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Revitalizing Community within and across Boundaries "Community Resilience in the 21st Century"

AFTER THE STORM

Rebuilding Cities on a Reflexive Urban Landscape

"Disasters don't just destroy lives; they mock them."

Susan Neiman, "The Moral Cataclysm," *New York Times Magazine*, January 16, 2005

In the last twenty years, I have taken part in recovery and rebuilding efforts following the 1993Mississippi River Floods, the 9/11 World Trade Center attack, and Hurricane Katrina and the levee collapse in New Orleans. Walking into the pit at Ground Zero or through New Orleans' flood ravaged neighborhoods, I have felt the heavy truth of Susan Neiman's words and seen it etched in residents' faces and scarred oak trees. I have witnessed the eerie silence as people, birds and all other signs of life disappeared in the darkness as the city struggled without power, water or the security of streetlights.

When a tsunami, hurricane or major earthquake strikes a city and metropolitan landscape, the winds, storm surges and tremors immediately strip away the veneer of everyday life, uncovering the hidden fragility of local life-support systems such as water supply, waste disposal, flood control, telecommunications, public health and personal mobility—to name just a few. System weaknesses usually are matters of public record long before disaster strikes but the decision to tackle the tough political and financial issues that come with each upgrade is routinely deferred "to another day" for the sake of budget deficits and political expediency. In the grim aftermath of the storm, responders discover that the day of reckoning has arrived. On top of the chaos and hardship of disaster recovery, the city now faces multiple system failures intensified by prior neglect. Urgent rebuilding demands have to compete with long-overdue infrastructure reconstruction. Meanwhile, besieged residents cope with added risks such as cholera and other water-borne diseases,

which seem unimaginable in modern-day America.

In their book, *The Resilient City, How Modern Cities Recover from Disaster*, the editors Lawrence J. Vale and Thomas J. Campanella summarize the publication's urban case studies with a concluding chapter: "Axioms of Resilience." They list twelve activities that cycle through an evolving process of recovery, reconstruction and rebuilding. As their disaster recovery chart illustrates**,** it is a lengthy process requiring great focus and endurance for any city to successfully navigate. For me, this chart provides an important visual framework that helps describe what happened to New Orleans in the wake of Katrina. (Figure 1.)

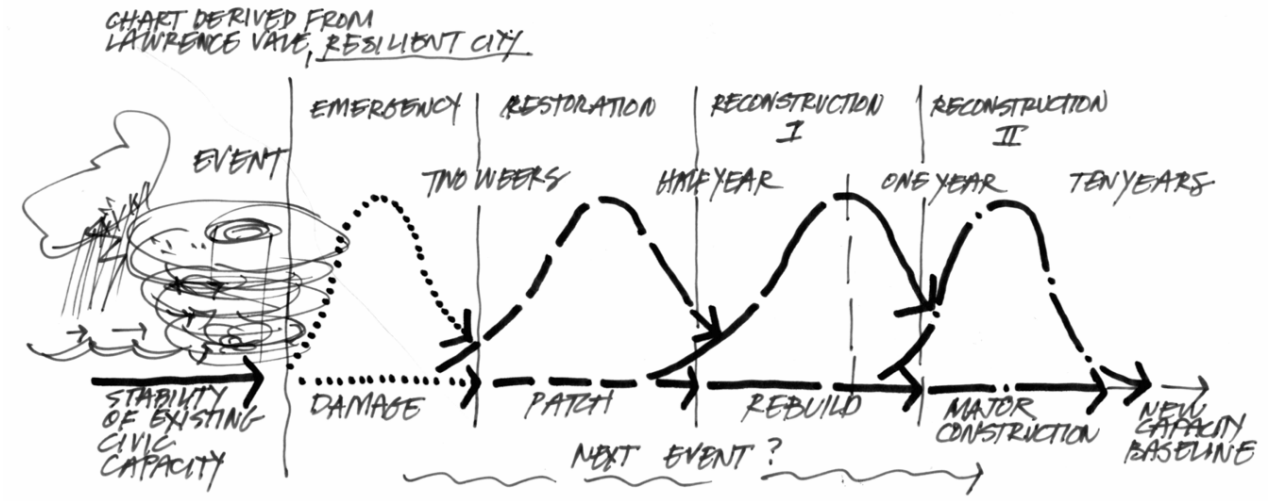

Figure 1. "Rebuilding Cycles"

Under so-called "normal circumstances", it takes a community years of focused work to overcome catastrophe's impacts.

On August 29, 2005, the annual Gulf Coast hurricane event turned into a massive urban disaster and human tragedy. Hurricane Katrina's Category 3 winds and subsequent tidal surge overwhelmed the region's patchwork of protective levees. In two days, 80 percent of the city was under water. Floodwater crushed water and sewer lines and inundated pump, fire, police and public health stations. Oil and toxic chemicals, mixed with fecal material, turned the water into a toxic brew that seeped into building walls and lingered in the yards of homes. Meanwhile, 75 percent of the city's celebrated oak and magnolia tree

canopy, which protected residents from summer heat and eased storm-water run-off for over a century, was wiped out by wind and saltwater intrusion. Most of the region's hospitals and emerging biotechnology centers were isolated by floodwater without access to power or dry cooling air, allowing heat and humidity to generate mold and bacterial growth throughout the buildings. Today, most remain empty, uninhabitable, requiring complete demolition. The disaster further exposed clumsy leadership at all levels of government, a balkanized and inept emergency preparedness organization, and an extensive map of disenfranchised citizens living on the edge of or outside access to basic city services.

These were just some of the preconditions that created a domino-like cascade of breaches and failures and magnified a comparatively routine Category 3 hurricane into a Category 5 catastrophe. The net result was that governance crumpled, the social safety net dissolved, critical municipal systems stopped working and nearly 1500 people died needlessly. The devastation of New Orleans was so complete that it was as if the horizontal line of the disaster recovery chart simply vanished and the city was left without basic civil gravity. (Figure 2.)

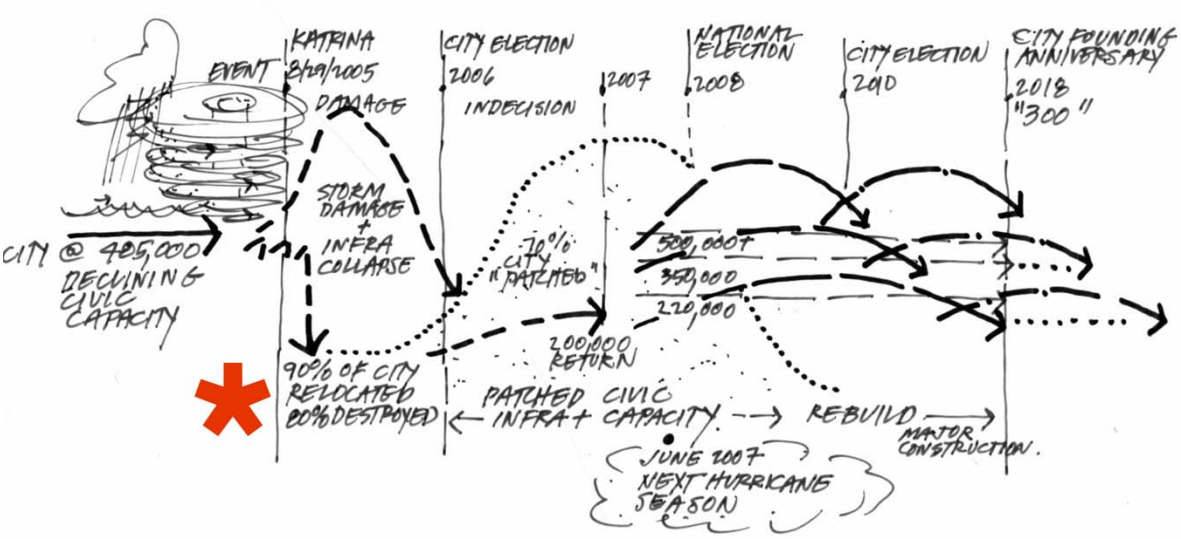

Figure 2. "Civil Terrain Collapses"

In New Orleans, the service, governance and safety networks collapsed, still not repaired and his limits repopulation and rebuilding efforts.

Infrastructure failure is now a daily fact of life in New Orleans. Utility providers struggle to keep aging systems in service--a task made much harder by the lack of steady power supply. Residents live with constant service interruptions, questionable water quality, unreliable sanitation and skyrocketing utility bills. They also have learned that their heroic efforts to rebuild homes and small businesses are not enough to bring New Orleans back to life; they still need the foundation of reliable municipal services accessible to and supportive of all residents. New Orleans' continuing inability to make tangible progress on infrastructure renewal has undermined its economic recovery and the ability of ordinary citizens to return, rebuild and realistically hope for a better future. If the trend continues, the city may become an even more segregated, fragmented and vulnerable place than it is right now.

While catastrophic failure on this scale is mercifully rare in the U.S., the event still serves as a potent symbol of the havoc caused by longstanding neglect of the public realm in New Orleans and elsewhere (Connery 2008). It vividly illustrates the risks and complexity we face to rebuild infrastructure systems in ways that will address past shortcomings but also meet new challenges posed by the disruptive shifts in economic, demographic, and environmental conditions underway across the nation. The required remedies and recipes will not be found in the default codes of traditional urban renewal and reconstruction; we must study the insights revealed by Katrina and fundamentally rethink the role of infrastructure in our private and collective lives and begin to create new models for more robust, resilient and sustainable systems and cities.

There are three critical insights that this storm revealed.

1. Long before Katrina arrived, another storm had been quietly brewing—out-of-sight, out-of mind, and mostly underground.

New Orleans' basic public infrastructure had been on a steady starvation diet for decades. A declining tax base, erratic lines of authority among public agencies, and a rich legacy of corruption all conspired to deprive the system of critically needed maintenance and investment capital. The city could barely keep up with emergency repairs and court-

ordered environmental upgrades, much less respond to the steady demands for ad hoc improvements to lure new development and jobs. In a nutshell, the city tried to squeeze as much service out of ragged outdated networks for as long as it could without taking stock of more strategic capital needs and investment priorities or the heavy odds that its piecemeal actions—to avert crises or cater to powerful private interests—merely accelerated overall system decline. In the end, New Orleans was the first city in modern US history to suffer a sweeping catastrophe due in large measure to public sector myopia and basic human denial.

2. Besides the apparent weaknesses of local institutions and infrastructure, Katrina revealed layers of reckless policies and feckless development decisions that had steered the City of New Orleans in self-defeating directions for more than 30 years.

One of the most notorious examples could be seen in the management of the city's vital levee system. The patchwork of local public authorities responsible for this task began to pay more attention to private real estate development than public safety and levee protection (Brinkley, et al). Like most other American cities, the city fought hard to attract major development projects, such as mixed-use commercial centers, high-income housing, casinos and professional sport facilities. The levee boards' special district taxing authority provided a handy vehicle to finance some of the costly improvements demanded by developers as a precondition for private investment. While precious tax dollars underpinned private gains, the prevailing public myth was that these projects would yield big tax revenues to invest in sorely needed infrastructure improvements throughout the community. Unfortunately, none of the "trickle-down" benefits promised to the neighborhoods and the working-class families who support these developments ever materialized.

At a more basic level, civic leaders—both public and private sector—and citizens in New Orleans showed little taste for crossing traditional cultural and institutional barriers to advance community-wide planning, development and emergency preparedness. Moreover, there was no leadership or serious political and economic incentives to

encourage the city to join forces with its metropolitan neighbors to strengthen the protective ecological systems in the region and to collaborate on less glamorous issues such as water, power, sewer, waste and transportation improvements.

Since Katrina, political and media attention to infrastructure has focused mainly on their construction of protective levees and design emergency evacuation systems for residents without cars. Remarkably little attention had been paid to vital services, such as drinking water that underpin the daily lives of all working families. Where many regions of the country are facing drought, water quality is a primary concern today in New Orleans.

In the past, it was mainly low-income families who had to worry about the quality and reliability of the public drinking water supply. Today the issue matters to everyone on the street and has become a big factor in the decision by middle-class families and businesses to remain in (or return to) New Orleans—on par with the collapse of the local public school system before Katrina. Poor households also endure extra hardships due to lead connector pipes, damaged home plumbing and the disproportionate pressure of rising water rates on skintight budgets. Failure to pay these rates can jettison ordinary tax-paying working-class families into second-class citizenship and third-world living conditions—if and when their water service is disconnected.

3. The disaster's historic forces revealed stark transformations in the urban economic environment and the form and function of the region's protective ecological processes.

After any disaster, the common desire of civic leaders and citizens is to quickly restore their city back to its familiar precondition map. This might be possible after a big storm that merely knocks down power lines or rips shingles from house roofs but in the aftermath of historic events such as Hurricane Katrina or 9/11, the cultural and physical landscape is fundamentally and irrevocably altered. Ecologists call this type of change, "succession," where one type of ecological habitat evolves into a completely different habitat—like when an open grassy field changes into a wood lot. The new landscape

demands an entirely different operating system to support its vitality.

Many understand the idea of ecological succession as a slow process of natural change. In fact, we are active agents in cultivating this process to suit our needs as long as we have time to manage and accommodate the progressive changes. In contrast, disasters are swift and decisive in their impact on the local cultural and physical ecology. They leave behind a huge list of "change" issues that can overwhelm local governance capacity and paralyze residents. In the case of New Orleans, the power of Hurricane Katrina and the weakness of its protective systems nearly undermined its landmark institutions and upended the norms of everyday life.

Once a diversified economy based on energy, finance and trade, pre-Katrina New Orleans had been reduced to a monoculture tied to tourism, entertainment and convention trade shows. Shipping and refining moved upriver to major barge terminals. The once industrious waterfront became a backdrop for expensive condos and flashy hotel casinos serving up big portions of lackluster food prepared in giant service kitchens. Meanwhile, many of the great local chefs and musicians who brewed up all the inventive recipes, unique cuisines, and exhilarating music that made the city famous, quietly moved onto new venues in less dangerous and more culturally cosmopolitan cities. When gumbo can be bought in a box with freeze-dried ingredients, culinary art no longer seemed essential to the city's economic vitality.

New Orleans' urban ecology is framed by two natural systems–the Mississippi River and the urban forest canopy of live oaks. Both reveal the complex water regime that defines life in the City well beyond the channels, lakes and levees. When the storm clouds cleared after Katrina, satellite photos revealed that the storm surge had stripped away 50 years of tidal grassland and trees compared to normal rates of decay in the wetlands of the river delta. A hundred years ago the City of New Orleans had 50 miles of wetlands separating it from the Gulf of Mexico; now in places, it has only 25. For every 2.7 miles of marshes/swampland that disappeared, there was a corresponding increase of one foot of storm surge. (Brinkley 2007) Katrina's deadly storm surges gave us a detailed picture of the new risks and vulnerabilities facing New Orleans neighborhoods in future storms; they also upended a lot of simplistic notions about "high ground vs. low ground."

Metropolitan New Orleans is a mosaic of five different drainage basins, which are urbanized sub-watersheds. (Eskew, Morrish, Schwartz, 2007) Katrina demonstrated that each of these basins has unique flood exposure conditions and that city topography is more complex and dynamic than previously assumed; in fact, the city is floating on a wet urban landscape surrounded by a massive wet Mississippi River delta landscape. Hence, the basis for New Orleans' stability, safety and survival does not rest on high ground--instead it depends entirely on the continuous gardening and tending of both landscapes. The silt, mud and water that pour through the bayous, underground conduits, canals, along curb gutters or in the main channel of the Mississippi River are all part of the same gigantic watershed that drains off all the fluids of the nation's vast mid-section. On the river, change is the only constant. (Figure 3.)

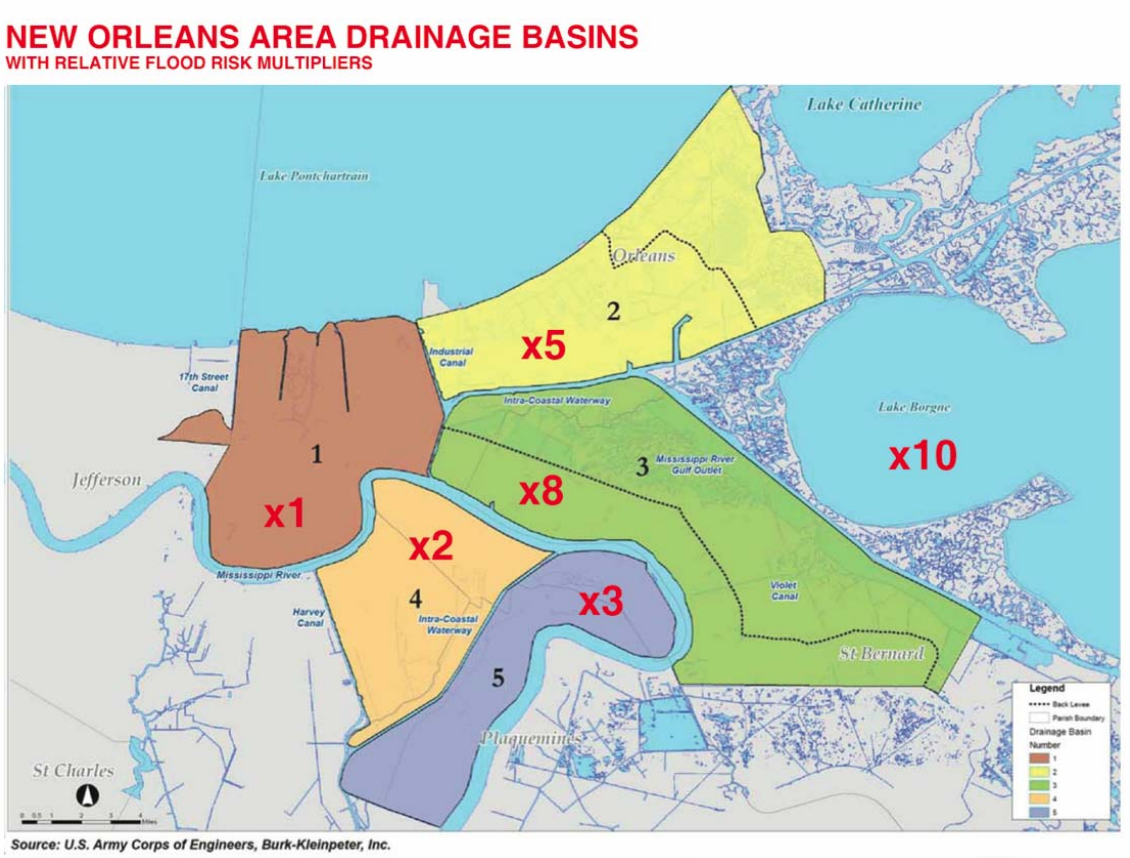

Figure 3. "A Drainage Basin Mosaic",

"One size does not fit all" when rebuilding infrastructure in a city that is in reality a composite of different cultural and ecological neighborhood exposures.

We take for granted that our cities are rooted on solid economic foundations and supported by benevolent environments yet many float on conditions as fragile and uncertain as those in New Orleans. They may not have abundant blue water nearby to remind them of their vulnerability but the basic circumstances are often the same-- faltering infrastructure, aging and/or diminishing population, waning tax base, severe weather events, declining resources, and the growing realization that time is not on their side. Cities that neglect the care of their basic economic and ecological footings set themselves up for swift and radical changes like those witnessed in the aftermath of Katrina.

What is the remedy?

…..the logics of ecology, culture, economics, politics and civil society –exist side by side, they cannot be reduced or collapsed into one another. Rather each must be independently decoded and grasped in its interdependencies.

Dr. Ulrich Beck, What is Globalization?

The above quote by Munich University sociologist Ulrich Beck sets the terms for a radically different thinking process and societal baseline from which to rebuild our city infrastructure. Any design methodology or development outcome needs to start with an understanding of modern-day global challenges—such as climate and demographic change, cultural differences and economic dislocation and disparities. The conventional logic of civil infrastructure engineering, which has emphasized single functions, separate projects, traditional institutional silos and uniform codes, now must be replaced by integrated design and development processes that increase interconnectedness and adjust to unpredictable risks.

Drawing inspiration from the tenets of sustainability, reflexive modernization is less concerned with expanding the resource base, but rather with re-evaluating and redeploying the resources already is use.

The word "reflexive" implies three concepts to help reshape the traditional view of infrastructure. These include:

1. Infrastructure as a **cultural repository** of memories and future hopes;

2. Infrastructure as interdependent services and support systems that form the threads of the local **safety net**; and

3. Infrastructure as a set of reciprocal transactions between civic authorities that promote the sustenance and equitable distribution of the **local common wealth**.

It is a cultural repository.

Infrastructure is a mirror that reflects our civic values, cultural identity and collective hopes for a better future. Transportation, water, power, sewer and waste systems represent an extraordinary collection of public assets and investments. Yet, as users, we rarely grasp their crucial value to our daily lives or the collective toll of our individual demands for services. Their components are buried underground, hidden behind drab paint and chain-link fences, or relegated to the poor end of town.

Before we can effectively rebuild our aging infrastructure, we must first rekindle public awareness of its central role in our collective existence. Its functional and aesthetic values determine the vitality of the urban landscape that adjoins all of our cherished homes, schools, businesses and institutions. Natural systems and utility networks need to become integral and interdependent parts of that urban landscape. As prolonged droughts threaten many regions of the world, we may begin to witness cities competing for global prominence on the basis of their stewardship of the local water resources rather than building the tallest skyscraper.

In the words of the late New York Times architecture critic Herbert Muschamp, "Instead of burying a city's vital organs out of sight, design could visualize a place for them on the cultural landscape. Into sight, into mind."

After a disaster, the affected communities often have the full attention of the nation. People want to help. While most cities have emergency plans to ensure their survival and reduce the event's terrible impacts, few have procedures in place to capitalize on the surge of disaster funds and social equity being offered to aid victims. Most of these donations are dispersed quickly with little opportunity to leverage any of this extraordinary outpouring of public generosity to help create a, equitable and "reflexive infrastructure foundation, that combines, sustainable regeneration, equitable operation, and resilient practice. Reflexive infrastructure systems cannot be created through technological innovation alone; they require a fully engaged citizenry with a strong sense of shared purpose. It takes these daily routines and celebrates them as major formal, functional and symbolic acts that gives shape and structure to the living and working environment, increasing productivity and conviviality. Sustainability's key design and development idea is to transform maintenance into a public activity that enriches the everyday routines of public spaces, buildings and landscapes. Likewise, public agencies or private companies cannot engineer the renewal of damaged systems; they need supportive citizens and customers. Active citizen participation is fundamental to daily operation of sustainable and resilient infrastructure.

Developing reflexive infrastructure begins with collecting a wide range set of data, translating that data into visual material that is accessible to the community so they can respond—either through individual efforts or as collective activities to support sustainable operations. Before the Hurricane, access to good data, maps and aerial images of New Orleans were haphazard at best and typically impossible for general public use. The city lacked the staffing, funding and impetus to develop a comprehensive digital picture of its cultural and ecological conditions. The disaster highlighted this shortcoming. Governmental and non-governmental grants have radically changed the local information scene. City officials, neighborhood organizations, academic institutions and citizens now have direct access to robust body of information. This has empowered New Orleans' non-governmental organizations with information and mapping capabilities to address precondition issues such as toxic soils and housing inequity and also to monitor recovery and rebuilding efforts.

Unfortunately, future strategies for rebuilding local infrastructure are being held behind closed doors of local utility officials working with the U.S. Army Corps, federal and state

agencies and consulting engineering firms. This activity has produced mistrust, insecurity and legitimate fears that the same old patchwork of separate silos and special interests will prevail.

It is a community safety net.

Citizens in New Orleans who are struggling to revitalize their homes and neighborhoods understand that simply patching the same old parts back together will not yield trust worthy results. Likewise, the renewal of the City's devastated infrastructure needs much more than the customary "patch & pray" approach to individual public works improvements. Since Katrina, various federal, state and local leaders, FEMA contractors and big developers have all tried to resurrect various parts of New Orleans without serious thought about the relationship of those parts to each other or the impact of these separate actions on the long-term cultural, economic and ecological life of the City. Local infrastructure providers continue to lumber along in isolation without the benefit of progressive civic vision and leadership or adequate resources—just as they did before Katrina.

New Orleans' future economic viability and security still needs a public works network that is fully legible and accountable to all citizens who depend on the safety net of their services. Without this assurance, many people feel that they cannot take the risk to stay and build a life in New Orleans. Every infrastructure investment should reinforce and vividly highlight the physical and cultural connections all of the city's neighborhoods and residents and the surrounding Delta wetlands whose natural resources sustain them all.

The traditional approach to infrastructure vulnerability and recovery is to harden defenses and focus recovery primarily on repair of big public works. For me, the term "resilience" demands the development of a distributed infrastructure that enables citizens to operate more independently, sustain themselves during service disruptions and assist the recharge of the larger systems upon return to normal conditions. This way, citizens become the first responders and more active and effective agents in recovery and the revival of the local economy.

In this finer-grained approach to infrastructure, every new urban structure or landscape

modification becomes an opportunity and responsibility to add needed value to system capacity and reduce its negative impacts. Recovery and safety can be greatly enhanced by many small lights and services instead of none. In a volatile world of changing climate and the potential for cascading infrastructure failures, the investment in sustainable distributed infrastructure will have a direct and substantial return for communities and businesses by enabling them to rebound more quickly after disasters and stay competitive in the global marketplace. The costs of being shut down for more than a few days or weeks can be catastrophic. For example, in post- Katrina interviews, local business leaders described the swift hemorrhage of top researchers and staff to other cities after New Orleans' major hospitals and bio-tech firms were flooded and destroyed.

A more reflexive and resilient infrastructure seeks to build reciprocal relationships between the center, branches and ends of all of its respective systems. As an example, heating and cooling systems in state-the-art green office buildings now include thousands of small electronic sensors that are embedded in the skin of the building and monitored by a central control computer. During the day as the sun tracks across the sky, the sensors make continuous small adjustments in internal temperature and airflow. The recognition that a building is not just a box but also a mosaic of changing thermal sub-surfaces has yielded new design approaches that lower energy costs and increase the productivity and wellbeing of building inhabitants. Every component—such as lighting or plumbing systems—are vital links of an increasingly integrated network that supports energy efficiency, alternative energy generation, water conservation, public safety and specific environmental needs of individual tenants.

Likewise, the infrastructure systems that support such buildings and the entire human-made landscape should also serve multiple goals. Besides their functional values, these varied system scan become cultural utilities and civilizing amenities that strengthen neighborhoods, job growth and local ecological systems.

Sustainable infrastructure design requires the integration of natural ecological processes into local "structural" systems. This means that infrastructure systems cannot be designed from the premise that "one size fits all urban situations." Public sector agencies and private utilities need to reach across their propriety service district boundaries to calculate

baselines and combined strategies. Power companies and urban water supply companies need to balance their demands for local water supplies with other critical needs to support healthy neighborhood streams and a cooling urban tree canopy, which help to reduce heat island effect and power demands. Power companies must also work in tandem with transportation agencies to reduce traffic congestion and air pollution; we cannot refresh our work places with open windows and local breezes if the air outside is increasingly polluted.

When the architecture of buildings, landscapes and cities begins to incorporate natural systems into design and operation, all of these elements can operate as capillaries in a major infrastructure network to continuously provide water, air, energy, communication, transportation and waste services to meet user demands with the least waste or cost to the environment.

For example, hurricane force winds stripped off the roofs of many New Orleans homes. Instead of simply replacing roofs with asphalt shingles in the customary hip roof shape, these roofs could become energy generators by using solar voltaic shingles and/or solar water heating systems. A citywide application of this idea would help residents reduce home energy bills, provide emergency energy to local citizens during the annual hurricane season, reduce overall metropolitan energy demands and jumpstart an emerging green industry with enormous job potential. In this way, end of the line users also become "generators" to support overall civic supply needs and incrementally build a comprehensive and redundant safety network of civic infrastructure. (Figure 4.)

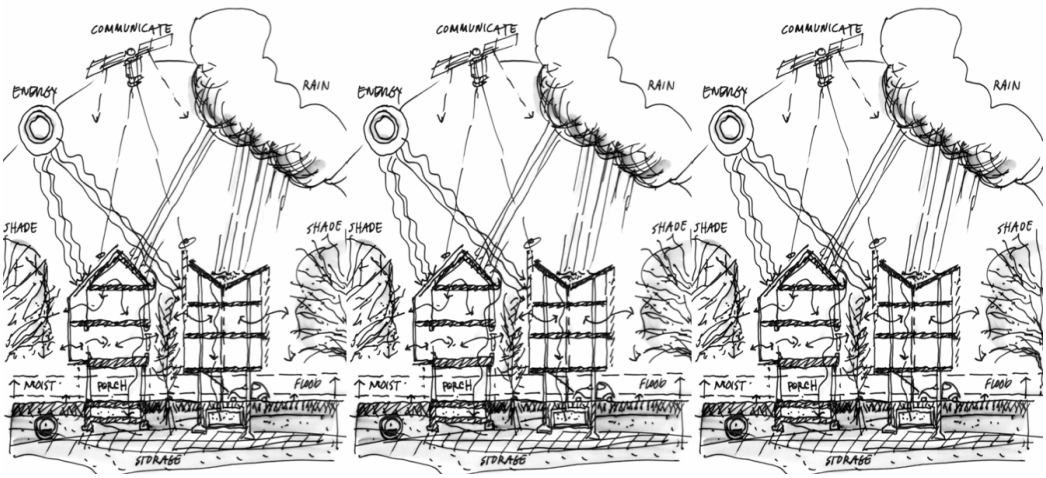

Figure 4. "Resilient and Redundant Neighborhoods"

New water and energy harvesting roofs and gardens, add up to a reciprocating looped infrastructure supply and demand network.

It is where we share our city's common wealth.

In a highly connected a global society, the words "redundancy and resilience" have become key concepts in infrastructure design as a means to reduce system vulnerabilities and risks of failure. Our daily existence and protection from extreme events such as hurricanes or major power outages depend on the ability to "switch over" to back-up or parallel networks when the main systems fail.

To convert our cities into healthier, safer and more productive and livable places, we need to see infrastructure as a second nature, an artificial urban landscape evolving with natural processes to serve the community and underscore their collective existence. (JB Jackson 1986, Cronon 1992) Infrastructure that derives its form, function and operation from a synthesis of natural and cultural processes represents a more sustainable set of systems and services with the potential of back-up resources to absorb the impact of natural or human-made disasters.

Redundancy and resilience is learning how to use landscape ecologies as a parallel system in dialogue with our built protective lines by adding and enriching local ecologies and by

reducing harmful global pollutants. In this way, urban tree forests and tidal wetlands can be seen as critical components of a city's water supply, treatment and protection system.

"The Katrina… illustrated the failure of infrastructure planning to incorporate non-structural alternatives. Wetlands were developed and, as a result, could not perform their natural function of absorbing surge water flows."

(CSIS 2006)

In New Orleans, the surrounding deltaic wetlands serve as the first line of defense to protect the city from the devastating impact of storm surges. Each mile of wetland reduces the height of a storm surge by one foot with a corresponding decrease in the required height and width of constructed earthen levees. These natural buffers also provide a nursery for its robust local seafood industry. But the traditional planning and engineering processes still view wetlands as peripheral to the levees and other structural elements of the formal urban flood protection system. In the engineering lexicon, natural and cultural systems are known as "non-structural alternatives." Many engineers view their use as evidence of weaknesses in the preferred engineered solution. Others in the land development and construction fields are more openly hostile since non-structural solutions may significantly reduce the scale and profitability of certain projects.

New Orleans' dramatic loss of canopy trees after Katrina is not unique; in the last 25 years, Washington, D.C. has lost over 60% of its tree canopy, exposing city residents to increased heat, storm-water flooding and neighborhood decline. In cities that are exposed to heavy summer downpours, the presence of a thick "green canopy" of assorted trees is another critical extension of the local storm water management system. Without them, pipes become quickly overwhelmed, causing local flooding. The oak canopy catches rainfall in its leaves and branches slowing the water as it falls to the ground. Tree roots absorb water and protect neighborhoods from wind damage.

The destruction of the urban canopy is rarely ever regarded as major urban infrastructure issue, even though numerous scientific studies demonstrate the cost effectiveness of healthy tree canopies for reducing water pollution, air pollution, children's illnesses and

neighborhood crime. However, in both New Orleans and Washington, D.C, community based organizations such as Replant New Orleans and the Casey Tree Fund have taken up this critical issue. Specifically, the Casey Tree Fund has created a citywide GIS based urban tree inventory and trained local youth to monitor and care for old and newly planted trees in their neighborhoods. Meanwhile, community groups in Sacramento, California have begun an aggressive campaign for a citywide "infrastructure" project to add thousands of trees on public and private property to enhance the city's skyline reduce heat island effect in the summer and generally promote a more amenable civic environment.

Most urban water supply and treatment facilities tend to follow generic designs with little adaptation to local cultural or ecological conditions. Specific site conditions or topography that complicate design intentions are simply "corrected" (with lots of bulldozing) to conform to prevailing technology standards, resulting in steep increases in projects costs, energy and other resource demands, and unintended environmental impacts. Yet, conventional engineering wisdom still maintains that mixing structural and nonstructural systems into hybrid and custom tailored solutions is too costly to build and operate—without considering the full spectrum of hidden costs caused by "one-size-fits-all" solutions.

The key lesson is that natural system and ecological processes are both "structural" components of sustainable infrastructure. Whether they are constructed from concrete and steel or consist of roots, leaves and mudflats, they can be organized to reinforce each other and provide the capacity to flex with constant environmental changes. The products from this type of design development can be tailored not only to meet the specific local needs and site conditions but also to educate users on how to maintain and utilize their system through its entire life cycle. After construction project plans become ongoing user manual as that are continually updated as conditions change or new information becomes available.

In the end reflexive infrastructure shapes and supports a city's basic everyday "second nature"—the economic and ecological flows that nurture the local place and connect the locale into the global environment. (cronon 1992). The systems are environmentally

sustainable, equitability networked, and resilient or accommodating to cultural and ecological succession, because they provide the public realm or spaces of community voice. It is sets the terms of basic civil security and citizen inclusion. As John Paul Lederarch writes:

"Voice requires a localness of context and space within which people feel the vibration of sound……In these levels of meaning voice as the metaphor suggests other key aspects of health found primarily in the need to feel close enough to processes that affect daily personal and collective life so that a sense of meaningful conversation is actually possible. Voice necessarily requires a context of community, localness of spatial distance where participation and dialogue create directed experiences of connections, exchange and responsiveness."

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