WATER MARKS

Louisiana Coastal Wetlands Planning, Protection and Restoration News

March 2006 **Number 30**

Louisiana's Wetlands After the Storms

Scientists Take the Pulse of a Pummeled Coast

Breaux Act Projects Stand Up to Hurricanes' Punishment

***WaterMarks* Interview with Robert A. Dalrymple**

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March 2006 Number 30

WaterMarks is published three times a year by the Louisiana Coastal Wetlands Conservation and Restoration Task Force to communicate news and issues of interest related to the Coastal Wetlands Planning, Protection and Restoration Act of 1990. This legislation funds wetlands restoration and enhancement projects nationwide, designating approximately $60 million annually for work in Louisiana. The state contributes 15 percent of total project costs.

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ABOUT THIS ISSUE'S COVER . . .

Once a tranquil vista of marsh grass stretching to the horizon, this segment of Louisiana's coastal wetlands shows the damage wrought by hurricanes Katrina and Rita in the autumn of 2005. Although debilitated by the storms, wetlands are credited with reducing damage further inland by absorbing wave action and decreasing the height of storm surge. Scientists are monitoring the ravaged marshes to gauge their resiliency and estimate the length of time they take to recover.

Photo credit:
Louisiana Department of Natural Resources

WaterMarks

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www.lacoast.gov
www.btnep.org
www.lca.gov
www.saveLAwetlands.org
www.crcl.org

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Storms Reveal High Cost of Marsh Loss

Hurricanes Prove the Urgency of Rebuilding Wetlands

In 2005, hurricanes Katrina and Rita dealt catastrophic blows to coastal Louisiana communities, proving the necessity of better hurricane protection.

Exposing the vulnerability of the fragile coastal environment, the storms also highlighted the wetlands' economic importance: When damage caused by Katrina and Rita shut down 90 percent of crude oil production in the Gulf of Mexico, gasoline prices soared nationwide.

"A fifth of the U.S. crude oil supply passes through Louisiana's wetlands, which shield pipelines, platforms and other infrastructure from hurricanes," says Rex Caffey, director of the Louisiana State University (LSU) Agricultural Center's Center for Natural Resource Economics and Policy.

Hamady Diop

Some 25 percent of U.S. fisheries production comes from Louisiana's wetlands, but after the 2005 hurricane season, says Rex Caffey of the LSU AgCenter, "It's possible that many fishing companies, particularly small operations, will never recover. We really don't know what Louisiana's fishing industry is going to look like after Katrina and Rita."

"It's impossible to say what might have happened if we had already rebuilt Louisiana's wetlands by the time Katrina hit, but the net loss of 1.2 million acres of coastal wetlands over the last century has definitely increased the vulnerability and exposure of the state's coastal infrastructure, and thus its economy."

Restoration Essential to Coast's Survival

While the impact of Katrina and Rita on the petroleum industry was felt almost immediately, the storms' effects on other industries such as fishing and agriculture might not be known for years.

The hurricanes' high winds and flood waters wiped out crops and damaged timber in south Louisiana; saltwater intrusion may have rendered some land unsuitable for farming. Both storms caused extensive damage to the state's commercial and recreational fishing industries, destroying boats, marinas, equipment and processing facilities and ravaging the marshes and barrier islands that provide habitat for oysters, shrimp, fish and other aquatic species.

"Our state's future depends on creating a system that treats coastal restoration and hurricane protection structures as equals," says Scott Angelle, Secretary, Louisiana Department of Natural Resources. "It can't be one or the other — we need both."

Cows crowd the porch of a Louisiana house, seeking to escape the rising water. Hurricanes Katrina and Rita flooded pastures across southern Louisiana, killing thousands of cattle and causing nearly $46 million in livestock and property losses to Louisiana's cattle and dairy industries.

As scientists and policy makers seek ways to protect coastal communities and industries from future hurricanes, they look to the marshes and barrier islands that form the coast's first line of hurricane defense.

"We've known for many years that vegetated wetlands reduce the tides, waves and storm surges that reach our levee system," says Colonel Richard P. Wagenaar of the U.S. Army Corps of Engineers and Chairman of the Breaux Act Task Force. "Hurricanes Katrina and Rita left no doubt that coastal wetland restoration must be a central component of any hurricane protection plan." WM

Hurricanes Deal Heavy Blow to Louisiana Economy

INDUSTRY	ESTIMATED LOSS of REVENUE
Forestry	$839,933,224.00
Agronomic Crops	$357,854,629.00
Fruits/Nuts/Vegetables/Honey	$41,951,686.00
Livestock and Forage	$75,580,644.00
Aquaculture	$58,330,115.00
Fisheries	$176,280,625.00
Wildlife/Recreational	$40,803,977.00
Total Estimated Revenue Loss	$1,590,734,900.00

LSU AgCenter

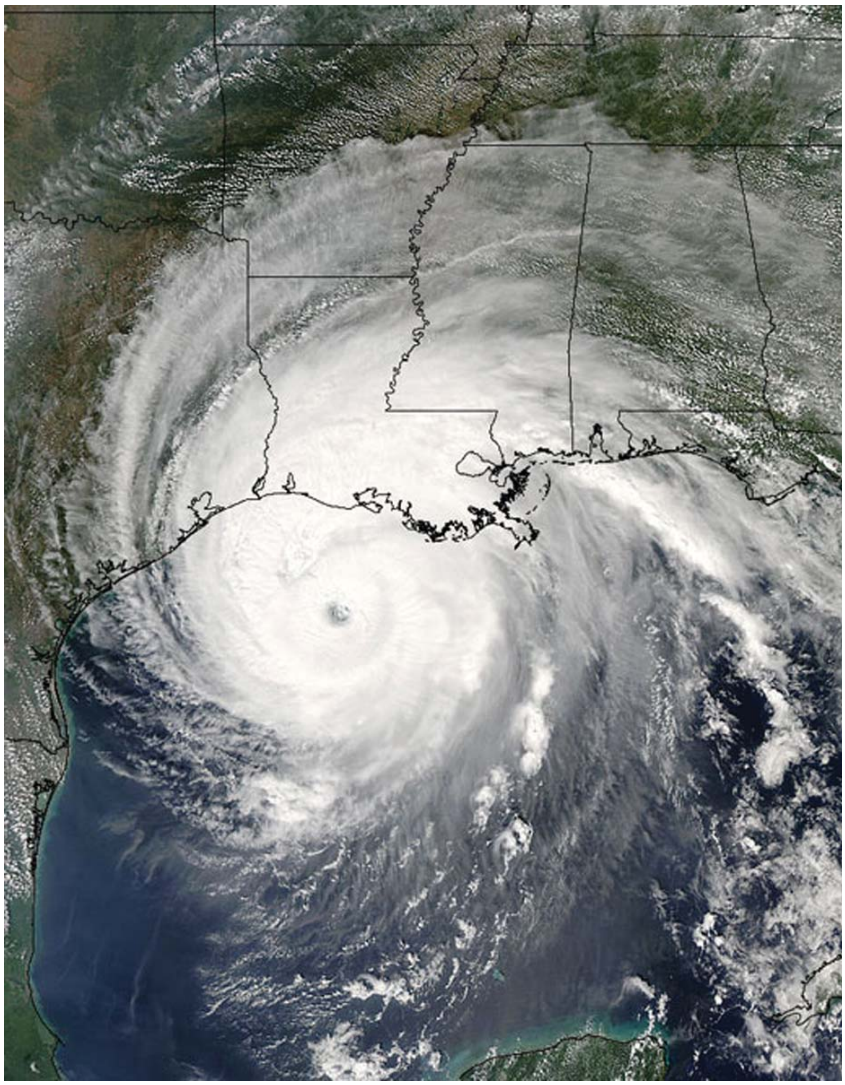
Wetlands Break Waves, Quell Surge

Coastal Landscape Battles Weather to Protect Mainland

Louisiana's coastline has been a top pick over the last century for major hurricanes making landfall.

Taking on the might and fury of these storms are the state's barrier islands and coastal wetlands — a fragile, yet proven, line of defense.

"Barrier islands and marshes can't stop the full force of a category 4 or 5 hurricane," says Jack Kindinger, associate director of the United States Geological Survey (USGS) Florida Integrated Science Center. "But because these natural buffers reduce the effects of daily wave action and winter storms on shorelines and levees, a coast protected by wetlands will fare better in a storm of any size."



NASA image courtesy Jeff Schmaltz, from the MODIS Rapid Response Team at NASA GSFC

The most powerful storm ever observed in the Gulf of Mexico, Hurricane Rita made landfall near Louisiana's western border September 24, 2005. The huge weather system pushed high winds and drenching rains northward across states from Texas to Florida.

USDA NRCS Golden Meadows PMC

Can a stalk of grass resist hurricane forces? Multiplied over hundreds of acres, wetland vegetation does moderate storm surge as well as wind and wave energy.

Marshes Soak Up Surge

As a hurricane moves inland, coastal marshes deprive it of the warm moisture that fuels the storm's growth. Wetlands also diminish a hurricane's destructive power by reducing storm surge and absorbing wave energy.

"Well-vegetated wetlands absorb much of the surge of category 1 and 2 storms because of their elevation and the friction the grass provides," says Kindinger. Against the strength and surge of category 4 and 5 storms, he says, wetlands have a more limited effect.

How much protection do wetlands offer? Many variables determine how well marshes reduce storm surge, including the slope of the continental shelf and the speed and direction of storm winds. Studies suggest that it takes as little as one mile or as many as four miles of functioning wetlands to reduce storm surge by a foot.

Throughout the year, wetlands protect levees from the erosive effects of waves by reducing their height and intensity. "A levee protected by marsh will require much less maintenance than will a levee exposed to daily tides and waves," Kindinger says.

Storms Stumble Over Sandy Speed Bumps

Delicate ribbons of marsh and sand, barrier islands seem too small and fragile to have any effect on a powerful hurricane hundreds of miles across. But the severe damage these islands endure — often losing as much as half their land area — is proof of their effectiveness.

"It takes a lot of force to remove that much sediment," says Greg Stone, James P. Morgan Professor at Louisiana State University's Coastal Studies Institute and Department of Oceanography. "That's energy depleted from the storm's surge and the wind-driven waves on top of it. Think of a barrier island as a 'speed bump' that dissipates hurricane-generated power."

Barrier islands, particularly those close to the mainland, also protect coastal marshes.

"Where barrier islands have weakened or disappeared, bays are exposed to higher wave energy, which accelerates wetland loss and makes the coast even more vulnerable," says Stone. "Putting money into rebuilding and fortifying levees and improving flood protection is vital, but it must be done in conjunction with the restoration of barrier islands and the wetlands that lie behind them." **WM**

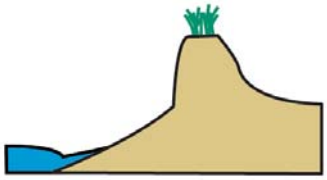
The Bigger the Bump, the Better the Barrier

Many factors determine how well barrier islands stand up to hurricanes, including storm size and strength and the islands' shape and elevation. Wide, moderately tall islands, such as those along the Florida coast, tend to fare well, says LSU's Greg Stone.

"The sand transported from an island's beach and dunes by storm surge needs someplace to go, and a wide island offers a platform for holding that sand," Stone says. "Because Louisiana's barrier islands are typically low and narrow, sediment tends to be pushed over the islands and into the bays behind them."

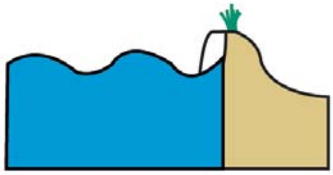
If that sediment isn't replaced, the island will eventually disappear, as is happening to many Louisiana barrier islands. The following illustrations show the different effects of storm surge on barrier island sediment.

1



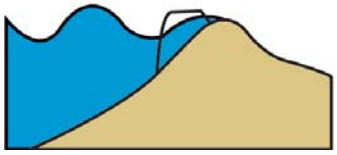
Impact Level 1: Storm waves reach no higher than the beach. The beach will erode, but over time normal wave action will return the sand to the island. Sand remains within the system.

2



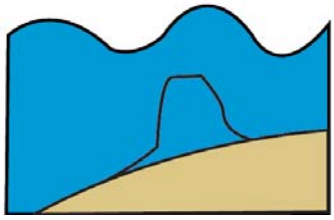
Impact Level 2: Waves reach higher than the base of the dune. The island's beaches and dunes will erode and retreat, perhaps permanently.

3



Impact Level 3: Waves overtop the barrier island. If waves reach over the dune, or if there is no dune, sand will be pushed landward. Over time, the island will migrate toward land.

4



Impact Level 4: If the storm surge is high and the elevation of the barrier island is low, the island can become completely inundated. Sand is removed and transported over the island into the bay behind it.

U.S. Geological Survey

From Satellite Imagery to Soil Samples

Scientists Take the Pulse of a Pummeled Coast

Marsh vegetation brown from salt burn. Wetlands shorn of grasses, exposing mud flats pitted with puddles. Trees dangling bands of twisted metal, plastic bags and bits of cloth from branches stripped of leaves.

As Katrina and Rita swept over southern Louisiana, they left their imprint on the landscape. Using data collected to assess the storms' effects, scientists are redrawing maps, refining hurricane modeling and improving techniques of coastal restoration.

From Big Picture to Fine Detail

Following Katrina and Rita, John Barras, a scientist with the USGS National Wetlands Research Center, has been mapping changes in Louisiana's coastal wetlands. In some areas, vegetation was torn from its roots to expose a muddy marsh floor. In other places the marsh soil and plants were ripped apart and pushed aside, allowing new bodies of open water to form. "Satellite images make the breaks in the marshes look like one big pond," Barras says, "but when you get closer to them, you can tell there are a few very large areas — areas over 500 acres — but most of the damage to the wetlands is from many, many smaller tears, rips and shears in the marsh."

Barras estimates the deepest of the new open water areas to be three feet; most are probably about six inches deep. The smaller the area of tear or shear, the more likely the marsh is to recover. Larger expanses of damage, such as in Upper Breton Sound or in White's Kitchen, will probably become permanent lakes.

Barras makes his determination of landscape changes by comparing satellite images taken before and after the storms. Classifying different colors in an image as land or water, Barras looks for new occurrences of water in post-storm photos. "Some areas are so large they are easy to find from the ground," says Barras, "but you need an

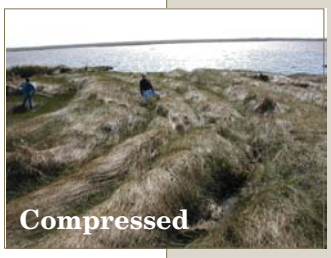
Words That Picture Marsh Damage

Scientists in the field often describe the effects of storms on the wetlands with colorful terms. Here's a glossary of their lingo.

Rolled: strips of marsh mat uprooted and rolled up jelly-roll fashion


Rolled

Shear: a rip between marsh surfaces that tears marsh and moves it apart, allowing expanses of water to form


Compressed

Compressed or **folded:** marsh mat blown into ridges resembling an accordion or, in more aqueous marshes, a crumpled bed sheet.

Scoured: marsh with vegetation ripped off at the roots, exposing a muddy bottom


Inverted

Inverted or **flipped:** unbroken marsh mat lifted from its clay base and overturned with roots pointing skyward


Folded

Marsh balls: marsh mud and grass pushed together into cinderblock- to sofa-sized clumps and blown about like tumbleweed

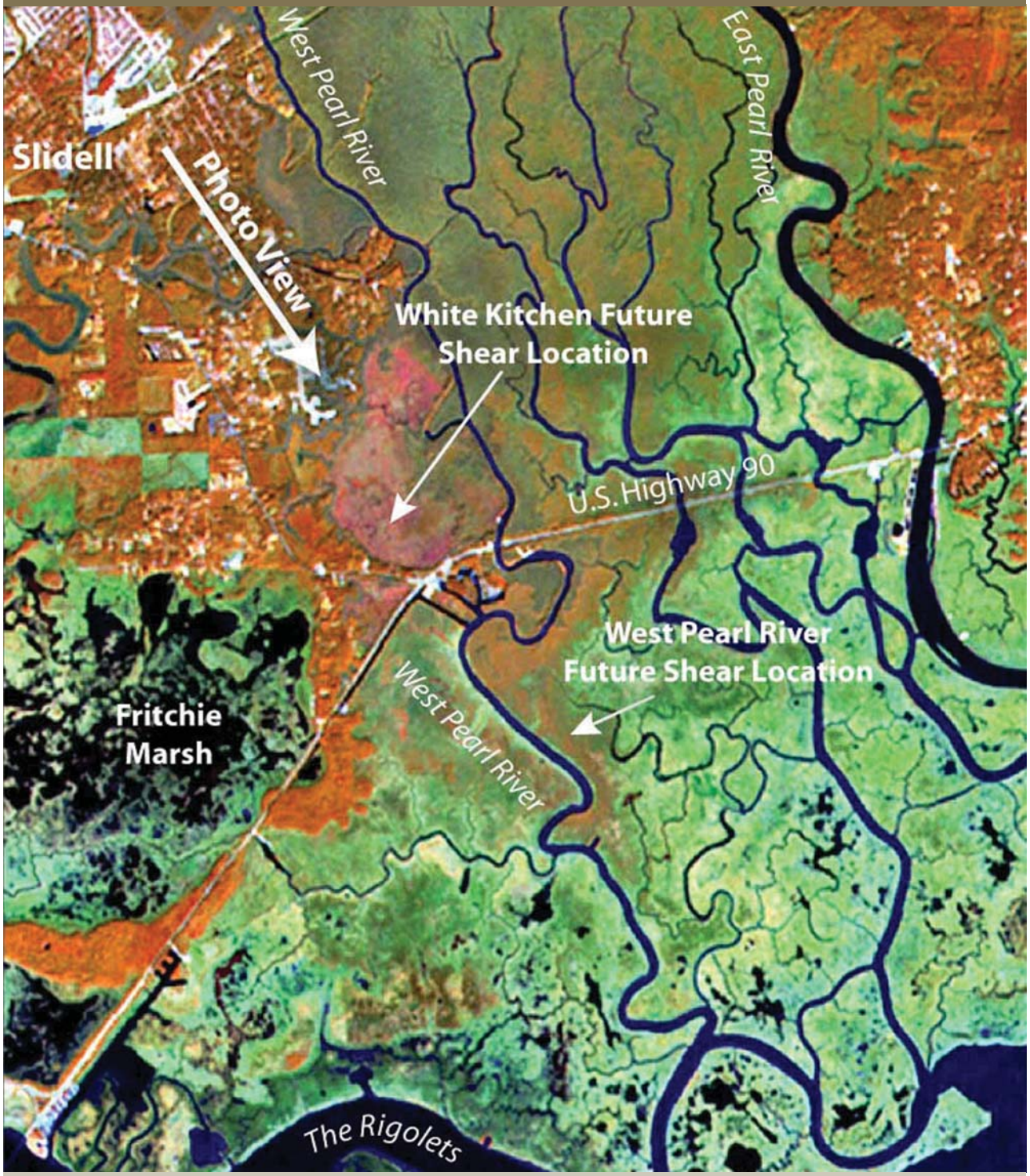
U.S. Geological Survey

aerial view to appreciate the extent of the changes that have occurred."
Fly-overs in small aircraft and field verification of conditions on the ground provide more detail about specific sites.

Preparing for Future Storms

Based on data gathered from past storms, hurricane modeling predicts the behavior and consequences of future storms. Assessments of Katrina and Rita will help refine modeling, to show when and where

Satellite Image Shows Prior Conditions



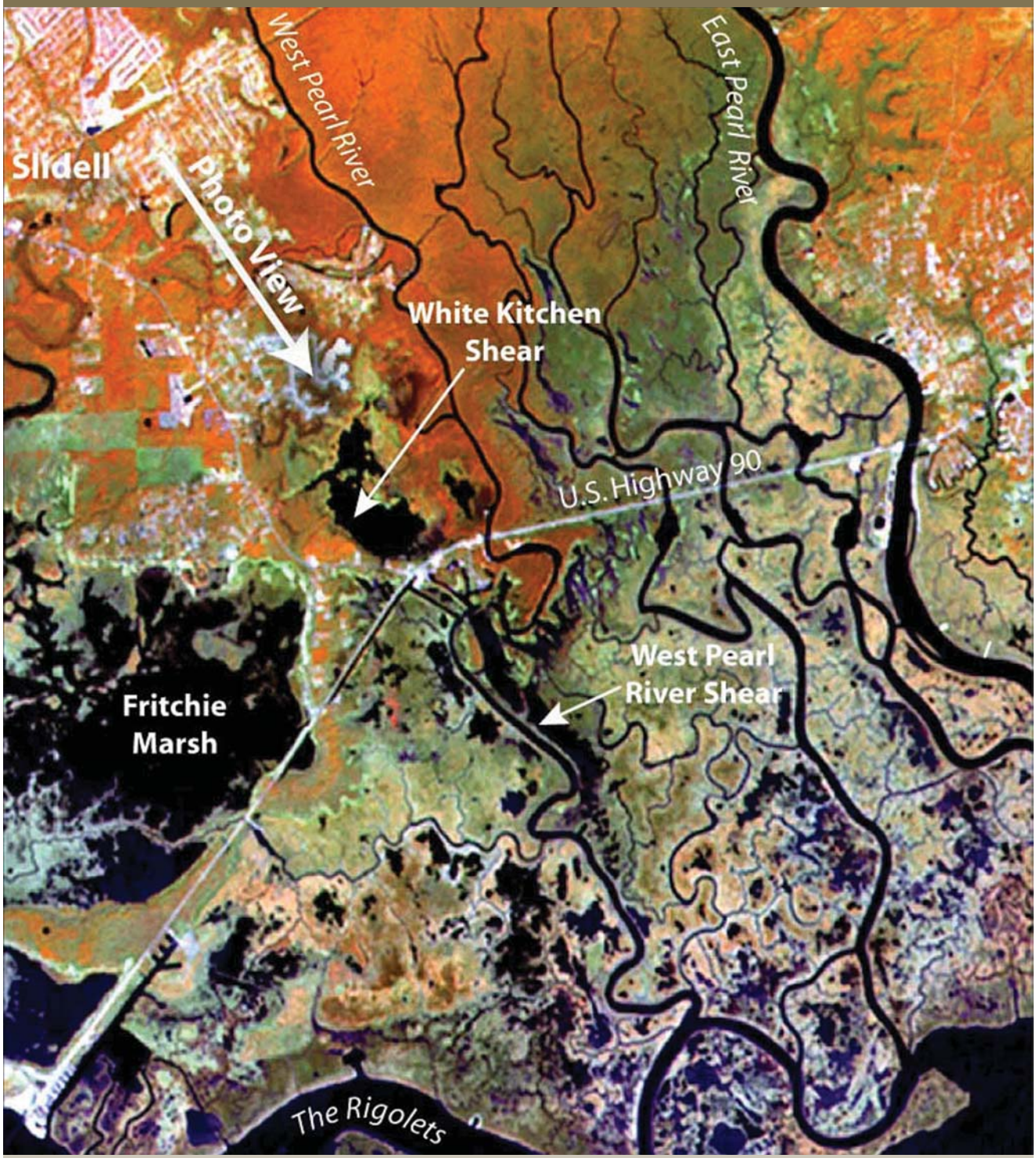
U.S. Geological Survey

This satellite image shows the condition of White Kitchen, Louisiana, southeast of Slidell, in November 2004.

the fastest winds and heaviest rains are most likely to occur. The assessments contribute to public safety by increasing the veracity of weather forecasts, giving prudent warning to people in harm's way while reducing the disruption and costs of unnecessary evacuations.

Assessments also influence coastal restoration efforts. By analyzing the performance of various projects during and after the storms, scientists and engineers can fine-tune

Post-hurricane Image Reveals Landscape Changes



U.S. Geological Survey

This image taken in October 2005 shows submersion of marsh land masses; new shears, or areas of broken marsh converting to open water, near the West Pearl River; and loss of vegetative cover throughout the vicinity.

techniques to increase their endurance or boost their protective capacity. For instance, observation of which plants best withstood high winds, or how the electronic components of water control structures fared in a storm surge, will affect future decisions and factor in evaluations of a project's cost effectiveness.

An Uncertain Prognosis

Within weeks of the hurricanes, the environment showed signs of recovery. Trees budded with unseasonable new growth, and sprigs of vegetation showed green in scoured areas of the delta.

But the lasting effects of the hurricanes are difficult to predict. How much of the estimated hundred square miles of lost land will remain open water? Will the freshwater marshes that were drenched with salt water turn brackish or convert to open water? Will fisheries dependent on the wetlands for food and habitat rebound? And how much of the wetlands' protective capacity remains as a new hurricane season approaches?

"It's impossible to tell the extent of damage yet," Barras says. "It may take a year, two years, to determine what changes are permanent. Scientists will continue to monitor and evaluate Louisiana's coast to answer these questions and many more." WM

Storms Disrupt Avian Itineraries

It was in the midst of the songbird migration season when hurricanes Katrina and Rita hit the Louisiana coast. Typically these birds fatten up for the long flight to Central and South America in the Pearl River bottomlands, according to Wylie Barrow, wildlife scientist at the USGS National Wetlands Research Center. After the hurricanes stripped plants of leaves, fruit and insects in the fertile reaches adjoining the river, radar tracking indicated an increased number of birds staging for their trip in the piney woods to the northwest. "Not only does this lengthen their journey by 15 to 30 miles," says Barrow, "but food in the piney woods is not as rich or as abundant as in the bottomlands, making it harder for the birds to fatten up."

U.S. Geological Survey

Stripping plants of certain insects, hurricane winds immediately robbed migrating birds of a critical food source. In the long term, however, the storms could cause a dramatic swelling in insect populations, as the decay of toppled trees increases their food supply. Ecologists will watch to see if exotic species of flora and fauna invade storm-damaged areas, further threatening the health and survival of Louisiana's coast.

Like other Louisiana coastal wildlife, songbirds such as the Northern Parula warbler shown below were severely affected by the hurricanes. Just as it will take time to gauge many of the storms' consequences, it will take time to fathom their full toll on the songbird popluation.

David L'Hoste

Few Sites Suffer Damage

Breaux Act Projects Stand Up to Hurricanes' Punishment

Hurricane Rita made landfall near the west Louisiana town of Holly Beach on September 24, 2005.

The storm's 120 mph winds and 15-foot storm surge wiped out subdivisions and camps along the shore, leaving behind only streets and the concrete slabs of buildings.

But nearby, a Breaux Act beach restoration project sustained only minor damage despite taking an even more direct hit from storm winds and waves.

Similar results were found across coastal Louisiana: Breaux Act wetland restoration and protection projects emerged from hurricanes Katrina and Rita largely unscathed.

"Out of 107 projects, only four or five experienced serious damage from Katrina and Rita — about $15 million in damage to $475 million worth of projects," says Garrett Broussard, senior operation and maintenance engineer with the Louisiana Department of Natural Resources (DNR). The storms swept sediment off barrier islands and uprooted vegetation, but in most instances, Broussard notes, the materials used to create earthen terraces, rebuild beaches

U.S. Geological Survey

The Cameron Parish community of Holly Beach, near the junction of Hwy 27 and Hwy 82, before Hurricane Rita.

U.S. Geological Survey

Hurricane Rita's 20-foot surge demolished the town and inundated the marsh.

Louisiana Department of Natural Resources

A Breaux Act project that had added 1.7 million cubic yards of sand to the shoreline helped protect the fragile marshland north of Hwy 82 and west of Holly Beach. "It's hard to say what long-term effects the slug of salinity from the surge will have on the marsh," says David Burkholder of the Louisiana Department of Natural Resources. "But the project held its ground, which gives the wetlands a fighting chance."

Louisiana Department of Natural Resources

Louisiana Department of Natural Resources

Above: Hurricane Rita inundated the terraces at Little Vermilion Bay, delivering a potentially damaging dose of saltwater to marsh plants. "But because the saltwater receded quickly, we expect a full recovery," says John Foret of the National Marine Fisheries Service.

Right: Foret says the only significant damage to the terraces was caused by this oilfield barge, torn free from its moorings and pushed onto a terrace by storm surge.

and shield shorelines remained in place.

"That's an excellent outcome given the size and intensity of these storms," he says. "It shows how well the science behind coastal restoration plays out on the ground."

Shoreline Project Survives Amid Devastation

The Holly Beach Sand Management project was designed to protect 8,000 acres of marsh. Sand was deposited along the shoreline behind existing rock breakwaters, then held in place using vegetative plantings and two or three rows of sand fencing.

"Rita destroyed the fencing and swept some sand across the highway and into the marsh," says David Burkholder, an engineer manager with the Louisiana Department of Natural Resources. But the fencing, installed in 2003 during the project's construction, had created high, stable dunes, so altogether the beach lost little sand.

With the beach intact, the marsh is still protected from the long-term effects of salinity, and the project is still doing what it was designed to do. "The fences were a big factor in preventing more extensive damage and marsh loss," Burkholder says. "We'll take that lesson with us to future projects."

Floodwaters a Boon to Land-Building Terraces

The 2005 hurricane season may have caused as much as 10 years' worth of land loss in less than a month as it flooded marshes and eroded barrier islands. But at Little Vermilion Bay, located in southern Louisiana's Vermilion Parish, hurricane flooding actually created new land.

Completed in 1999, the Little Vermilion Bay Sediment Trapping project built 19,700 feet of earthen terraces to reduce wave energy and trap sediment. "We designed this project to mimic the functioning of a river delta — to collect sediment between thin fingers of land," says project manager John Foret of the National Marine Fisheries Service.

Following Hurricane Lili in 2002, scientists discovered that as the storm surge receded from the bay, it left behind a thick layer of sediment on the bay bottom between the terraces. This experience was repeated with Hurricane Rita, says Foret, who vis-

ited the site by boat a month after Rita made landfall.

"Under normal circumstances this project traps sediment very well," Foret says. "The additional sediment accretion during storms accelerates the marsh building process."

That increases the restoration value of the project over time, Foret says. "This project has now survived three winters and two major hurricanes, and it has not only endured but has exceeded expectations for building a foundation for marsh plants to colonize. That confirms the validity of the science behind its design. We can build these kinds of projects with confidence that they'll perform well."

Island Losses Supply Valuable Information

As the coast's first line of defense against hurricanes, barrier islands like East Island endure the full force of these storms, suffering severe erosion as they absorb wind, waves and storm surge.

Funded through the Breaux Act, the Isles Dernieres Restoration East Island project restored the island in 1999. But as hurricanes Katrina and Rita tore through its east end, East Island lost almost a third of its land mass.

"About 2,000 feet of the island is gone," says Darin Lee of the Louisiana Department of Natural Resources. But the destruction offers important information to scientists who design barrier island restoration projects.

"The ends of these islands typically take more of a beating than other areas as water rises and scours around them," Lee says. "With each storm, we gather more data regarding the optimal combination of elevation, sand placement, fencing, plantings and other elements."

"Coastal engineering isn't an exact science," explains Burkholder. "But surveys of project sites after major storms give us an opportunity to fine-tune the science behind building wetlands. We call that process 'adaptive management' — evaluating projects and incorporating new information into our designs. We're constantly learning how to make these projects perform better." WM

Louisiana Department of Natural Resources

Hurricanes Katrina and Rita carved a four-foot-deep channel through East Island, part of the Isles Dernieres chain in Terrebonne Parish. "This breach lets higher wave energy into the bay behind the island, which will impact the wetlands that East Island protects," says Darin Lee of the Louisiana Department of Natural Resources.

WaterMarks Interview with Robert A. Dalrymple

Engineer, educator and author of numerous publications, Dr. Robert A. Dalrymple is the Willard and Lillian Hackerman Professor of Civil Engineering at Johns Hopkins University. On behalf of the American Society of Civil Engineers, Dalrymple participated on the New Orleans levee assessment teams that gathered information on the levees' performance in the wake of Hurricane Katrina. Dalrymple presented his team's findings to the U.S. House of Representatives' Subcommittee on Water Resources and Environment in October 2005. In this WaterMarks interview, Dalrymple talks about the lessons we can learn from Katrina.

WaterMarks: We've heard a lot about the failure of New Orleans' flood walls and levees after Katrina. From your perspective as an engineer, what went wrong?

Dalrymple: We understand the general principles of the failure but we don't yet know the specifics. For example, we know that factors such as the composition of the soil beneath the levees and the scouring effect that overtopping waves have on the levees caused problems. We also know that the overall strategy to protect New Orleans was sound.

WaterMarks: Does that mean that it may not be necessary to increase the protection level of the levees?

Dalrymple: The present levees are designed to withstand a category 3 hurricane. Another category 4 storm hitting the city will overtop the levees. When levees are designed and constructed correctly, you'll see flooding in the streets only for a matter of hours, not days. The levees would hold and the damage from floodwaters could be minimized.

WaterMarks: So why all the discussion about the need to increase the level of protection?

Dalrymple: There is the possibility of a storm stronger than Katrina. Although a category 5 hurricane is perhaps a 500-year event, no one knows when it might occur. The Netherlands has built levees to protect itself from a 10,000-year event. But the decision about the level of protection in southern Louisiana isn't an engineering decision, it's a political decision: Is the nation willing to invest the necessary funds to protect Louisiana's coastal wetlands and communities to withstand a category 5 storm?

WaterMarks: The Corps of Engineers is restoring the levee system to a category 3 level of protection. Will that happen before the next hurricane season starts on June 1?

Dalrymple: The breaches have already been repaired in the city proper, and by June the major part of the city's protective system will be back to pre-Katrina levels. What won't be repaired is the damage to the barrier islands and coastal wetlands.

WaterMarks: Just how important are Louisiana's barrier islands and coastal wetlands to storm protection?

Dalrymple: There's no question that these buffers are the first line of defense against a storm. It's estimated that every mile or two of wetlands reduces storm surge by about a foot. So when we talk about creating protection equal to conditions before Katrina, we must include wetland and barrier island restoration.

WATERMARKS: And the dollars that restoration requires?

Dalrymple: It will take a significant financial investment. But it doesn't make much sense to put money into rebuilding levees if we haven't put money into restoring our natural buffers on the coast.

WATERMARKS: In your testimony before the House Subcommittee on Natural Resources and Environment in October of 2005, you said that we must come to "the painful realization that some areas of the coast should not be rebuilt or inhabited again." Were you referring to New Orleans?

Dalrymple: No. Unlike other parts of southern Louisiana, New Orleans already has a network of levees and floodwalls in place. But the reality is that the combination of sea-level rise and subsiding land makes protecting some areas of southern Louisiana very expensive — the magnitude of damage from storms is going to increase, not decrease. We have to limit the loss of life and property, and that means making politically difficult decisions.

Natural Resources Conservation Service

In the aftermath of Hurricane Katrina, any boat promising rescue was a welcome sight in the flooded city. Using improvised paddles, these two men were among the many who responded to the crisis by locating stranded New Orleanians and carrying them to safety.

WATERMARKS: What do we need to focus on in our efforts to restore the coast?

Dalrymple: It's been talked about often, but it's worth emphasizing. We have to take maximum advantage of the sediment carried in the Mississippi River. Sediment — from the river or from dredging — is a primary resource for coastal restoration. We can't afford to lose it by allowing it to drop off the continental shelf.

WATERMARKS: Is there anything positive to look at in the aftermath of Katrina?

Dalrymple: Katrina was a terrible disaster, but it brought the crisis in southern Louisiana to the nation's attention. This country has begun to understand the connection between the destruction and the loss of coastal wetlands and barrier islands. We've seen that a hurricane in southern Louisiana can threaten the nation's oil supply, and we've experienced first-hand what that does to our pocketbooks — gas at three dollars a gallon gets our attention. It just may be that because of this crisis, southern Louisiana will get the federal funding it needs to address the terrible loss of wetlands that's occurred in recent years — and that would be the silver lining in a very dark cloud. **WM**

CWPPRA Partners Assist in Hurricane Rescue and Recovery

When Katrina's victims could not be located because floodwaters swept away New Orleans street signs, a CWPPRA partner transformed addresses of frantic 911 callers into geospatial coordinates and plotted them on maps for rescuers.

Faced with oil spills, burning debris and rotting animal carcasses, CWPPRA partners responded with expertise in containing and disposing of environmental hazards.

When the needs of displaced residents outstripped available resources, CWPPRA partners contributed food, water, housing and other essentials; and collected donations and supplies for school districts affected by the storms.

U.S. Geological Survey

Volunteers from CWPPRA agencies rescued some 600 New Orleans residents from flooded homes, attics and rooftops, and helped 2,000 more off boats and helicopters. Every stage of rescue, recovery and rebuilding has involved CWPPRA partners.

And in the aftermath of the 2005 hurricane season, the work continues. In addition to addressing environmental conditions in the wetlands, personnel from CWPPRA agencies — many themselves New Orleans residents displaced by the storms — have coordinated cleanup, evaluated health hazards, and worked around the clock to restore normalcy and improve hurricane protection across coastal Louisiana. WM

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