ABSTRACT

DANIEL H. DE VRIES: Temporal Vulnerability: Historical Ecologies of Monitoring, Memory, and Meaning in Changing United States Floodplain Landscapes
(under the direction of Carole L. Crumley)

This dissertation addresses the relationship between temporality—being bounded in time—and population vulnerability to hazards. Researchers and program managers typically integrate temporality in vulnerability assessments by analyzing either historical change in the level of population vulnerability or the historical (root) causes for disasters. The thesis of this dissertation is that the influence of temporality on population vulnerability is further determined by human relationships to time. In the modern context of fast changing, hazardscapes and a diminishing of sense of place in a global world, how do temporal reference making practices such as landscape monitoring, memorialization, and meaning attribution influence population-level emergency preparedness? Based on historical ecological fieldwork in four United States floodplains—New Orleans (LA), Savannah (GA), Kinston (NC), and Felton (CA)—the results of this study illustrate how *temporal vulnerability*, defined as the condition of population surprise, decreases population resilience in the contexts of hazard mitigation, historical preservation, early warning, and disaster evacuation. A dwelling model is constructed that can be used to guide temporal vulnerability assessments, adaptive management, and interventions aimed at increasing hazard resilience.

1. INTRODUCTION

1.1. Hazardscapes in a Time of Temporal Intensification

One of my informants in the City of New Orleans told me in passing that the surveying *benchmarks*—the physical reference points that had been used to measure change in the vertical height of the land—were sinking in the City of New Orleans. To the people of southern Louisiana, knowledge about the rate in which the land sinks (subsidence) is critical, as they have faced a rise in sea level of six to eight inches in the past century. Tidal data indicates that Louisiana faces the highest rates of subsidence and sea-level rise in the United States, where mean relative sea-level rise (including subsidence) is more than five times the Gulf of Mexico average and ten times more rapid than the rest of the globe (AAPG 1998). In the 1950s, a network of about 300 vertical control benchmarks was put in place around New Orleans to measure the height of the land and calibrate subsidence (sinking) relative to "known" points. These benchmarks showed scientists and the public that in the past decades, the city had been sinking at a rate of about one-fifth of an inch a year. This knowledge not only guided engineers and planners in their calculation of the necessary height of bridges, buildings, levees, and other critical infrastructure elements relative to water and ground levels (NPR 2005), but also—as one would presume—provided the public with a certain sense of urgency with respect to flood mitigation.

Traveling through floodplain landscapes in the United States, it became clear to me how for those dwelling in and managing these type of areas, the idea of a sinking floodplain would equate to even deeper "sinking" feelings that the next flood event might be nearer on the temporal horizon than expected. The realization of this problem would mean an adjustment in expectations about future flood events. Expectations about events that are associated with a toxic-soup of water, sewage, mud, and chemicals that destroy carpets, walls, cabinets, and even entire houses. Expectations associated with the stressful anticipation of having to move belongings up high, putting wooden boards and sandbags in front of the doors, and arranging to stay a night or two with relatives on higher ground. Expectations about carefully watching the news, having hopes that the backyard creek won't be dammed by fallen debris or trees, and that the engineers will turn the pumps on in time. Expectations about repairs that will have to be done and pictures of belongings that need to be taken in order to be able to claim damages to floodplain insurance contractors. And for those managing the risk landscape, expectations include emergency preparations which start as soon as the first warning sign arrives, decisions concerning calls for evacuation which backfire if the threat appears false, and the anticipation of a large number of flood claims and mitigation applications that will trickle into the planning and mitigation departments after the event is over. Living in and managing the infrastructure of a floodplain comes with its own temporality; one in which the coming of the "next" event is always on the planning horizon and evaluated based on what is known from past experiences, the memories of long-term residents, media reports, and the benchmark measurements of scientists and engineers.

But while the ground in New Orleans is sinking, the benchmarks aimed at measuring the extent to which this is happening were sinking as well. Did this mean that to some extent the lowering of the land went *unnoticed*? Did the failure of our instruments to "see" the complete extent of the subsidence mean that the population became more vulnerable to disaster, because they were *unable* to adjust their expectations? As benchmarks are the anchors that calibrate our risk expectations, what happens when they become inaccurate or outdated? Elevation research that was conducted in 2006 used 150,000 satellite measurements taken from space to calibrate vertical height, instead of the fifty-year-old benchmarks, and indicated that parts of the City of New Orleans had been sinking *much faster* than had previously been imagined. The authors concluded that in the three years before Hurricane Katrina struck in August, 2005, about ten to twenty percent of the region had subsidence in the one inch-a-year range, or five times the rate of change believed before (Associated Press 2006). Significant to the context of the Hurricane Katrina disaster, this faster rate of subsidence included an area next to the Mississippi River–Gulf Outlet (MRGO) canal where the levees failed during Hurricane Katrina's peak storm surge (Dixon et al. 2006). While expectations concerning the spatial distribution of the rate of change appeared to be in need of adjustment, the local political context instead forced an optimistic discourse of rebuilding in which increasing rates of subsidence were not the preferred vision. At the Tulane and Xavier universities' Center for Bioenvironmental Research, researchers used LIDAR (precise light imaging detection technology) data from 1999-2001 to report that "contrary to popular perceptions, half of New Orleans is at or above sea level" (Times-Picayune 2007; Campanella 2007). While this finding was referenced in numerous media and blog reports, the research itself largely bypassed the connection between the LIDAR dataset used in the study to calculate elevation and the sinking vertical height control benchmarks. As one *Time-Picayune* blog critic remarks in a comment: "That generation of LIDAR (99-01) was tied to benchmarks that are sinking; so unless the height is corrected it can easily be more than a foot off" (Times-Picayune 2007)[1]. While the criticism does not necessarily change the authors' argument (there *is* land above sea level), the decreasing extent to which this is the case makes the study seem to communicate a false optimism to the public. What these two examples illustrate is: first, even within the highly precise engineering world of land surveying, determining positions on the earth's surface is a *dynamic* activity wherein reference points change. These changes can have implications for population vulnerability, particularly if they go *unnoticed*. When reference points become outdated, homes, evacuation roads, hospitals and shelters appear built *in fact* further below sea level than engineers and emergency planners had thought. Or in other words, within the need for temporal coordination between our changing environment and our adjustments of hazard expectations, *deception* can enter into the equation. As a result, I argue, the cultural landscape is made more vulnerable.

The sinking elevation benchmarks of New Orleans provide an entry into what this study is about: population vulnerability resulting from a compromised human capacity to adequately monitor the changing environment, produce effective memory-networks, or correctly attribute the meaning of past events through effective temporal scales of reference. Because it deals with practices that coordinate the correspondence between cultural risk expectations and hazard probabilities in changing landscapes, it is about the influence of temporality—our being in time—on population vulnerability. What happens

[1] According to the authors of the study (Campanella 2007), LIDAR elevation models were processed to identify above-sea-level areas within Orleans Parish, on both banks of the Mississippi and on both sides of the Industrial Canal, but excluding the rural marshes. They used recent LIDAR elevation data, measuring topographic elevations at the five-meter pixel level, and noted that "No adjustments were made for the amount of topographic subsidence that has occurred between 1960 and the date of the LIDAR data (1999-2001), because such estimates are difficult to validate, and natural levees tend to subside less than former marshes." (p.4)

when flood baselines are outdated? What happens when we fail to remember past hazard events? What is the influence of high homeownership turnover rates on neighborhoods' ability to respond to early warning? What happens to public risk expectations if a river is dammed up, changing its flood ecology, during a thirty-year period with little flood activity? In an indirect way, the research focuses on the meaning of historical ecological knowledge that reminds us that all complex systems have particular histories that affect current behavior (Crumley 1994). In our tightly connected socioecological system, what happens if the interactive feedback between human history and ecological behavior are out of sync? How is this a driver for population vulnerability to hazardous events?

The field site of this research is specifically the hazardscape, or landscape in which the experience of hazards implies an influence of both the historical, material landscape and the perceptions, social constructions, discourses, and other cultural views used to make sense of its properties (Mustafa 2005). The hazardscape has been undergoing radical change in the past decades; several trends that have their origin in the enlightenment have led to a temporal intensification of dynamic environmental properties in hazardscapes. While landscapes have always been dynamic entities in constant flux, the speed or rate of landscape transformation has dramatically intensified since the 18th century relative to previous times in human history (Burton 1999; IGBP 2005; Whyte 2000). The expansion of industrialization and urbanization during the 19th century caused irreversible breaks with many "traditional" hazardscapes uses (often agricultural or with a short-term purpose) of which the hazardous properties had been known for centuries. Embedded in its larger historical context, this trend follows an overall rapid acceleration of the rate of landscape transformation since 1700, as illustrated in Figure 1 (adapted from Antrop 2005).

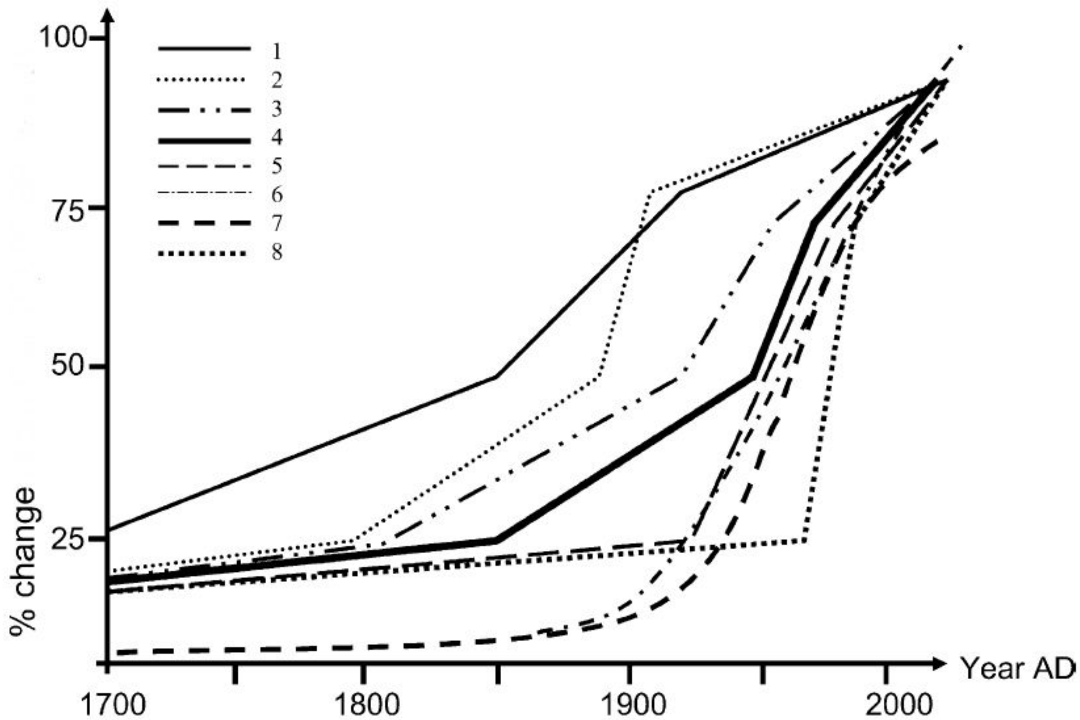

Figure 1: Percent changes observed in eight landscape ecology features since 1700 (from Antrop 2005).

This acceleration in the rate of landscape transformation is expected to further increase as a result of the impact of global climatic change. While there is limited understanding of the complex interaction and feedback loops inherent to the global socioecological system, the enormous uncertainties and important economic consequences of climatic change are expected to force socioecological systems to rapidly adapt to changing regional and local climatic conditions. While the ability of humans to rapidly transform their landscape can be an asset in adaptive management, the fast biophysical and human-induced landscape transformations at the same time make it more difficult for landscape managers, planners, and people living within hazardscapes to know how these landscape transformations alter the impact of hazards.

Responding to such challenges, humans have always kept an eye on landscape transformations to evaluate how it would change risk patterns in terms of agriculture, hydrology, epidemiology, and even warfare. Traditional, local environmental management systems excel particularly in the capturing of long time-series of local observations (Berkes & Folke 2002). Reliant on cultural memory, traditional learning formed a cumulative, intergenerational transmitted body of knowledge that evolves through adaptive processes and is helpful in capturing information important to risk evaluation. In modern times, this type of monitoring has increasingly been complemented, and often replaced, by a reliance on scientific measurement and management, which excels in the collection of simultaneously observed data, yet has a relatively shallow time-depth. For example, while sophisticated, the evaluation of sea level rise in southern Louisiana in the AAPG study (1998) is based on only 20 of the potential 80 tidal stations, because only those stations had more than 20 years of data. Because of the shallow time depth and the complexity of making spatial models, most landscape change studies do not focus primarily on rates of change and typically incorporate only a few time steps, usually two to four (Schneeberger et al. 2008). Knowledge about fluctuations in speed of change is not the primary goal of these analyses, and few quantitative approaches exist to examine rate of change.

But as our practices to evaluate and monitor landscape change have evolved, so have our *cultural frames of reference*—beliefs, thoughts, feelings, and attitudes—that help specify problems and set the baseline in the process of risk evaluation (Zube 1980).

In the case of United States hazardscapes, the possibility of rapid landscape transformation has its roots in a western, modernist attitude, which stresses the notion of human mastery of the environment. Based on the philosophical trend of separation—indeed, alienation—of Culture from Nature, the unbridled manipulation of objective "property" is made possible. This has both facilitated an increase in the rate of landscape transformation as well as an increasing reliance on scientific monitoring as the most "objective" and "accurate" way to evaluate landscape risks. Ever since the first modern disaster of 1755 in Lisbon[2], disaster mitigation and recovery efforts have mostly remained aligned to this modernist attitude toward the hazardscape (White 1945; Dynes 2000).[3]

While on the one hand modernist Nature remains the dominant prescription for landscape transformation, evaluation, and risk management, the post-modernist impact of globalization has on the other hand made our understanding of what the landscape actually *is* more detached, fluid, irregular, and perspectival than ever before (Appadurai 1996). In the post-modern condition, global mass media technologies allow us to escape into imaginary worlds driven by globally distributed marketing interests that bring together distant landscapes while perfectly concealing their traces of origin and the connections between past and present. Harvey (1989) argues that this "time-space

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[2] The 1755 Lisbon earthquake disaster came during a time when there were many strains between tradition and new ideas about progress. Because it was difficult for the Europeans to explain the destruction of Lisbon as part of the overall plan of God, the event provided an entry point for Rousseau's idea that Man is capable of reason and as such can transform its surrounding independent from God's predestined will, and as such brought to general attention a new modernist "social science" understanding of disasters. The recovery and rebuilding of the City initiated the first time that a State assumed collective responsibility for a disaster consequences. As such, the Lisbon earthquake is seen as the first modern disaster (Dynes 2000).

[3] As Gilbert White has argued, this over-reliance on mastery through structural works in the United States actually increased damages caused by flooding rather than decreasing them: "Floods are an act of God, but flood losses are largely an act of man" (White 1945).

compression" affects business markets and policy makers in the form of stress, as it becomes harder and harder to plan ahead and react accurately to events, and public psychology in terms of sensory overload, which leads to the blocking out of stimuli, denial, cultivation of attitudes of indifference, reversion nostalgia for of images of a lost imaginary past, and excessive simplification. The cumulative result of these cultural trends moves us to a situation wherein mental maps do not match realities anymore in an increasingly tightly coupled global world where the instantaneous moment dominates.

Within this cultural context of temporal intensification, the major challenge for emergency preparedness is to find effective ways to manage local risk expectations. Detached from the landscape, and increasingly lacking a historical sense of place, populations dwelling in hazardscapes do not notice the sinking benchmarks that miscalibrate their risk expectations. Increasing population mobility and the suburbanization process of the 20th Century have caused further alienation from the historical narrative embedded in our landscape. As concerns our historical relationship to the landscape, the cultural condition to which we have arrived is a *crisis of historical ecological knowledge,* which challenges the core goal for landscape sustainability and resiliency in the face of hazards (Gunderson & Holling 2002; Armitage et al. 2007)[4]. Its symptomatic consequence is a compromised ability to accurately set risk expectations that directly influence emergency preparedness. The result of this situation has been described for closed systems—such as nuclear reactors—as a situation where accidents

[4] Increasingly the concept of resilience is implied in the application of adaptive management. This concept refers to the capacity of a system to absorb disturbance without flipping into a qualitative different state (Gunderson & Holling 2002).

become normalized (Perrow 1984)[5]. What is at stake in our rapidly changing hazardscapes is our ability to "see" what is going on in order to engage in adaptive management, a process that involves learning through trial and error. When less time is available because landscape changes are faster, and the shared historical sense of place is shallower, the hazard impacts are more tightly coupled (instantaneous); our ability to be resilient through learning from mistakes and adapting to new conditions is reduced. The result of this temporal challenge is a population prone to be caught by *surprise* in an emergency, with the potential for major disaster. I argue that in order to avoid the surprises which might be hidden in this situation—normal or not—major efforts need to be made to rethink the meaning of hazards, risk, and societal sustainability from a *temporal perspective*. What we need is an effort to analyze our *temporal vulnerabilities* in order to find ways to increase the human capacity of *temporal resilience.*

[5] An anomaly or failure in one part of the system starts a cascading process of failures that cannot be adapted to on time because of the "tightness" of the coupling. The result is a catastrophic outcome.