Implementing information on the costs and benefits of adaptation in a portfolio – based decision framework

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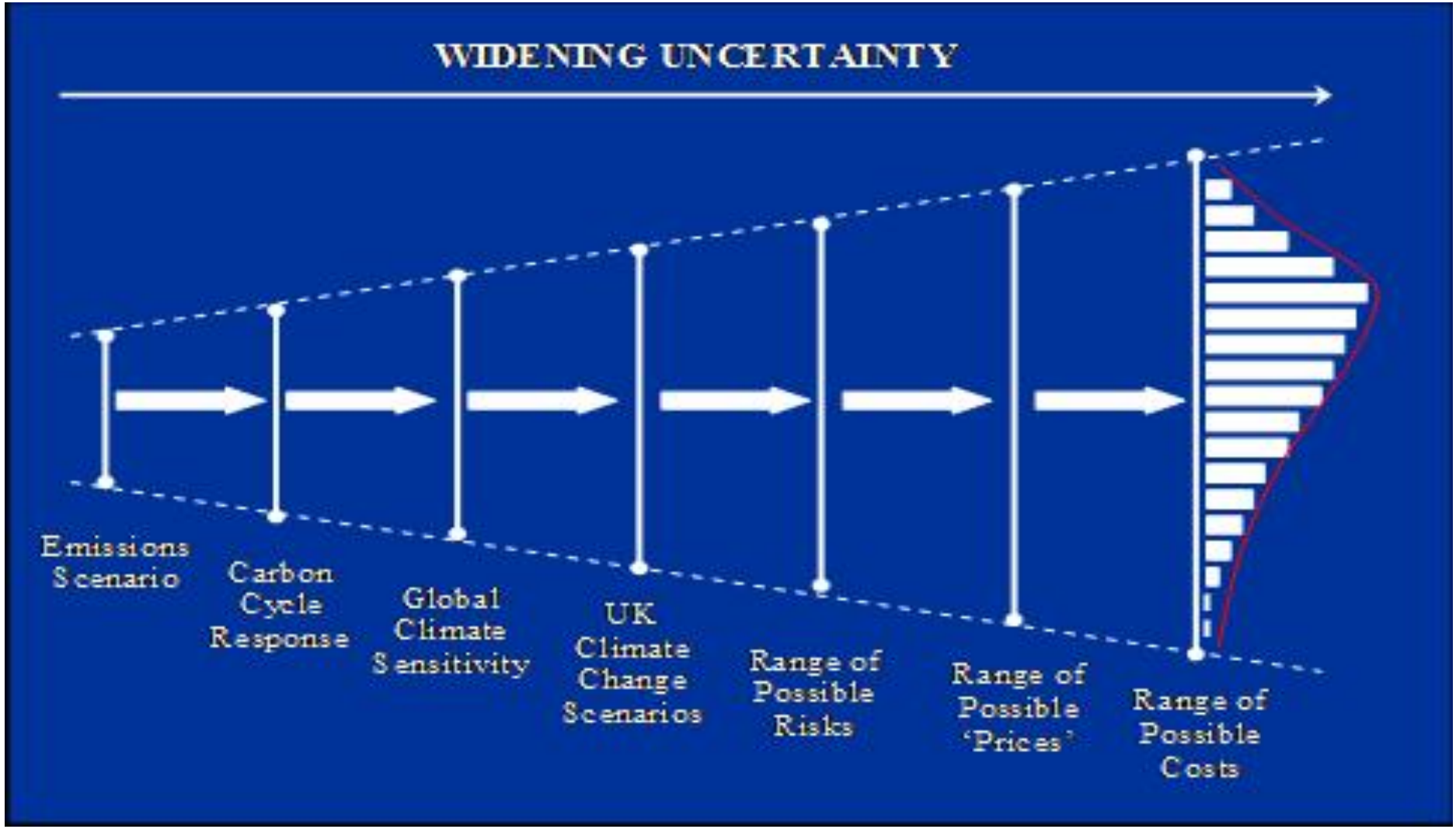
Motivation for Research

- Essentially practical: Test possible tools for evaluation of adaptation

- Credible adaptation policy likely to depend on treatment of uncertainty as well as of economic efficiency (balance of costs and benefits), etc.

Uncertainties in climate impacts



Implications for Flood Management

- Riverine flood risks in Shrewsbury, UK
  - Impacts
    - Direct physical damage to residential and non-residential property
    - Forgone output from short-term disruption to non-residential properties.
    - Direct impacts on human health (mortality, injuries and mental stress).
  - Uncertainties driven by CC and SE Scenarios as well as welfare cost estimation

Implications for Flood Management

- Riverine flood risks in Shrewsbury, UK
  - Adaptation
    - Key problem: uncertainty in impacts may result in inappropriate level or type of adaptation
    - Use of currently used decision rule (CBA)

    →May be better to adopt a portfolio of options that reflects decision-makers' preferences relating to economic optimisation versus reducing the chances of getting it wrong (i.e. Under- or over-adapting - variance from the "optimal")

Flood management decision-making: portfolio analysis

- Portfolio Analysis
  - Principle: since individual assets likely to have unpredictable rates of return over time, an investor should ensure that she:
    - maximises expected rate of return and;
    - minimises variance + co-variance of asset portfolio as a whole rather than manage assets individually, (Markowitz (1952)).

➢ the overall portfolio risk is minimised, for a given rate of overall return.

Flood management decision-making: portfolio analysis

- economic efficiency criterion (Net Present Value) - principal determinant of portfolio return. Also measure NPV variance as indicator of uncertainty

$$\mathrm{NPV} = \underbrace{\sum_{n=0}^{N} \frac{B_n}{(1+i)^n}}_{} - \underbrace{\sum_{n=0}^{N} \frac{C_n}{(1+i)^n}}_{} = \underbrace{\sum_{n=0}^{N} \frac{B_n - C_n}{(1+i)^n}}_{}$$

→ instead of appraisal of single flood response options, a group of options are collectively appraised.

→ may be better able to capture variations in effectiveness of responses across a wider range of possible (climatic and socio-economic) futures.

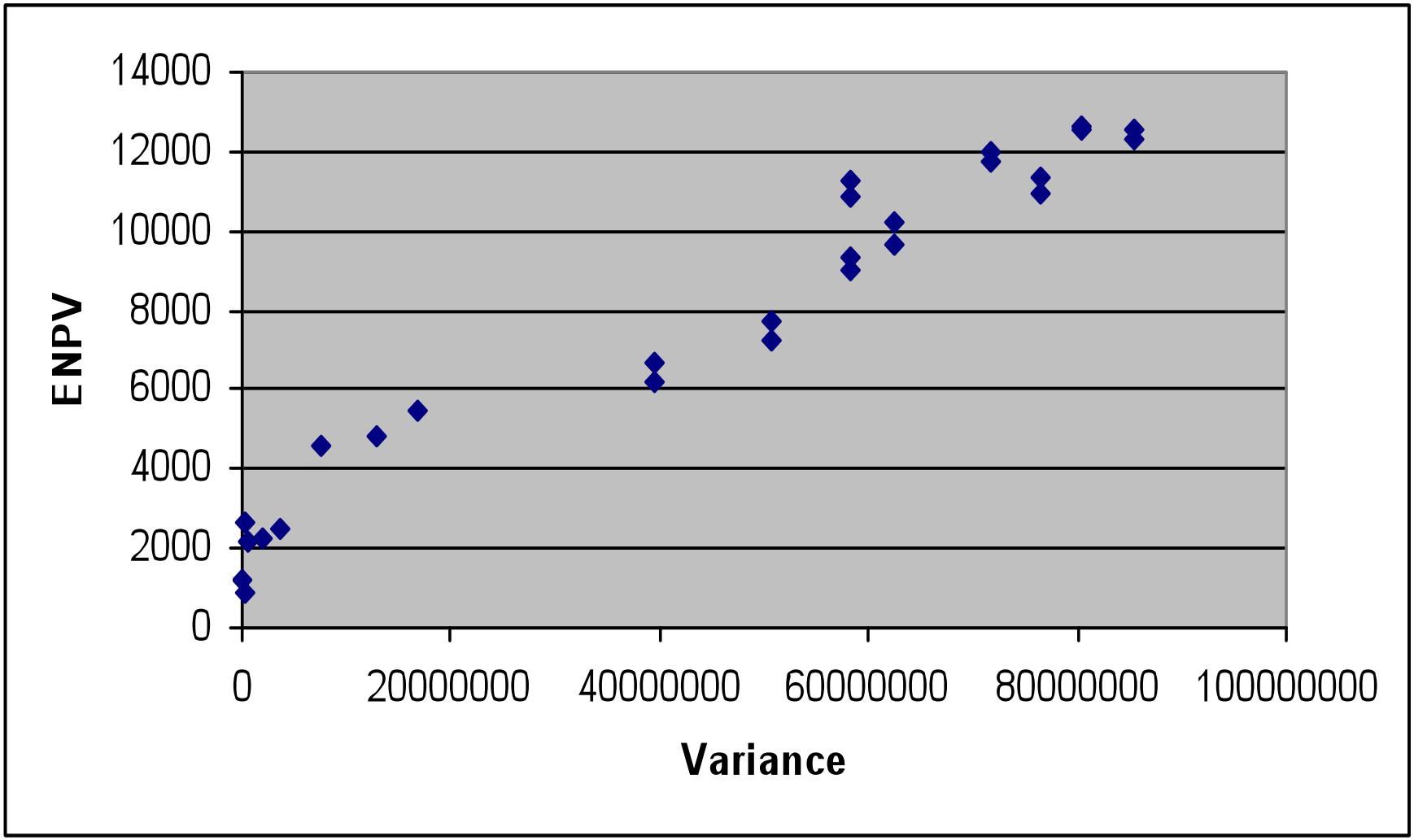
Potential Flood Management Options

Option Type	Specific Options
Managing the Rural Landscape to reduce runoff	Rural infiltration
	Rural catchment storage
	Rural conveyance
Managing the Urban Landscape	Urban storage
	Urban infiltration
	Urban conveyance
Managing Flood Events	Pre-event measures
	Forecasting and warning systems
	Flood fighting actions
	Collective damage avoidance
	Individual damage avoidance e.g. property resistance
Managing Flood Losses	Land use management
	Flood-proofing
	Land use planning
	Building codes
	Insurance, shared risk and compensation
	Health and social measures
River Engineering	River conveyance
	Engineered flood storage
	Flood water transfer
	"Hard" defences

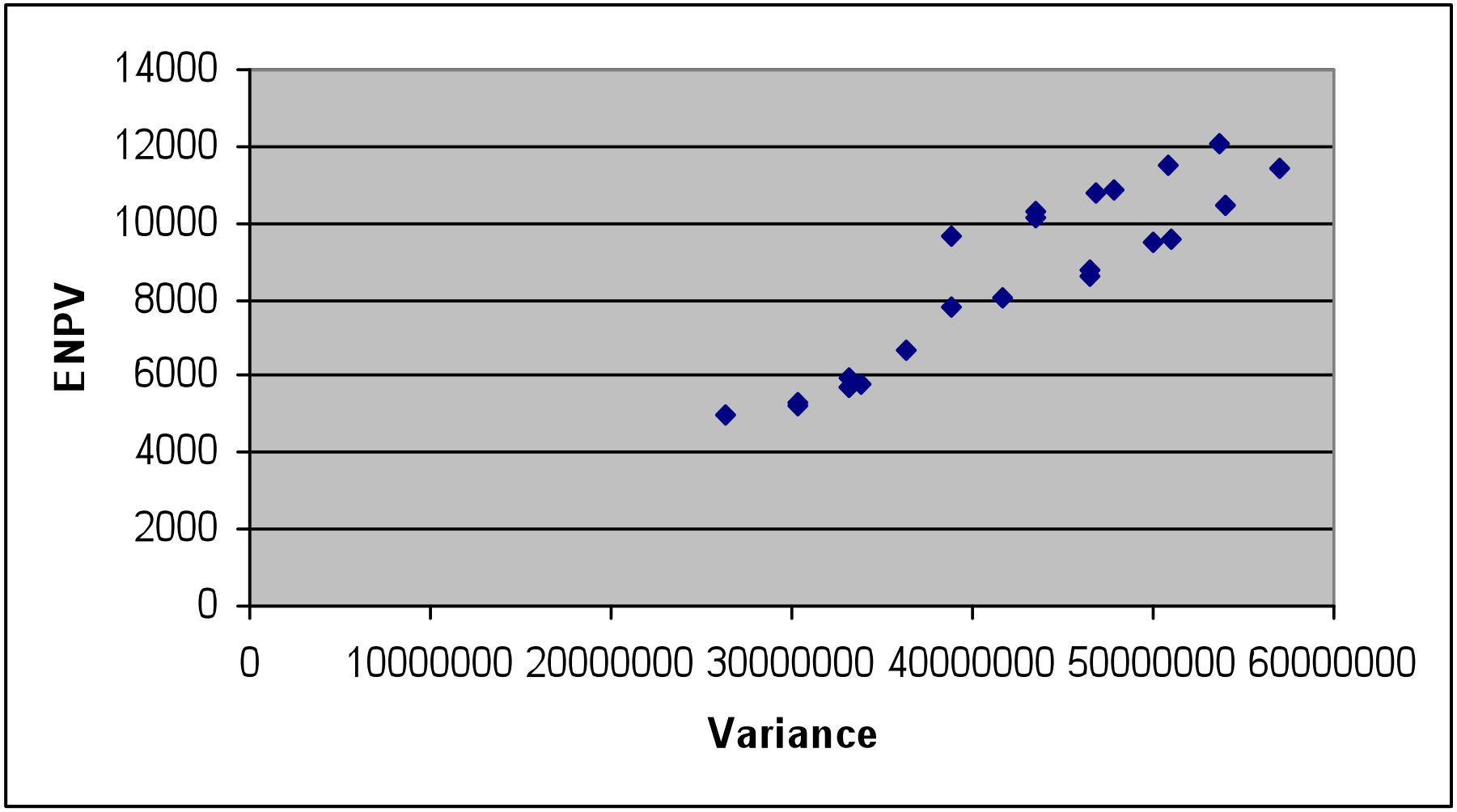
Economic welfare analysis of flood management options

- 3 options: hard defence; property resistance; warning system
  - Portfolios created from combinations of two options and three options, each option disaggregated according to degree of implementation
- Results of CBA for each option combined to produce ENPV and variance of each portfolio
  - Costs: Constant-scale economies assumed
  - Benefits: Four CC/SE scenario combinations of reduced impacts

Two-option Portfolio Analysis



Three-option Portfolio Analysis



Results - Summary

- Economic efficiency – variance trade-off (broadly) exists for both 2 and 3 option portfolios
- Sub-optimal portfolios can be identified
- Hard defences generally contribute most to higher NPV and higher variance; property resistance option has opposite effect.

Conclusions

- Adaptation assessment may be enriched by use of portfolio analysis – incorporates uncertainty more explicitly into decision-making.
- Example reliant on reliable, quantitative data relating to costs and benefits of identified adaptation options.
- But, illustrates broader principle of robustness over uncertainty

Future research priorities

- Testing adaptation options that are:
  - more scenario-sensitive e.g. in other contexts
  - Less data-rich – more reliant on qualitative interpretation

- Including dynamic dimension, incorporating value of new information (quasi-option)