Impact and Adaptation Assessment of Cyclone Damage Risks Due to Climate Change

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Scope of Talk

- Probabilistic Risk Assessment for Infrastructure Protection
- Climate impact and adaptation strategies for cyclone damage
  - Proof of concept work
    - housing vulnerability in North Queensland
    - scenario based
  - Assess damage risks (losses)
  - Assess costs and benefits of adaptation strategies
    - should we ‘do something’ or ‘do nothing’?
      - is an adaptation cost effective? and when?
- Other research @ The University of Newcastle
  - Centre for Climate Impacts Management (C²IM)
Many climate adaptation options
- differing cost
- differing effectiveness
- mitigate different hazards

Need to make decisions about how best to utilise finite resources to maximise risk reduction and benefits

Decision support criteria
- risk assessment and risk acceptability
  - Risk = expected losses = Probability of Occurrence x Consequences
  - e.g. damage / year
- net benefit = benefits - costs

Consistent with Australian & International Standards
eg. AS/NZS 4360-2004 Risk Management
Probabilistic Risk Assessment for Infrastructure Protection

- Climate Impact and Adaptation Risks:
  - climate scenarios ?
  - impact / consequences ?
  - vulnerability ?
  - effectiveness of adaptation measures ?
  - cost of adaptation measures ?

- Spatial and time-dependent processes (complex!)

- Large uncertainties in information
  - probabilistic and reliability modelling
  - risk-based decision support
Climate Impact on Cyclone Damage Risks
(Li and Stewart 2008)

- Probabilistic wind field model
  - peak gust wind speeds
    - extreme value distribution

- Building vulnerability functions
  - pre-1980 + post-1980 construction
  - 125,000 houses in region
  - + 2,500 new houses pa
    - insured value of a house = $320,000

- Event-based simulation methods
Climate Impact on Cyclone Damage
Houses Located in Foreshore Regions

eg. 10% increase in wind speed by 2050 will increase damages by $178 million, and $484 million by 2100
... Climate Impact on Cyclone Damage
Regional Losses in North Queensland

Large Increase in Damages

Regional Damage \( L_{c(1,T)} \) ($ million)

Wind Speed Increase

Time
1-10 years
1-25 years
1-50 years
2017

Large Increase in Damages
Cost-Effectiveness of Adaptation Measures

(Stewart and Li 2009)

- Many adaptation measures
  - e.g. Strengthen old (pre-1980 construction) to new standards
    - only for houses located in foreshore regions as these are most vulnerable to cyclones

- Cost-Benefit Assessment
  - Cost = costs of retrofit ($C_{st}$)
  - Benefit = reduced damages due to reduced building vulnerability
  - Net Benefit = Benefits – Costs
    - Variables ???
      - $C_{st}$ = retrofit cost as fn(house value)
      - $r$ = annual rate of retrofit
      - discount rate (= 4%)
      - time period (to 2050)
      - climate change scenario
        - assume 10% increase in wind speed by 2050
Adaptation Strategy
Retrofitting old houses in foreshore region

Adaptation strategy is cost-effective if $C_{st} < 5\%$ or $\$12,000$ per house.
Adaptation strategy will be cost-effective within 8 years if cost of retrofitting is low.
Risks of Infrastructure Deterioration
Effect of CO$_2$ on Reinforcement Corrosion
(Peng and Stewart 2008)

Adaptation measures:
- increase cover
- improve concrete quality
- corrosion inhibitors, coatings, etc.

Probability of Corrosion Damage

Year

cover = 30 mm
w/c = 0.50

Effectiveness? Cost? Benefits?
Centre for Climate Impacts Management (C²IM)
Water Supply Infrastructure

- Prof Garry Willgoose
- Prof George Kuczera

Research strengths in several areas vital for ensuring water supply infrastructure can cope with climate change and variability:
  - Stochastic hydrology
  - Tools for simulating the water cycle in urban system from allotment to regional scales
  - Support for decision making using multi-criterion optimization with explicit recognition of uncertainty
    • tools for selecting robust decisions
Stochastic hydrology fits probability models to climate data to enable sampling of events more extreme than in historic or downscaled record → Essential in drought security assessment

We are only now starting to understand multi-decadal natural climate variability (different to climate change)
… Centre for Climate Impacts Management

Water Infrastructure Simulation Models

- **WATHNET**
  - Regional scale simulation (e.g., Sydney, Melbourne, SEQ)
  - Uses linear programming to deal with network complexity
  - Extensive scripting to express rules and constraints

- **urbanCycle**
  - Allotment to suburb scale
  - Joint simulation of water supply, stormwater and wastewater
Impact and Adaptation Assessment - Probabilistic Risk Assessment –

- Centre for Infrastructure Performance and Reliability
- Centre for Climate Impacts Management

- Frameworks to assess risks, costs and benefits
  - helps decide which infrastructure needs upgrading, and is it cost-effective?
  - maximise efficient use of limited resources

- What are the BENEFITS of adaptation measures?
  - how effective are they in reducing ‘risk’?
Further Reading


Thank you!

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