Louisiana Water Resources Research Institute
Louisiana State University

Annual Technical Report
2018

General Information

Products

• Douglas Carlson, 2018, Impact of Agriculture on the Distribution of Chloride, Nitrate and Other Ion Concentrations in the Mississippi Alluvial Aquifer in Northeastern Louisiana in Transactions, v. 68, Gulf Coast Association of Geological Societies, Shreveport, Louisiana, 679p. [abstract].
• Douglas Carlson, 2017, Progress Report On the Determination of Chloride, Nitrate, and Other Ion Concentrations in the Mississippi Alluvial Aquifer in Northeastern Louisiana, Louisiana Geological Survey, NewsInsights, p. 13-19.
• Guo Hao, Hongliang Zhang#. 2018. Effects of climate change and emission scenarios on nitrate and sulfur deposition to surface water in Louisiana. 12th Annual Louisiana Groundwater, Surface Water and Water Resources Symposium, Louisiana State University, Baton Rouge, LA
• Tan, G. C.; Li, H. N.; Zhu, H. H.; Lu, S. D.; Fan, J. Z.; Li, G. Q.; Zhu, X. P.*, 2018, Concentration flow cells based on chloride-ion extraction and insertion with metal chloride electrodes for efficient salinity gradient energy harvest. ACS Sustainable Chemistry & Engineering, 6, 15212-15218.
• Zhu, H. H.; Xu, W. W.; Tan, G. C; Whiddon, E.; Wang, Y.; Arges, C. G.; Zhu, X. P.* 2019, Carbonized peat moss electrodes for efficient salinity gradient energy recovery in a capacitive concentration flow cell. Electrochimica Acta, 294, 240-248.
• Haihui Zhu, 2019, Concentration flow cells for efficient salinity energy recovery with carbonized peat moss and molybdenum disulfide electrodes. “MS Dissertation”, Department of Civil and Environmental Engineering, College of Engineering, Louisiana State University, Baton Rouge, LA, 1-48.
• Guangcai Tan, Xiuping Zhu. Activated Carbon Grafted Polypyrrole Anodes for Efficient Capacitive Deionization. Oral presentation at the “4th International conference on capacitive deionization and electrosorption”. May. 20-23. 2019. Beijing. China.
• Bhatta, D. and K. Paudel, 2019, Factors affecting groundwater use in coastal Louisiana agriculture “in” Proceedings of 6th National Forum on Socioeconomic Research in Coastal Systems, Center for Natural Resource Economics and Policy, New Orleans, Louisiana.
• Bhatta, D., K. Paudel, and F. Tsai, 2019, Groundwater use in the agricultural sector in Louisiana, 2004-2017 “in” Proceedings of the 13th Annual Louisiana Water Conference (LAWater 2019), Louisiana Water Resources Research Institute, Baton Rouge, Louisiana.
• Morales, Savannah R., 2019, Matrix recharge in a shrink-swell floodplain forest soil, "MS Thesis," School of Renewable Natural Resources, College of Agriculture, Louisiana State University, Baton Rouge, LA, 66 p.
• Herrmann, M., Entrekin, S.A., Evans-White, M.A., Clay, N.A. 2019. Direct and indirect low-level sodium additions to riparia impact leachate quality. Louisiana Tech University Research Day. Poster Presentation.
• Herrmann, M., Entrekin, S.A., Evans-White, M.A., Clay, N.A. 2019. Direct and indirect low-level sodium additions to riparia impact leachate quality. University of Louisiana System Academic Summit. Poster Presentation.
• Herrmann, M., Entrekin, S.A., Evans-White, M.A., Clay, N.A. 2019. Impacts of low-level sodium additions to riparian forest soils on water quality, decomposition, and detrital invertebrates. East Texas Forest Entomology Symposium, Nacogdoches, TX. Poster Presentation.
• Clay, N.A., 2019. Salt Impacts on Connections between Riparian-Stream Detrital Systems. Louisiana State University, Systematics, Evolution, and Ecology Seminar Series, Baton Rouge. Invited Seminar Presentation.
• Jina Yin and Frank T.-C. Tsai. (2019). Freshwater-saltwater interface approximation in a two-horizontal-well scavenging system. ASCE Journal of Hydrologic Engineering, 24(10): 06019008. https://doi.org/10.1061/(ASCE)HE.1943-5584.0001836
• An Li, Frank T.-C. Tsai, Kehui Xu, Jiaze Wang, Crawford M. White, Samuel J. Bentley Sr., and Qin J. Chen. (2019). Modeling Sediment Texture of River-Deltaic Wetlands in the Lower Barataria Bay and Lower Breton Sound, Louisiana, USA. Geo-Marine Letter, 39(2), 161–173. https://doi.org/10.1007/s00367-019-00566-2
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• Beigi, E., F. T.-C. Tsai, V. P. Singh, and S.-C. Kao. (2019). Bayesian Hierarchical Model Uncertainty Quantification for Future Hydroclimate Projections in Southern Hills-Gulf Region, USA. Water, 11(2), 268. https://doi.org/10.3390/w11020268
• Vahdat-Aboueshagh, Hamid, and Frank T.-C. Tsai, Developing statewide hydrostratigraphy model for Louisiana,

13th Annual Louisiana Water Conference, April 15-16, 2019, Baton Rouge, Louisiana
• Karakullukcu, Ramazan E. and Frank T.-C. Tsai, Calibration and Water Budget Analysis of Mississippi River Alluvial Aquifer Groundwater Model, 12th Annual Louisiana Water Conference, Baton Rouge, Louisiana, Baton Rouge, Louisiana, March 27-28, 2018
• Ramazan Karakullukcu, Groundwater modeling for Mississippi River Alluvial Aquifer of northeastern Louisiana, Master Thesis, Louisiana State University, Baton Rouge Louisiana, Fall 2018, https://digitalcommons.lsu.edu/gradschool_theses/4823/

Information Transfer Program

The LWRRI projects were disseminated to the public through the 13th Annual Louisiana Water Conference, April 15-16, 2019, Baton Rouge, Louisiana

Student Support

1 undergraduate student, 12 graduate students, 0 post-docs

Notable Achievements and Awards

The LWRRI initiated a Louisiana Well Log Portal (https://sites.google.com/site/louisianawelllogportal/) in 2014. Up to date, more than 127,000 electric logs and drillers logs have been added to the Portal. This academic year more than 270 CEE undergraduate students were trained to analyze electrical logs and drillers' logs through course projects. Students learnt documenting well log data into Excel spreadsheets, making Google Earth kml files, and displacing well log data to Google Earth. The students' data were eventually deposited to the Portal after quality control. State agencies, the public, and private sectors have been using the Portal to understand Louisiana's geology and groundwater resources. The Portal has been visited by more than 6,900 times and more than 10 countries.

The LWRRI co-organized the 13th Annual Louisiana Water Conference, Louisiana State University, Baton Rouge, Louisiana, April 15-16, 2019

Projects

Assessing the economic impact of delayed irrigation in agronomic crops

Project Type: Annual Base Grant **Project ID:** 2018LA118B

Project Impact: The objective of this research is to quantify the economics of delaying an irrigation event during the critical period of crop growth for forecasted rainfall. This study was conducted at the Red River Research Station on a 1.62 ha field of soybean irrigated by furrow using plastic polytubing and manual gate valves for individual plot control. The Smart Technologies for Agricultural Management and Production Irrigation Scheduling (STAMP) Tool was used to determine the irrigation requirement. The project found that normal station farming practices involved years of conventional tillage practices that has destroyed the soil structure resulting in reduced soil water holding capacity and decreased infiltrative properties. Given that furrow irrigation is considered 30%-70% efficient and the STAMP Tool was not adjusted for efficiency, the treatments received a conservative but appropriate amount of irrigation on a cumulative basis. However, soil health was a significant factor that impacted irrigation efficiency. Comparisons of soil moisture showed that the STAMP Tool allowed for more water storage within the soil profile than actually occurred. Overall, the STAMP Tool effectively estimated changes in soil moisture by reacting appropriately to irrigation and rainfall events, but exhibited certain characteristics that indicate the need for more complex algorithms for better accuracy in predictions. Future work includes a deeper evaluation of the treatments using crop models, improving the STAMP Tool to account for more dynamic soil water relationships, and repeating the study to gain better insight to the economic impact of delaying irrigation for forecasted rainfall.

Coupled chemical and hydraulic impacts of saltwater intrusion on the fate and transport of spilled chemicals in the Mississippi River

Project Type: Annual Base Grant **Project ID:** 2017LA114B

Project Impact: This study simulated the hydraulics of Mississippi River from Baton Rouge to GOM (232 miles), established the theoretical framework of the simulating chemical fate and transport; and reviewed hydraulics characterizing the stratification and turbulence of Mississippi River and Gulf of Mexico. The water flow profile shows that the river bed is approximately 50 feet below NAVD88 at GOM; and the water bed is as deep as -60 m (-200 ft) above NAVD88 at 94 RM (150 km). The deepest point is at the French Quarter at the City of New Orleans. The water flow velocity distribution at the Baton Rouge suggests that the profile at deep water has the fastest flow speed of over 5.0 ft/s, while the shallow water has a velocity of as low as 1.0 ft/s. Therefore, the behavior of chemical spill occurring in the middle of the river will be different to the occurring at the shallow water. The disadvantage of HEC-RAS is that this program assume one cross section has uniform water quality results. In other words, this program assumes an instant and complete mixing occurs at the spill site. Following conclusions are drawn based on the work performed: (1) HEC-RAS is ideal tool for simulating the hydraulics of stream like Mississippi River. However, this program is not able to simulate the water quality distribution at one specific cross section. (2) HEC-RAS along is not able to simulate the stratification of salt water and fresh water. Combining other program and algorithm is necessary.

Desalination of salt water for agriculture based on a novel battery system

Project Type: Annual Base Grant **Project ID:** 2017LA115B

Project Impact: The demand for freshwater has increased to critical levels due to population growth and economic development. Desalination of seawater and brackish groundwater has the potential to address this issue. This project used the novel Capacitive Deionization (CDI) method for brackish water desalination with low energy consumption. Capacitive Deionization (CDI) is an electrochemically controlled method for removing salt from brackish water when the electrode is electrically charged by an external power supply. CDI has low investment and infrastructure cost, and the process does not require high pressures or temperatures, unlike membrane or thermal processes. The projects found that the CV curves for MnO_2 and AC-Ppy suggest that they perform as pseudocapacitor. The respective specific capacitance of AC-Ppy, AC and MnO_2 electrodes decreased as the current density increased. The different charge storage mechanisms of AC-Ppy, AC and MnO_2 electrodes were also evident from the impedance analysis. The coulombic efficiency of both AC-Ppy//MnO_2 and AC//MnO_2 cells exhibited a downward trend as the cell voltage

increases, which can be attributed to aggravated parasitic reactions at high cell voltages. In summary, activated carbon grafted polypyrrole (AC-Ppy) is an efficient anode material for capacitive deionization. The enhanced desalination performance of the AC-Ppy electrode is attributed to its higher specific capacitance and lower charging resistance. This study demonstrated that capacitive deionization is a promising and alternative technology for desalination. The low-cost and easily manufactured ion selective AC-Ppy and MnO2 electrodes are good choices for the pilot scale capacitive deionization.

Development of low-cost online water level monitoring platform based on capacitive sensing

Project Type: Annual Base Grant **Project ID:** 2018LA117B

Project Impact: Accurate assessment of water flow rate at relief wells along Mississippi River levees can provide valuable information during the high-water season. However, due to the lack of affordable automated setups, it is very challenging to measure well water flow rate in a reliable and affordable manner. To address these technical issues, a fully automated cloud-based online water flow measurement setup was developed based on off-the-shelf components and commercial mobile network. Four (4) sets of the measurement setups were installed in four relief wells around the LSU School of Veterinary Medicine building. Hourly flow rates on these four relief wells were recorded from March 11 to August 11, 2019. The project found that average battery life was around 50 days, and can be further increased by adjusting the measurement interval and the data upload frequency. The cost of a measurement setup was less than $500, and can be further reduced if a large number of setups are made. In conclusion, a reliable, affordable, and automated IoT (Internet of Things) platform was developed to remotely measure flow rates from relief wells. The project had demonstrated six months of continuous operations in relief wells and the measured flow data showed good correlation with Mississippi River stages. In conclusion, such a platform can be deployed at large scale to monitor well flows of ground water and streamflows in realtime throughout Louisiana at an affordable cost such that water resources can be optimally managed and flood threats can be efficiently controlled.

Disinfection of Amoebae in Municipal Water Supplies

Project Type: Annual Base Grant **Project ID:** 2018LA116B

Project Impact: Recent stories of fatal amoebic infections—technically known as primary amoebic meningoencephalitis (PAM) caused by the amoeba known as Naegleria fowleri—have demonstrated that many Louisianan drinking water supplies are, in fact, infected with this ‘brain-eating’ amoeba. The objective here was to develop expertise within Louisiana to address this pressing issue. The project involved a literature review and the development of experimental procedures. A literature review was conducted and informed the laboratory methods. Experiments were performed with N. lovaniensis, as a non-pathogenic surrogate for N. fowleri. Quantification protocols were developed using a hemacytometer, turbidometry, and an automated cell counter. Automated cell counting was found have potential as a novel tool for the challenge of amoeba quantification, but there are several challenges for method development. Traditional methods are slow and require significant training and expertise, so the potential for automation is highly attractive. The work performed here has revealed the topic areas that must be addressed in order to make automated amoeba counting a reality. Specifically, pattern recognition software will be required in order to discern between amoeba cells and debris associated with sample solution or growth media, and research is also needed to manage the morphology of the amoeba, which can transition between flagellated, amoeboid, and cyst forms. Further, the literature search concluded that very few studies have been performed on the effectiveness of water treatment technologies, especially newer ones, on the viability of N. fowleri in municipal water systems.

Ecological consequences of low-level sodium inputs in riparian zones on decomposition processes and inputs to freshwater ecosystems

Project Type: Annual Base Grant **Project ID:** 2018LA120B

Project Impact: To better understand how agriculture-related increased salinization across multiple pathways impacts inputs from terrestrial to freshwater systems, this project conducted three experiments to test how increased

NaCl might impact water quality from non-point sources like irrigation water. The study site was the Wafer Creek Ranch in Ruston, LA, which is a Nature Conservancy Easement (32.570506, -92.720641). The project found that direct low-level NaCl additions had the largest effects across experiments on water quality (i.e., conductivity, cations). In the direct NaCl experiment there was no impact on decomposition of filter paper; however, nearly all of the filter paper had decomposed in all treatments. Whether or not soil chemistry changed was experiment-dependent. With Direct NaCl addition only pH (slightly more acidic in NaCl treatments) and Na differed, while there were no differences in the Indirect NaCl experiment after 3 months. Agriculture is increasing salinization of soils and riparian zones across the US including in Louisiana. Thus, understanding how salinization in terrestrial riparian zones impacts freshwater inputs is essential to understanding how increased salinization in irrigation water will impact freshwater quality. These results suggest that 1) even low-level increases in salinization through direct inputs, Na-enriched detritus and their interaction can impact leachate water quality and decomposition processes, 2) detrital processes are season-dependent in response to low-level NaCl additions where subsidy-stress thresholds shift. Whether the same patterns hold at whole stream-level in the field, and how saltier leachate impacts whole stream conductivity and salinity measurements and detrital processing remains unknown and needs further investigation.

Effects of climate change on nitrogen and sulfur deposition to Louisiana water bodies using climate downscaling meteorology and chemical transport model

Project Type: Annual Base Grant **Project ID:** 2017LA113B

Project Impact: This project developed tools to estimate the effects of climate change on spatial deposition of nitrogen (N) and sulfur (S) to Louisiana water bodies using climate downscaling meteorology and chemical transport model. The spatial distribution of PM2.5 emission shows high emission at Mississippi and south Louisiana, while NOx emission distributes along the highways and seashore of southeast Louisiana as majority of NOx emission comes from vehicles emissions. NH3 emissions have a significant peak at central Louisiana near Baton Rouge. SO2 emissions are higher along the bank of Mississippi River because of power plants and chemical industry. The PM2.5 emission is higher in August at northeast and southwest Louisiana while NH3 emission is also higher in majority parts of Louisiana. High sulfur deposition fluxes occur at boundary of Louisiana in August 2050 at three climate scenarios, which indicates a significant sulfur transported from adjunct states like Alabama, Mississippi and Texas. Due to controlling of anthropogenic emissions, nitrogen depositions show a decreasing trend in January and August 2050 of RCP 4.5/6.0/8.5 climate scenarios. In conclusion, this study offers insights of nitrogen and sulfur deposition in future, and contributions of different sources. EGU, industry and upwind sources are major sources of sulfur deposition and on-road vehicles, industry, and other inexplicit sources are important to nitrogen deposition.

Fine-grained floodplain forest flow paths and source water mixing in shrink-swell clays of a bottomland hardwood forest using stable isotope tracers

Project Type: Annual Base Grant **Project ID:** 2018LA119B

Project Impact: The larger scope of this project is to extend the current knowledge of floodplain hydrology in vertic, clay soils by addressing how the macropore network functions to recharge the matrix in forested shrink-swell soils. The study site is in Lower Mississippi Alluvial Valley (LMAV) near St. Gabriel, Louisiana (30°16'54"N, 91°05'21"W). The project found that percent organic matter decreased with depth across all peds. In general, dye coverage on ped surfaces became less as depth increased. There was no distinct pattern in differences of dye coverage occurrence with depth between flood durations. The ped water was heavier in ?D (i.e., greater percentage of flood water in ped) for the long flood duration than the short duration across all depth classes. Measured ?D was consistently higher (i.e., apparently more flood water) than the calculated expected ?D given moisture content increase. Much of the variance in ?D was related to organic matter. There was a significant relationship between percent organic matter and ?D in ped water for both short and long treatments. In conclusion, macropore activity decreases with depth, and combined with organic matter controls mass flux into soil peds. The combined influence of these variables is expressed in depth below the surface. Macropores are active and dominate during the initial wet-up period, but close relatively quickly resulting in diffusional processes recharging the matrix beyond initial wet-up. This interruption of macropore connectivity explains field observations of steady soil moisture, episaturation, and lack of connectivity between surface ponding and subsurface water pools in Vertisols.

Impact of agriculture on distribution of chloride, nitrate and other ion concentrations in Mississippi Alluvial Aquifer in northeast Louisiana

Project Type: Annual Base Grant **Project ID:** 2017LA112B

Project Impact: The Mississippi River Alluvial Aquifer (MRAA) is the principal to sole aquifer supplying groundwater in northeastern Louisiana. In the past 55 years groundwater use has increased in the nine parish study area. The project investigated if this large increase in groundwater use for irrigation impacted the water quality of the MRAA in Northeast Louisiana. For this study approximately 80 wells have groundwater samples collected throughout the MRAA. The project found that agricultural activity has impacted the MRAA only slightly and largely in the western five parishes: Catahoula, Franklin, Morehouse, Richland and West Carroll. However, change has been observed for specific conductance, a proxy of TDS, chloride, nitrate concentrations and less so iron concentrations. Nitrate concentrations are increasing due the additional fertilizer added over the same interval of time. What is somewhat surprising is iron concentrations have remained approximately the same over the 40 years. These results in general are a result of a robust aquifer that is controlled by a nearly infinite source of water on its eastern edge, the Mississippi River and the thin confining clay throughout most of the western portion of the aquifer allowing significant rates of recharge from precipitation. In conclusion, although the MRAA is typically only a third as thick as the Chicot Aquifer in southwest Louisiana it is similar in that it is extremely conductive and is even more robust with it vast recharge potential from the Mississippi River and its generally thinner confining clay allowing for greater rate of recharge.