Adapting to climate change: the costs and benefits of incremental and transformative changes

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Ruth Dittrich, Andy Evans, Naomi Fox, Klaus Glenk, Mike Hutchings, Davy McCracken, Malcolm Mitchell, Andrew Moxey, Alistair McVittie,Kairsty Topp, and Eileen Wall.

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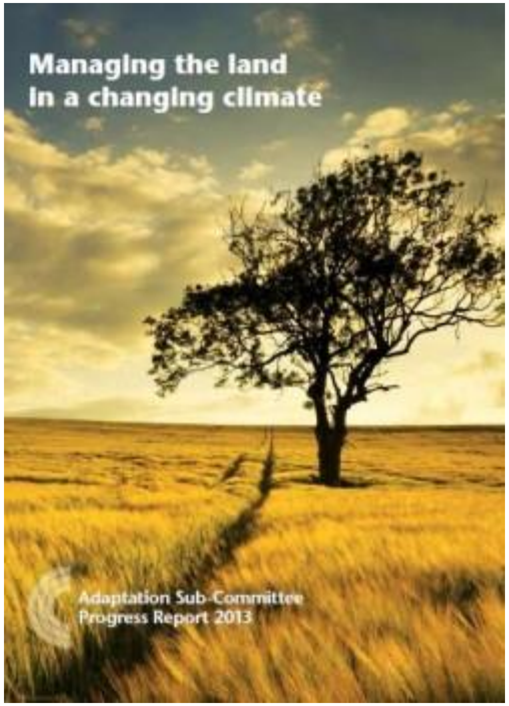
Background

- UK Committee on Climate Change
- 2013: Natural Environment
- (2012 was flooding and water scarcity)
- Adaptations necessary in next five years (win-wins, no-regrets)or those with long lead times
- Adaptive management OR landuse change (incremental or transformation)
- Locally specific or national level



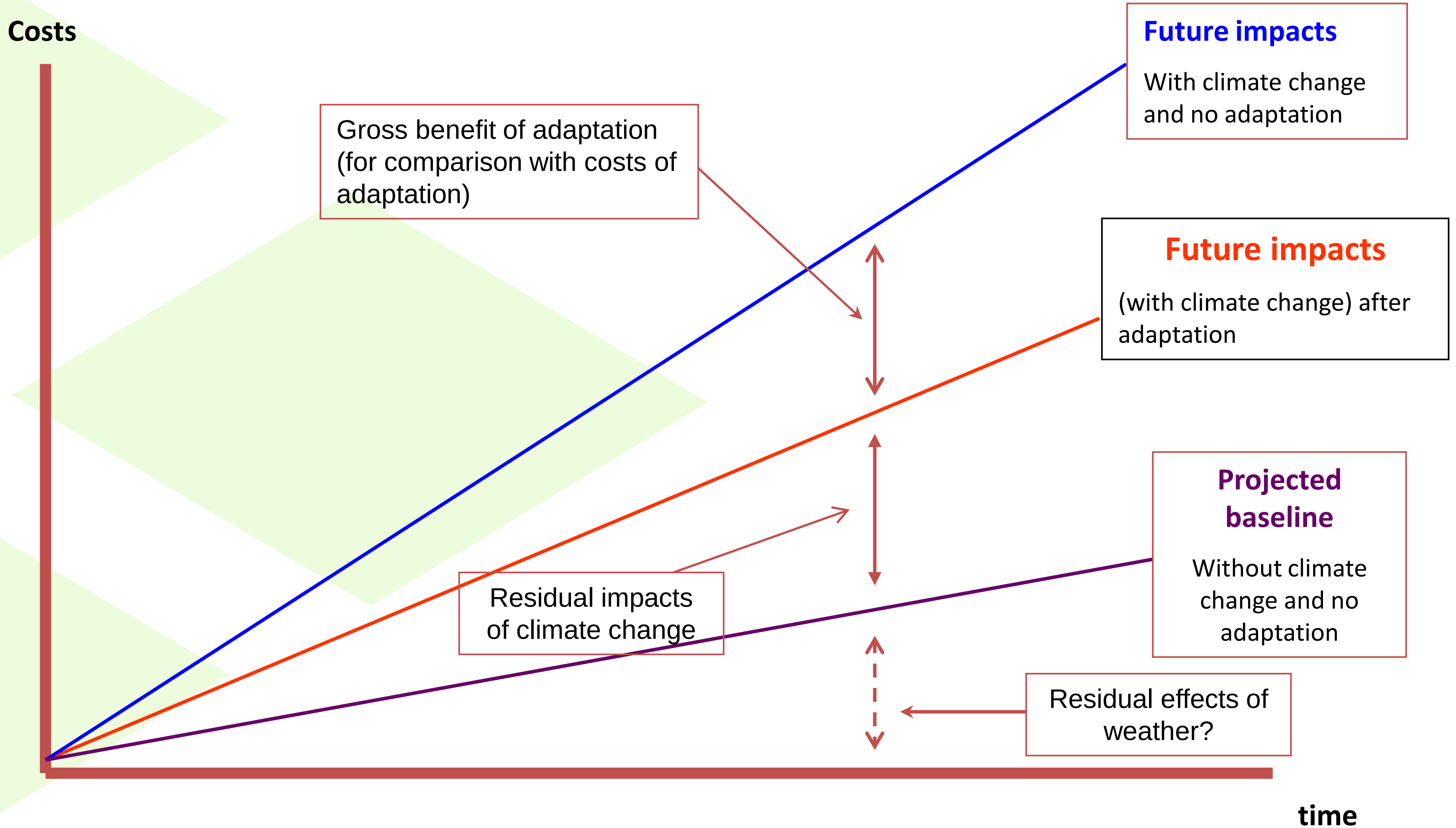
Adaptation challenges

- Costs are clear and immediate
- Benefits are uncertain – location, timing, magnitude
- Climate projections inherently uncertain
- Need robust actions (Hallegatte 2009):
  - Flexible/reversible
  - No regrets
  - Safety margins
  - Soft strategies
  - Reduced decision time horizons
  - Interaction with mitigation

Adaptations chosen

Agriculture	Biodiversity and Ecosystem Services
Animal disease surveillance	Biodiversity habitat connectivity
Water storage	Peatland restoration
Range of crop adaptations for crop disease	Coastal managed realignment
Soil management	**Forestry**
Heat stress in housing and transport	Species choice

Costs and benefits of adaptation



From Boyd, R., Hunt, A. (2006) Climate change cost assessments. Using the UKCIP Costing Methodology. Report for Stern Review

Methodology

- Cost benefit analysis

$$NPV = \sum_{t=0}^{N} \frac{R_t}{(1+i)^t}$$

- Calculated to end of this century
- Discount rate of 3.5% for the first 30 years, and 3% for the remainder of the century
- Where applicable ("science first" approach) UKCP09 climate scenarios used (Low P10 and High P90)
- Market and non-market benefits considered where possible

Appraisal challenges

- In many cases, the biological relationships or science of the effectiveness of the adaptation is not fully understood (e.g peatland, soil management)

Peatlands

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- Extent to which restoration will contribute to adaptation depends significantly on: location, initial baseline conditions, current land use and anticipated climate change

- The costs of restoration (including capital works, on-going management & monitoring plus income foregone) are poorly reported and highly context-specific

- Sensitivity analysis of different combinations of key parameters to explore the conditions under which restoration may be worthwhile.

- Using DECC carbon prices and indicative values for other non-carbon, non-market benefits analysis suggests that **restoration is worthwhile in most**, but not all **cases**

Illustrative range of NPV estimates for restoration under different climate change scenarios

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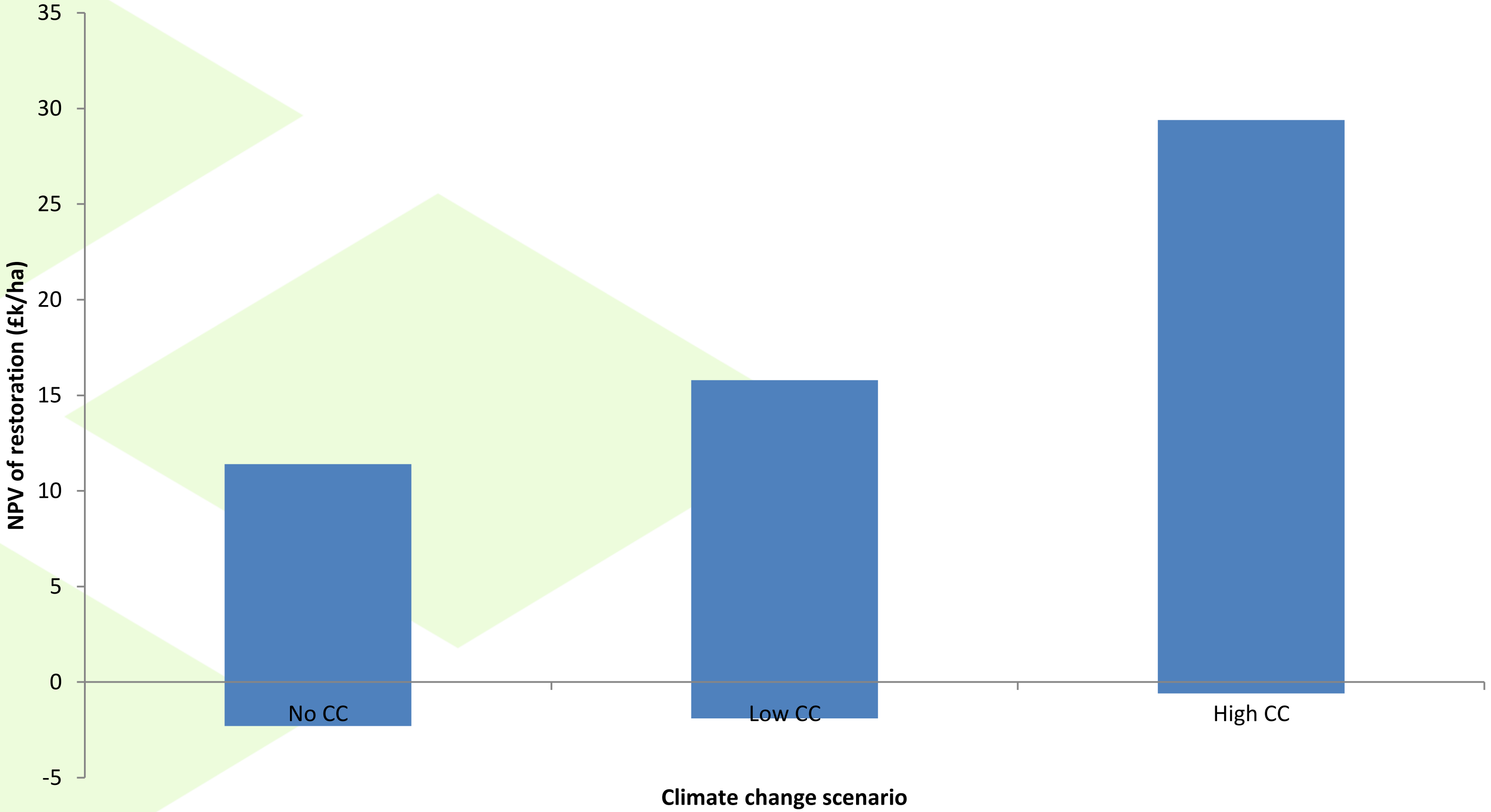

Soil management

- Measures include drainage, relieving compaction, shallow ploughing, spring cultivation of crops, incorporating a cover crop in the cropping sequence and contour ploughing aimed at maintaining productive capacity, on a range of crops
- Lack of evidence on the relationships between climate change and yield, soil health, and in particular soil organic matter
- Localised evidence may not scale up to the regional or national level due to other influencing factors – including local weather conditions, soil type, topography, as well as crop choice and management
- High NPVs associated with relieving compacted soils, shallow ploughing and contour ploughing

Soil management NPVs (£m)

Crop	Measure					
Crop	Drainage	Compacted Soil	Cover crop	Shallow ploughing	Spring Cultivation	Contour ploughing
W Wheat – free draining	0	0	0	178	0	59
W Wheat – required drainage	63	1744	0	256	0	86
S Barley – free draining	0	0	-83	17	50	6
S Barley – required drainage	2	123	-122	24	55	8
Potatoes	50	993	317	122	373	41
Carrots	0	0	143	42	130	5

Appraisal challenges

- In many cases, the biological relationships or science of the effectiveness of the adaptation is not fully understood (e.g peatland, soil management)
- Significant spatial variation meaning up-scaling not possible (e.g soil management, managed realignment, habitats and biodiversity)

Managed coastal realignment

- Deliberately breaching existing sea defences to create or restore areas of intertidal habitat helping to dissipate wave energy, and reducing pressure on adjacent artificial coastal defence structures
- Aim to realign approximately 10% of England's coastline by 2030, rising to nearly 15% by 2060
- Costs and benefits **highly site-specific**. capital requirements vary between £620/ha and £273,000/ha. Annual maintenance costs range from between £8/m to £104/m defence
- Costs include the opportunity costs of income forgone from agricultural land use
- Benefits include environmental benefits, reduced construction costs (and replacement costs) of realigned defences and reduced maintenance costs
- Smaller MR schemes may not be economically efficient
- Need careful investigation of economic welfare implications if residential property is affected

Appraisal challenges

- In many cases, the biological relationships or science of the effectiveness of the adaptation is not fully understood (e.g peatland, soil management)
- Significant spatial variation meaning up-scaling not possible (e.g soil management, managed realignment, habitats and biodiversity)
- Public or private decision-making?

Water management

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- Focus on water storage for drought alleviation
- But reservoirs can be appraised from private or public perspective:
- Private: short time horizons, water valued in relation to crop value (net-back analysis) – generally don't pass a B-C test
- Public: longer horizons –water valued at SOC (e.g. in stream value) - do pass a B>C
- Overlapping private/public objectives. How to incentivise resilience planning?

Other sectors more straightforward

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- Animal production and transport – adaptations to address the effects of heat stress on dairy production and broiler transport
- Climate scenarios linked to biophysical models
- Production and transportation system losses are expressed in terms of mortality and lower productivity related to heat stress
- Reliable data on both housed and transported livestock numbers allows estimates to be scaled nationally
- Market prices provide initial estimate of the value of impacts. Estimates of the non-market value of animal welfare are also available, although analysis shows that positive NPVs can be generated without adding these

Results

Sector adaptation	NPV (£m 2012)
Peatland	1200 - 1840
Coastal managed realignment	24 - 161
Protected areas and biodiversity	37
Crop disease	1.1-12
Animal disease (exotic incursions)	636 - 1850
Heat stress in livestock (broilers and dairy)	0.82 - 3279
Soil management	-122 – 1744
Water	1 – 21
Forestry	222 – 470

Conclusions

- Impossible to develop one number of adapting England's natural environment
- Is CBA the best method?
  - For dealing with uncertainty (real options, portfolio analysis, robust decision making)
- Level of decision-making important
- Process has identified a number of gaps in data, methods, understanding

Thank you!

- anita.wreford@sruc.ac.uk
- http://www.theccc.org.uk/publication/managing-the-land-in-a-changing-climate/

Animal disease surveillance

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- Assesses cost of increasing current disease surveillance programme
- Costs assume a 100% increase in scanning surveillance costs above baseline levels, as well as increases in import testing, targeted surveillance for specific exotic pathogens, and infrastructure costs
- Uncertainties also surround effects of climate change on disease outbreaks
- Returns to improved disease surveillance and detection can be estimated with reference to costs associated with previous disease outbreaks (e.g. foot and mouth) matched with trends observed in climate driven diseases (e.g. bluetongue)
- Results and sensitivity analysis indicate positive NPVs across the possible parameter values