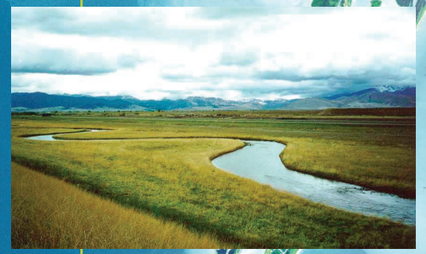
EARTH'S SURFACE DYNAMICS



Background: Mississippi River Delta. Image taken 5/24/2001 by ASTER, the Terra Satellite's Advanced Spaceborne Thermal Emission and Reflection Radiometer. *Image: USGS National Center for EROS and NASA*

Inset photo left by Dan Marshall

Inset photo lower right by Jon Chapman

NATIONAL CENTER FOR EARTH-SURFACE DYNAMICS NCED

THE SURFACE IS THE ENVIRONMENT

Human beings erect disciplinary boundaries—and nature ignores them. "When you see how biological systems interact with physical systems like flowing water and the channels it shapes, you simply can't disentangle these things," says Chris Paola, director of the National Center for Earth-Surface Dynamics (NCED), headquartered at the University of Minnesota (UMN).

"If you want to come up with real, predictive tools for managing the environment, especially if you're interested in the long time scales that are implied by sustainability; if you want to understand a system and what makes it tick, and work with natural tendencies instead of against them, you can't get around the fact that these different aspects that we divide up into biology and chemistry and physical processes are all put together," says Paola. "Nature doesn't separate them."

The center is focused on understanding how the Earth's surface changes over time from a multidisciplinary point of view. The approach involves everything from hydrology—the flow of water over the surface and the transport of particles and the shaping and sculpting of the surface—to ecology and the social sciences that address how the fate of the Earth's surface is intimately interwoven with the life on it.

It's a job that's "way too big for anybody," laughs Paola. "But increasingly, the most ambitious problems are ones that cross disciplines, that require a sustained effort, and involve a wide range of people because they're simply large problems."

The mission of the center is something to which many people can easily relate but may have a hard time articulating. "If you ask the members of the public what the environment is, it's very hard to pin down," says Paola. "A lot of people use it interchangeably with ecology, because people are fascinated with life.

"But the landscape, the form of the land that we see around us, and in particular the dynamism of the land, is intimately connected with the life on it. They influence each other—for example, the way soil is created at the microbial level and the distribution of channels on a river delta like the Mississippi are all influenced by the interaction of the physical surface and life.

"We say: the surface is the environment. That's our mantra."

What does this approach enable researchers to do that they couldn't do otherwise? "You can predict how the environment will respond to changes, like climate change, or human activities such as mining, industry, logging, reforestation," says Paola.

When you log a piece of terrain, for example, or allow regrowth of forest on a logged area, you change not just the way it looks but also the amount of sunlight that reaches the streams, the amount of sediment that's delivered to the streams, and those things in turn affect the populations of all kinds of organisms, including fish.

"To some extent perhaps what the public sees is 'fish' or 'salmon,' but what they may not realize is that those salmon are the tip of an iceberg that includes not only other elements of the food chain but also the physical environment that the salmon inhabit. And that environment is dynamic." □

TRANSFER OF TOOLS

Methods to calculate the movement of sediment might sound like mere mud pies to some people, but it's an important outcome of center research.

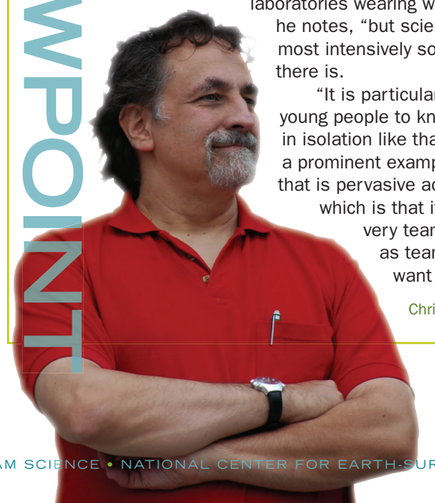
"As humble as it may be, sediment is what a lot of the world is built on," notes Paola. Knowing how fast it flows from one place to another is critical to understanding how the earth's surface evolves—and how long, for example, a reservoir will remain in service, what will happen to the lake behind a dam, or how fast you could fill in drowned marsh land in a place like the Mississippi Delta.

The Army Corps of Engineers is expected this year to adopt some of NCED's sediment transport tools, which means the technology would become part of the national standards for calculating the flow of particles in rivers.

FROM THE DIRECTOR

VIEWPOINT

Chris Paola



"When I interact with the public, particularly kids, they don't understand science is not done in isolation," says NCED director Chris Paola. "Most people think that scientists work by themselves in laboratories wearing white lab coats," he notes, "but science is one of the most intensively social disciplines there is.

"It is particularly important for young people to know we rarely work in isolation like that. The STCs are a prominent example of something that is pervasive across science, which is that it is very social, very team-oriented. It's as team-oriented as you want it to be."

Chris Paola, NCED Director

NEWS WATCH

RESEARCHERS UNLOCK THE MISSISSIPPI DELTA'S ANCIENT PAST TO CHART A COURSE TOWARD RESTORATION

Private Data Derived from Years of Oil Exploration Transferred to NCED for Research

The recent history of the Mississippi Delta region is more than meets the eye, says NCED director Chris Paola.

"It's not just about levees failing; it's not only a story about inadequate construction; and it's not just bad luck that a large hurricane happened to cross near New Orleans," he observes. "The story is intimately connected with the fact that we have allowed the loss of a great deal of delta surface area through sinking of the sediment column and drowning of the surface that hasn't been replaced by natural sedimentation."

Flying over the delta, you can see the effect of drowning of the surface in the form of enormous areas of dead and dying marsh and trees. "We need to understand the fundamental natural processes if we are to devise a long-term, sustainable plan," Paola believes. "Any place you are concerned about sustainability of the environment, you have to think about dynamism of the entire surface itself, whether it's a salmon stream in the Pacific Northwest, an urban stream in Baltimore, or the Mississippi Delta."

Paola is working with many colleagues inside and outside the center to develop tools to support sustainable restoration of the delta. Involved are researchers from Tulane University, the University of Louisiana–Lafayette, Louisiana State University, the U.S. Geological Survey, and the U.S. Army Corp of Engineers.

New insights may come from an unprecedented data set that is being made available to the center by oil companies, which have collected detailed information about the subsurface by bouncing sound off the layers under the delta.

"It's kind of a like an ultrasound of the Earth," explains Paola. "It gives you a record—and it's the only record we have—of how the Earth has worked over very long time scales. You can see its natural variability, how it responds to things that are quite topical right now, like climate change, like rises in sea level. We have a great deal of information in this subsurface 'archive' about how the earth has responded to those things in the past."

The data are the result of a very large investment on the part of the companies, which kept the results largely in-house until now. "The existence of a center that is committed to a sustained, large-scale effort allows the companies to justify transferring quantities of data that they probably wouldn't transfer otherwise," says Paola.

SCIENCE-ON-A-SPHERE AND WATER PLANET

Swirling clouds traverse the ocean, pushed by wind currents racing across the globe. You can view the moving projection from any angle and walk around the globe to see what's happening over Africa, Europe, or the U.S. Then change the program and follow a tsunami wave as it spreads across the oceans, watch an El Niño event move warm ocean waters eastward toward the Americas, or observe any one of a host of other geophysical processes at the touch of a button.

It's all thanks to an innovative visualization system that projects moving displays in time and space, not on a conventional flat screen, but rather, on a white sphere suspended above you in mid-air.

This is Science-on-a-Sphere, an exhibit developed by the National Oceanic and Atmospheric Administration and on display at the Science Museum of Minnesota (SMM).

The system will be a central element of a new 5,000-sq-ft traveling exhibition under development called Water Planet, which will help visitors better understand the role of water in critical global processes. Water Planet will allow visitors to observe global processes in a condensed time frame that otherwise happen on large temporal and geographic scales.

Two other NSF Science and Technology Centers join NCED in working with SMM on the development of Water Planet: The Center of Advanced Materials for Purification of Water with Systems (WaterCAMPWS) and the Center for Sustainability of Semi-Arid Hydrology and Riparian Areas (SAHRA),

Water Planet is scheduled to open at SMM in fall 2008 and to be available for rental beginning in spring 2009. For more information, contact Patrick Hamilton, hamilton@smm.org

Science-on-a-Sphere

A PASSION FOR PUBLIC OUTREACH

Big things continue to come from a close working relationship between NCED and the Science Museum of Minnesota (SMM).

From 2002 to 2004, NCED researchers and SMM exhibit developers collaborated on the design, prototyping, and construction of a 1.75-acre outdoor science park at SMM, called The Big Back Yard.

The park encourages visitors to explore the Earth's surface, and the processes that shape it, through interactive exhibits and landscaping. It features a nine-hole, regulation miniature golf course that leads golfers from the uplands of North America to the Gulf of Mexico, and along the way reveals the processes of sediment erosion, transport, and deposition. Interspersed among the miniature golf holes are interactive exhibits based on NCED experiments.

"They know how to package and present our work for the public and we know the basic science," says NCED director Chris Paola.

NCED support to the museum through July 2007 totals some $2.9 million, says Pat Hamilton, director of environmental sciences and Earth-system science at SMM. A good chunk of that was spent on creating the centerpiece components of The Big Back Yard.

"From our perspective, we never would have been able to do what we have done without NCED," observes Hamilton. "Not just in terms of the money, but the fact that this outdoor exhibit really required a lot of prototyping, and although we have excellent prototypers here, we don't have flumes. And we don't have engineers. NCED made their experimental facilities and their engineering expertise available to us, and it was a tremendously fruitful collaboration."

Museum president Eric Jolly points to a dimension that reaches well beyond the exhibit grounds: "We built that magnificent braided stream exhibit that's in our Big Back Yard; and when it's running, young people play in it for hours and they study it and learn from it. But before we could build the finished exhibit, we had to do models.

"Now, we have in our storage, tabletop-sized braided streams. When our teacher resource center opens spring 2007, we're going to be able to make those tabletop versions available to schools, so that teachers will be able to provide that kind of hands-on experience to students all across a multi-state region."

SMM President Eric Jolly

The partnership builds upon long-standing capabilities of SMM in exhibit development. "SMM develops and travels more exhibits than any other science museum in the nation," notes Jolly. "We're the largest exhibit construction company within any museum in the country—we have one hundred and sixteen people whose full-time job is building exhibits, renting them, and showing them."

Since joining SMM in 2004, Jolly has worked to cultivate a close working relationship with NCED, in part through the negotiation of a memorandum of understanding (MOU) that facilitates communication between SMM and UMN. Toward this end, Jolly has drawn upon his experience as a former psychology professor and university administrator. He is a nationally acclaimed leader in the field of science education and science literacy.

"The MOU allowed us to have a portal," Jolly explains. "It can be difficult to find a way in to a major research university—to an outside institution, a university can be overwhelming. You don't know exactly where to go—it's not intuitive. Having an MOU helped that," he says.

"There's a reciprocity in this that's pretty astounding," says Jolly. "I consider this one of the best examples of public-private partnerships in the country."

The energy that the players bring to the collaboration is infectious. "People have accused me of having too much fun," says Jolly. "I get to play scientist, educator, keeper of incredible treasures, and it's all aimed at my passion: science as an essential literacy for our youth—science education as a civil right in many ways."

GRADUATE CERTIFICATE PROGRAM IN STREAM RESTORATION FILLS AN EDUCATION GAP

BY KAREN GRAN

On a sunny day in central Minnesota, thirteen students armed with equipment and waders set up their cross-section lines and begin to measure channel topography. They are starting an investigation on the Maple River, where a local landowner has complained about bank erosion. The Department of Natural Resources wants to enhance fish habitat, and the Minnesota Pollution Control Agency hopes to reduce turbidity and improve water quality of the river.

These students are the first participants in the Stream Restoration Science and Engineering Graduate Program (SRSE), started by NCED at the University of Minnesota (UMN).

Stream restoration requires a complex understanding of engineering, physical, biological, and social sciences, yet few practitioners have such integrated training in these fields. NCED aims to fill that gap with a new year-long, interdisciplinary program, which completes its first year in June 2007. The certificate may be taken as a stand-alone qualification or incorporated into a master's or doctoral program. It is currently the only year-long graduate degree in the country specifically aimed at stream restoration, according to NCED.