

Resilience of cities to external shocks: Analysis, modeling and economic impacts

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The increasing frequency and intensity of disasters has made resilient and sustainable urban systems a primary goal for cities around the world. According to the United Nations Office for Disaster Risk Reduction (Wallemaq and House, 2018), climate-related and geophysical disasters have caused \$2.9 trillion in direct economic losses over the past 20 years, a 151% rise from the previous 20-year period. Such catastrophes also push 26 million people into poverty annually.

Urban areas, with structural and functional complexities, are projected to account for 68% of the world's population by 2050 (United Nations, Department of Economic and Social Affairs, Population Division, 2018). Their rapid expansion could affect disaster vulnerability in unforeseen ways and poses significant local and global challenges. While some cities and countries have implemented strategies to address disaster risks, considerable investment will be needed in the short to medium-term to improve the resilience of cities to external shocks.

International financial institutions such as the Asian Development Bank, the Asian Infrastructure Investment Bank and the World Bank are actively financing infrastructure projects to improve urban resilience. However, the quantitative impacts of such projects on social and economic dynamics, including human migration, economic productivity and development, and poverty and inequality, are not well understood.

Against this backdrop, the Asian Development Bank Institute (ADBI), Purdue University and the University of Tokyo organized a two-day virtual workshop in October 2020 that gathered 13 papers on analysis, modeling and economic impacts of urban resilience development worldwide. This special issue on “Resilience of Cities to External Shocks” features selected papers from this event.

Modeling flood risk and financing

The study by Causevic et al. (pp. 989–1010) investigates the investments in adaptation efforts to urban flooding and sea-level rise using three ASEAN cities as case studies. Their key finding is to focus on funding mechanisms beyond bi-lateral and multi-lateral agreements and consider incentives for stakeholders and projects that do not generate profits. Mestav Sarica et al. (pp. 1011–1024) study the spatio-temporal dynamics of flood exposure on the built environment using various high-resolution and open data sources. Predictions of the flooding impacts on the built environment were made for 2030 in

Shenzhen using the model. The analysis allows for prioritizing infrastructure against floods and potential investments for risk mitigation. Understanding household level adaptation is an important factor to bolster resilience to shocks. Maquiling et al. (pp. 1025–1041) provide a survey-based approach to understand household level adaptation of low-income households in the Philippines. The study encourages institutional interventions to allow better household level resilience.

Big data and disaster resilience

Several studies focus on the notion of socio-technical resilience and the use of big data to understand the dynamics of resilience. Yabe et al. (pp. 1042–1057) study the coupling between the recovery of physical infrastructure with socio-economic systems using Hurricane Maria from Puerto Rico as an example. They find that smaller urban communities have intrinsic resilience and are disproportionately affected by disaster impacts and recovery and learn to be self-reliant for their recovery. Pagsuyoin and Santos (pp. 1058–1074) study the impact of water disruptions on regional economies. They use an input–output modeling framework where an inoperability variable is considered that determines the inability to deliver water. They identified different sectors in Massachusetts and the US National Capital Region that contribute to significant losses due to water supply disruptions. In both regions, they observe that the utility and real-estate sectors suffer the greatest losses. Ogawa et al. (pp. 1075–1090) propose a sparse modeling framework for evaluating the potential damages of earthquakes due to Nankai megathrust earthquakes in Japan. They find that the urban system variables that are considered in their modeling framework can be extracted for this region and are correlated with vulnerability to the earthquake damage.

Infrastructure impacts and vulnerability assessment

Road networks are highly vulnerable to disasters. Using road network data from 69 cities in Japan, Santos et al. (pp. 1091–1107) identify the level of efficiency of different road networks, they evaluate the efficiency as a function of various shocks to these networks and they analyze the efficiency and robustness with city level attributes. They identify that large cities are more vulnerable to disasters; high populations make cities more resilient while car dependence makes cities more vulnerable. Wachtel et al. (pp. 1108–1125) explore the impact of disasters on tourists. They propose a new way to collect tourist locations and flows and develop a framework for efficient evacuation of tourists in disasters. They consider different population behaviors from the data within their modeling framework. Using Kyoto as a test case, they explore both low-cost and low-technology scenarios as well as advanced options to improve the evacuation of tourists. Continuing on the theme of infrastructure impacts due to disasters, Dhanak et al. (pp. 1126–1143) propose a model to estimate the impacts of disasters on ports. They develop a simulation model that considers port operations and they quantify the impacts on the vessels and nearby landside operations. Using Hurricane Mathew as a case study, they demonstrate the application of their simulation tool to quantify the impacts and the regional consequences of hurricanes. Tanaka and Huang (pp. 1144–1160) study the economic impacts and recovery budget after the 2011 Tohoku earthquake and tsunami using a computable general equilibrium model. Considering various economic sectors, they simulate 100 years of tsunami scenarios and 10 years of sectoral packages considering the ocean economy. They find that the fishery sector is highly vulnerable to

these disasters and will not survive with the current incentives in place. The study provides new ways to reduce the impacts on the ocean economy.

Collectively, this special issue addresses a diverse set of disciplines – economics, civil engineering, data analytics, disaster science, computational sciences and public policy. As such, this special issue should be of interest to diverse disciplines. This special issue advances the understanding of issues in urban disaster risks and will further encourage interdisciplinary and collaborative research efforts in this field. For wide dissemination and access to policy makers and practitioners, all the papers from this special issue are provided as open access, supported by the ADBI.

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