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Louisiana's Oil and Gas Industry — The Missing Link in Coastal Sustainability

by Chris McLindon, #2327 — McLindon Geosciences, LLC

The sustainability of coastal zones is becoming a global priority. Nearly half of the world's population lives within 100 miles of the ocean, and half of them live within 50 miles. Population centers tend to be in cities close to the ocean that are built on coastal plains or river deltas. South Louisiana is often recognized as a model for sustainability in coastal zones. What is generally not recognized is the critical role that the oil and gas industry must play in that model. The concept of sustainability has evolved over the past few decades. Many of the early ideas of trying to restore coastal ecosystems to a pristine state that preceded the industrial revolution have given way to a managed sustainability that balances ecology with economy. Real sustainability allows for the utilization of the natural resources of the coast while working to protect and preserve the essential ecological components. Fisheries, transportation, ports and oil and gas production can all coexist with a productive natural environment, if effectively managed. The truth is that the viability of the economic component of a coastal system in many ways determines the viability of the ecological component. The worst areas of pollution and coastal degradation tend to be in countries with the poorest economies.

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President's Column

Dawn S. Bissell, #3095
Corpus Christi, TX

Hello, all!

As the new SIPES President, I say hello!! I am a member of the Corpus Christi Chapter, and have been a member of SIPES since 2006.

I have been an independent since 1999. Why did it take me seven years to join? Mainly, I did not know what SIPES was. I was not aware of the networking opportunities within a wider group of professionals or mentoring that was available. Thanks to Brian Calhoun, #1586, who repeatedly invited me, I finally attended a luncheon, and soon joined.

Getting right to the business at hand, I have had many conversations with members of a variety of different organizations, from church to social to technical groups about how to get people involved. This seems to be a recurring, overarching concern.

We can blame it on the current trend of not wanting to commit to anything in case something else better comes along. Whether it is this 'millennial' or even our generation, we just don't want to be obligated.

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Louisiana's plan for sustainability is laid out in the document "Integrated Ecosystem Restoration & Hurricane Protection: Louisiana's Comprehensive Master Plan for a Sustainable Coast." The 2021 Fiscal Budget for the Master Plan was recently published by the Louisiana Coastal Protection and Restoration Authority (CPRA). It is based on $3.34 billion in revenue in the successive three-year period 2021-23. 81% of that revenue is derived from the oil and gas industry. A significant portion of this revenue comes from settlements from the Deepwater Horizon disaster, but almost $400 million comes from the Gulf of Mexico Energy Security Act (GOMESA), which provides revenue from offshore leasing, rentals and royalties. Another $100 million comes from the Coastal Protection and Restoration Trust Fund, which collects revenues from leases, rentals, royalties and severance taxes in onshore Louisiana. The economic viability of Louisiana's plan for coastal sustainability is directly tied to the economic viability of the oil and gas industry along the coast of Louisiana.

"The real value of the oil and gas industry's contribution may lie in the science of sustainability."

The real value of the oil and gas industry's contribution may lie in the science of sustainability. Regardless of the magnitude of its expenditure, the success of the Master Plan will ultimately be determined by the degree to which it is based on an accurate assessment of the natural processes in the wetlands. Earth science lies at the foundation of understanding the natural processes of the coast, and the oil and gas industry can provide a wealth of earth science data and knowledge base. The application of industry data to studying coastal Louisiana began in the first years of this century. Dr. Woody Gagliano started his career at the LSU Coastal Studies Institute before he founded his own company, Coastal Environments, Inc. Dr. Gagliano is a recipient of the Coalition to Restore Coastal Louisiana's Lifetime Achievement Award. In a 2003 publication that accompanied his report to the U.S. Army Corps of Engineers, he stated "A century of oil and gas activity has made the subsurface of Southeastern Louisiana, which lies in the Gulf Coast Salt Dome Basin (Gulf Basin), one of the most understood geological provinces on earth. Thousands of wells have been drilled; hundreds of thousands of seismic lines have been run; and the geological literature is voluminous. The success of the oil and gas industry in this and other similar sedimentary basins throughout the world attest to the validity of the process-response models of sediment loading, compaction, salt movement and fault adjustments developed by geologists and geophysicists working in the Gulf Basin. A working premise of the present study was to use this solid foundation of research as a basis for understanding and predicting land form and environmental change." Gagliano had recognized that subsurface geological processes played a fundamental role in controlling surface processes including subsidence and wetlands loss, and that oil and gas industry knowledge base was essential to understanding the geology.

Gagliano's study pre-dated the use of 3-D seismic for coastal research. It was not until 2014 that the first 3-D survey was used in a university research project on coastal geology. Geologists at Tulane University and the University of Texas at Austin used a 530-square mile 3-D survey in Plaquemines Parish which was donated by Western Geophysical. Their research produced the publication "Influence of growth faults on coastal fluvial systems: Examples from the Late Miocene to the Recent Mississippi River Delta," which documented 28 faults mapped with the 3-D survey. The study found that "Most of the seismically imaged faults appear to extend up to the modern land surface and some affect the modern delta morphology. … several of these faults correspond to abrupt shifts from emergent wetlands to fully submerged areas of open water on the delta surface." Their study found that the submergence of wetlands along the downthrown sides of faults that reached the surface was major factor in causing wetlands loss. Since then, seven 3-D surveys and one 2-D survey have been made available for university research through direct donations and internships at oil and gas companies. These data have been used in four M.S. theses at the University of New Orleans, three M.S. theses at the University of Louisiana at Lafayette, and one Ph.D. dissertation at Tulane University (**Figure 1**). Each of these research projects mapped faults that were projected to extend to the surface and to affect surface coastal processes. Publications from this research will be entering the scientific literature over the next few years. The first summary of this research "Synthesis of Fault Traces in Southeast Louisiana Relative to Infrastructure" was published in 2019 by the Transportation Consortium of South-Central States (TranSET). The surface fault traces are now available in GIS format on the Louisiana Department of Transportation and Development website. The TranSET study stated that "Highly detailed 3D seismic reflection data from the energy sector was donated for use by local universities to map geologic features identified on seismic data to help predict areas of future land loss. It is hypothesized that the locations of geologic features as deep-seated faults and salt domes will prove to be closely related to many areas of coastal land-loss in south Louisiana. As a result of this collaboration, coastal restoration, flood-control and sustainability initiatives that are based upon this knowledge should be optimized to deal with future relative sea-level rise."

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Figure 1. Four of the Master's candidates are using industry seismic to study surface coastal processes for their thesis. They are Jarrett Levesh, UNO (upper left); Jared Bullock, UNO (upper right); Matthew O'Leary, ULL (lower left); and Robert Mohollen, UNO (lower right).

Ironically, no meaningful consideration is given to the impact of faults in modern coastal sustainability planning. This is the missing link in the sustainability models. The paradigm under which the concepts about the causes of change in Louisiana's coastal wetlands were developed did not include geology. Nobody has described this better than Dr. Len Bahr, who ran Louisiana's coastal restoration program from 1993 to 2008. He wrote this in his blog post of May 2013 "Since its very inception in 1989 Louisiana's coastal restoration program has been dominated by coastal wetland ecologists like me, folks who deal in relatively short-term surface processes, not the long term geophysical and riverine processes that underlie the delta. In other words, the planning expertise has been dominated by those who deal primarily with surface processes on the visible veneer of the delta, not the riverine hydrodynamics and sedimentary processes that created the delta and the underlying tectonic processes and shallow and deep subsidence to which the delta ultimately responds." Louisiana's coastal sustainability planning has been very slow to integrate a consideration of the subsurface geological processes to which the delta ultimately responds.

It is the nature of science that new data is constantly changing our collective understanding of natural processes. This is true for coastal Louisiana. It turns out that many of the initial conceptions about wetlands loss were incorrect, but many of the popular narratives that developed early in the paradigm still persist. The average person in coastal Louisiana would be likely to tell you that the wetlands are in a state of ecological crisis. They would note that this is evidenced by the fact that the coast is losing land at the rate of a football field an hour. They would also note that the principal causes of loss are the lack of a sediment supply caused by the levees and erosion that is caused by "saltwater intrusion." None of these contentions are scientifically accurate. Correcting the misconceptions about the coast is essential to the long-term success of sustainability. New data is beginning to challenge the popular narratives of the old paradigm, but in order to be fully integrated into coastal sustainability planning new data must be understood in the context of subsurface geology.

CPRA and the USGS monitor a wide array of data from the coastal wetlands. These data include rates of subsidence, sediment accretion, surface elevation change and land area change. Data are measured at nearly 400 stations in the Coastwide Reference Monitoring System (CRMS). **Figure 2** shows a map of the CRMS network and data being collected

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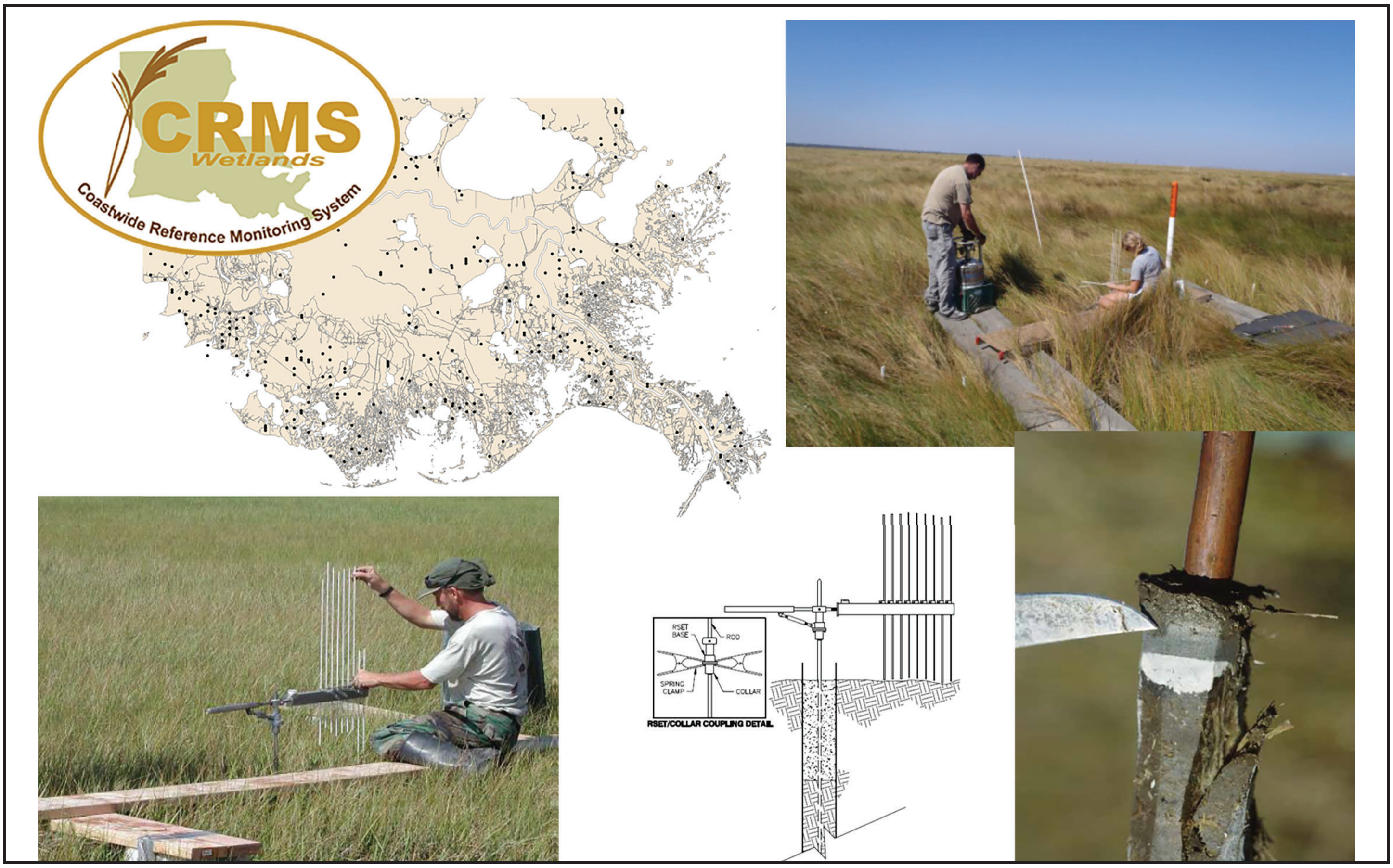

Figure 2. Nearly 400 stations in the Coastwide Reference Monitoring System have been measuring sediment accretion, surface elevation change, land area change and soil salinity for over a decade.

at some typical sites. Most CRMS stations measure rates of sediment accretion that are greater than subsidence rates, and in many cases greater than subsidence plus sea level rise rates. CPRA has reported that 70% of the stations in the delta region measure "positive elevation trajectories," meaning that the marsh surface is gaining elevation relative to a fixed rod at the station. Land loss rates were high in the mid-1970s when the popular narratives were formulated, but rates have been continually decreasing. In fact, a 2019 study from the University of Arkansas found that "Remarkably, during the recent period … coastal Louisiana gained a modest amount of land." CPRA determined in a 2019 study that subsidence rates used in the formulation of the 2017 Master Plan were over 1.5 times higher than the rates actually being measured by modern technology. This is the scientifically factual assessment of coastal Louisiana. The coastal marshes actually have a fairly robust sediment supply. Sediment accretion rates are high relative to subsidence, and much of the wetlands have been able to maintain surface elevation (**Figure 3**). The result has been over a decade of stability in total net wetlands area.

Geological interpretation using oil and gas industry data offers the best explanation for the revelations of the new body of data. The university research has produced a fairly extensive coverage of surface fault trace maps. These have shown conclusively that historical wetlands loss over the past few decades has been concentrated along the downthrown sides of the faults (**Figure 4**). Historical data from several tide gauges along the coast have been used to document a subsidence event in the 1970s that coincided with the land loss event (**Figure 5**). The most probable explanation for the coincidence of the timing of these events and the concentration of loss along the faults is that there was an episode of fault slip that spanned about two decades. This is what Dr. Woody Gagliano believed. LSU Geology professor Dr. Roy Dokka also believed that fault slip was a significant contributor to subsidence along the coast. He referred to the gradual progressive slip over time as being like "decades-long earthquakes." This type of slow-slip movement on faults has been documented in tectonic regions. It will require more detailed study to fully document this phenomenon in the gravity-driven faulting of the delta region.

The rapid submergence of large areas of coastal marsh over these decades would have resulted in a substantial addition of

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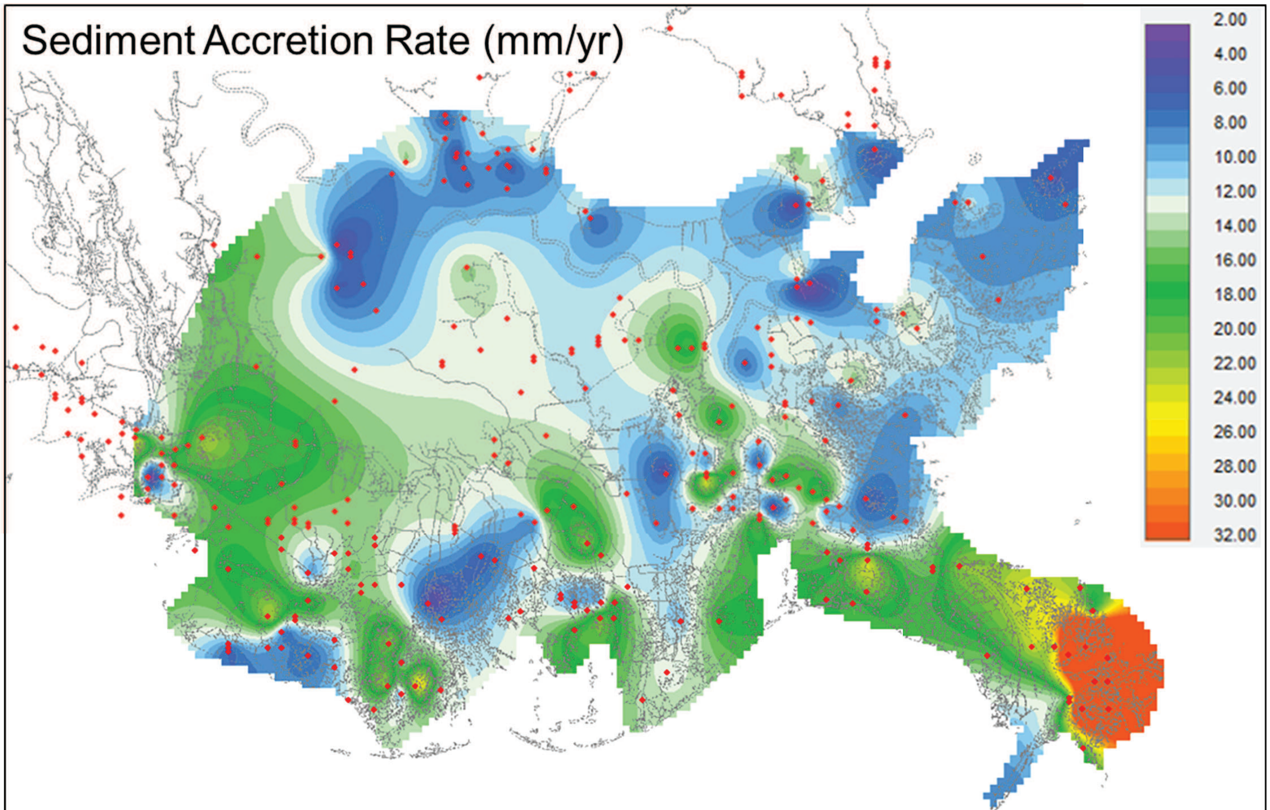

Figure 3. The rate of sediment accretion from individual CRMS stations is gridded with a standard algorithm. Rates of accretion in many areas are greater than subsidence and sea level rise combined.

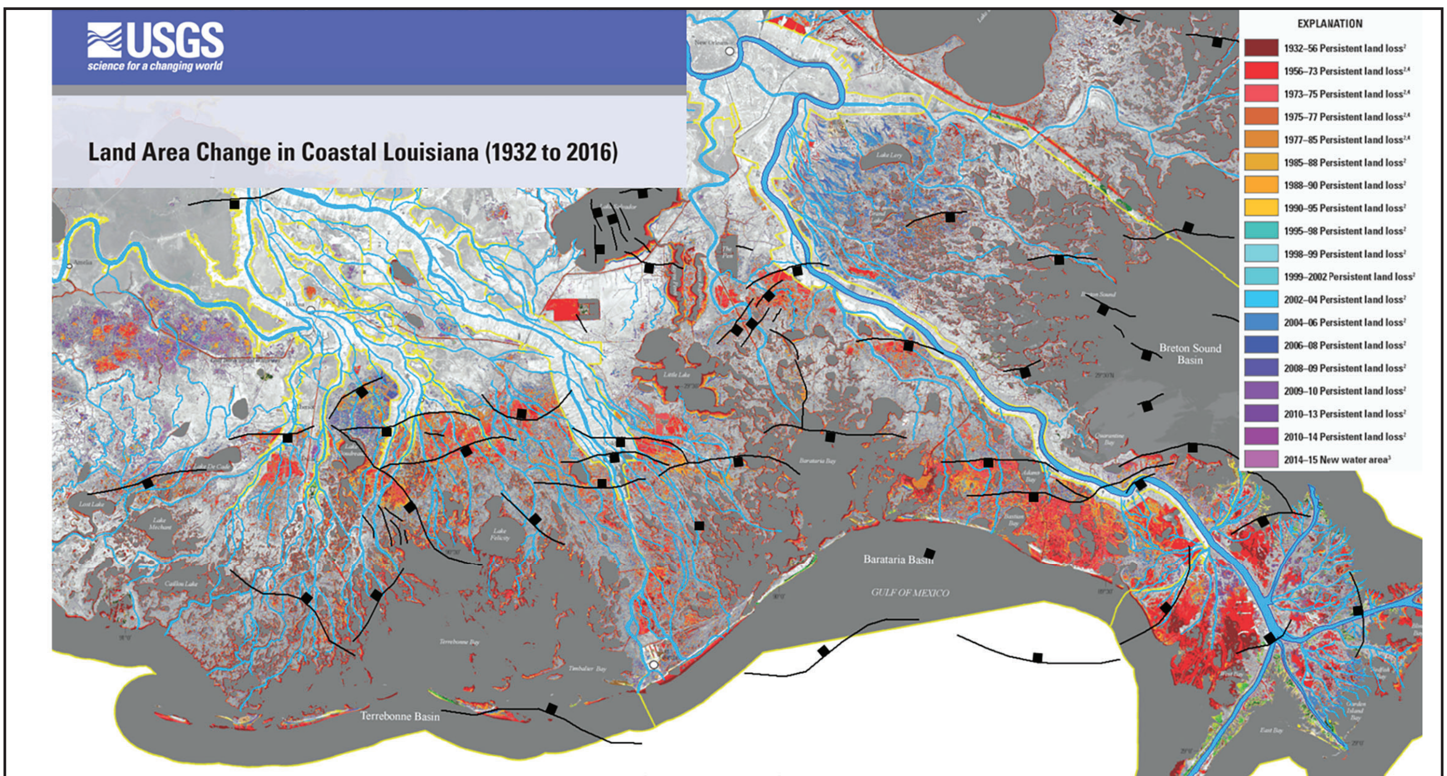

Figure 4. Surface fault traces and distributary channel networks superimposed on the USGS Land Area Change Map. Hot spots of wetlands loss in red and orange tend to occur on the downthrown sides of faults where they cross branching channel networks

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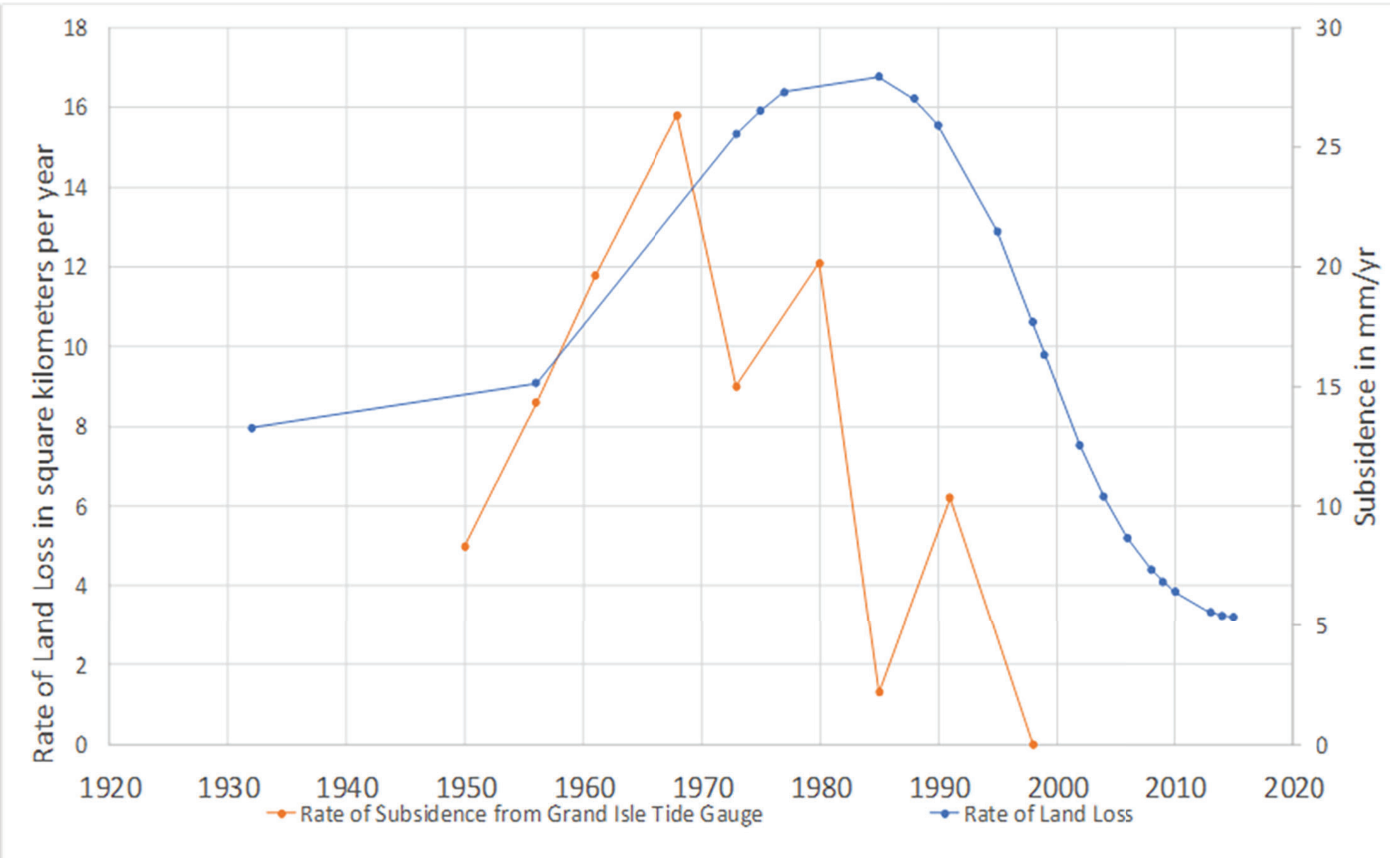

Figure 5. The rate of subsidence derived from the Grand Isle tide gauge by Kolker et al, 2013 is compared with the rate of wetlands loss in the Barataria Basin from the USGS Land Area Change study. The data suggests an episode of subsidence causing an episode of land loss. Fault slip is a likely mechanism for subsidence.

mineral sediment to the coastal hydrologic system. While high rates of land loss were being measured at the marsh surface, sediment was being redistributed in the coastal bays and estuaries. Several studies have shown that significant sediment accretion happens during tropical storms. Tidal flux carries sediment from the bays and estuaries onto the marsh platforms. The high rates of sediment accretion and surface elevation change measured by CRMS can be best explained as a redistribution of sediment from marsh material that was lost to subsidence during the fault slip event.

The integration of interpretations from oil and gas industry seismic data with data from CRMS points to a positive outlook for the long-term sustainability of the Louisiana coast. It appears that the natural processes of accretion are working to maintain the elevation of resilient marsh platforms in the face of subsidence and sea level rise. Many of the edges of these marsh platforms are coincident with the surface traces of faults. The most successful sustainability plans will work to supplement the natural processes of sediment accretion – perhaps by depositing dredged material from the Mississippi River in the bays adjacent to the marsh. The most effective of these plans can only be developed with a more complete understanding of the subsurface geology that is controlling surface processes. This can only be achieved by finding a way to integrate oil and gas industry data and knowledge base into the planning process. That is the missing link in coastal sustainability.

Chris McLindon has worked as an exploration geologist in coastal Louisiana for the past 40 years. Over the past five years he has worked with the Louisiana Geological Survey to promote the use of oil and gas industry data in coastal research at area universities. Additional information can be found in Chris' blog — https://www.mcgeo.me

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