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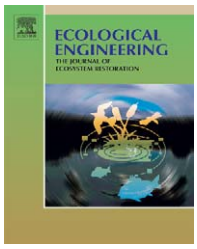

Editorial

Creating a sustainable and desirable New Orleans☆

1. A crisis of sustainability and the need for a new vision

Hurricane Katrina has been estimated to be the largest natural disaster ever to strike the United States. It was certainly a tragedy of enormous proportions, but it also raises broader questions about how the region should be restored (Bohannon and Enserink, 2005) and about the vulnerability and sustainability of coastal regions worldwide.

The Federal government has pledged over US$ 100 billion for the New Orleans and Gulf coast region to be rebuilt after this terrible (but predictable) tragedy. The question is not *if* but *how* it should be rebuilt. What was there can simply be replaced, but this would merely be setting the pins up to be knocked down again by a future big hurricane, the destructive powers of which are increasing worldwide, probably due to global warming (Webster et al., 2005; Emanuel, 2005). In addition, sea level is rising and New Orleans continues to sink, making the city even more vulnerable over time.

What is needed is a new vision of a truly *New* Orleans—one that can provide a sustainable and high quality of life for *all* of its citizens while it works in partnership (not in futile opposition) with the natural forces that shaped it. This *New* Orleans can serve as a metaphor and a model for the sustainable development of western industrial society more generally.

2. What happened in New Orleans?

New Orleans being devastated by a major hurricane was unfortunately both predictable and predicted.[1] While the immediate reaction to massive flooding caused by the levee overtopping and breeching showed an apparent lack of disaster planning, the hurricane damage itself could only have been prevented by actions taken years in advance. It was apparent from many studies in the past 50 years that New Orleans was becoming a more vulnerable city with each passing year. The wetlands surrounding New Orleans that previously provided protection from storm surges have been lost at a rate as high as of 100 km^2 (39 $miles^2$)/year, and barrier islands were rapidly eroding as well. These lost wetlands and islands were the only thing between New Orleans and the open ocean. 4800 km^2 (1800 $miles^2$) of wetlands have been lost since the 1930s due to a combination of land subsidence, sediment deprivation due to levee construction, sea level rise, and oil and gas exploration and extraction activities (Day et al., 2005). The blanket of freshwater, sediments, and nutrients from the Mississippi River Basin that used to spread across the Louisiana delta no longer does, as the heavily managed Mississippi River was forced to dump most of its load off the continental shelf into the deep waters of the Gulf of Mexico. It is not only the sediments that help build coastal marshes; the freshwater counteracts salt water intrusion and nutrients spur organic soil formation—the major way that new soil is formed in the delta. When the river flow is not delivered to the wetlands to counteract subsidence and sea level rise, the wetlands disappear along with their storm protection function. The Atchafalaya River, a branch of the river that now carries one third of the flow of the Mississippi demonstrates this point. This river discharges into shallow waters of the delta and has both built new deltaic lands and protected a large area of existing wetlands in the central Louisiana coast. The mainstem Mississippi river was managed to allow deepwater shipping and commerce in the New Orleans region and to stop flooding of developed areas, but this management regime ultimately devastated the city.

The net result was that the people who lived below sea level in New Orleans were in more danger every year as the river

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[1] There are a large number of reports in both the academic and popular press which predicted scenarios very close to what happened in New Orleans, including a special section in the New Orleans Times-Picayune titled "Washing Away" (June 23–27, 2002), a National Public Radio 2 part series in October, 2003, and M. Fischetti. Drowning New Orleans. *Scientific American*, Oct 2001.

passed them by, the surrounding wetlands disappeared, and their levees continued to strain with age and more hydrologic demands. So what happened in New Orleans, while a terrible natural disaster, was also the ultimate result of excessive and inappropriate management of the Mississippi River, inadequate preparation, a failure to act in time on plans to restore the wetlands and storm protection levees, and the expansion of the city into increasingly vulnerable areas. These areas are now (but were not always) below sea level. Up until the first quarter of the 20th century, the city was mostly above sea level. It was the drainage of the wetlands that promoted soil oxidation and rapid subsidence.

A well-conceived plan called the Louisiana Coastal Area (USACOE, 2004; Orth et al., 2005) project for the restoration of the wetlands surrounding New Orleans would have reversed the trend of continuing wetland loss. This plan may now be in jeopardy if priorities shift to civil engineering solutions of levees and pumps instead of ecologically engineered solutions of wetland restoration and sensible human settlements. The US$ 14 billion that was estimated to be needed for this "natural engineering" may well be swallowed up by the reconstruction of the city to its former design. Perhaps most importantly from a viewpoint of sustainability, all of this rebuilding of the city's hydrologic defenses is occurring in a climate of reduced availability and increased costs of conventional energy sources. (Roberts, 2004; Campbell and Laherrere, 1998). In a future irony, Louisiana and the rest of coastal America, will probably be subjected to increased storm intensity and sea level rise due to climate change, which is itself partly the result of the burning of fossil fuels (Watson et al., 2001), a large fraction of which came from coastal Louisiana.

3. What is the real economy and what is it for?

Before discussing options for restoring New Orleans, we need to discuss some options for how to think about the process. What are we trying to restore and why? The purpose of the economy *should be* to provide for the sustainable well-being of people. That goal encompasses material well-being, certainly—but also anything else that affects well-being and its sustainability. There is substantial new research on this "science of happiness" that shows the limits of conventional economic income and consumption in contributing to well-being (Kasser, 2003; Easterlin, 2003; Layard, 2005). These studies show that well-being tends to correlate well with health, level of education, and marital status, and not very well with income. Layard (2005) concludes that current economic policies are not improving happiness and that "happiness should become the goal of policy, and the progress of national happiness should be measured and analyzed as closely as the growth of GNP." There is also substantial and growing evidence that natural systems contribute heavily to human well-being. It has been estimated that the annual, non-market value of the earth's ecosystem services is substantially larger than global GDP (Costanza et al., 1997). The recent UN Millennium Ecosystem Assessment (http://www.millenniumassessment.org) is a global compendium of ecosystem services and their contributions to human well-being.

So if we want to assess the "real" economy – all the things which contribute to real, sustainable, human welfare – as opposed to only the "market" economy, we have to measure the non-marketed contributions to human well-being from nature, from family, friends and other social relationships at many scales, and from health and education. One convenient way to summarize these contributions is to group them into four basic types of capital that are necessary to support the real, human-welfare-producing economy: built capital, human capital, social capital, and natural capital.

The market economy covers mainly built capital (houses, factories, offices, and other built infrastructure and their products) and part of human capital (spending on labor), with some limited spillover into the other two. Human capital includes the health, knowledge, and all the other attributes of individual humans that allow them to function in a complex society. Social capital includes all the formal and informal networks among people: family, friends, and neighbors, as well as social institutions at all levels, like churches, social clubs, local, state, and national governments, NGOs, and international organizations (Putnam, 2001). Natural capital includes the world's ecosystems and all the services they provide. Ecosystem services occur at many scales, from climate regulation at the global scale, to flood and storm protection, soil formation, nutrient cycling, recreation, and aesthetic services at the local and regional scales (Costanza et al., 1997). Because of its enormous size (about 25,000 km^2) and productivity, the Mississippi delta is one of the most concentrated areas of natural capital in North America. This is reflected in the largest fishery and most important flyway terminus in the U.S., abundant fish and wildlife, high water cleansing ability, and high storm protection services.

4. New Orleans as metaphor and model for a sustainable and desirable future

The built capital of New Orleans has been radically depleted and must be rebuilt. We can recreate the vulnerable and unsustainable city that was there, or we can reinvent New Orleans as a model of a sustainable and desirable city of the future. To do this, we need to redesign and restore not only the built infrastructure, but also the social, human, and natural capital of the region. How do we do this and what would a truly sustainable and desirable New Orleans look like? Here are some of the elements of a sustainable vision:

1. *Let the water decide*: Building a city below sea level is always a dangerous proposition. While parts of New Orleans are still at or above sea level, much of it had sunk well below sea level since the first quarter of the 20th century. It is not sustainable or desirable to rebuild these areas in the same way they were before. They should be either replaced with coastal wetlands which are allowed to trap sediments to rebuild the land (see below), or replaced with buildings that are adapted to occasional flooding

(i.e., on pilings or floats). Wetlands inside the levees can help clean waters, store short-term flood waters, provide habitat for wildlife, and become an amenity for the city. Coastal wetlands outside the levees should be rebuilt so that the city has both wetlands and levees to protect the city.

2. One should *avoid abrupt boundaries* between deepwater systems and uplands. Gentle slopes with wetlands are the best division, and avoid putting humans, particularly those who have few resources to avoid hydrologic disasters, in harm's way. Of course the abrupt boundaries of the levees are necessary, since wetlands alone cannot protect the city, but we need to use both as appropriate.
3. *Restore natural capital*: Coastal wetlands in Louisiana have been estimated to provide US$ 375/acres/yr (US $940/ha/yr—these and all subsequent figures have been converted to US$ 2004) in storm and flood protection services (Costanza et al., 1989). Hurricane Katrina has shown this to be a large underestimate. Restoring Louisiana's coastal wetlands and New Orleans levees has been estimated to cost US$ 25 billion. Had the original wetlands been intact and levees in better shape, a substantial portion of the US$ 100 billion plus damages from this hurricane probably could have been avoided. Prevention would have been much cheaper and more effective than reconstruction. In addition, the coastal wetlands provide other ecosystem services which when added to the storm protection services have been estimated to be worth about US$ 5200/acres/yr (US$ 12,700/ha/yr) (Costanza et al., 1997). Restoring the 4800 km^2 (480,000 ha) of wetlands lost prior to Katrina would thus restore US$ 6 billion/yr in lost ecosystem services, or US$ 200 billion in present value (at a 3% discount rate).
4. In order to do this we should use the resources of the *Mississippi River to rebuild the coast*, changing the current system that constrains the river between levees, and allow the resources of freshwater, sediments, and nutrients to flow into the deeper waters of the Gulf. Diversions of water, nutrients, and sediments from the Mississippi are a major component of the LCA plan. These planned diversions should be greatly expanded in order to allow more rapid restoration of the coastal wetlands. Levees are necessary in some locations, but where possible the levees should be breeched by structures in a controlled way to allow marsh rebuilding.
5. We should restore the built capital of New Orleans to the highest standards of *high-performance green buildings* and a car-limited urban environment with high mobility for everyone. New Orleans has abundant renewable energy sources in solar, wind, and water. What better message than to build a 21st-century sustainable city running on renewable energy on the rubble of a 20th century oil and gas production hub. In other words, New Orleans should be built higher, stronger, much more efficient, and designed to make extensive use of renewable energy. One can imagine a new pattern for the residential neighborhoods of New Orleans with strong, multistory, multifamily buildings surrounded by green space, each with enough water and fuel storage for several weeks, and operating principally on wind and solar energy.
6. We should rebuild the social capital of New Orleans to 21st-century standards of diversity, tolerance, fairness, and justice. New Orleans has suffered long enough with social capital dating from the 18th (or even the 15th) century. To do this the planning and implementation of the rebuilding must *maximize participation* by the entire community. This will certainly be difficult for a number of reasons, including the historical antecedents of racism and classcism in the region, and the fact that much of the population has been forcibly removed from the city (Cutter et al., 2003). But it is absolutely essential if the goals of a sustainable and desirable future are to be achieved.
7. Finally, we should *restore the Mississippi River Basin* to minimize coastal pollution and the threats of river flooding in New Orleans. Upstream changes in the 3 million km^2 Mississippi drainage basin have significantly changed nutrient and sediment delivery patterns to the delta. Changes in farming practices in the drainage basin can improve not only the coastal restoration process, but also improve the nation's agricultural economy by promoting sustainable farming practices in the entire basin (Mitsch et al., 2001; Mitsch and Day, 2006).

5. Conclusions

The restoration of New Orleans and the rest of the Mississippi delta can become another disaster waiting to happen, or it can become a model of sustainable development. If it is the latter, it can be a truly unique inspiration to billions of people around the world. What better way to say to the world "look at what can be accomplished" than to create a sustainable and desirable city shining like a jewel on the Mississippi, where all the streetcars run on renewable energy and are named "desirable."

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Robert Costanza*
Gund Institute of Ecological Economics,
Rubenstein School of Environment and Natural Resources,
617 Main Street,
The University of Vermont, Burlington,
VT 05405-1708, USA

William J. Mitsch
Schiermeier Olentangy River Wetland Research Park,
School of Environment and Natural Resources,
352 W. Dodridge Street,
The Ohio State University,
Columbus, OH 43202, USA

John. W. Day Jr.
Department of Oceanography and Coastal Sciences,
School of the Coast and Environment,
Louisiana State University,
Baton Rouge, LA 70803, USA

* *Corresponding author*. Tel.: +1 802.656.2974.
E-mail address: Robert.Costanza@uvm.edu
(R. Costanza)

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