

An Economically Efficient Strategy for Coastal Defence and the Conservation of the Intertidal Zone

A report examining how the need for coastal defence may be balanced with the ecological imperative of maintaining the intertidal zone and the current impediments to such a strategy.

by

John Bowers

to

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1

The significance of Britain's intertidal zone and the problems it faces

Britain's intertidal flats, marshes and beaches are extraordinarily important to both people and wildlife. These habitats are the biological engines that fuel the ecology and biodiversity of much of the natural world and, in consequence, their human and ecological significance stretches far beyond their immediate boundaries¹.

- Their natural productivity is a vital source of food for internationally important wildlife populations, including commercially exploited marine species and migrating birds.
- They maintain the quality of the environment by absorbing and processing pollutants.
- They dissipate wave energy and control the magnitude of floods.
- They provide the basis of human communities.
- They are an integral part of many beautiful landscapes that attract people and form the foundation of important recreational and tourist economies.

Hitherto the system of management of coastal defence has been responsible for large-scale loss and damage to intertidal habitats and wildlife. A negative relationship between defence and wildlife is neither desirable nor inevitable. It is not desirable because it is economically inefficient and damages the ability of the environment to provide important ecological and socio-economic benefits. It is not inevitable because cost effective and sustainable coastal defence management would ensure the maintenance and improvement of coastal habitats for purely practical, as well as ecological, reasons.

Historically, inter-tidal losses have been mostly the result of land claim. Table 1 summarises loss from some of the major estuarine systems. Some of these large-scale land claims took place long in the past and are not realistically reversible. None-the-less, when viewed against the historic losses, the depredations of the twentieth century are not insignificant. Furthermore they

¹ See Appendix

are continuing. In the past 25 years more than 850 ha of intertidal habitat has been claimed from the Wash. In the Greater Thames in the fifteen years to 1988 nearly 100 ha of saltmarsh was reclaimed, a loss rate per hundred years of 643 ha, comparable with the historic long-term rates. While the large-scale land claims of earlier centuries are unlikely to be replicated in the immediate future, they are not beyond the bounds of possibility and reclamation remains a significant cause of loss of intertidal habitat. In the last 20 years major schemes for water storage on the Wash and Morecambe Bay and tidal barrages on a number of estuaries, including the Severn, have been seriously examined, with millions of pounds spent on feasibility studies. The Cardiff Bay Barrage to provide a water feature for urban regeneration is a recent example of large-scale destruction of the inter-tidal zone.

	Area of loss (ha.)	Period
The Wash	32,000	since 17th Century
Humber Estuary	6,700	since 17th Century
Severn Estuary	8,000	since Roman times
Dee Estuary	6,000	since 1730
Greater Thames Estuary	4,340	mostly pre 1800
Tees Estuary	3,300	since 1700
Ribble Estuary	2,320	since 1800
Firth of Forth	2,280	since 1900
Morecombe Bay	1,320	1200-1900
Suffolk Estuaries	9,740	since 1200
The Solent	1,180	since 19th Century
Poole Harbour	530	since 19th Century
Mersey Estuary	490	1800 - 1900
North Norfolk	180	since 1790
Tay Estuary	150	1802 – 1900

Table 1

Examples of areas of historical land-claim on some British Estuaries

Adapted from Davidson et al 1991 and other sources

Recent research shows that land claim has been replaced by erosion as the primary cause of intertidal habitat loss. English Nature studies of the Kent and Essex coast indicate that saltmarshes are eroding at a rate of about 1.5 per cent per year (Burd 1992). Another English Nature report (Pye & French 1993) predicts losses of between 110 to 130 square kilometres of intertidal habitat in the 20 year period to 2013 – an intertidal area about the size of the Humber!

This alarming increase in the rate of erosion is a consequence of global sea level rise, regional tectonic tilt and the legacy of land claim.

If the intertidal zone is to maintain itself in the face of rising sea levels, it needs to adjust. As the sea level rises, the coast, in the natural course of events, would retreat. It cannot do so because man-made 'hard' defences, sea walls and embankments, restrict it. Unable to migrate, the saltmarsh zone is eroded and destroyed, becoming open tidal flats. The previous tidal flats in turn are drowned and become permanently covered by water.

Table 2

Predicted losses of coastal habitats in England 1993-2013						
Habitat type	Area (ha)					
intertidal flats	8,000 - 10,000					
saltmarsh	2,750					
sand dunes	240					
shingle	200					
saline lagoons	120					
Total	11,310 - 13,310					

Source: Pye & French 1993

This squeeze on coastal habitats, which is party due to sea level rise and partly due to land claim and defence, poses a major threat to the integrity of the intertidal zone, thereby threatening valuable ecosystems with their attendant wildlife. It is also a threat to coastal defence, water quality, fisheries and treasured landscapes.

The extent of this threat can be gauged from Table 2, which gives the latest official estimates. These figures equate to 100-year loss rates of loss 55-65,000 ha, far exceeding historic rates of reclamation. Our 'guestimate', based on a reasonable geographic apportionment of these figures, is that over this 20 year period, 1,500 ha of intertidal habitat will be lost on the Wash, 6-700 ha. from the Humber and 3,000 ha from the Essex and Kent estuaries. These figures translate to 100-year loss rates of 7,500 for the Wash, 3,000-3,500 ha for the Humber and 15,000 ha for the Kent and Essex estuaries, which can be compared with the historic loss rates from land claim in these areas as shown in Table 1. Thus the present squeeze on the coast constitutes a serious crisis

for the intertidal zone. If action is not taken to offset the anticipated losses, valuable habitats and unique wildlife will be lost on a massive scale.

Box 1 How big is the intertidal area? A visit to a large intertidal area such as the Wash or the Humber may suggest that there is so much intertidal mud that the loss of a few thousand hectares is hardly likely to upset the balance of nature. However, local impressions can be deceptive. Intertidal flats and marshes are nationally and internationally scarce. In fact, intertidal areas cover just 1.3 per cent of the UK landmass considerably less than woodlands or urban areas. Most intertidal areas are associated with estuaries or sheltered coastal areas protected by offshore sandbanks. Proportion of intertidal area to land mass in the UK Agricultural land Other terrestrial Intertidal areas areas

Box 2 Sea level change and the intertidal zone

Sea level change is one of the natural variables that are responsible for the formation of many of Britain's most interesting landscapes. Indeed, the ecological value of the coast has much to do with the stresses imposed on it by the ever-changing nature of the sea. Archaeology tells a story of human society's ever-changing relationship with coastal change – a two way process of exploiting the riches of the coast when they are available and adapting to change when necessary. Many of the embankments and land claims of the 12th to 19th century were made possible by much lower rates of sea level change in the period.

The coast has the natural capacity to cope with change by evolving new and flexible habitats such as saltmarshes, mudflats and beaches. However, three things now threaten the coast's capacity to adjust and maintain its ecological value:

- the inflexibility imposed by coastal defence structures,
- the rate of sea level change, and
- the reduction in sediment supply which has resulted from coastal defence works.

Global sea level has been rising gradually for the past century. In the south and east of Britain this is amplified by isostatic sea level change – the sinking of the Earth's crust. Climate change is now further influencing sea level. As a result of atmospheric warming, the oceans are warming and thermal expansion is increasing the volume of water. Even if global warming slows, the oceans will continue to expand for many years because of the slow response times. The best estimates for average sea level change in the UK to the middle of the next century is 28 cm. However, due to changing land levels there may be considerable regional variation.

The actual measured rate of sea level change in recent years around the coast of Britain show a trend of sea level rise ranging from 0.7 mm/yr in

Aberdeen to 2.2 mm/yr in Sheerness. (Hulme & Jenkins, 1998). Government has asked coastal defence authorities to plan for and average sea level rise in the years to 2030 of 6 mm/yr in the south and east of England; 4 mm/yr in the north, and 5 mm/yr elsewhere.

Such rates of sea level rise are comparable with those following the end of the last ice age and unprecedented in recent centuries. These rates may breach thresholds in the coast's capacity to maintain the intertidal zone (Pethick 1993). Evidence of this comes from recent observations of shoreline erosion and the archaeological record. For example, archaeological research on the Wash reveals that the shoreline was able to adjust to gradual rises in sea level. However, when the rate of sea level rise increased above 5 mm/year over a fifty-year period, erosion occurred (Shennan 1992). The Government's figures suggest that this critical threshold will be breached in the near future. Events at one site where saltmarsh erosion is threatening the stability of the flood defence indicate that the process may already have begun.

The best response to the threat posed by sea level rise is to retreat to a more resilient line of defence where this is practicable in undeveloped rural areas, and to redirect resources to provide high levels of protection to centres of high population.

2 A sustainable coastal defence strategy

To offset the effects of rising sea levels on the intertidal zone and maintain the resilience of coastal defences, the shoreline needs to retreat. Indeed, successive governments have accepted that "the response to sea level rise should not be the construction of ever higher defences that commits future generations to unsustainable levels of investment". (MAFF, 1998b). The objective of policy should be that of maintaining at least the aggregate area of the intertidal zone with its attendant valuable habitats and wildlife. Anything less can hardly be considered sustainable. If English Nature's predictions are correct, this means abandoning the defence of approximately 13,000 ha of land over the next 20 years to meet the losses forecast in Table 2.

This objective, however, cannot be achieved by realigning the coastal defence line everywhere. Substantial stretches of the coast are under urban development and retreat in many parts of this area is impossible or impossibly expensive. In consequence, losses of valuable intertidal systems will be experienced on the urbanised coast and these losses will be accompanied by rising costs of increasing defence standards via 'hard' defence structures and (given predictions of greater severity of storms) maintaining them.

To offset these inevitable losses the inter-tidal zone does not simply need to be maintained but to be increased where the opportunity to do so exists. It exists primarily on the rural estuarial eastern coastline from the Humber southwards to Kent. Strategy in this area should aim at a net increase in the intertidal zone with the coastal realignment managed primarily by soft defences so as to allow the maintenance or development of saltmarsh and mudflats, or shingle and dune systems.

Whilst there has been talk of managed retreat in the press and elsewhere, the practice to date has been confined to a very few well publicised cases, which in no way offset ongoing losses to erosion and development. The latest estimates of saltmarsh loss in the six years since 1992 is 600 ha to sea level rise alone. The total area of managed retreat and saltmarsh creation in the same period, at less than 100 ha, falls far short of that (see Figure 1).

The UK's Biodiversity Action Plan establishes a target of recreating 140 ha of saltmarsh per year to offset recent and ongoing losses. If the published predictions of losses to intertidal flats prove correct, an even higher target will have to be established for mud and sand flats to maintain a position of no net loss. In any case, it is clear that in order to meet the Government's stated biodiversity objective, it will be necessary to engage in a far more widespread and extensive programme of managed realignment than hitherto.

Figure 1



We believe that a programme embracing this strategy is feasible and indicate below where the realignment might take place. Such a programme is necessary in order to protect the resources of the intertidal zone. It is furthermore an economically efficient strategy for coastal flood defence. It will cost less than maintaining the existing line, thereby freeing resources for the more expensive defences necessary to protect the urban areas from the impact of rising sea levels. This report thus concurs with the view expressed in the recent report of the House of Commons Agriculture Committee:

'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 coastal erosion.' (House of Commons, 1998)

The programme of realignment proposed in this report is not only feasible, it is economically efficient because the costs of protecting many rural areas exceed the benefits of doing so. Many of the defences involved would not have been built in the first place if the current rules for cost-benefit appraisal of flood defences had been applied to them. It will not be economic to replace them at their existing levels when they become due for replacement, still less to upgrade them to higher standards necessary to meet the problems of rising sea levels. (See Box 3)

Thus such a programme to protect the inter-tidal zone accords with the principles of sustainable development; it safeguards the interests of future generations without imposing needless sacrifice on the current population. MAFF's own definition of sustainable coastal defence is defence that is strategically planned and "avoids as far as possible tying future generations into inflexible and expensive options for defence" (MAFF 1993). This objective is diametrically opposed to much current practice but entirely consistent with the findings of this report.

Nonetheless, unless the existing system for administering flood defence is reformed, the required changes in defence management are unlikely to take place. The defences of many of the areas identified in this report will be maintained and upgraded; to the detriment of wildlife and at a high cost to the public purse. The reasons for this and how the system needs to be reformed are discussed in succeeding sections of this report.

A programme of realignment is not required simply to safeguard the intertidal zone. In some cases the obvious places to retreat may be valuable coastal habitats such as coastal grazing marshes and other types of wetland. Brancaster Marshes on the North Norfolk coast is one example. The UK's commitments to sustainability, biodiversity, and the protection of internationally important wildlife sites require that these scarce and valuable habitats be replaced. In the absence of a national programme of retreat, opposition to otherwise sensible but piecemeal realignment will be mounted not only by agriculturists but also by conservationists who will be forced into trading off losses of the intertidal zone against habitats above the tide-line whose value and existence, ironically, depends on the intertidal zone that is being sacrificed.

Box 3

The Economics of Hard Defences for Agricultural Land

Between 1953 and 1993, £200 million was spent improving and maintaining agricultural sea walls in Essex, equivalent to £14,700 per hectare of land protected. (Dixon and Weight 1995)

With a project life of 30 years and a discount rate of 5 per cent, expenditure on that scale, to be economically justified, would require an annual agricultural benefit of £1086/ha. At 10 per cent, the discount rate that applied to flood defence projects for most of the 1960s and 70s, the annual benefit would need to be £1549/ha.

The appropriate measure of benefit is the social net margin: the value of output net of subsidies less the costs of variable inputs and capital consumption. (Gross margin, net of subsidies less current costs of plant and machinery.) The main benefiting crop grown is winter wheat. Gross output/ha of wheat in the UK at current prices in 1953 was £61 (Marks and Britton, 1989). By the early 1970s, on the eve of entry into the CAP, it had risen to £179. It rose steadily thereafter to £1,115 in 1983 and £1,640 in 1993 (MAFF 1997). Thus only at the end of this period was the gross output, before deductions for inputs and subsidy, sufficient to yield a return on the expenditure. We may conclude that little, if any, of this expenditure could have been justified on a cost-benefit analysis.

Dixon and Weight's paper goes on to say, 'During this period rising sea levels and consequent increased tidal and wave energies had continued the erosion process to fronting mudflats and saltings requiring additional maintenance to some distinct lengths of sea walls, with equivalent 1995 costs of more than £40k per hectare of land protected.'

On the same assumptions, expenditure at that level would require a

benefit of £4,243/ha at a 10 per cent discount rate, or £2,602 at the prevailing 5 per cent. Again, these necessary benefits exceed gross outputs. It may be concluded that upgrading and maintaining sea defences for purely agricultural land could not be economically justified.

Proposals for Essex sea wall management (EA, 1998) fall far short of the degree of retreat that economics would dictate. The underlying reasons for this are political rather than economic and are analysed later in this report. The proximate cause in many cases is that agricultural flood defence is riding on the back of the defence of urban property. The case of Wallasea Island is examined in Case Study 2 below. With the Dengie peninsula, where there has been much recent reclamation, the protection of 4,500 ha of land rests apparently on the presence of 20 farm buildings (p 10). In contradiction of Government policy, the Essex LFDC states that any realignment that takes place should be coupled with full compensation to landowners for any land lost and that there should be no presumption in favour of managed retreat.

3 Where to retreat

A review of potential areas for defence realignment reveals that the predicted national losses of intertidal habitats could be offset by retreat in areas of purely agricultural land on the East Coast. These are the areas where the present loss to coastal squeeze is most rapid and where, in general, maintaining the existing defence standard on the existing line, still less raising it, is not economic (see Box 3). Table 3 identifies the areas where the required retreat can be achieved. If carried out in full this programme would more than meet the anticipated losses over the next 20 years and would go some modest way towards reversing the depredations to the intertidal zone that have taken place over recent decades.

		ha*
Humber	Inner Humber	650
	Outer Humber	3,200
The Wash	Lincolnshire Wash	4,000
	Norfolk Wash	2,300
Essex estuaries	Dengie Peninsula	4,500
	Crouch / Roach system	2,200
	Blackwater Estuary	1,700
Kent estuaries	The Swale and Medway estuaries	3,500
	Total	22,050
		* opprovimete erece

 Table 3

 Low lying agricultural areas that may be suitable for managed realignment

* approximate areas

Retreat on a scale sufficient to make meaningful contribution to the objective of maintaining the national resource in the next century can be achieved in three distinct geographical regions – The Humber, The Wash and the Essex and Kent estuaries. (Figure 2)

There are many other sparsely populated sections of coast, both in these regions and elsewhere, where the most sustainable and economically sound option may be to set back the line of defence. However, the sum of many such rational, but small-scale realignment schemes is unlikely to be sufficient to answer the need to prioritise defence expenditure towards densely populated

areas and provide enough new intertidal habitat to offset predicted losses. Economies of scale dictate that large-scale realignment in a medium timeframe will be the most economically efficient and ecologically effective way of meeting the objective.

Figure 2



The programme would save money in three ways:

1) Expensive and uneconomic hard defences to protect these areas would not be constructed.

2) While in some cases a hard line would need to be built further back to protect urban assets and limit the retreat of the shoreline, the total length of hard defence would be reduced

3) The soft defences in front of the new line would provide protection and reduce the scale and cost of the new defences.

The size of the savings and the extent of the retreat in each area will depend on estuarial dynamics, which in some cases have not been fully investigated. For this reason the programme is in broad terms.

Even in its entirety, at around 22,000 hectares, such a programme would amount to a little more than one tenth of one per cent (0.12 per cent) of the total agricultural land in the UK or 7.2 per cent of the total set-aside land in 1997. The programme would take place over an extended period and should be largely achieved, not by destroying existing defences, but by failing to replace them as they decline. In consequence, not all of the land would be lost to agriculture in the short run since initially, with rising flood risk, it would become fresh grazing marsh.

The programme would contribute to two of MAFF's key targets to be delivered by the end of the Parliament as laid down in the Comprehensive Spending Review of July 1998 (MAFF, 1998a). It would contribute (albeit modestly) to the target of reducing the cost of the CAP to consumers and taxpayers and help to sustain and enhance an attractive and accessible countryside. An Economically Efficient Strategy for Coastal Defence and the Conservation of the Intertidal Zone A Report to The Joint Marine Programme of The Wildlife Trusts and WWF UK by John Bowers

4 The existing structure of flood defence

Statutory responsibility for flood defence rests currently with the Environment Agency. It inherited these duties from the National Rivers Authority set up under the Water Act 1990, which privatised the water industry. Prior to privatisation, responsibility under the 1973 Water Act lay with the Regional Water Authorities (RWAs). MAFF was the sponsoring ministry for the flood defence and land drainage activities of the RWAs and this arrangement survived the changes of water privatisation. Thus we have the anomalous position that the Environment Agency is answerable to MAFF for its flood defence responsibilities but to DETR for all of its other environmental duties.

Direction of the flood defence activities of the Environment Agency is carried out by Regional Flood Defence Committees. These bodies comprise a Chairman and a number of members appointed by the Minister of Agriculture, one of whom represents conservation interests; two Agency nominees and elected members from local authorities. The elected members must constitute a simple majority of RFDC membership. This structure is also, in its essence, a carry over from pre-privatisation, when the similar committees had a different name, Regional Land Drainage Committees. Like their predecessors, RFDCs can devolve their responsibilities to Local Flood Defence Committees and have done so, notably, for our purposes, in Anglian Region. LFDCs comprise a Chairman and members appointed by the RFDC and, again, a majority of elected local authority members. The LFDCs parallel Local Land Drainage Committees of pre-privatisation times.

The continuity of the RFDCs with earlier bodies is evident in their statutory duties, which derive from the 1930 Land Drainage Act, namely:

- general supervision over flood defence;
- permissive powers to undertake flood defence work;
- consent powers for works affecting flood drainage systems;
- powers to raise drainage charges.

To these, the Environment Act 1995, amendments to the Water Resources Act 1991 and the Land Drainage Act 1991, added a number of overriding duties including:

- assisting in the achievement of sustainable development;
- promotion of conservation;

Statutory guidance under the act required the Agency: (EA, 1997)

- to operate on the basis of sound science;
- to provide value for money;
- to manage the environment in a holistic way;
- to achieve national consistency in its operations.

While a large number of coastal local authorities have responsibility for controlling coastal erosion which can clearly affect the intertidal zone, responsibility for flood defences on most major estuaries and lowland coasts lies with the Environment Agency. The principal exceptions are private defences, which tend to be around relatively recent land claims. Large sections of the defence embankments on the north shore of the Humber, for example, are owned and maintained by the Crown Estate. Executive powers for planning, approving and ensuring the funding for defence works lies with the FDCs. A case for rationalising the powers for coastal protection and concentrating them with FDCs was put strongly by the House of Commons Agricultural Committee which was concerned particularly with 'ending the artificial distinction between sea defence and coast protection responsibilities' (House of Commons, 1998 para 67). While this case is persuasive it is not a central problem for the issue of managed retreat.

Flood defence schemes are funded from precepts levied on local authorities and-grant aided by MAFF. To be carried out, all schemes have to be economically viable, this being defined as having a benefit/cost ratio >1 on a cost benefit analysis (cba). This has been the case since the 1973 Water Act. Previously it was a Treasury condition for the payment of grant-aid. That is still the case, but the requirement on the Agency to provide value for money makes it a requirement even on schemes that attract no grant. It is not clear that the requirement for a cba applied to coastal defences constructed before 1973. Thus the large scale strengthening of coastal defences following the 1953 East Coast flooding, was probably not subject to economic appraisal. Most of these defences were upgraded or replaced after 1973. But even though subsequent defences were subject to cba there is no reason to suppose they achieved economic viability. This is because the MAFF guidelines on cba were seriously defective. According to these guidelines agricultural output was to be calculated at farm gate prices, which included substantial subsidies. Depending on the timing of the scheme and the nature of the agricultural enterprises affected, scheme benefits would have been overstated by between 50 and 100 per cent from this cause alone, and some 16 other ruses for overstating benefits have been identified (Bowers, 1988). This treatment of subsidy was in breech of the Treasury guidelines on investment appraisal in the public sector, as was successfully argued by the environmental objectors to a public inquiry into a flood defence scheme at Amberley Wild Brooks in 1977. Nonethe-less MAFF did not issue revised Guidelines until 1985.

The areas that this report has targeted for realignment in order to safeguard the stock of intertidal habitats are all agricultural areas, some of them reclaimed in the last few decades. The flood defences that protect them would, in most cases, never have been built had the current cba guidelines been applied. They were built because either cba was not conducted or the guidelines applied were defective. On economic grounds alone they should not be replaced, still less upgraded for higher sea levels, when they reach the end of their effective lives. On environmental grounds they should not be replaced either; so in this case, economic and environmental considerations are in harmony.

Despite a strong environmental and economic case for retreat, there are strong pressures to maintain the existing line, subject to a few symbolic and expensive schemes for managed retreat, where the emphasis is very much on the managed. This is illustrated by the cases of the Yare Barrier (see Yare Case Study below) and with Wallasea Island (Case Study below). Subsequent sections of this report examine the obstacles to a rational and economic programme of realignment. Section 5 considers the administrative obstacles;

section 6 considers the obstacles posed by institutional practice and section 7 the defects in the appraisal Guidelines.

Case Study The Yare Barrier, Norfolk

The proposed Yare Barrier would have been an hydraulic tidal barrier located upstream of Great Yarmouth in Norfolk. When operated it would protect the rivers of the Norfolk Broads (the Yare, the Bure and the Waveney) from tidal surges. It is probably the single most environmentally disastrous flood defence scheme to be proposed in the post Second World War period. The area it would protect is entirely agricultural and, as envisaged in the original study (AWA, 1977), the 'benefit' from building it would have been the conversion of effectively the entire grazing marshes of Broadland to intensive arable agriculture. Although the Yare Barrier has not been built, it has equally not been abandoned, and has been removed from the shelf, dusted down and revamped for the new situation of sea level rises. The scheme is thus of more than historic interest and illustrates many of the malpractices discussed in this report.

The first study of the scheme identified 10,500 ha of land that would be affected by the scheme. Some of this had already been agriculturally improved. As a result of reduction in flood risk an additional 6,700 ha would be developed over the next 25 years, changing from grazing marsh to a mixture of cereals, root crops and intensive livestock. The measured agricultural improvements were valued at farm-gate prices with no adjustment for subsidy, and the quota controls on beet and potatoes were ignored. Despite these sources of substantial over-statement of benefits, the scheme proved not to be economic with costs exceeding benefits at the, then, 10 per cent test discount rate by £5.2 million at 1998 prices.

This finding should have led to the abandonment of the scheme. Of course, it did not do so. Instead the consultants were launched on a phase two study with instructions to find more benefits². And they found them. 'Studies of IDB records' increased the area at risk by more than 4,000 ha. 'Previous over-estimates' of the area already improved and of the amount of improvement that would take place without the scheme, added another 1200 ha. The period for

² This response to an adverse cost-benefit study is not unique. In the study of a flood defence scheme for the River Brue in the Somerset Levels the land drainage committee sought MAFF grant-aid to pay consultants to search for further scheme benefits!.

benefits take-up was reduced from 25 to 20 years and a highly unscientific telephone survey of farmers enthusiastic about the scheme front-loaded the take-up profile. A further slower development over the following 20 years to 'full potential' was also introduced, at the end of which presumably even National Nature Reserves would be down to winter wheat. As well as the benefiting area, the size of benefit per unit area was increased. Cropping patterns were changed towards higher gross margins and livestock enterprises reduced. Finally the problem of subsidy was recognised. The prices were adjusted to 'long-term world agricultural prices', which turned out to be above farm-gate levels, so that adjusting for subsidy raised scheme values!

Not all of the financial improvements to the scheme rested with agriculture. The alternative to the barrier would have been the raising of flood banks along the Broads rivers. This was rejected in the first phase study as an option because raising to a 1 in 100 year return period, the design level of the barrier, was not feasible. Consideration of bank raising as an option was ruled out in phase two because the flood defence authority had in the meantime committed itself to substantial raising of bank levels. Savings on this programme were henceforth treated as scheme benefits. Costs were also affected by the review. Thus the initial phase envisaged a write-off of existing IDB flood defence structures, primarily pumps, when the barrier was built. In phase two it was decided that these were all obsolete and in need of replacement anyway.

The result of the phase two exercises was a turn round of £12.8 million at 1998 prices with the benefits now comfortably exceeding the costs. Ironically, by the time that the scheme was being questioned in the early 1980s, the test discount rate had been lowered to 5 per cent. Phase one of the scheme would have been viable at that rate.

While the cost-benefit test was plainly not an insurmountable barrier to a flood defence authority determined to promote a grandiose scheme, it arguably did delay matters long enough for the environmental opposition to get organised. Phase 3 of the Barrier study (AW, 1983) took place against a background of mounting concern about the loss of Broadland ecosystems and landscapes. One of the objectives of the reappraisal was therefore to placate environmental objections to the Barrier. It did this in two ways: by excluding environmentally

valuable land: SSSIs, nature conservation areas and designated areas of landscape interest, from the areas at risk of agricultural improvement; and by arguing that this land would benefit from protection against tidal surges and including it as part of the benefit. Flood protection on 'environmental' land was arbitrarily valued at twice the imputed cost of a management agreement.

The resulting environmental benefit was needed because the benefit of agricultural development, on which phases one and two had rested, had fallen apart. The agricultural benefit of the Barrier depended on an untested hypothesis, that the factor preventing agricultural improvement of the Broadland grazing marshes was the high level of flood risk. This was wholly false. At the level of agricultural prices then prevailing, conversion to arable would have yielded an acceptable rate of return to the farmer at a flood return period of 1 year in 10. The existing banks provided lower risk than this over most of the area. Conversion would thus take place in any event and the most that the Barrier could do would be to speed up the process (Bowers, 1978).

By the time of the third phase of study the rate of conversion without the Barrier was exceeding forecasts of conversion rates with it. The consultants for the flood defence authority faced a dilemma. If they assumed that the Barrier was irrelevant to agricultural development, then there was no economic case for it, since the benefits of flood protection to existing cropland, even at subsidised farm-gate prices, which continued to be used, were trivial. On the other hand, the political need to exclude environmental land from potential development meant that if they continued to assert that the Barrier was necessary for agricultural improvement, there was not enough land remaining to be developed to provide the necessary benefits. Resort was made to the expedient of tying the scheme to urban flood protection, which could be relied on to yield a good benefit-cost ratio. Phases one and two had examined flood protection of Great Yarmouth downstream of the Barrier. This was loosely connected to the Barrier since the backing up of tidal surges with Barrier operation meant that the sea defences would need to be raised somewhat. In phase three a more extensive scheme of sea defence improvements for the entire urban area, unconnected to the Barrier but with a benefit cost ratio of nearly two, on an expenditure of £7.9 million (1998 prices) was incorporated. This, plus the alleged environmental benefits, when coupled with an

undefended assumption, in the teeth of the evidence, that the Barrier was necessary for further agricultural improvement, pushed the benefit cost ratio for the Yare Basin Flood Control Scheme, to a little above unity.

The current strategy for flood protection of Broadland developed in the 1990s centres on a programme of bank maintenance and raising along the Broads rivers. The works are designed to 'maintain the banks at approximately their existing standard over the next 15 years by building in an allowance for settlement and sea level rise.' (EA, 1997b). The Yare Barrier has been rejected at present on cost grounds but it has not been abandoned; 'in the long-term, particularly if sea level rise from global warming is a reality, the only effective method of flood protection would be a barrier or barriers.' (ibid.). Thus the Anglian Flood Defence Committee is having no truck with managed retreat. Not only will Broadland make no contribution to reversing losses of the intertidal zone but, if this strategy is adhered, to it will add to the problem since valuable inter-tidal habitat notably Breydon Water, an internationally important Ramsar site and Special Protection Area, will be drowned. It might be argued that what this strategy is aiming to do is to maintain the integrity of the Broadlands grazing marshes since, if the incidence of flooding on them is kept constant, then ecological change from sea level rise is avoided. Two comments are in order here.

First the current level of flood risk on these marshes was set by the programme of bank raising initiated in the late 1970s and discussed above in the context of phase two of the Barrier appraisal. Apart from climatic amelioration, over which the Land Drainage Committee has no control, there are two possible sources of ecological deterioration on the marshes: agricultural improvement and botanical succession consequent upon reduced flood risk. No mention of the latter is to be found in the strategic environmental assessment (EA, 1997a) or indeed in any other of the Broadland documents. The assumption seems to be that only the former is an operational force, so that if agricultural change is prevented. For example, by the creation of an ESA or management as nature reserves, then the flood risk may be reduced effectively to zero, or the balance between fluvial and tidal flooding altered in favour of the former, without any change in the biological status of the land as grazing marsh. If botanical change does take place from variation in tidal flood risk it is likely to be a slow process since the return period of tidal flooding on much of the marshes was low even before the 1970s improvements. But if it is taking place then the Broadlands strategy is consolidating it. Part of the trouble here seems to be a lack of clarity on the balance of environmental objectives in the strategy between landscape and ecology. The decision to maintain the flood risk standard imposed in the 1970s may conserve the landscape but it is not clear that it is appropriate for conserving the ecosystems of Broadland grazing marshes.

Second, bank raising contributed to the rapid rate of agricultural improvement noted in Phase 3. If the contribution of the Broadland to habitat conservation in the face of sea level rises is to be the retention of grazing marshes, then attention should be given to reversing the recent losses from agriculture. Raising the flood risk should be part of any strategy for doing so. An Economically Efficient Strategy for Coastal Defence and the Conservation of the Intertidal Zone A Report to The Joint Marine Programme of The Wildlife Trusts and WWF UK by John Bowers

5 The administrative structure

A major obstacle to the formulation and promulgation of sustainable flood and coastal defence is the deep-rooted tradition of privileged treatment of agricultural interests in coastal protection. While this was never economically justified, in the past the political pressures for it were strong. That they have now lessened is shown by the view of the House of Commons Agriculture Committee:

'the lessened need for domestic agricultural self-sufficiency, and the significant farm policies encouraging costs of agricultural explicitly acknowledged in overproduction. need to be the implementation of local responses to flood defence and coastal protection of agricultural land, including, where appropriate, the managed realignment of the coastline.' (House of Commons, 1998 para 40.)

The correction of the agricultural bias in the administration of flood defence is crucial to achieving sensible flood defence management and conserving the intertidal zone. While the bias remains, expedients will be found for protecting agricultural land whatever rules are laid down from the centre. The requirement to demonstrate economic viability through a cost-benefit analysis has proved no deterrent to the promotion of uneconomic schemes of agricultural flood protection and the ways that the requirement was circumvented have been documented (Bowers, 1988). With the bias intact, new thinking on flood defence yields other expedients for maintaining the protection of agriculture. Thus the need to gather information on estuary dynamics before proceeding to retreat is used as an argument against retreat itself. An example is Wallasea Island on the Essex coast (see Yare & Wallasea Case Studies below) where enhanced flood defences with a scheme life of 25 years are proposed because research to determine the consequences of retreat has not been done!³ (Letter

³ The necessary research would not take more than one or two years. The details of the cost-benefit appraisal of the Wallasea scheme are withheld on grounds of confidentiality, since all the benefits accrue to one farm, despite the fact that MAFF current guidelines actually state that 'A summary of the economic data used for the appraisal options should be provided on request.' (MAFF, 1996). This is an old and well tested device for suppressing opposition to controversial schemes, see Bowers *loc. cit.* The issue of whether it is

from the Environment Agency Area Flood Defence Manager (Eastern) to The Wildlife Trusts).

The dominance of agricultural interests is symbolised perhaps in the anomaly that the EA is answerable to MAFF for flood defence and land drainage activities rather than DETR, but it goes far beyond the symbolic. Chairmen of Flood Defence Committees are frequently farmers and agriculture is overrepresented among committee membership, particularly on Local Flood Defence Committees. Engineers and other staff in the land drainage divisions of the Agency in many cases served under the old Land Drainage Committees where the dominance of agriculture was intentional, and retain previous perspectives and habits of thought. Without reform, this structure is unlikely to deliver more than token retreat, heavily managed so as to cost little less, or even more, than defence of the existing line.

Comment is required on the choice of Ministry and on the composition of FDCs. Recommendations are underlined.

5.1 Should MAFF be responsible for flood defence?

A case can be made for MAFF being in fact an environmental ministry since it is responsible for habitat restoration and environmentally friendly farming programmes. Its guidance and directives on flood defence give high weight to environmental matters and agriculture is placed appropriately low in the scale of flood defence priorities (MAFF 1993). Following the 1998 Agriculture Committee Report on Flood and Coastal Defence, it is clearly the Government's intention that MAFF should retain its responsibility (MAFF 1988b). Indeed, there are good reasons for this in view of the criticisms of the operating authorities detailed below. Nonetheless, it is useful to critically consider MAFF's role. In addition to some criticisms of the detail that are made in subsequent sections, there are three main objections to MAFF as the sponsoring ministry for flood defence.

5.1.1 Compensation Probably the major concern over MAFF stewardship of coastal defence concerns the issue of compensation. MAFF's environmental

appropriate to spend millions of taxpayers' money for the benefit of one individual or farm company is of course not considered.

programmes all offer farmers compensation for environmental improvements and sustainable management. The schemes include one for saltmarsh recreation, which has been used in some of the experimental examples of managed retreat. There is clearly a case for compensation where farmers voluntarily forego income in order to protect or enhance the environment. In such circumstances, payments under management agreements are the efficient instrument for achieving environmental objectives (Bowers 1997). However, there is no reason why they should be compensated for losing land when it is not economic to replace or maintain flood defences. Flood defence is a permissive power and landholders have no right to any particular level of flood defence. Government restated this well established principle in its response to the Agriculture Committee report when it said "there is no general obligation to build or maintain defences either at all, or to a particular standard" (MAFF, 1998b). The cost of flood defence investment is borne by the taxpayer and not the landholder. As argued above, it is likely that there was no proper economic case for these defences when they were built. Thus farmers will already have benefited from many years of agricultural subsidies as a result of this initial subsidy from the taxpayers. The Agriculture Committee took the contrary view and were

'firmly convinced of the need to put in place a robust financial mechanism for the reimbursement of property owners and landowners whose assets are sacrificed in the wider interests of the community' (House of Commons, 1998. para 104)

The issue is whether landowners have the right to expect the taxpayer to protect their property when the costs of doing so exceed any possible community benefits. MAFF's traditional practice on environmental matters might be taken to mean that it would naturally look to some form of voluntary agreement with compensation as a way of achieving retreat. The saltmarsh scheme is indeed such a scheme. It might be thought that compensation to farmers for losses of land through coastal retreat is an issue for taxpayers but not for conservationists. However, compensation is potentially an obstacle to retreat. Flood defence committees are reluctant to lower defence levels, or fail to maintain them, if compensation is not forthcoming. The practice of treating saltmarsh payments as part of the benefits of a retreat scheme encourages this. This practice is wrong. Payments are a subsidy to the farmer and are in no sense a measure of the value of saltmarsh creation. The primary drive for retreat should be the desirability of improving the resilience of the intertidal zone and the economics of maintaining flood defence. Where it is not economic to maintain the existing line then it should not be maintained. The issue of compensation is irrelevant. <u>FDCs should be directed to this effect and compensation payments should not feature in project appraisal</u>.

Despite its past practice there is now no evidence that MAFF expects compensation for losses from retreat. The Environment Agency (particularly FDCs), rather than MAFF, are intransigent on the point of compensation, as the case of the Essex Sea Wall Strategy, referred to above, demonstrates.

5.1.2 Land use planning. A programme of realignment to protect the intertidal zone can be compromised by development in the flood plain. The Environment Agency recognises this problem and, as a statutory consultee, should object to unsuitable development. EA policy guidance on the protection of flood plains is good (EA 1997); unfortunately local practice which depends on the cooperation of local authorities and the DETR, lags behind policy. Land use planning is the responsibility of DETR, not MAFF, and this divided responsibility carries risks for a programme of realignment. Hence if MAFF is to remain the sponsoring ministry for flood defence it is necessary that in exercising its responsibilities for land use planning DETR acts in conformity with it in areas of flood risk. The Agriculture Committee believed that "a clear presumption should be made against future development in flood plain land where the flooding risk attached to a particular development, as determined by the Environment Agency, is deemed to outweigh the benefits. In such cases, the Agency should intervene at all stages of the planning process in such a way as to deter inappropriate development, including, where necessary, referring the matter to the Secretary of State for his or her determination". In its response, Government said that it would "consider whether the present guidance to local planning authorities should be strengthened' (MAFF, 1998b)

5.1.3 Urban interests. MAFF may be in the process of evolution into a ministry of rural affairs. However, according to both MAFF and the conclusions of this

report the main concerns for maintaining and raising flood defence levels are urban not rural. Realignment will be predominantly in rural (agricultural) areas. Flood defence investment will be mainly in urban areas where MAFF has no natural interest.

5.2 The non-elected members of FDCs

The Agriculture Select Committee Report into Flood and Coastal Defence considered that membership of flood defence committees "*should be vetted to ensure they fully reflect stakeholder interests*". Maximising agricultural production regardless of cost was an entrenched policy objective for much of the post-war period. Rural flood defence and land drainage was a primary means of achieving this objective. In these circumstances the central position of agriculture interests on FDCs was understandable. But the situation has changed and there is now no reason why agriculture particularly should have any representation on FDCs.

Agriculture clearly has an interest in both coastal and inland flood defences, since it can suffer losses of production from flooding. But so, by the same token, have a large number of other, if not all, sectors of industry. Urban based industry will have an interest in urban flood defence; industry located on the coastline will be interested in coastal defence and factories and offices located in river valleys will have their concerns. In terms of the allocation of resources between urban and rural, coastal and inland, the interests of industry will conflict. Local interests in flood defence: industrial, commercial, agricultural and domestic, are properly represented by elected local authority members. It is undesirable, indeed democratically improper, for direct representation of interests. The non-elected members should be there for their expertise, as engineers, hydrographers, economists, conservationists, etc. There is no particular need for agricultural expertise in flood defence.

5.3 Elected members and the local interest.

It is desirable, and in conformity with Agenda 21, that, where possible and provided that broader national interests are not compromised, decision making should be devolved to the local level. Elected members of local councils thus
play an important role on FDCs. Elected political representatives are primarily concerned with maximising the resources flowing into the areas they represent. They will wish to ensure that their areas receive their share of the available investment and that their flood defence needs are met, while at the same time limiting, as far as possible, the size of the precept that the FDC levies on participating local authorities. Conflict between elected representatives is too often resolved by increasing the total capital budget of the FDC. This means that FDCs are in competition for available national resources and united in the drive to increase the total taxpayer provision for flood defence. The regional interests, interpreted by flood defence committees are seen as requiring parity of inter-regional expenditure and maintenance of the inherited coast-line; that is, FDCs are likely to resist retreat as disadvantaging their region. To overcome this resistance a clear national strategy needs to be promulgated. This strategy should specify in broad terms the contribution that each region is expected to make to national objectives. Such a strategy should identify those urban areas where defence levels should be maintained or rise⁴ and rural areas where retreat is needed for maintaining the national stock of intertidal habitat. The provision of national funding should be for carrying out this strategy.

This conclusion is in conformity with the views of the Agricultural Committee who wanted MAFF to adopt "a more dirigiste role in guiding the efforts of operating authorities" and "to provide clearer guidelines for RFDCs ... to ensure that, while local needs are respected, the regional targets... also advance national strategic requirements." (House of Commons, 1998. para 70) In its response to the Agriculture Committee recommendations, Government acknowledged that "more needs to be done to translate the national strategy into action on the ground". It considered that "there could be a greater role for less interventionist measures such as beach recharge or realignment of defences, including managed retreat and washland creation, as options for operating authorities to consider within their strategies" and committee MAFF to working with operating authorities to facilitate "greater coherence of delivery and standards, through target setting". (MAFF 1998b).

⁴ Including inland defences against fluvial flooding. Many of the least satisfactory defences are inland and there is a clear need for enhancement of urban defences against fluvial flooding. Provision for inland urban defences will help to overcome opposition to the strategy.

Case Study Wallasea Island, Essex

An extreme example of a section that is hindering potential retreat is Wallasea Island in the Essex marshes.

Wallasea is a large Island (approximately 920 hectares) of reclaimed land between the River Crouch and the River Roach in Essex. It is connected to the mainland by a short tidal road. Most of the area is Grade 3 agricultural land owned by a single farm business. A port and boat yard, a timber yard, a hotel and several residences occupy the western corner of the island. The present standard of defence has been judged to be inadequate and the local and regional flood defence committees have devised a scheme to raise the defences all around the Island - a distance of approximately 17.5 km. The obvious alternative to this `Whole Island' scheme would be to build a new wall across the island to protect all the urban land uses: residential, commercial and industrial and to retreat on the remaining agricultural land. Since the Local Flood Defence Committee has not considered this 'Retreat' option, it is examined here.

The location of the suggested new cut-off wall is shown on the map. It is located so as to maximise the total length of wall that is abandoned, subject to the constraint that all urban land uses are protected. The proposed cut-off wall is 0.93 km in length and the length of sea wall outside of the cut-off wall is 13 km. The 'Retreat' scheme thus would save the expenditure on improving and maintaining 13 km of sea wall at the expense of constructing 0.93 km of wall. As a first approximation the calculations assume that the 'Retreat' scheme will save the cost of improving and maintaining 12 km of wall.

The area of the island outside of the cut-off wall is 801 ha. Not all of this is usable agricultural land for two reasons: about 3.25 ha is taken in the form of farm tracks; and the construction of enhanced defences would entail the digging of a 20 m wide borrow dyke. A dyke currently exists around parts of the area. This appraisal examines the retreat scheme on two alternative

assumptions about the land losses: that the 'Whole Island' protection scheme would lose 20 m (assumption A) or 50 m (assumption B) along the entire perimeter of the agricultural land. The area of usable agricultural land lost by the retreat scheme is, on these assumptions, 739.6 ha (assumption A) or 774.6 ha. (assumption B). The tables, utilising data from Nix (1998) provide the data for placing an economic value on this land.

Figure 3



For this appraisal it is assumed that the area is devoted entirely to the growing of winter wheat. MAFF's Project Appraisal Guidance Notes (PAGN 1993, para G10) say, 'Where it is estimated that the at-risk land would be producing milk, sugar beet, potatoes or horticultural crops or is set aside it should be assumed that the land is producing cereals and appraised accordingly.' This assumption is thus a reasonable one to make for an appraisal. Experiments with mixtures of non-quota controlled crops yielded similar results to those reported here. This appraisal is done in accordance with existing guidelines. It takes no account of the criticisms of PAGN made in this report which would serve to increase the viability of the 'Retreat' option.

Calculation of Adjusted Gross Margins (Nix, 1998 p.3; PAGN para G.11)					
(a)	Yield (tonnes/ha)	7.75			
(b)	Gross output (£/ha)	915			
(c)	Variable costs (£/ha)	255			
(d)	Gross margin (£/ha)	660			
(e)	Adjustment to resource cost (b)x0.35	320			
(f)	Adjusted gross margin (£/ha) [(d) -(e)]	340			

The foregone agricultural output at resource cost is £251,464 per annum (assumption A) or £263,364 per annum (assumption B). From this has to be deducted fixed costs.

Calculation of labour and machinery costs (£/ha)

The data are from Nix, 1998 p135 for a mainly cereals farm of > 200 ha.

	£ per ha per annum
Labour costs	155
Machinery costs	195
Other	70
Total fixed costs	420
Less 20% for efficiency of larger un	it 336

Imputed rent is excluded on the assumption that it is a pure transfer since, in the absence of the Whole Island scheme, the land has no opportunity cost. Other minor items such as vehicle tax and insurance might be deducted on the argument that they are transfers. However, they are conventionally included and are, in any event, too small to affect the outcome.

Thus the social net margin (adjusted gross margin less fixed costs) = $\pounds 4/ha/annum$.

Making the sanguine, but no doubt unrealistic assumption, that a decision to proceed with the 'Retreat' option would lead to an immediate breech of the sea defences of the excluded land, the total agricultural losses from the 'Retreat' option is given by the present value of the social net margin of the

requisite agricultural area. Present value of social net margin for 25 years at $5\% = \pounds 56.4/ha$. Total social net margin from the 'Retreat' scheme = \pounds 43,669 (assumption A) or \pounds 41,696 (assumption B). The longer the abandoned wall survives the lower the agricultural costs of the Retreat option will be.

Expressed per km of sea wall improvement saved the maximum agricultural losses from retreat are \pounds 3,639 (assumption A) - \pounds 3,475 (assumption B).

If the cost of improvement and the present value of maintenance of a kilometre of sea defences of Wallasea exceed approximately £3,700 at 1998 prices, the 'Retreat' option is economically preferred. It is easy to see that this will be so. On the conventional assumption of £5/metre maintenance of the sea walls, the present value of the maintenance programme over 25 years at 5 per cent is £70,470/km. Thus, under either assumption about the size of the foregone agricultural area, even if the sea wall could be improved for free, retreat would still be the best option.

As a check on this conclusion, the budget for the improvement of the entire 17.5 km of sea wall at Wallasea is £2.52 million or £144,000/km. (EA, 1998 table 2.2) Thus there is clearly a substantial saving from the 'Retreat' scheme. The conclusion may be put another way. Provided that new costs incurred in the 'Retreat' scheme (construction and maintenance of 0.93 km of cut-off wall plus any expenditure on items like a hydrological survey associated with abandonment of the defence of the agricultural area) are less than the sum of the cost savings minus the lost social net margin, retreat is the best option. The cost savings are 13/17.5 x £2.52 = £1.872 million. Thus 'Retreat' is the best option if its positive costs are less than £1.868 million.

These figures may be altered in detail by changing the assumptions, but no reasonable changes will alter the conclusion. Substantial reductions in fixed costs by the omission of imputed rent, which is normally included, have already been made. In addition, a very generous allowance has been made for economies of scale. Without these assumptions social net margin would be negative and there would be no benefit, other than savings in constructing 0.93 km of cut-off wall, from protecting the agricultural land. The social net margin would be positive if exceptionally high yields were assumed but there

is no justification for such an assumption and the assumed fixed costs would then need to be higher. Furthermore, a realistic appraisal should allow for the continuation of agricultural output for some time after the decision to abandon the defences is made. This appraisal, by assuming an immediate breech, puts a <u>maximum</u> value on the agricultural losses. A realistic appraisal would put the agricultural losses even lower.

In an attempt to defend the economically indefensible, the Local Flood Defence Committee has argued that a buried cable that runs across the Island warrants the additional expense. Since the cable runs under an estuary to get to and from the Island, this argument is incomprehensible.

This case demonstrates the reluctance of local and regional FDCs to look seriously at alternatives to 'holding the line', and the consequences of using the arguments for defending commercial and residential development to justify the continuing protection of agricultural land.

If the defence around the farmland were left unimproved the probability is that it would not immediately revert to intertidal flats. The pattern of flooding would, in time, probably lead to a change in agricultural use from arable to grazing. The UK Biodiversity Action Plan for Coastal Grazing & Flood Plain establishes a target of creating 2,500 hectares of grazing marsh on what is now arable by the year 2000. Saving money on the defence to Wallasea could also help provide almost a third of that target.

In the longer-term the site may be suitable for intertidal habitat restoration. The Crouch Estuary has been canalised by long history land-claim, causing large losses of intertidal areas and ongoing flood defence problems. According to a Nature Conservancy Council report in 1992, more than a quarter (124 ha) of the saltmarshes of the Crouch were eroded between 1973 and 1988. The current estimated national loss of saltmarshes as a result of rising sea level is 100 ha per year. Bridgemarsh Island (also on the Crouch) was formerly a claimed marsh, but since 1927 breaches in the sea wall have allowed flooding with seawater. The island has now reverted to ecologically valuable saltmarsh and intertidal mud.

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6 Institutional practice

Flood defence has traditionally been about the defence of property from the impact of tidal and fluvial floods. Despite the fact that the Environment Agency has a legal duty to protect the environment as its contribution to sustainable development⁵ but only permissive powers to protect private property, its attitudes and behaviour reflect traditional priorities. These priorities are reflected in its policy statements. Thus its stated overall aim relating to flood defence is:

'To provide effective defence and warning systems to protect people and property against flooding from the rivers and the sea.' where property is defined as 'anything which is owned by a person or an organisation. It may be a building, farmland, conservation area, flood defence, railway, road, culvert etc.' (EA, 1997).

The defence of property leads to a bias towards traditional land uses and flood defence activities are directed to maintaining those land uses in the face of sea level rises. The Agency has interpreted its statutory duty in terms of its traditional flood defence attitudes. Conservation is seen as just another land use and conservation areas are simply one form of property to be protected along with many others. But the statutory duty to conservation cannot be subsumed into traditional preoccupations in this way, since protecting the environment requires changes in land use via changes in the structure, location and form of flood defence. Entrenched traditional attitudes will be difficult to change. A more than symbolic start to the reform process could be made by a revision of the aims of flood defence to reflect the Environment Agency's statutory obligations.

Flood defence engineers have grown up in a culture where flood defence was structured and appraised for the benefit of agriculture. This culture is an aspect of the preoccupation with the protection of property, but it transcends it, since flood defence has been an important part of the drive to bring about agricultural

⁵ under s.4 of the Environment Act 1995.

change. The bias towards agricultural interests will be hard to break. It is at its strongest with regard to project appraisal. The appraisal process is not viewed positively by those required to conduct it; rather it is seen as a somewhat tiresome ritual to be gone through if approval and grant-aid is to be obtained. In consequence many unacceptable practices are common in the appraisal of flood defences. These practices and the attitudes that underlie them are not confined to the Agency employees; they are equally to be found in the reports of consultants who appear frequently to see their function as providing justification for flood defences which the Agency wishes to construct. The so-called cost benefit analyses are often feeble documents, full of ludicrous assumptions and easily criticised even by those not trained in project appraisal. These practices are not explicitly sanctioned in the Project Appraisal Guidance Notes (PAGN) but rest on interpretations of those notes to suit the ends of the users. This section considers some of these practices. It is illustrated with a case study of the flood defences of Broadland.

6.1 Sectioning of works

MAFF's guidance (MAFF, 1996) clearly indicates that 'In order to develop sustainable coastal defence options.... it will be necessary for operation authorities to divide the cell or sub-cell into management units. A management unit is a length of shoreline with coherent characteristics in terms of both natural coastal processes and land use. These units are likely to constitute discrete benefit areas at the economic appraisal stage.' In practice this guidance is frequently flouted to justify defence expenditure on rural protection schemes. This custom is a clear obstacle to managed realignment. Flood defences are reviewed and appraised, and programmes of work scheduled, according to sections that pay little regard to MAFF's guidance. The Essex shoreline management plan provides examples of this.

Sections that are divided up for purposes of engineering convenience or manageability usually have no economic or other logic. As such they are not suitable for economic appraisal since PAGN implicitly assumes that what is being appraised has some internal logical consistency and is not simply a stretch of the coast between A and B. Despite MAFF's Guidance, sections frequently encompass both urban and rural land. In these cases agricultural protection can ride on the back of the protection of urban land. The Wallasea Island case study highlights just one example of this problem of inappropriate sectioning and of its economic costs.

To resolve this problem and achieve sustainable coastal defence it will be necessary to provide much stronger direction to operating authorities, that predominantly rural areas, with one or a few complexes of farm buildings, should be treated as a sector and separately appraised. This may require, in some cases, an alteration of the existing hard line.

Flood defence committees should be required to structure their area so as to identify the maximum opportunities for potential retreat and to appraise defence for this structure.

6.2 Do nothing

PAGN requires that the 'do nothing' or 'do minimum' options are appraised as a reference point for assessing more positive action. The intention of this requirement is to make flood defence staff think constructively about the objectives of their investment; to consider what positive investment achieves, and thus to see whether it is required. It does not in practice work this way. Given the attitude to appraisal outlined above, where sectioning is done across different land uses, the 'do nothing' option becomes trivial, since doing nothing carries the risk of substantial damage and potential loss of life. It would be better if the reference point was a scheme to achieve the urban benefits, to protect life and urban property, but nothing else. Appraisal might then see whether schemes which achieved more than this, safeguarding agricultural interests at the price of losses of the intertidal zone, achieved a positive incremental cost-benefit ratio of a sufficient size to warrant the intertidal losses. A requirement for sectioning by land use might obviate this problem but in general it will not be a substitute for positive thinking.

The benefits of 'doing something' in project appraisal are net of the consequences of 'doing nothing'. Thus an inappropriate or unrealistic 'do nothing' option has the effect of increasing the benefits of doing something

thereby increasing the likelihood that defence structures will be maintained or enhanced.

The conclusion here suggests the need for an amendment to PAGN as follows. Where a project involves both urban and agricultural land use, a scheme to protect life and urban property, but nothing else, should always be included in the project appraisal. Schemes that protect agricultural property in addition should only be considered if they yield positive incremental net benefits. Where agricultural property only is involved, the 'do nothing' option should be realistically, not ritually, formulated and appraised. It should be recognised that 'do nothing' typically yields environmental benefits which should be properly assessed and given due weight in accordance with the Agency's environmental duties.

6.3 Risk assessment

The issue of risk assessment is intertwined with the use of the 'do nothing' option. 'Do nothing' typically involves a risk of breach of flood defences. The assumptions made about this are more often ritualistic rather than realistic and serve to maximise the rate of return from 'doing something'. Thus a defence that has stood for a number of years is arbitrarily assumed to breach in the first year of the appraisal period. In some cases this might be reasonable if survey shows that the defences are on the point of collapse, but that is not normally the case. Rather, the defence has come up for consideration as a result of routine survey or because it is built to something less than MAFF indicative standards. It is rare for serious analysis of the expected life of the asset and hence the probability of failure to be undertaken in formulating the 'do nothing' scenario. Over sanguine interpretation of risk is often complemented by excess pessimism of the consequences of failure in terms of the area flooded and the damage caused thereby. Agency responses are not analysed, and passivity in the face of need for action unrealistically, if implicitly, assumed. No attempt is made to model farmers' or other land users' responses to increased risk, even where a little thought would suggest that prudent action by the recipients would obviate much of the damage. This comes about because, as argued above, the 'do nothing' option is not taken seriously; is formulated only because PAGN requires it, and is presented so as to reinforce the case for flood defence expenditure. The discussion of risk under PAGN is examined in the next section. Meanwhile the recommendation here is as follows. 'Do nothing' and 'do minimum' options should be based on serious assessment of the risk of flood defence failure and the consequences of that failure. Year zero failure should not be assumed unless there is compelling evidence that the structure is on the point of collapse. Assessment of the consequences of failure should incorporate realistic assumptions both about the Agency's response and the behaviour of those affected. The 'do nothing' and 'do minimum' options should be formulated on the assumption that affected parties are informed of the situation.

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Case Study The Lower Witham, Lincolnshire

An example of the inappropriate use of the 'do nothing' option is found in chapter 12 of the consultants' report on the Lower Witham strategy. The central component of the defence system for this large area of fen-land is the Grand Sluice. The Sluice is supplemented by embankments along the Witham and subsidiary watercourses providing additional protection to areas of agricultural land and properties. If the Grand Sluice fails then a vast area of land would be flooded at enormous cost to property and risk to life. With current sea levels the consultants estimate the damage in the event of failure to be £515.8 million. They make no attempt to estimate the probability of such a failure in the event of a cessation of maintenance but instead assume a probability of 1, i.e. that it will fail in the first year. Thus the present value of damage from 'doing nothing' is £515.8 million. If the sluice was expected to survive without maintenance for 10 years, that damage would be reduced to £316.2 million; if the expected life of the sluice was equal to the 50 years of the assessment period, the present value of failure would be less than £50 million. Implicitly also the assessment assumes that, with maintenance, the probability of failure is zero. That also is probably unrealistic. Even a small residual failure risk from a continuation of maintenance would serve to reduce the costs of 'doing nothing' and equally the benefits of 'doing something' to the subsidiary defences. Thus unrealistic assumptions have the (intended) effect of creating a panic scenario which creates pressure for flood defence works.

But whatever the true risks it is clear that the Grand Sluice is critical to such a large area and must be maintained. Therefore, the appropriate reference point for realistic flood defence options should be to maintain the Sluice but do nothing else. This is important since many of the subsidiary works give only agricultural benefits and current defence levels reflect past attitudes towards flood defences for agriculture. But the 'do nothing' option for the subsidiary defences is not investigated. Instead a range of options incorporating sluice maintenance with other works are contrasted with failing to maintain the sluice. This has the effect of making additional flood defence benefiting only agricultural land to falsely appear to be economically viable. Benefit cost ratios

for all options are at unrealistically high levels and more than £70 million of improvement works are recommended.

7 MAFF's Project Appraisal Guidance Notes (PAGN)

If independent experts with no prior commitment to flood defence applied the existing PAGN to potential projects there is little doubt that less flood defence investment in general, and far less investment in the defence of agricultural land, would take place. Altering the mind-set of the flood defence industry is the fundamental requirement for achieving environmentally acceptable coastal defence and safeguarding the intertidal zone. This, however, is not to say that PAGN is not in need of revision. This section offers a critique of PAGN and suggests revision. The criticisms fall under three headings: agricultural flood risk scenarios; the valuation of agricultural output and the treatment of environmental effects.

7.1 Agricultural flood risk scenarios

PAGN, Annex G discusses the valuation of agricultural land under three scenarios for the failure of flood defences:

Scenario I All agricultural activity ceases thenceforward.

Scenario II. All agricultural output is lost for one year but is unaffected in subsequent years.

Scenario III The conventional problem of different return periods or flood frequencies as would be achieved, for example, by sea walls of different heights.

Scenario I would happen presumably if breach of the defences led to continuous tidal flooding resulting in land becoming part of the intertidal zone. It is difficult to envisage circumstances in which scenario II could be applied unless the year following the failure is devoted to repairing the breach and reinstating the defences. This would happen with a reactive maintenance programme and it may be that this scenario is intended for use in comparing such a programme with an alternative of investment in replacing the defences, although the PAGN do not say so. This is not an option that is usually

appraised in flood defence and in any event it only becomes an option *if there has been a prior decision to sustain the level of flood defence*. But the relevant issue is what, if any, defence standard should be adopted.

Under any scenario, valuation depends on the level of risk assumed. The Guidance Notes say nothing about this, presumably on the grounds that it is a technical engineering matter. But, as argued above, with a prior commitment to a programme and a need to demonstrate a satisfactory benefit-cost ratio, there is a temptation to be sanguine, particularly with the catastrophic scenarios I and II. In the case of the Lower Witham, the Grand Sluice was assumed to fail in the first year. This is implausible, but serves to maximise the benefit from action. Scenario III has the virtue of concentrating minds on true levels of risk.

The examples of valuation in Annex G do not contain any cases of change in agricultural enterprise as a consequence of changes in the level of risk. This is a serious omission since the risk of flooding is a determinant of enterprise choice. PAGN instead treat land use as exogenous to the appraisal process and, in effect, ask whether it is possible, within the economic constraints imposed by the requirement for a cost-benefit analysis, to provide the appropriate level of protection for that land use. Losses are measured with respect to that land use even though rational behaviour for the farmer in the face of increasing risk of flooding may be to switch enterprise, for example, from arable to pasture, or from grass leys to permanent pasture. The indicative standards of protection given in Annex K reinforce the message. Thus if a flood defence committee finds an area of land with a flood risk appropriate to extensive pasture, but which, in fact, is used for arable, it will design and appraise a scheme to validate arable farming. This has been the mechanism by which flood defence standards have been raised and coastal grazing land converted to arable; the process is land use led.

This process should be reversed. <u>Reference to Annex K should determine the</u> appropriate land use and appraisal then undertaken with respect to that land use. To proceed otherwise, as at present, allows the landholder to determine the level of flood protection. Flood Defence Committees recognise that this is unacceptable with non-agricultural land use and correctly seek to control development in flood plains to what is appropriate to the flood risk. <u>The right of</u>

the community, which meets the cost of the flood protection, to determine the land use should be extended to agriculture.

The present procedure in any event leads to an over-estimation of the costs of flood events by assuming that the farmer will irrationally maintain his enterprise even when the flood risk rises, rather than switching to a less intensive, and less vulnerable, enterprise.

With this alternative approach Scenario II of the Guidance Notes has an obvious role since it may make sense for a flood defence committee, contemplating retreat, to appraise an option of reactive maintenance of the existing defence for a limited time to allow for adjustment of land use. In many cases a breach of defences will not result in an immediate reversion to intertidal mud or sand flats, but initially to coastal fresh marsh, grading through upper saltmarsh to lower salt marsh and finally to open flats as the sea level rises. Agricultural enterprises will adjust with this process and output will decline through time. Time limited maintenance is an obvious part of a strategy of managed realignment.

7.2 Valuation of agricultural output

There are four issues here that need comment: the treatment of quotas, setaside, adjustment for subsidies and the situations where output, net of subsidy, is negative.

7.2.1 Quota controlled crops. If a quota is fully taken up then the opportunity cost of land on which the quota enterprise is produced is the enterprise that would have been produced on the alternative land that takes up the quota. PAGN say (Annex G.10) that

'Where it is estimated that the at-risk land would be producing milk, sugar beet, potatoes...it should be assumed to be producing cereals and appraised accordingly. This treatment is designed to ensure that output subject to quota ...is properly treated: it also makes for simpler appraisals.' In most cases it is likely that the appraisal will assume that the cereal is wheat. Table 4 gives data on gross margins of non-quota crops. At average performance levels wheat has the highest gross margin of any but minor enterprises and the use of cereals rather than some weighted gross margin across feasible enterprises will bias the appraisal in favour of the flood protection. In the case of milk the most likely alternative enterprise should surely be a grass based one where gross margins are substantially lower.

Enterprise	Gross margin/hectare (£)	% of wheat
Winter wheat	660	100
Winter barley	550	83
Oilseed rape	580	88
Linseed	530	80
Winter beans	575	87
Beef (double suckling)	495	75
Sheep (spring lambing)	445	67

Table 4Gross margins at average yields

Source: John Nix Farm Management Pocketbook 28th edition 1998.

The recommendation is as follows: <u>Quota controlled crops should be valued at</u> <u>average gross margins for feasible enterprises</u>. There should be two such <u>averages: one for arable crops and one for grass based enterprises</u>.

7.2.2 Set Aside The guidance for quota controlled crops quoted above is given also for the treatment of set-aside. Here the absurdity and the bias in favour of agriculture is manifest. The gross output of set-aside land is not 8 tonnes of wheat; it is zero. If the expectation were that 10 per cent of the land is set-aside each year, then flooding would cause losses of agricultural output on only 90 percent of the land. Thus the benefit area for agricultural land should be the area at risk less the expected area compulsorily set aside.

7.2.3 Adjustment for subsidy. Within the CAP set-aside land does not, of course, produce nothing; it produces subsidy. In the words of Annex G:

'adjustment is made in appraisals of agricultural benefits to allow for the UK share of the cost of support to farmers.'

and adjustment factors are given to be applied to gross output of non quota crops and livestock products.

The total element of subsidy in the value of gross output is greater than implied by these factors because support is made from community funds and is therefore paid, in part, by other members of the EU.⁶ These are treated as benefits because of the convention that a cost-benefit analysis of a project examines the costs and benefits to the country conducting it, in this case the UK. From the viewpoint of the EU this convention is obviously absurd and costly, since each member can indulge in agricultural development in order to capture subsidy from others, with the result that CAP surpluses and expenditure goes up, and all are made worse off. Where a policy is administered and financed jointly, as with the CAP, opportunity costs, which is what are supposed to be measured in cost-benefit analysis, can only be meaningfully defined for the common policy area. Because of collective financing, private opportunity costs, i.e. the costs as perceived by any individual member, will be less than the true collective opportunity cost. If decisions are taken on the basis of these private costs, then collectively there will be over-investment in the sector. We have a version of what is known as a Nash equilibrium. All members of the community would be made better off by recognising their interdependence and taking decisions on the basis of collective costs and benefits.

This problem could be dismissed as yet another example of the absurdities of the CAP if it was not for its potential consequences. By increasing the apparent social value of agricultural production, it reduces the chance of the landward realignment of tidal defences in the face of sea level rises, and hence poses a threat to the protection of a globally valuable asset: the biodiversity of the UK intertidal zone. To destroy biodiversity in order to collect EU agricultural subsidies borders on the criminal. <u>MAFF should amend the adjustment factors in Annex G to allow for the total element of EU subsidy in agricultural output.</u>

⁶ In 1996/7 total expenditure under the CAP, excluding agri-environment schemes was £4045.9 million and the UK received reimbursement (paid two months in arrears) of £3187.3 million. Some of these latter receipts originated from the UK contributions to the EU budget, from customs receipts and direct contributions. The adjustment factors given in Annex G rest on judgements of what proportion of the receipts originate from contributions from other EU members.

7.2.4 Negative social output. Adjustment for subsidy means that in some cases the gross margin on agricultural land will be negative. This means that it is costing resources to keep this land in production. The PAGN recommendation is that the gross margin on such land should be set at zero. This overstates the value of agricultural losses. <u>Negative adjusted gross outputs should not be treated as zero</u>. This problem will increase if EU subsidy levels are used for calculating the adjustment factors as recommended in 7.2.3. The Wallasea case study provides an example of this problem.

7.3 Environmental costs and benefits

Monetary valuation of the environmental impacts of public sector investment projects is now a large academic industry. Various techniques are available, and they are listed and explained in any number of texts and manuals. Valuation, where possible, is recommended by the Treasury and that advice is repeated in PAGN. The Agricultural Committee recommended that:

'As a matter of priority, MAFF must develop methodologies addressing social and environmental criteria for inclusion in PAGN.' (House of Commons, 1998. para 60.)

Valuation of the environmental effects of projects is typically eclectic or opportunistic, with use made of whatever techniques come to hand. This is undoubtedly wrong since different techniques have different spheres of applicability. Survey techniques, particularly contingent valuation analysis, are favoured among academic economists and are argued to be of general application.

But neither contingent valuation nor any other available technique is suitable for placing money values on the environmental benefits of coastal retreat. The reasons for this are straightforward. Coastal retreat projects make a contribution to the broad objective of conserving biodiversity, of which, safeguarding the integrity of the intertidal zone in the face of sea level rises is an important aspect. If a programme of retreat, such as recommended here, is carried out, the threat to biodiversity from the loss of the intertidal zone is removed, although other threats to intertidal ecosystems: from pollution of the sea, over-fishing, temperature rises and the increased incidence of severe storms, remain for example. It is not possible with current knowledge to quantify risks from these diverse sources.

Even if we could quantify the increased risks to intertidal ecosystems from sea level rise, it is not possible to say what contribution any particular example of realignment would be to the overall objective. System effects, in other words, dominate the process. The value of any example of retreat is to the policy as a whole; it has no separate value in isolation. It follows that, since we do not know how retreat on, say, 50 ha. of the Wash, will reduce the risk of loss of species of intertidal flora and fauna, no meaning can be given to efforts to determine the public's willingness to pay for that retreat. We cannot provide them with the information on which they could make an informed judgement, assuming that, with that information, their willingness to pay could be expressed⁷.

In circumstances such as these, the most that can be said is what carrying out the policy as a whole, i.e. safeguarding the intertidal zone from sea level rises, will cost. The evidence indicates that, in comparison with the alternative of maintaining the existing coastline, the costs will be negative, since, in the areas identified for retreat in this report, it would not be economic to maintain, still less enhance, flood defences.

Since no value can be put on the environmental benefits of specific areas of retreat, but retreat is necessary for the overall objective of maintaining the intertidal zone, the appropriate action is to constrain the policy so as to achieve the overall objective - this is what the proposals of this report are designed to do - and to require that the environmental consequences of specific schemes are stated in non monetary terms. The statement should provide a description of the habitat that will be created together with a quantitative assessment of the habitat creation to the overall regional target for the policy. A contribution to the policy objective is an argument for a specific act of retreat which should be weighed against economic losses, if any, as determined from the cost-benefit

⁷ This is doubtful. What is being criticised here is contingent valuation analysis. This rests on the assumption that the public's experience in placing values on goods in real markets allows them to judge values of things for which there are no markets, such as intertidal flora and fauna and biodiversity. The alternative view holds that knowing the value of a shirt or a washing machine in no way helps you to value the population of bartailed godwit or nematodes. (Bowers, 1997)

analysis, from retreating. A contribution towards the targets for retreat should constitute a presumption in favour of retreat, to be over-ruled only in the face of substantial economic loss.

The usual practice with flood defence is to ignore the impact of schemes on the natural environment; in many cases not even to notice that such impacts exist. The exception is where the avoidance or mitigation of impacts on the natural environment results in money payments to farmers, when those money payments are entered as part of the benefits. An example of this practice is the cost-benefit analysis of the managed retreat scheme for Orplands Sea Wall in Essex (Scott Wilson Kirkpatrick 1994) where we find the following:

"If saltmarsh is regenerated, habitat creation payments will be payable for the flooded land. MAFF have indicated that payments of £525/ha for arable or semi-permanent pasture and £195 for permanent pasture would be paid for 20 years. These payments are included as extra benefits and the managed retreat option is examined both with and without payments."

The result is a benefit-cost ratio of 0.57 without habitat payments and 1.13 with them.

There are three objections to this procedure:

- 1. The benefits of habitat creation are the same whether payments are made or not. The payment is a straight transfer: a subsidy to farmers for income foregone.
- The value of the habitat created is not measured by the size of the payments. The same saltmarsh would result whether the land was previously arable or permanent pasture. The size of the payments is determined by previous land use; they are unrelated to the environmental benefit.
- 3. It encourages the fallacious, but deeply entrenched view in the land drainage industry that flood defence is for the benefit of the landowner and

not for society. Specifically in the context of agriculture it suggests that nothing should be done that disadvantages the farmer. This message is reinforced by the accident that the benefit cost ratio is >1 with compensation and <1 without it. Presumably, if compensation in the form of saltmarsh payments had not been forthcoming, this pioneering scheme would not have taken place.

This practice is not encouraged by PAGN although the message it gives could be confusing. Thus in the section on environmental gains and losses, paragraph 2.46 says that

'Where no better alternative is available; and the expected change in the environment approximates to that which the payment scheme is intended to avert, it may sometimes be appropriate to include ESA or other payments as an approximation for a change in environmental value.'

but goes on to say that

'In general however it is better to have a crude measure of the relevant environmental change than a precise figure that measures the wrong quantity.'

On the other hand Annex G says that

'Any public environmental or recreational gains or losses should be appraised separately and not as part of the valuation of agricultural output and land: this includes any role for environmental payments made to farmers....'

A completely unambiguous statement is required in PAGN. For example, Payments under environmental schemes, including habitat creation payments, are neither part of agriculture benefits nor a measure of the environmental costs and benefits of schemes where such payments are involved. Furthermore, the availability of environmental payments is not a factor in decisions about coastal retreat. An Economically Efficient Strategy for Coastal Defence and the Conservation of the Intertidal Zone A Report to The Joint Marine Programme of The Wildlife Trusts and WWF UK by John Bowers

8 Summary and Recommendations

Summary:

If action is not taken to prevent it, there will be substantial losses of the UK's intertidal habitats. The intertidal zone is a valuable international resource and the anticipated losses put scarce ecosystems and the sustainability of tidal defences at risk.

In order to safeguard the intertidal zone the coastline must be allowed to adjust. The optimum strategy in the face of sea level rises is to increase the hard defences in urbanised parts of the coast and to retreat to soft defences in agricultural areas. Such a strategy, if implemented at the appropriate scale, is in accord with the principles of sustainable development. It would safeguard biological resources for future generations and involve less expenditure on flood defence than the alternative of holding the existing line. This is because the costs of maintaining hard defences in many agricultural areas have long exceeded the benefits.

There exist more than enough agricultural areas where maintaining hard defences is not economically justified, to offset anticipated losses from sea level rises. In many cases it was not economic to have constructed defences of these areas in the first place and it will certainly not be economic to enhance them to protect against rising sea levels. The losses of agricultural land involved, even in a maximal programme of realignment, are trivial.

Without reform of the current flood and coastal defence system, no more than symbolic realignment will occur where major agricultural interests are involved. Case studies in the full report demonstrate this and illustrate the sorts of arguments used to justify avoiding realignment together with the costs that this imposes on society.

Strategic recommendations:

- 1 A national strategy for identifying in broad terms those areas where, in the face of rising sea levels, the coastline should be maintained and areas where it should retreat is needed. In the areas where retreat is possible the objective should be a net increase in the intertidal zone to compensate for losses elsewhere. Flood defence authorities should be charged with implementing this strategy.
- 2 Flood Defence Committees should be re-constituted so as to eliminate the over representation of agricultural interests.
- 3 The stated aims of the Environment Agency in flood defence should be brought into line with its statutory obligations under the Environment Act 1995.
- 4 MAFF's flood and coastal defence Project Appraisal Guidance should be rewritten to properly reflect the Ministry's strategic goals and the real costs and benefits to society of public investments. A number of detailed recommendations are made – see below.

Recommendations pertaining to the general approach of operating authorities:

- 5 Flood Defence Committees should be required to section their land for work programmes by land use with the objective of maximising opportunities to implement a strategy to maintain the aggregate intertidal resource and improve coastal resilience.
- 6 The reference point for scheme appraisal should be designed to protect urban life and property but nothing else. The Guidance Notes should make clear that the 'do nothing' or 'do minimum' options are not a tiresome ritual but are a device to encourage constructive thinking about flood defence.

- 7 Many of the defence structures constructed for agricultural land prior to the mid 1980s would not have been built had the current appraisal criteria been applied. There should be a presumption that they will not be renewed and no question of raising them to counter rising sea levels.
- 8 In areas selected for managed realignment, Flood Defence Committees should consider the option of time limited maintenance of the existing defence line to allow the adjustment of agricultural land use.
- 9 A statement of the environmental benefits of realignment should accompany each appraisal of flood defence on agricultural land. It is not possible to place meaningful money valuations on these environmental gains. The environmental statement should contain an assessment of the contribution that the scheme would make to the national strategy and there should be a presumption that retreat will take place unless it would entail significant economic cost.

A summary of detailed recommendations for the revision of PAGN:

- 10 Reference to Annex K should determine the appropriate land use and appraisal then undertaken with respect to that land use. To proceed otherwise, as at present, allows the landholder to determine the level of flood protection. The right of the community, which meets the cost of the flood protection, to determine the land use should be extended to agriculture. (See 7.1 above)
- 11 Quota controlled crops should be valued at average gross margins for feasible enterprises. There should be two such averages: one for arable crops and one for grass based enterprises. (See 7.2.1 above)
- 12 The benefit area for agricultural land should be the area at risk less the expected area of compulsorily set aside. (See 7.2.2 above)

- 13 MAFF should amend the adjustment factors in Annex G to allow for the total element of EU subsidy in agricultural output. (See 7.2.3 above)
- 14 Negative adjusted gross outputs should not be treated as zero. (See 7.2.4 above)
- 15 The environmental consequences of specific schemes should be stated in non-monetary terms. A statement should provide a description of the habitat that will be created together with a quantitative assessment of the habitat creation to the overall regional target for the policy. A contribution to the policy objective is an argument for a specific act of retreat, which should be weighed against economic losses, if any, as determined from the cost-benefit analysis, from retreating. A contribution towards the targets for retreat should constitute a presumption in favour of retreat, to be over-ruled only in the face of substantial economic loss. (See 7.3 above)
- 16 Payments under environmental schemes, including habitat creation payments, should be treated as neither part of agriculture benefits nor a measure of the environmental costs and benefits of schemes where such payments are involved. Furthermore, the availability of environmental payments should not be a factor in decisions about coastal retreat. (See 7.3 above)

Appendix The significance of the intertidal zone

Paul Murby

The **biological productivity** of coastal wetlands is the foundation of much of their value. It is rarely appreciated how productive these habitats really are, even apparently bare mudflats. Figure 4 shows the comparative mean primary productivity of a number of global ecosystems. The comparative significance of coastal habitats is immediately apparent. These habitats are the biological engines that fuel the ecology and biodiversity of so much of the natural and human world. Their significance, in ecological terms, stretches far beyond their boundaries. For example, migrating species of fish and birds, which may range over thousands of miles, depend on such places on a seasonal basis or for key phases in their lifecycle. These coastal habitats are also an important source of shelter and energy for a number of commercial exploited fish stocks.



The work that intertidal habitats do in **absorbing and dissipating wave energy** and thus reducing the risk of flooding and damage to land is crucial for coastal defence management. Studies by the Environment Agency (then the National Rivers Authority) show that where there is an 80 metre width of saltmarsh in front of a sea wall, the necessary height of the wall is 3 metres and the cost £400,000 per kilometre. Whereas, when there is no saltmarsh a 12 metre high wall is required to meet the same standard of defence and the cost of providing that defence is £5,000,000 per kilometre – more than 10 times the cost (Table A1, NRA, 1995).

Width of saltmarsh* (m)	Height of crest wall (m)	Cost of sea wall (£ per m)
80	3	400
60	4	500
30	5	800
6	6	1,500
0	12	5,000

Table A1The effectiveness of saltmarshes in coastal defence

* distance between toe of sea wall and seaward edge of saltmarsh

The role of the intertidal zone in regulating and **maintaining a healthy coastal environment** is only just beginning to gain the acknowledgement it deserves. Coastal wetlands are highly effective sinks for both marine and river borne pollutants that would otherwise adversely affect the environment. Healthy coastal wetlands lock up and process pollutants, thus buffering the wider environment.

Vegetative buffers in the coastal zone have been shown to be highly effective in removing pollutants. One study (Desbonnet *et al* 1994) showed that a 200 metre vegetative buffer in the coastal zone removed more than 90 per cent of total suspended solids, nitrogen and phosphorus (Table A2). Vegetative buffers are also effective processors of hydrocarbons, PCBs, most metals, pesticides and nutrients (Desbonnet *et al* 1995, Meakins *et al* 1995, Nedwell 1996). Flood and coastal defence directly and indirectly affect these vegetation buffers. Furthermore, intertidal areas are effective carbon sinks that play an important role in the flux of CO_2 .

Table A2Estimated percentage removal of various pollutants according to vegetated buffer width

	Buffer width (m)				
% Removal	Sediment	TSS*	Nitrogen	Phosphorus	
50	0.5	2	3.5	5	
60	2	6	9	12	
70	7	20	23	35	
80	25	60	60	85	
90	90	200	150	250	

*Total suspended solids

Source: Adapted from Desbonnet et al. (1994).

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