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Advanced Course:
CLIMATE CHANGE IN THE MEDITERRANEAN REGION
PART II: SOCIO-ECONOMIC ASPECTS AND IMPACTS
(12 - 16 November 2001)

"Adaptation to Climate Change: Assessing Needs and Opportunities"

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Adaptation to Climate Change: Priority Issues

Adaptation: Needs and Opportunities

- Action to adapt is necessary whatever measures for reducing greenhouse gases are agreed on
- Scope for action is limited by adaptive capacity ∴ need to increase adaptive capacity

Adaptation: Needs and Opportunities (continued)

- Recognition of need for adaptation may encourage adoption of "win-win" development strategies
- Anticipatory adaptation allows costs associated with autonomous, reactive adaptation to be reduced

Adaptation: Research priorities

- "A key research challenge is to evaluate the feasibility, costs and benefits of potential adaptation options, measures and technologies" IPCC Working Group 2.
- Adaptation assessment neglected and under-developed relative to impact and mitigation assessment

Adaptation: Research priorities

- Methodological refinements and testing needed in adaptation:
  - identification
  - feasibility (measurement of adaptive capacity)
  - evaluation
- Multi-disciplinary approaches essential
- Urgency needed to reduce CC vulnerabilities

Adaptation to Climate Change : Assessing Needs and Opportunities

Alistair Hunt

University of Bath, UK

Structure of Session

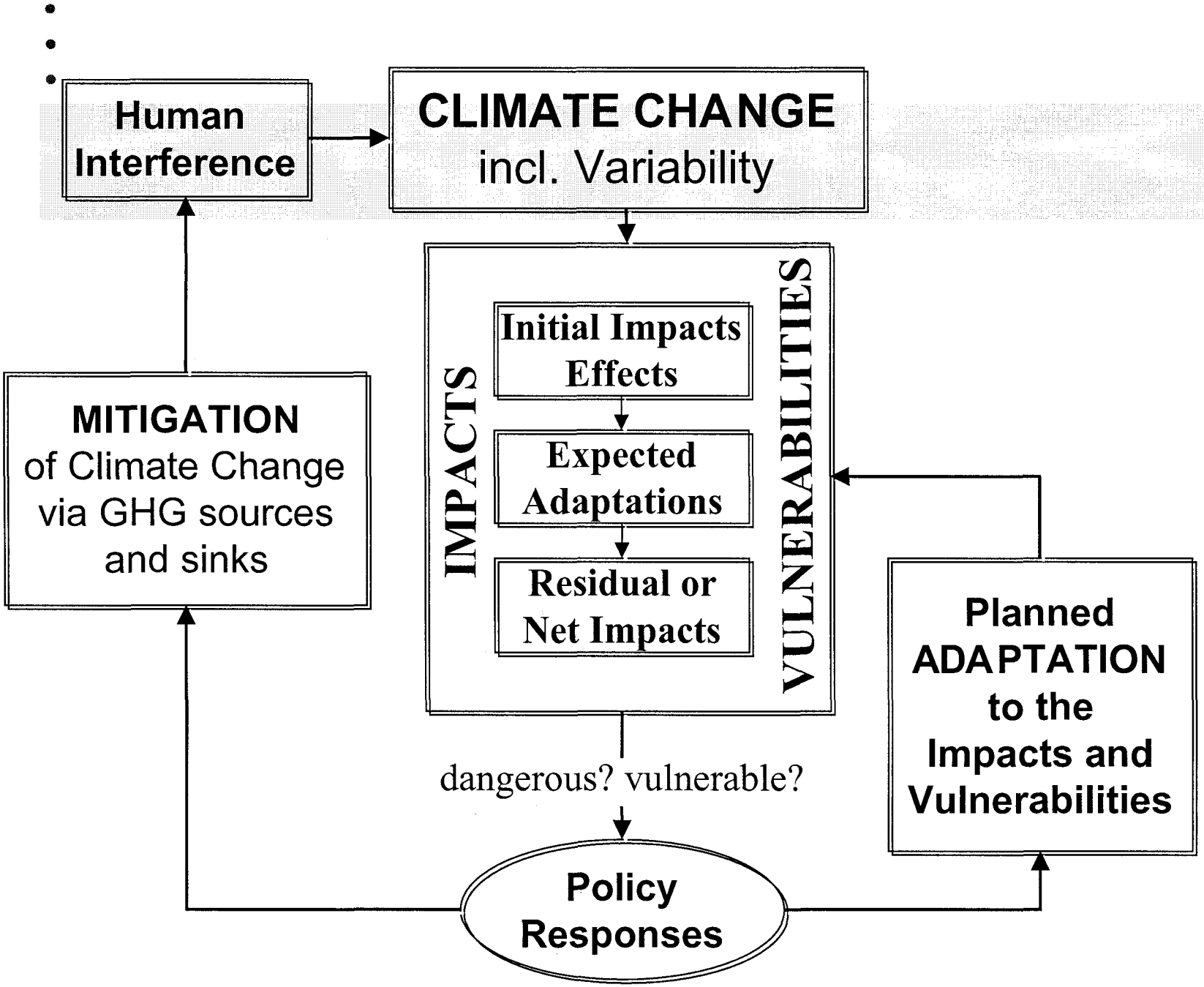
- What is adaptation?
- Why is there a need for adaptation?
- What determines the scope for adaptation?
- Who decides the form of adaptation?
- How to determine the form of adaptation?
- When to adapt?
- Case studies: How to measure benefits of adaptation
- Research priorities

What is CC Adaptation?

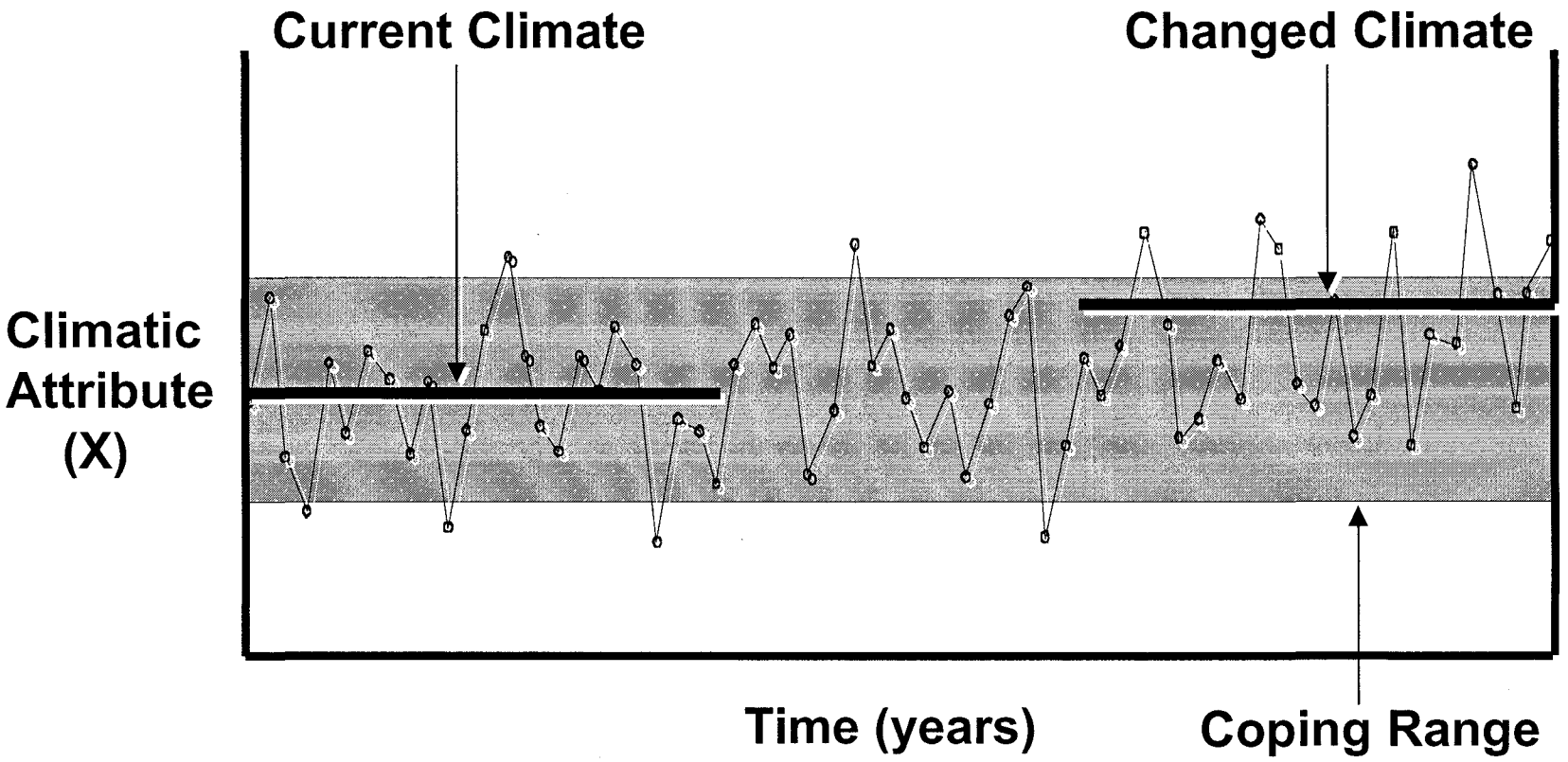
- Adjustments in ecological, social or economic systems in response to actual or expected climate change stimuli, their effects or impacts
  - to reduce vulnerability
  - to moderate damages
  - to realise opportunities
  - to complement other response options (mitigation)

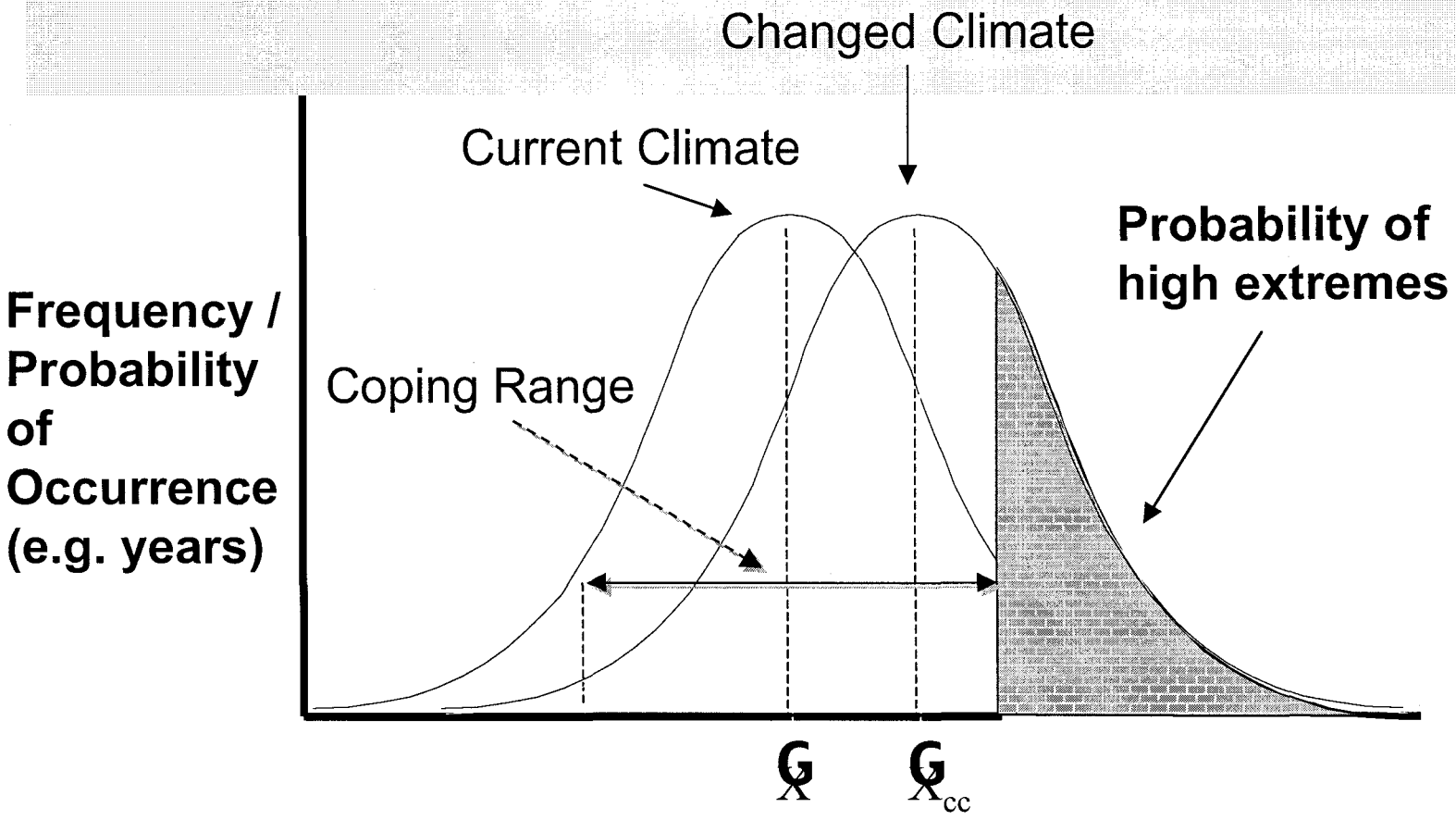
Why is there a need for adaptation?

- Responses to climate & climate variability built into all sectors of economy and society
  - houses designed to be warm in winter, cool in summer
  - crops chosen to suit prevailing temperature, planted according to timing of seasonal rainfall
- Historic climate patterns set to change in uncertain ways/magnitude and at uncertain rate


Human Interference
CLIMATE CHANGE
incl. Variability
IMPACTS
Initial Impacts Effects
Expected Adaptations
Residual or Net Impacts
VULNERABILITIES
MITIGATION
of Climate Change
via GHG sources
and sinks
Planned ADAPTATION to the Impacts and Vulnerabilities
dangerous? vulnerable?
Policy Responses

Climate Change Extremes and Coping Range




Changed Climate
Current Climate
Probability of high extremes
Frequency / Probability of Occurrence (e.g. years)
Coping Range
X
X_{cc}
Values of Climatic Attribute (X)

Vulnerability to Climate Change

depends upon

- **Exposure** to Climate Change Risks

and

- **Adaptive Capacity** to Cope with Risks

Mediterranean CC sectoral adaptation needs

- Water: increased demand, lower supply - rationing ?
- Agriculture: changes in crop composition?
- Coastal areas: protection - form of?
- Energy: space heating needs**6**, demand for air conditioning**5**
- Health: disease prevention from maintaining local sewage systems?

What determines scope for adaptation?

- Adaptive capacity - potential/capability of system to adapt to climatic stimuli or their effects
- Determinants of adaptive capacity
- -Economic resources: poor regions have less diverse, more restricted entitlements and lack of empowerment to adapt

Determinants of adaptive capacity (continued)

- Technology.
  - lack of technology limits range of possible responses since many adaptive strategies directly/indirectly involve technology
  - need openness to development of technology
  - e.g. development of heat resistant rice cultivars crucial in Asian agriculture

Determinants of adaptive capacity (continued)

- Information & Skills
  - recognition of necessity to adapt
  - knowledge of available options
  - capacity to assess options
  - ability to implement most suitable options
- Social Infrastructure
  - availability of, and access to, resources by decision-makers

Determinants of adaptive capacity (continued)

- Institutions
  - institutional constraints limit entitlements and access to resources e.g. financial capital
  - e.g. need to change agricultural tenure systems in regions may create conflicts that are beyond the capacity of local institutions to resolve

Enhancement of adaptive capacity

- Adaptive capacity closely related to sustainable development
- Development policy should prioritise climate adaptation measures according to similar criteria to general development
- Assess changes in adaptive capacity according to sustainable development indicators

Who decides the form of adaptation?

- Autonomous: Private agents
  - reactive or pro-active
  - market-based
- Planned: Private or public agents
  - acceptance and effectiveness of adaptation strategy enhanced by stakeholders' involvement
- Combination: Anticipatory measures used to leverage scope for reactive actions

Types of Adaptation

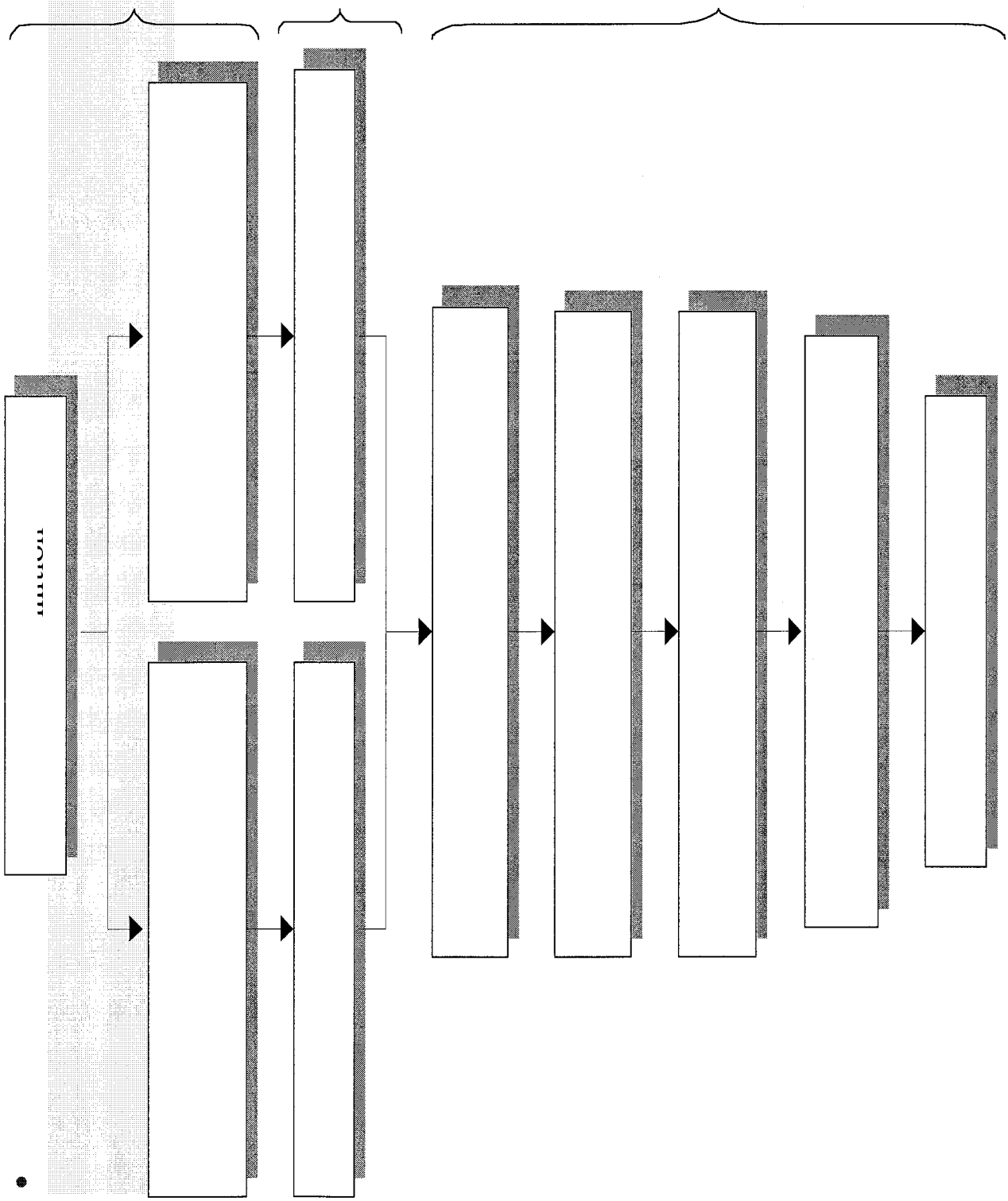
		Anticipatory	Reactive
Natural Systems			• changes in ecosystem composition, location • wetland migration
Human Systems	Private	• crop diversification • purchase insurance • house designs	• crop development • borrow, change activity • reconstruction, relocation
	Public	• early-warning • building codes • infrastructure	• disaster relief • relocation incentives

How to determine the form of adaptation?

- Criteria and tools for assessment
  - economic efficiency: Cost benefit analysis
  - environmental sustainability: Sustainability indicators
  - Public acceptability: Multi-criteria analysis, stakeholder analysis
  - All subject to stakeholder consultation

Tools for assessment of CC adaptation options

- **Cost-benefit analysis** (CBA)
  - designed to show whether total advantages (benefits) of an adaptation option exceed the disadvantages (costs).
  - monetarise costs and benefits accruing to all affected parties.
  - An adaptation project represents a good investment if the aggregate benefits exceed the aggregate costs.


STAGE 1
STAGE 2
STAGE 3

Risk in CBA

- **expected value criterion** involves ranking options according to expected value of outcome, given range of possible states of nature.
- 'expected' means probability that a particular outcome will be realised.

Expected value criterion

Example Outcome Array – NPV of Adaptation Options Under Five Flow Regimes (£ million)

Options	Flow Regime (State-of-Nature)				
	S_1	S_2	S_3	S_3	S_3
Probability	0.10	0.20	0.40	0.20	0.10
A_1	2.0	6.0	10.0	14.0	18.0
A_2	9.0	9.5	10.0	10.5	11.0
A_3	10.0	12.5	14.0	15.5	18.0

Uncertainty in CBA

- **maximin criterion:** decision-maker identifies 'lowest' net benefit that could result from each adaptation option, then select largest of 'lowest' outcomes, i.e. **max**imise **min**imum net benefit.
- **minimax (regret) criterion**: 'loss' experienced if best option, given the state-of-nature that actually occurs, is not chosen.
- **maximax criterion** identifies maximum (net benefit) outcome associated with each option, and selects the largest.

Tools for assessment (continued)

- **Multi-criteria analysis** (MCA)
  - developed since some effects cannot be measured, or cannot be costed.
  - economic efficiency may not be sole criterion in investment decision-making.
  - MCA involves defining a framework to integrate different objectives (or decision factors) in a quantitative analysis without assigning monetary values to *all* factors.

When to adapt?

- CBA rule:
  - Adaptation option should be delayed as long as benefits of delay (avoided investment costs) are greater than associated costs (higher climate change damages
- But, delay may have irreversible effects
- Early adaptation more relevant for e.g. long-lived investments

When to adapt? (continued)

- Investment in adaptive capacity likely to result in immediately increased options
- Planned adaptation options likely to be implemented only if integrated in existing management and development processes. So, easier to do now when we know what they are!
- Optimal timing achieved when turnover of capital Iv and operating costs shorter - flexibility maximised

A Methodology for Costing the CC Impacts avoided from adaptation

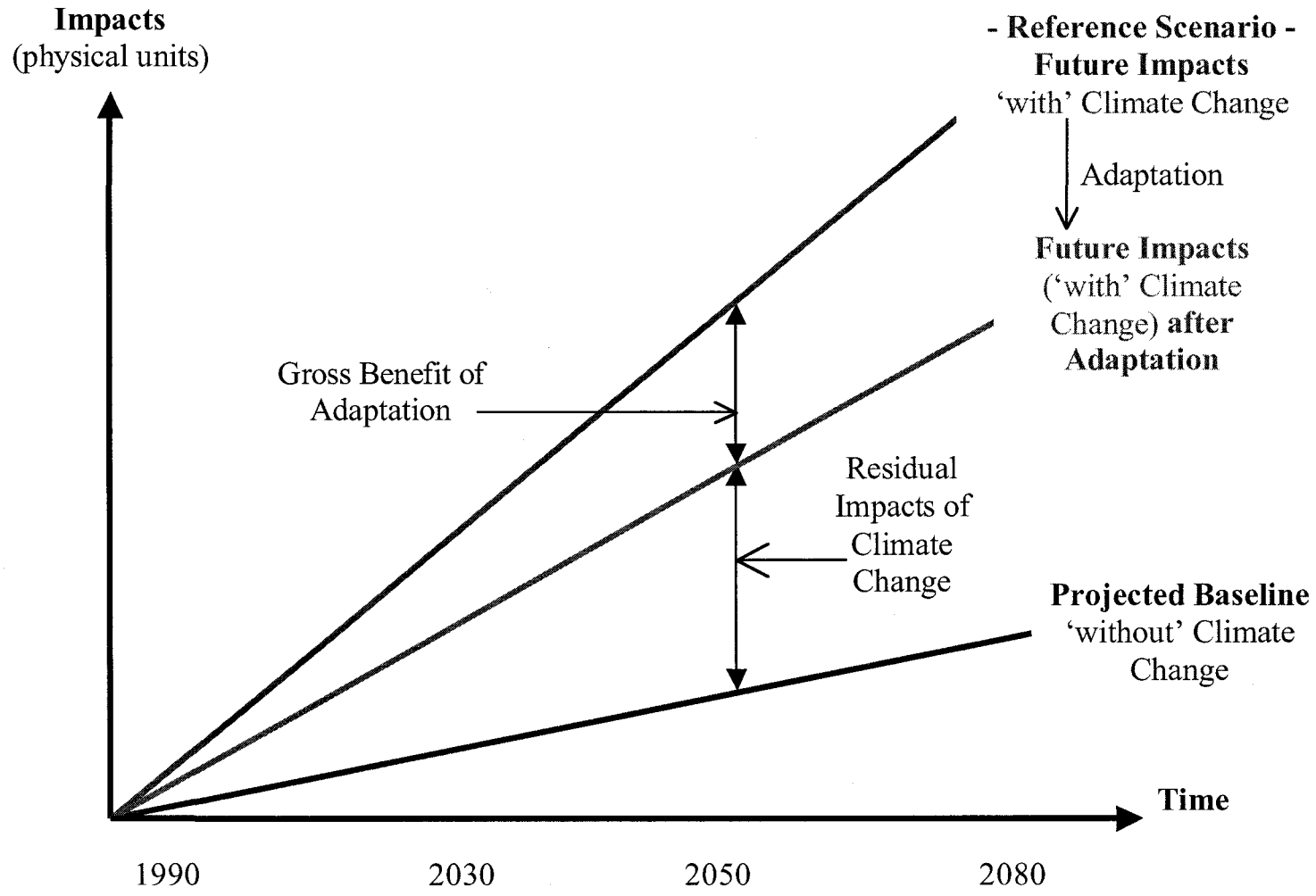
Specification of Decision Problem: Baseline

Adaptation Option Appraisal - to generate valid 'order-of' magnitude' estimates of the net benefits of adaptation to specific CC impacts.

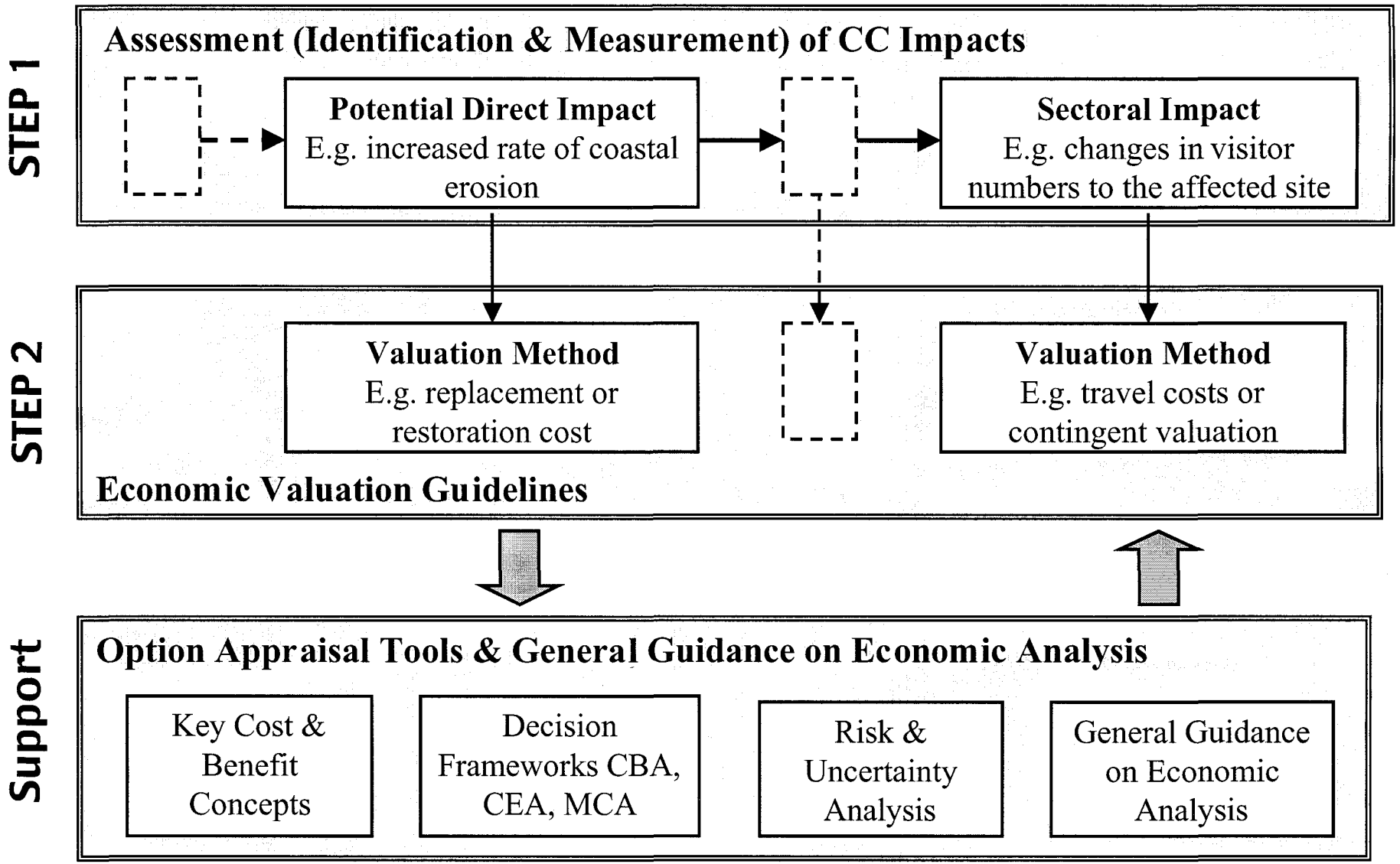
Appropriate Reference Scenario:

Decision-making Context	Appropriate Reference Scenario
Impact screening/prioritisation	'Without' climate change case
Adaptation options appraisal	'With' climate change case

Reference Scenario Relevant to Decision-making Context: Benefits of Adaptation Relative to a Projected Baseline



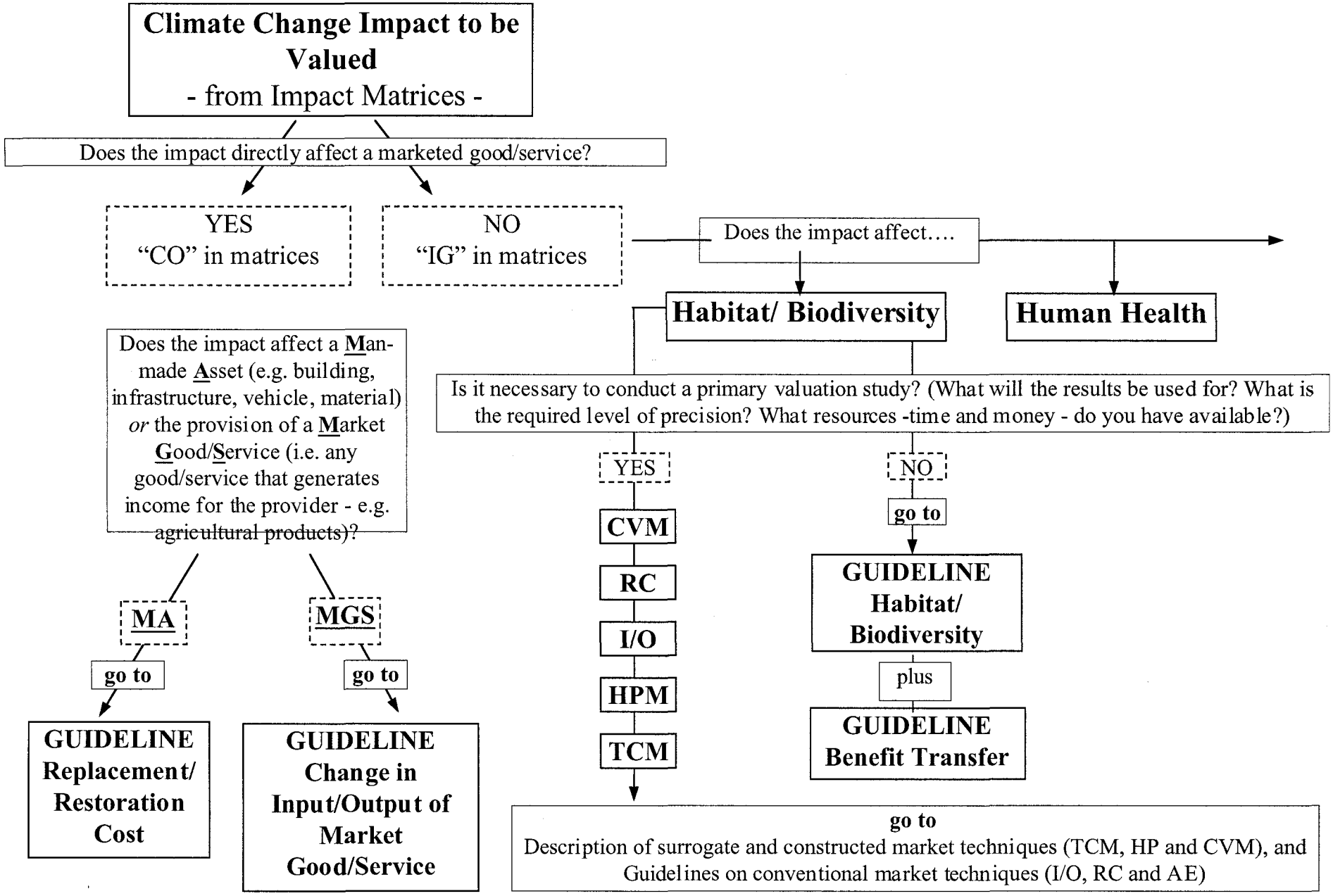
The General Structure of Costing Methodology



Avoided Impact Assessment – Extract from Coastal Zone Impact Matrix

Climate Change Impact: Sea Level Rise						
Direct Impact	***VM***	***Potential Indirect Impact***	***VM***	***Sector Affected***	***Potential Sectoral Impact***	***VM***
Permanent loss of territory	NT	Loss of private property	CO	Domestic sector	Property loss	CO
					Welfare loss	SC
					Changes in the demand for housing in the surrounding areas	NT
		Loss of agricultural land	CO	Agriculture	Loss of productivity	IG
		Loss of non-agricultural (natural habitat) land	CO	Habitat	Loss of species/ecosystems	IG
					Migration of species/ecosystems	IG
		Flooding of wetlands/marshes	CO	Habitat	Loss of species/ecosystems	IG
					Migration of species/ecosystems	IG
		Loss of recreational sites	IG	Tourism, general public	Reduction in demand at affected site	IG
					Shift in demand to alternative sites	IG
		Resettlement	CO	All sectors	Welfare loss	SC
					Temporary losses of productivity	CO
					Compensation	ET
					Removal management	CO

Going from the Impact Matrices to the Valuation Guidelines



Valuation Guidelines Using Conventional Market-based Methods

Techniques in this category value CC impacts using the market price of the affected good/service, and include:

- Changes in input or output of marketed good/service approaches
- Cost-based approaches such as Preventative Expenditures or Replacement Costs.

Valuation Guidelines for Non-market Impacts

General procedure for valuation of these impacts:

Step 1 – identify and quantify the CC-induced impacts;

Step 2 – identify and categorise the specific economic good/service affected;

Step 3 – identify the appropriate economic unit value and multiply this by quantified change (Step 1).

Options Appraisal & General Guidance on Economic Analysis

Select appropriate **discount rate**.

Estimate **prices** changes over time.

Account for **risk** and **uncertainty** in costing analysis.

options selection under certainty – NPV, IRR and B/C

selection under risk – 'probabilistic' criteria, e.g. EMV

selection under uncertainty – e.g. minimax, maximin, etc.

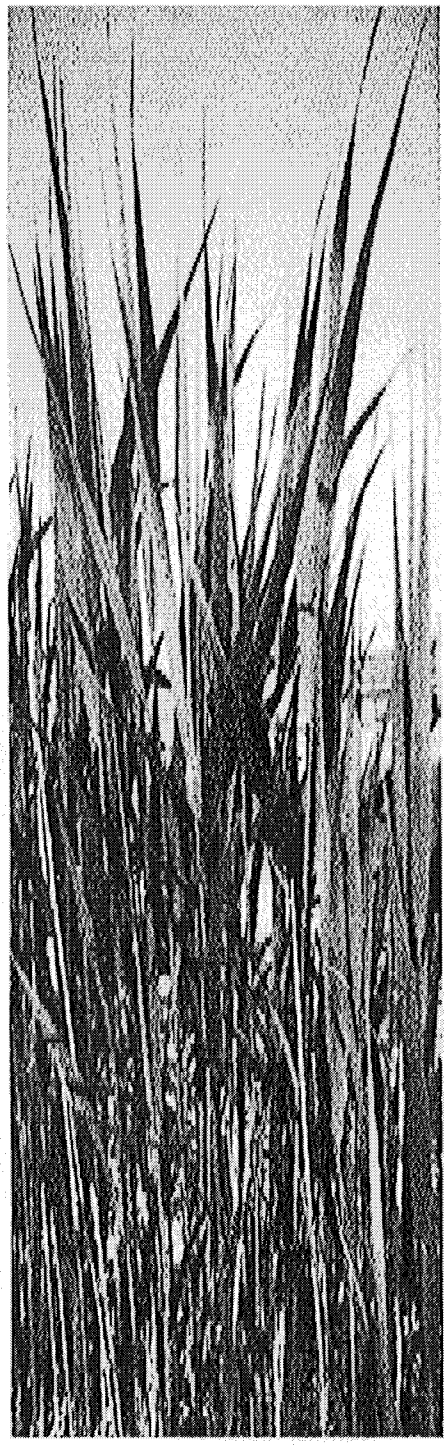
Treatment of **non-monetised impacts**.

Multi-criteria analysis & switching values.

Assess the **distributional effects** of estimated costs/benefits.

Incorporate **non-marginal avoided impacts** of climate change - CGEMs

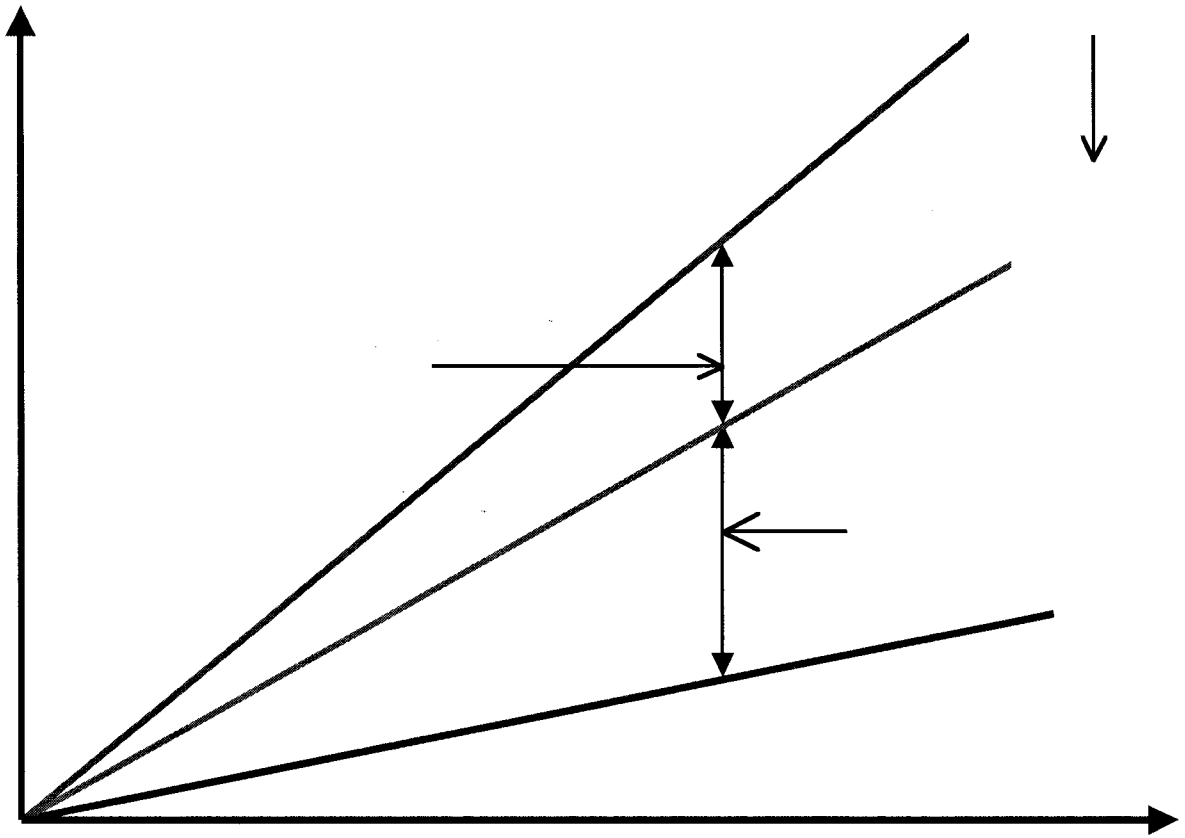
CASE Study:
Valuing protection of Saltwater Marshes in Italy

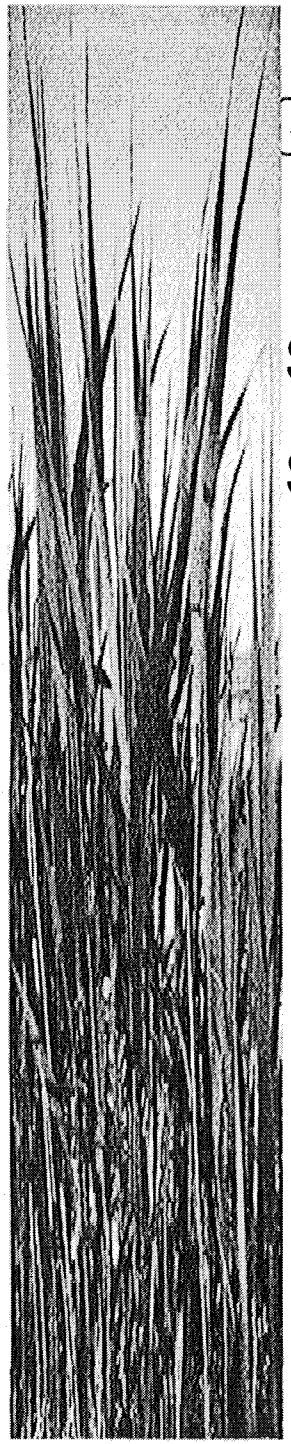


Context of Case Example

- Expected impact of climate change: Loss of saltwater marshes as a result of rising sea levels.
- The saltmarsh is an important wetland in Italy, providing habitat for rare plants, and breeding grounds for birds and fish.
- Perceived threats to saltmarshes: increased storms/flooding sea-level rise - inundation.
- Decision framework: Should the government invest in coastal protection?

Decision making framework





General Approach to Valuation

STEP 1: Identify and quantify impacts

STEP 2: Value impacts using standard valuation techniques

The cost of CC impact (**habitat loss**) (in **£ per year**)

=

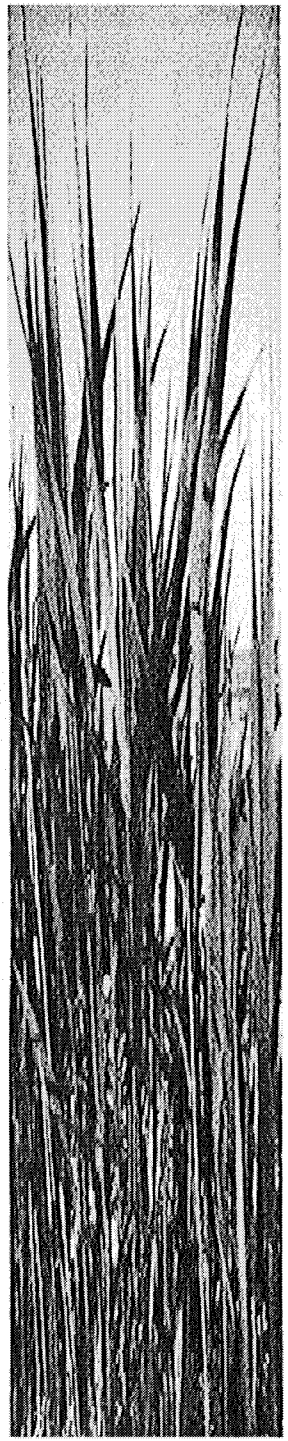
Expected impact (**area of habitat lost**) (in hectares)

X

Economic unit value (**£ per hectare of habitat lost**)

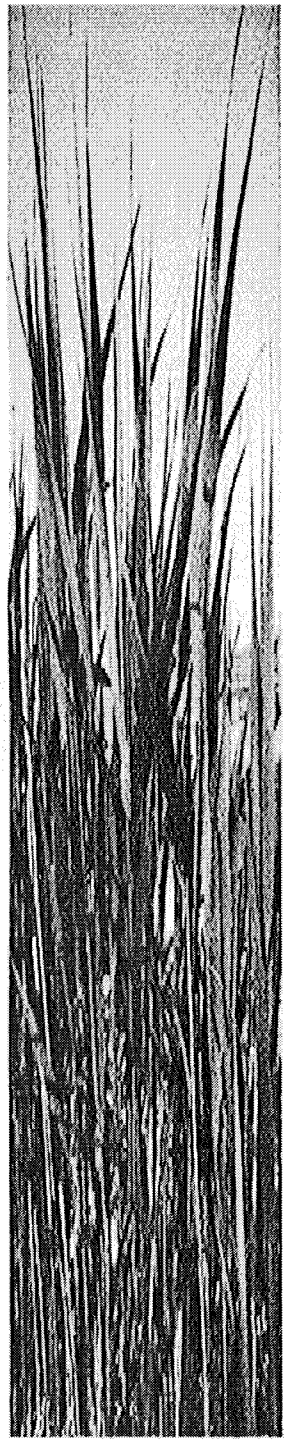
Impact Matrix

Climate Change Impact: Sea Level Rise							
Potential Direct Consequence	***VM***	***Potential Indirect Consequences***	***VM***	***Other Sectors Affected (if any)***	***Sectoral Impact***	***VM***	***Relevant Stakeholders***
Permanent Loss of Territory		Flooding of wetlands/ marshes	CO	Habitat	Loss/ migration of ecosystems/ species	IG	General public, tourists, national interest groups, government
		Loss of recreational sites	IG	Tourism, general public	Reduction in demand at affected site	IG	Tour operators, accommodation and related businesses, general public, tourists
					Shift in demand to alternative sites	IG	



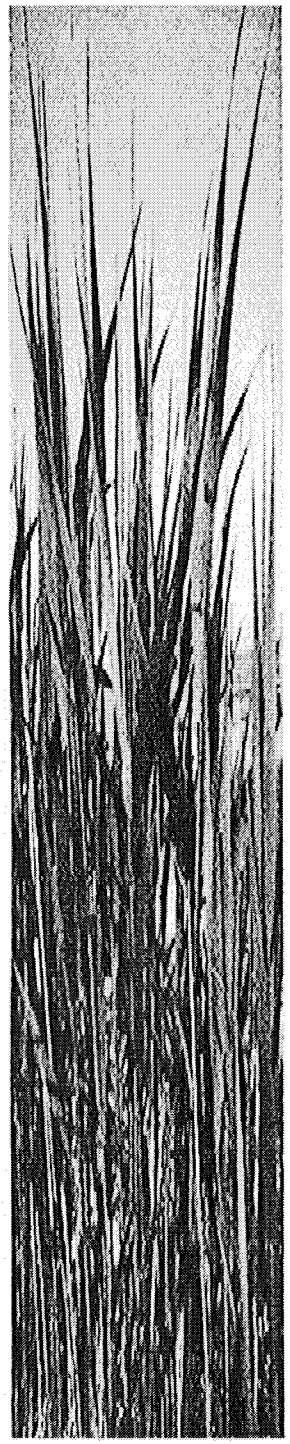
Avoided Habitat Loss: procedure

- Step 1: Identify and quantify the impact
- Step 2 (a) : Identify the types of service affected
- Step 2 (b) : Identify the appropriate monetary value for the change in services



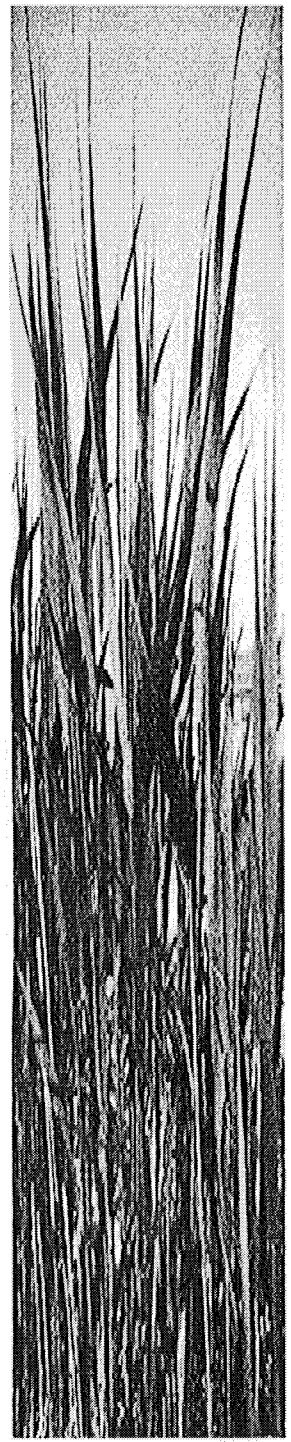
Step 1: Identify and Quantify Impacts

- Data on scale of impacts:
- Impact area: Existing saltmarshes
- Low sea-level rise scenario: loss of 74.6 ha (2.1% of existing stock)
- High lea-level rise scenario: loss of 505.7 ha (14.5% of existing stock)



Step 2 (a) : Identify affected economic services and values

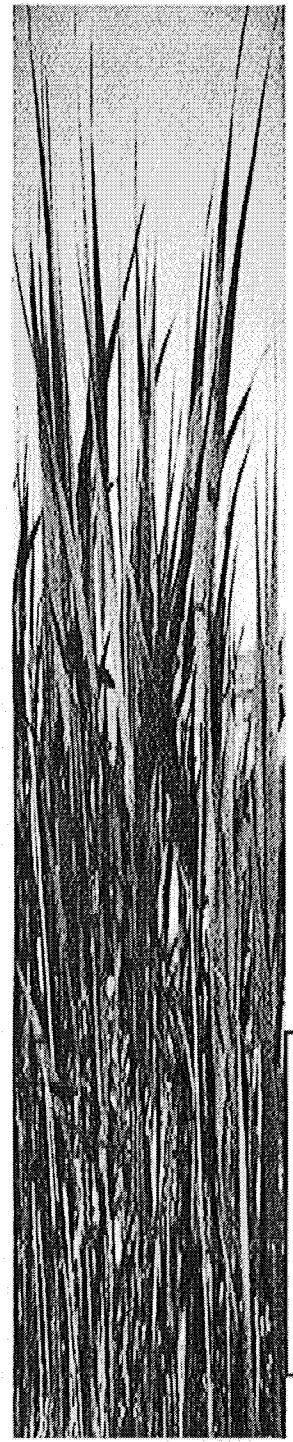
- Types of value provided by coastal habitat
- Impact matrix reveals affected services:
  - Non-use value of rare habitat/ biodiversity
  - Recreation (walking, bird watching)
  - Tourism



Step 2(b): Estimate value of impact

- Perform Benefit Transfer to estimate use and non-use values of saltwater marches
- Literature review identifies average WTP for use values: Euro 20, non-use values: Euro11
- Transfer values to policy site:
  - User population: tourists + local population Value =1,120,000 x Euro 20 = Euro 22.4 million
  - Non-user population estimated as 10% of population of Italy

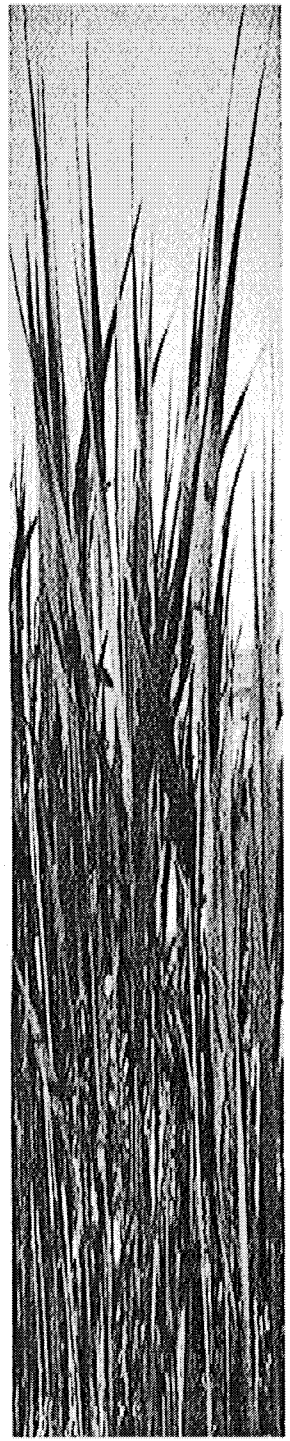
    Value = 5,000,000 x Euro 11 = Euro 55 million
  - Total Economic Value of Existing Wetland: Euro 77.4m
- Assume value decreases in proportion to size:
  - Cost of Loss of 74.6 ha.: Euro 1.6 million per year
  - Cost of Loss of 505.7 ha: Euro 11.2 million per year



Using values in decision-making framework

- Convert values into current capital value over the 20-year lifetime of project:
  - Capital cost of low sea-level rise: Euro 20 million
  - Capital cost of high sea-level rise: Euro 136 million
- Capital cost of coastal-defence: **Euro** 15 mn
- Outcome Array:

Options	Sea-level Rise: 9 cm	Sea-level Rise: 64 cm
Build defence	O_{11} = -15 million	O_{12} = -15 million
Do not build	O_{21} = -20 million	O_{22} = -136 million



Conclusion:

- The climate change valuation methodology has been applied to value a specific impact, within a decision-making framework.
- Given the values, and the project costs, the results indicate that the project is desirable, under both low and high sea-level rises
- If the capital costs of the project were higher, no longer an unequivocal answer. Uncertainty regarding the impact remains a significant issue