THE CIP REPORT

CRITICAL INFRASTRUCTURE PROTECTION PROGRAM VOLUME 6 NUMBER 10

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School of Law

CRITICAL INFRASTRUCTURE PROTECTION PROGRAM

In this issue of *The CIP Report*, the impact of the environment on critical infrastructures is highlighted. The environment plays a significant role in factors that affect the protection of assets and overall security of the United States because it is so susceptible to man-made and natural disasters. This vulnerability forces the private and public sectors to take a serious look at the environment when thinking about critical infrastructure protection (CIP). The United States has become more conscious of the environment in general, taking steps to better protect it so that some of the problems of today will not worsen or could even be remedied in the future.

Some of the efforts underway to help understand environmental impacts are presented in an article from the University of North Carolina at Chapel Hill about the Center for Natural Disasters, Coastal Infrastructure, and Emergency Management (CNDCIEM). This article describes the new Homeland Security Center of Excellence's work and research on coastal hazards and resilience. In another contribution, the National Infrastructure Simulation and Analysis Center (NISAC) explains its modeling, simulation, and analysis capabilities that allow for better understanding of environmental factors that can affect critical infrastructure and the relationships across sectors. James Madison University (JMU) provides an article on its research on environmental security, which focuses on environmental factors that threaten critical infrastructure and how added attention to environmental security can enhance CIP.

This issue also features an article on how a mapping and modeling tool, the geographical information system (GIS), is used to assess areas with rising sea levels and what impacts changes in sea level will have on critical infrastructure. Another article illustrates the importance of vegetation management to ensure electric reliability. This month's *Legal Insights* focuses on environmental law and policy in regards to CIP. Lastly, a reminder of next month's 2nd National Conference on Security Analysis and Risk Management, which the CIP Program is co-hosting, is included.

We hope you enjoy this month's theme as we observe the importance of our environment on April 22, Earth Day.

Center for Natural Disasters, Coastal Infrastructure and Emergency Management

The Center for Natural Disasters, Coastal Infrastructure and Emergency Management (CNDCIEM) is structured to conduct innovative research on coastal hazard resilience and translate the knowledge developed into practice. The Center achieves its mission by establishing four research focus areas: 1) Coastal Hazard Modeling; 2) Enhanced Resilience of the Built and Natural Environment; 3) Preparedness and Response Policy and Operations; and 4) Planning for Resilience (see Figure 1). Core research is facilitated, advanced and disseminated through three cross-cutting integrating programs: 1) Advanced Information Systems; 2) Education; and 3) Engagement and Extension. The development of data management tools supports research in all focus areas and provides the vehicle through which research findings are transferred to practitioners. Education and engagement activities provide linkages to current and future generations of scholars and practitioners.

The dual mission of creating knowledge and advancing practice is also achieved through the Center's management structure. An advisory board, comprised of hazard scholars and practitioners, is tasked with the assessment of proposed research projects, the evaluation of outreach and training efforts and assisting in the identification of additional resources beyond those provided by the Department of Homeland Security to sustain the Center. The Center is designed to develop a robust, sustained research agenda that is used to advance our knowledge base and aid stakeholders affected by natural hazards and disasters.

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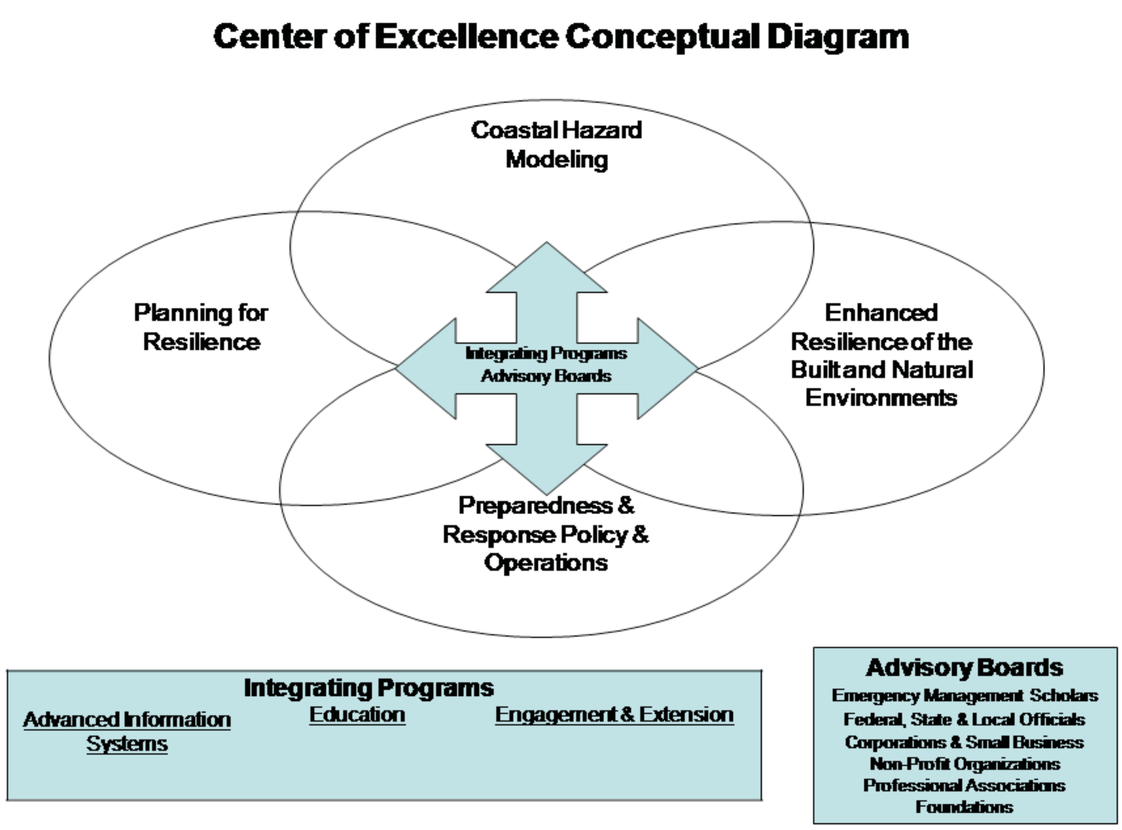


Figure 1: Center of Excellence (COE) Research Structure Diagram

CNDCIEM *(Cont. from 2)*

Description of Overall COE Objectives

The CNDCIEM draws on the rich intellectual and institutional capabilities of higher education and practice, building on a proven record of collaborative, large-scale and complex research programs and accomplished hazard and disaster practitioners. Taking the lead is the University of North Carolina at Chapel Hill (UNCCH), given its strong basic and applied research in natural hazards, coastal management, marine science, climate change, planning, public policy and public health. A Research I institution, UNCCH had over $593 million in sponsored research funding in FY 2006. Understanding the complexities of natural hazards, disasters and the means to create, sustain and manage resilient coastal communities, UNCCH and its national partners are poised to deliver solutions to the Department of Homeland Security and coastal stakeholders.

Coastal Resilience is defined as the capacity to lessen the impact and recover or bounce back from shock to social, economic and environmental systems. Resilience is achieved by engaging in activities designed to increase the capacity of social, economic and environmental systems to absorb this shock and still retain their basic structure and function.[1]

Center Overview

Through basic and applied research, the development of new technologies and decision support tools and education and engagement with the private sector, federal, state and local government agencies and community leaders, the CNDCIEM focuses on the themes of: 1) Natural Hazard Resilience; 2) Regional Land and Water Resource Management; 3) Public Sector Preparedness/Coastal Infrastructure and Regional Planning; and 4) Governance and Resilience. The CNDCIEM establishes four areas of research supported by three integrative programs (see Figure 1). The **Coastal Hazards Modeling** focus area emphasizes the study of the physical science of coastal hazards to understand the meteorological, hydrological, geophysical and other characteristics of hazards that occur along our coasts, develop improved models to assess their behavior and test these models in order to predict impacts on human settlements and natural systems. The **Enhanced Resilience of the Built and Natural Environments** focus area emphasizes the interaction between coastal hazards and the built and natural environments to promote an improved understanding of how coastal infrastructure, including natural systems, can be designed or managed to facilitate resilience. The **Preparedness and Response Policy and Operations** focus area examines the human reaction to natural hazards and disasters, emphasizing the means to understand risk perception and communication of that risk to stakeholders, including underserved populations. The **Planning for Resilience** focus area designs and tests risk-based planning and decision-support tools through the development of an integrated set of resilience indicators, assessing the current state of planning as a means to increase resilience, and studies existing pre- and post-disaster institutional frameworks and their ability to facilitate hazard resilient communities.

(Continued on Page 13)

Mission: The Center for Natural Disasters, Coastal Infrastructure and Emergency Management (CNDCIEM) focuses on advancing understanding of coastal hazard resilience and transferring that knowledge into action, resulting in reduced loss of life or injury, and lessened damages to the built and natural environment.

Vision: 1) To expand understanding of hazard science through rigorous interdisciplinary research focused on coastline resilience; 2) To develop a translational model that moves knowledge into practice using IT products, education, extension and training methods reflecting the diversity and needs of targeted audiences; and 3) To become a self-sustaining organization, leveraging opportunities fostered through Center partnerships.

[1] Committee on Disaster Research in the Social Sciences, National Research Council. 2006. Facing Hazards and Disasters: Understanding Human Dimensions. Washington, D.C.: National Academies Press.

Critical Infrastructure Protection Decision-Making & Policy Resources National Infrastructure Simulation and Analysis Center

Introduction

The National Infrastructure Simulation and Analysis Center (NISAC) is a Congressionally-mandated program which serves as a "source of National expertise to perform critical infrastructure protection" research and analysis. Consisting of approximately 100 personnel at Sandia and Los Alamos National Laboratories, as well as management and outreach staff located in Washington D.C., NISAC performs analyses of critical infrastructure and key resources (CIKR) including their interdependencies, vulnerabilities, consequences, and other complexities under the direction of the Department of Homeland Security's Office of Infrastructure Protection (IP).

NISAC employs a range of models and simulations to address infrastructure protection needs. However, researchers are continually developing new capabilities to deal with changes to the threat environment. NISAC applies a combination of process-based system dynamics models, network agent-based optimization models, economic models, and physics-based models.

A 5-year plan guides most NISAC activities, subject to annual Congressional appropriations. Because funding is limited, projects are prioritized by the Assistant Secretary for Infrastructure Protection and all NISAC tasking requests are coordinated through the Program Management Office.

NISAC and the Infrastructure Protection Community

NISAC provides strategic, multidisciplinary analyses of interdependencies and the consequences of infrastructure disruptions across all CIKR sectors at National, regional, and local levels. NISAC has extensive modeling, simulation, and analysis (MS&A) capabilities which can be used alone or in combination to carry out analysis in four primary functional areas including:

- Long-Term Studies of High-Priority CIKR Issues
- Incident Response
- Preparedness Exercise Participation
- Infrastructure Criticality Analysis

In-depth, pre-planned studies on such topics as hurricanes, pandemic influenza, the chemical

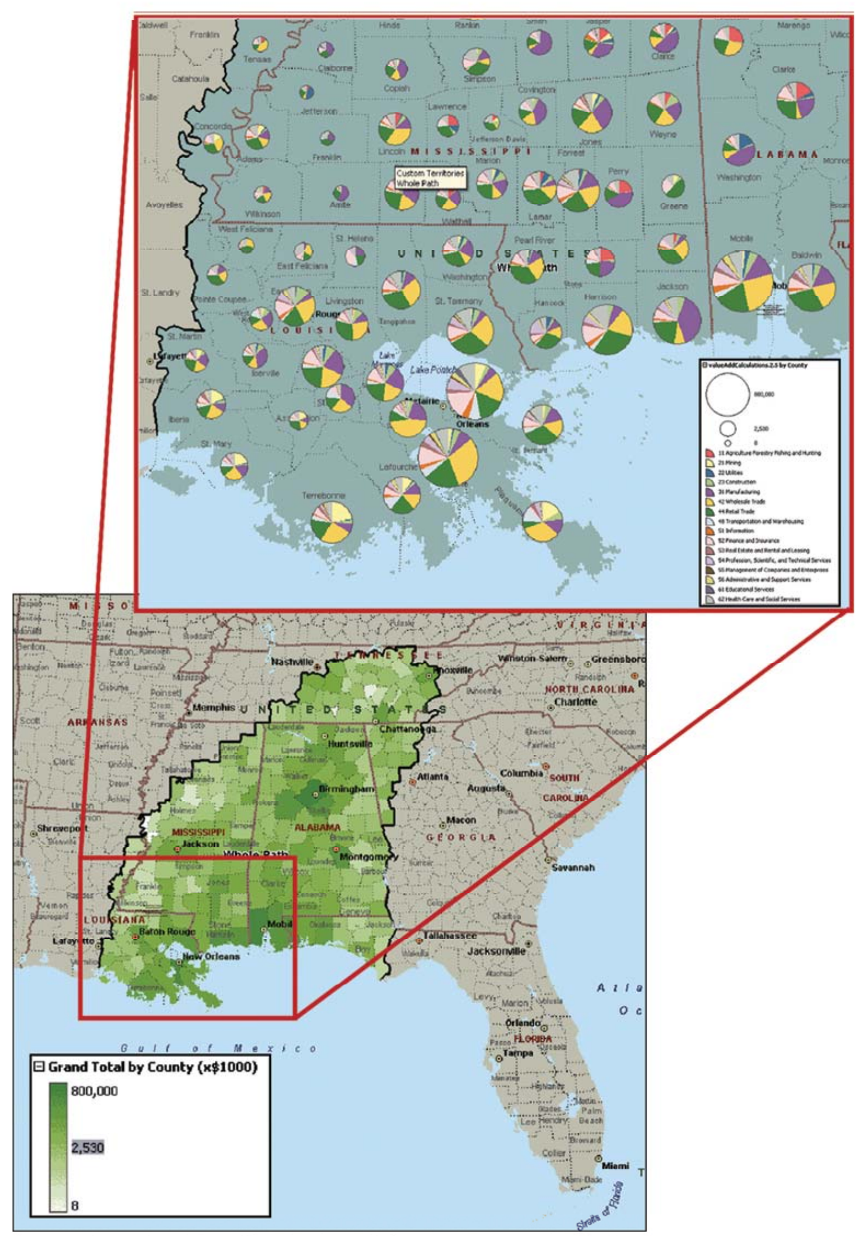
(Continued on Page 5)

Legislation Guiding NISAC's Mission Space

- **The 2001 USA Patriot Act** established the requirement for the National Infrastructure Simulation and Analysis Center (NISAC) with the chief mission being "to serve as a source of national competence to address critical infrastructure protection and continuity through support for activities related to counterterrorism, threat assessment, and risk mitigation."

- **The Department of Homeland Security Appropriations Act of 2007** requires that NISAC provide: "modeling, simulation, and analysis of the systems and assets comprising critical infrastructure, in order to enhance preparedness, protection, response, recovery, and mitigation activities." The Act also directs that NISAC share information – particularly vulnerability and consequence analysis – with Federal agencies and departments with critical infrastructure responsibilities.

NISAC *(Cont. from 4)*



Representation of economic loss due to Hurricane Ivan by county (shades of green) and industrial sector (disks)

supply chain, and dams and dams systems provide infrastructure owners/operators and policy decision-makers with an understanding of the interdependent relationships between multiple sectors and the potential for unforeseen effects occurring in other sectors. NISAC's mix of sector- or asset-focused and highly-aggregated analyses illustrate the inextricable linkages between multiple sectors, and add visibility to the critical nodes that serve as the "touch-points" between sectors.

Incidents of regional or National importance, such as hurricanes and the California wildfires, sometimes prompt short turn-around requirements from DHS leadership for perspective not necessarily available to those engaged in the incident management process. The NISAC Fast Analysis and Simulation Team (FAST) provides quick turn-around analysis of incidents of National importance with a primary focus on cross-sector and economic impacts to aid in leadership decisions related to the event, as well as long-range recovery.

NISAC participates in government preparedness exercises, reviews exercise scenarios during the planning stages, and provides integral feedback to planners. NISAC was a central player in TOPOFF III and IV, Ardent Sentry Exercises, and other National-level exercises.

NISAC Analyses

NISAC predominately engages in consequence assessment and impact research and analysis. Each year, NISAC produces several major reports or analyses with hundreds of individual tools or sub-projects required to facilitate the completion of key planned and unplanned tasks. Several NISAC studies reflect how natural or manmade incidents affect the surrounding landscape including the availability of resources, population shifts, and consequence of loss.

NISAC uses a 2-phase approach to model and analyze hurricane damage to CIKR:

- Off-season preparation which includes post-hurricane season lessons learned, implementation of improvements, and immediate preseason preparation

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Reframing Critical Infrastructure Protection: C-IT EnviroSec: Critical Infrastructure Threat Environmental Security

by Benjamin T. Delp and Coryn Giordano, James Madison University

Presented here are excerpts of an original research report by James Madison University students Benjamin Delp and Coryn Giordano titled *Reframing Critical Infrastructure Protection: C-IT EnviroSec: Critical Infrastructure Threat Environmental Security*, a report of the Institute for Infrastructure and Information Assurance (April 2008).

Introduction

Six days. Imagine if the authorities had six days notice before the 9/11 attacks on New York and Washington. Six days notice on the identity of the perpetrators, what planes would be hijacked, and the location of the targets. Six days notice on the location of the perpetrators and not just where they were the day before, but all possible locations of where they might be the next day. Imagine just how fast the Intelligence Community would have responded to halt the operation that killed more Americans than the attack at Pearl Harbor. Six days was the time between the formation of Hurricane Katrina and its landfall on the Gulf Coast. Despite six full days of information possessed by meteorologists and disaster officials, the emergency procedures in place were not up to the task of defending New Orleans and the U.S. Gulf Coast.

Since the end of the Cold War, threats from natural disasters and terrorism have been constantly evolving, creating new opportunities for critical thinking to develop solutions to counter the forces that spread instability. Natural disasters such as the earthquake in Pakistan, Hurricanes Katrina, Rita, and Wilma, and the tsunami in the Indian Ocean have significantly changed the way emergency preparedness officials view the destructive power of the earth. The rise of Osama bin Laden and al-Qaeda in the 1990s, culminating in what many believe to be a transition into a 4th generation of warfare (Shultz and Vogt 2003, 5), has presented numerous challenges to the military and intelligence establishments of the United States.

One way of combating these new threats is through environmental security. The Woodrow Wilson International Center for Scholars (Wilson Center) maintains the Environmental Change and Security Program (ECSP), which publishes the ECSP report on environmental security issues. Within Issue 11 of the ECSP report is an article by Rear Admiral John F. Sigler, USN (Ret.), who uses the environmental security definition of Center for Strategic Leadership scholars B. F. Griffard and K. H. Butts, reproduced here as, "an integrated proactive approach that ensures the protection, preservation, and restoration of the environment, including air, land, water, biodiversity, natural resources, and people, from natural and manmade disasters that might contribute to instability and conflict" (Sigler 2005, 51). The Institute for Environmental Security's website, an international non-profit organization operating out of the Hague since 2002, attributes four elements to environmental security:

1) The environment is the most transnational of transnational issues, and its security is an important dimension of peace, national security, and human rights that is just now being understood;

2) Over the next 100 years, one third of current global land cover will be transformed, with the world facing increasingly hard choices among consumption, ecosystem services, restoration, and conservation and management;

3) Environmental security is central to national security, comprising the dynamics and interconnections among the natural resource base, the social fabric of the state, and the economic engine for local and regional stability; and that,

(Continued on Page 7)

C-IT EnviroSec *(Cont. from 6)*

4) While the precise roles of the environment in peace, conflict, destabilisation and human insecurity may differ from situation to situation and as such are still being debated in relation to other security and conflict variables, there are growing indications that it is increasingly an underlying cause of instability, conflict and unrest.

While these definitions are specific to environmental policy abroad, there is no reason for environmental security not to have an application in the United States. Few would argue against a strategy ". . . that ensures the protection, preservation, and restoration of the environment" in America.

Few would argue against a strategy ". . . that ensures the protection, preservation, and restoration of the environment" in America.

There are numerous threats to critical infrastructure in the United States. Natural resources comprise a significant portion of critical infrastructure sectors. Higher education, think tanks, private corporations, and the U.S. military have provided environmental security (EnviroSec) and critical infrastructure protection with a considerable amount of attention in recent years. As a result, the authors will focus on those critical infrastructure threats that contain environmental factors, thus merging CIP with EnviroSec. This method takes into consideration the above-mentioned post-modern challenges, and seeks to present a fresh, innovative approach to prepare for both natural disasters and terrorist acts against critical infrastructure with a focus on the natural environment. While a broad examination would undoubtedly be useful, the authors' focus will concentrate on preparing for natural disasters and terrorism using the tenets of EnviroSec applied to critical infrastructure protection. The benefit of analyzing natural and manmade threats to critical infrastructure when the natural environment plays a significant role is a more robust critical infrastructure system assured by an increased emphasis on maintaining a clean and resilient natural environment. The product of incorporating natural and manmade threats into CIP with a focus on environmental security is *Critical Infrastructure Threat Environmental Security* or *C-IT EnviroSec*.

As previously stated, the focus of this examination requires a natural environment factor. The requirement of a natural environment component not only reframes the challenge of critical infrastructure protection, but it brings together stakeholders who are not usually present during the planning process – environmentalists and critical infrastructure protection specialists. If CIP has taught the United States anything in the last ten years, it is that significant decreases in vulnerability are not possible without including as many stakeholders and academic disciplines as possible. Placing those possessing environmental resource knowledge with critical infrastructure protection planners will increase the likelihood of developing useful protective strategies to prevent critical infrastructure system failures from natural disaster and terrorist attacks.

Natural Disaster Scenario

The natural disaster scenario comprises a large component of C-IT EnviroSec. In this case, either pre-event environmental factors contribute to a greater natural catastrophe, or the natural disaster event itself creates an environmental factor that contributes to critical infrastructure failure. The first scenario explains Hurricane Katrina where the natural environment played two roles. Not only did the winds and rain pummel New Orleans, leading to numerous infrastructure failures, but the erosion of wetlands and the environmental degradation around New Orleans served as a precursor to the event, which exacerbated the effects of the hurricane.

James Lee Witt: A Positive Case

When analyzing the case of floods, the actions of former Federal Emergency Management Agency (FEMA) director, James Lee Witt, serve as a positive example for

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Rising Sea Levels and Critical Infrastructures: Using Geographic Information Systems to Plan for the Future

by Michael Ebert, Principal Research Associate, and Joe Maltby, Law Intern

Rising sea levels along the coastline is a fact, based on measurements going back to 1894. The scientific consensus today is that there will be a change in sea levels as a result of volumetric increase in the world's oceans caused by thermal expansion and ice melt. In short, more water, and warmer water, means more ocean. Most scientists expect sea level rise to accelerate during this century and beyond due to increasing levels of greenhouse gases, primarily carbon dioxide, in the atmosphere. Uncertainty exists, of course, in just how much sea levels will rise and how fast. (ICF International, *The Potential Impacts of Global Sea Level Rise on Transportation Infrastructure: Phase 1 - Final Report: the District of Columbia, Maryland, North Carolina and Virginia*, 12 December 2007.) However, the danger is real. In February 2008, the Wilkins Ice Shelf in Antarctica lost a chunk of ice 160 square miles in size, more than seven times the size of Manhattan. Scientists now worry that the entire shelf may fall into the ocean.

This scientific consensus is not absolute. There are still dissenters who warn, perhaps rightly, that the fears of a massive sea level rise have been exaggerated. Predicting the outcome of gradual changes 50 years in advance is a tricky business. The current range of possibilities extends from a low-risk outcome affecting little infrastructure all the way to a "Waterworld" style post-apocalyptic future. However, for those unconvinced that rising sea levels pose a threat to infrastructure, it is worth remembering that, given the rate of erosion, the coastline is going to move even if sea levels remain absolutely constant. Additionally, even if the expected mean of sea level increase changes slightly, that translates to a larger change for the outcomes at either extreme based on that mean.

The three basic remedies for rising sea levels are barriers/protection (e.g., sea walls, levees, "pumping sand against the sea"), elevation of infrastructures, and retreat (i.e., abandon areas seriously inundated). Planners will use a combination of these three, though some are more appropriate than others based on the situation. As one would expect, the abandonment option is rarely exercised, given its political unpopularity. The situation in New Orleans perfectly illustrated the dangers in building near or below sea level and behind levees, yet there is little political support for relocating the city.

But what is threatened by coastal movement and sea level rise? Given the vast geographic size of the United States, it might be surprising to learn the extent of coastal development. The distribution of both existing development and expected new development will center in the coastal regions of the United States. As of 2003, 53 percent of Americans lived in coastal counties, a 14 percent change from 1990. Specifically, the total population in coastal regions was 153 million people in 2003, up from 148.3 million people in 2000 and 133.4 million people in 1990. Roughly speaking, the coastal population has grown by approximately one percent a year. Eighty-three percent of economic activity, 81 percent of jobs, and 82 percent of the U.S. population reside in the coastal states, even though they only represent 21 percent of U.S. land mass. (National Academy of Sciences, *Disasters Roundtable,* Roundtable Workshop 19, "Protecting Lives and Property at Our Coastlines," 28 March 2007.)

Most of the population of the United States is concentrated near the coastline and population growth in coastal areas is expected to accelerate as compared to the interior of the country. It is not surprising that much of the Nation's critical infrastructures are in coastal areas that will be either inundated by sea water or significantly at risk of flooding due to changes in storm surges and flood plains. Transportation infrastructures such as ports, airports, roads and railroads, tunnels, and bridges will be at risk. Other critical infrastructures at particular risk in coastal areas are in the energy, water, nuclear power, and chemical CI/KR sectors. We single out these five sectors because of the long lead times required to build

(Continued on Page 9)

Rising Sea Levels *(Cont. from 8)*

such infrastructures and the long "shelf life" such assets have once they enter into service. In cases where rising sea levels will compromise assets and particular facilities, a substantial amount of time may be required to dismantle assets and perform environmental remediation of abandoned sites. There are infrastructures which can be easily packed up and moved. These categories are not among them.

As a recent study conducted for the Department of Transportation's Center for Climate Change and Environmental Forecasting on the impacts of sea level rise on infrastructure noted, at least 25,000 people live on land about one meter from the existing high water mark, though the actual figure is likely greater. In the Mid-Atlantic Region alone, between three and ten percent of the total population live on land within one block of an area at least partially within 100 centimeters of the existing high water mark. This puts large swathes of infrastructure at risk, including railways, ports, and highways. For the states of North Carolina, Virginia, and Maryland and the District of Columbia alone, approximately 3,500 kilometers of highways and 1,390 kilometers of railway are at risk under a medium-risk scenario of 48.5 centimeters of sea level rise. (ICF International, 12 December 2007.) As illustrated in the figure on page 16, the Norfolk, Virginia area, home to a port, railways, highways, and numerous military installations, could be at great risk. Preparation for these risks is crucial to compensating for them.

The science of geography is used in making an enormous range of decisions in the field of critical infrastructure protection, from mapping existing assets to emergency planning to modeling locations for new facilities. A tool that is becoming indispensible to those working in or with CI/KR is a geographic information system (GIS). GIS provides integration of hardware, software, and data, including geographically-referenced information ("geodata"), which allows data to be visualized and interpreted. GIS is more than a simple mapping tool because it has many more problem-solving capabilities. The modeling functions of GIS provide information transformation tools that take existing geodatabases, apply assumptions, new data, and analytic rules, and visualize the results. Over the past decade, GIS has been used to model complex issues such as rising sea levels, future trends and probabilities, and potential impacts on critical infrastructures.

It is one thing to be able to quantify long-term changes, but using that data to model possible outcomes and compare different trends is a leap forward in disaster planning made possible by these information tools. Especially since, as is often the case, the effects of these different phenomena are interrelated. For

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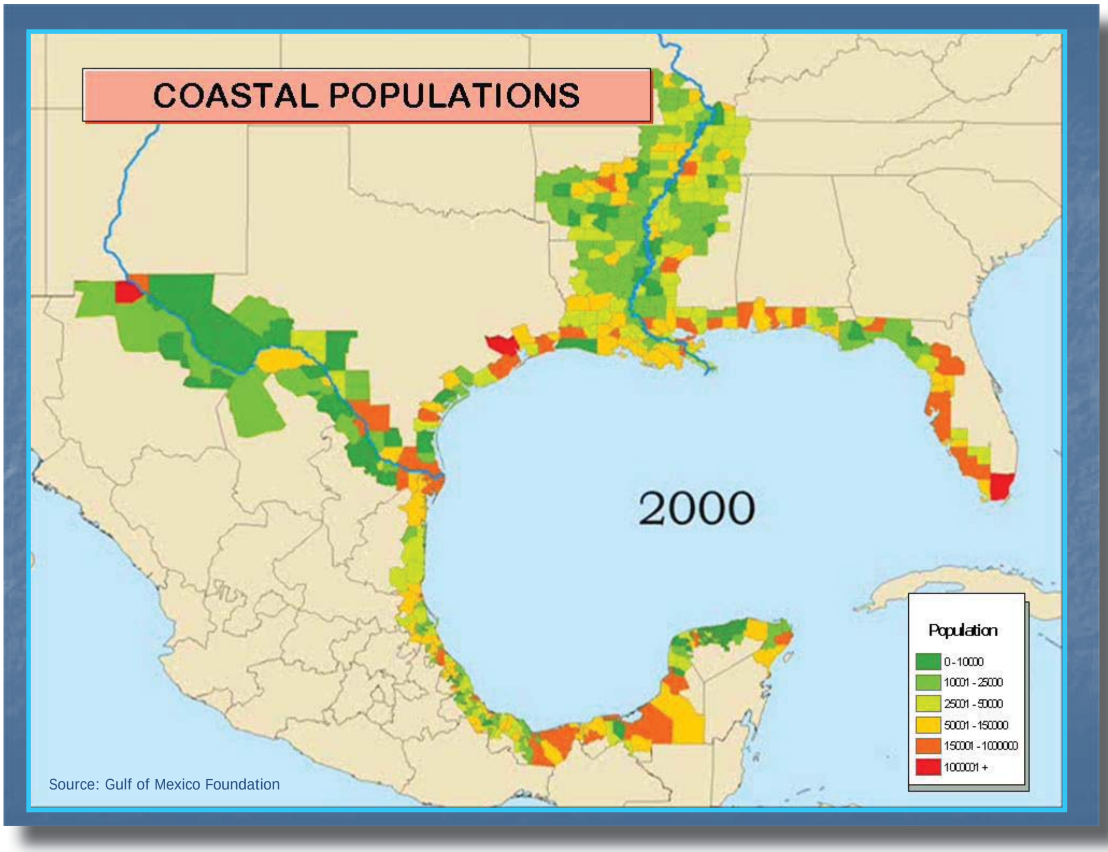


Source: Paul L. Kelly, National Academy of Sciences, *Disasters Roundtable*, Roundtable Workshop 19, "Protecting Lives and Property at Our Coastlines," 28 March 2007

Butterflies and Cascades: Ensuring Electric Reliability Through Vegetation Management

by Joe Maltby, Law Intern

There is a well-known expression in the sciences describing a situation where a small initial action can have large, if not massive, downstream effects. Like a series of billiard balls colliding with each other, each event's impact is magnified by the following event. This is the "butterfly effect." This is a simple concept that helpfully illustrates the problems that come from trying to control the outcomes of even relatively simple events, much less finding the root causes of complex occurrences.

A real-life illustration of this principle is the 2003 blackout. In August 2003, vast swathes of the Midwest and Northeast United States as well as portions of Canada went dark. Power outages struck Ohio, Michigan, Pennsylvania, New York, Vermont, Massachusetts, Connecticut, and New Jersey. It was a dangerous and unexpected event, which also caused millions of dollars in damages and repair costs. The disaster was so bad that the American and Canadian governments agreed to create a joint task force to discover its root cause and recommend solutions.

What did this investigation uncover? As the final report issued by the investigating commission indicates, the initial cascading failure, where several small interruptions began to have substantially larger impacts on the network as their consequences wormed their way through the grid, was caused by a series of trees coming into contact with nearby power lines. From Ohio, these little system failures spread like wildfire until over a quarter of the country was consumed with blackness.

There is a direct connection between the events of 2003 and the mandatory reliability standards contained in the Energy Policy Act of 2005. This traumatic experience of a system unprepared to deal with failures of this magnitude created an urgent drive for improvements in oversight. This movement culminated in the passage of the Act, which gave the North American Electric Reliability Corporation (NERC) the authority to implement mandatory reliability standards through an Electric Reliability Organization. In a way, this is another demonstration of the butterfly effect, as small events can have large-scale political consequences as well.

Learning to prevent these small but important failures is a central problem standing in the way of implementing viable mandatory reliability standards. A systemic approach to such implementation means an approach that oversees the entire system, which includes every power line susceptible to outages caused by environmental issues such as overgrown vegetation. This translates into an investment in trucks, cutting equipment, and workers, as well as a commitment from the utilities who own the lines to regularly expend money perform-

(Continued on Page 11)

Electric Reliability *(Cont. from 10)*

ing safety and maintenance activities. Any funds expended on safety programs does not go to the bottom line, which reduces the utilities' incentive to act.

The same issues are present where hurricane-ravaged states choose to implement electric infrastructure hardening programs. In storm-prone areas, trees and sometimes the lines themselves are blown over. When a windstorm knocks a tree branch into a power line, an outage is the result. Numerous measures can be taken to strengthen the electric infrastructure where another hurricane is expected to hit in order to lessen the amount of damage it will incur. Some of these measures are discussed in the CIP Program research report Critical Electric Power Infrastructure Recovery and Reconstruction: *New Policy Initiatives in Four Gulf Coast States After 2005's Catastrophic Hurricanes* and its subsequent cumulative updates. They include burying power lines underground, building transmission towers to resist higher winds, replacing distribution poles more often, and initiating more frequent vegetation management cycles. This last item reflects the dilemma which spurred the 2003 blackout and contributed to the damage from Hurricanes Katrina, Rita, and Wilma.

Small decisions can have large consequences. The decision by power companies to spend less money trimming trees and brush around power lines and to do it less often saved money in the short term, but it ended up costing them much more in the long term. This is not to assert that improved vegetation management cycles are a completely uncontroversial solution. Land owners and environmentalists often voice concern over vegetation management programs, though for different reasons. Environmentalists are concerned about the impact on the plants, while landowners dislike allowing their local power company to drive up and down their property. These objections are valid, but vegetation management is necessary to guaranteeing the electricity that these same landowners rely upon, and the environmental damage from a forest fire sparked by a power line surely outweighs concerns raised by trimming.

Now that both the federal and state governments are paying more attention to hardening electric infrastructure and guaranteeing a certain level of reliability in power delivery, these smaller issues are receiving a second look. Instituting improved vegetation management practices is a simple step which can save thousands, if not millions, of dollars and hundreds of man-hours down the line. Everyone has probably seen one of these vegetation management crews cutting back trees near power lines at least once. Their ubiquitous presence has made them invisible. Yet this is the process which is being used to save lives, property, and money. Protecting against the small causes of large, cascading environmental effects will end up protecting us and the critical infrastructure we depend on. As in so many other areas of life, big things turn out to be really just a cluster of little things. ❖

Vines growing on power poles are dangerous and illegal.

Legal Insights

What Environmental Science, Law and Policy Can Tell Us about Critical Infrastructure Protection

by Timothy P. Clancy, JD, Principal Research Associate for Law

If you drive north on New York State Route 28 through the Central Adirondacks you will see dazzling lakes and quiet ponds, ancient tarns left by the gouging of the ice caps over 11,000 years ago. Along the way, one will see forests of Northern White Pine that flourish in the sandy, rocky soil of the northern mountains. Increasingly, these woods are filled with huge stands of conifers completely stripped of their needles from the bottom up, as if by the hand of a giant.

This is not the work of a giant but of acid rain, fog and snow — precipitation filled with nitric and sulfuric acids produced from the burning of fossil fuels and in particular coal. Ejected into the atmosphere these acids drift with upper air currents and fall back to earth hundreds and thousands of miles away from their source — mostly coal-fired power plants in the Midwest in the case of the acid rain falling on the Adirondacks.

Those beautiful lakes — there are over 2,800 in the Adirondack Park — mask another devastating effect of acid rain: over 500 are classified as dead, supporting little or no aquatic life due to abnormally low pH levels, close to the pH of vinegar.

In economic terms, the environmental problem of acid rain is a classic example of a *negative externality* — when the marketplace doesn't adequately capture the costs of an activity. With acid rain, those receiving benefits from coal-fired power in the Midwest do not pay the full cost of damage caused by emissions (pollution) falling outside their region. Consequently, there is little incentive for the power plant owners to invest in clean emission technologies.

What does this have to do with critical infrastructure protection? Actually a lot. Negative (and positive) externalities abound in CIP. All of society would bear the terrible costs of a catastrophic attack on a critical infrastructure, not just the owners and operators. Just like the example of acid rain where power plant owners lack incentives to invest in cleaner technology, there are often inadequate market incentives for critical infrastructure owners to invest in better security since they will not bear the full costs of a catastrophic attack. Many experts have noted that in cases where private markets do not provide an adequate level of security, a mix of market-based incentives, minimum standards, insurance and third-party inspection are warranted.[1]

Again acid rain provides an interesting case study for such an arrangement; the Clean Air Act Amendments of 1990 (CAAA) established minimum national standards for sulfur dioxide emissions (nitrogen oxides were not covered) and allowed companies that produce emissions below the standard to sell credits to those companies with emissions above the standard. This approach has led to dramatic reductions in emissions, a robust private market of emissions trading and greater innovation and adoption of cleaner technologies — all at a tenth of the cost estimated when the law was passed.[2] Even better, the ancient, fragile Adirondack ecosystem is slowly recovering from the

(Continued on Page 19)

[1] Critical Infrastructure Protection and the Private Sector: The Crucial Role of Incentives, Peter R. Orszag and Joseph A. Pechman, The Brookings Institution, Testimony before the Subcommittee on Cybersecurity, Science, and Research & Development and the Subcommittee on Infrastructure and Border Security, House Select Committee on Homeland Security, September 4, 2003. http://cipp.gmu.edu/archive/353_BrookingsOrszagCIPtestimony0903.pdf.

[2] Acid Rain Control: Success on the Cheap, Richard A. Kerr, *Science*, November 6, 1998: Vol. 282. No. 5391, p. 1024.

CNDCIEM *(Cont. from 3)*

Three integrative programs support the research of the four focus areas and translate that research into action. The programs are Advanced Information Systems, Education and Engagement and Extension. The **Advanced Information Systems** program provides advanced information and geospatial technology underlying all focus area research. The **Education** program builds on existing models and creates new tools and programs to educate primary and secondary students at the high school, community college and university levels about emergency management and coastal resilience. An aim of this program is to educate the current and next generation of emergency managers, hazards practitioners and scholars, emphasizing the need to reach out to underrepresented populations. The **Engagement and Extension** program focuses on training and outreach activities aimed at transferring knowledge generated through interdisciplinary focus area research into materials that are used to train practitioners, including but not limited to emergency managers, federal, state and local government officials and their staff, business owners, the insurance industry, professional associations, elected officials, non-profit organizations, community groups and individuals.

Summary and Conclusion

The Center for Natural Disasters, Coastal Infrastructure and Emergency Management is designed to conduct innovative interdisciplinary research on coastal resilience and translate the findings into practice through the use of integrative programs. The mission of the Center is accomplished by leveraging a unique combination of hazard scholars and practitioners residing in a number of research institutions, agencies and organizations across the nation. The University of North Carolina and its national team of researchers, IT specialists, education and extension experts and practicing emergency management professionals stand ready to assist the Department of Homeland Security achieve its aim of making coastal communities more resilient to the impacts of coastal hazards and disasters. It is the intent of the Center to grow over time, addressing all natural hazards. ❖

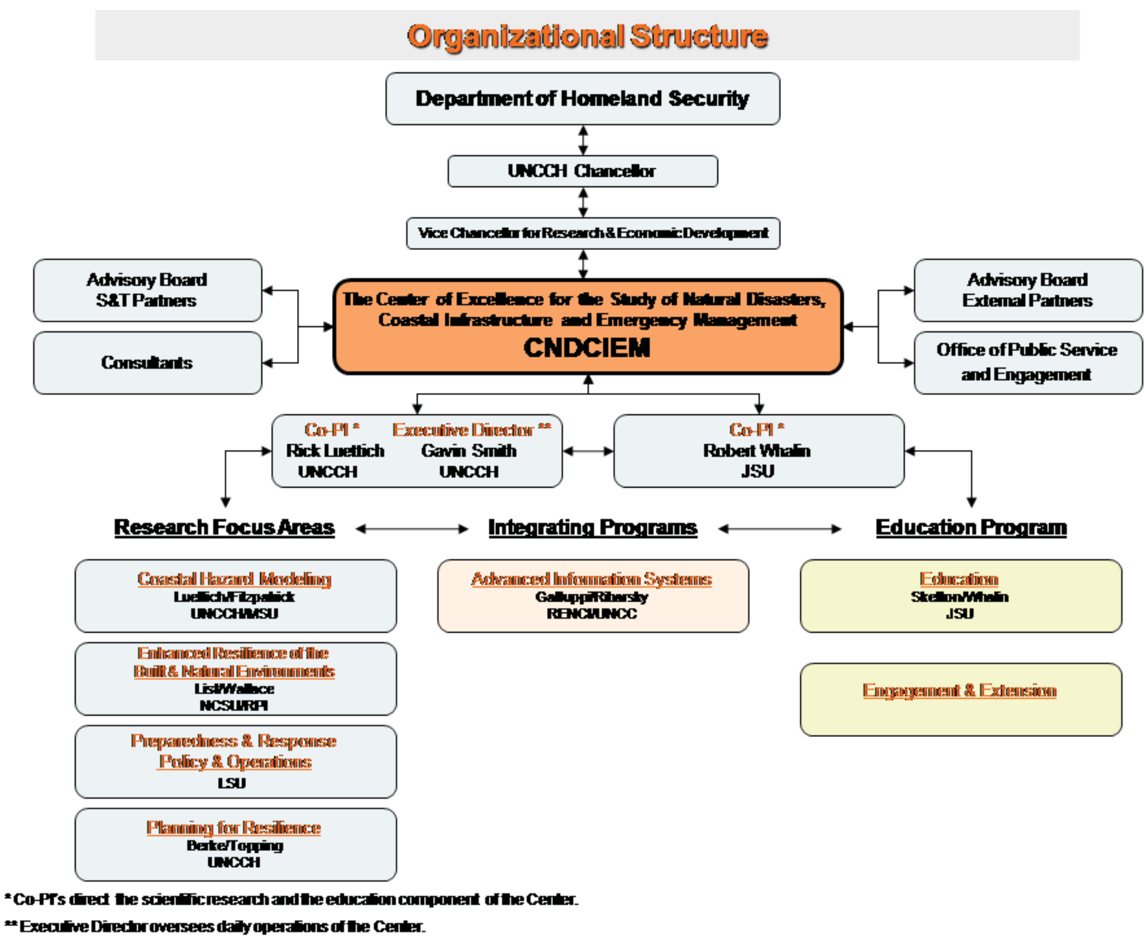


Figure 2: The CNDCIEM Organizational Chart

NISAC *(Cont. from 5)*

- Storm-related activities that include imminent pre-storm activities and post-hurricane landfall analysis

Storm-Related Activities

NISAC develops analyses for storms predicted by the National Oceanic and Atmospheric Administration (NOAA) to make landfall greater than Category 2 in strength. The Center reports findings to the National Operations Center, the National Infrastructure Coordinating Cell, the Federal Emergency Management Agency National Incident Management System Integration Center, and other consumers via the Homeland Security Information Network.

Damage impact analyses, carried out by the NISAC Damage Forecast Team, begin as a hurricane moves toward shore. Longer term projections of storm effects (e.g., 1 week, 6 months, and/or 1 year after landfall) take place 2 days before landfall. These analyses provide both public and private sector decision-makers with estimates and forecasts to assist in the immediate recovery and longer-term enhanced infrastructure planning efforts.

Subsequent to hurricane landfall, the NISAC Damage Forecast Team transforms into the NISAC Damage Analysis Team, which transitions to utilizing actual damage information to refine post-hurricane assessments and create tailored infrastructure recovery projections. Similar capabilities and procedures are under development for a variety of other significant events potentially affecting CIKR. ❖

NISAC Timeline for Hurricane Support (L=Landfall)

- **L-7 to L-4 Days (Pre-landfall)**
  - Storm monitoring
  - Category 2 or above:
  - Activate NISAC Damage Forecast Team
- **L-4 to L-3 Days**
  - Category 3 or above:
  - L-96 Hour Preliminary Forecast Report
  - L-72 Hour Preliminary Forecast Report
- **L-2 Days**
  - L-48 Hour Pre-landfall Hurricane Analysis Report
  - 2-Page Summary Report
  - Activate NISAC Damage Analysis Team
- **L-2 to L-1 Days**
  - Updates to 48-Hour Pre-landfall Analysis Report
  - Post-landfall:
  - Monitor and analyze damage assessment impacts on critical infrastructure and key resources

C-IT EnviroSec *(Cont. from 7)*

protecting critical infrastructure in terms of natural disasters. Witt's leadership in emergency management began in 1988 under then-Governor of Arkansas Bill Clinton. Witt was appointed as the head of the Arkansas Office of Emergency Services and successfully reorganized the state's emergency management process. When Clinton took office as President in 1993, he appointed Witt as the director of FEMA.

In 1993, the Midwest was plagued by extreme floods. Nine states experienced major flooding from May through September. Hundreds of levees were broken along the Mississippi and Missouri Rivers, thousands of people were evacuated for months, and many lost their homes. At least 10,000 homes were destroyed, while at one point 75 towns were completely submerged. Fifteen million acres of farmland were destroyed in a single year, a majority of which requiring extended periods of time for recovery. Estimates of the damages attributed to the floods were $15 billion with an unacceptable amount of human losses of at least 50 victims (Larson 1996).

Many critical infrastructures were destroyed or impaired as a result of the floods. Transportation was extremely limited as many highways and roads were inoperable. For two months, barge traffic was stopped on the Mississippi and Missouri Rivers. Most bridges providing passage out of major midwest cities were either impassable or not safely accessible. Ten airports flooded and all railroad traffic throughout the Midwest ceased. Many sewage and water treatment plants were destroyed, increasing the amount of taxpayer dollars necessary for rebuilding (1996).

Witt saw this disaster as an opportunity to organize an efficient mitigation program to save future tax dollars as well as future homes and lives. He began developing a plan during the mid-1990s reorganization of FEMA. The goal of the plan was to prevent another disaster like the 1993 floods in the same midwest area that is typically plagued by disaster. Witt put in a proposal to then-President Clinton for a voluntary buyout relocation and elevation program.

The aggressive program pursued by Witt was property acquisition and relocation for the area most severely affected by the flood waters. Properties that were repeatedly flooded because of their location were purchased and the former owners were relocated to safer grounds. This project was titled "Project Impact" (Witt 1998). FEMA worked closely with the Department of Housing and Urban Development (HUD) to initiate the program as soon as possible.

In 1995, floods of 1993-level severity impacted the same midwest area that was decimated two years earlier. When the floodwaters receded, minimal property was affected and taxpayers were saved millions of dollars though Project Impact's successful mitigation plan. When asked by Congress to perform a cost-benefit analysis on the program, Witt complied and found that every dollar that was spent on Project Impact saved between $3 and $5 in future losses (FrontLine 2005). This type of preventative strategy could easily be applied to different areas suffering from similar problems throughout the country. The innovative actions of James Lee Witt and FEMA were successful in preventing future disasters in the Midwest. Not only were lives saved, but the wetlands were preserved and allowed to assume their sponge-like role of soaking up excessive rainfall as nature intended (James Lee Witt Associates 2005).

Conclusion

While government agencies and the private sector have utilized innovative methods to safeguard the critical infrastructures absolutely necessary for American society to function, there are steps that can be taken to improve upon the current condition. Environmental scientists and biologists study water quality monitoring systems. Zoologists and biologists study animal pathogens. Economists and government agencies assess the impact when natural and malicious events compromise the natural environment, including when the natural environment just so happens to include a critical infrastructure. Motivating the many academic disciplines to strive together toward the human cause of safeguarding the natural environment will undoubtedly strengthen the critical infrastructure protection systems currently in place.

While the environmental terrorism threat is unpredictable and can strike virtually anywhere, the natural environment has proven to be somewhat predictable in recent

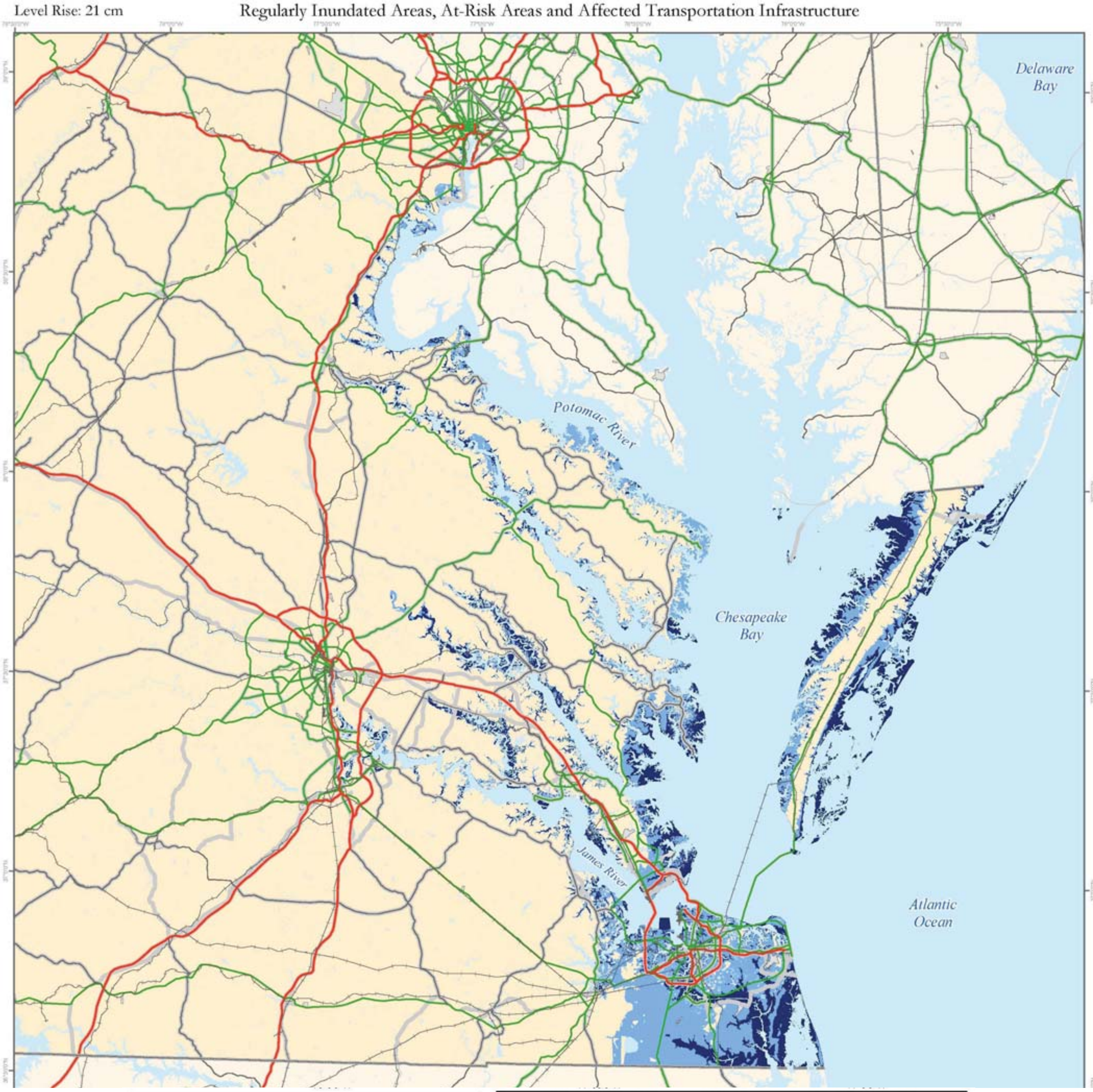
(Continued on Page 19)

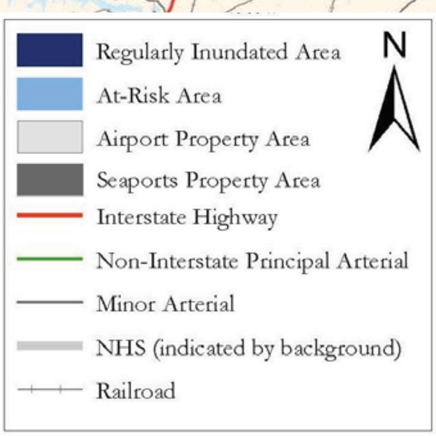
Rising Sea Levels *(Cont. from 9)*

Eustatic* Sea
Level Rise: 21 cm

Virginia

Regularly Inundated Areas, At-Risk Areas and Affected Transportation Infrastructure





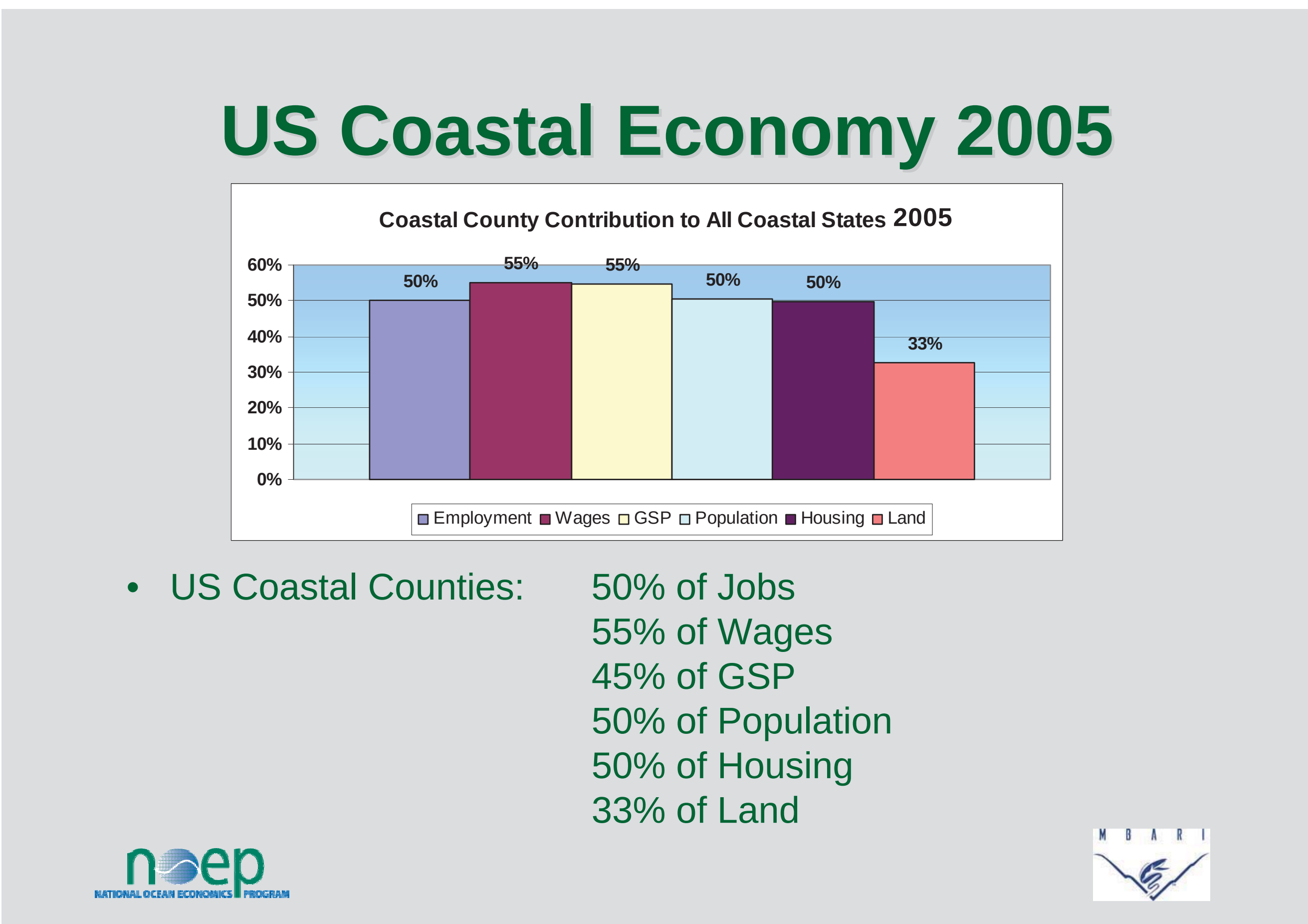
Potentially Impacted Transportation Network Type	Inundated	At-Risk
Roads (km)		
Interstate Highways	22.8	130.6
Non-Interstate Principal Arterials	66.4	429.8
Minor Arterials	8.2	43.1
National Highway System Features	74.1	437.4
Other Transportation Types (km)		
Railroads	78.2	443.6
Potentially Impacted Land Area (acres)		
Total Impacted Area	444,633	673,101
Airport Property Area	1,230	2,749
Airport Runway Area	129	295
Ports Property Area	378	937

(Continued on Page 17)

Rising Sea Levels *(Cont. from 16)*

example, the data needed to plan bridge construction and repairs in advance includes an estimation of sea level rise and an estimation of the salinity of the water. The more salt in water, the faster it corrodes metal and concrete. But changes in sea level will affect the salinity of sea water. It is impossible to estimate the second without knowing the first. Yet this knowledge is crucial in designing structures which are expected to last over a long period of continuous exposure to water. There is also the political aspect of these developments. Considering the public outcry when one bridge collapsed in Minneapolis (though the collapse was not coastal), one can only imagine the reaction to the news that bridges, roads, water and power installations, chemical installations, and "plain vanilla" developments are collapsing into the ocean up and down both coasts. And this is only one example of the interplay of shifting environmental conditions affecting coastal settlements. Planning and response decisions will not be made in a vacuum.

GIS data is not perfect. As the old computer programming saying goes, "Garbage in, garbage out." Anyone who has used one of the simplest and most widely accessible casual satellite imagery programs on the market will notice that some areas are very well mapped out and some are almost blank. As more and more of the Earth is repeatedly surveyed, this data problem will lessen in significance. One solution is to incorporate additional data from other sources as a cross-referencing device. For example, a study of coastal developments could be bolstered with GIS data cross-referenced with weather forecasts and census data. (D. James Baker, National Academy of Sciences, *Disasters Roundtable*, Roundtable Workshop 19, "Protecting Lives and Property at Our Coastlines," 28 March 2007.) The CIP Program is currently conducting research into the use of various data sets to bolster the accuracy of GIS as a disaster planning tool. ❖



Source: Judith T. Kildow, National Academy of Sciences, *Disasters Roundtable*, Roundtable Workshop 19, "Protecting Lives and Property at Our Coastlines," 28 March 2007

Upcoming Conference Reminder

The CIP Program is co-hosting, with the Security Analysis and Risk Management Association (SARMA), the 2nd National Conference on Security Analysis and Risk Management from May 13-15, 2008 in Arlington, VA. Please see the below for an invitation to this upcoming conference.

For additional information, visit http://www.sarma.org/events/conference/.

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- Experts on analysis of terrorist, counterintelligence, criminal and other threats
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C-IT EnviroSec *(Cont. from 15)*

years. Experts understand the conditions necessary for a wildfire or a tornado to form. Winter storms and hurricanes are monitored and analyzed days in advance. Even with the research already conducted on natural hazards and the ensuing disasters, the natural environment can wreak havoc on American critical infrastructure systems when the balance between nature and man is not respected. A comprehensive look at America's cities that are at risk of natural disaster must be completed in order to identify areas where the ability of natural protective barriers (wetlands, forests, river beds) to shield communities has been incapacitated.

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Legal Insights *(Cont. from 12)*

reduced emissions, but full recovery could take nearly 100 years.[3]

Simply using the analogy of environmental law in the context of CIP is often taboo among some in the private sector. This is a misplaced fear — raising the example of the environment does not mean that excessive command and control government regulations for CIP are right around the corner. On the contrary, much has changed since the 1970s as environmental law is undergoing great shifts particularly with greater integration of science and risk into environmental decision-making.[4] Indeed there is much CIP practitioners can learn by taking a fresh look at case studies — both positive and negative — from over 40 years of environmental jurisprudence, science and policy development. ❖

[3] Adirondack Lakes Recovering from Acid Rain, *Environmental Science and Technology*, The American Chemical Society, April 17, 2003.
[4] Law, Science, and the Environment Forum: A Meeting of the Minds, Daniel J. Rohlf and Elizabeth C. Brodeen, *Environmental Law*, November 2007: Vol. 37, Issue 4, pp. 931-934. http://www.lclark.edu/org/envtl/objects/37-4_Symposium_Intro.pdf.

The CIP Program works in conjunction with James Madison University and seeks to fully integrate the disciplines of law, policy, and technology for enhancing the security of cyber-networks, physical systems, and economic processes supporting the Nation's critical infrastructure. The CIP Program is funded by a grant from The National Institute of Standards and Technology (NIST).

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