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Modelling empowers impact and adaptation assessment of natural hazards

Jingyan Wu [a,b], Ilan Noy [b], Yaqiao Wu [a] and Saini Yang [a,c]

[a] Key Laboratory of Environmental Change and Natural Disaster of Ministry of Education, Academy of Disaster Reduction and Emergency Management, Beijing Normal University, Beijing, China
[b] School of Economics and Finance, Victoria University of Wellington, New Zealand
[c] School of National Safety and Emergency Management, Beijing Normal University, Beijing, China
Email: jingyan.wu@foxmail.com

Abstract: Climate change is already increasing the frequency and intensity of extreme weather events, and the impacts of disasters associated with extreme weather are localized and thus be tackled locally (Monier et al. 2018). As we continue to grapple with this increase in disaster risk, it is important to develop effective and cost-efficient prevention and adaptation measures to support decision-making. However, the assessment of these measures is still in its early stages in many locations and requires ongoing development. When things come to the vital and vulnerable transportation system, meteorological and geological hazards often lead to road malfunctions, while these disruptions, in turn, threaten development and cause significant economic losses through damaged infrastructure and increased transportation costs. Improved understanding the overall impact of hazards on roads, including their indirect economic impacts, and the performance of prevention, protection, and adaptation measures can help us better prepare and respond to crises.

The effectiveness of adaptation measures can be characterized by the reduction in losses. This study extends the quantitative assessment of indirect and direct economic losses caused by transportation system failures, to the broader benefits of adaptation measures, thereby generating a more comprehensive understanding of the cost-efficiency of relevant measures and better serving policy formulation. Here, actual road malfunction data, from road monitoring and emergency responses, have been used in scenario modelling. We propose a framework to comprehensively assess the effects of interventions, such as a weather early warning system, utilizing factor analysis, the quantification of direct and indirect losses, and cost-benefit analysis. With the help of computable general equilibrium (CGE) model, the interactions among various sectors in the economy could be quantitatively analyzed by including various agents to capture commodity flows and market factors. The introduction of disaster shock is represented by the intermediate input increment of transportation caused by the post-disaster efficiency reduction. Taking China as a study area, we found that the aggregate indirect economic losses from road malfunctions were more than an order of magnitude larger than the direct losses. Furthermore, information provided by the weather service could reduce these losses, with benefits exceeding costs by a very large ratio. This work represents an essential step forward in making quantitative assessments available. It has the potential to provide evidence for the effectiveness and cost-efficiency of interventions, thus offering guidance for future policy-making on climate adaptation and infrastructure resilience building.

REFERENCES

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