Investment in flood protection measures under climate change uncertainty

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Elbe (2002)

Source: Floodsite (IOER, City of Dresden)
UK flooding (2007)

Source: BBC

“Climate change will pose water management challenges, with increasing risks of floods throughout most of Europe” IPCC (2007)

“Most likely seasonal discharge will shift to more discharge in winter and less discharge in summer … and the frequencies of floods and droughts are expected to increase” Linde et al. (2008) Hydrology and Earth System Sciences
“Although extreme floods with return periods of 100 year and more occurred in central Europe in 1997 (Oder) and 2002 (Elbe), there is no evidence for upward trends in the occurrence of extreme floods in central Europe” Mudelsee et al. (2003) Nature

“Impacts of climate change on the hydrological regime of rivers is still an open question, especially regarding extreme hydrological events such as floods or droughts” Renard et al (2008) Water resources research

Issues

- Floods
- Uncertainty
- Flood protection measures
- Optimal investment strategy
- Example: peak discharge
Model

- Investment in flood protection measures under climate change uncertainty
- Goal: optimal investment strategy

- Discrete two-period model
- Relax discreteness assumption

- Adapt model from Hennessy and Moschini (2006)

Structural measures

Flood protection measures in Japan (Tokyo)
Non-Structural measures

Room for the river (the Netherlands)

Discrete two-period model

\[ t = \kappa \]

\[ C + \int_0^\infty ce^{-\alpha t} dt \]

\[ m = 1 \quad \alpha = 0 \quad C + \int_0^\kappa ce^{-\alpha t} dt \]

\[ m = 0 \quad \alpha = 1 \quad \int_0^\kappa De^{-\alpha t} dt + Ce^{-\alpha \kappa} + \int_0^\infty ce^{-\alpha t} dt \]

\[ 0 \quad \alpha = 0 \]
Building blocks – continuous model

2-Period

\[ t = 0 \quad t = k \]

\( s_0 \ & n_0 \quad s_k \ & n_k \)
\( \alpha = [0:1] \quad \alpha = \text{known} \)

3-Period

\[ t = 0 \quad t = k_1 \quad t = k_1 + k_2 \]

\( s_0 \ & n_0 \quad s_{k_1} \ & n_{k_1} \quad s_{k_1 + k_2} \ & n_{k_1 + k_2} \)
\( \alpha = [0:1] \quad \alpha = \text{sub-domain of} \ [0:1] \quad \alpha = \text{known} \)
Results

- Investment in structural and non-structural flood protection measures
- Objective: minimise expected costs
- Numerical example 2-period model

Structural
Non-structural

Implications for flood protection

- Structural and non-structural measures
- Waiting for new information
Summary

- Investment in flood protection measures under climate change uncertainty
- Goal: optimal investment strategy
- Discrete model
- Continuous model
- Application to case study

Thank you for your attention

Source: Natural Hazards OBSERVER