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On Reintroducing Riverine Processes in the Mississippi Delta Region

A Scientific Meeting

held at

School of the Coast and Environment

Louisiana State University

Baton Rouge

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On Reintroducing Riverine Processes in the Mississippi Delta Region

Introduction

The present-day Mississippi Delta was formed over the past six or seven thousand years as a result of two main competing processes. The first of these resulted from the enormous drainage area of the Mississippi-Missouri-Ohio River system, which has carried billions of tons of sediment from the central U.S. to the Gulf of Mexico. In opposition to this, the sea has been inexorably working to wear down and redistribute any sediments deposited around its margin.

While no constraints were placed on the river, sedimentation generally gained over degradation, and the delta could expand. At times, as the slope of the river became flatter, so the river would change its course and open new distributaries to the sea. This process meant that over time a vast area of flat, swampy land was built up between these distributaries, fringed by barrier islands that acted as breakwaters to reduce the effects of wave action and hurricane storm surges. This area, with its bays and estuaries, acted as a nursery ground for many commercial fish and shellfish species.

A major point in this scheme is that it was not static; as the river changed its course, so areas of deposition changed. The outer parts of the delta would turn from solid land to barrier islands, then to submerged sand bars, and finally even these would disappear. Then the river would eventually break through again and start the deposition process anew. However, the regular, usually annual floods distributed sediments across the whole delta region via sheet flow, ensuring that land building more than kept pace with erosion. The present coast of Louisiana and Mississippi owes its shape to the continuous interplay between the river and the ocean.

With the beginnings of European settlement in the delta region in the early eighteenth century, things began to change. Settlements demanded protection from the annual flooding, so levees were built which confined the river to particular channels. Entrepreneurs cut new channels through the swamps to allow them to extract the valuable cypress and other timber; later they further disrupted natural flow patterns by cutting more channels for oil and gas prospecting and drilling, or to improve shipping and navigation routes. These new channels allowed seawater to encroach into the swamps and disrupted vegetation growth patterns, as well as exposing the freshwater marshes to wave action. At the same time, dams were built upstream to ensure a regular water supply for the burgeoning towns and cities in the heartland and for the rapidly expanding farming community, so that the life-giving sediments could no longer reach the delta.

The combination of these factors has led to the present situation, where the whole of the delta region is threatened by waves and storm surges, exacerbated by sea level rise and sinking of the land surface from natural compaction, oil and gas extraction or ground faulting. Some areas of the delta are now sinking at a rate of several cm per year, and more than 1 million acres of land has been lost since the 1930s. The recent devastation brought about by hurricanes Katrina and Rita in 2005 is proof that without a major effort to reverse the ongoing land loss, things will only get worse, leading eventually to the forced abandonment of the entire delta region.

While various plans have been put forward over the past thirty years on how to save the coastline, to date no holistic attempt has been made to improve the situation; the only coastwide plan remains stuck in Congress as part of the Water Resources Development Act. Small, disconnected efforts to restore individual portions of the coast, as presently funded through e.g., the Coastal Wetlands Planning, Protection and Restoration (CWPPRA) Act of 1990, will not stop the continuing erosion of the land. While it is certainly too late to save all that has been lost, reversing some of the more drastic likely effects is possible. However it will require reinstituting the natural flow patterns that allow the river to interact with the swamps if we are to get anywhere.

In an attempt to stimulate debate on the subject of restoring the hydrology of the delta, the CREST program held a one-day meeting on the use of diversions in Baton Rouge in April 2006. The meeting was aimed at coastal area managers, scientists, and federal and state agencies.

Purpose of the Workshop

River diversions have long been part of many plans for the restoration of the delta. A large number of siphons exist along the lower Mississippi River and feed freshwater to nearby marshes. Additionally, two larger structures were completed at Davis Pond (nominally <300 m^3/s) and Caernarvon (nominally <227 m^3/s) above and below New Orleans respectively, as demonstrations of the likely value of such projects. Several other small diversions are planned as part of the Louisiana Coastal Area (LCA) plan for renovation of the coast.

The purpose of the workshop was to bring together experts in the fields of coastal hydrology, sedimentology and ecology to discuss the latest research in these fields in the Louisiana coastal region and the potential for additional diversions to help restore the eroding coastline. Additionally, we were treated to a discussion of some of the socio-economic and legal aspects that mitigate against the unlimited expansion of diversions. While it is certainly feasible to increase the use of diversions in the region, the consequences for the people who live here must also be considered.

Copies of the presentations made at the workshop are available from the CREST website: http://www.gulfcrest.org.

John Day, Louisiana State University
Issues related to diversions in the Mississippi delta

Professor Day began by pointing out that all aspects of restoration, and especially those concerned with diversions, need to be considered within a conceptual framework that includes both ecotechnology and ecological engineering to ensure that human society can coexist with the natural environment for the benefit of both, using only minimal amounts of energy in the process.

The Mississippi naturally works on a continuum of timescales, from the millennial river switching from one main pathway to another, via major flood events every 50-100 years, major storm events every 5-20 years, to annual flooding and even daily tides. The flood events create new channels for freshwater to reach the marshes and change existing flood patterns. Additionally, crevasses provide opportunities for both freshwater and sediment to replenish the delta–the Caernarvon crevasse created deliberately during the 1927 flood operated at about 10,000 cfs (~300 m^3/s) for four months and deposited clay sediments in a layer up to 30 cm thick.

Human activities, however, have altered all these functions. We have cut off the river from the floodplain by closing distributaries other than the Atchafalaya and seek to prevent both crevassing and over-bank flooding. This isolation of the wetlands from the river has led to major wetland loss, since flooding of marshes is required if accretion is to occur. It has also led to a waste of valuable nutrients which are now discharged directly into the coastal zone.

The present Caernarvon diversion structure was opened in 1992 with a nominal capacity of 227 m^3/s (6700 cfs), but an actual maximum operational discharge of about half this. If the water flow is below about 4,000 cfs the water stays in the channels, but above this figure it can flow over the marshes. Studies have shown that sediment is deposited close to the diversion (this of course depends on both the volume of water discharged and the sediment load, but the limit appears to be about 10 km), although the influence of the freshwater on e.g., nitrogen supply is felt further downstream. However, without large diversions that are considerably bigger than either Caernarvon or Davis Pond, we will not achieve much in the way of land building. The Atchafalaya delta is expanding, but this is using 30% of the total flow of the Mississippi and Red Rivers. The whole point is to use diversions to their maximum advantage when the river is at its highest.

While the added nutrients in the river water are high enough that nuisance algal blooms are possible, marsh plants can rapidly remove dissolved nitrogen and the added nutrients act to stabilize the marshes through the creation of new organic matter, particularly as part of their root systems. Additionally, nuisance algae can largely be controlled by pulsing flow through the diversion so that the temperature structure of the water column in the receiving area is not stable.

Day also discussed the effects of hurricanes on marshes. Katrina's main effect was on the marshes near Caernarvon, especially to the freshwater marshes around Lake Leary, which developed deep shear zones and where the marsh surface was rolled up into "marsh balls." Large amounts of organic matter were displaced into Breton Sound from this source. The salt marshes were less affected because of the higher mineral content of the sediment in these areas. Andrew (1992) and Lili (2002) also affected marshes similarly, but they recovered so it is reasonable to think that recovery from Katrina is also possible in many areas providing that similar strength hurricanes do not affect the area in the next year or so. Redistribution of sediment appears to be a major factor following hurricanes; near Port Fourchon about 10 cm of sediment was deposited after Katrina and Rita.

Finally, Day considered the likely effects of future climate change and energy costs. The likelihood is for increased global temperatures to lead to changing precipitation patterns, more rapid sea-level rise, hence more saltwater intrusion of the marshes and flooding as the land continues to sink. Add to this the observed increase in severity of hurricanes, and the window of opportunity for restoration is short. The likely continuing increase in the price of oil means that the cost of building newer, stronger and higher levee systems will become prohibitive. Diversions provide a relatively cheap and sustainable way to improve and preserve the environment.

<u>Questions and comments:</u>

What is the capacity of wetlands to keep up with sea level rise? What would it take? Currently our system is starved of sediment, so how much would it take to keep up with sea level rise?

> Relative sea level rise is a combination of subsidence and sea level rise. The delta survived and grew over a period of 5,000 years. Root growth of plants is what sustains the coast, but naturally, there have been deltaic degradation events before human disturbance. With nutrient fertilization, you can increase the production of plant biomass, and this can help the marshes sustain themselves against sea level rise.

Oil and gas prices are going up. Is rationing in this country a possibility?

> Yes, this is likely.

How useful are diversion in open water areas?

> Diversions are very useful to get marsh grasses to grow in shallow open water, but we will not get major land building with small diversions like Caernarvon.

Can diversions contribute to decreasng marsh stability?

> When you fertilize a plant, the root system becomes less stable, and more production goes into above-ground plant matter. Plants, especially the roots, help form organic soil, however it's an open area of study and the literature is inconsistent.

Mead Allison, Tulane University
Renewable and nonrenewable sediment sources in the lower Mississippi River and their application to coastal restoration in LA

Professor Allison discussed the important question of how much sediment is in the river and how easily it may be used for coastal restoration. He pointed out that the river should be considered as a three-part system: from the Old River Control Structure to Baton Rouge, from Baton Rouge to below New Orleans, and from Head of Passes to the Gulf. In the upper of these regions, the system is dominated by river flow. Below Baton Rouge, the system begins to feel the influence of tidal activity, particularly at low flow rates, while in the lowest part there is a strong tidal influence and a salt wedge is found. The salt wedge can reach New Orleans at very low discharge rates, and a sill has been constructed near Alliance to prevent saltwater from reaching drinking water intakes. The relative influence of fresh- and saltwater determines how the sediment in the river behaves.

Renewable sediment loads in the river dropped considerably from about 400 million tons in the period from 1850-1963 to approximately 230 million tons thereafter. In 1993 it is estimated that the flood carried about 190 million tons; this has been relatively stable since then, of which the load in the Mississippi itself is presently about 124 million tons.

Non-renewable sediments include material deposited post-levee building on the batture (much of this is relatively high quality sand and is already being mined), pre-levee point bars (also generally high quality but few exist below the Old River Control Structure), and highly consolidated relict incised strata of variable quality from Pleistocene to recent times.

Multibeam bathymetry and side-scan sonar surveys suggest that about 14 million tons of renewable sediment (both sand and mud) settles to the bed at low discharge and is subsequently remobilized as discharge increases. Another 10 million tons (almost all mud) are stored temporarily on the channel floor near Venice.

Measurements of load at different flow rates near Audubon Park, English Turn and Venice showed that bedload transport increases linearly as flow increases initially. As flow continues to accelerate, so bedload transport changes to water column transport, which is much harder to monitor.

As regards how much sediment can be used for restoration, of the 124 million tons measured at St. Francisville, about 22.3 million tons is suspended sand. Although the total load near Belle Chasse is the same as at St. Francisville, the suspended sand load is only about 9.9 million tons, and this decreases still further downstream so that at head of Passes it is only about 4.1-6.2 million tons (this amount is based on how much material is dredged annually by the USACE). This suggests that sand makes up about 10% of the total load to the Gulf. Bedload is not well known, but is likely less than 0.1 million tons at all three sites. The difference in suspended loads may depend on bed aggradation between river miles 266 (St. Francisville) and 76; however, there have been few comprehensive measurements and long-term monitoring is badly needed. It is hoped that regular monitoring will begin during 2006.

Estimating sediment loads is complicated because features on the river bed move downstream. At times dunes can move regularly, but they can also suddenly disappear. Because the whole river system is constantly changing, modeling is a potential way to estimate loads. This requires a 10-20 mile experimental transect and repeated sampling to facilitate model development.

Pipeline conveyancing of sediment has been suggested as a means of restoring areas of the coast. However, there is only a limited amount of bedload material, particularly sand, that is recoverable, so we must use it wisely. By far the largest amount of sediment is in the suspended load, but this is hard to collect and will contribute little to pipeline conveyancing as 90% of it is mud. Instead, it is delivered directly to the Gulf of Mexico. If we want to use the suspended load, the best way is to plan for larger diversions.

Syed Khalil, Louisiana Department of Natural Resources

Mr Khalil reported on surveys done by the Louisiana Department of Natural Resources along the lower river between mile markers 15 and 35, as well as at South Pass. The objective was to estimate the amount of river sand available for use in the restoration of barrier islands at Scofield and Shell Islands. The consensus is that about 6 million cubic yards (MCY) is required for Shell Island, and about 3-4 MCY for Scofield Island. While offshore deposits have been used previously, these are now getting scarcer, there are problems with removal of the muddy overburden, and oil and gas structures require significant buffer zones. In contrast, the river offers cleaner material, and the broad meanders on the river (< 8,000 feet in places) mean that there is a considerable area where sand can accrete.

Work included seismic reflection profiles across the massive (<70 ft thick, but generally between 20-30 ft) point bar at Nairn, near RM35, together with seismic and bathymetric profiling up and downstream and sonar surveys, plus reconnaissance sediment sampling. This area was chosen because of its proximity to the barrier islands requiring restoration and because of previous investigations in the area. The Nairn site showed clear evidence of sand waves 3-6 ft high in water 30-70 ft deep on the bed of the channel. Seven potential borrow areas at various sites were identified containing clean sand with less than 5% silt; the total available is about 32 MCY. The sand beds were estimated to be 50-65 feet deep, and 70 ft from the water surface was taken as the limit for working. Average grain size is about 0.17 mm, with a range of 0.13-0.23 mm.

At South Pass, work included bathymetric, seismic, sonar and magnetic surveys, and the collection of a number of vibracores. About 1.6 MCY clean sand was identified here, however the number of obstructions, such as shipwrecks and other debris, means that this site is not ideal for use as a borrow site. Bank destabilization is also seen as a potential problem.

While the survey showed that there is apparently enough sand available to restore the two islands of interest, about 60 MCY would likely be required to restore all the coastal barrier islands, thus relict deposits would have to be tapped.

<u>Questions and comments:</u>
What is the demand for sediment for restoration?

> We anticipate the max need to be 9-10 mill cubic yards (MCY) for the two islands; 3-4 MCY for Scofield, <6 MCY for Shell Island. It would take about 50-60 MCY to restore all of LA's barrier islands, which really need sand. Mead Allison says we should tap into the relic deposits, but it would be a one-time effort.

There is a current interest in pipeline conveyance of sediments for marsh creation; is it correct to say that there is only very little fine material that can be used from the bed load for wetland restoration?

> Yes, there is not very much fine sediment in the bed load because most of the fine sediment is in suspension. It would be very difficult to concentrate them for pipeline conveyance. There are many relict bed forms, but these are difficult to pipe because of

their highly consolidated nature. This makes it hard to cut them out and disaggregate them sufficiently for pipeline conveyance.

Comments:
The USGS monitoring site in Belle Chasse will be reestablished in May 2006.
There were lots of levee breaks along the northern Mississippi River resulting from the large flood in 1993. When the levees broke, water flowed out and deposited so much sand that they had to mine sand out of agricultural fields.
Further up the Mississippi River drainage basin dams are having a huge effect on sediment load, resulting in a sediment-starved system; we need to think about it before we utilize bed sediments.

Chester Watson, Colorado State University

Professor Watson gave a theoretical talk on the role of models in hydrological design. He pointed out that the lower Mississippi River system is affected by both natural (e.g., cutoffs and tectonic activity) and anthropogenic (e.g., dams and levees) factors; these have changed the amounts of water and sediment coming downstream, sediment movement within the lower river, and the river's slope. If you change any one of these, you will change the others. Diversions in particular change the slope of the water, and thus the coarse:fine sediment ratio, but hopefully will take sediment where you want it.

Since the slope of the water determines sediment transport, two small diversions will not transport as much sediment as one large one. Additionally, diversions reduce the total capacity of the river to transport sediment. The relationship between flow and sediment transport is not linear. He showed how sediment distributions in the river vary: there is presently degradation in the Mississippi from Fulton, via Memphis to Rosedale, relative stability near New Madrid, and aggradation from Vicksburg southward, but these relationships are not static. Diversions anywhere in this region will change the slope above and below the diversion, possibly causing upstream degradation and increasing downstream aggradation.

Any attempt at restoration needs a series of steps: initiation, planning, analysis, designing and building, monitoring, and feedback. He then went through these topics individually. For example, as regards the design phase, we need to know:

How much sediment and freshwater is needed in the marsh?
Is this supply available from the Mississippi River?
How do we divert water for maximum use?
What effects will diversions have on navigation, flood control, channel morphology or marsh building?
Can we keep the current river functions (cooling water, navigation, etc.)?

Modeling alternatives exist; these come in different forms with different requirements and outputs, e.g.:

1-D steady and unsteady models with and without sediment transport; these allow long-term simulations
2-D hydrodynamic models which can simulate the benefits of diversions in receiving marshes
3-D hydrodynamic and physical models which can simulate diversions and diversion structures.

Choice of a particular model depends on the availability of long-term support, whether it is a research model or one that is more widely available and studied, and whether a particular model can satisfy all the needs of a project. All have their own uses and require different inputs, such as the amount of data needed to calibrate them. Such inputs need to be considered carefully (e.g., sampling needs to be consistent, and variability of only one order of magnitude is probably good). While the analysis of the model output may appear simple, it can be extremely complex. For example, long-term data on discharge/sediment transport plots at Tarbert Landing show an apparent minimum in sand transport between 1986-1990; this was eventually found to result from a move to save money on sampling, so that fewer samples of the vertical sediment transport were taken than previously. As a result, the calculated sediment transport was considerably lower than in other years and at other locations along the river.

While models can be excellent tools for examining different scenarios, for river and marsh modeling it seems clear that we need to think on at least a 50-year time-scale. Monitoring and feedback to assess design approaches is essential and challenging, and improving sediment and water delivery will be an ongoing effort. Additionally, multidisciplinary teams are required, as are multiple models, both of which have to include ecology.

<u>Questions and comments:</u>
What is your sense of putting together a river modeling team?

> We've had a lot of landscape modeling, but hardly any of the river itself. You can't hire just one group or one person because you will get a biased view. You need to hire a multidisciplinary team. The USACE is working on Hec-6, other groups are working on other models. We need input from ecological groups too.

Paul Kemp, Louisiana State University
Post-storm coastal modeling in Louisiana? Ready, set, stop.

Dr. Kemp provided details of ongoing hydrodynamical modeling work in Louisiana, with particular reference to the modeling started as part of the Louisiana Coastal Area (LCA) plan and the physical model recently acquired by LSU. He pointed out that if you can't model the system, you probably have no business building it. Given that much of south Louisiana is now living in a post-hurricane world, things are very different than before summer 2005. An integrated modeling program that includes restoration, navigation and protection is now vital; despite the effects of the hurricane, however, this is not happening. While much coverage has been given to the "Dutch solution" of large gated structures and massive levees, the question is whether we can ever build such a system in southern Louisiana and whether we understand enough about how the components will interact.

The LCA study produced a suite of modeling tools to attack the problem from different directions. These included statistical, physical and numerical models (to understand both engineering and processes), and provided information on such aspects as initial and boundary level statistics, land area, sediment volume, waterway and land shape, and patterns of interaction. All this is expensive in terms of time, money and effort, but is necessary and provides an organized scheme for characterizing interactions across time scales and disciplines, and for generalizing processes spatially. Now, however, the program has ended.

LSU's small-scale physical model covers the river from Point a la Hache to Head of Passes, and is used to look at sand budgets and dispersion. Time compression techniques mean one can study the competing effects of several diversions simultaneously, and evaluate alternatives for freshwater and sediment diversions and new navigation channels. A major question is how best to trap the 90% of sediment that disappears onto the continental slope.

Storms put models in the spotlight. The National Hurricane Center model is fairly accurate for predicting and tracking hurricanes up 48 hours in advance. This can be coupled with a combined wind and water model, such as ADCIRC, to provide specific forecasts of flood threats to better than 10% error. During Katrina, ADCIRC was used to issue advisories forecasting overtopping of levees, storm surge potential and flooding likelihood. Following the disaster, the model was used forensically to investigate the response of e.g., levees and floodwalls and where overtopping occurred with and without breaching of levees. This showed that flooding severity was not necessarily related to the absolute elevation in an area, but depended more on where the breaches in the levees were situated.

The ADCIRC model also provided a way to show the value of natural systems for the protection of man-made systems. Despite the frequently repeated statement that marshlands reduce storm surge, models do not account for it and engineers therefore assume it is unimportant. During Katrina it was found that the marshes had a major effect in helping to protect floodwalls. Where vegetation was present along levees, however, the levees suffered less damage than where it was absent (note, the same effect was observed during the Indonesian tsunami in late 2004). Also during Rita, while the models forecast well the observed surges, the extent of surge attenuation by marshes varied considerably, from between 2.5 miles per foot of surge to 6 iles per foot as one went east of the storm track.

As regards diversions, models are presently being used to forecast the potential for nitrogen uptake by marshes and to estimate the likelihood of producing nuisance algal blooms, e.g., at the proposed Hope Canal site near Lake Maurepas where the trees are dying because of nutrient starvation and salinity. Forcing functions include tides, discharge volume, river nitrate concentration, salinity, elevation, and rate of subsidence. Variables to be studied include channel dimensions, tracer pathways and concentrations, and loading rates. Studies so far have shown that a 2500 cfs diversion could sustain the swamp, but that a 500 cfs diversion would likely not be able to do so in any reasonable time. A question then arises, is a diversion worthwhile if it is too small?

Future studies could be used to show regional changes by coupling hydrodynamic models with long-term ecological models. However at present, despite the effort made during the LCA planning stage, we are probably unable to do this as the necessary multidisciplinary framework no longer exists.

<u>Questions and comments:</u>

In your modeling, did you find sustainability in the Maurepas swamp with a 2500 cfs diversion in Hope Canal?

> Yes, you need to take into consideration the size of the diversion needed to get ecological benefits.

Is it a flaw that ADCIRC did not pick up surge removal by wetlands?

> No, not a flaw, but they’re addressing it now.

What can we do with the Atchafalaya River at the Old River Control Structure?

> It’s the world’s largest diversion structure, and we can optimize its flow to our benefit. We need to have engineers talking to ecologists.

Comment:

We may need to take into account water movement into the Gulf Intracoastal Waterway due to Hurricane Rita. South of the Intracoastal salinity was 22, but north of the Intracoastal salinity was only 3.

Mark Schexnayder and Rex Caffey, LSU Agriculture Center
Large v small diversions: which give more benefits?

Before we can answer this question, we need to consider what we mean by benefits, how this relates to cost, and any other important criteria. Not all questions will lead to the same requirements. In many cases, we are accepting preconceived notions as reality and therefore thinking too small.

a). Water quality or clarity: Lake Pontchartrain used to be a chocolate lake, and experienced regular eutrophication events. While these may look unsightly, they are actually good for the system as both brown and white shrimp stocks increase following such eutrophication. Similarly, the refusal to allow algal blooms to occur means that the Bonnee Carre and other spillways (Caernarvon, Davis Pond) are almost never used. This leads to increasing salinity which, coupled with the continuing decrease in nutrient levels, is killing the cypress forest, especially around Lake Maurepas. Our current thinking seems to have allowed short-term aesthetic considerations to trump long-term gains, so that we have built large, expensive structures that cannot be used.

Nutrients are not all bad! They are necessary to sustain the system and can be added during flood conditions without harming the ecology. The present situation seems determined to preserve current salinity levels rather than trying to return to historic salinity levels. This limits the maintenance of other landscape features.

b). Fisheries and habitat: Present management options seem to rely on controlling salinity, with the result that nobody is happy. Changing salinity will change the position of certain fishing grounds, but the effect of adding nutrients and decreasing salinity is generally that e.g., oyster populations and harvests increase. The Caernarvon diversion has put the oyster grounds back to where they used to be and increased production. Low salinity is similarly vital for fisheries productivity; without low salinity regions, there will be no juvenile fish and this applies equally to shrimp and crabs. These larvae and juveniles have to have access to spawning and nursery areas, so putting locks and gates on water control structures is counter-productive.

c). Structures: We need to remember that a project designed to last 100 years may not function at its best for the first decade or longer after construction. No structure will please everybody, but there are scales that need to be considered, such as short-term local economic benefit versus the long-term survival of the ecosystem.

Should we build new structures? First, let us use the existing structures properly, the way they were designed. The size of any new structure will depend on its intended use; siphons can function at about 10,000 cfs, diversions at about 20-50,000 cfs, while delta building and spillways will handle much larger flows. But if you are going to build it, then use it.

d). Cost-benefit relationships: Analysis of CWPPRA projects shows that the newer restoration projects are costing more and providing fewer benefits than the earlier ones. This is partly because they tend to focus on very expensive restoration practices, such as barrier island and shoreline protection. However, there remains a tremendous need to standardize the way we look at benefits, whether they be long-term v short-term, human needs v environmental needs, direct v indirect benefits, or reconciling gross v net benefits. (At present, there is no way to include any benefit for ecosystem restoration in the model.) Similarly, there has been no real attempt to consider the cost-benefit ratio of diversions when it comes to building land or how best to use them with other technologies for maximum benefit. The question is, who will define the benefits of a given scheme? It is clear that an acre of wetland in one area may be worth a lot more than the same area in another, but the present analysis treats them identically.

<u>Questions and comments:</u>
Early in CWPPRA, we didn't know much about restoration, so we chose easy projects. Now we know we didn't do the projects that we really needed. That's why our project costs have gone

up. We're now doing bigger, harder projects – we're now building barrier islands. It's very expensive to rebuild barrier islands, so we need to know what we want the landscape to look like, before we try to build it.

We're very accurate with our cost analysis, but our benefits model is not accurate. We're not doing a good job of showing the benefits. We've systematically moved away from benefits and cost efficiency because we've gotten this idea that we have a load of money to do whatever we want with.

Comments:
One aspect of WVA- an acre of wetland in one area is worth a lot more than an acre of wetland in another area. This is especially true if we are thinking of protecting a population center rather than a marsh in the middle of nowhere.
In post-Katrina, are we focused only on land building? We'll never be efficient and get funding if we don't look at benefits.
If we can modify the ADCIRC model to show benefits of wetlands, then we can have that additional justification.
With the work they've done with CWPPRA, it all starts in the organic fashion; we need to start with local partners and local support.
We have to decide and agree as to what benefits we're looking for. Each project leads to a different trajectory, but when you step back, you realize that we all want the same thing. Unfortunately, we've gotten into a competition with one another. A diversion will give you something different from pipeline conveyance, but both sets of benefits are important. Who is going to define the benefits? It must be a cross-section of everyone, because everyone has his pet objective. Everyone doesn't have to be happy, but everyone must support the end result.

Bob Gramling, University of Louisiana at Lafayette
Teche/Vermilion diversions: lessons for Bayou Lafourche

Dr. Gramling gave a social history of the Teche-Vermilion diversion and compared it with plans for Bayou Lafourche. Both bayous are cut off from their drainage basins; Bayou Lafourche was closed at Donaldsonville in the early 1900s, while the Teche-Vermilion (T-V) basin was cut off from the Atchafalaya following the 1927 flood.

Reduced flow in the T-V basin led to complaints about smells from the population of Lafayette, so in 1957 efforts started to reconnect the system to the Atchafalaya. Potential benefits were thought to include aesthetics, increased property values, tourism and recreation, together with additional water for rice and crayfish farming. The importance of water for farming can be shown by the fact that in the early 1900s rice farmers paid for water from a pumping station on the Vermilion River with 16% of their crop. The reconnection finally occurred in 1982. At present, flow is maintained at 1000 cfs by pumps which distribute water through a series of canals to Bayou Teche and the Vermilion River, feeding water to rice farmers through the Banker and Abbeville canals. Despite some problems, people are generally happy with the project.

The series of canals which distributes water to individual rice fields was started over a century ago and has been added to ever since. Today probably no one has an overall true understanding of the system. Hurricane Rita highlighted the lack of knowledge of the system, since the rice paddies and other parts of the waterway are still heavily contaminated by salt. Some farmers say the project should have been bigger initially and that this would remove this particular problem. Additional problems that have appeared slowly have to do with the weir on Bayou Catalba and Keystone lock and dam on Bayou Teche. The former keeps water levels high, so that this part of the bayou is eroding, the latter is silting up because of sediment deposition above the dam.

The main motivation for the Bayou Lafourche project is to improve drinking water supplies for the local population. Additionally, it is assumed that the increased flow will also help the wetlands. The plan is to add 1000 cfs water from the Mississippi. Major problems include the fact that people live all along the banks of the bayou and the increased flow will likely lead to flooding of the batture and legal issues, while the bayou will need to be dredged and the various bridges make this difficult (and expensive). Additionally, the lower reach of the bayou is intensely commercialized and a navigation channel must be maintained (although whether an additional 1000 cfs will actually make much difference below the Gulf Intracoastal Waterway is a moot point). Finally, there is the question of flood and hurricane protection. The hurricane protection gates at Golden Meadow have to be closed now on windy, non-hurricane days because so much water is pushed into Bayou Lafourche; some feel that adding more water upstream will likely only make this worse.

The moral is that you cannot ignore the social and economic aspects of such large projects. Raccoons don't care whether a river smells, similarly an estuary doesn't need more freshwater to grow rice –people do. And while adding freshwater may make sense scientifically, socially this might the last thing people want, and they vote and sue.

Questions and comment:
One big difference between Teche-Vermillion and Bayou Lafourche is that you can't justify water introduction into the Teche-Vermillion basin on the basis of restoring wetlands, but you do have this justification for water introduction into Bayou Lafourche.

Mike Wascom, Louisiana State University
Legal issues arising from diversion projects

Mr. Wascom considered two major potential problems likely to arise when diversion projects are proposed. These deal with enforced changes of ownership resulting from land loss and the need for compensation following salinity changes in oyster lease areas.

The property question relates to who owns previously private water bottoms that are reclaimed with public funds. The example chosen was Isles Dernieres, which were previously owned by LL&E and have since been eroded badly. If the state reclaims the land, who owns it? Small reclamation projects are covered by Article IX, section 2 of the Louisiana Constitution of 1972, which states that owners of land can reclaim land, including oil, gas and mineral rights, lost through erosion, compaction, subsidence or sea level rise occurring on or after July 1, 1921. A permit to reclaim the land may or may not be granted by the state. However, is this still true for large, publicly-funded projects such as Isles Dernieres, where the owner made no effort to reclaim the land himself and where the water bottom is now owned by the state?

According to the Louisiana constitutional amendment of 1996, the state may relinquish the mineral rights associated with restored coastal lands to the previous owners if the land has been restored with public funds. This requires that both the state and the previous owner are willing parties to the deal. In the case of the Isles Dernieres, this means that the state owns the land surface but that LL&E retain mineral rights (usually the driving force for all such claims).

Regarding oyster leases, if a lease is threatened by a diversion, the state will work with the owner to move the lease to a new location. However, following the opening of the Caernarvon diversion in 1991, oyster fishermen claimed in 1994 that damage had resulted to leases in Breton Sound and sued (Avenal case). Both state and federal law stated that private property cannot be taken for public use without just compensation, however the state act included wording about damage as well. (More recently, the U.S. Supreme Court has stated that governments may take property for economic reasons, not just for public good, such as highway development.)

The leaseholders sued the state on the grounds of damage caused to their property. The state counterclaimed on the grounds of a "hold harmless" clause in Louisiana state law and in most of the leases. Although the case was allowed in District Court, where the leaseholders were given $1 billion, subsequently reduced to $700 million, the Louisiana Supreme Court denied the claim on the grounds that the "hold harmless" clause was valid and that the time allowed for instituting the lawsuit had expired. An appeal was made to the U.S. Supreme Court, but the Court denied this in March 2005.

Before the lawsuit was settled, the state passed Act 652 of 2003, which claimed for the state water bottoms where management, preservation and enhancement were important. It also exempted the state from damage liability in any case concerned with coastal restoration. Additionally, an amendment to the Louisiana Constitution was passed in 2003 limiting the state's liability for past or future damages where the taking was for the purposes of coastal restoration.

Additional potential legal issues to consider when diversions are planned include real estate rights, acquisition of absolute ownership, easements/rights of flowage, pollution liability, and public access. There is also the question of consistency with CWPPRA and compliance with state and federal legislation. This makes paramount the need to engage lawyers at the beginning of any diversion proposal process.

<u>Questions and comment:</u>

It is a big issue when you take beachfront property and put state land between private land and a water body.

> Yes, this is a big issue. The state cannot alienate water bottoms.

Is there any way we can speed up the process? It takes 11 years from the point of authorization to start digging, and then once you start digging you get slapped with a lawsuit.

> Government or academia has to look at this issue and ensure you cover all bases during the process. It is best to have lawyers involved from the beginning.

Len Bahr, Louisiana Governor's Office on Coastal Activities
Reconnecting Mississippi distributaries, including Bayou Lafourche 1. The Bayou Lafourche river water reintroduction project. The little project that wouldn't die- and why.

There has been much talk about nourishing the Barataria and Terrebonne systems, but what is the best way to get river water into this area, which covers two thirds of coastal Louisiana? Dr. Bahr began his talk by showing how the distributaries from the Mississippi have changed over the years since 1736. He pointed out that there was always more than one distributary and usually three, not counting the Atchafalaya. Bayou Manchac was dammed in 1814, while Bayou Lafourche, which had its own subset of distributaries, lasted until 1903.

The proposal is to dredge Bayou Lafourche and add 1000 cfs, this flow to run continuously. The claim is that the present dredging in the bayou will stop flooding of the property along both banks, even though the water level may rise 5-6 feet. This is the only truly large-scale project on the books, and will provide long-range (60 miles) transport before the water enters the marshes. Additionally, unlike Davis Pond, there will be little change in chemical constitution from when the water leaves the river to when it reaches the marshes; the estimate is that only about 2% of the nitrogen load will be lost en route.

Introducing river water further upstream allows more flexibility, and we need to be more aggressive as regards restoration. Any plan to restore the coastal plain should include multiple diversions and multiple sediment transport projects. These will nourish any marsh created.

Bob Roberts, Louisiana Department of Natural Resources (given by Kyle Winslow, CH2M Hill)
Bayou Lafourche 2. Engineering and design update.

Mr. Winslow reported on the current status of the modeling and engineering side of the project. The project team has considered 144 different options, including choices on route, flow rates, water levels and dredge cross sections, and whether or not to replace the existing railway bridge near Donaldsonville. Estimated costs vary between $120 to $59 per cfs, with a total likely engineering cost of $60-179 million. The preferred alternative (#38) would require 2 ft of dredging below RM 29 and cost $138 million.

The grid for the model was extremely complicated, and included the coastal region from the Mississippi to Myrtle Grove. Various inflows and a non-constant tide are included in the forcing functions. Because of the tidal forcing, for 85% of the time water flows from Terrebonne to Barataria via the Gulf Intracoastal Waterway.

The model suggests that at steady state one can produce an estuarine gradient across both basins, but that the benefits are not the same in each and that Barataria has a better gradient. However, if the flow in Bayou Lafourche is increased by 1000 cfs, then all the additional salinity benefits accrue in the Barataria basin, mainly at intermediate salinities (5-8). This increase in total flow results in greater amounts of nutrients and sediment being introduced to Barataria. Increasing flow further east, e.g., via Davis Pond, will reduce the flow from the Atchafalaya because of the stage gradient across the coast. While there is a need to get fresh water into Terrebonne, any conveyance channel through the basin would act in the same way as the MRGO in St. Bernard Parish and lead to saline water penetration deeper inland than at present.

<u>Questions and comment:</u>
Did you use an off-the-shelf WVA model, or did you modify it?

> We modified it. Once we knew the areas of benefits to look for, we took salinity values out of the model. The numbers came out higher. A lot of work was done to quantify benefits with nitrogen and sediments.

If you increase flow in Davis Pond, are you still able to increase flow in Bayou Lafourche?

> You have a stage gradient across the coast- if you put water in from Davis Pond, water from the Atchafalaya doesn't go east because the gradient is changed.

You have a salinity gradient east of Bayou Lafourche. Following the hurricanes of 2005, salinity was 5 in downtown Houma, and that lasted for 60 days. We must get fresh water in through Terrebonne basin.

> If you had a conveyance channel through Terrebonne, you'd have a similar situation as St. Bernard has with the Mississippi River Gulf Outlet. You would get a net conveyance inland due to the gradient.

Comments:
They held off a couple of model runs because they wanted to be able to do additional runs if they learned more about the system. They found out that no water was moving to Terrebonne, so they tweaked the model and did more model runs, and were able to get water to Terrebonne.
The TABS model doesn't include upper reaches of basins.

Kyle Winslow, CH2M Hill
The Third Delta Conveyance Channel (TDCC) project: feasibility assessment

The idea of a constructing a third delta to build new land in Terrebonne and Barataria has been around for many years. Mr. Winslow reported on progress in the planning and analysis stages of this project.

Phase 1: The first question is related to the overall viability of the project. Can the necessary channel to convey water be constructed, and if so, can it carry enough sediment to be useful and actually build land?

Phase 2: The second phase looked at alternative project designs, environmental, engineering and economic impacts, and the economic feasibility of its construction.

Any large engineering scheme of this nature must allow for present use of the river to continue. This concerns especially river navigation, and the proposal is for the diversion scheme to operate only when flow is above 200-250,000 cfs. Above this level, about 40% of the excess flow would be diverted up to a maximum of 300,000 cfs. River flow data suggest that the scheme would be able to operate at maximum rates for less than 30% of the time.

Another assumption (probably a considerable over-estimate) is that 90% of the sediment in the river could be made available for the diversion. Initial analysis of diversion scenarios suggested that although sand is only available 20% of the time, more land can be built at the subdelta sites than is presently being deposited at Wax Lake, with between 3 and 8 million tons/yr being available. Thus, the scheme is technically feasible from an engineering standpoint.

Phase 2 considered alternative ways to build land. It takes about 4400 cubic yards of material to restore 1 acre. The present rate of land loss is about 8.5 sq. miles per year, which would require an 85% retention rate of sediment if the depth of fill required is 3 feet. This is extremely unlikely to be achieved in practice, a more realistic retention rate being 35%. Such a retention rate would build only 2.7 sq. miles of land each year. Thus there would still be a net annual loss of about 6 sq. miles. Additionally, building the conveyance channels would take 40 sq. miles of land, while 144 sq. miles would be impounded where the channel crosses Bayou Lafourche.

Even at the relatively high rate of sediment deposition and retention assumed in the analysis, it would take about 40 years for the project to reach full capacity and for land to start emerging. Any reduction in retention rates will have a major effect on land building.

Another factor to consider is local subsidence. This will result in less land being built than the theoretical maximum. The centers of both Barataria and Terrebonne Bays are subsiding considerably faster than the peripheries, so it makes more sense to concentrate on trying to stabilize only the shallower areas. Given the above, it seems that the scheme as originally conceived is unlikely to work. So what are the alternatives?

300 acres of the Bayou La Branche wetlands were restored in only one month using a single 30" cutting dredge with a borrow site in Lake Pontchartrain (90,000 cy/day). The total volume of sediment delivered to the site was approximately 2.7 mcy at a cost of about $1.40 per cubic yard. About 9000 cubic yards of material was needed per acre, but this was affected by a broken retention levee and it is thought that this amount is about double what can be achieved, particularly if you are not dealing with an open water site. To neutralize present day land loss would thus require about 50,000 cubic yards of material per day from three dredges running continuously, two in the river and one offshore.

If restoration areas are chosen correctly around the edges of Barataria and Terrebonne Bays, it should be possible to rebuild 500 sq. miles of land in 50 years with a combination of dredges and slurry pipelines. Such strategic efforts could also help reduce the continuing basal loss of land. There are many existing pipeline corridors in the basins that could be used for slurry pipeline transport. Selection of restoration areas would depend on recent and historic land loss patterns, habitat types (saline marshes need more inorganic sediment than freshwater marshes which have higher organic content), the average depth of the restoration areas, the need to protect local infrastructure, their relationship to CWPPRA areas, and the degree to which the areas are naturally confined. Additional aspects include the distance from sediment sources, the need for shoreline protection, land owners and oyster leases, and access for laying pipelines.

Questions and comments:
Wouldn't it make sense to combine diversions and pipeline conveyance now, while we have the resources and can afford it, and then nourish them with the Third Delta in the future?

> We need to have diversions to sustain them. Freshwater marshes are easier to sustain than salt marshes. The whole time these larger things are coming on line, the smaller ones need to be coming on line as well.

I am concerned about how much sediment is in the Miss River

> We need 30 million tons a year to maintain the system.

How can we get more sediment by building sediment traps?

> There are several engineering ways to do this. For example, one can dig a large hole and let the sediment fall out in the low flow part of river. You can harvest sediment from the trap and let it fill up again. Actually, the more diversions you have coming off of the river, the easier it is to harvest sediments downstream from the diversion structure. Once water is removed via a diversion, the river will flow more slowly, allowing more sediment to fall out of suspension, and therefore be available for harvest.

Since revenue sharing will presumably be the way we pay for this, shouldn't we be doing it now to coincide with the availability of fossil fuels?

> Time is certainly the big concern; we don't have 20 years to plan another Davis Pond.

Roundtable discussion: Where are the best places to put diversions, and how do we couple them with other techniques for restoring the coast?

Panel: Len Bahr (GOCA), Troy Constance (USACE), Sue Hawes (USACE), Paul Kemp (LSU), Chuck Villarrubia (LA DNR), Chester Watson (Colorado State University)
Moderator: Glenn Thomas (LSU Ag. Center)

Glenn Thomas introduced the panel and invited them each to respond to the question "What projects should be investigated that have dropped through the cracks?" Responses were as follows:

Bahr – Bayou Lafourche, reestablishment of historical oyster reefs off the Atchafalaya.

Kemp – Use the valve at Old River properly; in not doing it w are limiting ourselves. Also, divert 10% of the river's water through the spillway into the swamps to the east of Lake Palourde. We need all the water we can get in the swamps rather than going into the open sea. This will double the rate of land building.

Villarrubia – Currently there are about ten freshwater diversions along the Mississippi River. Only a few are functioning, some are old and need maintenance, while some are closed owing to the hurricanes. The LCA plan suggested ten new diversions, which would take 60-80,000 cfs out of the river in total. We should increase the use of Caernarvon; this can be done immediately. Additionally, we need to couple techniques; we could start using pumping schemes to redistribute sediment from the river along with diversions.

Watson – What priorities are being used to select diversion sites? We need to look at the infrastructure and municipalities and build around them. Socioeconomics aside, it would be a good concept to explore multiple diversions in the Mississippi River to mimic the numerous crevasses that historically occurred along the river.

Constance – I agree about the idea of using the Atchafalaya diversion better. Also we need more on the Mississippi, but used in the way the river does it naturally in different seasons. But, we need to walk citizens into restoration starting with small diversions, not drown them with large diversions. We should also make better use of beneficial dredged material.

Hawes – Build more diversions and build them to larger capacity so that there is the option for higher flow rates when needed. Use synergistic projects where possible.

Questions from the floor:
In terms of land rights issues, it's complicated now and will only get worse in the future. The panel has not considered these land rights use issues when deciding where diversions should be located. If we address this in advance of building, we could reduce complications and avoid lawsuits.

Bahr – We could start by reconnecting old distributaries where the state owns the river bottoms. If we have to create a right of way through private land, it will cost a lot more than if we go across areas the state already owns. We could perhaps also run a pumped slurry pipeline down a bayou and mix it with water at the target site downstream.

Constance - Even if state-owned water bottoms are available, you have to pay an easement in the areas of benefits. Even though land is accreting in state-owned water bottoms, you still have to pay easements. We have to get everybody on board and working towards the same end.

Hawes - Water is like a magnet- it attracts people. This is why it's so difficult to use state-owned areas. Even these areas are surrounded by people, and they own the land next to the water courses.

Smaller diversions can't move enough sediment to build land, so you end up with small, meaningless diversions. How can we build the coast if we don't use large diversions?

Constance - We need big diversions but we have to move first in the direction of citizen acceptance; this means starting out small. It was not that long ago that we regularly threw trash out of the car window. With advertisements, etc, we now we know better. We need to start working with what we have, and then work up from there. We also have to deal with land rights.

Villarrubia - We need to get water and sediment into the marsh, but freshwater and sediment diversions are different. Larger diversions will push water further into the marshes.

Kemp - We've had the technology to use sediment pumping since the 1970s, but we're talking about it now as if we've just discovered it. It's the same with freshwater diversions; we're not going to get to where we need to go immediately. There are fewer people living in hurricane damaged areas, so it may be time to use large diversions. Has the environment changed, or will we still be talking about the same things that held us back 5 years ago?

Bahr - Plaquemines and St. Bernard parishes have been highly depopulated. Why aren't we talking about large diversions and acquiring the necessary rights of way now that the landscape has changed so much? This is not meant to be insensitive, but it is our reality.

Put a cost per population on restoration- $1.7B for X percent of the population. As regards sediment availability, is there now a competition for sediments for levee building and for restoration? We need to integrate restoration and protection. Statewide Category 5 protection from USACE is a really bad idea, because it is not reality. This discussion is moving in the right direction, but there are still a lot of unanswered questions. How will Louisiana recover? Where will Louisiana invest? It's very difficult to decide who gets written off. Do you write-off residents of Plaquemines Parish? How do we distribute our limited recourses? A lot of these answers lie outside of science.

Hawes - We must consider navigation. When you take sediment and water out of the river, you affect navigation. Navigation is an important part of our economy, so we must consider it.

Katrina showed us that St. Bernard Parish is a critical buffer for New Orleans, the land bridge, etc. Why are we only talking about Barataria and Terrebonne basins?

Constance - John Lopez is talking about the Multiple Lines of Defense strategy, and he addresses that part of the coast. He also addresses how to integrate restoration and protection. Restoration is a very important part of protection.

There was hope that people would pay attention to the proposals that came out of St. Bernard. We need to talk to some of the parish folks to see what they want. They proposed 13 projects that got cut down to 6, using a worse evaluation process than WVA!

Bahr – Wasn't there a proposal for an uncontrolled diversion at Violet?

The delta is sinking at a very rapid rate and all the sediment in the river disappears into the Mississippi Canyon. What are the chances of abandoning the delta and putting in a new diversion channel upstream? It costs the USACE millions of dollars every year to dredge Southwest Pass.

Bahr - It's called the delta management plan.

Kemp - It's almost inevitable that we'll implement something like that in the next 15 years. We need to work on the same scale at which the processes are happening.

Constance – The key to success with that is to build consensus with all. There is a very small profit margin with respect to fuel cost, etc. To make this kind of change, you'd have to spend twice as much effort trying to build consensus and getting additional money to relocate, than it would to just maintain dredging at Southwest Pass. If you get consensus, it would be possible.

So far, we've looked at diversions solely as land building (i.e. restoration) structures. Is there anything else we can combine them with to get a more favorable view from the public?

Watson - Combine them with flood protection and take a true look at the benefits.

Bahr - Use modeling to show benefits - it's crazy for us to spend money on large operations without good models backing them. Unfortunately, there's no sustained funding for modeling.

Constance – That is not really true. The USACE is presently working with the Louisiana DNR to advance the modeling process for use in adaptive management. This is coupled to current hydrodynamic models to assess the effects of tweaking the system with small openings here and there.

Will this help feed into the two-year mandate?

Constance - No- we were already talking about this under LCA. We knew we needed adaptive management long before Hurricane Katrina. This effort is not coupled with the

24 mo study; it is something different.

What is being used for the natural resource piece of the 24 month study?

Constance - ADCIRC, looking at the 1956 landscape and two other landscapes in history ADCIRC will be coupled with ecological models. The two-year study should come out with a comprehensive protection plan.

Initially, we thought we could tease out important information from models, but I'm not so sure now. It appears that the models are getting stronger and at a higher resolution (i.e., the one CH2MHill showed for Bayou Lafourche). Can we use something good like this to reassess the Barataria-Terrebonne area?

Constance - Yes, we're using ADCIRC, and it's very good. The state is also using other models for the ecological side.

Can we put sediment transport into ADCIRC?

Kemp - While ADCIRC does not do sediment transport, it can be linked to TABS. At present, we are still at the research stage with this.

Why is Caernarvon running at high flow (5,000 cfs) after the hurricanes?

Villarrubia - We need to do something to help restore the marshes that sustained hurricane damage. We wanted to run it at 7500 cfs, but dropped down to 5,000 because of questions about the integrity of flood protection levees. We're trying to reduce salinity in Breton Sound.

Is anybody looking at short-term projects to mitigate the effects of the storm?

Bahr – There's an impression that the footprint of restoration is too small. We need to look at the larger scale and include the Old River Control Structure, the entire Pontchartrain basin, and the entire coast. How do we bring the Atchafalaya basin into the coastal zone? This is the state's one shot, and we should shoot as high as we can.

Meeting summing up - Where do we go from here?

Following the closure of the panel discussion, there was some additional general discussion on how to proceed. This covered topics such as:

How do we engage the planners in information-rich meetings? We have these information-rich meetings, but no higher-level planners show up. The same applies to the politicians who have to make the hard decisions. We have to talk to the planners about these meetings, and let them know that it's important for them to attend. A white paper is another possible way to disseminate the ideas discussed here today, as is to ask the constituencies involved to write to their legislators.

What is the status of the Coast 2050 Plan? Is it still viable, given that the USACE and DNR are now involved with a new 24-month plan? While Coast 2050 is now probably obsolete it is still relevant in that many of the ideas it contains are as valid now as when the plan was written. However, we need to move fast now after these storms, and a new plan is required to address specific issues. Given the status of the coastal area and its propensity for change, any "Master Plan" will need to be revisited regularly; this suggests at least revisiting Coast 2050, which is the state plan. However, saying that older plans are 'obsolete' is saying that we don't know what we're doing and will mean that funding dries up completely. Hopefully, some of our ideas from today will move up the chain to sway the political elite. If that happens, this meeting has been a great success.

How do we combine restoration with flood protection? This is the big challenge now being faced by our agencies. When restoration was just restoration, everybody knew everybody, and everybody knew what was going on. Now, the restoration side doesn't know what is going on with protection, and the protection side doesn't know what is going on with restoration. While unification is vitally important, this is a huge challenge.

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