Resilience-Informed Policies for Health Systems in Lima Metropolitan Area Under Severe Earthquakes

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1-Problem

- Major seismic events impact the built environment and population alike, causing disruption that might last for years
- Reduction in hospitals functionality that might be overwhelmed with patients can worsen injuries and increase the death toll

Built-Environemnt



Population



Current Need

Development of a framework that can quantify the impact of disasters on population, infrastructure, and healthcare service delivery while considering recovery trends given the interdependency of systems for any real and large-scale community

Introduction of new policies to reduce the catastrophic impacts on the community and the healthcare system

Establishment of actionable sectoral policies and investment priorities developed based on real data

2-Innovation

Providing new, comprehensive, and scalable approach to examine the performance of healthcare systems in the face of natural disasters

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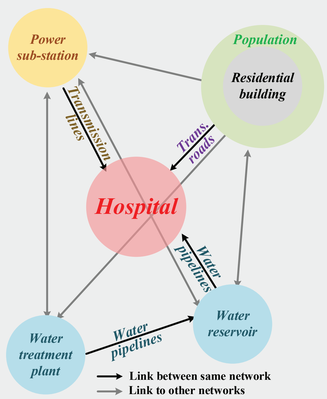
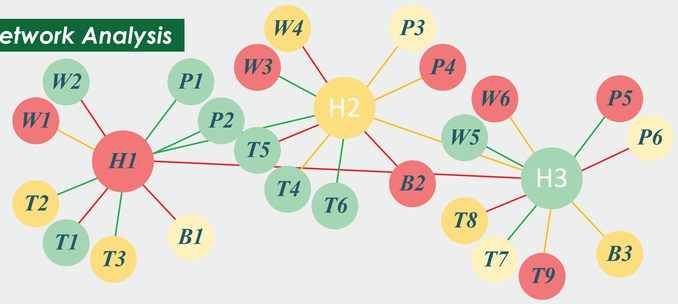
Establishing a network approach to link different healthcare facilities and capture their dynamic interaction using a system of systems approach

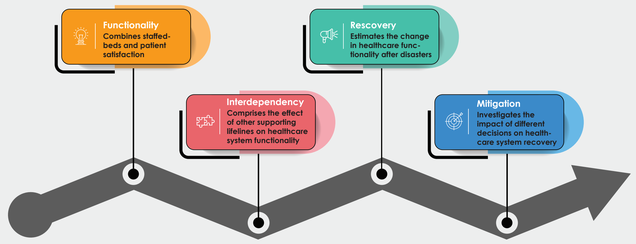


Network Analysis



3-Methods

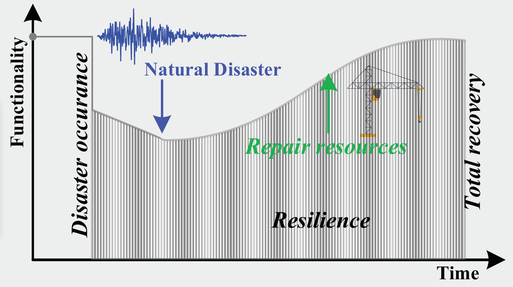
- We assess the potential impacts of a highly probable seismic event on both the healthcare system and critical infrastructure and identify key system components that require upgrading to enhance their seismic performance



- Recovery of the different network components is modeled, where the interdependency between the hospital's repair progress and the availability of the transportation, power, and water services at the hospital location is considered

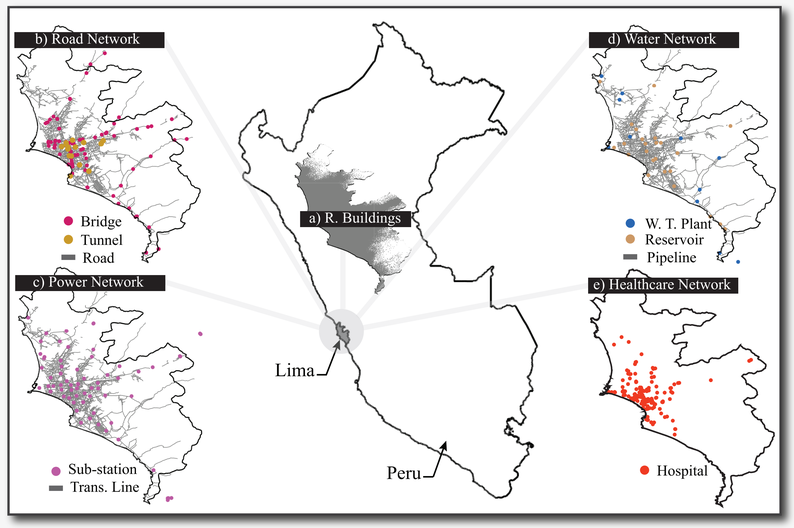
Functionality

$$B(t) = R^t_{ST}, R^t_{SP}, R^t_{SU}$$
$$= \begin{cases} 1 \\ -\left(1 - \prod_{i=1}^{3} R^t_i\right)(1 - R^t_4)\left\{R^t_5\,[1-(1-R^t_6)(1-R^t_7)][1-(1-R^t_8)(1-R^t_9)][1 \\ -(1-R^t_{10})(1-R^t_{11}))\,R^t_{12}\,R^t_{13}\,[1-(1-R^t_{14}\,R^t_{15}\,R^t_{16})(1-R^t_{17})]\right\}\left\{\prod_{i=18}^{23} R^t_i\right\} \end{cases}$$



4-Case Study

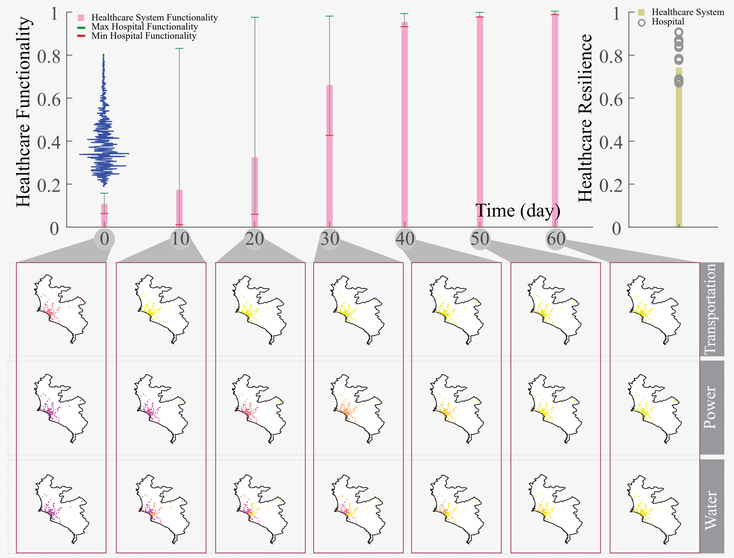
- The proposed framework is applied to the Lima Metropolitan Area, Peru, with a total population of 12.6 million
- Data for residential buildings, road networks, power networks, water networks, and healthcare facilities are collected



- We then subjected these networks to a strong earthquake with a magnitude of 7.5 Mw

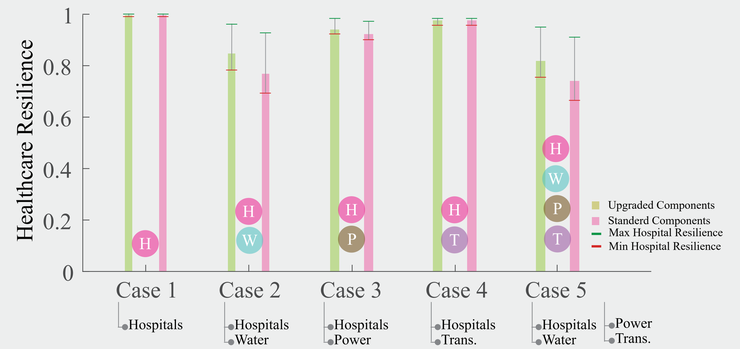
5-Results

- Damage analysis is conducted for the different components, including residential buildings, bridges, tunnels, transportation links, power substations, transmission lines, water treatment plants, water reservoirs, pipelines, and hospitals
- Healthcare system functionality and resilience are quantified over time, while considering the dynamic functionality of roads, power, and water networks



6-Mitgation Strategies

- We explored the impact of infrastructure enhancement and upgrade on healthcare resilience, given the interdependency between the different networks and required resiliency gain in the health sector
- This upgrade comprised replacing the power and water components with seismically anchored assets, seismically designed transmission lines, and ductile pipelines for power and water distribution links



- Seismic retrofitting of water and power components reduces functionality losses and the recovery time in their respective sector in the most cost efficient way

Hassan, E. M., Chulahwat, A., Mahmoud, H., Tariverdi, M., Cortez, M. (2024). Resilience-Informed Polices for Health Systems in Disasters. (unider review).