

On the mighty Mississippi

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tulanemag@tulane.edu



The crescent of the Mississippi River that gave New Orleans its nickname winds into the sunset. (Photo by Jackson Hill)

Amble just a stone's throw downriver of Mardi Gras World, upriver of the Crescent City Connection Bridge, on the East Bank of the mighty Mississippi River in New Orleans, and you'll note a sleek, modernistic grey building with water-retention gardens in front.

Within the interestingly patterned walls of the new Tulane River and Coastal Center, remarkable things are happening: The crème de la crème of scientists are putting their heads together to solve the enormous problems of coastal restoration, in the wake of eroding wetlands and rising seas, in Louisiana.

The River and Coastal Center is a new \$5.5 million, 5,500-square-foot facility on the riverfront campus. The center is a component of the newly established ByWater Institute, bringing together researchers from across the university to address how to negotiate water's peril and promise.

"The idea [for a riverfront campus initiative] was hatched in the early 2000s," said Mike Blum, associate professor of ecology and evolutionary biology, Eugenie Schwartz Professor of River and Coastal Studies and director of the ByWater Institute, "when it was referred to as the RiverSphere Initiative, which envisioned a campus dedicated to merging the arts with science and engineering. But Katrina waylaid the project for many years."

As the city recovered from the 2005 Katrina flooding, momentum for the riverfront initiative slowly picked up steam. Efforts shifted to address promising opportunities for economic development in the region, with an initial focus on establishing a test facility for river turbine technology for hydroelectric energy production.

But the initiative pivoted to focus on coastal protection and restoration to support implementation of the Louisiana State Master Plan in the aftermath of the Deepwater Horizon disaster, the nation's worst offshore oil spill, in 2010.

"This one disaster—the largest marine oil spill in history—reshaped everyone's priorities," said Blum. "It emphasized and brought to light the need for coastal protection. There was a poignant silver lining to the catastrophe, not in an environmental sense, but in that it accelerated our efforts to move this project forward."

On Sept. 14, 2016, the Tulane River and Coastal Center was dedicated. The complex includes state-of-the-art laboratories, large-scale conference rooms, office space and an enormous warehouse next door.

Much of Blum's own scientific work focuses on health risks that can arise following disasters. He is currently leading a team studying how responses to Katrina-related flooding have influenced rodent-borne disease risk in New Orleans. From intensive rodent trapping throughout the city, Blum and his colleagues are finding that rat populations track abandonment, as opposed to human population density, and that abandonment tracks recovery (or the lack thereof) since the storm. For many, rats are an unwelcome feature of city living, but Blum's team is more concerned about the pathogens carried by rats, like leptospira, which can result in a bacterial

infection that causes organ failure and death if left untreated.

As a signature program of the ByWater Institute, this work is highlighting how storms like Katrina don't just destroy coastlines. The attendant trauma can invite a host of unexpected consequences years to decades afterward.

DIVERSION TECHNIQUES

On another front, ameliorating coastal erosion is the prime concern of Mead Allison, professor of earth and environmental sciences.

"The proximity [of the center] to the river is all-important," said Allison, who has a joint appointment with The Water Institute of the Gulf in Baton Rouge. "It's a staging area with boats and a launching facility, and we can get right out onto the river and adjacent delta to examine how to best redeposit sediment through diversion or sand-mining and long-distance pipeline techniques. The sediment so vital to keeping wetlands intact was straitjacketed beginning in the late 1920s, when the federal flood protection levees were built along the river."

The river diversions that Allison and his colleagues are assessing will involve creating holes in levees downstream of New Orleans. The holes would allow silt through a series of stringently managed gates. They are also currently examining sandbars that line the shallows of the river's channel that can serve as an additional source for marsh creation and barrier island restoration through dredging and pipeline placement.

But redepositing sediment is only one part of the equation to restore the shrinking coastline, which buffers New Orleans and coastal communities from the devastating effects of storms.

OIL DISPERSANTS

Another vital element in protecting the coast involves tackling the eventuality of another petroleum industry disaster. Kyriakos Papadopoulos, professor of chemical and biomolecular engineering, believes that methods of cleanup must be more environmentally friendly to the very fragile ecosystem, already in crisis.

"The primary goal is to disperse the oil as quickly as possible," said Papadopoulos. "Dispersants are a mixture of various surfactants, which come in all shapes and sizes. Some are harmless, like the ones contained in the food we eat, or the ones we brush our teeth or wash our hair with. But those harmless surfactants, like lecithin,

are less effective in oil cleanups. The current state-of-the-art surfactant is a compound called Corexit, used by BP to clean up the gulf oil spill. But according to many, it contains molecules that are definitely toxic.”

Corexit has not been fully tested for human and environmental safety, said Papadopoulos. And BP poured 1.8 million gallons of Corexit onto the gulf’s surface.

Papadopoulos’ particular study is designed to quantify how crude oil that is trapped in sands and sediments mobilizes in the presence of key surfactants. He’s working in conjunction with Eni, Italy’s oil company, to test surfactants that have been modified to specifications based on what works under strict laboratory conditions.

“Optimally,” he said, “we’d like to find a surfactant with the efficacy of a Corexit, minus the nasty side effects.”

Papadopoulos added, “It’s important to build bridges with oil companies to solve problems, rather than have adversarial relationships.”

COASTAL GRASSES HOLDING ON

Much funding for research projects is coming from damage settlements imposed by the courts on BP, relative to the Deepwater Horizon disaster.

And most everyone who followed the aftermath of the 2010 oil spill is aware of the toll it took on birds and fishes, including crabs, pelicans and other living creatures.

But oil spills do more than compromise sea life. The very plants and coastal grasses that are the framework holding the marshy deltaic land together are severely compromised by manmade gluts of petroleum.

Sunshine Van Bael, assistant professor of ecology and environmental biology, said that oil exacerbates erosion, a problem already of primary concern to the region.

“Spartina, the grass species we study, was negatively impacted by the spill,” she said. “We found that the fungi that interact with the plants were severely reduced in oiled areas, and the root bacteria had changed drastically in terms of composition. The area was already vulnerable from subsidence exacerbated by oil exploration. And then the wetland plants holding the soil together were damaged by the oil spill.”

In her research, Van Bael and her colleagues are trying to make wetland plants more resilient by inoculating them with bacteria and fungi that promote growth.

“Along with grasses, we’re in the beginning stages of inoculating our bald cypress seed and seedling population,” said Van Bael, “since many trees are suffering from saltwater intrusion. With sea-level rise and a lack of oxygen to the roots of these trees, we’re trying to understand what sea-level rise will mean for the long-term prognosis for all of these soil-holding arboreal entities.”

ICE AGES NO MORE

To understand how we came to the scientific conundrum we face today requires venturing back in time, and looking at just how the delta was formed, beginning around 7,000 years ago. It was the early part of the Holocene Age, the geological epoch subsequent to the Pleistocene Age, when glaciers retreated, signaling the end of the last ice age.

Torbjörn Törnqvist, Vokes Geology Professor and chair of the Department of Earth and Environmental Sciences, is an expert in the Quaternary Era (the last 2 million years), comprising the Pleistocene and Holocene epochs, and thus including the present. He studies the ramifications of melting ice sheets on rising sea levels, figuring out what’s happening now and in the future, based on what happened in the past.

“The melting of the Laurentide Ice Sheet that covered much of North America caused sea levels to rise very quickly,” said Törnqvist. “When it had disappeared, sea-level rise slowed down, and the delta started forming.

“The interval between ice ages is about 100,000 years, and climate change is tied into all of this. Ice ages are driven by changes in the Earth’s orbit around the sun, which happen very slowly over enormous amounts of time. Therefore, climate change ebbs and flows with the cyclical nature of the progression and receding of the ice ages. But this is key: We’ve seen sea-level rise increase very rapidly in the last 100 years.”

What’s important here is that until some 100 years ago, the delta was still growing. Then levees were built to armor the Mississippi River to prevent flooding. These levees stopped sedimentation across the wide delta plain and, consequently, sediments that once sustained delta wetlands instead flowed offshore. And it is this sedimentation that is necessary to offset land subsidence that continues unabated. The digging of canals for navigation and energy exploration, like the much-maligned (and now closed) Mississippi River Gulf Outlet, aggravated land loss by contributing

to erosion, subsidence and saltwater intrusion.

But land loss is not a one-sided problem. There is also sea-level rise. What then has been leading to sea-level rise?

The rapid increase of greenhouse gases in the atmosphere, in particular carbon dioxide, is a major factor in present-day sea-level rise, said Törnqvist. “We’ve created this issue by the combustion of carbon-based fuels, principally coal, oil and natural gas.

“You cannot put 400 parts per million of CO₂ into the atmosphere, and then expect to have another ice age. So, the temperature will keep rising, Antarctica will keep melting, and sea-level rise will continue to accelerate, resulting in coastlines drowning.”

Törnqvist’s research involves studying core samples extracted by drilling down up to 80 feet underneath the Mississippi Delta. His work is determining the rate of sea-level rise during the rapid retreat of the Laurentide Ice Sheet some 8,000 to 10,000 years ago, to help better understand and predict melting of ice in Antarctica in the next centuries.

TAKING ACTION

The new Tulane ByWater Institute is also turning to historians to understand issues of coastal living in this era of climate change.

Andy Horowitz, assistant professor of history, is the author of *How to Sink New Orleans: Katrina’s History, America’s Tragedy, 1915–2015* (forthcoming, Harvard University Press). He said that the number of naysayers regarding climate change seems to be shrinking.

“Whether you have a sophisticated understanding of the science behind climate change as the cause of rising sea levels, no one is denying that the water is here, or that it’s getting warmer. We have become realists in terms of climate change,” said Horowitz. “The harsh reality is that with rising sea levels, coastal erosion and climate change, no one should be without flood insurance.”

New flood maps issued this year by FEMA, the administrator of the National Flood Insurance Program, may result in lower flood insurance premiums for some people in New Orleans. That’s because of a \$15 billion hurricane protection system installed

around New Orleans since Katrina.

“But it’s a thorny issue,” said Horowitz. The lower flood insurance rates may “encourage people to rebuild in areas that are not safe.”

Instead, “we should be making smart decisions about where we live,” said Horowitz. “The citizens of Louisiana are tired of being resilient. ... They want action that will protect them from harm in the first place.”

Action is where the ByWater Institute can step in, said Mike Blum, the institute’s director. The confluent factors challenging Louisiana mandate that the best minds come together to solve problems.

“This is about the translation of research into application,” said Blum. “Of equal interest is telling the story of the river to our neighbors and accentuating the immediacy of the problem. When you’re losing a football field of land an hour [which Louisiana has been doing for decades], the coast is indeed disappearing.”

Blum added, “We’ve had a 150-year run behind us, but we won’t have 150 years ahead of us to debate scientific certainties. Fishermen can see the loss on a day-to-day basis. We’re talking Plaquemines, St. Bernard, LaFourche, Terrebonne, Jefferson and Orleans parishes, all being threatened.”

It’s the age-old question of jobs and the economy in the short-term versus the long-term survival of an ecology that supports those very economies.

“Look,” said Mead Allison, the sediment diversion expert, “you might be catching a redfish here today, but if we create river diversions necessary to rebuild the coastline, your redfish [later] may be someplace else. And you don’t want to move to catch them. But out in the not-too-distant future, if we don’t do anything, and we destroy the wetlands, the redfish are going to be gone, altogether. The [statistical] models tell us what’s going to happen if we don’t do anything, and the future scenarios are pretty bleak, if indeed we do nothing.”

A GLOBAL ISSUE

The dynamics of deltaic regions are similar around the world, said Allison, who has studied the Amazon, Ganges and Mekong deltas as well as the Mississippi.

“The Mekong [in Southeast Asia] is the Mississippi 50 years ago,” he said. “Dams are being built everywhere, primarily by China, reducing sediment and affecting shrimp

and rice farmers. When you alter the basin, someone suffers. And while we're in the hurricane zone, they're in the typhoon belt, in the southern part of Vietnam on the Mekong delta. So, the similarities are staggering. In developing nations, they have real needs to feed their people, but if you build dams and change the dynamics of water supply, will the salinity then ruin the rice fields?"

The ByWater Institute and its River and Coastal Center will serve as a hub to bring global experts together to address these questions.

"Scientists can say a lot," said Van Bael, "but if no one is listening, and no one is changing their behavior, then the future is not promising."

Törnqvist echoes Van Bael's comments and emphasizes the necessity of taking immediate action.

"It's not going to be pretty," said Törnqvist. "We won't be around to see it, but our kids and certainly our kids' kids will. We're not talking about five to 10 generations down the line. I think by the end of the century New Orleans will still exist, but not in the form that we know it. And by the end of the next century, New Orleans, if it remains at all, will not be where it is today."

As far as greenhouse gas emissions that cause the warming of the atmosphere, Törnqvist said, "It's certainly conceivable that we've already crossed thresholds that make the problem irreversible. But it doesn't mean we can't slow it down, nor should we stop working on the problem. Sadly, no one's been listening for the last few decades, when most of the damage was done."

For Papadopoulos, it's too painful to imagine a world without New Orleans.

"I'm from Greece, yet I have put all of my stock in this city. It has generated culture and exported food and art. So much flows economically from this region by way of the Mississippi River. If we make no immediate effort to fix things, I don't want to imagine it. Losing this area would be a great loss to the world."

"You have to pick your battles," added Van Bael, "and this is a battle worth fighting."

Perhaps Blum said it best: "Scientists have long believed that business as usual will not be enough to sustain our future, nor will simply doing more research. Prudent and well-supported actions need to be taken with growing urgency."

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