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# EDITORIAL

## Science Should Inform Sustainable Rebuilding

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The return of hurricane season prompts reflection on how well those charged with rebuilding New Orleans and the U.S. Gulf Coast are integrating scientific understanding into important decision-making. An associated question relates to whether we, as scientists, are doing all we can to communicate our research results effectively to those very people who need it the most. Some AGU members may feel constrained engaging those responsible with rebuilding the Gulf Coast without an authoritative synthesis of the science that most directly bears on the challenges of rebuilding after hurricanes Katrina and Rita.

Such a synthesis is now summarized on this page. There is a link to the full report on the AGU Web site. The report derives from an experts' conference held in January 2006 at AGU headquarters in Washington, D.C. The central objective of the conference was to bring together an interdisciplinary group of experts on various aspects of hurricane impacts to review our current scientific understanding of topical areas such as hurricane variability, storm surge response, flooding, wetland loss, subsidence, effects of climate change, and so forth.

The conference was a success. But now comes the more challenging part: communicating the results as effectively as possible, so that sound science is routinely available during discussions about storm protection, environmental restoration, land use, transportation infrastructure, and neighborhood planning. Ideally, knowledgeable scientists, or those informed about the science, should be readily available to check the facts and explain what we know or do not know when science is invoked to support or oppose a policy decision. This new AGU report can serve as a reference in those instances.

Science will not provide the only decision criteria, however. Other factors such as economic and social issues will also be considerations. Yet science must play its appointed part, and we, as citizens, must also hold our elected officials accountable if they ignore or misconstrue the best scientific understanding of the problem. We urge scientists to speak out, reasonably and constructively, when those responsible for rebuilding the Gulf Coast cite scientific justifications in their deliberations.

The impetus for the experts' conference and report stemmed from the New Orleans and Gulf Coast disasters in 2005, yet its contents should be useful to those living in similarly vulnerable regions in the United States and other countries. There is an opportunity here to match scientific expertise, embodied in the global AGU membership, with the needs of decision-makers struggling to protect lives and property from extreme weather and its consequences. Communicating the contents of the new report to people accustomed to treating science as a minor factor in hazard mitigation is a starting point for broader engagement between scientists and decision-makers. We urge you to make the best use of the report wherever you live.

—DONALD BOESCH, Center for Environmental Science, University of Maryland, College Park; CHARLES GROAT, Jackson School of Geosciences, University of Texas, Austin; TIMOTHY KILLEEN, AGU President-elect

# Hurricanes and the U.S. Gulf Coast: Science and Sustainable Rebuilding

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The knowledge available among AGU members provides scientific expertise on nearly all of the physical environment of the dynamic Gulf Coast ecosystem complex. Intelligently rebuilding features such as fisheries, oil fields, seaports, farms, and wetlands after hurricanes Katrina and Rita will require "a well-constructed collaborative effort to maximize the role of science in decisions made about the rebuilding," wrote Charles Groat, former director of the U.S. Geological Survey, in a news article published in *Eos* that stimulated an AGU meeting of experts.

As a step toward developing a scientific basis for safer communities along the Florida-Alabama-Mississippi-Louisiana-Texas coastline, AGU convened an interdisciplinary 'Conference of Experts' on 11–12 January 2006 to discuss what we, as Earth and space scientists, know about the present and projected environment in New Orleans and the Gulf Coast areas affected by the hurricanes of 2005. Twenty scientists, all experts in the fields of science relevant to the Gulf Coast, met to consider ideas for a coordinated effort to integrate science into the decision-making processes necessary for the area's sustainable rebirth. Political, economic, and social issues were intentionally not discussed. Nevertheless, it was recognized that these issues are intertwined with science and are of paramount importance. This report contains a summary of the discussion and is intended to be helpful in providing scientific understanding useful in redevelopment of the affected area.

The objectives of the meeting were to review and assess the scientific knowledge in the areas most relevant in hurricane protection, to identify gaps in knowledge that could be filled by focused research, and to propose mechanisms to link science to the most effective reconstruction of New Orleans and other coastal areas affected by the recent hurricanes. The meeting attendees considered seven topics addressing the current understanding, near-term needs, and longer-term directions for: hurricanes, storm surge and flooding, subsidence, climate change, hydrology, infrastructure, and disaster preparedness and response. The messages from the conference are as follows.

### *Hurricanes*

While all hurricanes are detected before landfall and their trajectories known to some degree, predictions of cyclone intensity and structure still contain great uncertainty. Although there have been substantial increases in the accuracy of hurricane track prediction over the past decade, seasonal predictions have shown little skill, for example,

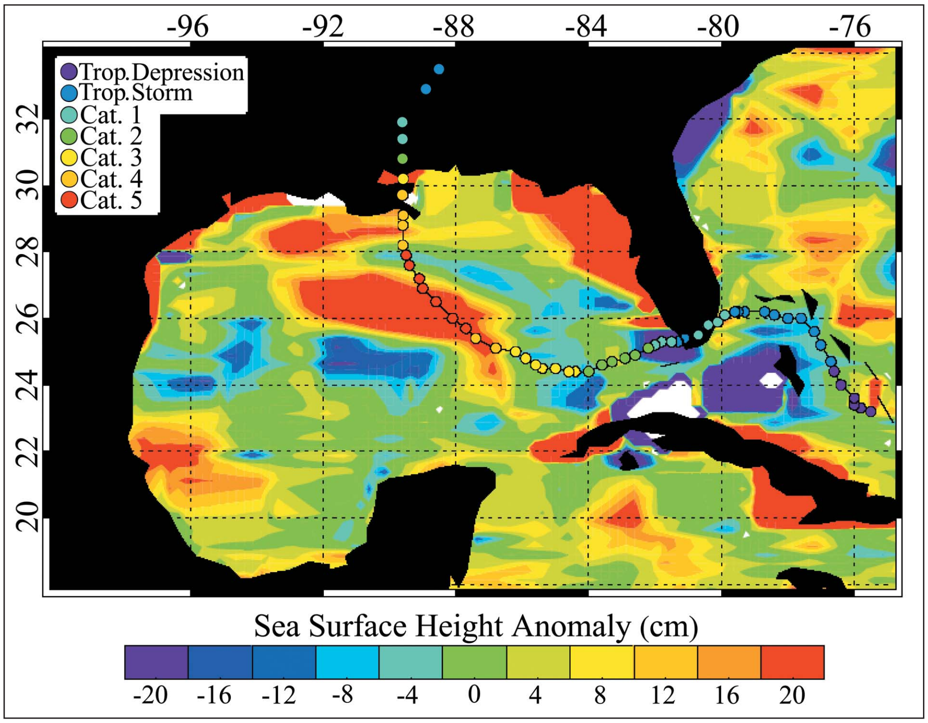


*Fig 1. Intensifications of Hurricane Katrina correlate with highs in the ocean dynamic topography, which is an indicator of the depth of the warm-water pool. There are strong theoretical reasons to expect that warming of the oceans already has led to more intense hurricanes and will continue to affect tropical storm characteristics. See R. Scharroo et al. (*Eos, 86*(40), 366, 2005) for more details. Figure courtesy of Peter Webster and Paula Agudelo, Georgia Institute of Technology.*

predicting an increasing number of hurricanes when fewer actually occur. European ocean-atmosphere models, however, have demonstrated improved capability and may provide more reasonable approximations in the future. Rising sea surface temperatures, routinely observed through infrared and microwave emission satellite sensors, increase the tropical cyclone heat potential and contribute to tropical cyclone formation and their intensification. The conference participants proposed the use of improved seasonal forecasts such as those being applied in Europe.

### *Storm Surge and Flooding*

The basic physics of storm surge is well understood. Remarkably accurate numerical models have existed for approximately 25 years in the United States and abroad for geometrically simple coastal areas. Recent developments have allowed modeling of complex regions such as the Louisiana shoreline that include channels, levees, and buildings.

Nevertheless, better wind data, enhanced shoreline topography, and improved techniques to assess the location and range of flooding are necessary in storm surge models for simulating the range of flooding probabilities. Such modeling scenarios can be used to predict the extent of damage such as levee overtopping, were such an extreme event to take place. In the longer term, advanced high-resolution data could provide even better approximations of inundation and expected damage from flooding, thus allowing cities and regional disaster mitigation agencies to prepare an appropriate response to an impending disaster.

### *Subsidence*

Natural processes as well as human impacts have contributed to subsidence, the sinking of land over time, along the Gulf Coast. Presently, there is considerable discussion and debate among the scientific community regarding mechanisms and rates of subsidence in the Mississippi delta area. Regional faulting, forced drainage, oil and gas extraction, and groundwater withdrawal all have led to lowering of the elevation of highways and levees below their originally designed levels.

As a result of subsidence, new U.S. Federal Emergency Management Agency Base Flood Elevations maps that will be available for the area in 2007 may not be accurate; yet those maps will form the basis for flood control and establish levels for rebuilding. In the future, levees and other flood control systems should be designed and built to account for the amount of sea level rise and predicted subsidence expected over the design life of the structure. In designing new structures, consideration should be given to likely changes over time in storm surge, subsidence, and sea level. New and improved instrumentation would allow researchers to make better predictions of geological and subsidence processes.

### *Climate Change*

There are strong theoretical reasons to expect that warming of the oceans already has led to more intense hurricanes and will continue to affect tropical storm characteristics. Increasing ocean temperatures also cause sea level to rise due to thermal expansion and thus enhance storm surge. It is well established that a sea surface temperature of at least 26°C (79°F) is required for hurricane formation.

Recent analyses have found that the frequency of intense hurricanes and severe rainfall has increased in recent decades. Hurricane strength and numbers are projected to increase further with rising ocean temperatures. The hurricane climatology of the twenty-first century will be quite different from that of the twentieth century. Planning should take into account the strong probability of more frequent and more intense hurricanes. In the near future, prediction models will be able to provide notice of exceptionally strong hurricane seasons more in advance than is presently possible. As these advances continue, and as more is known about the fundamental physical basis of climate change, hurricane response plans can be continually improved.

### *Hydrology*

Human settlement in New Orleans and throughout the Gulf Coast has greatly modified the natural conditions of the Mississippi River system. In New Orleans, for example, canals have been dredged for navigation and drainage, levees that limit flooding have been raised, tidal wetlands have been eliminated, and dams and locks have been constructed. As development projects have continued and expanded, the mechanisms that had preserved the Mississippi delta in the face of subsidence and erosion have been largely stifled. While the rebuilding of coastal communities has to account for such conditions, long-term flood protection will likely require reestablishing some natural systems such as wetlands that serve as a natural barrier adding some protection from storm surge and flooding.

### *Infrastructure*

When floodwaters from hurricanes Katrina and Rita spilled through the Gulf Coast and breached the levee system in New Orleans, infrastructure damage ranged from unusable roads and bridges to inoperable telecommunications, electrical, and satellite observation systems. The breakdown of communications, both physical and organizational, will require extensive attention and modification. Additionally, ravaged systems such as navigation channels and coastal ports will require renovation and better protection against future damage. Improved models supported by a better understanding of the region's natural systems are needed to plan a unified system of storm protection.

### *Disaster Preparedness and Response*

No matter how resilient the new Gulf Coast may be, preparation for future hurricanes will require development of the capability for massive and timely responses to protect resources and lives. Key to an effective response are detailed scenarios, maps, and visualizations of the affected areas. In addition, training of first responders is necessary so they can react to ever changing scientific data. Most critical is accurate information with three to four days notice that would provide time for evacuations, if necessary. Improved forecasts of hurricane trajectory, intensity, and structure are most vital to completing these tasks.

*Future Considerations*

The key objective of the conference of experts was to ensure the integration of science into the overall reconstruction efforts after the recent hurricane disasters along the Gulf Coast. Given the breadth of the Earth and space science topics within AGU's purview, the organization and member scientists are well prepared to discuss and demonstrate the relevance of sound science to decision-makers charged with rebuilding when future catastrophes strike.

Several recommendations emerged from the conference that would continue the dialogue between scientists and planners at all levels. The suggestions are as follows: (1) Establish a multidisciplinary steering committee to maintain an overview on reconstruction and new threats to the region from natural disasters, and charge that committee with monitoring the rebuilding and identifying key scientific issues and assets to address these issues; (2) assemble a database of experts who would be available to provide scientific guidance as needed; and (3) provide periodic assessments of reconstruction and planning efforts.

Successful and sustainable reconstruction of New Orleans and the Gulf Coast and the effective planning for future hurricane events must incorporate the best available science. This can only be ensured by strong continuing interaction among scientists, planners, and decision-makers at all levels.

The full report is available on the AGU web site: http://www.agu.org/report/hurricanes/

*Meeting Participants*

Mead Allison, Department of Earth and Environmental Sciences, Tulane University; Donald Boesch, Center for Environmental Science, University of Maryland; George Born, Colorado Center for Astrodynamics Research, University of Colorado; Tim Dixon, Center of Southeastern Tropical Advanced Remote Sensing, University of Miami; Roy Dokka, Center for Geoinformatics, Louisiana State University; Charles Groat, Jackson School of Geosciences, University of Texas; Bob Harriss, Institute for the Study of Society and the Environment, National Center for Atmospheric Research (NCAR); Greg Holland, Mesoscale and Microscale Meteorology Division, NCAR; Steve Jayne, Physical Oceanography Department, Woods Hole Oceanographic Institution; Timothy Killeen, Director, NCAR; Rick Luettich, Institute of Marine Sciences, University of North Carolina; Hassan Mashriqui, Hurricane Center, Louisiana State University; John Pardue, Department of Civil and Environmental Engineering, Louisiana State University; Denise Reed, Department of Geology, University of New Orleans; C. K. Shum, Division of Geodetic Science, Ohio State University; Joseph Suhayda, Department of Civil and Environmental Engineering, Louisiana State University; Byron Tapley, Center for Space Research, University of Texas; Torbjorn Tornqvist, Department of Earth and Environmental Sciences, Tulane University; Peter Webster, Department of Earth and Atmospheric Science, Georgia Institute of Technology; Gordon Wells, Center for Space Research, University of Texas. Rapporteur: John Perry, National Research Council (retired).

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# Johann von Lamont: A Pioneer in Geomagnetism

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The 200th birthday of John Lamont (1805–1879, Figure 1), a pioneer in the study of geomagnetism, was marked on 13 December 2005. Lamont founded the Munich Geomagnetic Observatory in 1840 and was a member of the group of scientists including Carl Friedrich Gauss, Alexander von Humboldt, Eduard Sabine, Jonas Angstrøm, Humphret Lloyd, Adolf Kupffer, Karl Kreil, and Adolphe Quetelet who composed the Göttingen Magnetic Union. They organized an international network of geomagnetic observatories [*Barraclough et al.,* 1992]. The present knowledge of the geomagnetic field and its secular variation is largely based on the data collected by the global network of geomagnetic observatories during the last 170 years.

Lamont's talents and his dedication and enthusiasm for discovery are reflected in the depth and scope of his contributions to a broad variety of natural sciences such as astronomy, meteorology, geomagnetism, and geodesy. However, this article just touches on his merits in geomagnetism.

Modern paleomagnetists and geomagnetists have profited from his improvements to the accuracy of absolute determinations of magnetic fields through his construction of better instruments and measuring techniques for laboratory and observatory work, as well as for regional magnetic surveys he conducted at stations in the field. Lamont's famous 'Reisetheodolit,' a nonmagnetic instrument for measuring the declination (*D*), the inclination (*I*), and the horizontal intensity (*H*) became a standard instrument in the nineteenth century, and as a result of his extended measurements in various parts of central and western Europe, he was able to produce the first maps with isolines of *D*, *I*, and *H* for Bavaria and southern Germany (1854); Central Europe (1854); France and Spain (1858); and Belgium, Holland, Denmark, and Prussia (1859).

He not only constructed a prototype of high accuracy instruments for geomagnetic field work (which is now a standard technique in geophysical prospecting), his maps also provide the database for the study of the regional secular variation of the geomagnetic field in Europe since the middle of the nineteenth century. The 200th anniversary of Lamont is a good opportunity to remind us of this pioneer.

*Lamont's Early Work*

Lamont was born on 13 December 1805 in Corriemulzie, near Braemar, in central Scotland. In 1817, he received a fellowship from the Scottish Benedictine Monastery of St. Jakob, in Regensburg (Bavaria, Germany). As a boy, he was interested not only in theology but also in mathematics, the natural sciences, and mechanics; he was educated in these fields by Father Benedict Deasson, a prior well-trained in mathematics.


*Fig. 1. Portrait of John Lamont from 1856 showing him at the age of about 50.*

In 1827, Lamont began spending most of his vacation time at the Royal Bavarian Astronomical Observatory, which had been built in 1816–1817 in Bogenhausen, a small village close to the present center of Munich, Germany. In 1828, he was appointed as an