Ecology and Vulnerability: Islands and Sustainable Risk Management

Version 1

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5 figures

ABSTRACT

Two conceptual models are combined to contribute to achieving sustainable risk management: “Disaster Ecology” which brings an ecological framework to the understanding of disasters and “Island Vulnerability” which provides practical case studies for learning. The importance and nature of vulnerability are described leading to a framework for the ecology of vulnerability. Then, the importance and nature of islands are described to introduce the ecology of island vulnerability. This ecology is applied for the case study of the vulnerabilities of built heritage on Koltur, a Faroese island. The case study and conclusions indicate lessons for sustainable risk management based on the definitions, information, and ideas presented while suggesting ways forward for completing and applying the analysis in practical situations.

INTRODUCTION

In this paper, two conceptual models are combined in order to propose insight into and a way forward for achieving sustainable risk management. These models direct research and application towards the appropriate issues and encourage multidisciplinary work and solutions.

The first conceptual model summarized is “Disaster Ecology”. This term was first used by Lewis (1980) and brings an ecological framework to the understanding of dealing with disasters. Applying similar reasoning for “Risk Ecology” widens the concept beyond specific disaster events, setting the stage for a focus on vulnerability in order to achieve sustainable risk management. The second conceptual model summarized is “Island Vulnerability”, which has developed through the website http://www.islandvulnerability.org Island vulnerability describes the importance of and advantages from exploring the vulnerability of islands.

Using the disaster ecology approach for island vulnerability illustrates the insights which can be gained from, and highlights lessons to be applied by practitioners for, moving towards sustainable risk management. To begin, the meaning and importance of vulnerability are described.

VULNERABILITY

The disaster management and risk management literature (e.g. UN DHA 1992) tends to converge on definitions similar to:

Disaster: An event with detrimental consequences beyond the coping ability of the affected community. For example, houses collapsing during an earthquake.

Risk: The potential for disaster or expected losses over a given timeframe, usually expressed or calculated as a combination of hazard and vulnerability. For example, a community might estimate that 5% of their properties will be flooded by a river during the next decade.

Hazard: An event, process, or entity interpreted as posing a threat. For example, the hazard of a landslide which might bury a town. A "natural hazard" stems from the natural environment, such as earthquakes, tornadoes, or viruses.

Vulnerability: The potential for damage or harm to occur. For example, during smog, emergency ambulance calls for respiratory complaints might increase 60% with people older than 50 years accounting for the majority of extra calls.

The term "natural disaster" frequently denotes a disaster requiring a natural hazard. Because vulnerability is also required for a disaster to occur, few disasters are truly "natural" (e.g. Wisner et al. 1976). Thus, "natural disaster" is a misnomer and this paper uses the phrase "disaster involving a natural hazard".

Before a disaster, much effort is often expended in quantifying risk. After a disaster, much effort is often expended in studying the disaster's effects. Hazard studies, usually coming from the physical sciences such as meteorology and seismology, tend to receive prominence, such as the annual predictions of Atlantic tropical cyclones (e.g. Gray et al. 2003) and analyses of earthquake frequencies (e.g. Murray and Segall 2002).

Vulnerability, with perhaps the least concrete of the previous definitions, could appear to be secondary or less important. No annual report exists of the vulnerability of Atlantic communities to tropical cyclones. Few studies estimate the frequency by which communities vulnerable to earthquakes are built. Vulnerability therefore warrants a more detailed investigation.

Expanding the definition of vulnerability, it is often taken as (a) mathematically a function of and (b) non-mathematically comprising:

1. Resistance, the ability to withstand change due to a hazard.
2. Resilience, the ability to return to the original state following a hazard event.
3. Susceptibility, the current physical state, without taking into account temporal changes.

This definition may be interpreted for natural environments, individuals, societies, structures, infrastructure, social networks, communities, cultures, and the built environment.

An example of a coastal settlement in a tropical cyclone illustrates the definition's applicability. People have resistance in their ability to live through the tropical cyclone without having nightmares for the next year and without being fearful each time the wind blows more strongly than usual. Houses have resistance in their ability to withstand structural collapse due to wind speed, debris, and external water pressure from rain or a storm surge. People's resilience appears through their ability to carry on with their normal routines soon after the tropical cyclone has passed. Houses also have resilience in their materials' physical properties relating to the ability to dry without damage following inundation. Finally, people have susceptibility due to gender and age distributions, prior disabilities, familiarity with survival and coping strategies, and mental and physical states when the tropical cyclone strikes. The houses have susceptibility due to their value, state of maintenance, and location.

Vulnerabilities of houses and people influence each other. People can affect their house's vulnerability by boarding up windows and securing or removing loose objects in the garden. Houses can affect the people's vulnerability by their ability to withstand damage. The difference is that houses do not make decisions and choices, whereas people do. People's decisions frequently affect others' vulnerability more than their own.

Thus, rather than looking at vulnerability as only related to location or place, Lewis (1999) suggests that social and political issues must be considered as much the physical recognition of a current state of vulnerability and a community's physical resistance to natural hazard forces. Vulnerability often manifests after an event, such as river floods affecting poorer people more than richer people (Pelling, 1999).

This vulnerability, though, is not just in the dilapidated state of the poorer dwellings or in the physical presence of the financially disadvantaged population in a flood-prone location. Vulnerability also encompasses the hidden and intangible external pressures--social, economic, political, and historic--over which this sector of the population may have no control, which prescribe living in such locations, and which produce the lack of options and resources for mitigation.

Lewis (1999) notes, therefore, that commonly "vulnerability is related to overall policies and activities in the control of others". Vulnerability is not only about the present state, but also about what we have done to ourselves and to others over the long-term; why and how we have done that in order to reach the present state; and how we could change the present vulnerability state to improve in the future.

THE ECOLOGY OF VULNERABILITY

The importance of vulnerability has been shown. An approach for examining and understanding vulnerability is now required.

The traditional view of disaster is of a detrimental phenomenon to both the society and the environment which must be avoided. The concept of recovery, for example, implicitly assumes that an ideal pre-disaster state exists to which society, communities, and individuals must return following a disaster event. The presupposition is that returning to this pre-disaster state is viable and desirable. Similarly, a disaster destroying an ecosystem or cultural heritage is generally assumed to be unwelcome. While disasters can have appalling consequences, they may also provide opportunities to rebuild to a different and better state than had existed before and to enact beneficial changes which might not have been feasible otherwise.

While this view applies to society over shorter time scales such as human life and smaller space scales such as a city or country, it also applies to global natural history. Conceptual conflicts result. The mass extinction event which included the death of the dinosaurs approximately 65 million years ago permitted the rise of mammals followed by the development of humanity (e.g. Cooper and Penny, 1997), but a similar event today would not be considered acceptable.

These analogies and conceptual linkages between environmental/ecological and societal/sociological aspects, on differing scales of space and time, yield a set of linked questions:

-How might it be possible to extract the positive consequences from disaster while minimizing the negative consequences?

-Might the positive and negative consequences be inextricably linked?

-How are positive and negative consequences defined and identified? This question effectively investigates how “disaster” is defined and indicates that detrimental consequences are subjectively defined.

Kelman (2003) and Lewis (1999) detail examples where disasters involving natural hazards were a trigger for political change or influenced a war’s deciding battle. Disaster and risk can become a resource in some circumstances--or from the victor’s viewpoint. To fully understand the presence and consequences of this potential “risk resource” and the role of vulnerability, a wide overview is necessary. Ecology provides such an overview.

Ecology investigates the relationship between organisms and their natural environment. By analogy, disaster ecology investigates the relationship between society and the social and physical environment which results in disaster. The role of disaster could be defining of that relationship or a defining component of the specific society considered. For example, many riverine societies are dependent on annual floods and their annual cycle centers around the floods’ appearance. Etkin and Stefanovic (2004) and Fraser et al. (2003) discuss how society’s dependence on and interaction with natural hazards is a key component of vulnerability.

The ecological term “disturbance”, or the generic word “change” incorporating both the nature and rate of that change, might therefore be more appropriate than “disaster”. This term provides linguistic neutrality and indicates the complexity of outcomes which a disaster event yields and the pace at which such outcomes might occur.

Actions by society to resist change, such as from a disaster, themselves create change. Therefore, anticipating disaster or merely the thought or idea of disaster, irrespective of an actual event, is part of the disaster ecology of a society. Disaster ecology applies not only to society’s reactions following a disaster, but also to the influence of the threat of disaster on society’s attitudes and decisions, which might lead to prevention, mitigation, and adaptation activities. Therefore, the initial idea of disaster ecology based on Lewis (1980) has moved into “Risk Ecology”.

Understanding ecologies is used for improving the relationship between organisms and their environment as well as for improving interaction between society and the environment. By analogy, understanding disaster and risk ecologies can be used for improving the changes which occur when society encounters disaster or risk.

These changes would be dominated by society’s ability to prevent, mitigate, and cope with disasters; that is, society’s vulnerability. Understanding how vulnerability changes society and how society changes its vulnerabilities yields an ecology of vulnerability. The importance and relative lack of investigation of vulnerability suggests that an ecology of vulnerability would be a vital component for sustainable risk management.

Given the complexities of ecological studies and their far-reaching nature, fully understanding the ecology of vulnerability presents challenges. A system in which such studies could be undertaken is needed. This system should be small enough that linkages could be viewed, analyzed, and interpreted. Isolation would assist to keep the analysis relatively simple. In order to ensure that recommendations are practical and workable, this system should also be realistic rather than being artificial or created specifically for research purposes.

One system which meets these criteria in ecological studies is islands, particularly small islands (e.g. MacArthur and Wilson, 1967; Schmidt and Jensen 2003). Understanding island vulnerability to disasters is thus proposed for understanding the ecology of vulnerability and, hence disaster and risk ecologies.

THE ECOLOGY OF ISLAND VULNERABILITY

Islands

The focus on islands arises because the physical and psychological isolation of islands tends to prioritise them disproportionately low in comparison to their importance. Reasons for neglecting islands include small size, lack of resources, and relative inaccessibility, yet these same characteristics make islands more unique and more vulnerable.

When the risk in a vulnerable situation manifests, such as in the form of a disaster, an island's insularity tends to preclude a timely response with the needed resources. The result is worse consequences than would occur at another location experiencing a similar situation.

A set definition for terms including "island", "small island", and "isolated" does not exist in a geographical context. Many authors (e.g., Briguglio et al., 1996; Crowards, 2002; Royle, 2001) have discussed definitions of these terms using such criteria as:

-dictionary definitions
-population size
-land area
-arable land area
-gross national product
-environmental influence, for example defining an island to be a landmass which does not create its own climate or ecology due to its volume
-characteristics of social geography, such as the presence of a unique people or culture.

In the end, it is appropriate to answer the question "What is an island?" with an intuitive concept of a comparatively small landmass, generally without an adequate land transportation network connecting with a larger land mass. This statement is not a definition but a working description. Obvious examples of islands are the Chatham Islands (New Zealand) and St. Lucia. Africa and Nebraska are not islands in the sense of physical geography. Brazil and Galicia are arguably cultural and linguistic islands. Ambiguities emerge, including

Andorra and Ceuta (Spain).

In defining islands, the experience of smallness and isolation, as distinct from theoretical analyses, should be considered alongside traditional criteria such as population size, land area, and resources. The 122 km^2 of St. Helena or the 400 km^2 of Barbados are substantial “smallnesses” when compared to that of Tuvalu’s 26 km^2. Much more significant is that Tuvalu’s minimal land area is scattered amongst nine atolls over oceanic distances of 650 km. Although all are “small”--islands or states--the experience of their land formations, whether by visitors or indigenous inhabitants, is vastly different.

Understanding islands thus requires an understanding of “dispersiveness” or “entireness” in order to convey the fragility and the remoteness that is a part of a special experience of islands. “Remoteness from what?”--such as a continental land mass, capital city, or other islands--would need to be considered. Smallness is more a complex matter than simply size. Interactions with the environment and neighboring societies, as often dictated by dispersiveness, emerges in an ecological context.

These interactions and the smallness and remoteness of islands makes them highly vulnerable to some of the most devastating disasters involving natural hazards. The most lethal tsunami (Papua New Guinea in 1998) and the most lethal volcanic eruption (Martinique in 1902) of the 20th century struck islands. When tropical cyclones threaten, island populations cannot evacuate inland as coastal populations do.

Moreover, islands often experience longer-term, more chronic vulnerabilities including:
-Maintaining adequate water and energy supplies.
-Preventing emigration which depletes the population and removes a needed skill base.
-Maintaining self-sufficient economies.
-Preserving their culture and heritage.
Such vulnerabilities are as dangerous and important as the single, catastrophic event, for example an earthquake or cyclone (e.g. Pelling 2001, Kelman 2003).

These difficulties and challenges can lead to advantageous outcomes. The vulnerabilities of isolation and dispersiveness imply an impetus towards developing local, small-scale energy sources and water supplies. These techniques could be transferred to other locations to reduce community vulnerability. The same argument applies to other resources and community needs because the potential exists for focusing on self-sufficiency and locally sustainable resource and risk management.

A further advantage of islands is that they provide the compactness and isolation needed to fully analyze and communicate the inter-relationships amongst vulnerability, sustainability, and risk. The ability to demonstrate and to articulate the processes which create, maintain, and could be used to reduce vulnerability can be learned through island study and then applied to non-island geographies. The transferability of lessons from islands to other locations (e.g. coastal zones or small, landlocked countries) is a vital outcome from island vulnerability studies.

Islands are examined due to their importance, their vulnerability, and the lessons which can be gained.

Island Vulnerability

From the previous discussion, island vulnerability refers to the potential for harm to come to island locations. More than the present state of potential harm must be covered. Island vulnerability also examines why that state of potential harm exists in such a relatively small environment, how it arose, the advantages and disadvantages of its existence, how it should be changed, and how that change might be effected given the challenges and advantages of islands. The processes which created that vulnerability and the processes which that vulnerability creates are examined in the island context where they can be much more readily understood than in other locations.

Pelling and Uitto (2001) quantify island vulnerability by using socioeconomic data to develop a vulnerability index or indicator number by which islands may be ranked. They conclude that "The larger, and least globally connected island states are those most severely affected by disaster...Although it is the smaller islands that are most at risk from 'knock-out' by a single event." The vulnerabilities experienced by islands are aptly illustrated.

UN DHA (1992) also provides a quantitative definition of vulnerability: "Degree of loss (from 0% to 100%) resulting from a potentially damaging phenomenon". When considering vulnerability as a percent loss, the importance of islands becomes apparent, as Lewis (1999) notes in discussing "proportional impact". Proportional impact reports percentages; for example, the percent of the population killed or affected or the percent of the infrastructure damaged. In contrast, disaster magnitude reports numbers; for example, the number of people killed or affected and numbers or monetary value of buildings damaged or destroyed.

Prior to the start of the volcanic eruption in 1995, the total population of Montserrat was approximately 11,500, about half the death toll from the 26 January 2001 earthquake in Gujarat, India. Superficially, it appears that the tragedy in India far surpasses any event which could possibly afflict Montserrat. Proportional impact, however, shows the territory of Montserrat to have far greater vulnerability than the state of India. Every Montserratian, 100% of the population, has been directly affected by the volcano. More than 50% of the population has migrated away from the island. The 25 June 1997 pyroclastic flows killed at least 19 people, which proportionally would be equivalent to more than 1.5 million people dying in India. Similarly, nearly 100% of Montserrat's main infrastructure was destroyed. The issue is not to downplay disasters in India, but to give island disasters the prominence they deserve.

Therefore, island vulnerability encompasses "proportional impact" and "potential proportional impact" as indicators of the importance of a disaster or potential disaster. Island vulnerability investigates the processes which produce the potential proportional impact, of which the small size of islands is an obvious element, and, more importantly, looks at ways in which proportional impacts could be diminished by reducing vulnerability. Thus, the ecology of island vulnerability emerges.

The compactness and smallness of islands implies that a reasonable grasp of the entire vulnerability ecology could be attained. Meaningful analyses could be completed on the entire system providing lessons that could be scaled up to non-islands.

APPLICATION

The conceptual background has now been established. In addition to the theoretical combination of two conceptual models--disaster ecology and island vulnerability--application is needed to indicate how the ecology of island vulnerability could be used operationally to contribute to sustainable risk management. The first operational lesson, already implied, is that studies on islands are an appropriate starting point, but lessons should be considered for and applied to non-island geographies.

The island case study selected is Koltur, one of the Faroe Islands in the North Sea (Figures 1 and 2). Koltur epitomizes the remoteness, smallness, and ongoing, chronic vulnerabilities experienced by small islands. The specific vulnerability addressed is the sustainability of Koltur’s heritage.

With an area of 2.5 km^2, Koltur is the smallest of the 17 inhabited Faroese islands. No commercial ferries travel to the island, but a public helicopter route has a few scheduled landings each week, weather-permitting. Otherwise, a private boat or helicopter is needed. The population is two: a couple who farm the island, who were selected from a group of applicants to live there, and who are guardians of the unique Faroese heritage on Koltur.

Koltur has exceptional examples of old building traditions, in terms of community layout, building design, and architecture (Figure 3). After the historical process of settlement, declining opportunities, and abandonment, two clusters of buildings remain. Their principal vulnerability is being left to decay with the consequent loss of heritage. Another historical and continuing process contributing to this vulnerability is emigration from the Faroes to seek better opportunity and the increasing Faroese preference for urban, consumerist lifestyles.

For tackling Koltur’s vulnerability, an opportunity exists to turn the island into a prominent heritage site displaying traditional Faroese building and community styles. One idea is making Koltur a living site where the buildings would be preserved and maintained yet become a functional farm illustrating Faroese farming techniques over the past millennium.

One principal issue is accommodation and facilities for visitors. Achieving modern safety and access standards could damage the island or the old buildings, either physically or through altering their character (Figure 4). Camping would be an appropriate alternative, but the cold, damp climate could preclude that option and it would not solve the emergency management challenges posed by Koltur’s isolation and smallness. Regular and affordable transport to and from Koltur assist, yet would impact the island’s isolation and access is not straightforward (Figure 5).

Teams of visitors could be used to work on the farm and to restore and maintain the buildings. With groups arriving and departing irregularly, chartering a boat or helicopter becomes viable with minimal impact on Koltur’s remoteness.

The challenge for Koltur is balancing preservation with tourism. Visitor numbers should not exceed the ability to provide facilities without damaging the island or the heritage, including the character of the surroundings. Nonetheless, visitors would bring in revenue which would be needed to run and maintain the heritage site.

Plans would be needed to protect the buildings from natural hazards, particularly the wind and rain but also including extreme waves, coastal erosion, and subsidence or heave. Visitors could also cause damage and disparaging word-of-mouth feedback could affect Koltur's popularity. To avoid inadvertent damage or disappointment, visitors would need to understand the environment they visit and its vulnerabilities. An off-island orientation session would help, but could drain resources from managing Koltur.

This brief description of the historical processes, future potential, and present tradeoffs being examined to make Koltur a viable visitor centre illustrates the challenges faced by isolated small islands in managing their heritage's vulnerability. Detailing each concern and placing it within disaster ecology frameworks, such as that proposed by Etkin and Stefanovic (2004) for disasters involving natural hazards, would yield the needed vulnerability and risk ecologies for Koltur.

The risk ecology is particularly seen in understanding how changes to preserve the heritage could augment its vulnerabilities or cause direct harm. Conversely, preventing such changes could also augment the heritage's vulnerabilities or cause direct harm. Once these issues, and others involving single-event and chronic hazards and vulnerabilities, have been identified, resolving them could be attempted to yield risk management, inclusive of decisions made by others, which would be as sustainable as possible.

Although Koltur's situation parallels the experiences of many non-island heritage sites, the advantages of islands appear in that the options are straightforward while each choice's impacts are directly seen--in isolation. Meanwhile, the entire population of Koltur can be directly consulted and their entire experience and knowledge, covering the island in detail, can be applied. A further vulnerability is then revealed because this expertise of, and contributions to, Koltur could be lost if an inhabitant were injured or decided to leave.

Rather than being strictly about tourism at a heritage site, the ecology of island vulnerability for Koltur indicates how the heritage's vulnerability changes the wider society (including visitors) and how wider society affects Koltur's heritage vulnerabilities. The vulnerabilities of smallness and isolation also become advantages by being part of the Koltur experience beyond the heritage meaning of the old buildings.

CONCLUSIONS

The conceptual model of disaster ecology has led to risk and vulnerability ecologies. Island vulnerability is seen as a useful approach for applying this conceptual model, as shown by the case study of Koltur. Fully analyzing the ecologies of Koltur would be needed to develop solutions for sustainable risk management. This analysis would also assist in answering questions posed here, including those regarding the positive and negative consequences of disaster, and filling in gaps, such as developing specific recommendations for sustainable risk management at a site.

The complexity of these analyses and the need for different disciplines collaborating should be emphasized. Application on islands yields significant challenges.

Non-islands face those challenges without islands’ advantages. Nonetheless, the thoroughness, breadth, and depth implied by combining the conceptual models examined would be a significant step towards creating and maintaining sustainable risk management.

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Fig. 1. The Faroes, highlighting Koltur.

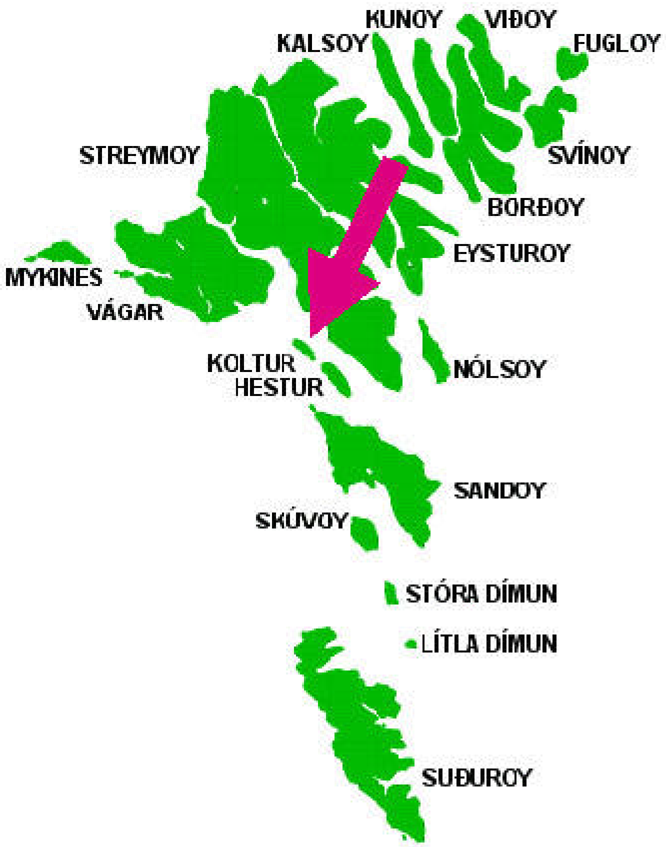

Fig. 2. The Faroese island of Koltur, population 2 in 2003.

Fig. 3. The old buildings of Koltur.

Fig. 4. Koltur’s old buildings do not meet modern safety and access standards.

Fig. 5. The challenges of getting on and off Koltur by boat.