ScholarWorks@UMass Amherst

Title

Social vulnerability, green infrastructure, urbanization and climate change-induced flooding: A risk assessment for the Charles River watershed, Massachusetts, USA

Author

Chingwen Cheng, *University of Massachusetts Amherst* Follow

Date of Award

9-2013

Document Type

Open Access Dissertation

Degree Name

Doctor of Philosophy (PhD)

Degree Program

Regional Planning

First Advisor

Elizabeth A. Brabec

Second Advisor

Robert L. Ryan

Third Advisor

Qian Yu

Subject Categories

Landscape Architecture

Abstract

Climate change is projected to increase the intensity and frequency of storm events that would increase flooding hazards. Urbanization associated with land use and land cover change has altered hydrological cycles by increasing stormwater runoff, reducing baseflow and increasing flooding hazards. Combined urbanization and climate change impacts on long-term riparian flooding during future growth are likely to affect more socially vulnerable populations. Growth strategies and green infrastructure are critical planning interventions for minimizing urbanization impacts and mitigating flooding hazards. Within the social-ecological systems planning framework, this empirical research evaluated the effects of planning interventions (infill development and stormwater detention) through a risk assessment in three studies.

First, a climate sensitivity study using SWAT modeling was conducted for building a long-term flooding hazard index (HI) and determining climate change impact scenarios. A Social Vulnerability Index (SoVI) was constructed using socio-economic variables and statistical methods. Subsequently, the long-term climate change-induced flooding risk index (RI) was formulated by multiplying HI and SoVI. Second, growth strategies in four future growth scenarios developed through the BMA ULTRA-ex project were evaluated through land use change input in SWAT modeling and under climate change impact scenarios for the effects on the risk indices. Third, detention under climate sensitivity study using SWAT modeling was investigated in relation to long-term flooding hazard indices.

The results illustrated that increasing temperature decreases HI while increasing precipitation change and land use change would increase HI. In addition, there is a relationship between climate change and growth scenarios which illustrates a potential threshold when the impacts from land use and land cover change diminished under the High impact climate change scenario. Moreover, spatial analysis revealed no correlation between HI and SoVI in their current conditions. Nevertheless, the Current Trends scenario has planned to allocate more people living in the long-term climate change-induced flooding risk hotspots. Finally, the results of using 3% of the watershed area currently available for detention in the model revealed that a projected range of 0 to 8% watershed area would be required to mitigate climate change-induced flooding hazards to the current climate conditions.

This research has demonstrated the value of using empirical study on a local scale in order to understand the place-based and watershed-specific flooding risks under linked social-ecological dynamics. The outcomes of evaluating planning interventions are critical to inform policy-makers and practitioners for setting climate change parameters in seeking innovations in planning policy and practices through a transdisciplinary participatory planning process. Subsequently, communities are able to set priorities for allocating resources in order to enhance people's

livelihoods and invest in green infrastructure for building communities toward resilience and sustainability

Recommended Citation

Cheng, Chingwen, "Social vulnerability, green infrastructure, urbanization and climate change-induced flooding: A risk assessment for the Charles River watershed, Massachusetts, USA" (2013). *Open Access Dissertations*. 781.
https://scholarworks.umass.edu/open_access_dissertations/781