

Coastal hazard, vulnerabilities and resilience

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1. Introduction

This volume seeks to explore environmental hazards in a coastal context. We know in this respect that populations are moving to the coast on a global scale, and development there is faster than in inland locations. The risk of hazard is growing, and this is occurring in both the developed and developing parts of the world, not least owing to the threat of global sea-level rise (Nicholls et al., 2008). The past decade has seen major disasters in coastal locations, such as Hurricane Katrina and the Indian Ocean Tsunami, and no doubt others will follow.

Therefore, there is good evidence that coastal communities are increasingly at risk, from flood and erosion, exacerbated by the kind of land subsidence that is affecting or has affected most megacities at the coast such as Bangkok and Shanghai, itself a result of the intensifying human occupancy of coastal regions. Increased vulnerability to the hazards that are experienced in coastal areas is the result.

But we see the concept of coastal vulnerability as based on human value judgements concerning risk to various elements of the natural and human environment from a variety of sources, not as an absolute (Green and McFadden, 2007). Therefore, the vulnerability of a coastal community is a function of the state we wish that community to be in, its relations with other communities, the relevant governance arrangements at the coast in question, and linkages or integration with the natural environment of the space it occupies.

Thus in developing this volume we have been minded to identify research that illuminates these aspects of coastal hazardousness in different situations and with different emphases. In so doing we have followed the key themes that *Environmental Hazards* pursues: human dimensions and policy implications. In this respect, we look, below, at some aspects of the six papers that they share in common, starting with the concepts of resilience and the different scales at which it needs to be recognized.

2. Concepts and scales

Lesley Ewing and her colleagues remind us that the dynamism of the coast is one of its enduring features, and that the ever-changing water levels and shifting shoreline conditions are part of people's fascination with the coast as well as the source of its hazardousness. Change at the coast is inherent, not to be unexpected but part of regular coastal processes, and the difference between a normal coastal event and a hazardous or extreme event is only a matter of degree and the rare occurrence of coinciding events.

Indeed, we need to remember that the coast has been an area of significant hazards throughout human history and that in modern times at least hazard responses have typically been focused on resistance – constructing stronger buildings, enhancing natural barriers or creating artificial barriers between the land and the sea. However, interest in resilience has grown as

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resistance alone has come to be seen as less effective than is desirable, or even unsustainable, in the longer term.

This paper also makes the key point that resilient communities tend to learn from past experience; each disaster provides valuable lessons to avoid development in high hazard areas or to redevelop near the coast in ways that will lessen consequences of the next event. The dilemma here is that those without this experience do not learn so readily, and so are trapped by their inexperience into pursuing or maintaining behaviours that exacerbate risk.

Lesley and her colleagues come from an engineering background and stress that the role of engineering technologies remains important, especially in monitoring risk trends using modern methods. Science is generally mature in these areas, but the continuous improvement in hazard modelling coupled with the rigorous use of field surveys can be used to identify policy options. They can also provide the foundation for improved design guidance for the development and infrastructure that needs to be located in coastal hazard areas.

All the papers in this volume stress the importance of spatial scale and its effect on the analysis of both vulnerability and resilience: viewed from a global perspective, local vulnerabilities may shrink in importance, even if they are acutely felt by the communities affected. These differences are pursued more systematically than has been common in the past by Suzanne McLaughlin and Andrew Cooper in developing vulnerability indices incorporating a diversity of indicators to provide different levels of spatial analysis of vulnerability. What this shows, naturally, is that some important local variations in vulnerability are masked by the necessary simplifications that map vulnerability at a national scale. Data availability is also a key issue here: for some variables more detailed information is available as the spatial resolution of an analysis increases, while others become obsolete as data are of insufficient resolution to differentiate real variability at more detailed scales.

This research highlights that while a common index architecture can be applied, the selection of variables must take account of the scale at which the hazard is to be assessed. The results show the value of a nested approach to index development and the scale-dependent nature of policy response. A national-level vulnerability analysis gives a broad overview of the relative vulnerability of the coast, to be used, for example, in the implementation of coastal planning restrictions or in the allocation of money to be spent locally on coastal defences. A regional scale index can provide the context for the development of setback lines or hazard zones to control coastal development. At the local level, detailed analysis can identify infrastructure in potentially highly vulnerable areas. They stress that it is therefore the responsibility of the coastal manager or policy maker to learn what is the most appropriate scale or scales at which to investigate the vulnerability that they observe, depending on whether the policy 'push' or hazard response imperative is a national-, regional- or local-level one.

3. Communication and networks

Two papers in this volume concentrate on the importance of communication, both in the immediate hazard situations and in pre-planning for risk reduction in the promotion of resilient communities. In doing this, Frank Thomalla and Rasmus Larsen reiterate the 'old chestnut' that the technological aspects of early warning system development have commonly been receiving considerably more attention than human aspects.

They regret the situation, as they see it, that even though the importance of addressing community linkages in warning systems is strongly emphasized in current guidance from international agencies, practitioners still face considerable challenges in applying these insights in their operational contexts. Their research conducted a multi-stakeholder participatory assessment to create an improved understanding of

the challenges and enabling conditions for practitioners to implement such recommendations and guidance.

In this paper, the canvas is broad. Insights from Thailand, Sri Lanka and Indonesia are used to analyse selected elements of resilience based on the Coastal Community Resilience (CCR) framework (US-IOTWS, 2007). Their findings indicate, first, that developing participatory and people-centred early warning systems has not been sufficiently translated into action in the implementation of national policies and strategies for early warning.

They also conclude, second, that policy and guidance place significantly more emphasis on the procedural compared to the normative and cognitive dimensions of early warning systems and that practitioners engaged in early warning and disaster risk reduction operate in contexts shaped by multiple stakeholder agendas and face considerable challenges in negotiating diverse needs and priorities. Many issues are outstanding, in their view, not least that few arrangements exist that enable stakeholders 'to coordinate and reconcile agendas, negotiate joint targets, share knowledge and critically reflect on lessons learnt, and to improve the integration of early warning with other priorities such as livelihoods improvement, natural resource management, and community development'. Clearly, there is much more that needs to be done to make their coastal communities safer than they are now.

In my paper in this volume, I also take up the theme of communication but have focused my research on communication networks. Exploring ideas from the Institutional Analysis and Development Framework (Ostrom, 1990) within the South Australian coastal management context, I have identified a range of inter-agency interactions as potentially significant drivers for increasing the resilience of the coastal environment.

I work, as before (Green and McFadden, 2007), with the understanding that resilience is a function of a normative statement on the characteristics desirable in a functioning coastal system.

One of my conclusions is that cross-scale interactions and informal relationships within and between users and managers are key interactions defining resilience outcomes within the current system in the case study that I investigated. Also a key conclusion from this exploratory analysis is that resilience to hazard could be substantially improved by a better understanding of, and facilitation between, informal and formal knowledge and processes of decision making. I also reiterate (see McFadden et al., 2009) that careful, well-constructed analysis of the physical, social and institutional systems at the coast is essential for policy progress.

4. Promoting resilience through economic development

Resilience to hazard is promoted through economic development: it is poor communities that cannot suffer the harm that hazards bring and cannot quickly recover from the economic downturns that result. Two very different case studies form the final papers in this volume, and each illustrates this phenomenon in different ways.

The first of this pair of papers, by Audun Sandberg, analyses coastal farming in Tanzania. In this respect, when reviewing coastal zone management and constructing its research base, we must not forget that most coastal areas are not developed as urban centres or as the focus for recreation but are valued and valid as locations for agriculture: providing the world with food from fertile flat floodplains and deltas. These areas are also vulnerable to hazard and, if affected, suffer the diminution of output that harm their farmers and reduce the globe's ability to feed its increasing population.

Audun Sandberg's paper, in this context, stresses that the transformation of risky floodplain systems into socially controlled environments was the result of an intricate interplay between ecology, demography, religion, social organization and the technology of the time. We need to see coastal agriculture, and its vulnerability, in this broad historical context, and Audun's

case study research investigates one of the few natural deltas and floodplains left to study in the warm regions of the world: the Rufiji Coastal Delta and Floodplain.

In contrast to many other deltaic areas of the world, where engineering-based irrigation and drainage have been the culture of intervention designed to promote agricultural intensification, here a multi-crop agriculture has evolved based on rice, maize, cotton and peas. This arrangement, locally developed rather than imposed from without, has created a robust risk-minimizing system that has endured, helped by Arab, German and British colonization attempts to 'modernize' the system, resulting in new crops and varieties being incorporated in a way that made it even more robust.

As the research shows, this robustness – in the face of the risks involved in floodplain farming – comes from the flexibility of the system and its transparent feedback mechanisms, the latter facilitating learning. If the system is disturbed by a hazardous event, it is self-correcting within the same agricultural year and thus also has a high resilience: if a major flood drowns all the rice in April, 'large areas of moist and fertile soils can be planted with cotton, maize and cow peas'. But before we rush to commend this system without caveats, we need to remember that the research also shows that the economic return to labour will always be low in such a system, despite its apparent robustness. Audun concludes that, 'It takes a lot of extra work to constantly prepare for multiple futures. Low labour productivity is therefore the premium the Rufiji peasants have to pay for their complicated risk insurance system'. So here is no panacea for development elsewhere if we wish to promote higher incomes for those many impoverished agricultural communities at similar risks elsewhere in the world.

The last paper in this volume, by Deborah Peel and Greg Lloyd, also takes a case study approach, in this instance to critically discuss how economic regeneration in the coastal resort of Porthcawl, South Wales (UK), has integrated flood defences into part of a strategic spatial planning

approach to the redesign of the town's seaside, promenade and harbour quarter. This integrated policy coupling approach is part of a plan to upgrade the town's waterfront and enable regeneration of the kind of run-down small seaside resort that is so common in Britain now that those seeking holiday locations prefer the sun of the Mediterranean rather than the bracing weather of the typical English summer.

The bipolar arrangement of two interlinked policies for hazard reduction and regeneration means that they have together contributed both to risk reduction and to promoting resilience in a way that individually they could not. The 'policy coupling' analysis research shows that this twin track process has sought to raise public awareness of the issues and risks associated with the town's coastal location and to integrate flood defence aspects within the strategic regeneration plan. This is designed to promote a greater sensitivity to climatic risks and potential flooding. The research reminds us of the inherent adaptive capacity of humankind, in this case of coastal communities, and identifies the need to accommodate in our coastal towns and cities a new civic awareness of potential environmental hazards in articulating the public interest and balancing the trade-offs involved in planning their futures.

5. Some conclusions

I have two main conclusions from editing this research, one concerning methodology and the other concerning learning.

Concerning methodology, much of the research reported in this volume necessarily and usefully investigated coastal case studies, because locally derived information is essential for understanding – and advocating – relevant policy options. Indeed we have no apologies here. These case studies, as I see them, have been conducted within a general theoretical framework that recognizes the complexity defining how combinations of variables affect the behaviour of the coastal system. They illustrate local

or regional issues, but do not attempt to over simplify. Above all, they show how hazard and coastal management needs to be evidence based, and policy development needs to be grounded in reality rather than the abstractions of over generalized modelling and over simplistic master plans.

But what about learning? In my view, one major conclusion is that we have moved in hazard management at the coast beyond the state where risks are inadequately assessed owing to paucity of technique or lack of data (although the latter often remains a constraint). We no longer do not know what the problems are; we do not know how to implement the solutions. But what we do know is that social learning of communities and professionals is vital for vulnerability reduction and in promoting resilience, and that governance arrangements need to facilitate this learning process. In general, we are dealing with a human problem, not a technical issue. Social learning is, of course, not easy in situations where motivation is low because hazard events are sporadic and infrequent or where other imperatives dominate. Nevertheless, it remains clear that communities and their institutions need to remain vigilant and learn from their experience and that of others.

Otherwise the hazards of the future will simply replicate those that we have seen in the past. If our research can assist this understanding and learning, then it will have been of some value.

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