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Defining 'vulnerability': conflicts, complexities and implications for Coastal Zone Management

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ABSTRACT

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This paper argues that important insights for improved coastal management can be gained by examining complexities involved in defining vulnerable coastal environments and communities. 'Vulnerability' has emerged as an important concept in understanding and managing coastal environments: yet a significant degree of conflict has been associated to the use of the term. Definitions of 'vulnerability' have been contested in terms of the nature of, and the driving forcing underpinning, vulnerable environments. However, conflicts also surround the very concept itself, in particular efforts towards identifying a 'true' definition of the term. The paper suggests that such conflicts highlight the fact that the definition of a coast as vulnerable is not a neutral act. Conceptualising 'vulnerability' must be considered not only as a technical matter but in terms of social relationships between those involved in coastal management. This necessitates that scientists, policy-makers and other stakeholders involved in managing the coast, consider vulnerability analysis a comprehensive systems assessment of coastal environments and communities. The learning process, through which such a comprehensive assessment is achieved, is critical to creating new and more useful insights into the behaviour of the total coastal system. Simplifying vulnerability for coastal management has occurred at the cost of the essential complexity of coastal systems. If vulnerability analysis is to make a significant contribution to sustainable management of 21st Century coasts, we must be certain to retain this complexity in our approaches to understanding the term.

ADDITIONAL INDEX WORDS: *Systems, Stakeholder, Learning-process, Integration*

INTRODUCTION

Given the array of pressures experienced by coastal systems, the range of responses which characterise coastal behaviour and the multiplicity of actors involved coastal environments; it should come as no surprise that 'vulnerability' is a complex concept. Pressures on coastal systems related to large-scale high-magnitude/low-frequency events are an example of a relevant focus for vulnerability analysis. The devastating December, 2004 Indian Ocean tsunami has raised important questions as to the vulnerability of coastal communities and the physical environment to such high-magnitude natural hazards. The impacts of Hurricane Katrina in Louisiana, Mississippi and Alabama, especially in New Orleans, in August, 2005 have continued these concerns and raised a debate about coastal habitation in low-lying flood prone areas (MCFADDEN et al, in press). However, the dynamics of coastal change also mean that understanding and managing vulnerability is important in the context and reality of day-to-day living with the coast. Thus, the problems presented by vulnerable coasts and coastal communities can be very much linked to such day-to-day management of local and regional-scale coastal behaviour. From a basic perspective, the coast is a contested and complex environment with many conflicts of interest and challenges surrounding the use and management of coastal resources (GREEN and PENNING-ROWSELL, 1999). The complexity of coastal systems is the central argument on which this paper is developed.

A primary aim of this paper is to challenge approaches to vulnerability analysis to make a fuller use of system understanding when conceptualising 'vulnerability' for coastal management. It examines challenges in defining vulnerable coastal environments and communities and argues that the definition of vulnerability is not only a technical matter but is also a social act. The paper suggests that defining vulnerability is a learning process central to successful integrated management and as such it should be focussed on more specific ideas of the complexity of coastal systems. It explores the implications of this claim for managing coastal environments, drawing a series of lessons for moving towards a shared knowledge of the coastal system. The paper presents 'vulnerability' as a flexible and adaptable concept: one which should be more effectively used as an aid to managing complex environments.

EXPLORING COMPLEXITIES DEFINING VULNERABILITY

A brief introduction to the issues and questions that surround the concept of a vulnerable coastal zone, very quickly suggest that vulnerability research is characterised by a wide range of challenging process dimensions. At the coast, three systems collide: the socio-economic system; the geomorphological system

and the ecosystem. Vulnerability can be defined for each system individually but there is growing recognition of the importance to coastal management of understanding integrated dimensions of coastal behaviour and the subsequent impact on the vulnerability of a coastal zone (MCFADDEN, in press). Pressures on coastal ecosystems, for example, are defined by an array of land-, river- and ocean-based drivers and pressures and demands for goods and services on these systems are expected to increase for the foreseeable future (MILLENNIUM ECOSYSTEM ASSESSMENT, 2005). Many economic sectors and major urban areas are located within the coastal zone so that important economic and social processes characterise coastal systems. The coastal zone has historically been preferably settled, although in some areas there is in practical terms nowhere else to settle: the average population density within 100km of the shoreline (112 people/km2) is several times higher than the average global population density of 44 people/km2 (SMALL and NICHOLLS, 2003). Alongside the functional role of coastal systems are the significant hazards which impact these regions, which in addition of the hazards of more landward areas can include: surge and sea-water flooding, extensive erosion and sedimentation hazards, hurricanes and tsunamis. Such dynamics of coastal environments means that there are wide ranging spatial and temporal scales over which coastal vulnerability can be considered.

However, defining vulnerability is not only a technical matter but is also a social act. Many different actors are involved in coastal zones. Different stakeholders generally have different preferences for the course of action to be adopted and often come to the choice with strongly held beliefs as to the nature of the course of action that should be adopted. This collision of beliefs and preferences, for example, is often witnessed between those whose interest is in maintaining natural processes (e.g. geomorphologists) and those whose primary interest is in either some current state or some other desirable state. Given this social context, the relationship between vulnerability and the preferred course of action must be considered reflexive: vulnerability implies a course of action; the course of action implies a definition of vulnerability. Both also necessarily embody some claim as to the appropriate objectives that should be pursued. Thus, defining vulnerability can be considered as a social act in two senses. Firstly, it is a claim that one course of action should be preferred over those courses of action preferred and perhaps proposed by the other stakeholders. Secondly, it is often a claim as to the relationships between, and roles of, the different stakeholders; it is a claim as to the basis upon which one particular definition of vulnerability should be preferred to all others.

The coastal zone is an area of collision of interests as well as the collision of processes. This means that in addition to focussing on vulnerability as a property of a physical or socio-economic system, the conceptualisation of the term must also be related to social relationships between the range of stakeholders involved in coastal management. Understanding vulnerability in both dimensions is a challenging but critical task.

DEFINING 'VULNERABILITY': A LEARNING PROCESS FOR UNDERSTANDING COMPLEX ENVIRONMENTS

Exploring the different ways in which stakeholders (including scientists) interpret the world and hence the different ways in which we use words and concepts is a process through which we can move towards understanding the complexities of coastal vulnerability and hence the choices which underpin decisions for coastal management.

In making choices, we are seeking to choose a future and, by doing so, to change it: choice is therefore a central concept to sustainable management. A choice only exists if there are at least two mutually exclusive options (GREEN and PENNING-ROWSELL, 1999) and a primary condition for the existence of a choice is some form of conflict. There are several different reasons why conflict occurs between different options and in coastal management these may be illustrated by the following examples. Firstly, the alternatives may be functionally exclusive: for example, the choice between the use of timber groynes or fishtail rocky groynes to protect an eroding coast. Secondly, the alternatives may be mutually exclusive in time or space: someone cannot be in two different places at the same time and a wetland and a port cannot simultaneously occupy the same piece of land. Thirdly, no one option may be preferable to all others against all of the objectives we bring to that choice. As soon as the choice involves more than a single individual, then the different stakeholders can disagree as to the relative importance that should be given to achieving each of the objectives that they collectively bring to the choice. Finally, scarcity of resources acts as a constraint on choices but in collective choices the scarcity of resources is an external constraint - a cause of conflict - on choice (GREEN, 2003). For example, we may all be able to agree that integrated coastal zone management strategy A is preferable to the alternative strategy B and that transport policy M is preferable to transport policy N. But the scarcity of resources may then force us to choose between the combinations of policies A + N, and B + M. Scarcity of resources is typically an external constraint on choice rather than an internal constraint because we would still be forced to make a choice even if we had infinite resources. Thus, infinite resources would still not allow us to have a wetland and a port on the same piece of coastal land.

In collective choices, the central reason why we have to choose is that no one option is superior to all other options when compared to against all the objectives that are brought to the choice. If no one option dominates all others in this way then a conflict arises when the different stakeholders disagree as to the importance that should be given achieving each of those objectives. If a choice is necessary because the objectives conflict then that choice is simultaneously a choice of means and ends. If no one option is superior to all others against all of the objectives that are brought to that choice, then any choice of means is simultaneously an assertion that the achievement of one objective is more important than any other. Hence, either the choice of means is simultaneously a choice of ends or the choice of ends has to be made prior to any particular choice of means.

Viewing vulnerability analysis within a theory of choice brings an important insight to the implications of varying definitions of the vulnerability term. Words are not neutral; we use them in order to persuade others towards a particular choice within a decision-making process and one strategy to do so is to re-package a preferred approach under a popular label. Consequently, differences in the use of the vulnerability term arise, not only because we inherently define them in different ways but because we are trying to persuade others to adopt our point of view (DE BRUJIN *et al*, in press). Different approaches to defining vulnerability can therefore be understood as a claim to causation; why something is susceptible to some change in its environment. That claim to causation then implies the nature of those courses of action which should be successful in reducing that vulnerability. If coastal vulnerability, for example, is defined as people unwisely deciding to live in hazard-prone locations then the responsibility could be deemed to lie with them and not with the state. If vulnerability is alternatively defined as resulting from a failure of

the emergency services (as happened in New Orleans in 2005), then the responsibility cannot be said to lie with the individual.

Claims by scientists to be able to give a universal definition of vulnerability are claims to access to special knowledge and understanding by reason of being a scientist and to preferred courses of action for managing vulnerable environments. When definitions of vulnerability used in by different stakeholders - including different disciplines - vary, then we are apparently faced with unresolvable claims as to the relative merit of the special knowledge and understanding of different stakeholders. Asking whether a particular definition of vulnerability is useful instead of whether it is true is one way of breaking out of this apparent impasse.

LESSONS FROM CONFLICT: IMPLICATIONS FOR THE USE OF 'VULNERABILITY' IN COASTAL MANAGEMENT

Choices are difficult; if they were not, then there would not be any choices to make because the answer would be obvious. The reason we seek to define vulnerability is in order to help us decide what to do to reduce that vulnerability. This means that the value of a definition is consequently the degree to which it gives new and useful insights to the nature of the problem at hand and the choices of action to be adopted. A simple but important argument thereby emerges for the use of the term in Coastal Zone Management: scientists, policy-makers and other stakeholders should consider vulnerability analysis as a comprehensive systems assessment of coastal environments and communities. The learning process through which such a comprehensive assessment is achieved is critical to understanding the world-views of the stakeholders involved in promoting particular definitions of vulnerability. In moving towards enhancing vulnerability analysis to: (1) increase shared meaning and improved communication and (2) create new and more useful insights into the decisions we must make, some basic lessons or guidelines in conceptualising vulnerability for coastal management can be identified. These lessons focus vulnerability analysis on a dynamic systems approach to understanding the behaviour of the coast.

Vulnerability as a trans-disciplinary perspective on coastal change

Many vulnerability studies within the coastal zone have been based on a long heritage of traditional physical or social scientific viewpoints on the nature of change and the value of resources. From the social science perspective, while considered a multi-dimensional concept, vulnerability is primarily conditioned by past, current and future populations and settlement patterns combined with the aggregated and per capita economic wealth of the region (KELLY and ADGER, 2000). To the engineer, vulnerability is associated in quantitative terms with the extent of structural harm or damage that results from an event (DE BRUJIN et al, in press). However, for the ecologist, vulnerability is related to biodiversity and functional redundancy. The concept of resilience entered vulnerability analysis from the subject area, introduced to emphasise the capacity of an ecosystem to bounce back to a reference state or maintain certain structures and functions despite increased forcing on the system. (HOLLING, 1973). Similarly, from a geomorphological perspective, vulnerability analysis is strongly related to relaxation periods: reflecting the time taken for a system to adjust morphologically to a change in energy input and regain a form of equilibrium (PETHICK and CROOKS, 2000). To use the vulnerability concept to its greatest potential in decision making, these different and differing approaches need to be integrated into a common framework, achieving a more comprehensive assessment.

The need for inter- and trans-disciplinary research is becoming widely acknowledged and considerable discussions have surrounded multi-dimensional approaches to assessing vulnerability of coastal zones. This discussion has focussed on exploring the linkages between ecosystems and human societies: modelling vulnerability in the context of coupled socio-economic and ecological systems and the capacity of these systems to adapt to uncertain change and to re-generate after disasters (e.g. TURNER *et al.*, 2003; WALKER *et al.*, 2004). Such discussions play an important role in defining the sustainability of coastal systems; however a central point must be raised: they reflect only two dimensions of the coastal landscape (i.e. social and ecological systems). There has been limited debate as to how the vulnerability concept can be applied in the context of the total coastal system. Important questions such as the role of the physical state of the coastal zone as reflected in the morphological and sediment dynamics of the system i.e. the geomorphology of the coast and the nature of interactions between these dynamics and socio-economic/ecological model, have been inadequately (if at all) addressed. The fact remains that truly integrated approaches to modelling the problems and solutions to coastal change are still relatively few in number.

Beyond the context of climate forcing: the 'drivers' of coastal change

Literature shows that a large majority of coastal vulnerability studies are characterised by their sole application to sea-level rise and the related effects of climate change upon the coastal zone (e.g. BRYAN et al., 2001; LI et al., 2004;). Although a major forcing agent within the coastal zone that must be accountable within models of vulnerability, climatic variation *per se* is not the sole driver of change experienced within the coastal zone. A range of drivers related to anthropogenic influences must also be considered if a comprehensive tool is to be developed, which is of significant value to CZM. Many of the world's open coasts and estuaries, for example, are extensively developed with high levels of population, property and infrastructure resulting in development and regeneration pressures being the key drivers of change.

Recognising the importance of modelling coastal system response to a range of physical and socio-economic drivers is not a new phenomenon. The Foresight Flooding and Coastal Defence Project run by the UK office of Science and Technology is a key example of progress towards addressing this issue (EVANS et al., 2004). Producing a long-term vision for the future of flood and coastal defence in the UK, the project focussed on a wide range of drivers that may change the state of the flooding system; these included climate change, urbanisation, changing agricultural practices and rural land management. The UK Foresight Project is an important example of a comprehensive assessment incorporating the context and impacts of change within fluvial and coastal systems. However, the bulk of vulnerability assessments for CZM do not facilitate such a broad-scale approach to understanding the drivers of coastal behaviour. Developing frameworks and approaches to modelling vulnerability that are embedded within a comprehensive analysis of the drivers of change within the system, must become a goal for the coastal management and scientific community. Vulnerability is a multi-dimensional concept: however, it must also be understood in the context of multiple dimensions of change.

Local studies to broad-scale assessments: vulnerability across spatial and temporal scales

Many vulnerability studies within literature focus on fine-scale vulnerability of coastal behaviour in response to a given environmental forcing agent. Multiple forcing stimuli and the complexities and dynamic nature of coastal behaviour mean that scale, region and hazard-specific indicators of vulnerability are important in decision-making: this is particularly true at the local management scale. However, broad-scale vulnerability assessments can be useful as a tool for identifying sections of the coast that require further analysis or as a basis for strategy planning and management guidance. Such analyses identify the different elements which comprise the total coastal system and develop an understanding of how these elements interact on a range of both spatial and temporal scales. Many uncertainties surround the broad-scale relationships between physical and human systems, feedback linkages between the two environments and scaling issues (across space and in time), which need to be explored. Detailed, local response-driven models are critical: however, the necessity of such analysis should not negate the value of broad-scale models. Understanding the total behaviour of the system across such scales remains a fundamental problem for CZM. Given that vulnerability may be more highly linked to large-scale processes today than in the past (ADGER et al., 2005), such approaches may provide increasingly important insights for understanding and managing coastal change.

The metrics of vulnerability analysis: modelling the primary processes of change

To be effective when understanding conflicts of interests within coastal environments, approaches to vulnerability analysis must be framed within a strong process-based analysis of the coastal system. The metrics of vulnerability analysis should reflect the principal driving processes that define the behaviour of the coast. The exact label given to these metrics may actually be relatively insignificant, i.e. do we use the idea of resilience or adaptive capacity to describe negative feedback in coastal response? Physical systems have a capacity to absorb external forcing, producing a dynamic status quo within the environment. This means that physical systems are in principle self-organising, though their capacity can be and often is limited either naturally or by human agency. In reality, many physical coastal systems are 'managed' to promote self-organisation. This concept of resilience is most frequently associated with physical coastal environments i.e. ecological or geomorphic driven studies. The converse is true in the context of society, which largely must be managed to be resilient, a concept most frequently described as adaptive capacity. Both concepts (i.e. resilience and adaptive capacity) are used in different scientific communities, with different conceptual and empirical backgrounds. However, despite these differences, the basic principle underpinning both concepts is essentially the same and reflects the dynamic (and managed?) response of the system when subjected to a disturbance (DE BRUIJN *et al.*, in press).

It may be argued that rather than multiplying or re-defining the metrics and concepts of vulnerability analysis, more emphasis should be placed on understanding the interactions, differences and similarities between system processes which underpin existing approaches to conceptualising the term. There is a clear need, for example, for a greater understanding of the non-linear processes which define the complex behaviour of coastal systems. This knowledge is central to understanding the potential for and the direction of change (both now and in the future) in the critical states or behaviour which defines vulnerable systems. Adding new dimensions (and metrics) of vulnerability *per se* may not necessarily improve the effectiveness of the analysis, if that analysis does not reflect the physical *and* socio-economic processes that drive change. The key point is that in developing approaches to assessing vulnerability, the components of the analysis must give insight to the processes which define the behaviour of the total system.

Stakeholder engagement: involving the players who deliver change

The previous guidelines have stressed the importance of an integrated scientific approach to conceptualising vulnerability. They focus on the need for a comprehensive assessment of both scientific knowledge and experience to gain insights to the vulnerability term. However, it is critical to move further beyond this, involving all categories of stakeholders, including the public, in the decision-making process on the causes and management of vulnerable coastal systems. Understanding and implementing 'good governance' is an important (legislative) component of decision-making for environmental management and identifying relevant stakeholders is critical to this process. A key group are those who have the resources and powers, including behavioural choices to impact options for managing coastal zones: another, those whose actions can significantly promote or inhibit the sustainable management of the particular environment in question. A further category is those who will be affected in one way or another by the outcome of the choice: this includes those who will bear the costs of adopting a particular approach to 'vulnerability'. A possible category reflects those who have an interest in the particular coastal zone in question. This is a much more problematic category because it is not clear by what moral right such an institution (or an individual) can claim involvement in a particular choice.

The involvement of stakeholders and the public in decision-making raises a whole series of questions regarding 'better' decisions, to which we have little established answers (see GREEN, 2003). It is important not to romanticise public involvement, to assume for example, that it will result in a consensual outcome being achieved. However, it is clear that without effective stakeholder engagement we loose an important aid to understanding the range of conflicts and choices which define the vulnerable environment: as well as the commitment of individuals or groups of stakeholders to any coastal management plans which emerge from the process of decision-making. There are clearly different levels of interaction, differentiated into who and what it is intended to change (Figure 1). If vulnerability analysis is to be enhanced as a management tool, key institutions involved in defining and managing vulnerability must move beyond 'informing' the public and engage in participatory practices to both change conceptualisations and choices for coastal management and be changed.

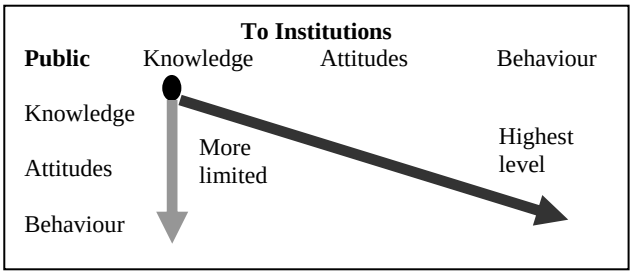

Figure 1 Public involvement as interaction

CONCLUSIONS

Discussions on the meaning of words and the different conceptualisations of the world are intrinsically useful, especially as these discussions illuminate differences between the 'worldviews' of different individuals or groups. Differences in our understanding of the challenges and processes which define coastal systems, underpin the use of specific language in describing and modelling vulnerability. In turn, these differences in our understanding of 'vulnerability' result in a disparity in our responses to managing the coastal system. Exploring definitions of vulnerability is important to furthering progress on integrating methodologies and options for managing coastal systems.

This paper highlights the need to adopt a comprehensive approach to defining vulnerability, focussing on a dynamic systems approach to understanding the behaviour of the coast. In such a manner, conceptualising vulnerability becomes a useful learning process whereby new and useful insights into understanding 'the coast' and the choices for coastal management can be made. Simplifying vulnerability for coastal management often occurs at the cost of the essential complexity of coastal systems. If vulnerability analysis is to make a significant contribution to sustainable management of 21st Century coasts, we must be certain to retain this complexity in our approaches to understanding the term.

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