

STERN COMMITTEE ECONOMICS OF ADAPTATION WORKSHOP 9TH MAY 2006

Assessing the costs and benefits of adaptation: perspectives from the front line

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Preamble

This contribution derives most from my experience in working to achieve operational delivery of adaptation actions in and from the Environment Agency. The Agency is the leading public body for protecting and improving the environment in England and Wales. On climate change mitigation it is the competent authority for the EU Emissions Trading Scheme and has roles promoting the use of renewable energy.

On adaptation, it has statutory responsibilities for the protection of air, land and water, flood defence, water resources and biodiversity. It also recognises that climate change has the capacity to undermine improvements that have been made in environmental protection, for example in water quality, fisheries and air quality.

This input essentially shows that much more attention is needed to construct the policy frameworks to allow full appraisal to be undertaken with the economists' toolkit at the appropriate entry point, scale and time. The working assumption or loose characterisation, often deriving from the direct juxtaposition of adaptation versus mitigation, is that CC adaptation policy is a distinctive and different set of approaches/ strategies or policies, but in my view that is not the case in practise. Moreover mention is often made that adaptation is "situation specific", but the consequences of this on appraisal are not always thought through.

The UK is one of the "advanced group" on adaptation according to the OECD, and widely recognised as a leader in Europe on this issue. But even here, decisions that should lead to adaptation actions are not always based on a sound comparison of advantages or disadvantages of a certain course of action. Essentially adaptation policy is developing by modifying approaches to existing policy and responses to events. Assessment of actions on climate change currently falls within established policy and institutional frameworks, and these frame timescales and the types of economic appraisal undertaken. The system does allow for innovation, exceptionally around major vulnerabilities and in response to extreme weather events, and that is happening in the Thames Estuary studies. We need to build on these initiatives.

To explain and explore the situation, I have adopted three propositions, and treated them sequentially.

- Tackling gradual climate change in general takes place as an incremental process embedded within existing policy strategies, but outcomes are constrained.
- Responses and planning for extreme events on a large scale and over long time frames with significant impacts on lives and property potentially do allow for changes in assessment methodologies.



- The policy guidance/ legislative/ regulatory framework is critical to determining how adaptation will play out.

I then draw some conclusions about the need to develop new capacities, tools and skills.

1. Tackling gradual climate change in general takes place as an incremental process embedded within existing policy strategies, but outcomes are constrained.

In the appendix are tables which show this in relation to the core agendas of flood risk management and water resource planning, which are often held up as exemplars of good practice. The tables show the various policy levers/ issues, the timescales of the decision-making process, players, treatment of costs and climate change. Basically what this initial analysis shows is that dealing with the climate change dimension of floods and droughts is gradually being embedded within existing policy strategies, in a piecemeal way and depending on the planning cycles of the various components. The incorporation of climate change is itself linked to the current climate change scenarios which are available - in the UK they have their own cycles of revision. It is difficult to create the space within these processes for establishing overall frameworks and improving use of the economists' toolkit.

2. Responses and planning for extreme events on a large scale and over long timeframes with significant impacts on lives and property potentially do allow for changes in assessment methodologies.

With experience of extreme weather events and anticipated long-term climate change, opportunities have already been created in public policy dialogues to analyse and explore in more systematic and open frameworks. In the UK there have been major studies of the economic impacts of recent droughts where their policy influence has been strong, but not yet on strategic water resource planning. On flooding, our Chief Scientist (Sir David King) initiated an innovative study of flooding and coastal erosion over the next 100 years to see what were the best options for Government and the private sector, in which 60 leading experts were involved. The Foresight study (which however only used the Hadley Centre GCM) identified the additional risks which climate change could bring. But, strategic analyses do not necessarily lead to dramatic policy shifts on climate change adaptation policy unless special provision is made. With the Foresight studies, a process for monitoring implementation has been put in place, including a major Government initiative, "Making Space for Water". This type of shake-up is potentially powerful.

Our work on the Thames Estuary 2100 project shows that where there are resources and policy frameworks to allow for analysis and innovation, longer term appraisal can occur eg the Thames Estuary 2100 project that will develop a Thames Estuary Flood Risk Management strategy for the next 100 years. Flooding would obviously cause immense disruption to the capital's commercial activities, and could cause direct damage equivalent to around £30 billion. Preliminary estimates for maintaining current protection levels in the face of climate change are £4 billion. A complicating factor is that the Thames Gateway region has been designated as one of the largest regeneration areas in Europe.

This work commenced before the Foresight project and is driven by the need to replace the Thames Barrier by 2030, if the same levels of protection for London are to be maintained (against a 1 in 2000 years event).

The table below is extracted from a short paper submitted to the Exeter Science Conference, which for the first time looks at the costs and benefits of meeting different stabilisation targets in relation to the Barrier. We can see that stabilising at lower levels of greenhouse gas concentrations reduces sea-level rise and damages due to floods. Preliminary work undertaken as part of our Thames Estuary 2100 project has shown that without climate change, maintenance costs of defences in the estuary will be £3.8bn (discounted £1.1bn), with the UKCIP02 High scenario £5.3bn, (discounted £1.9bn) and with the medium high scenario and storm surge £6.8bn (£2.8bn discounted).

Table 1: Flood risk estimates in the Thames Estuary for different stabilisation scenarios¹

Scenario	Relative sea level rise (in m) in the Thames Estuary 2050 (relative to 2005)	Relative sea level rise (in m) in the Thames Estuary 2100 (relative to 2005)	Present Value (flood risk) (£billion)	Benefit of stabilisation (£billion)

¹ Hall J., Reeder T. et al. 2005. Tidal Flood Risk in London Under Stabilisation Scenarios

S450	0.16	0.34	0.61	13.9
S550	0.19	0.40	0.62	13.9
S750	0.21	0.46	0.89	13.7
IS92a	0.24	0.61	14.6	-

Recent work undertaken as part of the TE 2100 project by my colleagues (Bill Donovan, Tim Reeder and Sarah Lavery) shows that with a long term, large problem, the full panoply of technical options can be explored: maintenance, modest defence improvement, flood storage, and major investments. This type of analysis shows that short-term decisions are needed to keep long-term flexibility, for example some of the best flood storage areas are currently built-up areas (see **powerpoint slides** on options planning).

3. The policy guidance/ legislative/ regulatory framework is critical to determining how adaptation will play out

This proposition may seem self-evident but this is where we have to start. I will cover several issues here:

a. We need a clear, coherent framework from European, though to national, regional and local levels.

This would then help to ensure that appraisal was undertaken, or framed at the necessary and appropriate level. Currently the best example of things going wrong is the European Directive on Water Quality (the Water Framework Directive). This was only drafted in 2000 but did not mention climate change. Moreover it also suggests that major floods and droughts can be treated as exceptional. Potentially this is a major tool for climate change adaptation policy as it allows for economic appraisal of measures, covers water flows and quality issues and sets up new systems of River Basin Management Plans, involving partnership working. It is also cyclical, with 6 year timeframes, so provides for revision as understanding increases and uncertainty reduces. The first cycle completes in 2015, when at least the temperature changes associated with climate change are well established. Water companies will be required to invest in improvements to ensure good water quality (according to specified standards). Currently climate change will not be factored into this. I have met with resistance at European and UK levels to even putting on a “patch” in the first cycle, such as testing the sensitivity of the programmes of measures to climate change.

In the UK we have an active network of regional climate change adaptation partnerships. Often they are tackling issues at that level which could be resolved more effectively at national level or need resources from national level. Issues are also evident at the local level where a clear national framework would help, but there is no time to cover these here.

b. Costs fall varyingly across the public and private sectors which affect how incentives are constructed for action and with climate change could lead increasingly in the UK, to some anomalies.

For example, water is now delivered though private companies who charge for water supply and sewerage. But the sector is regulated and subject to other legislation such as biodiversity conservation. In some locations, water abstractions authorised under licences granted years ago are causing environmental degradation. There are some 600 sites where current licensed abstraction is causing problems, or has the potential to do so under current conditions (such as damage to fish stocks). Dealing

with these damaging abstractions will be expensive. Under the EU Habitats Directive we have reviewed consents. We believe that up to £480 million in compensation could be payable to licence holders if their licences have to be revoked or modified. The Government will not give us resources to pay so we will be required to raise charges for abstraction and discharges. But if a climate change lens is put on some of this expenditure, such as the protection of salmon in rivers in southern England, these may not be sensible investments. These sums will be resourced by increasing charges to users, and the first stage - an £80 million programme - is shortly to start.

Elsewhere, expenditure on flood defence schemes (financed mostly by central Government and some local levies) has to cover compensation when habitats are affected. But overall flood risk management is a permissive duty not an obligation. If we withdraw protection no compensation is required, but if we flood land we must pay up. And, if we decide to stop pumping water out, we are liable. One of the national newspapers recently picked up we were spending thousands of pounds pumping water out of a (coastal marshland) area to stop it flooding, although it is now covered by drought orders. We are currently paying £20 million, principally to protect the habitat of breeding pairs of birds in a part of East Anglia. But under coastal erosion provisions, there is no mechanism whereby those whose homes are falling into the sea elsewhere in East Anglia can be compensated. Government is under pressure to defend all areas of the coast with hard defences, but this is not a tenable strategy in the long term. Some major difficult decisions have to be made.

I will briefly touch on one other very important current issue here. There is currently a major drive by Government to undertake a massive new programme of house building in south-east England to try and provide lower cost housing. But this is the area in the UK known to be under pressure in terms of water resources (there is less rainfall per capita than the Yemen) and, many of the proposed sites fall within flood plains. Developers will benefit from selling the houses but national needs for more low-cost housing will also be met. Who then should pay for the necessary infrastructure: national or regional government (taxpayers), developers, or residents? I believe that this issue is currently being addressed elsewhere in this building.

There are others, for example the delicate balance between the flood risk insurers, household premiums and Government policy; Jane Milne may touch on this.

c) It is very difficult to undertake evidence-based policy appraisal when the basic framework is not constructed appropriately.

I will briefly touch on two important issues here. The cases of water quality and the treatment of water demand management will be overviewed. Managing water quality is a much more expensive issue than providing water resources. Climate change has the potential to change fluxes and flows substantially, radically affecting capacity to abstract or discharge. The problem of combined sewer overflows (where sewage and rainwater flow through the same pipes, which can overflow into water bodies after storms) will be exacerbated by increased rainfall events. Possible increased algal growth and algal blooms will mean that water quality will need more monitoring, reduced flow with droughts worsens quality, and overflows of sewers in floods cause health and social problems too. Costs associated with the treatment of raw water could also rise. For example, removal of Dissolved Organic Carbon (DOC) represents the single largest treatment cost to the water industry, and has become an increasing source of concern in recent years due to rising concentrations across much of northern Europe².

² Worrall F, Burt T, Shedden R (2003) Long term records of riverine dissolved organic matter. *Biogeochemistry*, **64**, 165-178.

Yet on water quality, there are no 25 year strategic plans, schemes are appraised on a one-off basis and in relation to specific drivers such as the Shell Fish Directive. In London, where it is prohibitively expensive to reduce need or build a separate system, there is already a proposal to install larger capacity on the existing system, although this has not yet got Government approval. The “Thames Tideway” project is estimated to cost £1.5billion. This scheme is vital if we are to avoid any repeat recurrences of flash flooding such as the August 2004 event when 10,000 fish were killed. The Thames Tideway scheme would be the first major investment in London’s sewers since Sir Joseph Bazalgette’s, which were built in response to the great stink of 1858 and cholera outbreaks. We have just calculated that there are maybe £10-20 billion of additional costs for storm-flow management with climate change in England and Wales by 2080.

More studies on the benefits of water demand management as an alternative to supply are needed. So far the issue of water demand measures has also been handled piecemeal and is not constructed into any of the assessment processes as an alternative to big capital investment schemes. There is scope for people to use less water. Current usage of 150l/day is significantly above the levels of 100l/day that would support the same utility that people enjoy from water today. Reducing water use to these levels in new homes can happen at almost no cost³. However it will be more expensive to retrofit water saving devices, although we have calculated that the costs can pay back in 18 months with water metering and that 25% water savings can be achieved, resulting in savings of £55/ year to households when they have meters. *(check)* This high level of usage also gives us some capacity to reduce water use in drought situations, eg by restricting garden watering. We also need to cope with the increased demand for water as a result of climate change, due to garden and personal watering. Overall by 2025 this is estimated to be an additional 1-2%, however it only takes place over 20% of the year.

Conclusions



We need to develop new capacities and skills. We need to construct better frameworks for economic appraisal and make major changes to policy and regulatory approaches. We need to recognise that we have “stranded” legislation.

This is particularly necessary because the challenge may be greater than we think.

New research in the Agency has shown there are worse extreme events locked in past patterns of variability - for example drought periods in the 1850s and 1880s are worse than anything we have experienced this century. **SLIDE**

One major issue which we need to address is how will we use the emerging probabilistic CC scenario information. Potentially these new scenarios (once fully unpacked and delivered) might overcome a lot of the constraints on action and remove the uncertainty problem, at least for decision-makers. These decision-makers, often national Governments, will need to decide whether 70%, 80% or 90% probabilities should be used for planning. **SLIDE**

³ See Sustainable Homes – the financial and environmental benefits, Environment Agency 2005, www.environment-agency.gov.uk

Decisions on which probability to use will depend on tolerance to risk aversion, and will vary according to the types of hazard. More attention needs to be paid to the identification of options value, as we are doing in the Thames Estuary.

One way to drive change is to embed targets within business planning and develop measurable success criteria. We have started to do this in the Agency, although it is challenging. With climate change mitigation there are clear targets on greenhouse gas emissions reductions which can be set but that is often not the case with adaptation.

Draft 08-05-06

Acknowledgements: The views expressed are my own and not the Agency's. Material used here should not be cited. It includes work from the TE 2100 Project led by Tim Reeder, work by Rob Wilby and has benefited from discussions with colleagues in the Agency.

Appendix

ENTRY POINT ON FLOOD RISK MANAGEMENT	TIME SCALE	STATUS AND CYCLE FOR REVISION	MAIN PLAYERS	TYPE OF ECONOMIC APPRAISAL	HOW CLIMATE CHANGE FACTORED IN
Flood Risk Mapping	Finished in 2004-05 in agreement with PPG25 requirements	Difference in depth output -for use within the EA being produced. No revision planned	EA makes available on web and for Regional Government Bodies, & Local Authorities	None	Not factored in (except in detailed mapping at area level if business case for it, and internally in EA as difference in depth)
Planning Policy Guidance Note 25 for local authorities (PPG25→PPS25)	2001 for all new investments in flood risk areas when in spatial planning and Flood Risk Assessments for new developments	Statutory guidance. Revised in 2005-06 to become Planning Policy Statement: PPS25	ODPM, National Assembly for Wales, EA, Regional Government Bodies, Local Authorities, Flood Risk Industry, developers	None	Yes CC allowances reviewed 2006 to cover post 2050s, up to 2110s and to include peak rainfall intensities peak river flow volumes, offshore wind speeds and wave heights.
Flood and Coastal Defence Project Appraisal Guidance (FCDPAG): CC precautionary allowances for capital works	Five volumes issued between 1999 (Economic appraisal) and 2001 (Overview)	Statutory guidance. Interim allowances (based on PPS25) to be issued ASAP, and further research programmed to review allowances & science	DEFRA, National Assembly for Wales, EA, Flood Risk Industry, Local Authorities (planning development behind defences)	CBA moving to MCA Proposed CC adaptation (rivers) included if within 10% of cost- new measure EA March06	Up to 2050s and only as sensitivity analysis (i.e. CC adaptation if within standard cost and/or precautionary margin: 'freeboard')
Flood and Coastal Defence Project Appraisal Guidance (FCDPAG): Possibility of factoring CC in economic analysis for capital works (new, upgrades &	Guidance issued in 1999 not precise on how to account for future benefits from CC adaptation. This needs to be addressed ASAP	Statutory guidance. Revision not yet planned, though moving towards multi-criteria analysis (incl. socio-economic, and environmental factors)	DEFRA, National Assembly for Wales, EA, Flood Risk Industry	Future benefits from CC adaptation cannot be taken into account at present in economic analysis for capital works -except in some cases	Only as sensitivity analysis -in some cases (e.g. culverts, where it can be justified that pipe will be under-capacity soon thus needing replacement & incurring further cost)

maintenance)		rather than cost-benefit			
Flood Risk Legislative powers	Water Resources Act 1991, Land Drainage Act 1976; and regional Byelaws -created around 1980, they need to be reviewed ASAP	Statutory legislation. No schedule for revision available, but EA has powers to create, amend and rescind Byelaws (former Water Authorities used this power to create existing Byelaws)	EA, Local Authorities, Riparian owners community	None	Only for finished floor levels (e.g. deckings), soffit levels (e.g. bridges), and capacity (e.g. culverts) if modelled data on levels and flow including CC available - depends on area and business case. Larger areas where legislation applies will mean larger areas where CC should be factored in
Shoreline Management Plans (SMPs)	50-100 years	1 st round produced by 2000, currently under review	DEFRA, National Assembly for Wales, EA, Maritime Local Authorities, Regional Bodies and Local Authorities	None	In theory but perceived difficulties due to CC scientific uncertainties
Catchment Flood Management Plans (CFMPs)	50-100 years	1 st pilots finished, 70 catchments to be finished by 2007	DEFRA, National Assembly for Wales, EA, Regional Gov. Bodies and Local Authorities	None	Same advice following flood risk mapping. Difficulties due to CC scientific uncertainties
River Basin Management Plans (RBMPS) established under the EA Water Framework Directive 2000	6 years	First round finalised in December 2012, to be reviewed and updated in 2015	Environment Agency , Defra and regional and local government and key stakeholders	Yes within appraisal for Programmes of Measures	Not planned for first round

ENTRY POINT FOR WATER RESOURCES	TIME SCALE	CYCLE FOR REVISION	MAIN PLAYERS	TYPE OF ECONOMIC APPRAISAL	CLIMATE CHANGE FACTORED IN
Strategic Water Plans of Water Companies- (made statutory in 2003 Water Act	25 years	Every 5 years, next round due 2009	Water Companies, Ofwat, EA, Defra have final decision powers.	Following assessment of water resource need, (where climate change element is assessed) an assessment method- the economics of balancing supply and demand, looks at the incremental cost of each option, including social and environmental costs, to identify an optimised series of options to meet deficit.	2004 was the first time and treatment was uneven some companies who either put an allowance in headroom for the 2015 - 2030 period or factored it into scheme size from 2015. Others did nothing, promising more work in the next five years. Overall, water companies' latest plans propose eight new or extended reservoirs between now and 2025. These will cost well over £1 billion. We are currently undertaking joint research with the water companies to develop better guidance for the next round (but issues about timing of new scenarios).
Drought Plans (cover operational management of droughts).	3 years	Every 3 years	Water Companies, Environment Agency, Defra	None	No
Abstraction Licensing	Started 1963	Many licenses granted in perpetuity, 2003 Act allowed for time limited licensing but no revocation without	Environment Agency Water companies, farmers	None	Will be through Catchment Abstraction Management Plans (CAMS)

		compensation. All now being reviewed under Habitats Directive			
Catchment Abstraction Management Plans (CAMS) non-statutory	First round to be completed in 2008 years	6 years	Environment Agency with key stakeholders abstractors, recreation users, environmental groups	None	Not yet in detail, intended it will be as plans revised. Some built-in mechanisms can assist. Time Limited Licenses can be issued. A series of Hand Off Flows allow more water to be abstracted when flows in rivers are higher.
Environment Agency Strategic Water Resource Strategy non- statutory	First plans in 2001, for England and Wales and regions. New round being planned.	As needed.	Environment Agency with key partners and stakeholders	Yes, within broad framework	Climate change not fully covered in first round, next round will extend 50 years so we can cover it better, but new probabilistic scenarios will not be available
River Basin Management Plans (RBMPS) established under the EA Water Framework Directive 2000	6 years	First round finalised in December 2012, to be reviewed and updated in 2015	Environment Agency , Defra and regional and local government and key stakeholders	Yes within appraisal for Programmes of Measures	Not planned for first round
Water Trading (of un required abstraction rights) Introduced in 2003 Water Act	In perpetuity without compensation	Ad hoc	Environment agency and riparian owner	Not relevant	Not relevant, but the Agency does undertake an environmental assessment