Paper 1331

2005 Hurricane Impacts to U.S. Energy Infrastructure in Coastal Louisiana

by

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Abstract

2005 Hurricane impacts to U.S. energy infrastructure in coastal Louisiana

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Coastal Louisiana provides 27% of the U. S. energy production and transports 40% of its energy products through an extensive pipeline system that extends from many miles offshore through the coastal marshes. Much of this infrastructure was severely impacted by Hurricanes Katrina and Rita, resulting in rapidly rising energy costs for Americans.

During hurricanes, offshore production platforms have to be shut in and crews evacuated. Hurricanes Katrina and Rita damaged many of these platforms, and resumption of production was thus delayed. Additionally, many pipelines were moved or broken by hurricane forces.

In this presentation, we will use a timeline to reveal how much of the infrastructure was damaged by these hurricanes, explain how much time is needed to restore capacity and illustrate the extent of the energy infrastructure at risk from future hurricanes.

This GIS technology was also used after the storm to aid oil spill response efforts.

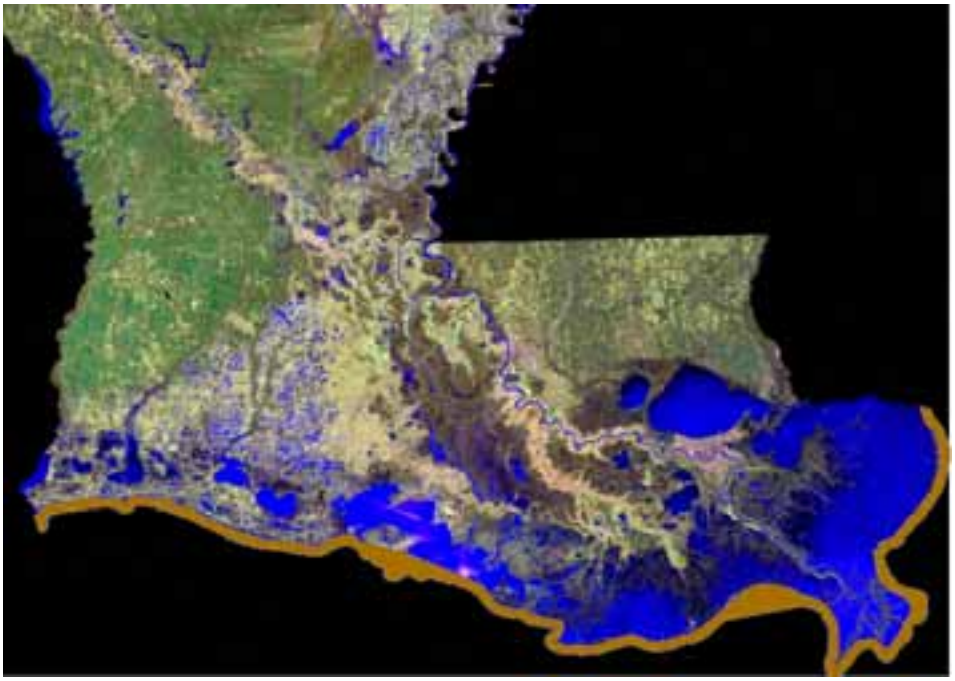
Introduction

This paper documents the extent of the oil and gas infrastructure in Louisiana and the role Louisiana plays in providing energy to the United States. There is a tremendous amount of oil and gas production as well as all of the support facilities for the offshore production located in Louisiana's coastal area. The coastal area of Louisiana is very large in size and has little or no elevation and is subject to flooding and inundation during storms. The paper then examines the impact of Hurricanes Katrina and Rita to this infrastructure and its impact to the U.S. oil and gas production and transportation.

Just before Hurricane Katrina hit, DNR put all of the information on platforms and pipelines as well as oil and gas wells on a password protected web site. We then made available to all response agencies the userid and password to the web site for use in emergency response and oil spill cleanup. This action proved to be one of the bright spots in hurricane preparation and response.

Louisiana and Outer Continental Shelf (OCS) Waters

The state of Louisiana owns out to three nautical miles from its coast. This boundary was determined and set by the U.S. Supreme court in a decision in 1975. All offshore waters beyond the 3 mile boundary are owned by the Federal Government and known as the Outer Continental Shelf (OCS) waters. The State owned offshore waters are depicted in brown in picture one below. Everything landward of the state offshore waters is considered inland and everything seaward of the boundary is OCS. All of the revenue from the oil and gas produced on the OCS waters goes to the U.S. Treasury. Picture two below displays the extent of oil and gas development in the OCS waters. The management and leasing of these waters for oil and gas is the responsibility of the US Minerals Management Service.



Picture 1 - The state owned offshore waters

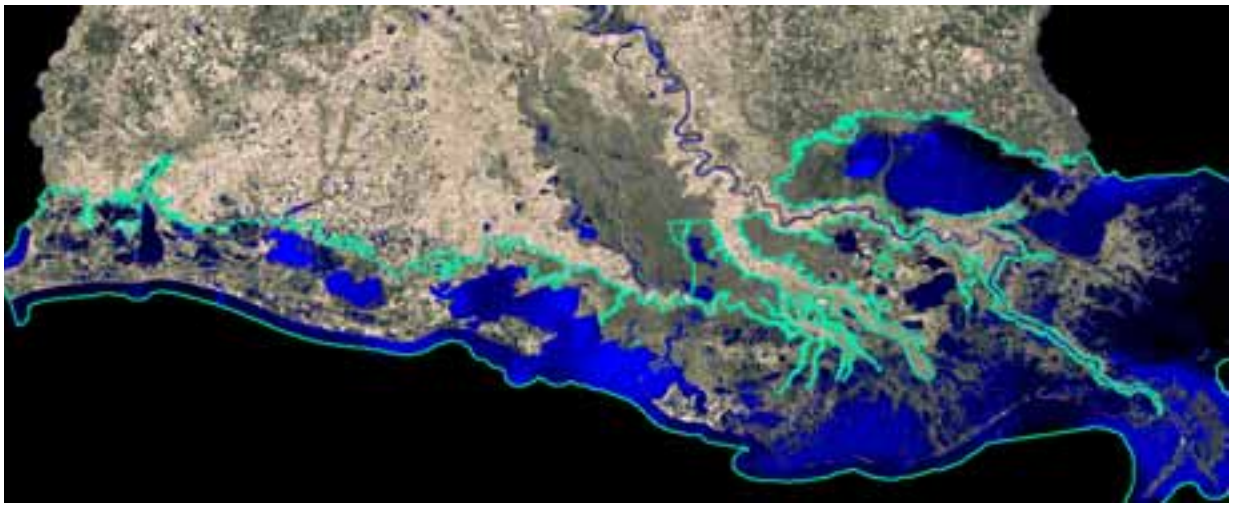
There is much debate in Congress about whether to share the revenue produced in the OCS area with the adjoining states. Coastal states wish a share of the revenue. Louisiana especially is fighting for a share of the OCS revenue to be used toward coastal restoration efforts, an effort of enormous consequence for Louisiana. The revenue generated by the Gulf of Mexico OCS production in 2005 was over $6,055,500,000. A share of these funds would greatly assist Louisiana with the coastal wetland restoration effort.

Picture 2 - The area of Oil and Gas development in the OCS waters as depicted by platform locations.

Louisiana's Coastal Area

The boundary depicted below is the delineation of the extent of tidally influenced wetlands. It is not really a contour line, but roughly represents about 4 feet in elevation. This line was developed for implementation of the Louisiana Coastal Wetlands Conservation Plan by an employee of the US Fish and Wildlife Service and the author working together using quad maps, aerial photography and years of field experience for the Louisiana Coastal Wetlands Conservation Plan. The band of wetland in the western part of the state is roughly 18 miles wide to the coast line with some areas extending much farther back.

All of the infrastructure in this region is vulnerable to hurricanes and flooding.



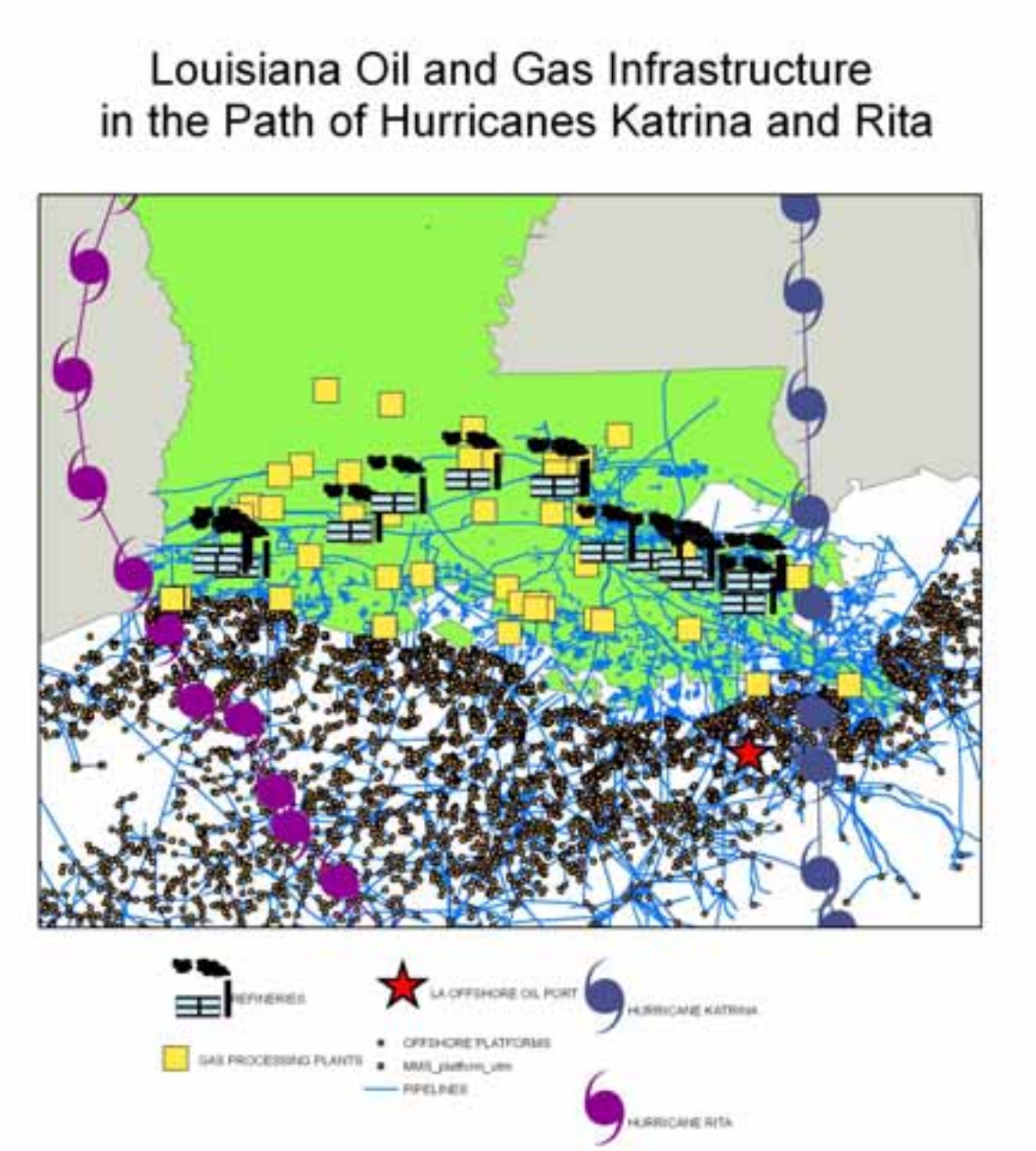
In the picture above, notice that the higher elevations are near the river and streams. Because the land was formed as a river delta, the geology is interesting. The highest elevation is near the rivers because during the annual spring floods the heavier sediments, sands and silts, settled out first. The lighter sediments, clays, settled out much later and farther from the source. The eastern part of the coastal area is sometimes called the deltaic plain as it was formed by the Mississippi River delta. Tragically, the construction of levees on the Mississippi River for navigation and flood control prevent any sediments from reestablishing the Mississippi River delta wetlands. The Corps of Engineers controls the waters of the Mississippi River for navigation. Also note the Atchafalya River Delta where there is an active delta being built. Elsewhere the wetlands are being lost to erosion and subsidence. Even with the small amount of wetlands forming in the Atchafalaya delta, we are losing approximately 24 square miles of wetlands per year.

The western part of the state is the Chenier Plain region. The old cheniers are relic beaches with wetlands developed behind the ridges from vegetation and other organic matter and wetlands developing in front to the ridges from sediment drifting from the Mississippi River

with the longshore currents. These cheniers have about 3 feet of elevation and are the only elevated land forms in this part of the state.

What is at Risk

The discussion that follows details the oil and gas infrastructure and production that is at risk from storms and flooding. Much of the infrastructure to support the OCS production is in the Louisiana coastal area. This system of coastal marshes and wetlands is in dire danger of being lost to open water, greatly increasing the risk to the nation's energy infrastructure. The nation benefits from the energy development in coastal Louisiana and the nation should recognize what is at risk and assist in restoring and protecting these wetlands.

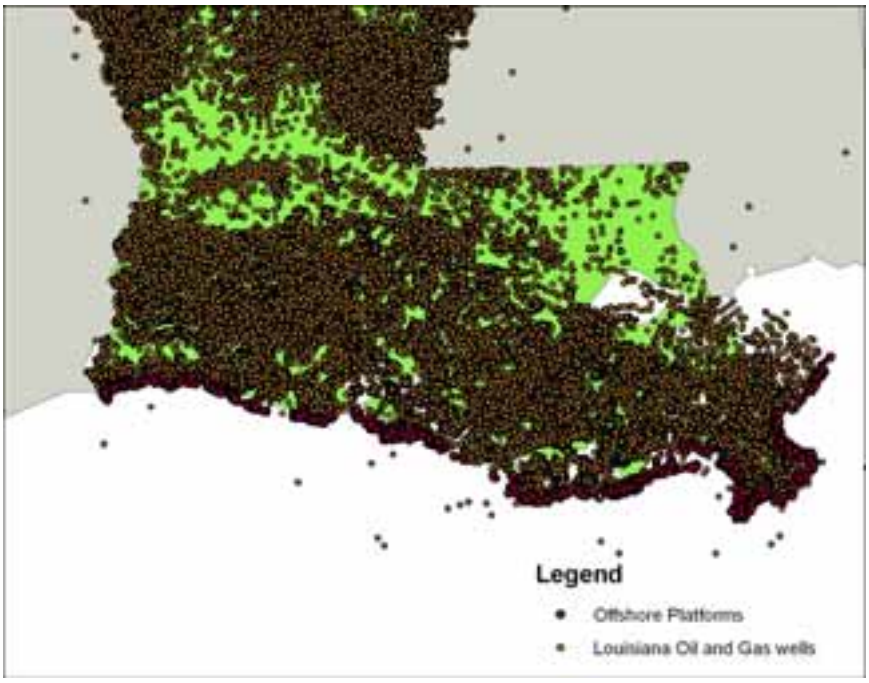


<u>Louisiana's Oil and Gas Contribution to the Nation's Energy Supply</u>

The number of producing wells in Louisiana for 2005 (see picture 3 below)
Oil -19, 674 excluding OCS
Gas – 16,125 excluding OCS

- In State offshore waters there are over 2,700 platforms. Many more in inshore bays and lakes

- In coastal LA there are over 12,000 producing wells not including OCS
- In OCS waters there are over 2,800 platforms, of which over 800 are manned



Picture 3 – Oil and Gas Wells in Louisiana

- Coastal and offshore LA produce 27% of US oil and gas
- La -190,000 barrels per day and OCS -1,500,000 barrels per day of oil
- La -1.2 million cubic feet and OCS -3.65 trillion cubic feet of natural gas
- Including the OCS waters, Louisiana is 1’st among the states in Crude oil production. Second in natural gas production.
- Excluding OCS for production within the state boundaries, Louisiana ranks 4’th in crude oil production and 5’th in natural gas production.

2005 Total Crude and Condensate production in La. 71,531,625 barrels excluding OCS
2005 Total Crude and Condensate production in La. 405,825,406 barrels including OCS

2005 Total Gas production in La. 1,206,797,402 MCF excluding OCS
2005 Total Gas production in La 3,194,715,118 including OCS

See the graphs below from the *Louisiana Energy Facts 2005*, published by La. DNR.

Figure 1

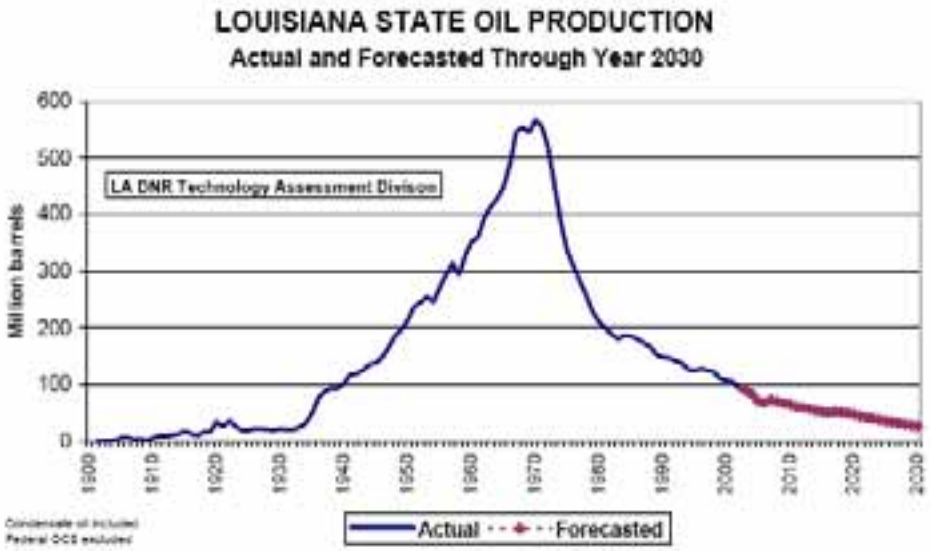
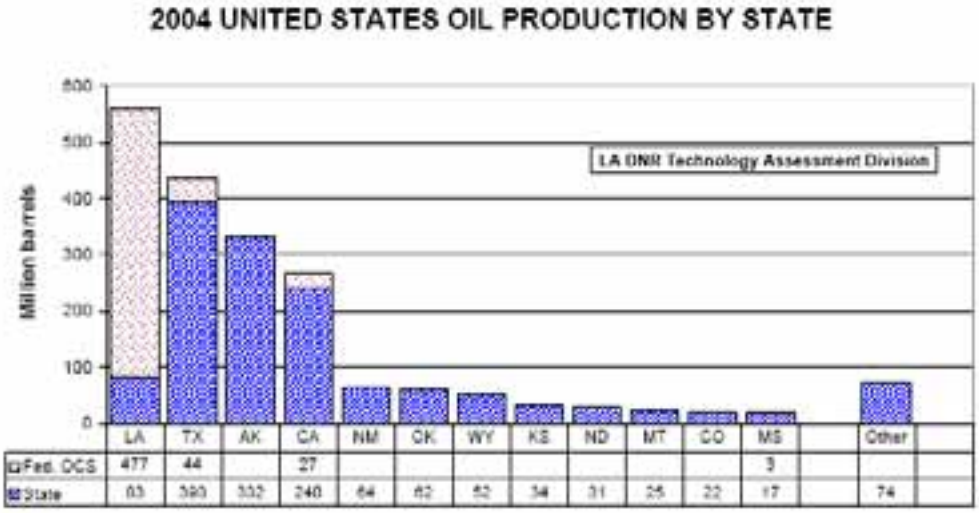


Figure 2



	LA	TX	AK	CA	NM	OK	WY	KS	ND	MT	CO	MS		Other	
Fed. OCS	477	44		27								3			
State	83	390	332	240	64	62	52	34	31	25	22	17		74	

Figure 3

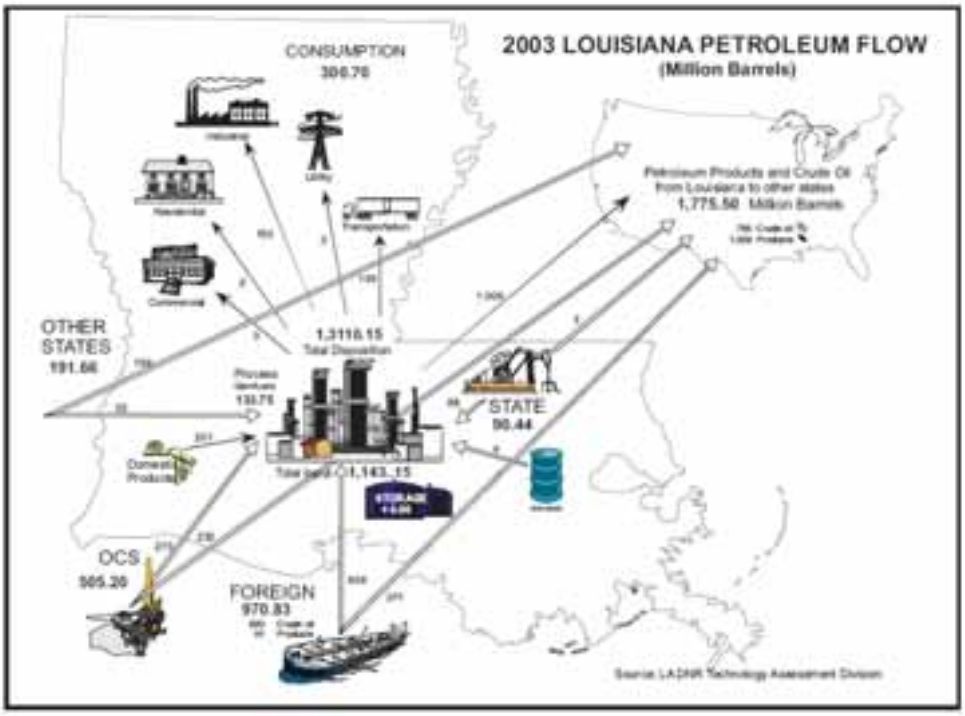

2003 LOUISIANA PETROLEUM FLOW
(Million Barrels)
CONSUMPTION
Petroleum Products and Crude Oil
from Louisiana to other states
1,775.50 Million Barrels
OTHER
STATES
191.66
1,311.15
Total Disposition
STATE
90.44
OCS
505.20
FOREIGN
970.83
Source: LA DNR Technology Assessment Division

Figure 4

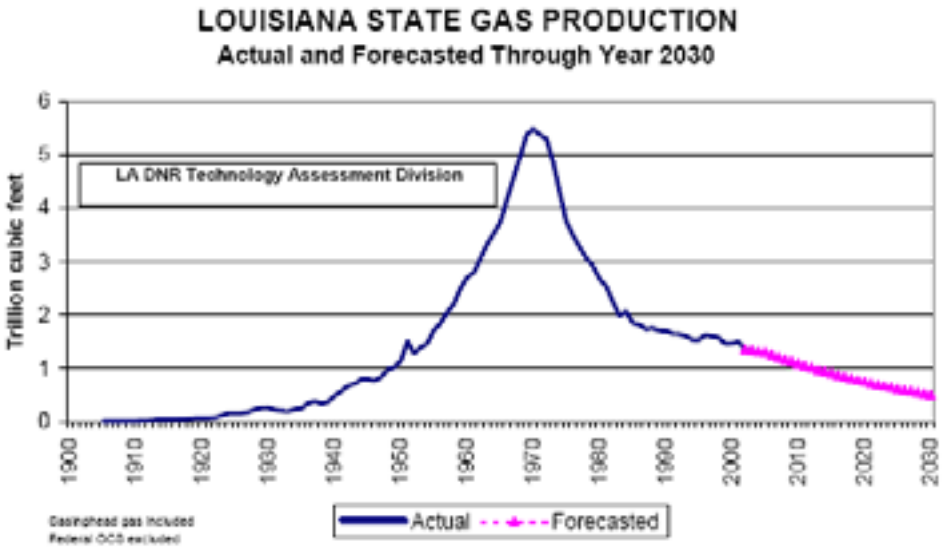
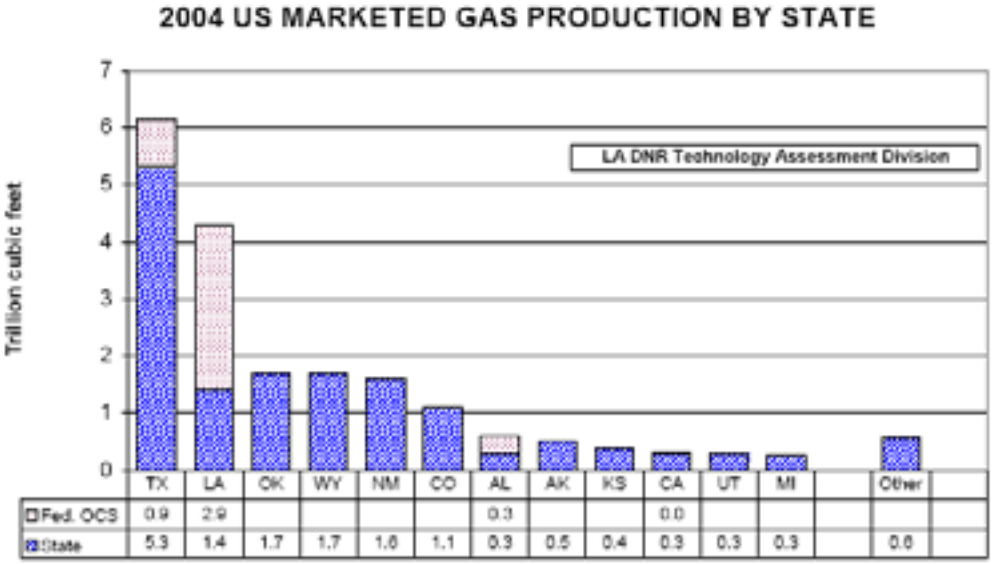
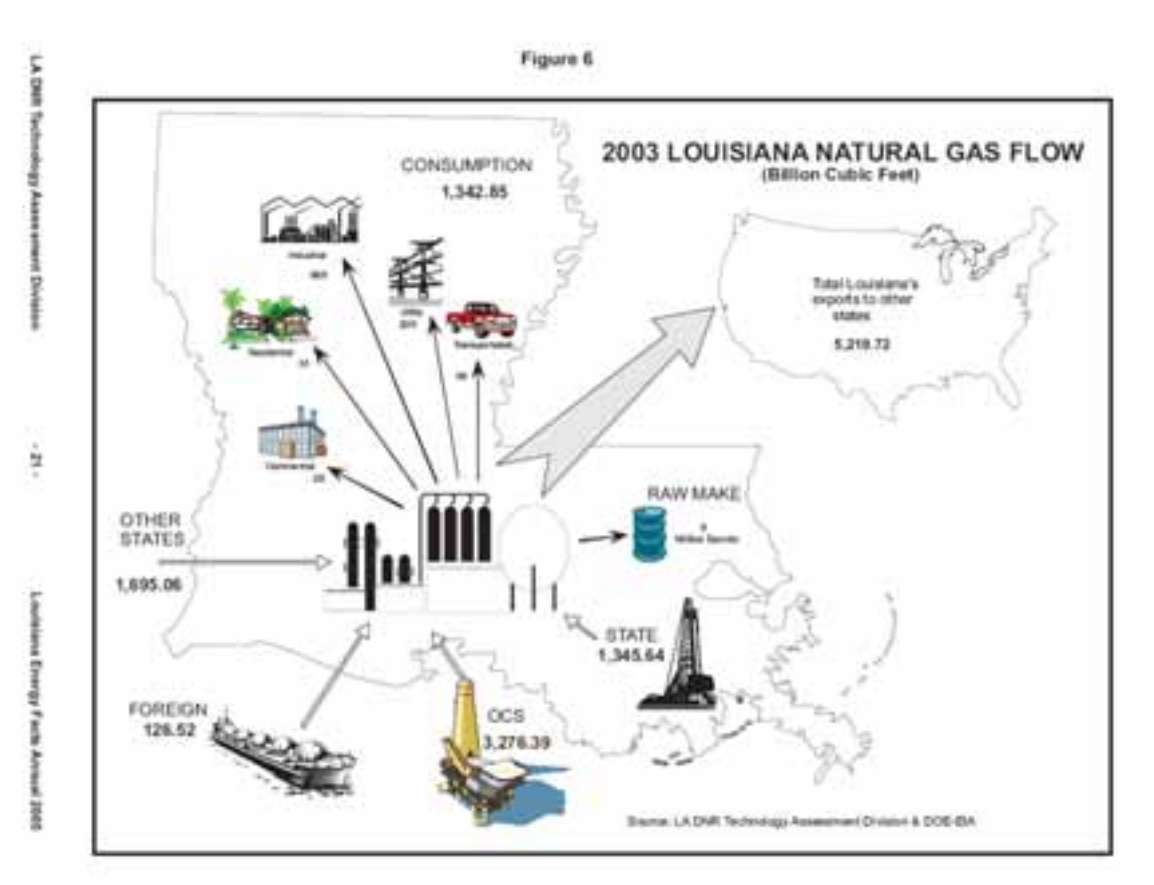


Figure 5





The Louisiana Offshore Oil Port (LOOP)

The Louisiana Offshore Oil Port is an offshore terminal where large ships and supertankers offload imported crude oil. The facility became operational in 1981 and is owned by a consortium of oil companies. It operates under the oversight of state and federal regulatory regimes. The location was selected due to the nearby location of the bulk of the nations refining capacity and the location of underground salt domes to store the inventories of crude oil. It is located 18 miles south of the Louisiana coast in 110 feet of water, (the tankers can draft up to 85 feet). Oil flows to an onshore booster station through a 48 inch pipeline and is then pumped another 25 miles inland to the Clovelly terminal. LOOP also operates another 48 inch pipeline system connecting to an inland terminal to distribute the crude oil to refineries in Louisiana, Texas and the Midwest.

This facility, LOOP, transports 10% of the nation's imported oil. Approximately 365,000,000 barrels per year of imported oil flow through the LOOP facility.

Liquefied Natural Gas (LNG)

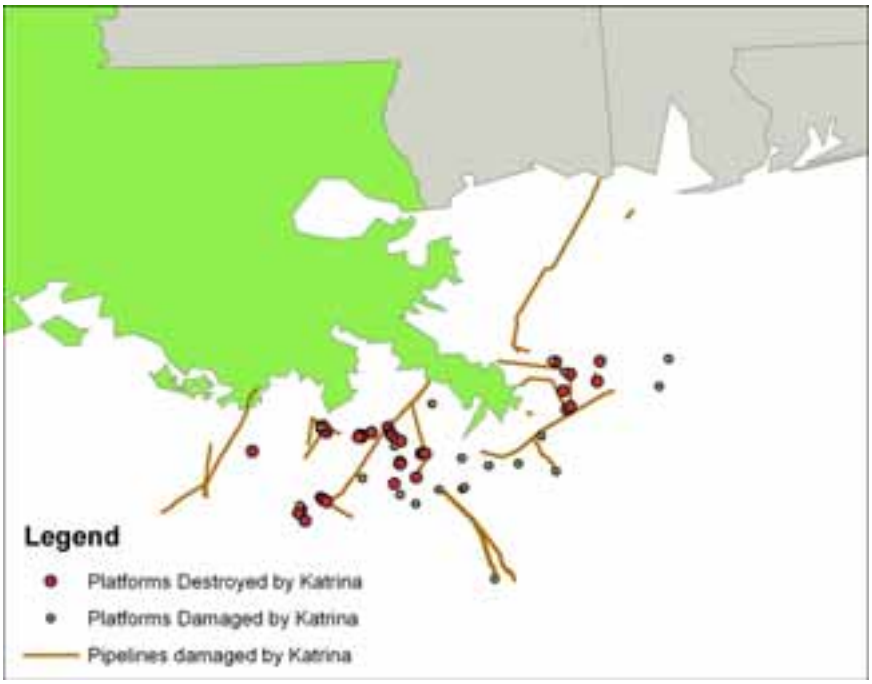
The nation is becoming more and more dependant on imported natural gas. This gas is shipped in liquid form and revaporized at plants that then transport the gas via pipeline. US consumption of natural gas in 2005 was 22,000 BCF yet domestic production was only 18,000 BCF. There is currently one LNG facility operating in Louisiana, one under construction and many more planned near and offshore of Louisiana. Almost all new United States LNG facilities under consideration are along the Louisiana/Texas Gulf coast.

Impacts to OCS Production and Facilities

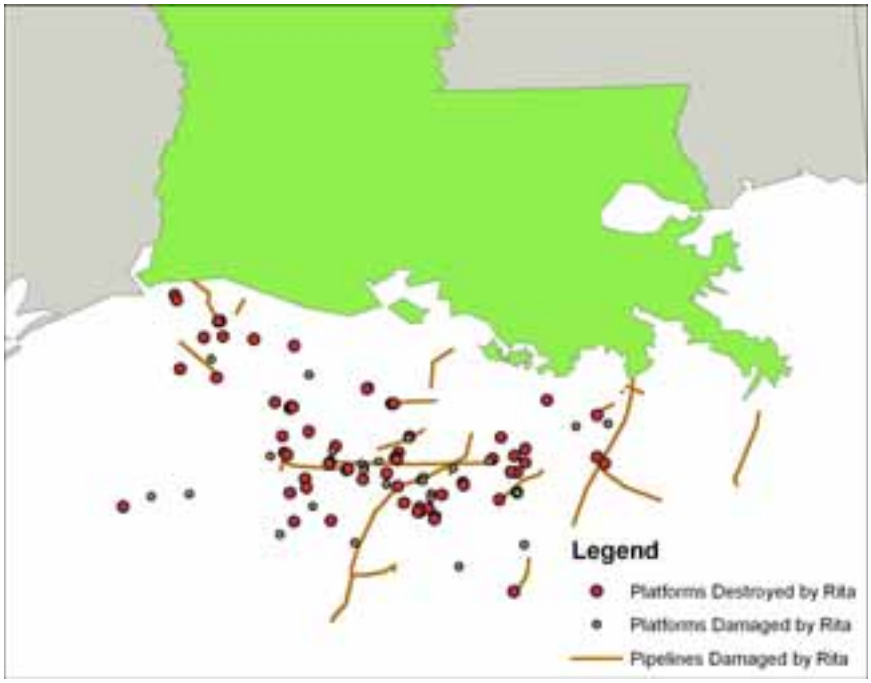
(The following text is taken from the *U.S. Minerals Management Service News Release* dated January 19, 2006, release 3418. Graphics created by the author in ArcGIS from MMS data.)

The Gulf of Mexico, one of the nation's largest sources of oil and gas production, was dealt a one-two punch by these hurricanes, causing destruction and substantial damage to offshore platforms within a four-week period in August and September. MMS estimates that 3,050 of the Gulf's 4,000 platforms and 22,000 of the 33,000 miles of Gulf pipelines were in the direct path of either Hurricane Katrina or Hurricane Rita. Because of the large amount of infrastructure in the path of hurricane-force winds and waves, the amount of damage was substantial. In comparison with Hurricane Ivan in 2004 (which destroyed seven platforms), Hurricanes Katrina and Rita accounted for considerably more damage because of the paths taken by these two devastating storms. However, there was no loss of life or significant oil spills from wells on the outer continental shelf (OCS) attributed to either storm.

Hurricane Katrina, which was a category 5 hurricane when it entered the OCS, destroyed 46 platforms and damaged 20 others. As of January 2006, 100 damaged pipelines and 211 minor pollution incidents on the OCS have been reported to MMS. Minor pollution incidents are defined as incidents involving less then 500 barrels of oil that do not reach the coast line. Included in the 100 damaged pipelines in Federal waters were 36 large diameter pipelines (10" or larger) that were damaged. Twelve of these 36 have returned to service as of January, 2006.



Hurricane Rita, which was a category 4 hurricane when it entered the OCS, destroyed 69 platforms and damaged 32 others. As of January 2006, 83 damaged pipelines and 207 minor pollution incidents on the OCS have been reported to MMS. Included in the 83 damaged pipelines in Federal waters were 28 large diameter pipelines (10” or larger) that were damaged. Ten of these 28 have returned to service.



One hundred percent of Gulf oil production, which is approximately 1.5 million barrels a day, was shut-in during both storms and 94 percent of gas production, which is 10 billion

cubic feet of gas a day, was shut-in during Hurricane Katrina. More than 90 percent of the manned platforms and 85 percent of working rigs were evacuated at one time. Daily production of about 396,000 barrels of oil and about 1.8 billion cubic feet of gas remain shut-in in January 2006. For a long-term projection, approximately 255,000 barrels a day and 400 million cubic feet of gas a day will probably not be restored to production prior the start of the 2006 hurricane season.

Inshore Impacts

The Henry Hub is the nexus of 13 natural gas pipeline systems that draw supplies from prolific offshore and onshore gas fields in Louisiana and Federal OCS waters. These crucial supplies are then piped to markets along the East Coast as far North as the New England area, east and west across the Gulf Coast, north into the Midwest , and even up to the Canadian border. The Sabine Pipeline system, operator of the Henry Hub sustained wind damage in the vicinity of the Port Neches compressor station and water damage at the Henry Hub facilities. There was also no electric service in most areas of the system and the Sabine Pipeline was out of service for several weeks shutting down the Henry Hub.

After the hurricanes passed, the following 14 gas plants closed due to flooding, lack of supplies, an inability to move stored liquids, or as a safety precaution (the parish of each location is in parentheses): Barracuda (Cameron), Bluewater (Acadia), Burns Point (St. Mary), Cameron (Cameron), Gillis (Calcasieu), Lake Charles (Calcasieu), Lowry (Cameron), Paradis (St. Charles), Tebone (Ascension), Sabine Pass (Cameron), St. Landry (Evangeline), Stingray (Cameron), Venice (Plaquemine), and Yscloskey (St. Bernard). The processing plants known to be not operating have a combined capacity of more than 10 BCF per day, however, this number does not reflect actual flows before Hurricanes Katrina and Rita. In December, Duke Energy Field Services (DEFS) noted that refineries and fractionators along the Gulf Coast affected by the hurricane are discontinuing their operations, resulting in a lack of natural gas liquids take-away capacity. The loss has delayed, and will continue to delay, the recovery of natural gas production in the area. Even if platforms and pipelines are either unaffected or readily restored to service, the gas often can not flow to market without treatment. In 2003 (the latest year with complete data), almost three-fourths of total U.S. marketed gas production was processed prior to delivery to market. On December 27, 2005, EIA reported that most of the inactive plants are expected to be operating by January 2006.

Refineries

(Text in this section on refineries from *Impacts of '05 Hurricanes on Louisiana's Energy Industry* by Bryan Crouch, Manuel Lam, and Patty Nussbaum, Louisiana Department of Natural Resources)

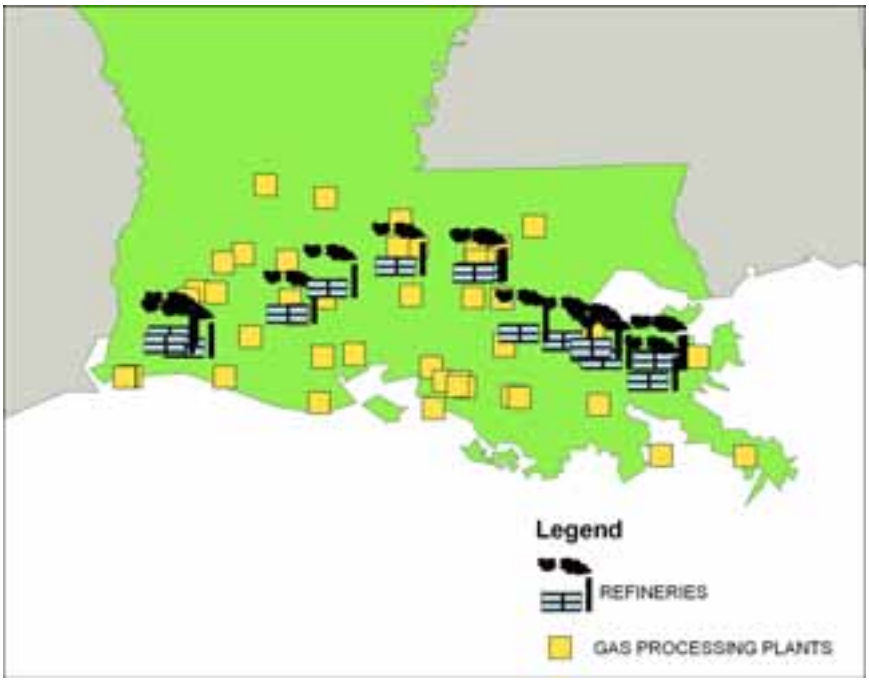
Two characteristics of the U.S. refining industry were highlighted when Hurricanes Katrina and Rita struck; the concentration of refineries along the Gulf Coast, and the low surplus refining capacity. Operable refinery utilization rates increased dramatically from the early 1980s to the late 1990s and have remained high since then. High operable utilization rates

translate into low spare capacity which reduces the industry's ability to maintain adequate fuel supplies should a loss of capacity occur. Basic economics teaches us that when supply decreases relative to demand, prices increase. That was precisely the scenario that played out in the summer of 2005 when Hurricanes Katrina and Rita blew ashore into areas of Louisiana and Texas that are home to 38% of the U.S. refinery capacity. Prior to Hurricanes Katrina and Rita, the U.S. refinery operable capacity was 17,124,870 million barrels per calendar day (bcd) (with an operating utilization rate of 93.2%), and idle capacity stood at 118,580 bcd. The combined refinery capacity that was in the paths of hurricane Katrina and Rita totaled approximately 6.5 MMB per day, or 38% of the total U.S. refining capacity. On August 28, in preparation for the storm, approximately 2.1 million bcd (325,000 bcd from one refinery in Mississippi and the rest from ten refineries in Louisiana) went off line. After Katrina blew through and power began to be restored, refineries that sustained minor or no damage began to come back online.

Then, on September 24, with 879,000 bcd of refinery capacity in Louisiana and Mississippi still shut down due to Hurricane Katrina, Hurricane Rita came ashore and reduced refinery capacity by an additional 4 million bcd (594,000 bcd from three Louisiana refineries and 3.4 million bcd from thirteen Texas refineries). Table 1 lists the 13 Louisiana refineries affected by Hurricanes Katrina and Rita. In the wake of the storms, several refineries sustained significant damage. Three refineries in Louisiana (see Table 1) and Chevron's Pascagoula refinery sustained major damage. All of the affected refineries are currently back on-line and operating at or near full capacity, except Murphy Oil in Meraux which expects to return to operation by April. Figure 2 shows shut down refinery capacity versus time.

Table 1. Louisiana Refineries Affected by '05 Hurricanes

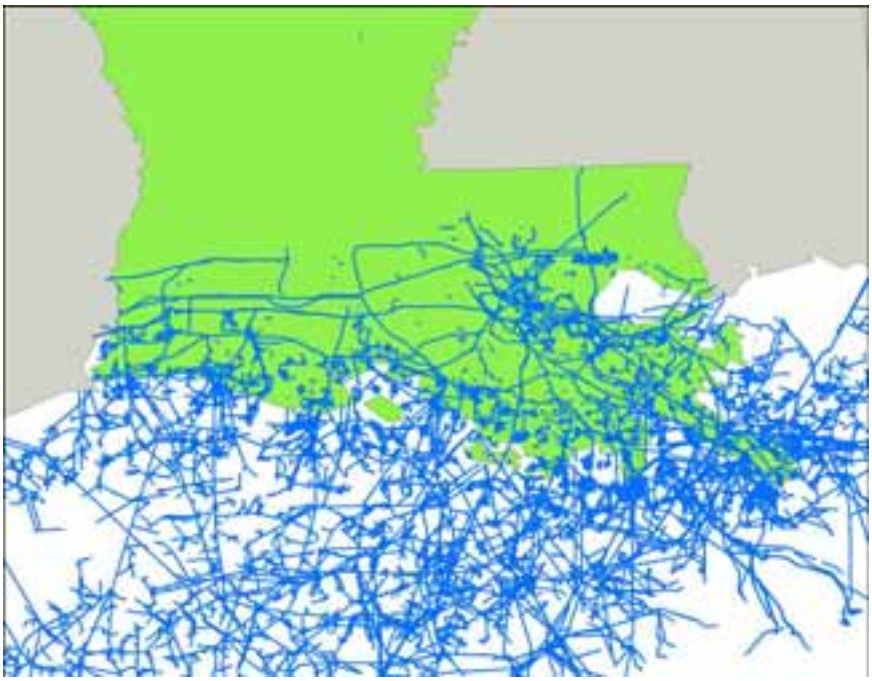
Hurricane	Refinery	Location	Capacity (bcd)	(Note)
Katrina	ConocoPhillips	Belle Chase	247,000	(major damage)
	Chalmette Refining	Chalmette	187,200	(major damage)
	ExxonMobil	Baton Rouge	493,500	
	Marathon Petroleum	Garyville	245,000	
	Murphy Oil	Meraux	120,000	(major damage, still shutdown)
	Motiva	Convent	235,000	
	Motiva	Norco	226,500	
	Placid	Port Allen	48,500	
	Valero	Krotz Springs	80,000	
	Valero	Norco	185,000	
Rita	Citgo	Lake Charles	324,300	
	ConocoPhillips	West Lake	239,400	
	Calcasieu	Lake Charles	30,000	



Pipelines

In order to move the tremendous volumes of oil and gas, many miles of pipelines have been laid in coastal Louisiana. All of the oil and gas from the OCS region and coastal Louisiana is transported via pipeline to consumers all over the country.

- In OCS waters there are almost 14,000 pipeline segments and total of 37,000 miles of pipeline
- In Coastal Louisiana there are almost 23,000 pipelines and total of over 26,500 miles of pipeline
- Total of more than 63,500 miles of pipeline


Pipelines in Coastal Louisiana

Other Effects

Inshore, the two hurricanes shut in 14 major gas plants and 8 refineries, causing major damage to 3 refineries. It shut in over 1400 producing wells and numerous pipelines and smaller tank batteries and production facilities.

The Murphy Oil refinery in Meraux spilled several million gallons of oil into the town or Meraux. Four other major spills totaled over 11 million of gallons of oil spilled between New Orleans and the mouth of the Mississippi River.

Lessons and Messages

The Gulf of Mexico OCS production is a major supplier of the nations energy needs and is dependant on the inshore facilities. What can we do? We have to protect, restore and rebuild our wetlands. Our coastal wetlands are home to numerous world ranked ports, and supply a large percentage of the nation's oil and gas and at the same time produce the most seafood in the nation and provide immeasurable recreational enjoyment. We need to have these wetlands healthy to help reduce the impacts of storm surges. The wetlands absorb and reduce the wave forces and flood heights during a storm much more than open water. Much of the oil and gas infrastructure was designed and built to be onshore. Without the wetlands to protect the oil and gas infrastructure, much of the industry will have to be redesigned and rebuilt to withstand open water forces. The energy consumers of our nation will have to pay for this. The future appears to be one where our marshes are facing rising sea level, more

and stronger storms, the length of the storm season appears to be extending; all due to warming sea temperature. Coastal Restoration must be a priority for America.

Acknowledgments

Louisiana Energy Facts 2005, published by La. DNR.

Impacts of '05 Hurricanes on Louisiana's Energy Industry by Bryan Crouch, Manuel Lam, and Patty Nussbaum, Louisiana Department of Natural Resources, February 2006.

America's Energy Corridor, Louisianan Serving the Nation's Energy Needs by Paul Sprehe, published by La. DNR.

U.S. Minerals Management Service News Release dated January 19, 2006, release 3418.

Various other MMS press releases concerning production and shut-in data during the periods August 2005 through March 2006.

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