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LSU & ULL researchers receive $3 million from NASA EPSCoR & LA Board of Regents

BATON ROUGE & LAFAYETTE, Louisiana – Louisiana research teams at LSU & ULL were awarded a combined $3 million in Federal and State Funding under the 2018 NASA Established Program to Stimulate Competitive Research (EPSCoR) Implementation Award program. NASA EPSCoR is a federal-state partnership program, and awarded projects are funded equally in our jurisdiction with a $750,000 base award from NASA and a cash match from the Louisiana Board of Regents Support Fund, administered through the LaBoR with technical & management support from the LaSPACE / LA NASA EPSCoR Management Team at LSU.

Both the LSU & ULL proposals were submitted to a single solicitation from NASA EPSCoR for projects being awarded over two fiscal years. From 54 eligible proposals, 13 were selected for FY17 funding and 14 were selected for FY18. Of the 27 awarded projects, Louisiana was one of only two jurisdictions to have two proposals funded (Montana was the other). The LSU project had an official start date in January, while ULL kicked off in July.

The LSU project, "Understanding and Quantifying Carbon Export to Coastal Oceans through Deltaic Systems," is led by Zuo "George" Xue, Assistant Professor in the Department of Oceanography and Coastal Sciences and at the LSU Center for Computation & Technology. Xue's team includes 3 additional investigators from the LSU College of the Coast & Environment: Eurico D'Sa, Kanchan Maiti, and Victor Rivera-Monroy. On August 23, 2018 a formal Subaward was issued by LSU to Southern University, lead institution for the largest Historically Black Colleges and Universities (HBCU) system in the nation. The research team at Southern is led by Zhu Ning, Endowed Professor in the Urban Forestry and Natural Resources Department. Her team's co-investigators include, Christopher Chappell & Kamran Abdollahi, also of the Urban Forestry and Natural Resources department at Southern. Several undergraduate and graduate students at both LSU and Southern have been recruited to work on this 3-year project. The full project abstract is included as an appendix to this press release.

The ULL project, "Production of Fuels and Other Life Support Products Using Wastewaters as a Feed into a Space-Based Biochemical Conversion System (BIOSYS)," is led by Mark Zappi, Dean and Professor in the UL College of Engineering. Zappi's interdisciplinary team of co-investigators at ULL includes, Endowed Professor Daniel Gang and Instructor Wayne Sharp of the Civil Engineering Department, Assistant Professor of Industrial Technology Emmanuel Revellame, and from the Department of Chemical Engineering, Research Scientist Dhan Lord Fortela and Department Head and Professor Rafael Hernandez. The full project abstract is included as an appendix to this press release.

For more information about:
NASA EPSCOR, https://www.nasa.gov/offices/education/programs/national/epscor/home/index.html
NASA EPSCoR in Louisiana, http://lanasaepscor.lsu.edu/
LA Board of Regents EPSCoR Programs: https://web.laregents.org/programs-2/epscor-programs/

Appendix A: Proposal Abstract for "Understanding and Quantifying Carbon Export to Coastal Oceans through Deltaic Systems," Science Investigator: Zuo "George" Xue, LSU (Faculty webpage: https://www.lsu.edu/cce/research/faculty_profiles/zuo_xue.php)

This project focuses on critical carbon processes at the interface of human-natural ecosystems, addresses the transport of carbon through the land-sea interface, and supports NASA's major strategic goal to advance our understanding of Earth. Lateral export of carbon from delta-dominated systems to the coastal ocean is still largely unknown. This carbon export driven by river discharge is considered in global carbon budgets to be a "leakage" from the biosphere-atmosphere interaction that eventually ends buried in marine sediments and stored over long timescales. We propose to investigate two contrasting coastal sites across one of the world's most dynamic systems - the Mississippi River Delta plain - to evaluate the carbon cycle at different stages of delta evolution: 1) the Barataria Bay region where the coastline is experiencing significant subsidence and land loss, and 2) the Wax Lake Delta region where a fast prograding delta is expanding. These two sites are analogues of contrasting responses to climate change, sea-level rise, and human activity. Understanding these two contrasting environments is critical to assess the role of delta systems in carbon export to the coastal oceans at a global scale.

The objectives of this project are to (1) Quantify different forms of carbon (dissolved vs. particular, organic vs. inorganic) and nitrogen fluxes from two deltaic sites to the coastal ocean; (2) Evaluate carbon transformation along salinity gradients; (3) Connect delta carbon and nutrient export to the coastal ecosystem using a coupled numerical modeling approach; (4) Improve satellite algorithms to couple remote sensing information with biogeochemical processes in land and oceanic environments; and (5) Use state-of-the-art remote sensing data to evaluate coastal wetland (above ground) biomass and carbon storage. We plan to achieve these objectives by combining remote sensing, oceanography, carbon cycling, and biogeochemistry to understand key biogeochemical processes regulating water and carbon cycling in subtropical deltaic/coastal systems and to project water and carbon cycle's response to climate change.

The work will leverage and bolster existing NASA investments in observations and modeling of physical and biogeochemical ocean processes. In particular, we address Earth Science objectives 3 ("Detecting and predicting changes in Earth's ecosystems and biogeochemical cycles, including land cover, biodiversity, and the global carbon cycle") and 4 ("Enabling better assessment and management of water quality and quantity to accurately predict how the global water cycle evolves in response to climate change") under the NASA Strategic Goal to "Advance understanding of Earth" as identified in the NASA 2014 Science Plan. This work is also aligned with the area of interests of several NASA centers including the Goddard Space Flight Center and the Jet Propulsion Laboratory. Project outcomes will contribute to the development of systematic approaches for exploiting next-generation remote sensing missions with higher spatial, temporal, and waveband resolution. The project will forge collaborative partnerships between Louisiana State University, the "flagship" university of Louisiana, and Southern University - Baton Rouge, main campus of the largest Historically Black Colleges and Universities (HBCU) system in the nation. This project emphasizes student and faculty exchanges, benefits teaching and research effectiveness, promotes diversity, and enhances scientific and technological understanding on the United States coast that is most vulnerable to the changing climate.

Appendix B: Proposal Abstract for "Production of Fuels and Other Life Support Products Using Wastewaters as a Feed into a Space-Based Biochemical Conversion System (BIOSYS)" Science Investigator: Mark Zappi, ULL (University webpage: https://engineering.louisiana.edu/about-us/administration)

Human exploration activities on celestial bodies, such as the Moon and Mars, will produce human life support-derived wastes and consume fuel, water, and oxygen. Key waste streams to be expected include (1) Black Water (toilet-derived); (2) Food Wastes (kitchen-derived); and, (3) Grey Water (aka. hygiene water). Further, water and oxygen will both need to be conserved and recycled. Therefore, to sustain human life during extended off-Earth excursions, recovery of the carbon, oxygen, and hydrogen along with the microchemicals making up the food, water, and air provided to the astronauts is needed to reduce the frequency of expensive makeup deliveries of these life support products. The technology used to recover resources must operate using compact, low weight designs; utilize minimal energy and oxygen footprints; be simple to operate with low maintenance; and, recover a high percentage of the life support resource chemicals that can placed back into beneficial use. The ideal system should also be flexible and contain built-in failsafe mechanisms that can adjust as unplanned events occur; yet, maintain operational capacity.

The proposed Biochemical Conversion System (BIOSYS) will effectively treat all human activity-derived waste (black water, grey water, and food waste streams) while producing beneficial by-products: fuels, recycled potable water, oxygen, protein cake, and machinery lube oils. The BIOSYS concept is based on a series of successful projects performed by the Project Team over the past 15 years that focused on converting wastewater into value-added products. The key development goals for the BIOSYS project are (a) be energy and oxygen use neutral; (b) have a compact process footprint and low payload weight; (c) be capable of treating water and air to reusable qualities; and, (d) be capable of producing co-products that can also be used for life support.

The primary BIOSYS concept design utilizes a series of treatment steps to convert wastewater constituents and cabin CO2 into recovered beneficial life support products. The design is composed of both anaerobic and aerobic bioreactor units; lipids extraction; a microalgae reactor; and an adsorption polishing step. This design results in the treatment of the contaminants in the water to essentially zero concentrations. Several products will be produced as system outputs: (1) Hydrogen - fuel for fuel cells; (2) Methane - also as fuel for fuel cells or potentially fed into the aerobic bioreactor for producing more protein and/or lipids; (3) Recovered O2 - recycled back into the cabin environment; (4) Lipids - Production of "green" lube oils or used as a nutraceutical; (5) Protein Cake (with or without lipids) - a food source; (6) Soil Amendments - fertilizer; and, (7) Recovered Water - recycled as potable water. One challenge could be oxygenating the aerobic unit which causes an oxygen sink that may be too costly. Hence, to reduce energy/oxygen use, a design option which eliminates the aerobic stage and replaces it with a passive solids separator will be considered.

The research plan involves evaluation of each unit operation performance via small reactor systems operated using a wide variation of feed rates and composition to test normal and stressed performance. Optimized individual units will be integrated into a bench system that will, in turn, be evaluated for its operational performance under stress. Mass and energy balances across the entire system and in between each unit operation will be used to optimize the performance of the bench system. A pilot system will be constructed based on the work done in the bench phase and its performance will be evaluated. Payloads and systems operation protocols will be evaluated and included as part of a comprehensive design evaluation. Publications including reports, peer-reviewed papers, and presentations will be key products along with outreach to recruit future STEM majors interested in space exploration.