Crawford School of Economics & Government

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The end of certainty and the economics of adaptation to climate change

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a working thesis

- most observers implicitly assume some degree of certainty about the effects of climate change
- But the nature and extent of future climate change is highly uncertain
- all three levels of Australian government risk maladapting and misallocating resources
  - because they are trying to develop policy using familiar paradigms
  - rather than embracing and acknowledging the inherent uncertainties

mitigation was easy …

- specific ‘pollutant’ (greenhouse gases)
- established economic theory: externalities
- Coasean approach not practicable
- possible choices:
  - Pigouvian tax (price)
  - tradeable permits (quantity)
- but adaptation is context, time and spatially specific. No unique approach

what is adaptation?

- response to biophysical impacts of climate change
- anthropocentric perspective
- only human preferences count, even for ecosystems
- relationship to mitigation not analysed here

Despite flooding, education continues on rooftops in Bangladesh, ADB Photo Library 2008.

what should adaptation policy address?

- Increased temperature
- Health effects
- Crop failures
- Economic refugees
- Ecosystem collapse
- Heat wave deaths
- Coastal inundation and retreat
- Inadequate drainage and sewer systems
- Funding constraints
- Hostilities in the region
- Unpredictable effects
- Governance issues
- Responsibility for payment
- Mainstreaming of policy
- Future infrastructure needs
- Increased disease
- More intense rainfall
- More severe drought
- More frequent cyclones
- Effects on tourism
- Increasing business awareness
- Effective decision criteria
- Competing social needs
- Improved modelling of CC
- Many approaches required
- Strategic Adaptation Plan
- “Climate proofing”
- Precautionary Principle
- Maladaptation
- Catastrophe bonds
- McKinsey graph
- Capacity building for adaptation assessmrents
- Insurance for climate change
- Legal liability
- Jurisdictional responsibility
- Indigenous experience & lessons
- Geographic analogues
- Historical analogues
- Tighter building standards
- Market mechanisms
- Wicked problem approaches
- Trade-offs with mitigation
- Risk management
- Adaptation deficits
- Sinking Pacific islands
- Composite indexes
- Multicriteria Analysis
- Real options
- Cost-benefit Analysis
- Vulnerability assessment
- Ethics
- Adaptive Management
- Autonomous adaptation
- Robust Decision Making
- Climate sceptics
- Increased regulation
- Paleo-climatic evidence
- Reduced economic growth
- Adaptive Capacity Index
- Storm surge
- Community Based Adaptation
- Protection, Accommodation, Retreat
- Retrofitting versus climate proofing
- Mainstreaming
- Gender issues
- Government as insurer of last resort

etcetera

etcetera

historical analogues

- **Orlove (2005): Norse colonies in Greenland failed to adapt to cooling period**
- **van der Eng (2010): 1930s Java droughts ameliorated by well-functioning rice markets**
- **Chinese dynastic changes not due to climate change alone (Fan 2009)**

geographic analogues

- e.g. Hallegatte et al (2007)
- analysed 17 European cities (Athens, Barcelona, Berlin, etc)
- depending on climate scenario, Paris in 2070-2100 likely to be:
  - more Cordoba-like, or
  - more Bordeaux-like

insurance

- vanilla insurance: correlation of risk
- re-insurance: cost?
- group insurance: how to define index?
- catastrophe insurance: need capital reserves
- catastrophe bonds: short term

- slow-onset CC : issue of principle of fortuity

conflict and environmental refugees

- **Furnass (2007): potential for invasion of Australia**
  - **reminiscent of 1950s 'Yellow Peril' thinking**
- **evidence is that victims of natural disaster tend to move within own country or culture**
- **other studies : both for and against**

other

- governance (Adger 1999)
- mitigation instrument analogues(Butzengeiger-Geyer)
- precautionary principle
- national emergency management (Yates & Bergin)
- national food security
- trade as adjustment mechanism (Julia & Duchin, Mendelsohn)
- ‘wicked problem’ approach (Verweij)
- mainstreaming (meaning?)
- government as insurer of last resort (?Moss 2002?)
- gender issues
- regulation and standards (e.g. coastal development)
- etcetera

the composite index approach

- techno-science (espec. engineers) prefer single number ⟶ composite indexes (V,R)
- politicians and media also like indexes
  - e.g. ‘most liveable city’, ‘most comp. country’, etc
- indexes are attractive: summarise large range of attributes, easy to formulate, can just use existing data, etc
  - but cannot indicate type or time of warranted action
- composite indexes: arbitrary and non-replicable

simplified vulnerability index

attribute	units	impact	score (0 to 7)	weight %	weighted score
land at risk from sea level rise and storm surge	sq km	20,000	5	25	125
average distance to water and food resources for 80 per cent of population	km	10	6	25	150
public warning systems per head (e.g. mobile phone automated warnings)	% population	23	3	25	75
population growth per annum	number	89,000	2	25	50
total				100	400

deterministic risk management

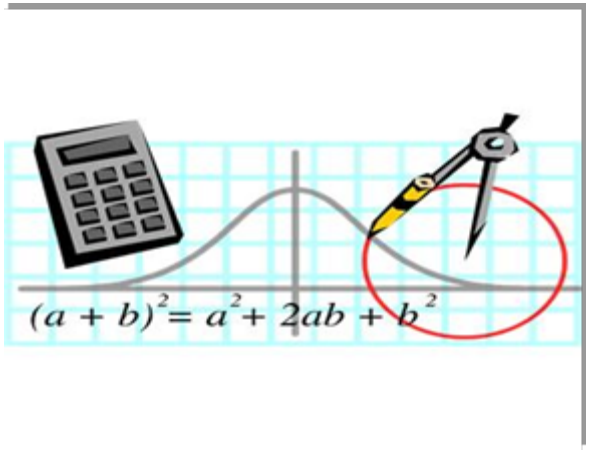
- the techno-scientific policy preference (e.g. Jones)
- based on international standard ISO31000:2009
  - identify risk, including probability of occurrence
  - treat risk
  - monitor residual risk etc
- easy to do: use focus groups etc.
  - consultants love it! ($$$$$)
- problem: estimation of probability implies certainty
- but effects, timing and intensity of CC are uncertain!
- an intellectual and policy dead-end?

the Maginot line of certainty

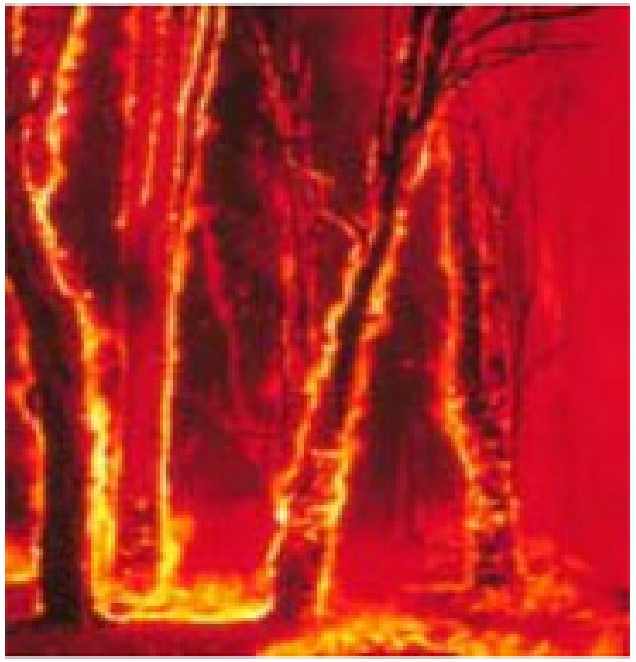
- all of the approaches characterised by implicit search for certainty
- represents a reversion to the comfort zone of the familiar
- danger is inability to respond to unexpected and unpredictable ‘fat tail’ events
- adaptation policy needs to accept uncertainty, not the Maginot principle
- new framework needed

Knightian risk and uncertainty

risk (?)



uncertainty (?)



?

‘Rumsfeldian’ uncertainty

	known consequence or probability	unknown consequences or probability
known event	(II) known knowns e.g. temperature and crop cycles	(I) known unknowns e.g. rising ocean temperature may increase cyclone intensity. But frequency?
unknown event	(III) unknown knowns e.g. Black Swan, Wollemi Pine, intuition, indigenous knowledge of rare pest	(IV) unknown unknowns ex post only. e.g. Melbourne sewer pipes tornadoes??

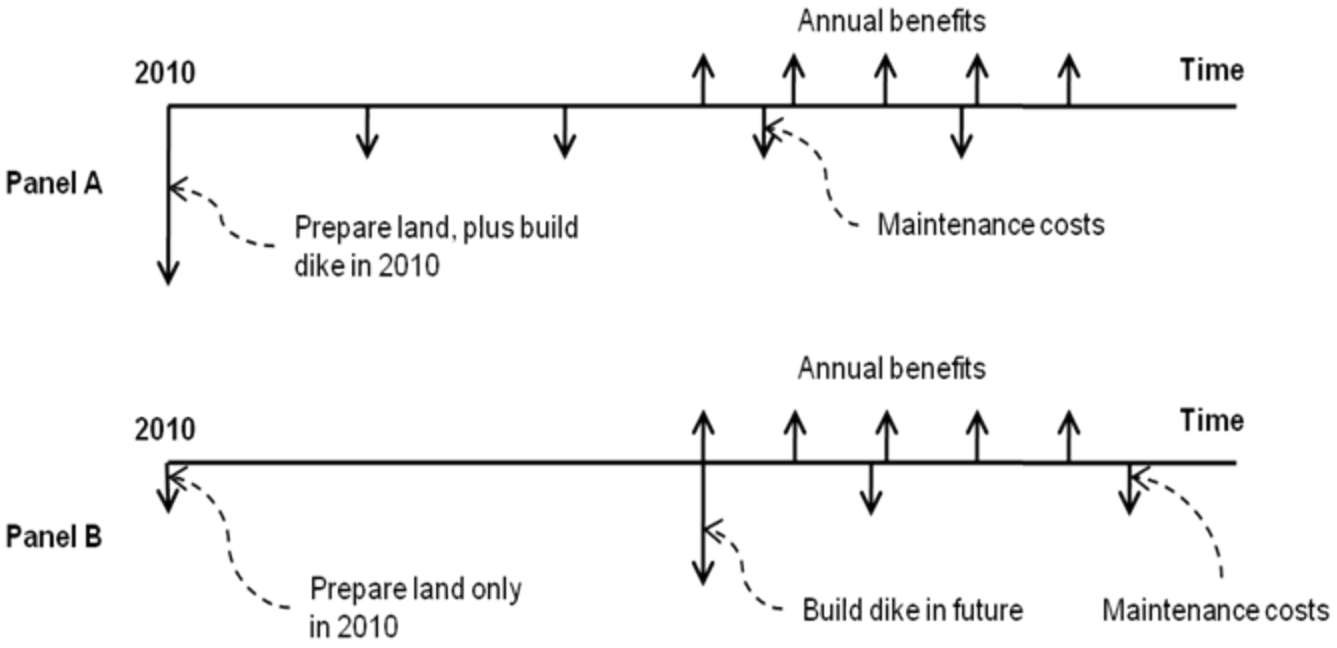
policy: ‘known knowns’

	known consequence or probability
known event	(II) known knowns (Knightian risk) e.g. temperature and crop cycles impacts and probability distribution known **use conventional cost-benefit analysis**

policy: ‘known unknowns’

	unknown consequences or probability
known event	(I) known unknowns (Knightian uncertainty) e.g. rising ocean temperature may increase cyclone intensity. But frequency? **use ‘real options’** **within cost-benefit framework**

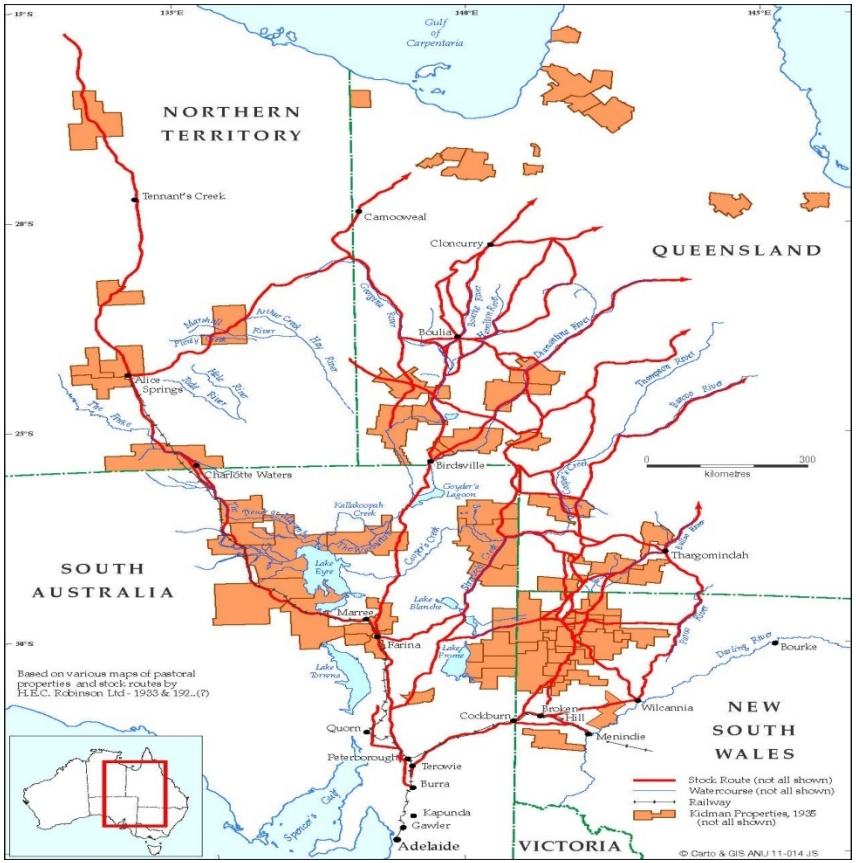
climate change: a sea wall option



panel A: build wall immediately in 2010. No option, no flexibility – a common approach.
panel B: build only the foundation in 2010. Wait for better CC information – a better paradigm
Net Present Value (A) < Net Present Value (B)

real world examples of real options

real world examples of real options



‘real options’: conceptual issues

- **replicating portfolio approach (Kulatilaka)**
  - **but few real assets traded like financial assets**
  - **Black-Scholes – European option, Brownian motion (random walk price), assumes known ln N(μ,σ^2) so not ‘uncertainty’?**
- **subjective approach (Luehrman)**
  - **assume probabilities, use Black-Scholes**
- **Marketed Asset Disclaimer (Copeland)**
  - **binomial lattice assumes probabilities known**
  - **Monte Carlo implicitly assumes pdf known**

‘uknown knowns’

	known consequence or probability
unknown event	(III) <u>unknown knowns : *examples?*</u> • intuition, feeling • riding bicycle • black swans • business affected by CC in supply chain not under its control or knowledge • Wollemi Pine • indigenous knowledge of rare pest • society suppressing knowledge

policy: 'uknown knowns'

- analogous principle to 'real options'
  - but on macro-economic level
- embed flexibility in
  - jurisdictional and institutional governance
  - principle of subsidiarity, decentralisation
  - collection and dissemination of information by government and social networks
- governance flexibility is 'no regrets' or 'low regrets'
  - but politically more challenging
  - and does not provide certainty of comfort zone

‘unknown unknowns’

	unknown consequence or probability
unknown event	(IV) <u>unknown unknowns</u> <u>*ex post only: examples difficult to find*</u> • Melbourne sewer pipes? • e.g. higher temperature results in more and stronger tornadoes, not drought?

policy: 'unknown unknowns'

- analogous principle to 'real options'
  - but on macro-economic level
- embed flexibility in factor and product markets
    - i.e. microeconomic reform
- product and factor market flexibility is 'no regrets' or 'low regrets'
  - but politically more challenging

final thoughts

- key feature of CC is uncertainty
- policy needs to acknowledge uncertainty

- different types, levels of uncertainty
- flexibility is most appropriate strategy

- Maginot line thinking risks maladaptation

from our sponsors ….

- Executive Course on adaptation
- 14 May 2012
- Crawford School
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