

Redesign of Coastal Cities: City Concepts for the Future

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Background

In the United States, islands and coastal living areas are under threat due to rising sea levels and, in many cases, extreme weather events like hurricanes, storm surges and torrential rainfall events. The experiences of disasters, recovery, and relocation have deleterious effects on local communities in terms of quality of life, economies, physical and mental health, and social cohesion. Innovative human-centric design and infrastructure solutions are needed to preserve and create resilience in coastal communities. Solutions to create resilience in these communities must preserve local communities, strong social ties, and economies.

Not mitigating hazards has considerable consequences since disaster relief, recovery, and relocation are very expensive. Hurricanes Katrina and Harvey, for instance, had estimated total costs of \$161 billion and \$125 billion, respectively. Massive critical infrastructure improvements and redesign efforts may thus be economically viable in the long term, especially considering hazard-related illnesses and infections and how cultural and economic loss during outmigration harms coastal communities.

Proposed Framework

A redesign of city concepts is proposed. **This multidisciplinary human-centric infrastructure project will develop, implement, and evaluate designs to keep coastal communities in place.** Though not all cities will financially or logistically be able to rebuild or redesign--and some communities will inevitably be relocated or abandoned--the present project will focus on communities that show promise for future vitality with appropriate redesign.

We propose a group-randomized study of 8 United States communities to examine factors related to keeping communities in place as sea level rises and floods their homes and businesses. We will choose 4 small communities on the west coast and 4 on the east or gulf coast, with 2 cities in each coastal group eligible for redesign implementation and the other 2 in each region as control sites. Those on the west coast will be randomized to making themselves floating cities or control while those on the east or gulf coast will be randomized to make themselves raised cities or control. Minimum average elevation and maximum population requirements will be established for city eligibility.

For communities that do not typically face hurricanes, floating cities may be a solution to rising sea levels. The residences of floating cities consist of people living on boats, houseboats or floating platforms. They may or may not be moored together, and may or may not be used for transportation. Examples of floating cities include large populations in the Mekong delta, and the proposed floating island project in French Polynesia). The human dwellings of raised cities consist of buildings that are elevated above the water on piers/posts and are thus fixed in place. Raised dwellings exist all over the world in waterfront, riverine and coastal areas. One of the question we propose is whether a group approach to raised dwellings will be more effective than is the house-by-house approach of FEMA or the national flood insurance program. Such projects requiring a large capital investment are not without precedent--HUD projects have reached hundreds of millions of dollars, as have disaster recovery funded by the Federal

Emergency Management Agency.

In the proposal experiment, roads, utilities and other critical infrastructure supporting and connecting raised or floating dwellings can likely take a number of forms. Similarly, retail, food markets and other services can take a number of physical and organizational forms. Such infrastructure systems provide the services that are required to support the health, safety, and economic activities of a city and include power, water, communication, and transportation services.

Methodology

For each of the study cities, we will investigate the feasibility and efficacy of two main general approaches to provide infrastructure services. The first is to create self-sufficient systems, which would be able to provide services without reliance on external sources. For example, for power, a combination of solar power generation, wind power generation, wave energy, and energy storage through batteries would provide power. This would be particularly applicable for floating cities.

The second general approach to providing critical infrastructure is through connections between buildings and connected generation and distribution systems. For example, for power, these would be through traditional transmission and distribution lines from the power grid, regardless of the power source. Since these systems have been shown to be vulnerable to coastal hazard events, we will also investigate combinations of these two approaches and evaluate how differing infrastructure designs are able to provide utility services for differing communities under a range of conditions occurring over the study period. We will also examine these combinations through modelling. Recruiting communities to come together to endure a large redesign project may present challenges. Any difficulty in recruiting communities may require project flexibility (such as staged redesign components) to ensure feasibility.

Though it is not expected that raised cities will eliminate the need for evacuations in eastern and gulf coastal communities when an extreme weather event may occur, infrastructure redesign is expected to minimize the need for rebuilding and recovery--including resistance to wind, storm surge, debris impacts, and variable water and stream flows through column design. The study's two cases of floating cities do not need such a level of consideration of exposure to acute hazards since they would be located in west coast areas without typical exposure to hurricanes or similar storms (and rainfall and flooding events are not particularly disruptive to floating cities).

This project would prospectively follow individuals and families in the 8 communities for at least 10 years. To ensure that the project continues to follow individuals even after outmigration, we will prospectively collect information on participating individuals' non-coastal contacts so we can continue to follow these participants even after they outmigrate. Participants will respond to surveys on social networks and community cohesion, physical and mental health, and economic indicators, and will be supplemented with the National Death Index to examine mortality outcomes. Beyond the raising of dwellings on the east coast or moving into floating dwellings in the west coast, participants in redesign and control cities will receive incentives (gift cards or cash payments) to encourage survey participation on an annual basis.