.5mm p.a for Southend and Sheerness referred to in 2.2. above.

N.J.C.

3.7.90