RESILIENCE AND SUSTAINABLE COMMUNITY DESIGN: THE CASES OF PUKAPUKA, LOWA, AND LA BAHIA DE JIQUILISCO

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Abstract

Our awareness of the value of resilience in architecture and community design emerged through the application of criteria for sustainability to emergency management efforts as carried out in three diverse sites: a South Pacific atoll, the plains of middle America, and a shoreline in Central America. In each case, the author, an architect, academic, and community designer, and his associates conducted on-site research and prepared agency reports that quickly refocused on the larger scale environmental design and planning issues rather than on the often costly but futile local mitigation efforts.

The three criteria for sustainability include: *equity* in the present and future, *economy*, and *ecology*. These criteria were used to assess weather-related emergency management activities typically conducted as a *contingency* before an emergency, the *reaction* during an emergency, and *recovery* activities conducted after the event.

Considerations included social equity, economic costs, and ecological balance in prevention and mitigation efforts; agility in response to weather related events; and sensitivity to environmental threats in reconstruction efforts. The results of these analyses are instructive in developing sustainable architecture, community design, and planning. The quality of resilience rather than resistance to events prevailed in all of these efforts. With this change in perspective, architecture and community design efforts become both more local in nature and regional in scope, less intrusive, and of a scale and magnitude more appropriate for community-based cultures.

Sustainability; resilience; community design; disaster management

INTRODUCTION

A very direct relationship has been established between environmental disasters and development, including:

- disasters as agents that affect development forces,
- development as an agent that can generate disasters, and
- disasters as generating agents of development opportunities (Castillo, 1993).

PukaPuka

The research on cyclone events on coral atolls in the South Pacific (Findlay and Katoa, 1998) was motivated by the absence of such information discovered in the wake of Cyclone Martin in early 1998. The purpose of the project was twofold: a risk assessment of Pacific islanders and a model study for replication on other islands. The work was supported by the Asian Development Bank and accomplished through an agreement between the U.S. Crisis Corps (a program for former Peace Corps volunteers to accomplish international relief) and ONU Group, engineering consultants, in the Cook Islands.

An argument for management for resilience, rather than resistance to such events was developed. This approach was appropriate considering the limited resources and capacities in this isolated, largely self-sufficient and communitarian society. To structure the model study, we settled on five areas of assessment:

- the physical makeup of the island and related hazards,
- the social, economic, and physical vulnerability of the people,
- the morphology of the settlement that the people built on the island,
- storm-related preparation routines in the community, and
- mitigation activities over the longer term.

In completing this study of risk factors, we assessed the relationship of the land, water, and wind; challenges to the communitarian society of islanders; the physical form of their communities and buildings; their preparedness for storm events; and sustainable mitigation recommendations. We informally interviewed many PukaPukans, often as part of social events and chance meetings on the street, to gain their perspectives on preparedness, storm histories and experiences, and recovery practices. In the course of the research we observed the everyday conflict between traditional and capitalist tendencies as well as the persistence of their long-held communitarian survival strategies.

The several risk factors required multi-disciplinary academic research and became what might be termed scholarship of service. References available in Auckland and on the capital island of Rarotonga included technical studies of the shoreline ecology (Chikamori and Yoshida, 1988; Easther, 1994; Richmond, 1990; and Sherwood and Howarth, 1996) that complemented research on the dynamics of barrier islands in the U.S.A. (Bush, Pilkey, and Neal, 1996). Even more engaging were resources uncovered on PukaPuka itself which included two valuable ethnographies: a classic inventory of the people and their tools (Beaglehole and Beaglehole, 1971), and a more recent description of community decision making (Borofsky, 1987). Particularly useful were the docu-fiction writings of an American author who resided on the atoll in the 1920s that provided in one chapter an invaluable understanding of the communitarian society that continues on the atoll (Frisbie, 1939).

Sharing and directly investigating the atoll and the life thereon for several weeks, and keeping a laptop computer journal and photographic record of observations related to these documents, was an invigorating research experience. We were surprised to find land movement on the tops of these 4K meter tall mountaintops that happen to emerge 2-3 meters out of the ocean. We were taken in by this self-sufficient, communitarian society and experienced the challenges of capitalist consumption. A society based on sharing was feeling the distancing effects of monetary exchange and modern communications.

Housing contrasts exist on the atoll as PukaPukans who have lived elsewhere return to build houses of imported concrete blocks while cash-poorer relatives reside in indigenous thatch and pole structures. Even the former construct the thatch structures on the same atoll as seasonal or vacation homes since a ten minute walk can situate residents in a contrasting climate. A few motorized land vehicles have appeared, and outrigger canoes are found alongside powered aluminum boats. These practices, although considered progressive, demonstrate the futility of resisting natural forces. Block houses are difficult to repair while traditional dwellings flex in the wind or more easily return to the natural environment if weak. Year-around occupation and road building in food reserve lands make them more susceptible to human misdeeds and to storm surges. On-island communications are maintained by highly social and strategically located cooking shacks while inter island communications are conducted via a once a day ham radio broadcast. Satellite telephone calls to the capital and beyond are also possible but at considerable expense.

Again a parallel existence was found between purchased and locally produced goods. The direct observation of the connection between raw material sources and their dwellings and utensils was a powerful message of sustainable design in practice. Employment, or cash wage, opportunities are few as most residents produce comestibles and goods to contribute in the traditional manner. But some youth are restless after seeing videotapes and hearing stories from their traveling relatives, and there is a resulting outmigration. But, as a research colleague back home reminded me, in this way it is a lot like Iowa.

Iowa

Under contract with the state Emergency Management Division, a method was designed to monitor and assess emergency management activities in each of the ninety-nine counties of Iowa (Findlay, Knox, and Austin, 1999). Emergency Management Division activities include services to individual citizens and public and private entities that attempt to minimize the effects, and speed the response and recovery from floods and tornadoes. The goals were to comply with program assessment mandates of the Federal Emergency Management Agency, and to develop an evaluation routine to systematically aggregate information that was already available and to make some useful sense of it. The research group adopted the three criteria for sustainability - equity, economy, and ecology - as

the evaluation measures for the annual reports of county data. It was interesting to the research group that rather than embracing these criteria for sustainable design and planning, the state agency found the use of these criteria to be too academic. They are, however, using the data gathering system we proposed and continue to use the expression sustainability without adopting evaluation criteria that would effectively assess progress in this area.

As a general shift in program focus, the division now follows a FEMA mandate to promote mitigation activities, which would lessen the effects of future disasters while maintaining a strong response and recovery capability (FEMA, 1998). Mitigation refers to activities which actually eliminate or reduce the chance of occurrence or the effects of a disaster. Mitigation activities may be found in all three phases of emergency management: preparedness, response, and recovery. *Preparedness* is planning how to respond in case an emergency or disaster occurs and working to increase resources available to respond effectively. *Response* activities occur during and immediately following a disaster. They are designed to provide emergency assistance to victims of the event and to reduce the likelihood of secondary damage. *Recovery* is the final phase of the emergency management cycle. Recovery continues until all systems return to normal, or near normal. Short-term recovery returns vital life support systems to minimum operating standards. Long-term recovery from a disaster may go on for years until the entire disaster area is completely redeveloped; either as it was in the past or for entirely new purposes that are less disaster prone. In this way, the division is at least adopting a sustainable community perspective. In its literature, FEMA itself continues to relate sustainability to disaster resistance rather than resilience. In time we expect that more rigorous measures of sustainability will become part of their practice and self-assessment.

During the course of this study, within the context of potentially disastrous events, we began to summarize the characteristics of a *sustainable and disaster resilient community.* A sustainable community would be one that is able to stay healthy over time in the absence of a disaster. A healthy community is one that has

- social equity,
- economic viability, and
- ecological integrity.

A resilient community is one that is normally healthy and that has systems in place that will enable it to avoid disasters or return to a healthy state within a reasonable time after a threatening event. Communities that are not socially, economically, and environmentally healthy are more vulnerable in events that can become disasters. Moreover, communities that are socially, economically, and environmentally healthy will still be susceptible to crippling disasters if they do not have mitigation systems in place as they prepare for, respond to, and recover from the events.

Social Equity

Communities in which social capital is low or nonexistent and social networks are sparse or not functioning will not be healthy, sustainable communities. Social capital and strong social networks can be important aspects of preparing for and recovering from a potentially disastrous event. When we speak of social capital and networks, we are referring to both the existence of systems of volunteers and the willingness of state and local government to invest in communities. Equity is also an important part of healthy communities. For example, housing of lower income citizens tends to be located in areas prone to flooding or built without sufficient shelter.

Economic Viability

The damage caused by the dust bowl of the 1930s or by the 1993 Mississippi River flooding in the United States was caused in part by short-term economic decisions. Thousands of people decided to ignore environmental constraints and instead to pursue short-term economic gain. The ensuing disasters disrupted or destroyed the economic and social health of many communities. Within the context of sustainability, rational economic decisions are those that do not ignore the future needs of either present or future generations, nor of those residents downstream. Sustainable communities need economies that provide quality jobs that will last and that will contribute to community capital. Boom economies do not lead to healthy, sustainable communities. Obviously, economic activities that provide employment in the short-term but that contaminate either the workforce or the environment do not lead to healthy, sustainable communities.

Ecological Integrity

A community that has ecological integrity does not harm the local, regional, or global ecological processes upon which it depends. Unfortunately, communities throughout history have damaged the environmental and community health because they concentrated on short-term gain and ignored long-term, environmental consequences. For example, Plato lamented, “What now remains compared with what then existed is like the skeleton of a sick man, all the fat and soft earth having wasted away ... There are some mountains which now have nothing but food for bees, but they had trees not long ago … and boundless pasturage.” The degradation of ecological systems threatens the long-term viability of communities and often worsens the consequences of such weather-related disasters as drought and flooding. Consequently, counties and cities that plan for and protect flood plains, waterways, wetlands, aquifers, steep slopes, and so on, will be ecologically healthier and more resilient than communities that do not.

Six overarching concepts help to develop a working definition of *resilience for community sustainability.*

- Sustainable communities have environmental integrity, a healthy economy, and equitable treatment for everyone.
- The present generation has an obligation to protect the options of future generations.
- We should be cautious about making irrevocable decisions.
- More holistic thinking will help us to achieve sustainability.
- We should be humble when dealing with complex natural and social systems.
- We should look to nature for design guidelines and work with nature rather than against it.

Bahía de Jiquilisco

The sustainability criteria were now more readily understood by our research group and, therefore, utilized more effectively in the third project in El Salvador. It is a small country in Central America that has a relatively high density of population, resulting in environmental degradation and the threat of damage from tropical storms such as Hurricane Mitch that struck in late 1998 (CEPAL, 1998). The people and their environment in El Salvador are experiencing increasing vulnerability, a result of living at high densities increasingly close to dynamic natural events that more frequently turn into disasters (USAID, 1999). It is a risky environment because the threats have become part of everyday experience in an environment in which capacities have been stressed and diminished by human actions.

The study was conducted by DEICO, a non-profit research and management contractor in San Salvador, under contract with the U.S. Crisis Corps (Findlay, 1999). The damage observed in the coastal villages was clearly the result of development decisions being made throughout the watershed, including deforestation, channelization of rivers, and increasing density of inhabitants living and working ever closer to increasing risk (Garcia, 1998). Each of these practices actually increased the risk of disaster through the large scale of the activity or the employment of structural resistance to natural phenomena, causing increasing risk for downstream residents. The populations on these lowlands were marginalized by these practices and were without the resources to structurally resist or remove themselves from harms way (CCPREDENAC, nd). The El Salvador report was written in Spanish, in which there is no word for resilience. The authors, therefore, had to use analogous terms of agility and flexibility to explain the difference between resilience and resistance to weather-related events. Several phenomena became apparent in the research on El Salvador.

Living in an increasingly incapacitated environment

Development that is motivated by one objective, usually economic, at the cost of other objectives such as equity among the population and equilibrium in our ecology carries associated costs. Marginal economic development in agriculture has resulted in deforestation and rainwater runoff. In an attempt to deal with the increasing quantity of water, channelization incapacitates rivers from their positive behavior of providing nutrients and lowland drainage, and serves only to transfer larger quantities of water at higher speeds directly to the ocean, endangering and marginalizing communities along the way.

Watersheds are the appropriate scale of analysis

The problems that exist in coastal areas are the consequence of decisions made and capacity diminished throughout the watershed. Problems have a way of intensifying as they are passed along downstream. In contrast, through reforestation, river waters may return to run more slowly and the land may again have the capacity to absorb water so that there are fewer and smaller floods, and safe and useful terrain may thereby be recovered from flood plains little by little downriver.

Challenge to understand the dynamic conditions found along coastlines

The coastal islands and river delta areas themselves are in constant change and we need to maintain an agile resilience in order to coexist with these changes. The action of water and wind continually transform these terrains and shorelines. We fight these forces when they threaten our communities during disasters and live with the risks in order to continue there in more tranquil times. The water always wins any fight in which we engage. Instead of being in continual resistance to these forces, which is costly and futile in the long term, we need to learn to live with them, adapting the community accordingly. In the past year, the exceptional rainfall and earthquakes transformed the watershed, amplifying the magnitude and speed of water through courses whose capacity was already diminished as a consequence of human interventions.

The failure of the two sides of cost-benefit analysis to produce solutions

Cost-benefit analysis depends upon local investment taking advantage of and surpassing the increased benefits predicted in the calculation. Most often the initial funds are not forthcoming for lack of evidence that local investment will be made in the benefits. The analysis, however, is often made by international consultants whose experience of home country success with the equation encourages them to draw up the plans on the chance that the predicted investment in benefits will hold true once again, in another cultural context.

Proposals that are subjected to cost-benefit analysis, typically an engineering procedure, often involve physical constructions to resist or contain natural events, and such structures give the illusion of permanence but are designed to protect against hazards of limited size and duration, and often amplify the vulnerability of populations downriver (Shiraiwa, 1997).

SUSTAINABILITY OBJECTIVES AND THE CYCLE OF EMERGENCY MANAGEMENT

The three characteristics of a sustainable community include *equity* for the present and the future, *economy,* and *ecology*. It was productive to relate these sustainability criteria to the several steps of emergency management that are typically undertaken in the three phases of an emergency: *contingency* planning before, *reaction* during and *recovery* after the disaster. The following matrix of criteria and emergency phases was developed as part of the research on El Salvador.

Resilience and Community Sustainability

We should recognize that we participate in an ecology, not in a losing fight with the forces of nature. We need to think in terms of maintaining a balance or equilibrium with nature in the individual and collective decisions we make in order to reduce vulnerability and to sustain our communities. Structural resistance, as was learned in 1993-4 along the Mississippi River in the United States, is

SUSTAINABILITY AND EMERGENCY MANAGEMENT

		CRITERIA FOR SUSTAINABLE COMMUNITIES:		
		EQUITY	**ECONOMY**	**ECOLOGY**
		PRESENT & FUTURE		
PHASES OF AN EMERGENCY:				
BEFORE (Contingency)	**PREVENTION**	PRESENT: risk zoning and building code enforcement. FUTURE: avoid future vulnerability and expense	Minimize additional costs; consider prevention and recovery costs in development	Recognize natural behavior and protect capacity of coastal areas and of watersheds

	MITIGATION	PRESENT: equity and fairness of protection; FUTURE: limit dangers for future residents	Cost effectiveness of efforts; remove from rather than resist danger. Cost, duration, and degree of protection	Enhance resilience of environment in order to endure the event
	PREPARATION	PRESENT: inclusive evacuation plans FUTURE: human accounting/ networking	Integrate refuge capacity with public facilities; map and inventory of human and built resources	Inventory environment, risks, mitigation efforts, and disaster history. Don't pass danger downstream
DURING (Reaction)	**ALERT**	PRESENT: surveillance and notification; universal warning FUTURE:	Household and business survival plans	Minimize disequilibrium to enhance resilience to events
	RESPONSE	PRESENT: equitable distribution FUTURE: document response for future effectiveness	Agile authority to make adjustments to contingency plans	Resilience to events
AFTER (Recovery)	**REHABILITATION**	PRESENT: equitable return of services & shelter FUTURE: limit damage downstream and to future	Limit collateral damage to infrastructure and to enterprise	Limit event-associated damage to natural environment
	RECONSTRUCTION	PRESENT: consider changes in post-event environment FUTURE: enhance opportunity, capacity, and resilience	Consider prevention in location and construction, zoning and codes. Healthy economy is more resilient to future events	Recognize post-event capacity and change in environment; contain damage, pollution, and subsidence

expensive, has capacity limits, and often fails. Our university agencies, Iowa Community Design and the Program for Weather-related Disaster Research, have explored a concept of resilience. Resilience may be thought of as community preparedness, agility to endure or "weather" the storm, and rapid recovery from events. If we consider equity for current and future local inhabitants, short and long term economic costs and benefits, and the ecological

effects of our design and planning decisions, the choices we make may be more appropriate for areas with limited economic resources and elsewhere, as well.

A community works to prevent natural events from becoming disasters by regulating land use and construction, and by providing safe locations for all development. It realizes that failing to plan ahead often results in higher damages, associated costs and recovery delays to the community and its environment. A sustainable construction is resilient rather than resistant to natural forces. The floodwaters and tides flow through or under a resilient structure without structural damage, refuge may be found above, or a structure can be dismantled and/or moved in its entirety when it is no longer supported by its surroundings.

CONCLUSIONS

Through human actions, we have altered our surroundings and the course of natural processes. Rivers moved more slowly as they meandered through retention areas such as wetlands and deposited water and nutrients along their courses both normally and more broadly in times of flooding. River uplands, however, have been deforested, decreasing the nutrients and increasing the deposit of less-productive soils downriver. The water moves more rapidly off these barren hillsides, its flow further directed and sped up by channelization, or the effort to move river water and its contents past lowland agricultural areas and settlements. This rapidly moving water results in more structural damage as it rushes through fragile channels to the sea, developing more physical power and less predictable behavior, conditions potentially more hazardous to life and our surroundings. These interventions are further complicated by human error and wrongdoing.

Many people of modest means find themselves living in these more vulnerable environments as they have not had the resources to remove themselves from harms way. These populations are sometimes at the end of the line; the recipients of the discharges and questionable activities upstream. Not only are they in the process of changing their economic activity and life style accordingly, they have to deal with an environment greatly changed by natural events and conditions caused by these other interests - be it upland deforestation or chemical pollution of low farmlands. There is often a feeling of being place-bound through economic limitations or tradition associated with livelihood and families. These communities also have not been able to improve their sources of water, sanitation, schools or other public infrastructure necessities even in the best or safest of times.

When in the midst of recovering from a disaster, there is a tendency to think very locally and sometimes in a piecemeal manner. People are tired from responding to recent events and exasperated by modest means and capabilities for remedies. The cost-effectiveness of expensive proposals for protection is hard to

establish. Grander solutions are sought and sometimes donated that can be even more risky as they further concentrate the forces of nature and heighten the hazard when there are events such as hurricanes and earthquakes. Providing the illusion of safety, or relief from the more frequent minor events, these resistant structures may actually put more people and their surroundings at higher risk when they fail. This report, therefore, provides a broader view of disaster management with the aim of sustaining community through community members helping themselves and helping others to help them in time of need. Through preparation, response, and recovery, and the overarching considerations for hazard mitigation, resilient communities may better be able to weather the storm, to quickly recover, and to optimize the events as opportunities to strengthen themselves.

The Cyclone Management Report for PukaPuka atoll was the first of its kind and serves as a model for the preparation of reports on the other 14 islands in the Cooks and for other cyclone-prone Pacific islands. An educational benefit is the use of the reports as lesson books in the Cook Island schools as preparation for future storm events that regularly occur in the islands. The materials prepared in Iowa are beginning to be incorporated in pre-event prevention and mitigation planning by emergency management agencies and local planning agencies. The study of resilience in sustainable approaches to development in la Bahía de Jiquilisco has been incorporated into the training of Peace Corps volunteers so that it informs their program assignments in reforestation, health and sanitation, and municipal development.

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