Applying a Resilience Approach to Flood Management in Rapidly Changing Landscapes

Abstract

Human land use activities have significantly changed the capacity of ecosystems to deliver essential service. Additional stresses brought about by climate change will require a shift in how ecosystems are managed. Global increases in the magnitude and frequency of flood events in particular have raised concerns that traditional flood management approaches may not be sufficient to deal with future uncertainties. Resilience approaches aimed at understanding and managing the capacity of social-ecological system (SES) to adapt to, cope with, and shape uncertainty and surprise offer a possible avenue to deal with these challenges. Accordingly, through the use improved systems approaches and knowledge on floods, flood regulation services and its impact on people and infrastructure this dissertation contributes towards developing and piloting of a flood resilient management strategy. Research was carried out using three flood prone municipalities in the Eden District of South Africa as a case study.
The Millennium Ecosystem Assessment, in its final report, highlighted regulating services as some of the most important and degraded, but least understood ecosystem services. Regulating services moderate the flow of energy and materials and play a critical role in regulating the impacts of extreme events. The progress in research and understanding of regulating services was investigated, with a particular focus on progress on their assessment and quantification. Findings flag key research gaps in all regulating services in developing countries and globally, in specifically understudied regulation services of disease regulation and air quality regulation. Results also revealed the need to include the human dimension into the study of regulating services, which will require an increase of multi-disciplinary research using a social-ecological system approach. Based on these findings and the objectives of the study the use of an existing decision support tool SCIMAP was adapted and explored using globally available data to provide a practical and informative approach for identifying flood receiving areas at a watershed scale. Model outputs highlighted how the combined effect of natural and anthropogenic factors can aggravate or attenuate a flood event, adding valuable insights into flood generation and how it can be managed, especially in under resourced areas. In order to assess the resilience of communities to floods, a composite index and spatial analysis approach was piloted. The approach allows for a simple, yet robust index able to include an array of datasets generally available in flood prone areas with potential to disaggregate and trace variables for management and decision making. iii

Finally, based on the methods and results developed in previous chapters of the dissertation, an approach to characterise and spatially connect the flood regulating ecosystem service flows from supply to demand is introduced and illustrated. The proposed method builds on from the thinking in flood vulnerability and incorporates landscape connections from supply to demand areas. By identifying and linking supply areas to the downstream benefitting areas of the watershed, areas directly linked to high demand can be conserved to ensure a sustainable supply of the flood regulation service. This dissertation provides new and improved approaches for building and managing flood resilient watersheds. The results have immediate applicability to landscape managers in areas where data for process-based models and the capacity to interpret model outputs may be limited.

KEYWORDS:

Flood regulation, ecosystem services, flood risk management, ecosystem management