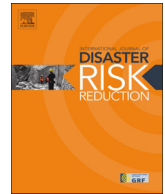




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# Recovery and resilience of communities in flood risk zones in a small island developing state: A case study from a suburban settlement of Port Louis, Mauritius

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## ABSTRACT

Small island developing states (SIDS) are characterised by their small size, remoteness and their dispersal in vulnerable regions globally. In Mauritius, rapid economic growth and expansion of suburban and coastal settlements in flood risk zones have exacerbated challenges from increased vulnerability of local communities to frequent flooding and inadequate resilience. While most studies are devoted to coastal flooding due to sea level rise, inland flooding aggravated by human settlements on exposed areas and by human-environment interaction is rarely considered. Generally, studies have focused on immediate flood impacts rather than on post-event recovery factors that reduce resilience and lead to the inability to recover through successive events. This includes living through onslaught of secondary hazards post-event. This study (2008–2014) focuses on the recovery and resilience of a flood-prone community living in a suburban area of Port-Louis, the capital of Mauritius.

A mixed method of quantitative and qualitative approaches was used to examine the recovery and resilience of the community at household level. Results from quantitative analysis showed significant associations at  $p \leq 0.05$  between variables relating to recovery and those of income level, literacy level, and household size with children, and/or elderly persons. Qualitative results from focus group interviews indicated that social inequity and environmental injustice hindered recovery among low-income households. However, some resilience was present through community capital, with solidarity in times of adversity amongst some community sub-groups. Outcomes from a participatory exercise showed that experiential knowledge of how to cope with floods was crucial in resilience-building strategies of households and communities.

## 1. Introduction

Small island developing states (SIDS) are characterised by their small size and their remoteness in tropical or subtropical locations that make them vulnerable to a wide range of natural hazards including floods, cyclones and other extreme events whose impacts are exacerbated by climate change and sea-level rise [32,48,55]. While SIDS have certain characteristics in common, they are geographically, politically, socially and culturally diverse and differ in their levels of economic development.

Whereas sea-level rise is of particular concern to SIDS, IPCC projects that inland settlements and rural communities will also be adversely affected by the negative effects of climate change due to changing rain patterns and more intense storms [31]. These issues are particularly

significant in relation to overall development trends towards urbanisation as nearby rural villages are gradually drawn in to form large urban agglomerations within SIDS [78]. A report by CRED-EMDAT in 2015 recognised that of the 65 million inhabitants in SIDS, 38 million (59%) live in urban settlements that increase human vulnerability to natural disasters. The report also revealed that some 19% of all natural disasters in SIDS (1994–2013) occurred as a result of development trends and became worse as a result of climate change. Consequently, some sectors of communities have been found to be unable to cope and recover from successive flood events [14,57,9]. Studies carried out in the Caribbean islands [17,39,55], and in Fiji [51] have shown that underprivileged sectors of communities have limited capacity to cope with hazards or overcome vulnerability.

The vulnerabilities of SIDS to natural hazards have increased over

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the last two to three decades, whilst resilience building has not kept pace [30,70]. This growing vulnerability results from increased exposure to hazards [32], in particular among more deprived groups. Increasingly, governments are being urged to address, with the help of civil society, the challenge of natural hazards impacting on human settlements through resilience building, a commitment reinforced by The Sendai Framework for Disaster Risk Reduction 2015–2030 [73]. At the same time, they have to take into account the relationships between primary and secondary hazards during recovery processes, and the vulnerability of citizens of lower socio-economic status living in hazard zones.

The research gap, in the context of SIDS, involves understanding issues of resilience through lack of recovery during successive flood events or through secondary hazards. In particular, over 75% of disasters in SIDS relate to torrential rain and flash floods [74]. In Mauritius, these issues have not been researched despite disaster losses (1980–2014) amounting to over US\$420 million, with 51,951 people affected [13]. Research reported here aims to investigate the factors that determine the vulnerability and resilience building capability of households within a Mauritian community in the recovery phase of flood hazards caused by torrential rain, over the period 2008–2014. It then assesses the implications of the findings for policy and practice of hazard mitigation, reductions in vulnerability, building of resilience, with specific reference to the recovery phase, among deprived flood risk groups in Mauritius.

## 2. Background framing

### 2.1. Linking concepts of vulnerability, resilience, environmental justice (EJ) and lay knowledge to recovery and rehabilitation processes

Resilience and vulnerability represent two related yet different approaches to understanding the response of systems and actors to change; to shocks and surprises, as well as slow creeping changes. Their respective origins in ecological and social theories largely explain the continuing differences in approach to social-ecological dimensions of change. However, there are many areas of strong convergence [50]. The concept of vulnerability has its roots in geography and natural hazard research, but the term is used in a variety of other research contexts [20] and in various disciplines. Consequently, there is no universally accepted definition of vulnerability [14,2]. The United Nations Office for Disaster Risk Reduction differentiates physical, social, economic and environmental vulnerability. It defines “social vulnerability” as:

‘the inability of people, organisations and societies to withstand adverse impacts to hazards due to characteristics inherent in social interactions, institutions and systems of cultural values. It is linked to the level of wellbeing of individuals, communities and society. It includes aspects related to levels of literacy and education, the existence of peace and security, access to basic human rights, systems of good governance, social equity, positive traditional values, customs and ideological beliefs and overall collective organizational systems.’

Variables that impact on wider vulnerability therefore encompass the social, economic, cultural, political, environmental and geographical contexts in which people live [45,55].

The concept of resilience has been extensively framed in various disciplines to denote ideas of resistance, transformation, coping, adaptation and recovery [83]; hence it has gained multiple meanings [41,60]. Timmerman [69] was among the first to apply the concept to natural hazards, to express the idea of the ability of a system or a community to plan ahead to ‘cope, accommodate, resist or adapt and recover’ from a disaster impact [43]. Implicit in the above definitions are ideas of ‘exposure to’ and ‘recovery from’ hazards and the building of long-term resilience. Critical is differentiating the ability to “bounce back” to a previous state and to “bounce back better” through

adaptation. More recently Manyena [42] argued that adaptation is not synonymous with living with conditions previous to the occurrence of a disaster. Instead he suggested the need to transform by bringing in new ideas in areas of social and environmental justice, good governance and equitable allocation of resources to vulnerable groups. He visions transformation as the best option in building resilience. Matyas and Pelling [43] have also elaborated transformation, as well as resistance and incremental adjustment, as expressions of resilience in policy for disaster risk management.

Over the years, the linkage between resilience and vulnerability has become a debatable theme because of the lack of proper theoretical or philosophical understanding. According to Buckle et al. [7] and Akter and Mallick [4], resilience is linked to vulnerability in multiple ways. Some authors define resilience as the opposite of vulnerability, meaning that a high level of vulnerability implied a low resilience and vice-versa [1,65,69,8]. Others consider that resilience and vulnerability are linked [15,19,22] and overlap in complex ways [33]. As an example, a person may be vulnerable to flooding but still have resilience in terms of adequate personal skills to devise ways to cope and recover [7].

Recognising these opposing or overlapping characteristics of vulnerability and resilience several studies [16,33,42,43] consider these as two key concepts that are crucial in the prevention and mitigation of the impact of hazards on communities. Resilience assessment, like vulnerability, could be applied as an additional tool in the collection, analysis and interpretation of data when assessing community resilience [17,3] in the recovery process [42]. According to Matyas and Pelling [43], adopting the concept of resilience-thinking in disaster risk management could eventually be used to reveal the root causes of vulnerability of communities exposed to hazards. Hence, most of the factors that determine the vulnerability of a community, namely social, economic, environmental and psychological factors could be similar to those determinants that also influence community resilience.

Another important concept that originates from studies of the relative vulnerability and exposure of communities to risk is ‘environmental justice’ (EJ) that recognises disproportionate exposure of certain community groups to environmental harms [64,79]. This issue was first highlighted in the case of communities that were exposed to pollution and toxicity problems in the US in the context of the politics of race and civil rights. But the application of EJ has now been extended to more and less developed countries for the purpose of addressing poverty, exclusion, marginalization of minority groups and social inequities that increase the susceptibility of a community to hazard impacts [66]. Environmental injustice has been reported in hazard impacts within some More Economically Developed Countries (MEDCs). According to Houston [29], social and environmental inequalities prevailed in the aftermath of Hurricane Katrina in New Orleans, resulting in complex differential impacts on lower income groups and on African American residents - for diverse systemic reasons (including racism, institutional failure and neglect by the authorities). In a rather different setting, Werritty et al. [80], working in Scotland, evaluated the extent to which flooded households experienced participative justice from the perspectives of both environmental vulnerability and EJ. They found that low income households were disproportionately more vulnerable to flood risks, and were more susceptible to lasting impacts that could reduce post-disaster recovery (see also [61]). In developing countries and SIDS, the impact of each new hazardous event can exacerbate existing vulnerability with the consequence that fragile sub-groups of communities have weakened capacity or resilience to cope with hazards on their own [57,9]. This can lead to a decline in resilience, with reduced likelihood of any increase.

### 2.2. Disaster cycle and recovery

In exploring vulnerability and resilience alongside issues of environmental justice, it is important to consider the four phases of disaster cycle, namely Mitigation, Preparedness, Response and Recovery

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