PRE-DISASTER MULTI-HAZARD DAMAGE AND ECONOMIC LOSS ESTIMATION MODEL

Estimating Economic Impacts of Natural Disasters

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PROBLEM STATEMENT

In 2012 alone, the total economic cost of natural disasters in Australia is estimated to have exceeded $6 billion. Further, these costs are expected to double by 2030 and to rise to an average of $23 billion per year by 2050 (Deloitte Access Economics, 2013).

Chart i: Forecast of total economic cost of natural disasters: 2011 – 2050

$bn (2011 prices)

Source: Deloitte Access Economics (2013)
PROBLEM STATEMENT

- The research consortium formed for this project identifies two major requirements that seek immediate attention to bridge the related gap –

  - First, a disaster risk assessment system that provides quantifiable potential *damages* as a result of different types of disasters for regions of Australia, and
  - Second, a method that will estimate the indirect economic *losses*.
  - Third, *spatial distribution* of economic losses as result of a natural disaster
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bnhcrc.com.au

- **Expected Outcomes:**

  - **National Level:** Identifying the nexus between natural disasters and economic development in Australia

  - **State Level:**
    1. Spatially enabled hazard specific risk assessment information (physical damage assessment for bushfires, floods);
    2. Pre-disaster natural hazard economic loss estimation and geographic distribution of it
    3. Identification of optimum economic policy for reducing disaster risks
    4. Publication of a paper on natural disasters risk and economic growth of Victoria
Mapping, Data Integration and Visualisation

Economic Models and Analysis

Vulnerability and Risk Analysis and Communication

Open Standards

Interoperability

End Users Input and capabilities

End Users Input and capabilities

adpc
**OUR APPROACH**

### Disaster Risk Assessment: Calculating Potential Damage

- **Hazard Assessment**
  - Consolidate existing catalogs of hazard maps for bushfire, and flood

- **Exposure Assessment**
  - Identify existing exposure
  - Develop a database by asset types
  - Analyze each asset type

- **Vulnerability Assessment**
  - Identify existing vulnerability assessment
  - Classify exposed assets into vulnerability types
  - Develop asset-specific vulnerability functions
  - Prepare disaster vulnerability maps

- **Disaster Risks Assessment**
  - Overlay hazard, exposure & vulnerability maps, and calculate scenario-specific potential damage

### Economic Model: Estimating Economic Losses

- **Model Specification**
  - Identify existing macroeconomic models
  - Finalise econometric estimation framework

- **Disaster Impact Estimation**
  - Estimate overall economic losses by sectors using potential damage scenarios for each disaster type

- **Policy Implications**
  - Identify the effects of different policy options for DRR
  - Analyse the prevailing risk financing strategies to mitigate disaster effects

### Spatial distribution of loss

- **Spatial analysis of disaster impact**
  - Prepare a scenario based hazard-specific economic losses matrix by economic sectors
  - Spatially enabling Destination Zones (DZNs), Journey to Work (JTW) and planning zones
  - Spatially enabling economic sectors based on JTW units
  - Spatially enabling scenario based hazard-specific economic losses matrix by economic sectors
DISASTER RISK ASSESSMENT

INTELLIGENT DISASTER DECISION SUPPORT SYSTEM
DISASTER RISK ASSESSMENT

Features of the IDDSS SYSTEM

- Webmapping component
- Modelling component
- Optimisation component
- Access to authoritative information
- Crowd sourcing component
SPATIAL DISTRIBUTION OF LOSSES

1) Data integration
   a) Australian Businesses (ABR, CLUE) in post code level
   b) Generalise and identify the dominant sectors of economy
   c) Sector specific GDP at the state level 1990-2013

2) Spatial Analysis
   a) Spatio-temporal analysis
      • Estimate sector specific GDP at post code level area occupied based on the size of the business (workforce/land size, building size), proximity (restaurants source from a closer producer) and sectoral inter-linkages
   b) Spatio-economic analysis
      • Spatial cross-sectoral relationship
      • Impact of natural disasters
POTENTIAL EFFECTS OF NATURAL DISASTERS
DISASTER EFFECTS: HYPOTHETICAL SCENARIOS

![Graph showing disaster effects with bars representing damage, losses, and gains over time.]

- Damage
- Losses
- Gains
POTENTIAL IMPACT OF NATURAL DISASTERS ON GDP

Scenario 1: No effect
Scenario 2: Negative longrun effect
Scenario 3: No longrun effect
Scenario 4: Positive longrun effect

Disaster event
TIMELINE OF DISASTER EFFECTS

Risk Assessment Mapping + Economic Model = Total Effects

- Damage
- Losses
- Full Recovery

Disaster event
METHODS OF DAMAGE AND LOSSES ESTIMATION
METHODS OF DAMAGE AND LOSSES ESTIMATION

- ATC-13/HAZUS (Hazard in the U.S.)
- Advanced Component Method (ACM)
- CAPRA: Probabilistic Risk Assessment

- Damage and Losses Assessment (DaLA)
- Cost and Benefit Analysis (CBA)
- Catastrophe Simulation (CatSim) Model
- Input-Output Model
- Econometric Models (e.g., VAR & COPS/ORANI Model)
DAMAGE AND LOSS ASSESSMENT (DALA) METHOD

Widely accepted method over the last 40 years.

- Develop **baseline** for assessment
- Develop potential-disaster **scenarios**
- Estimate **direct** and **indirect losses** with regard to forecasted scenarios on a **sector-by-sector** fashion
- Estimate **total value** of direct and indirect losses
- Estimate **macro-economic impact** of direct and indirect losses

**Drawbacks**

- It does not consider **inter-sectoral** linkages
- It cannot estimate **pre-disaster economic losses**
- It excludes the **positive effects** of natural disasters
LOSS ASSESSMENT PRACTICES IN AUSTRALIA

**Emergency Management Australia**

**Disaster Loss Assessment Guidelines**

**Economic Costs of Natural Disasters in Australia**

- **Figure 1.** Step-by-step loss assessment process. (From Queensland Government 2002a)

**State-wide Natural Hazard Risk Assessment**

*Report 6: Australian natural disaster losses and climate change: Implications for disaster risk Management*

Prepared by Risk Frontiers for Queensland Department of Community Safety

March 2011
ECONOMIC MODELS
MACROECONOMIC MODELS

1) Macroeconomics was born with Keynes’s 1936 General Theory

2) Economists began to measure macroeconomic variables (Kuznetts) and to try to model the macroeconomy (Klein)

3) In 1950, Lawrence Klein developed the first macro-econometric model of the U.S. economy, widely known as Klein Model I.
BUILDING A MACRO MODEL

Typically, a Macro Model can be built in two ways:

1. Non-structural approach and
2. Structural approach
VECTOR AUTO-REGRESSIVE (VAR) MODEL: A NON-STRUCTURAL APPROACH

Pros:
1) can examine how a shock to one variable affects all other variables
2) can see how important one variable is in affecting movements of other variables
3) Do not require strong theoretical assumptions - model is rather based on actual trends in data
4) Impulse responses describe reaction of variables on exogenous shocks

Cons:
1) hard to use them to interpret historical events
2) Primarily used for short-term forecasting (up to 4 periods)
3) models lack structure, so the channels through which exogenous shocks affect GDP are not visible clearly
SIMULTANEOUS EQUATIONS MODEL (SEM): A STRUCTURAL APPROACH

Pros:
1) Advantage of structural interpretation, detail, what-if scenarios
2) Usually models are too large to estimate simultaneously—potential parameter bias

Cons:
1) Given its enormous sizes, typically it’s difficult to tease out causality among the variables
2) It’s hard to attain identification condition for solving the model
3) Traditional macro equations may include parameters that are not invariant to changes in the environment—The *Lucas critique*
4) Large models are expensive to maintain
1) Exogenous shocks such as natural disasters are modelled using single-equation estimators instead of system settings (Cavallo et al 2010, Dell, Jones, and Olken, 2014)

2) Our Team of Economists will model and estimate potential losses of natural disasters using a set of single-equation models by highlighting on the requirements of our End-users
THANK YOU