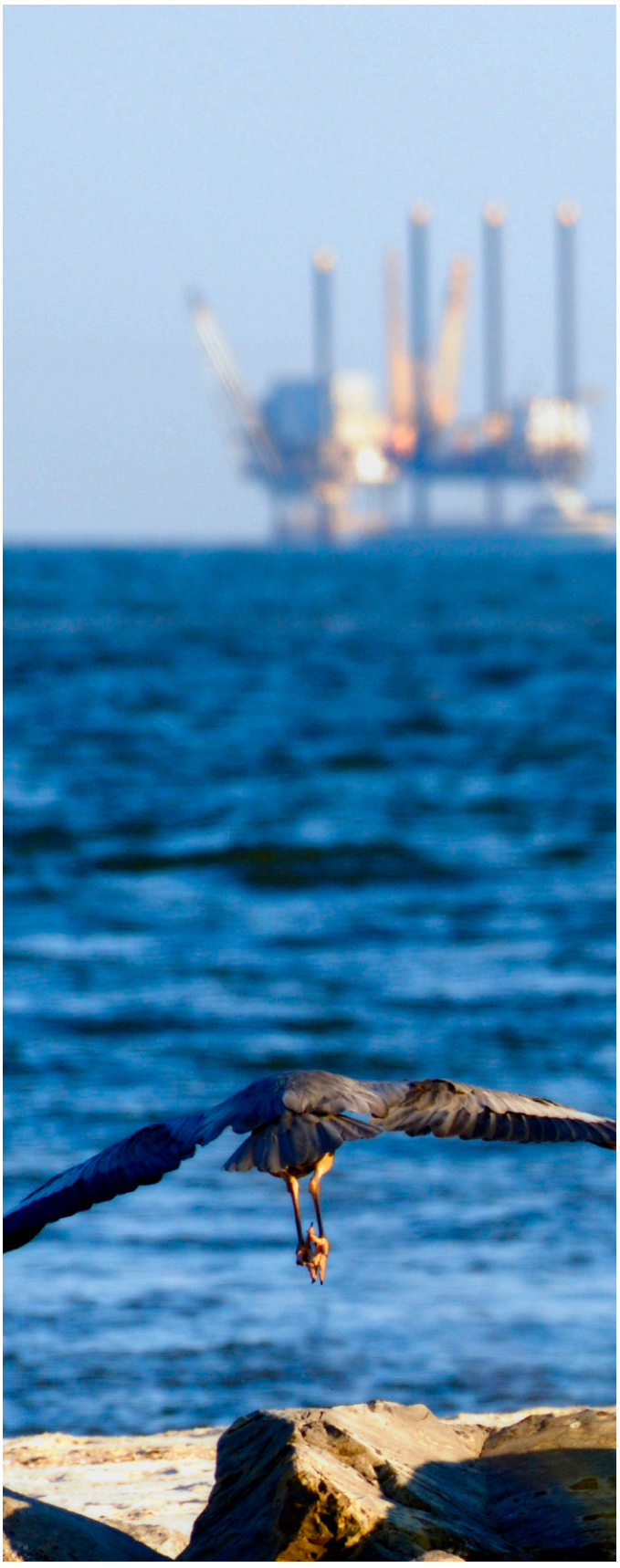


ANNUAL REPORT 2015

LSU
CENTER FOR ENERGY STUDIES

ANNUAL REPORT 2015

CONTENTS

2015: Center for Energy Studies

DAVID DISMUKES
EXECUTIVE DIRECTOR
enrg.lsu.edu

This past year represents a transition to crisis in so many ways for the energy industry. Prices have fallen to lows not seen in several decades as U.S. producers struggle to preserve hard-fought gains made over the past eight years propelling the U.S. back into the top ranks of the world's leading crude oil producers. OPEC, under Saudi Arabian leadership, has been unwilling to accept the successes of the American "Shale Revolution" and continues a predacious production strategy that could ultimately backfire, challenging its very existence, much less its position as swing producer to the world.

Russia, not known to back down from a spirited geo-political challenge, has helped exacerbate recent excess market supply conditions by pumping additional barrels of crude oil in order to fund expansionist policies along their borders as well as increasingly in the Middle East.

Iran, once a pariah to the global community, is close to reaching its pre-sanctions level of production and exports as a result of U.S. nuclear treaty negotiations. At the same time, a tense relationship continues between Iran and Saudi Arabia over who will dominate Middle Eastern geopolitics and OPEC. Both appear more than willing to enter into a crude oil producing game of "chicken" in order to financially crush one another, as well as fund their respective proxy wars and conflicts throughout the region.

Couple these supply-side challenges with economic malaise in Europe, challenged Japanese economic activity, a U.S. economy that stubbornly cannot seem to claw its way from back to its pre-recession levels of growth, and it is easy to see why the current energy crisis could prove to be one of the more extreme, harsh, and long-lived ever faced.

Industry and market changes over the past year have kept CES extremely busy. Media inquiries have picked up to levels not seen since the advent and aftermath of Hurricane Katrina. Our faculty and staff continue to be highly-sought after speakers at professional, academic, and civic association meetings and conferences, domestically and abroad. Center faculty have also sponsored several energy-related seminar sessions at important academic conferences over the past year.

The Center continues to work with our LSU colleagues to expand our collective energy industry-related research, as well as develop new energy minors, certification programs, and concentrations of study that will prepare the next generation of energy professionals. Center faculty teach very popular under-graduate and graduate level courses in the College of Engineering and the College of the Coast and Environment and are often called upon to give guest lectures on a regular basis throughout the LSU curriculum. Our educational contributions are not limited to LSU alone, but include short course instruction and professional education at the University of Oklahoma and Michigan State University.

This past year represents another in which the Center has been able to grow our research faculty ranks with the addition of Dr. Mallory Vachon, an expert in the analysis of energy labor markets: a skill set in high demand given current market changes and industry re-configurations. The Center's strategic plan envisions continued growth in both our own internally-funded faculty numbers

as well as through the development of joint faculty lines with other LSU colleges and research institutes. We hope, in 2016, to develop a new Research Fellows program and add new adjunct faculty lines to expand the scope of our research potential and to facilitate greater interaction between the Center and LSU's traditional academic units.

CES faculty productivity continues to be enviable based upon any commonly used academic or professional research metric. Externally-funded research dollars per faculty member, publications, academic conference papers, peer-reviewed journal and proceedings articles are all at impressive levels. But our work has not been limited to just the academy alone. CES faculty publish extensively in trade and professional publications, led by one of our more prolific faculty researchers, Dr. Mark Kaiser. One of our newer faculty members, Dr. Greg Upton, also produced a highly-cited and timely public policy report examining the issue of allowing U.S. crude oil exports and the potential impact on Louisiana.

Louisiana Geological Survey researchers and cartographers continue to be called upon to provide expertise related to the state's energy, mineral, water and environmental resources. Contracted by The Water Institute of Gulf on behalf of Coastal Protection and Restoration Authority of Louisiana, LGS staff are developing a 3-D GIS dataset of the Holocene-Pleistocene surface of the Louisiana coastal plain and waters. Ultimately, this comprehensive surface model will assist in engineering design for coastal restoration projects and support decision-making on coastal issues and subsidence modeling. The award-winning LGS Cartography Section is updating the Oil and Gas Fields Map of Louisiana, last published in 2008. The map will show depleted and inactive oil and natural gas fields, as well as waterways, main highways and parish boundaries.

LSU Radiation Safety, which oversees the implementation of radiation control policies and ensures safety practices for the LSU System, currently monitors the work of 875 radiation workers in more than 200 laboratories on the main campus and at the Agricultural Center, the Pennington Biomedical Research Center, the Center for Advanced Microstructures and Devices, the Louisiana Emerging Technology Center, and the National Center for Biomedical Research and Training. In 2015, RSO Director and Professor Wei-Hsung Wang was elected as a fellow of the Health Physics Society, an honor limited to less than one-half of one percent of the society's members.

While the challenges of the past year have been considerable and sobering, the Center continues to deliver a significant return on investment to our primary shareholder: the citizens of the State of Louisiana. We hope this annual report communicates our continued strong productivity and contributions during a fiscally-challenging time period for both government and industry. The Center appreciates the continued and strong support we get from the LSU administration, particularly from the LSU Office of Research and Economic Development, our Industry Associates Advisory Council, and stakeholders like you who help the Center maintain its unique role as Louisiana's flagship university energy research institution.

David E. Dismukes
Executive Director and Professor

Research

Upton Examines Implications of Lifting of Crude Oil Export Ban

In late 2015, the federal government repealed the 40-year ban on the export of crude oil as part of its omnibus spending bill. Prior to the repeal, in November, Gregory Upton, assistant professor, LSU Center for Energy Studies, released a report that analyzes the potential economic implications of the removal of the export ban, which had been in place since the adoption of the 1975 Energy Policy and Conservation Act (EPCA).

The study, titled "Crude Oil Exports and the Louisiana Economy: A discussion of U.S. policy of restricting crude oil exports and its implications for Louisiana," takes into account implications of the ban in light of the recent shale boom, which has created historic increases in oil and gas production and prompted Congress to consider whether the export ban was still in the best interest of the nation.

Upton's analysis considers the claims made by prior studies that, were the ban repealed, there would be significant economic benefits primarily due to increases in domestic oil production and that the lifting of the ban would not lead to increases in gasoline prices for consumers but could possibly result in a drop in gasoline prices.

In addition to determining the plausibility of the claims made by previous studies, Upton considers how the lifting of the export ban might impact Louisiana's economy by focusing on the likely effects of the ban on Gulf Coast oil producers (upstream) and refineries and petrochemical plants (downstream). His results suggest that large economic benefits associated with the removal of the export ban are implausible.

According to the report, most of the price differential between domestic and foreign crude prices is likely associated with shipping costs and constraints within the U.S., not the export ban. And while refineries in general benefit from the export ban at the expense of producers, these transfers are transitory and are likely not large in magnitude.

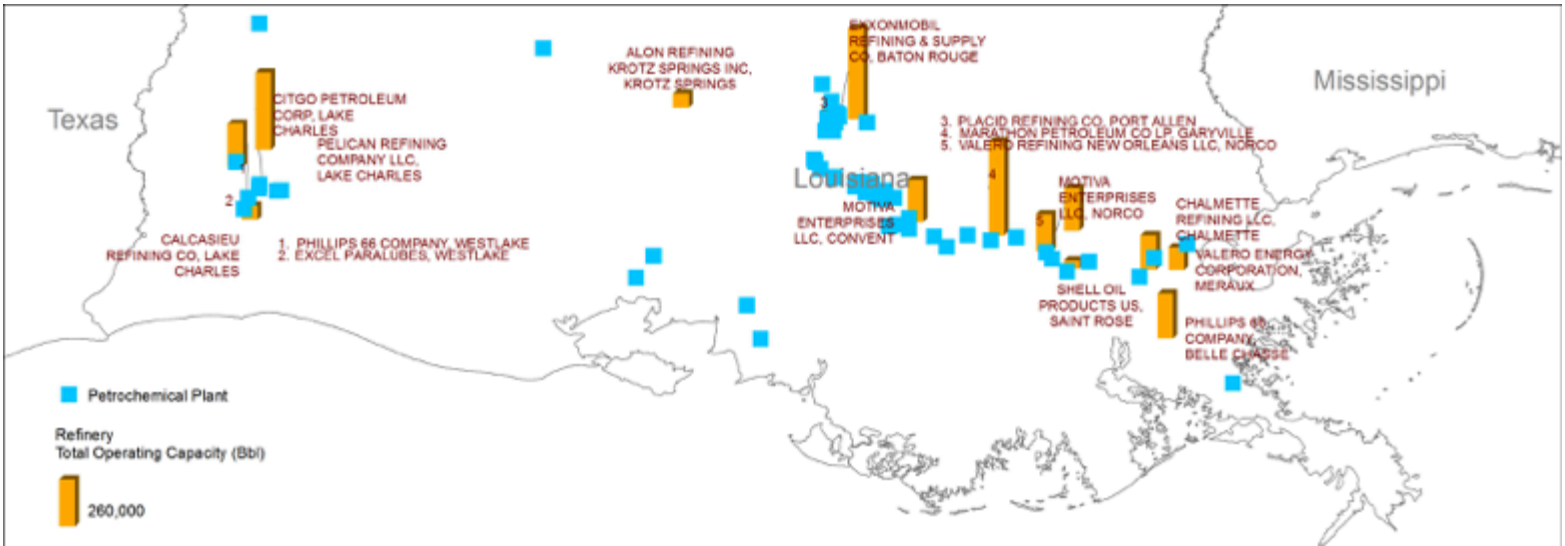
Upton's analysis does corroborate other studies that have determined that the lifting of the ban would not likely impact gasoline prices.

Upton has stated that the purpose of the study was not to make a specific recommendation on whether the ban should be lifted, nor did itquantify a net cost/benefit to Louisiana's economy. Instead, it identifies specific tradeoffs that could be considered by policymakers when deciding whether the ban was in Louisiana's or the United States' interest.

The report states that the export ban is effectively a protectionist policy for the refining and petrochemical industries and that, if U.S. crude production continues to rise and reaches a point for which current refining capacity is insufficient to process the domestic crude, an export ban effectively guarantees that the investment in new refining capacity will be here in the U.S.

The complete report can be viewed and downloaded at http://www.enrg.lsu.edu/files/images/publications/online/2015/Upton-CrudeOilExports_LouisianaEconomy.pdf

Lifting the export ban and allowing for free trade of all hydrocarbons can create an environment that allows for the Gulf Coast to become the epicenter for hydrocarbon trading.



Upton, Snyder Examine Renewable Energy Potential, RPS Adoption

In their paper published in *Utilities Policy* (36 October 2015: 67-70), Assistant Professor Greg Upton and Research Associate Brian Snyder examine the impact of renewable energy potential on renewable portfolio standards adoption. Thirty states have adopted renewable portfolio standards (RPSs) that set targets for renewable energy generation by mandating electric power utilities obtain a minimum percentage of their power from renewable sources. To date, there have been a number of studies that have consistently found that political and economic factors impact RPS adoption. There have also been studies that examine the impact of the amount of renewable energy potential in a state on the probability of RPS adoption, but results have largely been statistically weak and inconclusive. After controlling for political and economic factors, Upton and Snyder estimate that a one-standard deviation increase in wind potential is associated with an approximately 4.2 percentage point increase in the probability of having a RPS, and a one-standard deviation increase in solar potential is associated with a 6.1 percentage point increase in the probability of having a RPS. Currently, a follow-up study is being conducted to test the impact of RPSs on a number of state level outcomes such as renewable energy generation and electricity prices while taking into account non-random selection into the policy.

Renewable Energy Analysis Tests for Economies of Scale, Learning Effects for Wind Projects

Recently, "pilot projects" for offshore wind development have been proposed in states such as Maine and New Jersey, with the goal of inducing cost savings in future larger utility scale projects, resulting in the need for a close look at the impacts of country-specific learning effects. A recent paper by David Dismukes and Greg Upton, published in *Renewable Energy* (83 November 2015: 61-66), presents a model of overnight development costs for offshore wind projects and tests for the presence of economies of scale and learning effects, both industry-wide and country-specific. Forty-one European offshore wind projects were used in the analysis. Results do not suggest that the costs exhibit economies of scale, nor is there robust evidence of either industry-wide or country-specific learning effects.

USAEE Dialogue Publishes Vachon's Economic, Labor Market Comparison Study

In "A Comparison of the Economic and Labor Market Impacts of Resource Extraction," (*USAEE Dialogue*, Vol. 24. No. 1, January 2016), Mallory Vachon examines differences and similarities between the local economic landscapes of the Appalachian coal-producing region and the Bakken oil-producing region in North Dakota. In particular, she considers the local labor market conditions in each of the resource-rich regions to provide insights into the relative impacts of the different resource shocks that impacted the demand for labor. Using the Integrated Public Use Micro Samples of Census and American Community Survey (ACS) data, she provides a comparative analysis of employment and industry trends across the two regions. Overall, the evidence suggests that the two regions were similarly impacted by their respective booms, and the characteristics of the overall workforce and extractive industry workforce are nearly equal over time, findings that suggest that valid comparisons can be made across the two regions.

Decommissioning, Revenue Sharing, Focus of 2015 Kaiser Research

In approximately one dozen published works in 2015, CES Professor Mark Kaiser addresses timely offshore oil and gas issues related to decommissioning, Gulf of Mexico revenue sharing, and offshore service vessel activity. In a paper titled "A new approach to decommissioning cost estimation using settled liability data," published in *Engineering Economist* (60, 3:197-230), Kaiser uses settled liability data from 17 public companies with operations primarily in the Gulf of Mexico to infer private information on the cost of decommissioning in the Gulf of Mexico. The cost to decommission a structure, between 2008 and 2012, evaluated on a regional basis and by operator, is estimated to be $6.4 million in water depth less than 200 ft and $15.6 million in water depth greater than 200 ft. Average cost statistics are suggested as a market index for Gulf of Mexico decommissioning activity.

In his paper "Asset decommissioning risk metrics for floating structures in the Gulf of Mexico," (*Risk Analysis: An Official Publication of the Society for Risk Analysis* 35(8):1562-1590), Kaiser presents a decommissioning risk metric defined in terms of the ratio of the expected value of an asset's reserves to its expected cost of decommissioning. He states that asset decommissioning risk (ADR) is more difficult to compute than a consolidated corporate risk measure, but can be used to quantify the decommissioning risk of structures and to perform regional comparisons, and also provides market signals of future decommissioning activity. Application of the proposed metrics in the regulatory review of supplemental bonding requirements in the U.S. Outer Continental Shelf is suggested to complement the current suite of financial metrics employed.

Kaiser's *Oil & Gas Journal* series of articles, "GOM revenue sharing," examines implications of the Gulf of Mexico (GOM) Energy Security Act of 2006 (GOMESA), which provides for sharing offshore lease revenues in the GOM Outer Continental Shelf (OCS). The three-part series estimates the range of future GOMESA Phase II qualified revenues without specifically forecasting GOM hydrocarbon futures, a particularly challenging task given inherent market uncertainties and the Phase II time frame, which extends beyond midcentury. Instead, the series describes, what amount of qualified revenues will be generated and how much of them will be shared. This first article reviews lease sales, the engine of OCS activity, and describes the leasing process and revenue components. It analyzes 20 years of lease-sale data, including the amount of acreage available, bid on, and awarded. Parts two and three qualify and model the individual components of OCS revenue and forecast qualified revenue streams for GOMESA Phase II.

In his *Marine Policy* paper, "Offshore Service Vessel activity forecast and regulatory modeling in the U.S. Gulf of Mexico, 2012–2017,"(57:132-146), Kaiser quantifies port activity according to offshore activity expected to arise from current and new lease sales categorized according to water depth, planning area, and vessel class. He notes that between 53,000 and 119,000 trips per year are expected to be required to support exploration, development and production in the Gulf of Mexico from 2012 to 2017, and approximately half of all trips are expected to emanate from Port Fourchon, La., with the next largest port, Cameron, La., contributing an additional 14 percent of activity. During the 2012–2017 period, the majority of trips are expected to support shallow water production operations.

To view or download CES publications, visit www.enrg.lsu.edu/publications

CES 2015 Publications

Dismukes, D.E. and G.B. Upton, Jr. Economies of scale, learning effects and offshore wind development costs. *Renewable Energy* 83 (2015): 61-66.

Dismukes, D.E., G.B. Upton, Jr., and S.R. Barnes. Economic and Policy Issues in Sustaining an Adequate Oil Spill Contingency Fund in the Aftermath of a Catastrophic Incident. *Proceedings of the Thirty-seventh AMOP Technical Seminar on Environmental Contamination and Response.* June 2014.

Kaiser, M.J. A new approach to decommissioning cost estimation using settled liability data. *Engineering Economist* 60 (3): 197-230.

—. Asset decommissioning risk metrics for floating structures in the Gulf of Mexico. *Risk Analysis: An Official Publication of the Society for Risk Analysis* 35 (8): 1562-1590.

—. Clarifying GOM decom costs 2: Method reveals benchmarks for decom market valuation, risk. *Oil & Gas Journal* 113 (1): 58-65.

— Decommissioning forecast in the Deepwater Gulf of Mexico, 2013-2033. *Marine Structures* 41 (April): 96-126.

—. Empirical analysis of dayrate factors in offshore contract drilling, 2000-2010. Ships and Offshore Structures 10 (4): 367-384.

—. GOM revenue sharing. 1: Lease sales drive gulf OCS revenues. *Oil & Gas Journal* 113 (3): 66-73.

—. GOM revenue sharing. 2: GOMESA Phase II revenues impacted by several factors. *Oil & Gas Journal* 113 (4): 66-75.

— . GOM revenue sharing. 3: Forecast sheds light on GOMESA Phase II expected revenues. *Oil & Gas Journal* 113 (5): 78-87.

—. Hurricane Clean-up Activity in the Gulf of Mexico, 2004-2013. *Marine Policy* 51: 512-526.

—. Offshore service vessel activity forecast and regulatory modeling in the U.S. Gulf of Mexico, 2012-2017. *Marine Policy* 57: 132-146.

Kaiser, M.J. (with M. Liu). Decommissioning cost estimation for deepwater floating structures in the U.S. Gulf of Mexico. *Ships and Offshore Structures* 10 (4): 436-455.

—. Quantifying decommissioning risk in the deepwater Gulf of Mexico. *Engineering Economist* 60 (1): 40-74.

Snyder, B.F. Solving conservation's money problems. Conservation Biology 29 (1): 1-2.

Upton, G.B. Crude oil exports and the Louisiana economy: A discussion of U.S. policy of restricting crude oil exports and its implications for Louisiana. LSU CES Whitepaper.

Upton, G.B. and B.F. Snyder. Renewable energy potential and adoption of renewable portfolio standards. *Utilities Policy* 36 (October 2015): 67-70.

— . The intended and unintended consequences of renewable portfolio standards. *IAEE Energy Forum* 24 (Antalya Special Issue 2015): 11-12, 15.

Outreach & Education

Energy Summit™ 2015

On October 21, CES hosted Energy Summit™ 2015, titled "Disruptive and Game-Changing Energy Trends: Implications for Louisiana." A diverse group of attendees numbering more than 100 participated. Highlights included CES Assistant Professor Greg Upton's presentation, "Unconventional Oil and Gas Activity and Crude Export Restrictions: A Discussion of U.S. Policy of Restricting Crude Oil Exports," a discussion of small modular nuclear reactors by Mike McGough, chief commercial officer for NuScale Power, and the development of battery systems capable of storing megawatts of power by Stefanie Goldman, research and development manager for battery maker Eos Energy Storage. Energy Summit™ presentations are available to view or download at http://www.enrg.lsu.edu/Conferences/energysummit2015/presentations.html

CES Executive Director David Dismukes welcomes participants to the 2015 Energy Summit™

CES Hosts Gulf Coast Power Association

On August 18, the Center for Energy Studies and the Gulf Coast Power Association co-hosted a one-day workshop titled "Gulf Coast Disaster Readiness: A Past, Present and Future Look at Power and Industry Readiness in MISO South." More than 100 attendees gathered for the MISO Special Briefing to learn how power and industry experts manage Gulf Coast disaster readiness in the MISO South.

Sessions focused on operations and financial lessons learned from Hurricane Katrina and other disasters; challenges to infrastructure and planning reliability; how large industries and utilities coordinate and operate during weather events and how their natural gas suppliers operate; and which technologies or practices are being developed to improve grid resilience and restoration.

The event was the GCPA's third special briefing in Louisiana.

GCPA
Gulf Coast Power Association

At Energy Summit™ 2015, held October 21, Jennifer Vosburg, senior vice president, NRG Energy and president, Louisiana Generating, discusses the use of microgrids during main power grid failure.

LSU President and Chancellor F. King Alexander introduces Sen. Bill Cassidy at the GCPA Special Briefing.

Photo courtesy of GCPA

View or download CES presentations at www.enrg.lsu.edu/presentations

Presentations 2015

"What Louisiana Can Expect from EPA's Recently Proposed Revisions to the National Ambient Air Quality Standards for Ozone." Mike D. McDaniel. Air & Waste Management Association, Louisiana Section, January 15.

"Energy Prices and the Outlook for the Tuscaloosa Marine Shale." David E. Dismukes. Baton Rouge Rotary Club, January 28.

"Louisiana's Changing Energy Environment." David E. Dismukes. John P. Laborde Energy Law Center Advisory Board, March 27.

"Louisiana Tax Study, 2015." Gregory B. Upton, Jr. The Central Louisiana Chamber of Commerce, April 9.

"Unconventional Oil and Gas Activity and Crude Export Restrictions: A discussion of U.S. policy of restricting crude oil exports." Gregory B. Upton, Jr. Tulane Engineering Forum, April 17.

"Incentives, Risk and the Changing Nature of Utility Regulation." David E. Dismukes. NARUC Staff Subcommittee on Accounting and Finance Meetings, April 22.

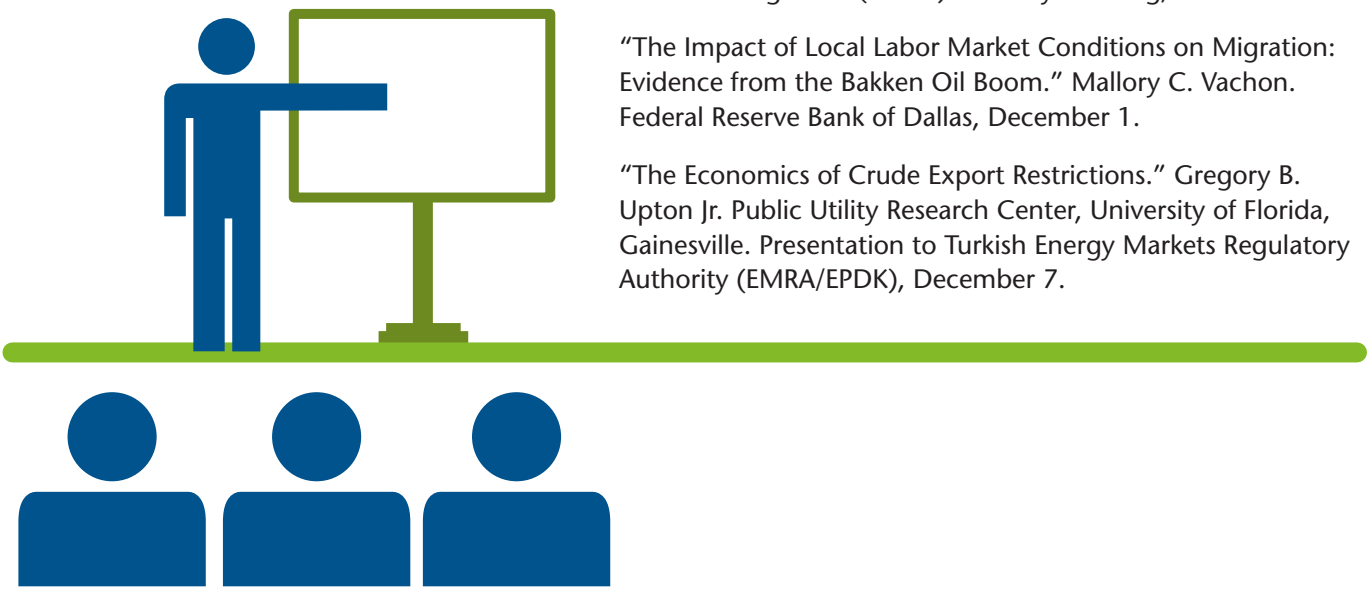
"Energy Market Changes and Impacts for Louisiana." David E. Dismukes. Kinetica Partners Shippers Meeting, April 22.

"Industry on the Move - What's Next? What will the changes in energy prices mean to industry in South Louisiana?" David E. Dismukes. Event Sponsored by Regions Bank and 1012 Industry Report, May 5.

"Unconventional Oil and Gas Activity and Crude Export Restrictions: A discussion of U.S. policy of restricting crude oil exports." Gregory B. Upton Jr. World Trade Center New Orleans, Energy Committee Meeting and American Institute of Chemical Engineers (AIChE) Monthly Meeting, November 19.

"The Impact of Local Labor Market Conditions on Migration: Evidence from the Bakken Oil Boom." Mallory C. Vachon. Federal Reserve Bank of Dallas, December 1.

"The Economics of Crude Export Restrictions." Gregory B. Upton Jr. Public Utility Research Center, University of Florida, Gainesville. Presentation to Turkish Energy Markets Regulatory Authority (EMRA/EPDK), December 7.



Quotable

The price of oil, delayed industrial development plans, and the export ban dominated energy-related media stories in 2015. Several outlets turned to CES faculty for their expertise throughout the year, starting in January with a *New York Times* story ("Louisiana Squeezed as Oil Prices Drop") on the effects of the drop in oil prices on the state's budget and employment outlook. In the article, David Dismukes explains that many Louisiana-based service companies operate in other states and that those service sector jobs would be impacted most quickly by the downturn in oil prices and subsequent slowdown in shale drilling.

Sasol's delay of its gas-to-liquids plant in Lake Charles, a possible $14 billion dollar investment, prompted an April *10/12 Industry Report* piece ("How does oil's price plunge affect south Louisiana industrial expansion") that features Dismukes. In it, he says that determining the future of projects like Sasol's requires speculating not only on the direction of commodity prices, but also on how close the price of oil may come to the price of natural gas. "It's not the absolute price that matters for some of these projects, it's the differential between gas and crude," he said. Dismukes predicted substantial development being maintained and the bulk of the announced projects materializing.

Later in 2015, as Congress debated whether to repeal the 1975 Energy Policy and Conservation Act that banned the exporting of crude oil, Greg Upton's white paper, "What If the Crude Oil Export Ban Were Lifted?," garnered attention from regional media, including *The Advocate, The Times-Picayune,* and *The Daily Comet*, among others. In December, Lafayette's *The Advertiser* ran Upton's opinion piece, "We must shift the discussion on lifting oil export ban," in which he questions the conventional wisdom that the export ban would lead to a large increase in domestic oil and gas production and create hundreds of thousands of jobs. Instead, Upton discusses the potential risks and benefits that the Gulf Coast region faces associated with the lifting of the export ban. He writes, "Due to the shale boom, the U.S. Gulf Coast is on the cusp of becoming the world hub for hydrocarbon commerce. With the Louisiana Offshore Oil Port (LOOP) commoditizing storage and multi-billion dollar investments in Liquefied Natural Gas (LNG), trade liberalization on hydrocarbons can create a unique opportunity for the Gulf Coast to truly be the epicenter of oil and gas trading…. But in return, the Gulf Coast will have to give up a long-run federal protectionist policy on the domestic refining industry." He argues that the debate on lifting the ban should be shifted to "whether the export ban continues to achieve national security objectives and whether a federal policy that protects [the refining and petrochemical industries] is appropriate." In addition, he argues that "proponents should not make promises of hundreds of thousands of jobs, and opponents should not be concerned that the lifting of the ban will exacerbate CO_2 emissions." In December of 2015, the export ban was lifted.

Scholarships

Hood, GCPA Scholarships Awarded

F. Malcolm Hood Memorial Scholarship winner Jennifer Kenyon met Hood's daughter, Celeste Cheramie, at the fall CES Industry Associates meeting.

In the fall of 2015, the Center awarded two scholarships. The F. Malcolm Hood Memorial Scholarship was awarded to geology and geophysics senior Jennifer Kenyon of Marrero. Kenyon developed an interest in energy, specifically energy conservation, after conducting biogeochemistry research last summer at the Smithsonian Institution. The research project focused on the remediation of excess chemicals due to acid mine drainage as the result of abandoned mines. During the fall 2015 semester, Kenyon participated in the SEA Semester at Woods Hole Oceanographic Institution, where she pursued oceanographic and environmental research, with an emphasis on public policy.

The David Olver Memorial Scholarship, provided by the Gulf Coast Power Association emPOWERring Foundation, was awarded to senior electrical engineering major Sung Jung of Kenner. Jung's career goals include answering the demand for reliable energy. He interned for two years at Oncor Electric Delivery in Dallas, where he worked in transmission operations and transmission planning. He plans to pursue a master's degree in electrical engineering and to qualify as a PE.

David Olver Memorial Scholarship recipient Sung Jung met GCPA Executive Director Tom Foreman at the Special Briefing held at CES on August 18.

Personnel Update

Vachon Joins CES Faculty

Mallory Vachon Joins CES Faculty

In August, CES welcomed its newest assistant professor, Mallory C. Vachon. Vachon earned her Ph.D., M.A., and B.A. in economics from Syracuse University. Her research interests lie at the intersection of energy, labor, and public economics, with a focus on the local economic impacts of natural resource extraction.

She is a member of the American Economic Association, the International Association for Energy Economics, the Southern Economic Association, and the Society of Labor Economists.

Stickle Retires

CES Librarian Versa Stickle retired in June after 22 years of service to the Center. She was honored June 9 with a party attended by current and former CES faculty and staff and her family.

Stickle joined the center's staff as head librarian under Director Bob Bradley for the Louisiana Energy and Environment Resource and Information Center, or LEERIC, program, which served K-12 educators state-wide. While with LEERIC, Versa gave presentations to college classes, performed public outreach, and developed lesson plans to accompany science films, among several other duties.

When the LEERIC program relocated to the Louisiana Resource Center for Educators, Versa remained with the Center to manage the CES library, providing faculty, staff and the public access to energy research publications. She skillfully managed the library's reference services, specialized book collection, and supporting documents for the Center's statistical databases.

CES honored Versa Stickle upon her retirement in June 2015. Pictured l-r are CES Professor Mark Kaiser, Stickle, LSU Radiation Safety Director Wei-Hsung Wang, and Louisiana Geological Survey Director Chacko John.

Personnel

Administration

David E. Dismukes, Ph.D., executive director, director of the Policy Analysis Division, and professor

Allan G. Pulsipher, Ph.D., associate executive director and Marathon Oil Company Professor of Energy Policy in the Center for Energy Studies

Diana Reynolds, assistant to the executive director

Marybeth Pinsonneault, communications manager

Division of Policy Analysis

Gregory B. Upton, Jr., Ph.D., assistant professor

Mallory Vachon, Ph.D., assistant professor

Mike McDaniel , Ph.D., professional-in-residence (retired) and an adjunct professor of environmental sciences in the School of the Coast and Environment

Don Goddard, Ph.D., associate professor (retired)

Elizabeth Dieterich, research associate

Kathyrn Perry, research associate

Division of Research & Development

Mark J. Kaiser, Ph.D., director of the Research & Development Division and professor

Brian Snyder, Ph. D., research associate

Siddhartha Narra, Ph.D., research associate

Yunke Yu, research associate

Paul Sloan, J.D., research associate

Division of Energy Information & Data

Omowumi (Wumi) Iledare, Ph.,D., (retired) director of the Energy Information and Data Division, professor of petroleum economics and policy research, adjunct professor of petroleum economics at the Craft & Hawkins Department of Petroleum Engineering at LSU and the University of Ibadan.

Versa Stickle, librarian

Ric Pincomb, research associate

Stacy Retherford, computer analyst

Mike Surman, computer analyst

RALPH PIKE, DIRECTOR
www.mpri.lsu.edu

Minerals Processing Research Division

The Minerals Processing Research Division (MPRD) was established in 1979 by federal legislation as one of 31 State Mineral Institutes associated with the U.S. Department of the Interior. The mission includes facilitating research and public service programs in process research and technology transfer, sustainable development, energy management, and inherently safer design. This minerals processing research and public service complements and benefits from the energy research and geological research performed by others in the Center for Energy Studies and the Louisiana Geological Survey.

The current research focus of the MPRD is to develop the latest methodology for energy education with learning modules with interactive interfaces and graphical displays that are available on the web at no cost to students and practicing engineers. Research continues on improving the resilience of the infrastructure of the Chemical Processing Industry (CPI) by expanding the description of the chemical production complex based on multiple plants in the lower Mississippi river corridor. The objective is to evaluate the capability of the complex to absorb and recover from adverse events and of the impact of these events on the supply chain of critical chemicals.

Web-Based Learning Modules

Energy Sustainability Remote Laboratory

The Center for Energy Studies hosts the Energy Sustainability Remote Laboratory at www.esrl.lsu.edu. This web site has been developed under the direction of F. Carl Knopf, associate director and Anding Distinguished Professor of Chemical Engineering, and Kerry M. Dooley, BASF Distinguished Professor of Chemical Engineering, in cooperation with three other universities and three major companies. The project has received continuous support for 10 years from the National Science Foundation.

The Energy Sustainability Remote Laboratory (ESRL) has 20-plus modules that cover many key aspects of energy production and sustainability: cogeneration, biomass utilization, solar, nuclear, coal, geothermal, micro-grids and process intensification. Available free of charge, the instructional activities contained within them are based on actual processes, and provide data (real-time/archived) from these processes. Most of the modules can be seamlessly used in the two-to-four week cycle of a typical engineering laboratory course, and all of them can be modified for use in traditional lecture-based courses (e.g., Thermodynamics, Heat Transfer, Reactor Design) as assignments or projects. Current Cogeneration teaching modules include:

- Introduction to Cogeneration Performance Using Ideal Gas Calculations;
- Data Reconciliation in a Cogeneration Facility;
- Data Reconciliation and Instrument Bias using Monte Carlo Simulation;
- Levelized Economics for Analysis of Energy Systems;
- Cogeneration Performance Using Real Gas Calculations;
- Gibbs Free Energy for Emissions Prediction in Combustion Processes;
- Perfectly Stirred and Plug Flow Reactors (PSR + PFR) Emissions Prediction and Remediation in Combustion Processes;
- Heat Transfer in a Cogeneration System Heat Recovery Steam Generator;
- Cogeneration System Optimal Design and Costing.

Chemical Complex Analysis System Tool for Sustainable Manufacturing of Chemicals

The Center for Energy Studies will soon host a web-based learning module on "Chemical Complex Analysis System Tool for Sustainable Manufacturing of Chemicals." The web site is being developed with a recently awarded grant from the National Science Foundation as part of the "Sustainable Manufacturing Advances in Research and Technology (SMART) Coordination Network" sponsored by the NSF Research Coordination Networks-Science, Engineering and Education for Sustainability (RCN-SEES) track. The module will also be available on the Computer Aids in Chemical Engineering (CACHE) web site, cache.org.

Research on Resilient Critical Infrastructure for the Chemical Industry

Resilience is the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events. Research has begun with the objective to improve the resilience of the infrastructure of the Chemical Processing Industry (CPI). The project uses the simulation of a chemical production complex based on multiple plants in the lower Mississippi river corridor to evaluate the capability of the complex to absorb and recover from adverse events and of the impact of these events on the supply chain of critical chemicals. Realistic evaluations are being performed with the assistance of the MPRI Industrial Advisory committee and the ExxonMobil Operations Integrity Management. The methodology developed at the National Infrastructure Simulation and Analysis Center of Sandia National Laboratories with an agent-based chemical supply chain model are being included in the evaluations, and collaboration with this group is being developed.

Technical Sessions at National Meetings

The following three technical sessions and poster session at the American Institute of Chemical Engineers' 2015 Annual Meeting and International Congress on Energy in Salt Lake City, November 8-13, 2015, were chaired by Ralph Pike and Debalina Sengupta. Each technical session included eight presentations from industry engineers and university researchers on numerous aspects of developing innovative processes to produce fuels and chemicals from renewable resources, with an average of 50 attendees in each of the four sessions.
The poster session featured 56 presentations.

- Sustainable Fuels: Advances in Innovative Processes;
- Sustainable Chemicals: Advances in Innovative Processes;
- Sustainable Fuels from Renewable Resources;
- Environmental Division Poster Session.

Three technical sessions on "Advances in Innovative Processes for Sustainable Fuels and Chemicals" and "Fundamentals of Environmental Transport Phenomena" are being organized for inclusion in the AIChE Annual Meeting, San Francisco, on November 13-18, 2016.

Professional Development Courses, Publications and Programs Available Online

A professional development course on Layer of Protection Analysis is being completed to complement other process-safety-related courses available on the Division's web site, www.mpri.lsu.edu. The interactive heat exchanger synthesis program THEN is being rewritten and enhanced with an Excel interface and graphical display. This course and computer program are part of the web site materials that are continually being revised and extended with new research journal articles, conference proceedings, technical reports, theses, dissertations and professional development self-study courses for professional engineers' PDH requirements.

Personnel

Ralph W. Pike, director,
Horton Professor of Chemical Engineering

F. Carl Knopf, associate director,
Anding Professor of Chemical Engineering

William Fernandez, Biological Engineering major

Jennifer Le, Health Sciences major

Louisiana Geological Survey

CHACKO J. JOHN
DIRECTOR & STATE GEOLOGIST
www.lgs.lsu.edu

Since 1869, the Louisiana Geological Survey has been providing geologic information reflecting its primary mission of promoting the environmentally sound economic development of the energy, mineral, water and environmental resources of Louisiana. Recognizing the importance of geologic information to the state's various economic and other developmental projects and activities, the Louisiana legislature permanently established LGS in 1934 (Act 131).

LGS currently has 14 full-time and two part-time staff, including all categories of personnel. Results and reports of LGS research projects are first provided to the project funding sponsors and after their approval are made available to interested parties. LGS staff regularly makes research presentations at appropriate technical conferences and submit papers for publication in professional journals. LGS publications and maps are available for sale. Current research projects are conducted primarily under the following four sections:

1. **Geologic Mapping and Mineral Resources Section** - conducts investigations of the surface geology of Louisiana, including surface mapping funded by the State Map Program managed by the U.S. Geological Survey.
2. **Water and Environmental Section** – currently monitors and provides data on streams and lakes to add to the state water data base, which supports the efforts of the Louisiana Department of Natural Resources, along with the USGS for management for the states' water resources.
3. **Basin Research Energy Section** – was previously the Basin Research Institute at LSU and is now integrated into LGS and conducts oil, gas, coal, and unconventional energy resources related investigations.
4. **Cartographic Section** – prepares the final maps, reports, desktop publications, various types of geological bulletins, posters, etc., and does the GIS work on research projects. Over the years, maps and brochures produced by the LGS Cartographic Section have received national awards for the excellence of its projects.

Projects

Water Institute of the Gulf, CPRA Request Investigative, GIS Development of the Buried Holocene-Pleistocene Surface in the Louisiana Coastal Plain

The Louisiana Geological Survey was contracted by The Water Institute of Gulf on behalf of Coastal Protection and Restoration Authority of Louisiana to investigate, assess, and develop a three-dimensional GIS dataset of the buried Holocene-Pleistocene surface, a regional unconformity sometimes known as the "base of the Holocene," for coastal Louisiana. This investigation was undertaken because of a lack of a single comprehensive map delineating the Holocene-Pleistocene surface that covers the entire Louisiana coastal plain and coastal waters.

Rather, the available data consisted of maps created by various authors at different times in different study areas and using different criteria. As a result, many gaps exist in the coverage of these maps as well as conflicts in their interpretation.

The technical work conducted for this project consisted of: (1) a search and investigation of 15,863 existing published and unpublished boring locations; (2) an assessment of the effectiveness of the source data; (3) data development and compilation of 3,012 useful H-P data points; (4) the development of a GIS dataset of the Holocene-Pleistocene surface; and (5) the preparation of deliverable GIS datasets, digital maps, and a final report with an interpretation of the data.

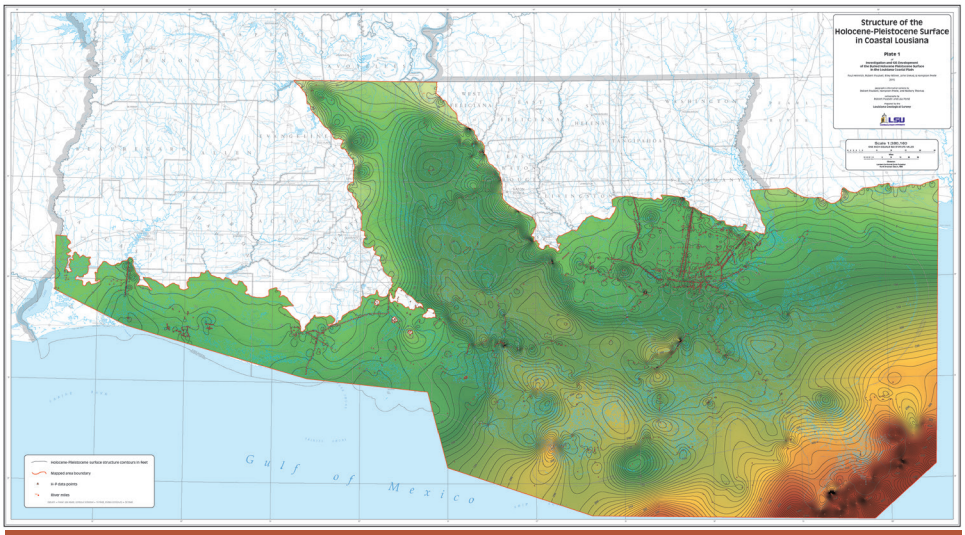
It is intended that the Holocen-Pleistocene surface model of the entire Louisiana coastal plain will offer improvement in understanding geologic variables in engineering design for coastal restoration projects, reduce uncertainties in accessing future geo-environmental conditions, support decision-making on coastal issues, and help improve data and assumptions used in predictive subsidence modeling.

The creation of a more comprehensive database of subsurface data for the shallow subsurface of the Louisiana coastal zone is needed. It will require more than just data concerning the depth of the Holocene-Pleistocene surface to fully understand the variation of subsidence rates. Eventually the variability in the stratigraphy, morphology, and lithology of the individual facies of the many fluvial, deltaic, and marine deposits that overlie it will have to be understood as thoroughly as the older geologic units underlying it, now revealed by deep oil and gas geophysical logs, micropaleontology, and 3D seismic technology.

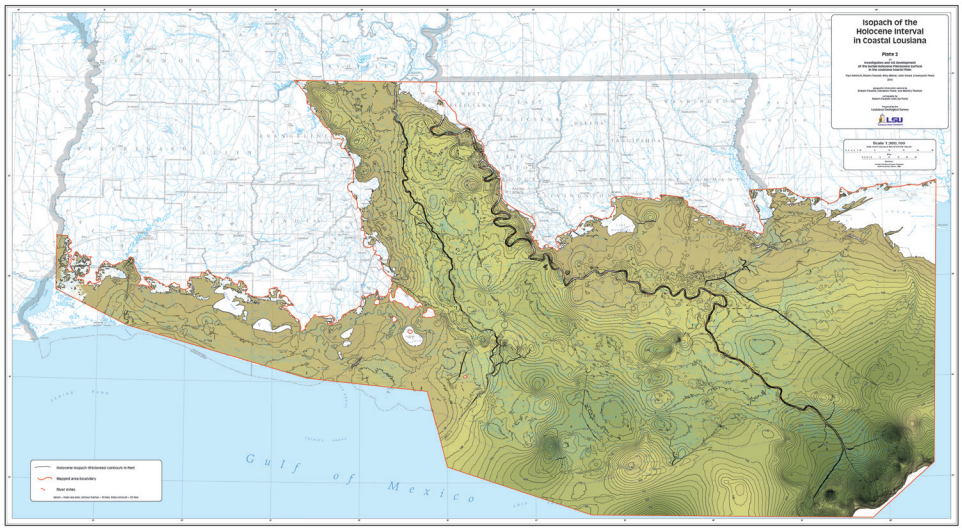
Robert Paulsell presented preliminary results of this study at the 2015 Louisiana Remote Sensing and Geographic Information Systems (LaRSGIS) workshop in Baton Rouge. RSGIS 2016 will be held in Lafayette, La.

Project Examines How Prehistoric Coastal Plains, Continental Shelves Responded to Sea-level Rise

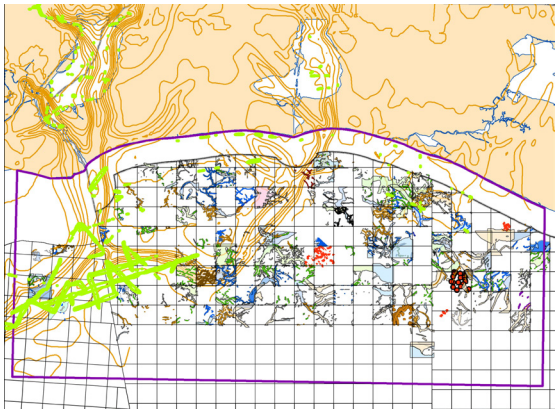
The project "Late Quaternary Stream and Estuarine System Responses to Holocene Sea Level Rise on the OCS Louisiana and Mississippi: Preservation Potential of Prehistoric Cultural Resources and Sand Resources" was initiated to better understand how prehistoric coastal plains and continental shelves responded to sea-level rise and determine the preservation of paleo-landscapes. The preservation of paleo-landscape is important because it is a factor in the preservation of scientifically significant archaeological deposits during the submergence of Pleistocene and Holocene coastal plains during the Holocene transgression to form the modern continental shelf. During terminal Pleistocene and Holocene sea-level rise, a variety of sedimentary processes extensively modified the Louisiana coastal plain and continental shelves. As the Late Pleistocene-Holocene transgression occurred, both shoreface and tidal processes deeply eroded the interfluves of coastal plain interfluves. This erosion created well-defined ravinement surfaces and likely destroyed the existing archaeological deposits and sites within this part of submerged coastal plains. However, segments of paleo-landscapes and their associated archaeological deposits



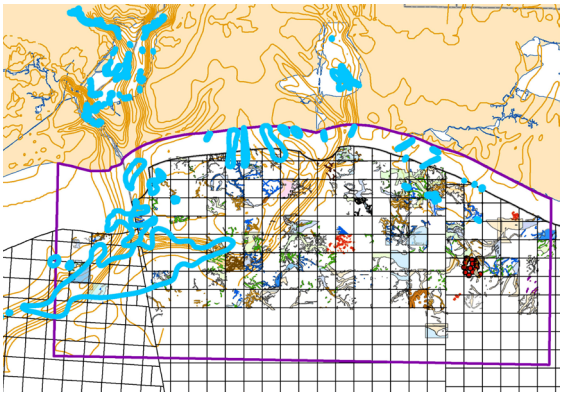
Structure Map of the Holocene-Pleistocene Surface



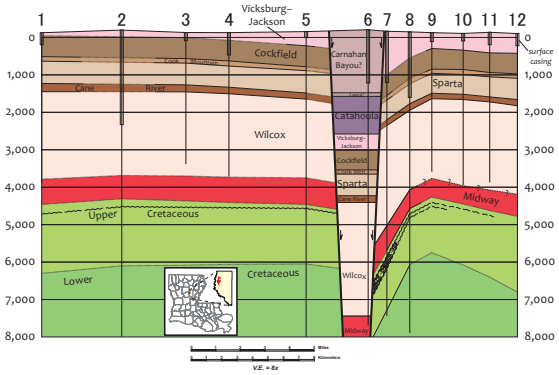
Isopach Map of the Holocene Interval



Excerpt from ArcGIS workspace showing segments of seismic lines, in green, that intercept areas with preserved paleolandscapes.



Excerpt from ArcGIS workspace showing areas, in blue, favorable to the preservation of paleolandscapes.



could have escaped shoreface and tidal erosion and destruction when buried below the ravinement surface within deeply cut paleovalleys. In addition, the backstepping of fluvial and estuarine sedimentation during a period of rapid sea level rise offered the possibility of the preservation of isolated segments of the paleo-landscape and associated archaeological deposits.

The evaluation of the circumstances that resulted in the preservation of paleo-landscapes required the interpretation of internal stratigraphy, structure, and relative age of individual paleovalleys. This was done using a geographic information system (GIS) compilation of the southwestern Louisiana continental shelf, developed from industry hazards survey maps with interpreted paleovalley deposits for 131 blocks, seismic profiles, and boring data.

An examination of this data resulted in the recognition of five Upper Pleistocene-to-Holocene stratigraphic units and four associated unconformities. For a few units, unambiguous correlations could be made with units previously dated, and characterized onshore for their sedimentology and geoarchaeology. It was found that shallow seismic and scant vibracore data lack the resolution to discern the nature of paleovalley fills and determine if features such as paleosols, middens, etc. are present. Moreover, constraining the age of paleovalley fills is difficult because of their stratigraphic amalgamation, time-transgressive nature, limited absolute dates, difficulty correlating onshore-offshore, and stratigraphic incompleteness. Existing models used for predicting prehistoric cultural resource potential should be revisited to account for multiple sea-level fluctuations and further refined using absolute dating methods and sedimentological models.

Structure Map of the Holocene-Pleistocene Surface Cross Section through Little Creek Structure, Northwestern La Salle Parish

Little Creek is unique among geologic structures in Louisiana and possibly in the U.S. The surface feature is a tight collapse structure 4.3 km (2.7 mi) across, which drilling shows extends to a minimal depth of nearly 8,000 ft (approximately 2,440 m). Fisk (1938) originally mapped the surface structure in detail on his geologic map of La Salle Parish (his Plate II), and mapped the subsurface structure at a regional scale using oil and gas well data (his plates VI and VII).

Since his work, little information about the feature has appeared in the public domain, though it appears to have garnered attention from some geologists at least intermittently. One of these is J. E. Rogers, with whom consultation in connection with the compilation of the Louisiana state geologic map in the early 1980s (Rogers, 1982) revealed his interpretation, based on correlation of water well logs, of the feature's surface unit as Carnahan Bayou Formation, Fleming Group rather than the Catahoula Formation of Fisk's original mapping. This interpretation greatly increases the displacement attributable to the structure at the surface and in the shallow subsurface.

A summary paper by Echols and McCulloh (1998) listed three hypotheses of origin of the Little Creek structure known to the authors: 1) salt withdrawal marking the location of a former salt diapir near the southeastern edge of the north Louisiana salt basin (J. E. Rogers), (2) long-term response to a meteor impact that occurred during deposition of the Upper Cretaceous chalk (M. D. Butler), and (3) response to emplacement of a deep post–Jurassic igneous diapir (D.H. Wilson). The paper contained a dip section through

the structure that utilized oil and gas wells laid out with an arbitrary horizontal spacing in order to maximize the number of wells included and the length traversed. Thus, the section had no consistent horizontal scale, and its vertical exaggeration also was not uniform. The section nevertheless portrayed in condensed fashion the shallower, tight collapse feature and its areal coincidence with a broader, deeper-subsurface overall positive structure marked by really restricted unconformities in Upper Cretaceous strata.

Revised *Oil & Gas Map of Louisiana* Due Out in 2016

The Louisiana Geological Survey (LGS) is working on producing a revised and up-to-date *Oil and Gas Fields Map of Louisiana* which is expected to be published digitally by the middle of 2016. The last map was published by LGS in 2008 and showed active depleted and inactive oil and natural gas fields, including streams, main highways and parish boundaries.

New Technologies Employed for Update of *Geologic Map of Louisiana*

The 1984 *Geologic Map of Louisiana* was the first modern state geologic map published and has proven very useful, having gone through three printings. But much has changed in the last 30 years. The 1984 map was compiled, designed and produced entirely by hand, well before the availability of digital satellite imagery, computer graphics, and geographic information system (GIS) technology. Three decades of new field geologic investigations at 1:24,000 and the publication of a new 1:100,000 geologic quadrangle series has made many new interpretations available. Recently LIDAR technology has revolutionized the mapping of geomorphic landforms in a state where 55 percent of the area is comprised of Quaternary units.

A new state geologic map is now being prepared by the Louisiana Geological Survey to take advantage of the new technologies and new interpretations. The map will be designed for a scale of 1:380,160, the same scale as the popular *Official Map of Louisiana,* the *Louisiana Coastal Zone* map, and the *Louisiana Shoreline Change 1937-2000* map. The new *Geologic Map of Louisiana* will be made available both as a traditional published lithograph, a GIS dataset, and a digital PDF map useful on computers and digital devices. The project is anticipated to take two years to complete.

Abstracts of Research Presentations at GCAGS Conference, Houston September 20-22, 2015

Changes of Global Sea-Level Rise and Relative Sea-Level Rise in Coastal Louisiana in the 21st Century

Douglas Carlson

The rate of relative sea-level rise has been measured for approximately 200 years at ports largely in the north Atlantic and measured at sites along the Gulf of Mexico coast of Louisiana for nearly 100 years. The rate of relative sea-level rise (RSLR) has been determined to be accelerating due to global warming measured over the past 130 years. However, in the past 18 to 20 years there has been observed a pause of global warming when the temperature has remained approximately constant. Has the temperature pause impacted RSLR for Louisiana? For the Louisiana coastline RSLR was impacted more by local subsidence than global sea-level rise. A number of studies have determined Louisiana RSLR is to up to 10 times greater than that due to only global RSLR. For the Louisiana coast line, has a reduction in oil production during the past twenty years impacted RSLR significantly?

Values of RSLR in Louisiana and Florida were determined using U.S. Geological Survey tidal gaging stations located in those states, which were located in rivers or streams where records clearly show the daily influence of tides. This set of data includes over a dozen stations in Louisiana and Florida. The RSLR value at each station was determined by taking a linear regression of daily mean gage values. Stations' records are typically 10 to 15 years in length. Florida is considered a stable area where RSLR lacks any significant impact from local subsidence. By contrast, Louisiana is an area where RSLR is dominated by local subsidence due to isostatic flexure caused by a thick pile of sediment, over 50,000 feet thick that has been dumped into this region by the Mississippi River and ancestral versions since the Jurassic. This explains the difference of average RSLR between Louisiana and Florida.

The Environmental Impact of No-Till Farming on Lower Mississippi River Quality

Douglas Carlson

Mississippi River water quality has been studied for approximately 175 years. Many of these studies focus on total suspended sediment (TSS), and/or nutrients. There have been a number of changes to the river itself and the surrounding watershed that impacted water quality. One of the major changes that has recently occurred within the watershed is the adoption of no-till farming practice, mainly in the last 25 years. How has this change impacted water quality?

Numerous studies indicate that no-till farming reduces sediment loss by approximately 80 to 100 percent and nutrient loss of 20 to 40 percent, when compared to conventional tillage practices. In the last three decades, millions of acres of cropland within the watershed have been converted to no-till cultivation practice. What has the change of TSS and nutrient concentration been at stations with long histories, generally over 30 years? For example, the concentration of TSS for the Mississippi River at New Orleans has fallen from typically 700 ppm in the 1920s, to 500 ppm in 1950s, to 200 ppm in 1970s, and to 100 ppm in 2010s. Changes through 1970 are largely the result of construction of control structures. However, these structures were largely completed by 1970. If so, why has TSS concentration been cut in half and there been a reduction in nutrients, even though sale and consumption of fertilizers has remained approximately constant over the past 30 years? The focus study is on results for the lower Mississippi River. However, dozens of sites within sub-watersheds throughout the Mississippi River watershed are examined in order to see if the changes within the full watershed are mainly a result of change in cultivation practice toward no-till practice. This involved the comparison of concentrations prior to no-till farming in the 1970s to concentrations in last decade, using two different nonparametric statistical tests of Median and Mann-Whitney Ranks.

Control structure

Mississippi River Basin

Trials of Near-Surface Geophysics at Archeological Sites in Southeast Louisiana

Brittany Gregory, Marty Horn, and Brooks Ellwood

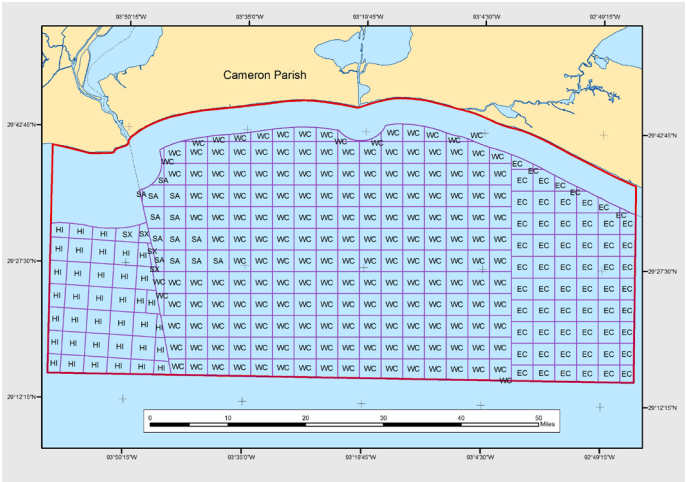
The Louisiana Geological Survey, in coordination with LSU, conducted a series of geophysical surveys at archeological sites in the Gulf Coast region of southeastern Louisiana to evaluate instrument and field technique performance in densely vegetated, organic-rich, water-saturated, and nonconsolidated sedimentary substrate. Test measurements of magnetic field intensity and electrical resistivity over appropriately sized and spaced sampling grids at 19th c. sites in the Baton Rouge-New Orleans area aimed to detect known or suspected anthropogenic features. Magnetic gradiometer data successfully resolved artifacts in these settings, such as subsurface occurrences of building foundations, steel or iron objects, and cemetery burials. Electrical resistivity and induced polarization data also resolved cemetery burials and abandoned pathways, depending upon electrode array configuration.

Both field methods have strengths and weaknesses that are significant to investigation in the Louisiana coastal setting. Measurements using the proton precession magnetometer are not affected by water table level and the raw data require minimal processing. However, the instrument does not differentiate between artifacts vs. irrelevant modern steel clutter from over two centuries of human habitation. The 4-electrode electrical resistivity survey is less sensitive to small isolated objects and can resolve stratigraphic horizons, but is impacted by ground water, and the data typically require processing. Nevertheless, application of both instruments constitutes a valuable component of archeological exploration. Continued development of field and data processing techniques will broaden application to settings with fewer interpretive constraints, making them attractive tools for inexpensive and noninvasive exploration of archeological sites, particularly when applied in conjunction with archeological observations and expertise.

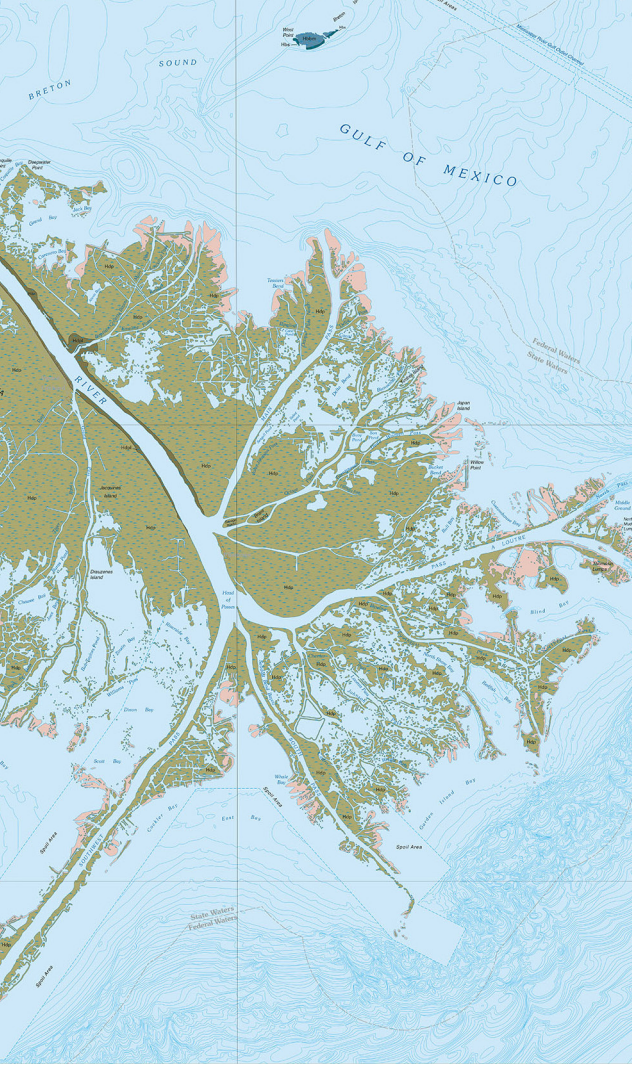
Late Quaternary Stratigraphic Evolution of the Southwestern Louisiana Inner Continental Shelf: Paleo-Landscape Preservation Potential and Implications for Offshore Sand Resources

Paul Heinrich, Michael Miner, Robert Paulsell, and Richard McCulloh

Understanding how exposed coastal plain shelves respond to sea level rise is important to determine paleo-landscape and associated intact prehistoric cultural resource preservation potential within the modern shelf. During sea-level rise, wave and tidal ravinement eroded the coastal plain interfluves. Backstepping fluvial and estuarine sedimentation within incised valleys potentially preserved landscape features below the depth of ravinement. Along-strike variable shoreface retreat rates locally favored preservation landward of barrier islands, shoals, and headlands as adjacent landscapes were eroded.



Shallow seismic and scant vibracore data lack the resolution to discern the nature of paleovalley fills and determine if features such as paleosols, middens, etc. are present. Moreover, constraining the age of paleovalley fills is difficult because of their time-transgressive nature, limited absolute dates, difficulty correlating onshore-offshore, and stratigraphic incompleteness. To interpret better internal stratigraphy, structure, and relative age of individual paleovalleys, a geographic information system (GIS) compilation of the southwestern Louisiana continental shelf was developed from industry hazards survey maps with interpreted paleovalley deposits for 131 blocks, seismic profiles, and boring data. Five Upper Pleistocene to Holocene stratigraphic units and four associated unconformities are recognized. For a few units, unambiguous correlations can be made with units previously dated, and characterized onshore for their sedimentology and geoarchaeology. Chronostratigraphy is refined based on cross-cutting relationships and identification of bounding surfaces identified in previous studies adjacent to the southwestern Louisiana shelf, and indicates that existing models used for predicting prehistoric cultural resource potential should be revisited to account for multiple sea-level fluctuations and further refined with absolute dating methods.



Geologic Mapping of The Mississippi River Delta Region at 1:100,000 Scale

Richard McCulloh, Paul Heinrich, and Chacko John

In the post–World War II era, the Holocene Mississippi River delta complexes were first defined in work by oil companies (e.g., H. R. Gould and D. E. Frazier of Esso Production Research Company, H. N. Fisk and E. McFarlan, Jr. of Humble Oil & Refining Company, and R. J. Leblanc of Shell Oil Company); the Louisiana State University Coastal Studies Institute (especially W. G. McIntire, J. P. Morgan, J. M. Coleman, and H. H. Roberts); the U. S. Army Corps of Engineers (USACE) Waterways Experiment Station (e.g., C. R. Kolb, J. R. Van Lopik, and R. T. Saucier); and others. Their depictions of the delta complexes were very small-scale and either as vegetation, facies, or in the case of the USACE, in stack-unit format; they were not treated at larger scales as mapped polygons representative of suites of surface-geologic map units. The Louisiana state geologic map (1984) also did not depict delta-complex polygons at 1:500,000 scale, and showed marsh types in the delta plain instead. The plate depicting Quaternary geology of the Lower Mississippi Valley prepared to accompany the volume on Quaternary non-glacial geology of the conterminous United States for the Geological Society of America's Decade of North American Geology series (1989) depicted the delta complexes, but at a scale of 1:1,100,000.

Among the Louisiana Geological Survey's titles in its 30 × 60 minute geologic quadrangle series, begun in 2000, six sheets cover nearly the entire delta plain at 1:100,000 scale. The most-recent and final deltaplain sheets completed in the series are Black Bay and Mississippi River Delta; these show the distribution of meanderbelt, natural levee, and undifferentiated delta-plain deposits of the Plaquemines–Balize (modern), Lafourche, and St. Bernard delta complexes as polygons for the first time at this level of detail.

Peele, McCulloh Present at RSGIS

At the May 2015 Annual Remote Sensing and Geographic Information Systems Workshop, held at the Pennington Biomedical Research Center in Baton Rouge, Hampton Peele and Richard P. McCulloh presented an overview of the LGS geologic mapping process and status. Final review of these GIS data and associated metadata preparation is underway for the coastal Louisiana series.

Beginning in the late 1990s, LGS undertook the construction of GIS data of the surface geology of Louisiana, using light tables, mylar and colored plastic lead mechanical pencils to draw the geologic contacts and faults. The mylar sheets were then scanned and digitized using Intergraph MGE software. Years later, ESRI ArcGIS was selected as the software of choice for digitizing the mylar sheets. Subsequently, the geologists began using ArcGIS to digitize the geology in a "heads-up" GIS environment. The GIS mapping was the initial stage of data development producing open-file geologic map publications, available as plots on demand. Final reviews and edits are made when 30 x 60 minute quadrangles are selected to go through cartographic design and publication as color lithographs. The geologic lithographs are then uploaded to the LGS website for download, in PDF format. In the final stage, GIS data are edited according to the final reviews; and FGDC-compliant metadata files are populated in final preparation for GIS data release.

Personnel

Administrative Personnel

Chacko J. John, Ph.D., director and state geologist, professor-research

Patrick O'Neill, LGS Publications Sales and Resource Center

Basin Research Energy Section

Brian Harder, research associate

Reed Bourgeois, computer analyst

Geological Mapping & Minerals Mapping Section

Richard McCulloh, research associate

Paul Heinrich, research associate

Water & Environmental Section

Marty Horn, assistant professor-research

Douglas Carlson, assistant professor-research

Riley Milner, research associate

Cartographic Section

John Snead, cartographic manager

Lisa Pond, research associate

Robert Paulsell, research associate

R. Hampton Peele, research associate

Staff

Melissa Esnault, administrative coordinator

Jeanne Johnson, accounting technician

Radiation Safety Office

WEI-HSUNG WANG, DIRECTOR
www.radsafety.lsu.edu

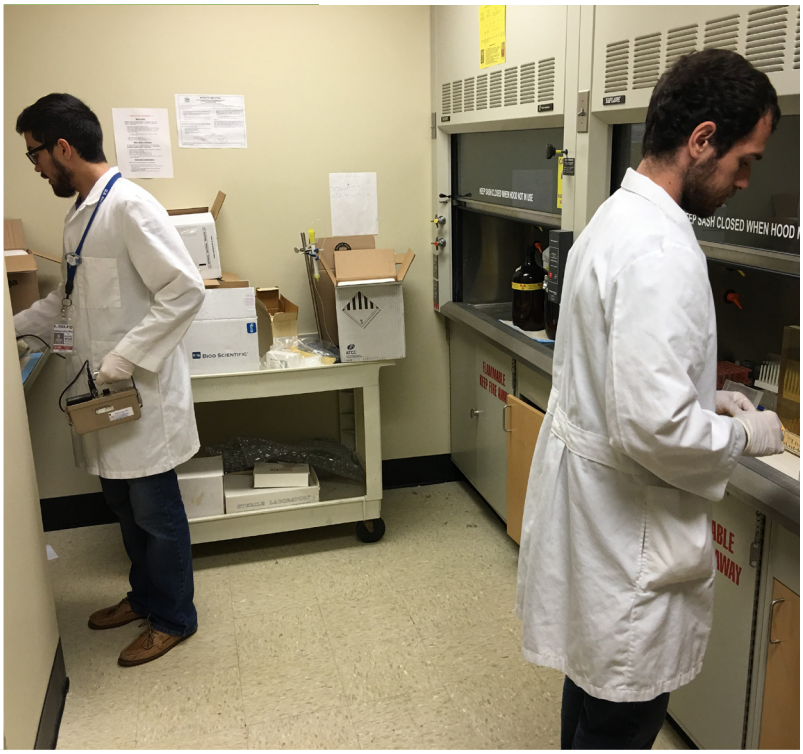
General Information

The LSU Radiation Safety Office (RSO), which reports through the Center for Energy Studies (CES) to the Office of Research and Economic Development, is an essential, unique, independent, and vital regulatory radiological control unit. The RSO not only directly supports but also engages in research, teaching, and clinical activities involving the use of sources of ionizing and non-ionizing radiation at LSU. The LSU System's broad-scope Radioactive Material License issued by the Louisiana Department of Environmental Quality (DEQ) allows the University maximum flexibility to accomplish legitimate and realistic research and teaching objectives through the effective and efficient operation of a regulatory-mandated radiation protection program carried out by the RSO. Under the direction of the Radiation Safety Committee, the RSO implements the radiation control policies and procedures such that radiation exposure to faculty, staff, students, the general public, and the environment will be maintained as low as reasonably achievable and that no radiation exposure will be received without societal benefits. Administrative authorization for the radiation protection program from the University is contained in LSU System's Permanent Memorandum-30 (PM-30): *Radiation Protection Program*. Enforcement actions for radiation safety violations are authorized under LSU Policy Statement-99 (PS-99): *Radiation Safety Violations*.

RSO technical assistant Daniel DiMarco conducts a smear test to determine the level of removable radioactive contamination on the external surface of a metal pig containing a radioiodine syringe for a radiotherapy procedure.

RSO technical assistant Jennifer Kenyon uses a high-purity germanium gamma spectroscopy system to characterize various radionuclides.

RSO technical assistants Isai Martinez (left) and Gregory Martini carry out routine laboratory radiation and contamination surveys using a Geiger-Mueller pancake probe survey meter and smears.



RSO radiation specialist Amin M. Hamideh conducts inspections on portable digital X-ray systems, used for detecting explosives, weapons, narcotics, and other contraband at the LSU National Center for Biomedical Research and Training.

In fiscal year 2014-2015, the RSO reviewed and approved 41 grant proposals involving the use of radioactive materials or radiation producing equipment. Funds requested by these proposals were $34,713,114.50. Actual funds granted to LSU were $23,156,425.50. Twelve out of the 41 grant proposals are still under review by the funding agencies. Currently, there are 875 approved radiation workers (including 93 radiation principal investigators) in 202 radiation laboratories with 6,856 annual radiation monitoring devices issued under the LSU's radiation protection program, including the Agricultural Center, the Pennington Biomedical Research Center, and associated facilities under LSU such as the Center for Advanced Microstructures and Devices, the Louisiana Emerging Technology Center, and the National Center for Biomedical Research and Training. The RSO is also responsible for the non-ionizing radiation safety within the purview of the LSU *System's Safety Procedures for Non-Ionizing Radiation*. There are 85 active Class 3B and Class 4 laser systems, 112 approved laser users (including 22 laser principal investigators), and 34 laser laboratories.

Global Threat Reduction Initiative Assessment and Final Rules on Louisiana Administrative Code Title 33, Part XV (LAC 33:XV), Chapter 16: *Physical Protection of Category 1 and Category 2 Quantities of Radioactive Material*

The Global Threat Reduction Initiative (GTRI) program, sponsored by the National Nuclear Security Administration under the U.S. Department of Energy (DOE), provides security enhancements that are beyond the current U.S. Nuclear Regulatory Commission (NRC) standards. This program fully funds all acceptable recommendations for material and labor (including a three-year warranty of the installation) to radiological facilities for national security efforts.

In order to efficiently address and comply with the expected Final Rules (effective November 20, 2015) on *Byproduct Material; Distribution of Source Material to Exempt Persons and General Licenses: Domestic Licensing of Special Nuclear Material;* and *Safeguards Information* (LAC 33:XV) that were promulgated by DEQ to reflect the newly implemented federal mandates on security of radioactive materials (Title 10 of the Code of Federal Regulations, Part 37; previously Increased Controls Order), the GTRI's Technical Program, Project Management & Planning team from Sandia National Laboratories was invited to LSU to conduct site assessment on March 3-4, 2015. Attendees of this exercise included representatives of the GTRI program, officials of DEQ, officers of the LSU Police Department, and staff of the RSO. A proposed security enhancement plan was presented at the end of the site visit. Subsequently, a Statement of Work and a Sustainability Letter from the GTRI program were submitted to the RSO for review.

The Radiation Safety Office had been working closely with the LSU Office of Facility Services, Police Department, and Office of Sponsored Programs to examine the specifications of this enhancement plan and resolve administrative concerns. On December 15, 2015, the Technical Program, Project Management & Planning team visited the Radiation Safety Office to help complete the Statement of Work, review the Sustainability Letter, revise the installation quote, and answer questions in regard to technical issues, procurement process, contract, warranty, etc. The process of this security enhancement planning is moving forward, and it is expected that a final contract between LSU and DOE will be executed by the end of March 2016.

Pathological Incinerator Stack Removed

The Pennington Biomedical Research Center (PBRC) planned to decommission a pathological incinerator, which was installed in 1984 and modified in 1990 to burn biological wastes. The use of the incinerator was discontinued in 2003 because of the high cost of gas. Because the waste records were only required to be kept for five years, no official documentation of the waste inventory was available. However, it was the PBRC's policy that no radioactive waste was allowed to be put into the incinerator. Due to the normal inclusions of certain traceable radioisotopes in the refractory of the incinerator, the radiation level must be evaluated for proper disposal. SC&A, Inc., an environmental health and safety consultant recognized by DEQ, was hired to assess the incinerator conditions and prepare a decommissioning plan. Subsequently, an ambient radiation survey was performed for the incinerator. Casing material samples were also taken from different parts of the incinerator for radio-analysis. The results from the radioanalysis showed that the casing material of the incinerator was not regulated as NORM in Louisiana.

The badly deteriorated stack of the incinerator was removed to eliminate the danger of collapse. An SC&A representative conducted a pre-survey of the stack prior to the stack removal to determine the PPE requirements. As a precaution, the SC&A representative was also present to provide the radiological coverage during the stack removal. A metal cap over the stack pipe opening was installed. The incinerator was left at its present location until such time as the PBRC decides to remove the incinerator from the site.

Dual-Energy X-ray Absorptiometry Scanning System Used at the PBRC

Tiffany Stewart, associate professor at the PBRC, had proposed a research project to study the efficacy of an intensive intervention to assist soldiers in meeting standards for body fat and fitness. General Electric Model iDXA dual-energy X-ray absorptiometry (DEXA) equipment would be used to scan the voluntary participants to determine their body composition. The subject pool would be male and female soldiers at least 18 years old from the Louisiana National Guard. Known or suspected pregnancy would disqualify any potential female subjects. Subjects would lie on a table while the DEXA device, which emits low-energy X-rays, passes along the body. Each scan would take approximately 10 minutes, and the corresponding radiation dose is equivalent to less than one day of environmental exposure. A total of three scans would be performed during the study of 12 months. Subjects would be required to sign voluntary consent forms to participate in this study.

Under LAC 33:XV. Radiation Protection, Chapter 1, Subsection 110.E: *No person shall intentionally apply or allow to be applied, either directly or indirectly, radiation to human beings except by, or under the supervision of, persons licensed by Louisiana to practice the healing arts and who are authorized to use radiation on humans. Supervision, as used in this Subsection, shall mean the responsibility for, and control of, quality, radiation safety, and technical aspects of the application of radiation to human beings for diagnostic and therapeutic purposes.* In order to be in accordance with the above regulation, the PBRC needed to stipulate that the medical investigator (i.e., licensed physician) of this research project would supervise the scanning activities as defined above and review the scans for abnormalities for referral, if necessary.

NRC Senior Health Physicist Discusses "Title 10 of the Code of Federal Regulations, Part 37 (10 CFR Part 37) implementation"

Janine F. Katanic, CHP, senior health physicist of NRC, was invited to give a presentation on "*10 CFR Part 37 implementation*" at LSU. 10 CFR Part 37-*Physical Protection of Category 1 and Category 2 Quantities of Radioactive Materials was developed based on the International Atomic Energy Agency's Code of Conduct on the Safety and Security of Radioactive Sources* as well as the U.S. NRC Order EA-07-305. Category 1 and Category 2 radioactive materials include 16 radionuclides that are risk-significant. The general purpose of 10 CFR Part 37 is to provide reasonable assurance of the security of Category 1 and Category 2 radioactive materials by protecting from theft or diversion. States that have signed an agreement with the NRC authorizing the states to regulate certain uses of radioactive materials within the states had three years from March 19, 2013, to issue and implement compatible requirements.

"Effective approaches to locate a missing radioactive source" Poster Presented at LSU International Research Fair

Ningle Yu, a visiting scholar sponsored by LSU's Department of Physics and Astronomy and the RSO, gave a poster presentation on "Effective approaches to locate a missing radioactive source" at the second annual LSU International Research Fair on November 17, 2015. This poster presentation described the responses to a radiation incident, which involved a missing iridium-192 industrial radiography source in China in 2014. The LSU International Research Fair is sponsored by LSU International Programs in collaboration with the LSU Office of Research and Economic Development to promote interaction and engagement with colleagues and the LSU community. Ten visiting scholars and Fulbright participants at LSU were selected to showcase their research activities.

DEQ Conducts Inspections

Radioactive material license and Increased Controls inspections were conducted by two inspectors from DEQ's Radiation Surveillance & Enforcement Section. They examined the policies, procedures, and implementation for Increased Controls and Unescorted Access. They reviewed the records of personnel and environment radiation monitoring, investigation of elevated personal exposure, escorted access to Increased Controls areas, list of Trustworthiness and Reliability Officers, radiation user training and approval, radioactive waste disposal, inventory and leak tests of sealed radioactive sources, inventory and calibration of survey meters, and meeting minutes of the Radiation Safety Committee. The inspectors also inquired about the qualifications of the radiation safety staff, the membership of the Radiation Safety Committee, the authority and policies of the radiological control program and enforcement, the current status of the National Source Tracking System, the Radiation Safety Manual, and the management system for radioactive waste. In addition, they looked over the procedures for radiation user training and approval, radioactive waste handling, ordering and receiving of sources of radiation, and operation/quality control of radiation counting equipment.

The team inspected the Increased Controls areas, inquired about the alarm drills and arrangement with local law enforcement agencies in response to unauthorized access, tested the alarm system, and verified the list for individuals with unescorted access. They walked through the radioanalytical laboratories and the radioactive waste storage facilities under the RSO. In addition, they visited 27 radiation laboratories (two laboratories in Choppin Hall, seven

laboratories in Life Science Building, three laboratories in Life Science Annex, six laboratories in the School of Veterinary Medicine, and nine laboratories in the Pennington Biomedical Research Center) and the Ecology Plot. During the laboratory visits, the team checked the radiation levels, calibration of survey meters, face velocities of fume hoods, and posting requirements. They also questioned the approved radiation users about the operational knowledge in handling radioactive materials and quality assurance/standardization of radioanalytical equipment as well as the recordkeeping for the order, use logs, and transfer of radioactive material, the in-house radiation laboratory surveys, and the radioactive waste disposal.

After the walk-through, an exit interview was held and no areas of concern were listed on the DEQ's Field Interview Form.

New Radiation Therapy Vault Review Approved for LSU Vet Med

The Veterinary Teaching Hospital and Clinics at the School of Veterinary Medicine was planning to build a radiation therapy vault and install a linear accelerator for radiation treatment on animals. The radiation shielding design for the radiation therapy vault was performed by a qualified expert contracted by WHLC Architecture, the contractor for this construction project. The shielding design was submitted to the RSO for review on November 25, 2015. After evaluation of the layout of the facility and the shielding design, the RSO prepared an X-ray shielding review packet and submitted it to DEQ for review and approval per LAC 33:XV. Radiation Protection, Chapter 6, Subsection 603.C, on November 30, 2015. On December 7, 2015, DEQ issued a letter stating that the shielding review was approved, pending written verification that the conditions concerning the protective radiation shielding have been incorporated into the facility structure.

Academic and Professional Recognitions

Kenyon Awarded F. Malcolm Hood Memorial Scholarship

Jennifer A. Kenyon, technical assistant at the RSO and a geology and geophysics senior, was awarded the F. Malcolm Hood Memorial Scholarship administered by CES. (See story above in the Center for Energy Studies section). The scholarship, established to honor one of the original supporters of CES, supports the educational goals of LSU students interested in energy-related fields, with a particular emphasis on energy policy. Kenyon will begin her doctoral studies at the Massachusetts Institute of Technology/Woods Hole Oceanographic Institution Joint Program in Oceanography/Applied Ocean Science & Engineering in the summer of 2016.

Wang Named Health Physics Society Fellow

Wei-Hsung Wang, professor at the Center for Energy Studies and director of the RSO, has been elected as a fellow of the Health Physics Society, an honor limited to less than one-half of one percent of the society's members. The Fellow Awards are designed to honor senior members of the society who have made significant administrative, educational, and/or scientific contributions to the profession of health physics. The selection was made by the society's awards committee, which is composed of the president and four most recent past presidents of the society.

Wang, along with nine other members from Cleveland Clinic, Columbia University, Florida Department of Health, King & Spalding, LLP, Los Alamos National Laboratory, Mayo Clinic, MJW Corporation, University of California Davis, and University of Michigan, were recognized for their accomplishments at the 60th Health Physics Society Annual Meeting awards banquet in Indianapolis on July 14, 2015.

Health Physics Society Fellow Wei-Hsung Wang serves as vice chair of the American Board of Health Physics Part II Panel of Examiners and is a member of the society's Academic Education Committee.

Scholarly Activities

Grants Awarded

- Radiation monitoring equipment for LSU-CAMD. Marceau-Day, M.L., Wang, W-H, Board of Regents, Contract # LEQSF(2015-16)-ENH-TR-14.
- LSU graduate fellowships in Health Physics. Newhauser, W.D., Matthews II, K.L., Wang, W-H, U.S. Nuclear Regulatory Commission, Contract # NRC-HQ-84-15-G-0017.
- LSU undergraduate scholarships in Health Physics. Newhauser, W.D., Mat thews II, K.L., Wang, W-H, U.S. Nuclear Regulatory Commission, Contract # NRC-HQ-84-15-G-0005.
- Nuclear Energy University Programs- fellowships and scholarships. Newhauser, W.D., Wang, W-H, Lu, F., US Department of Energy, Contract # 43302-1.
- LSUHSC-NO Radiology Physics for Residents. Matthews II, K.L., Dey, J., Jia, G., Wang, W-H, LSU-Health Sciences Center, Contract # 44008-1.

Grants Pending

- Combining soft x-rays and electron beams to purify air from industrial chimneys. Jia, G., Matthews, II K.L., Wang, W-H, Penn, A. L., Lomnicki, S., The National Academies.
- Nuclear science and engineering nonproliferation research consortium. Newhauser, W.D., Wang, W-H, Matthews, II K.L., U.S. Department of Energy.

Publications

- Wilson IV, C.A., Steele, A., Waggenspack, Jr., W.N., Wang, W-H, Ramsey, L. Engineering supplemental instruction: Impact on sophomore level engineering courses. Proc. of the American Society for Engineering Educa tion Annual Conference, paper 12632, June 14-17, Seattle, Washington, 2015.
- Yu, N., Wang, W-H, Steiner, J.R., Hamideh, A.M., Jia, G. Effective approaches to locate a missing radioactive source. The 2nd LSU International Research Fair, November 17, Baton Rouge, La., 2015.

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