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Congress on Charting a
New Course for the
Mississippi River
Watershed

Congress on Charting a New Course for the Mississippi River Watershed

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Introduction

The Mississippi River watershed routinely experiences severe flooding events, causing damage to infrastructure, agriculture, the economy, and the environment. Climate change is exacerbating this flooding, guaranteeing that the situation will only get worse. A new radical course needs to be charted.

Directors of the Renewable Natural Resources Foundation sought to examine how communities are preparing for and reacting to extreme events related to climate change. As a result, the Congress on Charting A New Course for the Mississippi River Watershed examined the severe flooding issues to be faced in the basin. The congress drew individuals from RNRf member organizations and professionals from academia, government, and nonprofit organizations. Delegates met on December 3, 2019, at the headquarters of the American Geophysical Union in Washington, D.C.

Congress speakers described the Mississippi River Basin's transformation over the decades and what can be expected with the new climate normal of increased precipitation and severe storms in the watershed.

Delegates also examined the complicated challenges of managing resources in the Mississippi River watershed including flood control and risk reduction as well as unwise land-use policies in our floodplains. Emerging strategies and tools for preserving and restoring ecological resources, and lessons in river management from the international community were also evaluated. Lastly, we examined longstanding impediments to sustainably managing resources within the watershed and what is needed to prompt meaningful change.

This report is a synthesis of information and professional judgments presented over the course of the congress. Presentations are supplemented by insights offered by delegates during each subsequent question-and-answer session.

PowerPoint presentations, when available for publication, have been posted at the end of each summary.

Renewable Natural Resources Foundation

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Editorial Staff: Robert D. Day, editor; Madeline Voitier, assistant editor; Stephen Yaeger, assistant editor.

Executive Summary

The Mississippi River Watershed – As We Found It and Today

Craig Colten, a professor of geography and anthropology at Louisiana State University, presented a historical perspective on the basin and how humans have transformed it into what we know today. The Mississippi River began as a wild, untamed river but is now constricted by extensive human engineering.

This human intervention brought profound and lasting changes to the river's riparian settlements, flood protection, navigational systems, floodplain ecology, water quality, the region's economy, and land use in the basin.

The human role is vital to understanding the historical perspective of the river. Colten asserted that viewing the river merely as a biophysical system neglects the underlying complex social, cultural, and economic factors that impact decision-making in managing the environment.

Observed and Projected Physical Climate Change

Dan Barrie, program manager in the Modeling, Analysis, Predictions and Projections Program of NOAA's Climate Program Office, discussed the significant climatic changes coming to the Mississippi River watershed. He described recent multi-decade trends of increased precipitation and streamflow in the watershed. These trends have contributed to wetter overall conditions and higher incidence of flooding events. Barrie noted that it is possible that these trends are resulting from increased moisture availability in the atmosphere due to climate change but attribution of specific events remains difficult.

Modeling future flooding trends is also a challenge due to the countless influencing factors that exacerbate and moderate flood risks. Barrie emphasized that the complexity of the system makes predicting future flooding trends less certain, but the scientific community is making progress on understanding it more clearly with more advanced climate models and data.

Flood Control and Risk Reduction

Todd Bridges, national lead of the Engineering with Nature Initiative of the U.S. Army Corps of Engineers, described the legacy of flood control and risk reduction along the Mississippi River over the last century, as well as the role of nature-based solutions for the future of the watershed. Starting with the Mississippi River and Tributaries Project after the flood of 1927, the Mississippi has a long legacy of infrastructure development. While this infrastructure has decreased flood damages significantly over the last century, recent increases in flooding demonstrate a continuing need for more innovation.

Bridges described how the evolving engineering needs of the watershed can be met in large part by nature-based solutions. These solutions can provide multiple benefits, solving infrastructure challenges while also being environmentally friendly and promoting human wellbeing. They are also usually more expandable and adaptable in the long-term than traditional solutions, creating potential for long-term cost saving if they are implemented properly.

Floodplain Management

Chad Berginnis, executive director of the Association of State Floodplain Managers, discussed how the United States can break free from a cycle of repeated, devastating flooding, and work to rectify its poor land-use choices. The Mississippi River has always been subject to flooding but the construction of levees, federal flood policies and unwise floodplain development exacerbate the problem.

U.S. flood damages are increasing and by 2050 it is predicted that there will be 460 million people in the United States, increasing the demand for development and further compounding existing river management issues. Berginnis argued that employing and expanding use of existing flood risk management techniques, improving land-use standards and enlisting strong state leadership in tandem with federal programs focused on resiliency could significantly improve floodplain management in the Mississippi River basin.

Analytical Tool Guides Protection & Restoration of Ecological Resources

Kris Johnson, the associate director for science and planning for The Nature Conservancy, discussed an analytical tool that allows floodplain managers to make informed decisions about where to direct limited funds and investments toward effective floodplain management. Floodplains are critical pieces of our landscape and provide multiple benefits for people and nature, including nutrient cycling, habitat for wildlife, recreation, and flood-risk mitigation and reduction. Floodplains in the basin are being damaged by development as well as nutrient and sediment pollution from cities and farms.

The Nature Conservancy launched the Floodplain Prioritization Tool to help decisionmakers identify opportunities for floodplain protection and restoration in the Mississippi River basin. Johnson emphasized that proper floodplain management is key to reducing our flood risks and ensuring productive floodplain ecosystems.

Lessons in River Management from the European Union: Governance and Legislative Framework

Giuliana Torta, counselor for Environment, Fisheries, and Ocean Policies in the European Union Delegation to the U.S., provided an overview of the European framework for watershed management. She emphasized the differences between Europe's rivers and the Mississippi. The Mississippi is significantly longer and a larger catchment area than the Danube, Europe's largest river. However, Europe has far greater population density. More than twice as many people live in the Danube watershed as live in the Mississippi. This means that the same sized flood is likely to have a greater human impact, a motivating factor in developing flood management policy.

The EU-level policies for flood control are the EU Water Framework Directive and the Floods Directive, which provide rules for international cooperation. Torta described the origins, structure, and benefits of these directives, along with areas where they could improve. While they provide a structure for international cooperation, they do not use sanctions as an enforcement mechanism and do not provide funding for projects. The EU's river basin-wide approach integrates upstream and downstream decision making, an aspect that Torta said is integral to effective management.

Lessons in River Management from the European Union: The Dutch Perspective and the Rhine

Hans Pietersen, senior advisor for International Affairs in the Netherlands' Rijkswaterstaat, discussed Dutch perspectives on water management and the international governance structures for the river Rhine. The Rhine watershed, divided among nine countries, ends with most of its delta in the Netherlands. Pietersen described the centuries-long effort among these countries to coordinate for the management of the river. Progress was slow, one step at a time, and often motivated by environmental disasters.

Since 1950, the primary international governing body for the Rhine has been the International Commission for the Protection of the Rhine. It was originally founded by the nation states in the watershed to collaborate on pollution control. Since then, it has become more effective in controlling pollution and has added flood control, ecosystem conservation, sustainability, and groundwater management to its list of responsibilities. These additions were facilitated by the fact that they were being added to a pre-existing framework, as opposed to starting from scratch. Pietersen also explained the plan for the governance of the Rhine over the next 20 years, focusing on climate-proof and sustainable integrated water basin management.

Longstanding Impediments to Effective Management

Gerry Galloway, the Glenn L. Martin Institute Professor of Engineering at the University of Maryland, examined the stubborn and longstanding impediments hindering effective river management in the Mississippi River basin. The United States has no national vision for river management and therefore no agreed upon federal role to

coordinate interstate actions. On the state level, there is a lack of consensus on how to manage the Mississippi River Basin among the 31 states that occupy its shores. There also is no effective process for securing funding for the maintenance and operation of the river and associated infrastructure. These, and many other challenges, create impediments to introducing positive changes in the basin. Galloway outlined numerous reports that have examined these problems but whose recommendations have been largely ignored by decisionmakers. Galloway contended that we must act on previous recommendations to institute fundamental change in U.S. water resources management.

Observations and Recommendations

The congress yielded many constructive observations and recommendations that can be found throughout this report. A brief list of leading observations follows:

The Mississippi River of today is the result of a long history of natural hydrologic processes, and more recently impacts associated with a changing climate. However, equally significant impacts have been human modifications of structure and use since the 1850s. As the river and its natural influences evolve so must human approaches to living with the river. History's lesson has been that physical scientists must collaborate with social scientists in facilitating an evolving relationship between people and the river environment. Major management adjustments lie ahead.

Precipitation, streamflow, and flooding have all increased in the Mississippi River watershed in recent decades, coinciding with the advance of climate change. Decision makers should plan for the possibility that these trends will continue in the future as climate change advances further. Additionally, efforts to produce more accurate climate models in the watershed should be supported to improve understanding of this complex system.

The legacy of infrastructure within the watershed, dating back to the origins of the Mississippi River and Tributaries Project in 1928, has contributed to a significant reduction in flood damages. However, rising flood risks mean that more innovation is necessary to prepare for the future. Natural water management solutions can address infrastructure needs in the Mississippi watershed while also promoting human and ecosystem wellbeing. If implemented properly, they can also be more adaptable and expandable than traditional infrastructure, reducing long-term operations and maintenance costs.

Flood damage in the Mississippi River watershed has been increasing and will continue to do so until development in the floodplains is significantly modified or curtailed. At some point, losses will likely exceed the nation's ability and/or willingness to pay. Development and land-uses within floodplains have largely been sustained by the perception of relative safety provided by the use of levees and land-use policies (including publicly-subsidized flood insurance). There is no permanent solution to curbing flood damages as long as people occupy the floodplains – this relationship needs to be recognized and redefined. Making room for the river will be difficult and expensive because of the extent of legacy development. Walking back from the river's edge will require collaboration by landowners, local and state governments, and other stakeholders.

Ecological resources within floodplains are being degraded by expanding development and nutrient and sediment pollution from cities and farms in the Upper Midwest. River management requires new analytical tools like The Nature Conservancy's Floodplain Prioritization Tool to assess where and how to strategically protect ecological resources in the floodplains in the most cost-effective manner.

Rivers of Europe are divided among multiple countries. Structured cooperation among the nation states has been achieved through their river commissions established for that purpose. The EU Water Framework Directive and river commissions lack enforcement mechanisms and require member states to fund their own infrastructure projects. However, they provide valuable frameworks for cooperation and coordination among countries. Water management plans for each nation state, drafted using common terminology, aid in comparing each state's approach to water management. Increasing transparency and communication lay the groundwork for improving the integration of upstream and downstream decision making.

Over many decades, numerous groups have examined the intractable water management issues facing the United States and suggested solutions, most of which were disregarded. These recommendations provide a foundation for improvements to U.S. water management but will need to be modified to adhere to our changing river systems. Our relationship with the coasts and rivers will be forever dynamic and water resources managers should be flexible and creative in their problem solving.

Building political support is vital for basin-wide planning in the Mississippi River watershed. Stakeholder involvement is crucial to building this support. Stakeholders including local and state officials, tribal leaders, and the federal government need to be involved in the process to build consensus.

Editor's Note: Following the congress presentation summaries, selected excerpts from a 2012 paper by John Briscoe, Gordon McKay Professor of the Practice of Environmental Engineering at Harvard University, are included to offer additional observations and recommendations regarding management and governance challenges related to the Mississippi River watershed (see Editor's Note on page [38](#)).

The Mississippi River Watershed – As We Found It and Today

Introduction

The once meandering Mississippi River is now a heavily engineered river. To understand how this came about and the consequences of this intervention, the history of the basin must be examined. The Mississippi River occupies a massive watershed that drains thirty-one states. Managing its resources has been a complicated challenge since the 1800's. Over the decades, the river has resisted being tamed and its management has been comprised of numerous piecemeal measures.

Craig Colten, a professor of Geography and Anthropology at Louisiana State University, provided a historical perspective on the basin and how humans have transformed it into what we know today.

Historical Overview

Colten described the different groups that inhabited the basin over the years. Beginning with tribal societies who used the river in various ways, to colonial powers fighting territorial battles, newly formed states and eventually the federal government. This river was at the center of it all.

The first Europeans were introduced to this important waterway by Spanish explorer Hernando de Soto in 1541. The arrival of Europeans brought profound and lasting changes to the river's riparian settlements, flood protection, navigational systems, floodplain ecology, water quality, and land use in the basin. These changes altered the fundamental nature of risk throughout the basin. The region's economy and the health and well-being of the communities along the course of the river were impacted.

Human Role

Colten emphasized that the historical perspective of the river is critically important because it allows us to focus on the human role. There are complex interactions between people and the physical

landscape that should be assessed holistically. He argued that when we look at the river merely as a biophysical system we neglect the underlying complex social, cultural, and economic factors that play into decision-making in managing the environment. It is important to keep in mind that humans will continue to play a role in this engineered river. Colten went on to quote Gilbert White, the father of hazardous geography, who examined the changing nature of flood risk in the 1940s. He wrote "floods are acts of God, but flood losses are acts of man."

Human Settlement

To describe the history of human settlement in the basin, Colten went back to the time of prehistoric inhabitants. These settlements were identified by the earthen mounds built by settlers. Mounds discovered in the Biloxi marsh south of New Orleans date back to 4,000 years ago. Analyzing these mounds was a chief tool for archaeologically dating the early advance of the Mississippi River delta. Mounds have also been discovered on Louisiana State University's campus that date back to approximately 7,000 years ago. These mounds are perhaps the oldest human made structures in North America.

These structures represent an important facet of human settlement of the basin. The mounds were built on the terrace adjacent to the floodplain and provided early inhabitants with access to upland forests, the floodplain, and riverine resources including food and transportation. These settlements set the model for mound building throughout the Mississippi River Valley.

Europeans arrived in the lower Mississippi River basin and established New Orleans in 1719. According to Colten, these colonial settlers had a fundamentally

different set of desires than previous inhabitants. The European settlers, namely the French, wanted to control the basin as a colonial territory for France.

The geography of the basin and its resources were fundamental to the site selection for New Orleans. Its location allowed upstream resources to be brought down the river and European goods to be transported through Lake Pontchartrain. The city was also a strategic point for keeping the British out of the territorial area claimed by the French.

Flood Protection

The site of New Orleans created a precarious situation for the residents of the city since it is located along the banks of the Mississippi River. Settlers began building levees in the 1720s to protect this nascent colonial capital. As New Orleans expanded up and down the river, the levee system grew with it. By the end of the colonial period, Louisiana statehood in 1812, the levees extended from New Orleans as far north as Baton Rouge and further upstream on the west bank of the river.

The levee systems, originally built by landowners and later by the various parishes, were far from perfect. The levees were inconsistently built and poorly maintained. There were numerous crevasses, or breaks in the levees, that regularly inundated the city and agricultural land. Although early levees suffered from severe inadequacies they remained the main tool to curb flood damages. This set the foundation for the region's dependency on levees that survives today.

In order to improve the chronically inadequate levees, the U.S. Congress established the Mississippi River Commission (MRC) in 1879. The MRC set out to prevent destructive floods by building more consistent and durable levees. Importantly, these levees were built during the Reconstruction period following the U.S. Civil War. Colten explained that Congress was hesitant to build a sophisticated and expensive levee system in the south, which had recently rebelled against the Union.

Due to this sentiment, Congress authorized levees for navigation. This approach was based on the theory that a river confined between levees would scour a deeper channel and ensure interstate commerce. As a result, the levees using federal funding were built for the purpose of interstate commerce. This basic principle guided the U.S. Army Corps of Engineers to later adopt a "levees only" policy.

The "levees only" policy called for flood control efforts to be focused solely on levees. As a part of this policy, branches of the river that flow away from the main channel, called distributaries, were cut off to streamline the levee building process and lower costs of the project. This strategy meant that nature's safety valves were taken out of the Mississippi River system. During this period, levees were fundamentally designed to protect, more than anything, the city of New Orleans.

In 1927, the Army Corps' "levees only" policy was put to the test and failed. The flood of 1927 was one of the most devastating floods in the river's history and still stands as the flood of record. It caused a fundamental rethinking of the levee system. The Army Corps shifted from the "levees only" approach to a "levees and outlets" strategy. This launched the construction of spillways in the lower Mississippi River in the 1930s and 1950s to be operated as needed during high river stages. The spillways were designed to mimic nature and function like the original distributaries that were cutoff when engineering the river.

The spillways have been used in various instances but the federal levee system has largely protected the river valley since the 1930s. After the flood of 2011, the Army Corps' historian Charles Camillo reported that the levee system had prevented approximately \$478 billion in damage since largescale levee building began in the 1880s. Overall, levees vastly reshaped the landscape of the Mississippi River basin.

Land Loss and Restoration

Human engineering of the river system, through levees and outlets, came with environmental consequences. Outlets denied renewal of important nutrients to freshwater swamps in the Atchafalaya Basin, damaged oyster harvesting through fresh water discharges into the Mississippi Sound and Atchafalaya Bay, and caused saltwater

encroachment on oyster leases by shunting water out of the lower delta. An oyster lease is an agreement with the state of Louisiana that allows a person to raise and harvest oysters in the seabed, which is owned by the state out to three nautical miles. This led to the opening of a number of small diversions in the lower course of the river to try to offset the incursion of saltwater into the oyster leases. Colten emphasized that one manipulation of the river system inevitably leads to another manipulation of the river system.

Coastal land loss is another important environmental impact of this engineered system. Coastal land loss is caused by numerous factors including natural processes such as land subsidence and faulting. However, human activities have taken a toll on the delta as well. Canal dredging for offshore oil and gas operations allowed saltwater intrusion into the marsh and levee building has diverted sediment and caused sediment starvation in the Mississippi delta.

Coastal land loss became a pressing issue in the 1930s, and by the 1950s Louisiana was greatly concerned with its shoreline. Colten explained that Louisiana was worried about losing oil revenue based on the three nautical mile state territorial limit if its coastline receded. In 1994, it was predicted that without effective intervention certain areas of the Gulf shoreline will move inland 30 miles in the next 50 years.

Today, the state continues to focus its attention on coastal land loss issues. In 2017, Louisiana published its Coastal Master Plan that provides a 50-year, \$50 billion blueprint for restoring and protecting the state's critical coastline. Colten pointed out that the state does not have the funds for these projects in its budget and that even with the plan in place there would be a net loss of land after restoration efforts.

Sediment Diversions

Large-scale sediment diversion projects have been proposed to counter these detrimental environmental impacts and rebuild the delta. These projects will divert sediment from the river into nutrient depleted areas to curb coastal land loss. Diversion projects are a key component of Louisiana's Coastal Master Plan. The plan includes two diversion projects planned downstream of New Orleans that will divert sediment into the marshes on either side of the Mississippi River.

The planning of these diversions is ongoing but they are projected to send sediment and freshwater into the most extensive areas of oyster leases in the state. The large-scale diversions face fierce pushback from the oyster fishing community, a powerful lobbying group, because of their potential negative impacts on the fishery. Colten noted that the human dimension is significant and complicates a simple science and engineering approach.

Colten repeatedly emphasized the importance of recognizing the human element with these types of projects. He typically recommends bringing in the social scientists and the humanities scholars at the outset of a project. The earlier you bring people in, the more you can factor in their consideration and work in conjunction with scientists and engineers.

Water Quality

Another environmental issue facing the Mississippi River watershed is water quality pollution. Colten illustrated the far-reaching impacts of water quality degradation by describing the case of *Missouri v. Illinois*. In the late 19th century, Chicago used Lake Michigan for its water supply while simultaneously dumping sewage into the lake, which caused disease outbreaks. To combat this, Chicago built a system to flush its waste into the Upper Illinois River towards St. Louis, Missouri. Missouri then filed a lawsuit against Chicago and it ultimately became the first state water pollution case heard by the U.S. Supreme Court.

Further south, massive sugarcane farms and the arrival of the petrochemical industry in the 20th century caused water quality issues. These industries built up facilities along the river and used the Mississippi as a diluting medium for their waste. For many years this practice was tolerated but things began to change in the 1960s.

Rachel Carson raised public awareness about environmental issues through her book *Silent Spring* in 1962, which revealed the damaging environmental impacts of pesticides. And, in 1964 there was a massive kill of

approximately five million fish in the watershed and the Gulf. The disaster was initially blamed on runoff of the sugarcane pesticide endrin but the U.S. Public Health Service ultimately determined the waste came from the endrin manufacturing plant in Memphis, Tennessee. Colten noted that this event exposed how politics can play into pollution. For example, many early state pollution laws placed the burden on the water suppliers, not the industry, to proactively ward against contamination.

As a result of these environmental issues, the federal government passed numerous pollution enforcement measures including the Safe Drinking Water Act in 1974. Over the past thirty years, however, the Mississippi River watershed has struggled to deal with nonpoint source nutrient pollution from farms and fields throughout the upper Midwest. These farmlands drain into the Gulf of Mexico causing a massive hypoxic “dead zone” devoid of most marine life. Colten underscored that the impacts of water pollution in the watershed can be felt beyond the basin and into the Gulf.

Conclusion

In closing, Colten highlighted three takeaways from his presentation. First, that every aspect of human use of the basin is durably inscribed in the landscape – levees, sewage treatment plants, industrial landscape, cities, towns, transportation and infrastructure. Humans are an inextricable part of the system now.

Secondly, that historical contingency is entwined in local, regional, and basin-wide culture, economics, and politics and that you cannot predict the human course of action. Lastly, we need to keep in mind that science and environmental management are both rooted in dynamic and complex social processes and deserve attention by appropriate experts. Namely, social scientists and humanities scholars who are willing and ready to assist with discussions and deliberations about managing the Mississippi River.

Observed and Projected Physical Climate Change

Introduction

Climate change is already impacting the natural systems that govern the dynamics of the Mississippi River, and many of these impacts are expected to become more significant as time goes on. It is a complicated story, and understanding it will be increasingly important to future management of the watershed. **Dan Barrie**, a program manager in the Modeling, Analysis, Predictions, and Projections Program of NOAA's Climate Program Office, shared observed trends in relevant hydroclimate variables in the region and discussed what we can expect in the future of climate in the watershed.

Increasing streamflow and flooding in the watershed

Barrie began his presentation by explaining recent hydroclimate trends in the watershed. A knowledge of these past trends is important to fully understanding the inputs affecting the system today, since many of them are expected to continue into the future.

One of the most important factors influencing increased river flooding is streamflow. Streamflow refers to the volume of water moving through the river over time. **Figure 1** displays changes in streamflow at USGS monitoring stations between 1940 and 2014. Many of these stations throughout the country have seen no strong upward or downward trends over that time period. However, most of the stations that have seen strong upward trajectories (greater than 50% increase in streamflow) are located in the Upper Mississippi region.

Data sets detailing low streamflow conditions, when rivers are not in flooding events, indicate an even significant and consistent increase in flow over the same period, as shown in **Figure 2**. This means that streamflow has risen in the Mississippi when flows are at their lowest – an increase in the base flow of the river.

The incidence and severity of riverine flooding events have also increased in the region over recent decades. While streamflows have mainly been increasing in the upper Mississippi River valley, flooding has increased

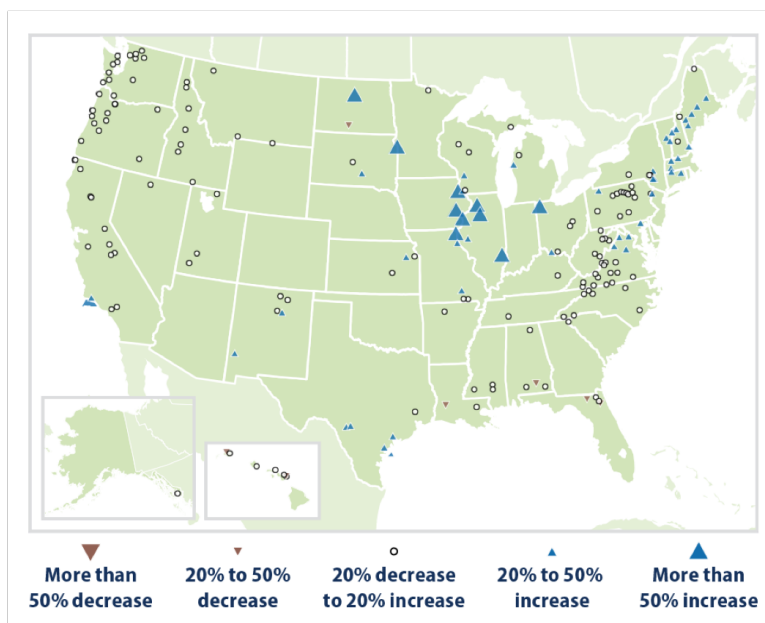


Figure 1. Annual Average Streamflow in the United States, 1940-2014

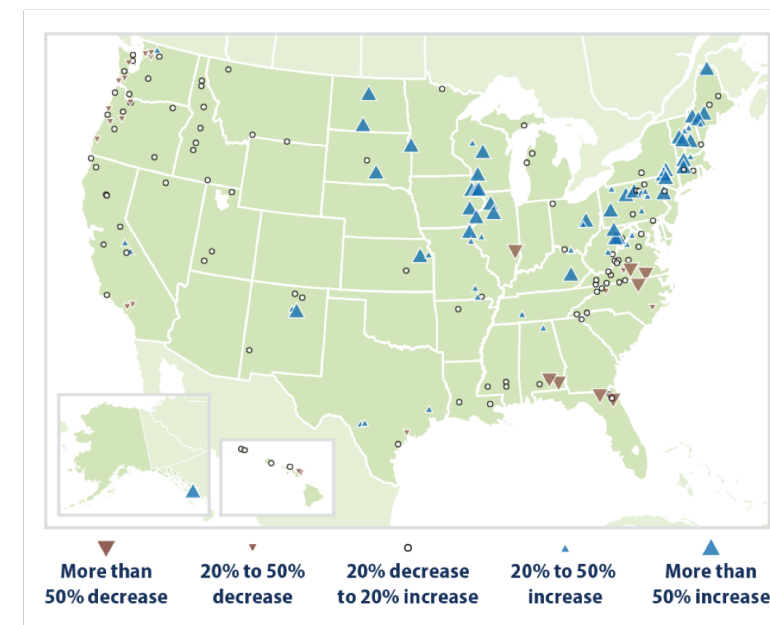


Figure 2. Seven-Day Low Streamflows in the United States, 1940-2014

all across the Midwestern United States, especially in tributaries to the Mississippi. This trend was detailed in the [Fourth National Climate Assessment](#), a congressionally mandated report by the U.S. Global Change Research Program which aims to authoritatively summarize climate change's impacts in the United States.

Increased precipitation in the watershed

Barrie continued to describe some of the climatic phenomena contributing to these increases in streamflow and flooding events in the watershed. He emphasized that increases in flood risk and severity are not attributed to 20th century agricultural practices, but instead to observed increases in mean and extreme precipitation, among other factors. **Figure 3** displays an increase in total precipitation in the watershed, both annually and in each season. **Figure 4** shows how extreme precipitation events have also increased over the decades. Barrie emphasized the map on the bottom left of Figure 4, which describes a two-day rainfall event that is the most extreme you would expect over a five-year span. This is especially relevant to the incidence of riverine flooding because a two-day rainfall event is generally what is required to cause significant flooding.

Wetter overall conditions

Next, Barrie discussed soil moisture data in the watershed, an indicator that integrates precipitation, runoff, and percolation into groundwater to give a useful measure of the health of a hydrological system. Data from NOAA's Earth System Research Laboratory shows that soil moisture has been generally increasing in the watershed over the last 100 years. This is indicative of gradually wetting conditions in the basin.

The Palmer Hydrological Drought Index (PHDI) is another integrative metric that takes into account temperature and precipitation to measure the overall wetness of a region. As depicted in **Figure 5**, it indicates that conditions have become wetter in the watershed over the last thirty years when compared to the long-term average over the 20th century. As the figure shows, the region of the country seeing wetter-than-average conditions correlates very strongly with the extent of the Mississippi River watershed.

Snow Cover

Another somewhat complicated factor that contributes to the hydrological situation in the

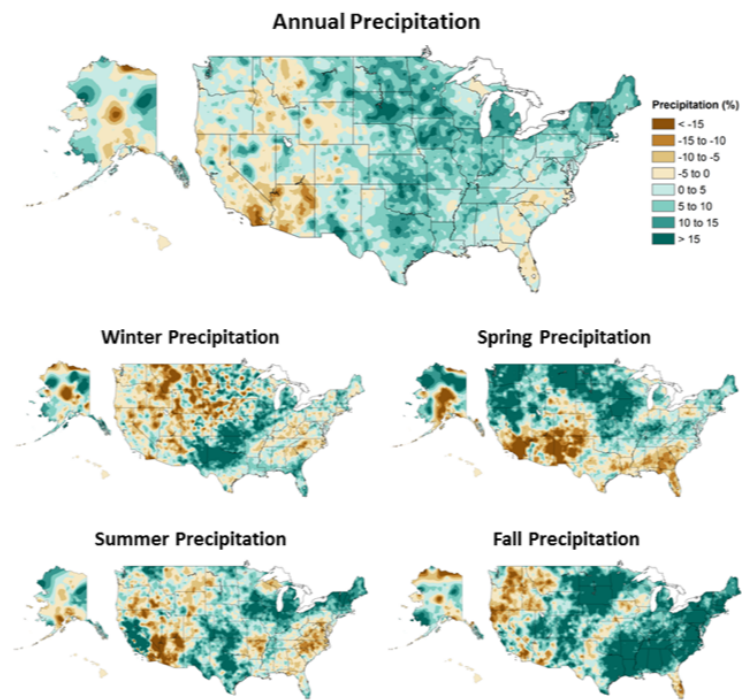


Figure 3. Increases in total precipitation in the United States

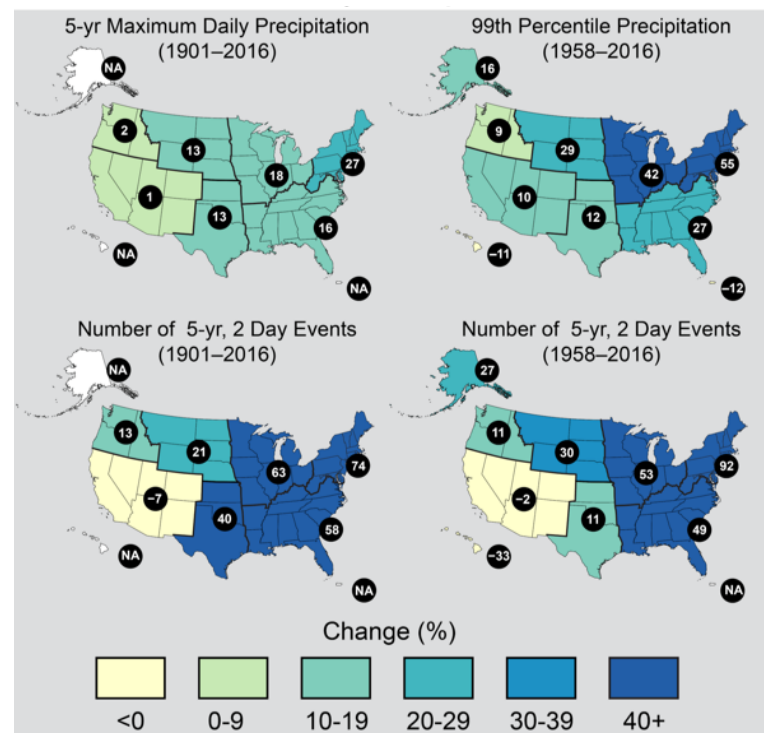


Figure 4. Observed change in heavy precipitation in the U.S.

watershed is snow cover. Due to temperature rise in the region, less precipitation is falling as snow and more as rain, especially early in the autumn and late in the winter. When early-spring snow melt coincides with heavy rainfall, extreme flooding often results as an abnormally high volume of water from these two sources enters the system all at once.

Snow cover can also impact how much water is entering the river system through rain-on-snow events. In the late winter and early spring, the snow cover left over from winter snows makes soil impervious to rain. Rainfall runs off of the snow and directly into the river, with no absorption or percolation into the soil. Normally, the land would provide a buffer, absorbing some moisture, but this capability is diminished when snow is still covering the ground. Rain falling on snow also tends to melt the snow it is falling on very quickly. This dual effect amplifies the potential of spring rains, which are often large, multi-day storms, to flood the Mississippi River and its tributaries. This generally contributes to the largest of flooding events in the basin, and is one of the reasons why a disproportional amount of flooding events on the Mississippi happen between February and June.

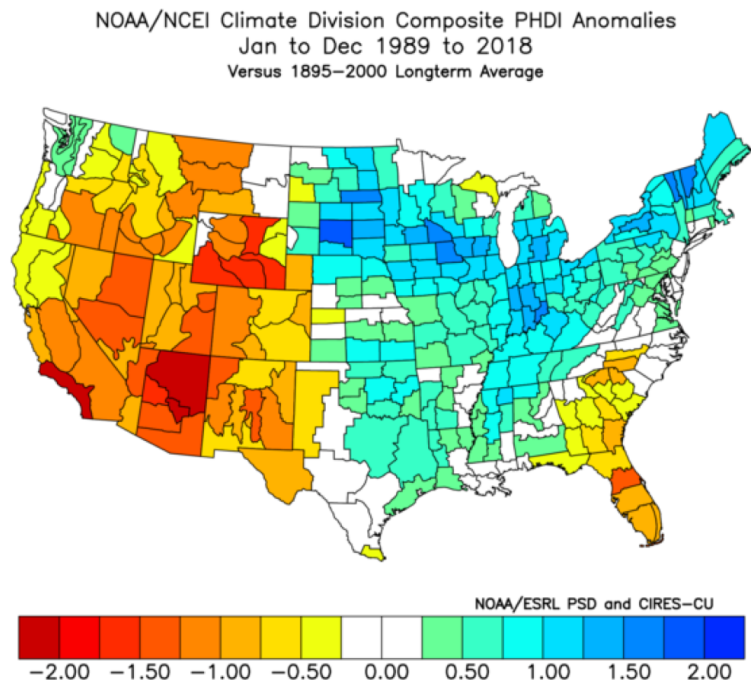


Figure 5. The Palmer Hydrological Index shows wetting conditions in the Mississippi River Basin over the last 30 years

Channel Capacity

The amount and type of precipitation are not the only contributing factors to flooding, however. Capacity of the river channel, or the amount of water that can flow through the river without it flooding, is also important. Channel capacity is determined by the width and depth of the channel, but also by its viscosity. Viscosity refers to the fact that channels with smooth river beds have faster streamflow than those with rough beds, and therefore carry a higher volume of water. USGS streamflow records have indicated that channel capacity effects have actually tended to reduce flood hazards in the Mississippi River basin by increasing its capacity to hold water in-stream. However, increases in precipitation have more than offset this effect, leading to increased flooding overall.

Impacts of flooding on life in the watershed

The National Climate Assessment, Volume II (2018) built upon Volume I by providing qualitative analysis of the secondary effects of climate change in the United States. In the section about the Midwest, the Assessment discussed flooding's impacts on life in the watershed. There are, of course, direct impacts, like flooding of surface streets, highways, and other low-lying areas, as well as other infrastructure impacts like bridge scour. High water levels can disrupt barge traffic on the Mississippi River, a major commerce corridor for taking Midwestern agricultural products to market. There are also public health considerations like drinking water contamination, mold growth in flooded buildings, and mental health issues like sleeplessness, anxiety, depression, and post-traumatic stress disorder. Adaptation and recovery efforts made necessary by these impacts will become increasingly common – and costly – as flooding becomes more common and severe.

Attribution of climate trends

The Mississippi River has seen clear trends toward more precipitation and flooding events over the decades, coinciding with the advance of climate change. According to the Fourth National Climate Assessment, it is

possible that this is linked to moisture availability in the atmosphere and increasing temperatures. However, the assessment noted, no formal attribution of precipitation changes and flooding to anthropogenic climate change has been made so far. Additional scientific rigor in flood attribution studies will be necessary to make such claims.

Future of the Watershed

Soil moisture, in every season and almost the entire country, is expected to decrease in the future. This is due to an increase in average temperatures, causing more water to withdraw from the ground into the atmosphere. This could actually contribute to reducing flooding in the Mississippi channel, since drier soil will be better able to act as a buffer against severe flooding events. Barrie noted that this makes flooding predictions in the Mississippi itself a little bit less clear, while the flooding correlation in the tributaries remains stronger.

Barrie ended on this note of uncertainty, describing a recent developing model by the Geophysical Fluid Dynamics Laboratory of NOAA. They conducted this study to increase understanding of the hydroclimate of the entire Mississippi River basin, past and future, in one model. The model predicts that average precipitation will continue to increase in the spring and winter, as it has over recent decades. Significant increases in the most severe precipitation events are also expected. However, a main takeaway is the model's prediction for extreme river discharge – flooding events on the Mississippi river channel. The model actually predicts that most types of flooding events of the channel will decrease over the next century. However, Barrie noted that this model is far from conclusive and there is a lot of work still to be done in accurately modelling flooding events on the Mississippi. This uncertainty is part of the reason why the National Climate Assessment did not predict increased flooding on the Mississippi channel in particular.

The Assessment notes that the conditions required to cause flooding tend to differ based on the size of the channel. To create flood conditions, larger rivers like the Mississippi require longer periods of heavy precipitation than smaller streams. The Assessment finds strong trends in increasing flooding and streamflow in the Upper Mississippi Basin as a whole. However, it makes no such claims for the main channel of the river. While the complexity of inputs to the hydrology of the main channel makes predicting flooding trends in the Mississippi channel less certain, the scientific community is making progress on understanding this issue more clearly with more advanced climate models and data.

To view the PowerPoint associated with this presentation, click [here](#).

Flood Control and Risk Reduction

Introduction

Flooding is a major issue in the Mississippi River watershed. To combat this flooding, the U.S. Army Corps of Engineers (USACE) employs a variety of flood control and risk reduction measures, including both traditional engineered structures and nature-based solutions. **Todd Bridges**, national lead of the Engineering with Nature Initiative of the USACE, described the history and background of Mississippi River flood control and risk reduction over the last century, as well as the role of nature-based solutions for the future of the watershed.

The Great Mississippi Flood of 1927

Bridges began his presentation by discussing the Mississippi River flood of 1927, the most destructive river flood in U.S. history. The flood covered 27,000 square miles with up to thirty feet of water. The width of the river south of Memphis was about sixty miles. The human toll was enormous: one million people were driven from their homes, 700,000 of whom were left homeless after the disaster. It also dealt a severe blow to the country's economy. In terms of current dollars, the flood caused \$1 billion in damages, roughly one-third the size of the federal budget at the time. It was one of the most devastating natural disasters in the history of the country, and precipitated the first-ever reimagining of how the Mississippi River should be managed.

Flood Control Act of 1928 and the MR&T Project

In response to the 1927 flood, the Flood Control Act of 1928 was passed, establishing the Mississippi River and Tributaries Project (MR&T). Over the following decades, this project was implemented on the lower part of the river to mitigate the growing flood risk. The structures built as a part of this project include the world's largest network of levees, spanning more than 3,700 miles. Now, there are over 1,000 miles of "articulated concrete mattress revetment" (**Image 1**) to protect those levees and the river itself from erosion. A series of floodways also was created as a part of this project. One of these is the Bonnet Carré

spillway, constructed in 1931. It has been activated 14 times throughout its history. However, a disproportional number of these openings have occurred in the past decade – it was opened in 2011, 2016, 2018, and twice in 2019. The last two years were the first time that it was opened in consecutive years, and the first time ever that it has been opened twice in the same year. While the Mississippi is still prone to flooding with this MR&T system in place, it is estimated that it has prevented over \$1 trillion worth of flood damage over its lifetime.

Inland Navigation

Inland navigation along the Mississippi has been incredibly important to the development of the U.S. economy. Five hundred and fifty million tons of cargo are transported along the river every year, including 97 million tons of agricultural products. One sixth of all goods transported between U.S. cities uses the inland and intracoastal waterways system. This massive industry is also aided by infrastructure built along the river. There are 122 lock sites along the Mississippi and 1,933 cargo-loading docks, which make this inland shipping industry viable.

Ecosystems in the Mississippi River Watershed

The Mississippi River watershed, spanning over 1 million square miles, also is the home to an incredibly



Image 1: An example of concrete revetment along a riverbank

diverse set of ecosystems. It provides habitat to a multitude of different species – 25% of the fish species in North America exist in the watershed, and 60% of the continent's bird species use it as their migratory flyway. There are also numerous applications of ecosystem services which either are generated or could potentially be generated from this system.

Engineering Trends and the Need for Innovation

Over the past century, engineering has advanced considerably, including the civil engineering used to manage the Mississippi River. In many ways, advanced engineering has actually removed complexity from the system, improving its efficiency and straightening out the river to be able to carry more water, more quickly. However, despite the advances that have been made since the passage of the Flood Control Act of 1928, more innovation is still needed. Flooding that occurred during the spring of 2019 across the Midwest was the longest in duration on record. The USACE was fighting the flood for more than 200 days; this coincided with the wettest 12 months on record in the watershed. Only counting the levees managed by the USACE, there were more than 160 breaches during this period. The estimated cost to repair the system, Bridges said, likely will be over \$2 billion.

One of the focuses of Mississippi River management is to reduce the losses from flooding as much as possible in the future. The National Oceanic and Atmospheric Administration (NOAA) has tracked every event since 1980 that has caused at least \$1 billion in damage in the United States. In that period, the U.S. has experienced natural hazards totaling \$1.5 trillion in damages. Bridges emphasized the importance of figuring out how to reduce these costs when future disasters inevitably occur.

Sustainability and Engineering with Nature

Bridges defined sustainability as being achieved by the efficient investment of resources to create present and future value. He noted that, since 2002, the USACE has been applying this idea of sustainability to its operations through its Environmental Operating Principles. One way that they have done this is through the Engineering with Nature (EWN) program, established in 2010, for which Bridges is the national lead. Through this program the USACE aims to promote the alignment of natural and engineered systems to provide a broader range of value that increases over time.

Restoring Natural Processes and Functions

Bridges described how future engineering needs of the watershed can be met in large part by adding back natural complexity to gain multi-use function. Bridges described three such functions. First, the natural engineering capacities of the basin, like flood capacity and water treatment, can be promoted by restoring natural components of the river. There are also environmental benefits to such actions, like habitat restoration, biodiversity, and species recovery. Social value can also be derived from restoration projects, promoting human wellbeing, recreation, and community resilience.

A levee setback project along the Missouri River provides a vivid example of this kind of nature-based engineering solution. The setback, spanning 3.5 miles in length, restores 760 acres of floodplain near Nebraska City, Nebraska. This provides flood risk management benefits, lowering flood stages in this stretch of the river. It also adds to the natural and social value of the region. Projects like this one have been implemented in many situations, both in the U.S. and around the world. Bridges reiterated that examples of the USACE successfully setting back levees already exist; the question is how much more of this could be done.

In the Q&A session at the end of this talk, an audience member asked Bridges to compare the maintenance costs of natural and traditional flood management solutions. He responded by saying that natural solutions can save money in the long-term, but they have to be implemented in the proper settings. If a nature-based solution is forced into a system where it does not fit, much higher operation and management costs could result. However, natural solutions tend to be more adaptable over time than traditional alternatives. For example, if a flood wall needs to be higher than it was built, it essentially needs to be removed and rebuilt. Nature-based solutions are generally easier to expand and adapt to changing conditions.

Social Engagement: Facilitating Change

Bridges emphasized the importance of engaging local communities at every point of the process when developing new water management approaches. Such principles have been applied to many successful water management efforts in the U.S. and abroad. This is an important part of the Engineering with Nature program that Bridges highlighted. The EWN program has had over 50 meetings and workshops with a variety of groups to find ways to deliver more innovative solutions. Innovation can also play a role in facilitating stakeholder engagement: Bridges discussed EWN's [Natural Infrastructure Opportunities Tool](#), which displays environmental conditions and USACE projects, allowing the user to map resource availability and needs.

Nature-based Solutions as Leading Practice

In a statement in October 2019, Peter Glas, the Delta Commissioner of the Netherlands' Rijkswaterstaat, emphasized the importance of “building with nature” as a leading focus of hydraulic engineering in the coming decades. He said that, since natural processes are more flexible, adaptive, and sustainable than traditional solutions, they need to be given higher priority moving forward. The Environment Agency of the UK, which is responsible for managing flood risks across its nation, has released a new draft flood risk management strategy that also includes multiple statements supporting nature-based solutions. This strategy includes a goal of returning 75% of water bodies to natural or near-natural condition within 25 years. Bridges noted that this is how progress begins – the establishment of ambitious goals for the future.

Nature-based flood management is being promoted in the United States as well. The 2016 Water Infrastructure Improvements for the Nation (WIIN) Act directed the USACE to be explicit in describing how they are considering nature-based features as a part of flood risk management. The USACE is required, starting in 2020 and every five years thereafter, to submit a report that documents its progress in considering the use of natural flood management.

The Other Two Legs of the Sustainability Stool: Nature and Human Wellbeing

Engineering value is not the only positive outcome of natural solutions, however. There are numerous natural benefits as well. For example, wetlands provide a natural water quality function. This could contribute to decreasing nutrient pollution in the Mississippi and a reduction in the size of the dead zone in the Gulf of Mexico. They also provide habitat for threatened and endangered species, 150 of them in the Mississippi watershed alone.

Natural solutions can also have huge benefits for human wellbeing. Bridges observed that people need nature. The majority of humans live in urban settings, and therefore do not necessarily encounter nature in their everyday lives. There is significant scientific evidence that contact with nature is good for human health: both physically (positively impacting blood pressure, healing, and immunity) and mentally (improving cognitive function, reducing depression and anxiety, and improving socialization). Nature-based solutions are not only useful for accomplishing engineering goals in a sustainable fashion, but also provide additional benefits for ecosystems and humans, benefits that are not afforded by traditional, grey infrastructure.

Conclusion

The problems facing the Mississippi River are difficult to definitively formulate, and there are no definitively right or wrong solutions, only better or worse solutions. To find the better ones, a broad diversity of opinions and voices are necessary. For this reason, Bridges advocated for a systems approach to the management of the watershed. In considering options for watershed management, one must consider increasing both efficiency and overall value; using conventional and natural infrastructure; promoting innovative solutions; engaging the private sector; and thinking, engaging, and planning on a large scale over the long-term.

To view the PowerPoint associated with this presentation, click [here](#).

Floodplain Management

Introduction

The Mississippi River Basin has always naturally flooded, but flooding has become more problematic due to continuing unwise development in the floodplain. The construction of levees along the river as well as federal flood policies encourage people to live, work, and farm in risky flood-prone areas. **Chad Berginnis**, the executive director of the Association of State Floodplain Managers, spoke about how the United States can break free from this cycle of repeated, devastating flooding and work to rectify its poor land-use choices.

Where We Stand Today

Despite all of the efforts to curb flooding over the last 150 years, devastating flooding continues. On top of this, flood damages are increasing and large demographic changes coming to the United States will impact future flood damages.

Flood Damages

A major issue with assessing the amount of flood damages in the United States is that an accurate estimate does not currently exist. Berginnis explained that there is debate within the professional community about the magnitude of flood damages. The spectrum is wide because there is no single federal agency assigned to conduct an overall damage assessment. For example, the National Oceanic and Atmospheric Administration tracks billion-dollar flood events but does not cover the numerous smaller events around the country.

ASFPM previously compiled a flood damages assessment and is currently working to update this data. According to ASFPM's earlier assessment, the United States was averaging about \$5.6 billion a year in flood damages in the 1990s. This number doubled in the 2000s and is on track to double that again in the 2010s. The United States will be averaging well over \$20 billion a year in flood losses. Berginnis noted that the increase in damages correlates with increases in heavy precipitation that have accelerated over the past two decades.

Demographics

Demographically, significant growth is occurring in the United States. By 2050, it is predicted that there will be 460 million people in the United States (the U.S. Census Bureau projected a population range of between 313 to 552 million by 2050) and with this increased population comes increased demand for housing development. Approximately 200 million housing units, up from 116 million in 2000, are expected to be built by 2050. Berginnis emphasized that when dealing with development, we need to keep the lifespan of development in mind. For instance, the average life span of homes is over 150 years, while a commercial building may be built and knocked down within 20 or 30 years. He stressed that we need to be thinking about 100 to 150 years from now in terms of flooding for the developments we are putting on the ground today.

Keys to Success

Berginnis distilled his thoughts about issues being faced within the Mississippi River Basin to four key takeaways. He pointed out that only one takeaway involves the federal government, and therein lies a message about state involvement. Berginnis believes that it is not too late to act now to affect future outcomes but the challenges are daunting.

Leverage Approaches Already Being Used to Solve the Problem

States and local communities are already implementing successful formulas to effectively manage flood risk in the Mississippi River Basin. Berginnis argued that if we deploy existing flood management approaches we could solve our flooding problem. Solving this problem, however, remains contingent on political will and necessary funding. Surely, new technologies and techniques will be developed to aid this effort but implementing current approaches could make significant progress against devastating floods.

Berginnis suggested that we need to consider what it means to be successful in flood risk management in

general – what are the metrics for success? He explained that in the Mississippi River Basin, in Minnesota in particular, we are starting to see this take shape. Of course, Minnesota benefits from being closer to the headwaters. For the first time, we are beginning to have states that no longer have declared flood disasters. This shift brings up another set of issues because significant resources are made available for disaster relief, which may perversely incentivize poor planning and not reward good behavior.

The Midwest has the only national examples of largescale neighborhood or community relocation. One such example is Darlington, Wisconsin. Darlington is a chronically flooded community of 2,500 people straddling the Pecatonica River in southwest Wisconsin. By the 1990s, it was a small historic downtown that faced significant damages from repeated flooding. After a major flood hit, the city took radical action. The community mobilized multiple agencies, both federal and state, as well as businesses and homeowners to enact much-needed mitigation measures. The city developed its first mitigation plan and integrated flood loss reduction into its comprehensive planning. As a result, the city acquired commercial businesses near the river, floodproofed the old downtown and setup a business park outside of the flood prone area. The next time Darlington flooded, most downtown businesses reopened within 24 hours.

The basin also provides examples structural solutions being complementary to non-structural approaches. In Minnesota, there is a structural focus on farmsteads. The state has a grant program where it creates ring levees or dikes around the farmstead to maintain the family there and allow farming to continue in the floodplain. Another successful approach is complementing the federal hazard mitigation program with state or local mitigation programs. There is a small community outside of Chicago, with approximately 25,000 people, that offers a mitigation tax credit. Berginnis believes that this is the kind of forward thinking approach we need to employ basin-wide.

Dramatically Improve Land Use

Berginnis asserts that land use for flood risk management in the Mississippi River Basin, and across the United States, is atrocious and must be improved. First, he explained that land use management is different than building codes and standards. Building codes dictate how something is constructed, but land use standards govern where and what type of construction can be built in a certain community. Relying solely on building codes to deter unwise development is not enough, we must complement codes with land use standards to effect change.

Subdivision standards need to be improved as well. The National Flood Insurance Program (NFIP) minimum standards are ineffective when it comes to subdivision standards. The NFIP is a federal program, run by the Federal Emergency Management Agency (FEMA), created to provide affordable property insurance and encourage the adoption of floodplain management regulations. The NFIP only generically mentions subdivision standards and does not do enough to effectively curb unwise development in hazardous areas.

There also needs to be a focus on the concept of avoidance of highly hazardous areas. The Dutch “Room for the River” approach embodies this concept. The “Room for the River” plan is strategically designed to create open space for the river to flood safely. Berginnis contends that many Upper Mississippi River Basin states are practicing the “Room for the River” concept by implementing improved floodway standards that exist under the NFIP.

Under the NFIP, any activity in the floodway requires a detailed engineering study to be conducted to ensure flood levels are not increasing for development in that area. In several states in the Upper Mississippi River Basin, the allowable water surface elevation in the floodway ranges from no rise to a tenth of a foot, while the minimum NFIP standard is one foot. In these Upper Mississippi River states where you have a no water surface elevation allowed, for example, the entire floodplain becomes a floodway. This means that you have very little development in the floodplain. This approach has worked well in the Upper Mississippi River and Berginnis believes it could be exported elsewhere in the basin.

Berginnis acknowledged that flood mitigation efforts, land use planning in particular, affect land ownership and

require buy-in from property owners. He advised reaching out to local elected officials and reframing the argument to focus on impacts to their communities. This is important since those local county officials have the ultimate approval authority over subdivision codes and zoning.

When confronted with high risk development already within a floodplain, Berginnis explained that you need to recognize the entire range of approaches. Regulatory and planning approaches work best in the yet to be developed environment because you can steer development and make it more resilient. In the already developed stage, you need to have strong hazard mitigation programs such as adjustments to the tax code with tax incentives for hazard mitigation, an effective loan mitigation program, or grant programs. Regarding relocating entire communities, he explained that there is no way that most communities could absorb that kind of shock. It is a multi-decadal process to go from extremely flood prone in certain areas to a moderately resilient city. Again, it is using all the different approaches but also recognizing the appropriate timescale.

Berginnis also advised against relying too heavily on levees as flood protection. He pointed to the disassociation that people have between levees and land use policy in the United States. The predominant view by the public is that levees are sufficient protection from floods thereby encouraging development in the floodplain. The 1936 Flood Control Act focused solely on structural measures and did not have anything related to complementary land-use measures or basin-wide management. Gilbert White recommended a veto of Flood Control Act because of this alarming disassociation. White recognized that we needed this piece because human nature relies too heavily on structural protection and encourages increased exposure and risks behind it.

Mapping flood prone areas is also an issue. The United States has only mapped 1.3 million miles of streams, rivers, coastlines for flood risk out of 3.5 million miles. To illustrate why mapping is important, Berginnis pointed to the Cameron Chase Subdivision in Ohio. In this subdivision, the FEMA floodplain is identified but other tributaries shown on the National Hydrography Data Layer are not identified. There are seven tributaries unaccounted for, with some making up seven to eight square miles of drainage. One of these tributaries goes directly through the Cameron Chase subdivision. To combat this problem, ASFPM has partnered with the American Planning Association in a good practitioner publication called *Subdivision Design and Flood Hazard Areas (PAS 584)*. It recommends over 60 standards that communities can adopt in their subdivision codes to be more flood resilient.

State Leadership is Key

Strong state programs are vital to effective floodplain management. In fact, several states in the Mississippi River Basin had state floodplain management programs that predated the NFIP. Berginnis expressed disappointment that many congressional officials today prioritize obtaining federal funding over discussing their states' involvement in flood protection. He believes that states need to take the initiative and increase their role in addressing floodplain management issues in the basin.

To aid states, ASFPM developed a publication called *Effective State Program* that identified 10 dimensions that ASFPM considers effective programs. These effective programs include everything from using post-disaster mitigation techniques to providing adequate technical assistance to local communities. States need capacity to carry out floodplain management and hazard mitigation and we are not investing enough right now.

A strong state enabling authority is another important element for effective floodplain management. In New Jersey, the state gave its communities the authority, for the first time, to establish stormwater utilities. Stormwater utilities are becoming increasingly important as a source of non-federal funding to complement federal mitigation programs as well as Army Corps projects. Illinois has some of the nation's lowest numbers of repetitive loss properties because the state aggressively focuses on this issue. Minnesota has the entire range of measures including a focus on stream ecology, statewide setbacks from streams that promote riverine corridors, higher floodplain standards, and higher mapping standards. These are just a handful of success stories that could be a blueprint for elsewhere in the basin.

Berginnis also explained that accounting for climate change is critically important to floodplain management. For

example, Norfolk, Virginia is using the correct planning horizon in tandem with improved land use tools. While some communities are debating between planning for 2030, 2050, or 2070, Norfolk is planning for 2100 and it updated its zoning code to implement this plan. Berginnis believes that this is a fascinating case study that could chart the course on how to manage floodplains in the changing climate.

Federal Programs Must Stop Incentivizing Bad Behavior

Too many federal programs are structured to lead to negative long-term results. Berginnis argues that federal programs need to be modified to stop incentivizing bad behavior. He stressed that this is not a replacement for effective state and local commitment but there is significant room for improvement in the federal realm.

Berginnis proposed several alterations to improve the numerous federal flood programs starting with FEMA disaster relief funding. He suggested that FEMA public assistance could be tied to mandatory requirements to adopt effective codes and land-use standards or mitigation plans that are incorporated into a state's comprehensive plan. Regarding the NFIP, which is administered by FEMA, Berginnis pointed out that flood insurance is only mandated in the 100-year floodplain. He posited that flood insurance could be mandated nationwide, inside and outside of the floodplain, to shift the dynamic.

The U.S. Army Corps of Engineers and Natural Resource Conservation Service (NRCS) both provide funding for structural flood control. Berginnis proposed that flood control funds could be contingent on adopting stringent land-use standards behind levees or downstream of dams. Additionally, ASFPM recommends a transformational change in how the Army Corps approaches technical assistance. The Army Corps could implement a model, like the NRCS, that allows the agency to provide on the ground technical assistance to communities.

The Department of Housing and Urban Development offers a housing choice voucher program to provide affordable housing for eligible participants. Berginnis suggested that these housing vouchers should not be accepted for housing in the floodplain. Enacting this change would eliminate the moral hazard of incentivizing vulnerable people to live in flood prone areas. This presents a complex problem, however, because most of the country's affordable housing is located in highly flood prone areas. Many people could lose their affordable housing option if these vouchers are not permitted. Berginnis explained that in order to enact this proposed voucher change, affordable housing must be developed outside of flood prone areas.

Additionally, the federal government needs to take a leadership role when it comes to the latest codes and standards. Berginnis proposed that the federal government could only use flood fighting products that meet the ANSI 2510 standard for flood protection. Federal agencies could also undertake standards development themselves. For instance, the Department of Defense is adhering to the highest standards of resiliency because it is concerned about its bases being affected by storms and flooding.

Conclusion

In the end, Berginnis stressed that federal programs must stop incentivizing bad behavior and focus on resiliency. This will be a step in the right direction but it is not a replacement or substitute for effective state participation and leadership. In dealing with land use issues, Berginnis recognized that the United States, unlike the Netherlands, has significant room to grow and expand to accommodate flooding. That may be more difficult for some communities, but we have the ability to change and build a more flood resilient future than what we have now.

To view the PowerPoint associated with this presentation, click [here](#).

Analytical Tool Guides Protection & Restoration of Ecological Resources

Introduction

The Mississippi River Basin is America's iconic watershed and supports vast ecological resources. Many of these ecological resources occupy floodplains throughout the basin. Floodplains are currently under threat from nutrient and sediment pollution as well as development that has caused the loss of tens of millions of acres of floodplains along the Mississippi River and its tributaries. **Kris Johnson**, the associate director for Science and Planning for The Nature Conservancy, described an analytical tool that allows floodplain managers to make better decisions about where to direct limited funds and investments toward effective floodplain management. As managers come to terms with changing climate conditions in the basin, analytical tools like this one, will become increasingly important in determining where and how to do the most good for ecological resources.

Multiple Benefits of Floodplains

Floodplains are critical parts of our landscape because they provide multiple benefits for people and nature. Floodplains are powerhouses, both ecologically and hydrologically, in terms of the nutrient cycling they perform and the dynamics they create in forming habitat for terrestrial and aquatic species. Increasing the productivity floodplains increases vital ecosystem services.

Floodplains clean water for local municipalities and provide spawning habitat for fish as well as habitat for migratory water fowl. These areas also provide recreational benefits for people including hunting, fishing, bird watching, and kayaking. Flood risk mitigation and reduction is another significant benefit provided by floodplains. Johnson believes that proper floodplain management is key to reducing our flood risks and managing floods more effectively.

Successful Floodplain Projects

The Nature Conservancy and many others have been focusing on these dynamic parts of our ecosystems for

many years. The Nature Conservancy has conducted numerous projects up and down the basin, working with local partners, state and federal agencies, and other non-governmental organizations to reconnect and restore floodplains and vegetation. According to Johnson, each of these projects showed positive results including fish spawning increases and the return of waterfowl, hunters, and fisherman to the area. Additionally, when levees were broken, and the natural floodplain reconnected to the river, denitrification and nutrient processing were allowed to resume.

Floodplain Prioritization

Johnson explained that despite The Nature Conservancy's efforts to improve floodplain protection and restoration, these examples are merely anecdotal. We are not achieving the scale of change that is needed to help restore the Mississippi River Basin as a whole. This reality prompted The Nature Conservancy to think about how to scale up projects and where to invest resources and capacity to be most effective. As a result, The Nature Conservancy launched a collaborative research project in partnership with the University of Bristol, United Kingdom, and a flood analytics company called Fathom.

U.S. Floodplain Analysis

Together The Nature Conservancy, University of Bristol, and Fathom developed a large-scale hydrodynamic model that generated floodplain maps and flood depth grids at a very large scale. Johnson explained that having an accurate two-dimensional hydrodynamic model for a particular river reach, with local channel parameters and bathymetry measures, allows for better performance. This information is very powerful in determining how to manage floodplains more holistically.

This partnership built out floodplain maps for the entire United States at a number of different return intervals. This new U.S. model includes regionalized

flood frequency analysis, 10 return periods from 5 to 1000 years and was validated with FEMA and United States Geological Survey data. Johnson emphasized that once you have this type of foundational information, you can start asking a broader range of interesting questions to help manage floodplains more proactively.

The Nature Conservancy first used this floodplain analysis model to discover where people are living in the United States and how many are exposed to flood risk. This analysis is important because previous estimates of people at risk from riverine floods in the United States were incomplete and fragmented. In February 2018, The Nature Conservancy released the results in a [study](#), titled *Estimates of present and future flood risk in the conterminous United States*, conducted in collaboration with the University of Bristol, Fathom, and the U.S. Environmental Protection Agency. The study determined that 41 million people in the United States, which accounts for approximately 13 percent of the population of the study area, are at risk from riverine flooding.

This estimate is more than three times the current estimate based on FEMA regulatory maps. FEMA regulatory maps use the 100-year-flood as a metric, which is a flood event that has a 1 in 100 chance of occurring in a given year (also referred to as the 1% flood). Based upon this estimate, a large portion of the population that is exposed to the 100-year flood is unaware of their flood risk. Additionally, the report calculated that \$5 trillion worth of assets are currently exposed to the 100-year flood in the United States. Johnson underscored that knowing this information is important to educate people on their flood risks, and to guide comprehensive floodplain and flood risk management.

In December 2019, shortly after the RNR Congress concluded, The Nature Conservancy, the University of Bristol and Fathom released a [study](#), titled *A benefit-cost analysis of floodplain land acquisition for US flood damage reduction*, assessing how floodplains could be conserved to reduce flood losses. According to the study, every \$1 invested to protect floodplains saves around \$5 in potential future flood damages. The study identified over 104,000 square miles in 100-year floodplains where conservation measures would be an economically feasible way to avert future flood damages. The study also discovered 675,919 km² of natural area in 100-year floodplains that could be acquired as a proactive conservation measure. Acquiring this area would cost \$306 billion but would avoid \$593 billion in future damages by 2070. Johnson stressed that we need to be proactive with our investments in flood risk mitigation, rather than reactively dealing with flood damages. Shifting from a reactive to a proactive approach would save everyone money in the long run.

Floodplain Prioritization Tool

The Nature Conservancy recently released a new online interactive [Floodplain Prioritization Tool](#) to help identify opportunities for floodplain protection and restoration in the Mississippi River Basin. The goal of the Floodplain Prioritization Tool is to provide it to decisionmakers, such as local, state or federal officials and local governments and businesses, to minimize development impacts and improve their restoration and protection efforts in the basin. Johnson walked the audience through the tool to give a sense for the data and the science that has gone into its development.

Johnson described the logistics of the Floodplain Prioritization Tool as well. You can ask a variety of questions related to different management types such as restoration or protection. As you play around with different selectors, watersheds pop in and out based on whether the data suggest they meet those criteria. The Floodplain Prioritization Tool also allows you to zoom in on a particular watershed and discover why they meet those criteria.

All pertinent information on how we manage our rivers and floodplains was included in the Floodplain Prioritization Tool to give the user a comprehensive picture of the basin. It contains various data points including water quality data, habitat data, soil quality data, flood risk data and other risk layers as well. Johnson expects the Floodplain Prioritization Tool will be the most effective when used in partnership with local planners and stakeholders.

Floodplains naturally trap sediment and help denitrify water but the Floodplain Prioritization Tool has the potential to amplify this natural process. The Floodplain Prioritization Tool can help identify ideal nutrient

reduction targets for floodplains to maximize their denitrifying power. To find these target areas the Floodplain Prioritization Tool compiles different data layers that contribute to water quality issues such as nutrient loading to local waters and the Gulf of Mexico and the surrounding temperature of the water.

Wildlife habitat is also an important component of floodplains that the Floodplain Prioritization Tool can help to protect. The Floodplain prioritization Tool includes numerous data points including important bird areas, migratory bird corridors, at-risk wetland species, threatened and endangered species critical habitat, and national fish habitat conditions. Knowing where and how these habitats overlap with flood risk and potential development is vital to sustainably managing the basin.

Farmers in the Midwest suffer losses from flooding every year. In many cases, these farmers are looking for a way out of this repeated flooding cycle. The Floodplain Prioritization Tool can help by using soil quality metrics to identify potential floodplain restoration targets in agricultural areas. The Floodplain Prioritization Tool uses the National Commodity Crop Productivity Index to measure the soils' inherent capacity to produce commodity crops. Less productive areas are assigned a lower index value, and therefore make for more viable opportunities for restoration efforts.

To convey flood risk in the basin, the Floodplain Prioritization Tool includes population projection and future economic asset exposure as well. The Floodplain Prioritization Tool allows you to use a high growth or low growth population scenario. The population in the floodplain, coupled with expected future property damage from flooding, displays the risks to those living, or projected to live, in the floodplain. Assessing these data elements together is key to proactively managing the floodplain and avoiding greater flood risks.

Only being guided by economic losses, however, can lead to the unintended consequences of focusing on protecting wealthy communities and expensive real estate to the disadvantage of more vulnerable populations. The Nature Conservancy worked with the University of Iowa to create a new national data layer for social vulnerabilities data. This new social vulnerability index can be used to bolster floodplain management planning that benefits all of society.

The Floodplain Prioritization Tool is currently being used to help guide floodplain management planning for the Meramec River in Missouri. This area has experienced severe flooding in recent years, which prompted the Army Corps' Silver Jackets Program to launch a floodplain management process for the lower river. The Silver Jackets program includes federal, state, local and tribal agencies that work toward minimizing flood risk in the United States.

The Nature Conservancy, and its Silver Jackets Lower Meramec Floodplain Management Plan partners, developed a customized pilot version of the Floodplain Prioritization Tool for this local geography. The Floodplain Prioritization Tool was used to visualize and communicate elements that were going into the plan for the stakeholders to easily understand. This project demonstrates the Floodplain Prioritization Tool's potential for basin-wide adaptation for floodplain management projects. Overall, the Floodplain Prioritization Tool brings vital components of the Mississippi River Basin into focus so that we can move forward with planning in a more collaborative and sustainable way.

Upcoming Data and Development

In conclusion, Johnson detailed upcoming data and development on The Nature Conservancy's agenda. For example, The Nature Conservancy is currently conducting a national study focused on the potential for certain areas to support migration, adaptation and resilience to climate change. This map will be biodiversity and species focused with places selected based on their elevation, connectivity, topography and geomorphology that would make them resilient in the face of climate change. The Nature Conservancy also plans to create future floodplain maps based on climate change data.

To view the PowerPoint associated with this presentation, click [here](#).

Lessons in River Management from the European Union: Governance and Legislative Framework

Introduction

Around the world, there are many watersheds that face river management and governance challenges that can be compared to those of the Mississippi. The European Union, with large rivers like the Danube and Rhine that flow across international boundaries, can provide lessons and experiences that may be helpful to American decision-makers. **Giuliana Torta**, Counselor for Environment, Fisheries, and Ocean Policies in the European Union Delegation to the U.S., provided an overview of European river management, the challenges they face, and the governance systems they employ for cross-boundary cooperation on these issues.

Differences between the EU and U.S.

Torta began her presentation by describing some of the differences between the European Union and United States when it comes to river management. The main difference between the two is that the EU does not have an equivalent of the Mississippi River. Its largest river is the Danube, which is much smaller than the Mississippi. However, Europe's population is much more concentrated. This means that more people live in the Danube and Rhine watersheds – 82 and 60 million people, respectively – than in the Mississippi River Watershed, where approximately 30 million people reside. Torta noted that this makes water management solutions more urgent since each major flood has a huge human impact.

Another key difference is that 60% of waters in the EU are transboundary, meaning that cooperation is important both between EU member states and with non-member states. In contrast, the Mississippi watershed is almost entirely located within the U.S., with only a small portion reaching into Canada. However, the fact that the Mississippi watershed spans numerous states creates some similar governance challenges to adopting an integrated watershed-based approach to river management.

Regardless of these fundamental differences, there are still lessons to be learned from the EU's model of flood management.

Historical Context

EU flood management policy, like many landmark environmental policies around the world, has its roots in the 1960s and '70s when public awareness of environmental issues increased drastically. However, the most important moment for these efforts was in 1987, when the EU introduced the primary basis for a common environmental policy under the Single European Act. Through this act, member states agreed to share responsibility for environmental policy on the European level. This shared responsibility is the basis for the EU Water Framework Directive (2000) and Floods Directive (2007), which govern water policy and floods policy, respectively.

Division of competences within the EU

Different policy areas fall to different competences between states and the EU. Environmental and agricultural policies, including water management, fall under "shared competences." This means that the EU and national governments work together on these policies. To carry out the Water Framework Directive, a "Common Implementation Strategy" between the EU and individual nations is used.

Under the Common Implementation Strategy, the highest level for decision-making and strategic steering is that of the Water Directors, appointed individually by each state. They meet twice a year to discuss EU-level water resources legislation. Torta suggested that the U.S. equivalent of Water Directors could hypothetically be someone from the Office of the Governor for each individual state. Acting under the direction of the Water Directors is the Strategic Coordination Group, which assists in implementing water-related legislation and engages with stakeholders. Five working groups also provide technical support in different areas, one of which is

floods. **Figure 1** displays this organizational structure.

EU Water Framework Directive

Torta then explained the legal framework of EU water resources policy. The EU Water Framework Directive, passed in 2000, is the mother directive under which other water-related directives fall. It covers the protection and management of all waters, including rivers, lakes, transitional, coastal, and groundwater, from all impacts. Torta compared it to the Clean Water Act in the United States, although it has a wider scope and more complex enforcement mechanisms, making it more difficult to enforce. Right now, the main objectives of the Water Framework Directive are to focus on the river basin-level approach, as well as to reach good overall quality of surface and ground waters by 2027 at the latest. This is quantified by water quality, quantity, and flow, among other metrics.

The Water Framework Directive's goals for integrated river basin management include balancing environmental protection and economic development, focusing on the socio-economic needs of the population residing in the basin, abandoning unsustainable practices, repairing damage, and improving the environment in the most cost-effective way possible. Additionally, they are always aiming to improve governance for water management, fostering effective communication and cooperation amongst sectors and across boundaries.

EU Floods Directive

The Floods Directive, passed in 2007, falls under the Water Framework Directive and governs EU flood risk management. It is conducted in three step cycles which last six years each. Each cycle includes the production of Preliminary Flood Risk Assessments to identify risks; Flood Hazard and Risk Maps to evaluate the territories most prone to flooding; and Flood Risk Management Plans to react and plan for the future. The first cycle lasted from 2009 until 2015, and the directive is now in its second cycle. Torta emphasized that the six-year length of these cycles is important because they allow many member states to avoid politics related to the election cycle.

Benefits of EU-Wide Implementation

Next, Torta explained the benefits of these flood management policies being implemented on an EU-wide level. One benefit is the sharing of terminology between nations, ensuring that the management plans and other products that each country drafts are relatively easy to compare. It is also comprehensive – it covers all types of floods, and all aspects of management, including protection, response, prevention, and preparedness. Additionally, it uses a river basin-wide approach, and prioritizes the integration of decision-making upstream and downstream. Since many of these rivers flow through multiple countries, this integrated process is absolutely necessary for effective river management. This is facilitated through increased cooperation and coordination under the Floods Directive, both through multi-nation river commissions (at the basin scale) and bilaterally between nations. Finally, each country consolidates its flood management strategy into a single reference document, a Flood Risk Management Plan, simplifying the communication and coordination of their efforts.

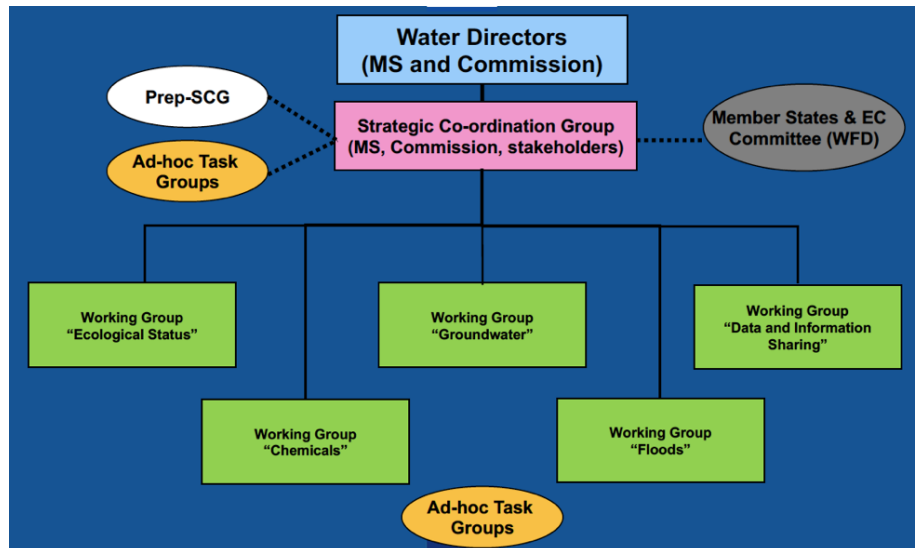


Figure 1: Common implementation strategy for EU water governance

Areas of potential improvement

Torta concluded her presentation with a discussion of how the EU can continue to improve its water management in the future. Since the implementation of the Water Framework Directive, the deterioration of bodies of water has effectively been halted. However, only 40% of surface water and 74% of groundwater bodies are in good condition. This means that further progress in restoring bodies of water is necessary to achieve the goals of the Water Framework Directive by 2027. Additionally, new challenges have come about in recent years, including pharmaceutical pollution, microplastics, and climate change. This changing field of water management challenges requires a dynamic approach that adapts policies to the changing environment.

To view the PowerPoint associated with this presentation, click [here](#).

Lessons in River Management from the European Union: The Dutch Perspective and the Rhine

Introduction

The Netherlands, situated in the delta of the river Rhine, has always faced chronic issues with river flooding. They have approached this challenge by building a world-class water management system domestically, and also by coordinating with upstream nations on matters of river management. **Hans Pietersen**, a Senior Advisor for International Affairs at the Netherlands' Rijkswaterstaat, discussed Dutch perspectives on water management and the international governance structure of the Rhine.

Background

The Netherlands is located in a very flood-sensitive region. Fifty-five percent of the country is prone to flooding: 26% is located below sea level, and 29% is susceptible to river flooding. This is a basic issue of geography that the country has been dealing with for hundreds of years. Rijkswaterstaat, the executive ministry of Infrastructure and Water in the Netherlands, was founded in 1798 to address infrastructure challenges, many of which are related to flooding and other water issues. Pietersen compared the ministry to the U.S. Army Corps of Engineers, as the government entity that builds, manages, and maintains national infrastructure, including highways, waterways, and the main water system. Pietersen emphasized that contributing to a sustainable environment is central to their mission.

The Rhine, the delta of which is largely located in the Netherlands, is much smaller than the Mississippi, running less than a third of its length with an even smaller fraction of its flow. However, many of the interests and pressures on the river are the same as in the United States. Like the Mississippi, it has a plethora of uses, ranging from natural habitats and recreation to transportation, industry, and agriculture.

Since the Rhine watershed is divided between nine countries, international cooperation for its management has been developing for centuries.

Structured international cooperation for the Rhine began with the Central Commission for the Navigation of the Rhine (CCNR), dating back to the Vienna Congress in 1815. This international institution is still in place today, dealing with all issues of inland navigation on the Rhine. However, it did not cover water quality issues, so when that issue rose to prominence in the 1950s, a new agreement was necessary.

The International Commission for the Protection of the Rhine

This agreement, also still in place today, is called the International Commission for the Protection of the Rhine (ICPR). In 1950, this commission was founded by Germany, France, Netherlands, Luxembourg, and Switzerland to analyze pollution in the river and enact solutions. Since its inception, the EU has joined the commission and Belgium, Austria, and Liechtenstein have begun to co-operate with it. As was the case in much of the world, the Rhine watershed had been rapidly industrializing with minimal environmental consideration since the beginning of the industrial revolution. This commission was conceived to address that issue, and has seen increasing success in doing so over the course of its history.

Rules of cooperation for the ICPR

Pietersen then described the rules of cooperation for the ICPR. The commission works within a decentralized organizational structure, a group of delegations from each country each acting through a political mandate. Each national delegation contributes technical expertise and a negotiated percentage of the annual budget, which totals 1.2 million euros to fund the secretariat of the commission. It is a purely political framework and does not include sanctions as an enforcement mechanism. The current legal framework for the ICPR is structured according to the Water Framework Directive and Floods Directive, and carried out domestically in each country. However, each

nation also coordinates its efforts through the ICPR using rules agreed to in the river basin management plan. The plan currently in place was implemented in 2015.

In practice, the ICPR is based upon unanimity and political consensus. This is important because the commission lacks any formal enforcement mechanism. Any decision made by the body is a recommendation, but each member state has an obligation to report how they are implementing measures.

The ICPR and pollution control

While the ICPR was originally founded in 1950, it went through many iterations and changes before becoming the integrated river basin commission that it is today. Pietersen noted that the Rhine was once so polluted that it was seen as the “sewer of Europe.” Regardless, it was not until 1963 at the Berne Convention that a formal treaty was instituted. The treaty the member states signed, known as the “Convention on the International Commission for the Protection of the Rhine against Pollution,” gave the ICPR its first legal basis in international law. This established a monitoring network to keep track of how polluted the river was. However, this newfound ability to assess the river’s water quality did not directly lead to improvements. It was not until a severe chemical accident in 1969 caused massive fish mortality that member states were motivated to take countermeasures against pollution.

In 1976, member states signed two agreements for the protection of the Rhine against chlorides and pollution. While these agreements caused some improvement in water quality, they were ultimately insufficient in preventing environmental disaster. Unfortunately, another major chemical incident was necessary to provide the impetus for more progress. The 1986 Sandoz Incident in Switzerland, in which a warehouse fire caused up to thirty tons of pesticides to flow into the river, was seen as a turning point for the management of the Rhine. After this incident, public pressure led to a new “Rhine Action Programme,” a more ambitious plan to clean up the river which was in place between 1987 and 2000.

The Rhine Action Programme had three general goals: prevention of accidents from industrial plants along the river, reduction of chemical discharges by 50% over ten years, and to return the salmon population to the river by 2000. Pietersen emphasized that the return of salmon was seen as emblematic of these environmental goals; however, even today, the salmon population in the Rhine is not independent of human assistance and stocking exercises.

The ICPR and flood control

The ICPR added flood control to its list of responsibilities in the 1990s, bringing it one step closer to the integrated model of river basin management that it uses today. Unfortunately, this addition was also motivated by environmental disaster, this time a pair of major floods along the river in 1993 and 1995. In 1998, the commission responded with the new “Action Plan on Floods.” Predating the EU Water Framework Directive and Floods Directive, this action plan called for reducing flood damage risks and flood stages, as well as drafting risk maps and improving flood forecasting. This was an important precursor to the EU-wide Floods Directive passed in 2007.

The current rules for flood management are detailed in the ICPR’s most recent [flood risk management plan](#), mandated by the Floods Directive. This plan was implemented in 2015, the end of the directive’s first six-year cycle. It details the guidelines and coordination efforts for flood management in the Rhine watershed. The targets of improving Rhine flood management are described as a four-step cycle: the reduction of existing risk, reduction of negative consequences during a flooding event, reduction of negative consequences after an event, and avoiding new risks.

As each country develops its flood management with these targets in mind, they have agreed not to take any action that will increase flood risks outside of their respective territories. The following rules are detailed in the 2015 Flood Risk Management Plan:

- 1) Regional or local measures which are known not to have any transboundary effects will be implemented regionally/locally;
- 2) Regional measures with transboundary effects will be implemented only after an exchange of information on a bilateral level or through river basin commissions for sub-basins in order to find joint solutions;
- 3) Measures with supra-regional effects must be included in the mutual exchange of information within the ICPR. Due to this approach, measures with transboundary effects are coordinated through the river basin district.
- 4) National or regional agreements targeted at keeping floodplains free of all uses will be enhanced; information about these activities will be exchanged within the ICPR.

The “measures” referenced by the plan include infrastructure approaches such as creating retention areas, dike relocation, room for the river and measures regulating discharges, the construction or strengthening of dikes, etc.

EU Water Framework Directive and Rhine 2020

In 1999 at the “New Rhine Convention,” member states agreed to a new legal basis for the ICPR, replacing the Treaty of Bern (1963) and Chemical Convention (1976). This convention provided for the implementation of integrated river basin management, covering not only pollution and flood management, but also ecosystems, sustainability, and groundwater in the watershed.

The following year, this new legal basis was accompanied by a new action plan for its implementation, dubbed “Rhine 2020” or “The Programme on the Sustainable Development of the Rhine.” This action plan supported the newly passed EU Water Framework Directive, setting the agenda for integrated river basin management up until 2020.

Rhine 2040 and priorities looking forward

In 2020, this plan is expected to be succeeded by “Rhine 2040,” a new plan for the cooperative management of the river that will chart the path forward for the next two decades. It is expected to be officially adopted at the 16th Conference of Rhine Ministers on February 13, 2020 in Amsterdam. The main focus of this new plan is promoting climate-proof and sustainable integrated river basin management.

Pietersen also discussed the current priorities for the immediate and long-term future of Rhine management. First, he re-emphasized water quality, which has always been an aspect of the ICPR but remains an ongoing challenge. While member states are moving in the right direction on water quality, Pietersen emphasized that there is still work to be done in reducing pollutants and improving the water quality of the river. Similarly, the commission has made good (but still insufficient) progress in ecology and fish migration. New efforts like opening weirs in the Netherlands to allow migration are making a positive difference. The areas of water quantity and flooding, which have been included in the ICPR since 1998, also will require more work. In the past, this was largely restricted to efforts on flood protection, warning, forecasting and awareness, but now, low water conditions have become an important issue as well. Another ongoing challenge that Pietersen noted is the levee improvement program, which will likely be an indefinite endeavor due to the perpetual challenge of flood management.

To view the PowerPoint associated with this presentation, click [here](#).

Longstanding Impediments to Effective Management

Introduction

Stubborn and longstanding impediments hinder effective river management in the Mississippi River Basin. There is an absence of a national vision of how the river should be managed and thus no agreed upon federal role to coordinate interstate actions, a lack of consensus about management among the 31 states along the river, and no effective process for securing funding for the maintenance and operation of the river and associated infrastructure. **Gerry Galloway**, the Glenn L. Martin Institute Professor of Engineering at the University of Maryland, examined these political barriers.

Water Challenges

Galloway described the arms of the Mississippi River as the branches of a beautiful tree that stretch from the

northwestern United States to the Gulf of Mexico. In fact, the Mississippi River Basin drains 41% of the contiguous United States, stretches 3730 km, and covers 3.1 million km² which amounts to 32% of total U.S. farm acreage. The vastness of the Mississippi River Basin brings numerous challenges with it.

The United States will face many difficult resource challenges in the decades ahead and it is operating without a plan to manage and sustain these resources. Significant water challenges facing the nation include many issues such as drought and water demand, degraded water quality, increases in flood damages and needed restoration of environmental damages. For example, flood damages in the United States amount to \$8 billion annually and continue to grow.

Our planning efforts are lacking as well. The United States is not executing watershed-based planning on a

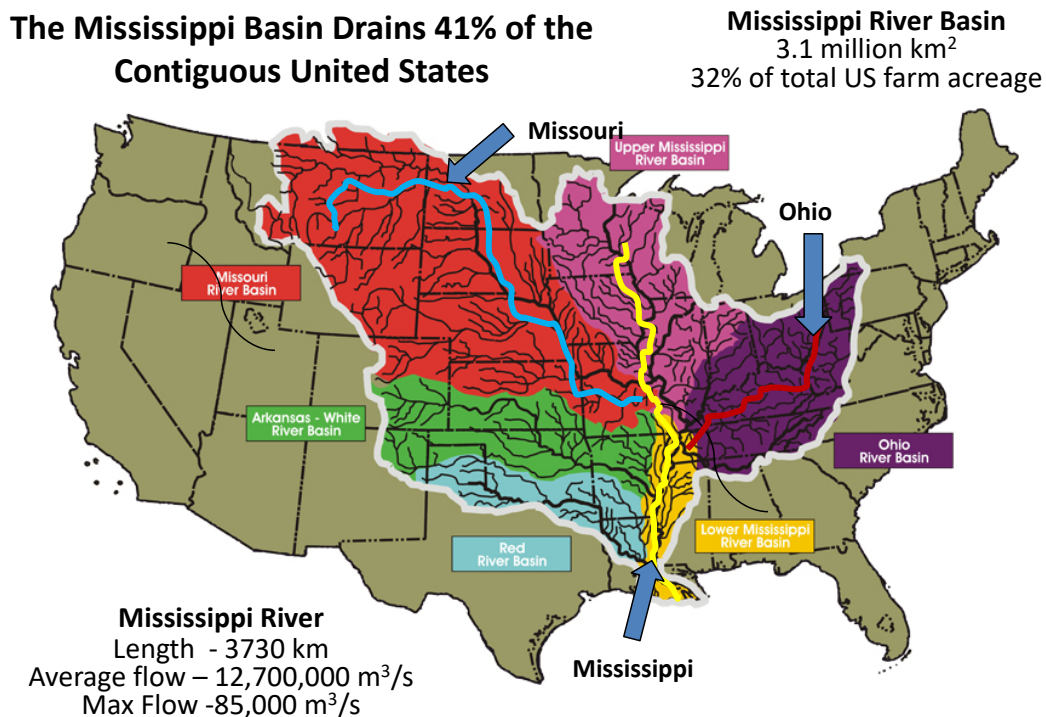


Figure 1: region of the United States drained by the Mississippi Basin

large scale and lacks adequate assessment and monitoring measures. Compounding these issues are many interstate conflicts between different states on how to deal with water management issues. Galloway stressed that federal and state governments need to clearly define the role they should play in dealing with water issues.

Impediments

All of these challenges create impediments to enacting significant changes in the basin. Galloway detailed the impediments plaguing the basin including numerous 21st century changes, an unresolved past, lack of a broad vision, poor water resources management and a general lack of attention to water issues.

Change

Our 21st century is not like the 20th century. We are now faced with population explosion, pressures for further development, scarce resources, aging infrastructure, technological surge, complex national and international political situations as well as climate change. Climate change will bring with it increased temperatures, sea level rise, increased hurricane intensity, increased flooding, increased drought as well as combinations of all of the above. Galloway stressed that we must first recognize these changes before we will be able to implement lasting change in the basin.

Unresolved Past

The problems in the Mississippi River Basin are not new. Galloway explained that water and its governance issues have been extensively studied by blue ribbon groups but most recommendations are ignored. Where recommendations are implemented, they are often later reversed when political parties shift.

Previous reports, spanning over 40 years, identified impediments to change and recommended solutions. In 1949 and 1955, the Hoover Commissions were appointed by President Truman to discover ways to improve efficiency between federal departments. The 1949 commission found ongoing unresolved interagency conflict among the dominant members of water resources management that went wholly unaddressed. The 1955 commission determined that there are complex conflicting policies governing federal development of water resources and that this led to “competition, duplication, and waste” among agencies.

In 1973, the National Water Commission, a body established by Congress to provide a comprehensive review of U.S. water resources issues and programs, recommended that the level of government closest to these problems should be controlling the development, management, and protection of water resources. Additionally, the commission determined that floodplain management should be the priority of the United States’ strategy moving forward.

The Water Resources Council, a council established under the Water Resources Planning Act of 1965 to address water management issues, published the Second National Water Assessment in 1978. The assessment was conducted to determine the adequacy of the nation’s water resources to meet present and future water needs. The council concluded that the United States did not have a defined federal interest in the nation’s waters. Galloway pointed out that the United States cannot accurately measure its success in managing its waters if there is no defined metric to measure it against.

In 1989, the Western Governors’ Association, a nonpartisan policy organization comprised of governors in the Western United States, advocated for improved coordination of federal water programs and state water policy. Its white paper recommended that a White House level group be appointed by the President. The group would be chaired by a high-level White House official and include membership from agencies and departments that oversee water programs. The Western Governors’ Association pointed to the lack of a centralized national water policy and observed that federal water policy is made ad hoc and lacks a unifying vision.

After the 1994 Mississippi River floods, Galloway authored a report titled *Sharing the Challenge*. In the report, he emphasized that the United States needs a Floodplain Management Act that clearly defines federal, state, and local responsibilities. This national flood policy must also establish co-equal national objectives of flood damage reduction and preservation and enhancement of the environment. There should also be a balanced

approach in using structural and nonstructural measures. Overall, the report urged the nation to plan comprehensively and avoid using the floodplain and provide adequate protection to those at risk. Soon after this report was released political dynamics shifted and its numerous recommendations never were implemented.

Many of these reports identified the same issues and recommendations over time. These recommendations, however, have largely gone unheeded. Galloway argued that we must act on previous recommendations to bring about fundamental change in U.S. water resources management.

Lack of Vision

A proper national water policy establishes relationships, develops agreed-upon direction and principles and sets priorities. Galloway explained that the United States has no vision for its water future – it is rudderless. There is no roadmap for how to deal with growing challenges, no defined federal interest, and states vary in interest and ability to deal with water. Decisions are made and programs are operated primarily on the basis of ad hoc, short-term political interests and near-term fiscal issues. Galloway argued that hard choices are not being made and problems are being ignored and only growing worse.

Galloway touched on the jumble of conflicting laws, regulations and procedures that deal with the water as policy or vision in the United States. For instance, the Water Resources Planning Act of 1965 was enacted to promote improved water resources planning and foster economic development. The Act created river basin commissions and the Water Resources Council, a federal entity that would coordinate the river basin commissions. The Water Resources Council created decision-making guidelines for evaluating federally funded water projects called “Principles and Standards.” These guidelines incorporated economic, regional, social, and environmental values of water use. However, the Water Resources Council was defunded in 1981.

In 1983, under President Reagan, White House Principles and Guidelines were established to govern federally funded projects. These were guided by economic considerations only. Projects were built only when they had an economic benefit-cost ratio and the project did not do grievous harm to the environment. This economics-only approach narrowed agencies abilities to carryout effective water resources projects.

To counter the economics-only approach there was a push to modernize federal water policy to include environmental considerations as well as economic development. In 2007, Congress directed the U.S. Army Corps of Engineers (Army Corps) to update its “Principles and Guidelines” to this effect. These new regulations were designed to promote sustainable economics, public safety, avoidance of unwise use of floodplains, protect and restore the natural environment, and promote regional and watershed-based projects. To be consistent with these guidelines, President Obama reviewed and updated the “Principles, Requirements and Guidelines” that govern how proposed water resources projects are evaluated by federal agencies in 2014. Since 2014, however, the Army Corps has been prevented from implementing these rules due to Congress, even though the guidelines were asked for and approved by Congress. Galloway explained that this type of gridlock is why economic considerations, as opposed to social and environmental value, still guide water resources project development.

Poor Management

The United States is not effectively managing its water resources. There is a lack of federal leadership, lack of coordination of national and federal water effort, and federal, state, tribal, and local responsibilities are not adequately defined. This leaves states feeling ignored in the federal process. Overall, the Nation faces the same water problems time and again without comprehensive action.

Galloway explained that federal water resources projects in the United States are subject to the Silo Effect. The Silo Effect happens when projects are studied and planned in individual silos without considering other similar projects and their impacts. Due to this effect, U.S. water resources projects do not consider broader watersheds, rather they are uniquely focused on the project at hand. This poor management has resulted in an ongoing practice of ad-hoc projects, rebuilding in risk zones, a jumble of federal standards, minimal comprehensive planning, and little attention paid to the environment.

In 2015, President Obama attempted to remedy the issue of multiple conflicting federal standards by establishing the Federal Flood Risk Management Standard. The new standard raised building elevation requirements and aimed to increase resilience to flooding and preserve the value of natural floodplains. In 2017, President Trump revoked this standard. Today, we are left with no federal standard.

Galloway stressed that there needs to be coordination among the federal parties of water resources management. There are 32 federal agencies and 25 congressional committees that have responsibility for water. We need to work together to do something about it.

Lack of Attention

Water Challenges

Except during a crisis, water is not on the radar of most federal or state decisionmakers but our waters are facing extreme challenges. A major water issue in the Mississippi River Basin is nonpoint source pollution. Over the last several decades nutrient pollution from agricultural lands in the upper Midwest has poured into the Mississippi River. This results in a large hypoxic “dead zone” in the Gulf of Mexico. The National Academy of Sciences conducted a study and recommended actions to reduce nutrient pollution which included identifying contributors, establish reduction goals and allocating targets. Unfortunately, no significant progress was made and we still see this nutrient pollution causing problems for Gulf shrimpers today.

We are also not taking care of our water infrastructure. In 2017, the American Society of Civil Engineers issued its Infrastructure Report Card that gave D grades to numerous sectors including dams, drinking water, levees, and wastewater facilities. Galloway indicated that U.S. water infrastructure is in trouble but Congress cannot seem to cooperate to find a solution.

How Are We Addressing These Challenges?

To deal with these challenges someone needs to act. Galloway suggested numerous ways to deal with both Congress and administrations. First, Congress and the Administration need to resolve conflicts and inconsistencies in *de facto* water policy. The Administration should establish a body to coordinate federal activity, potentially by reviving the Water Resource Council. The “Principles and Guidelines” should also be revised so that benefit-cost analysis is not the sole decision criterion. Additionally, Congress should fund ex-post project evaluation and the Army Corps should track public participation.

When asked how to build political support for basin-wide planning in the Mississippi River watershed, Galloway pointed to stakeholder involvement as key. He explained that an interstate compact for the Mississippi River states is not likely to succeed due to disagreements among states over water use and other seemingly intractable political barriers. He asserted that we need to get stakeholders such as local and state officials, tribal leaders, and the federal government involved in the process to build a consensus on these issues moving forward.

Galloway then listed numerous instances when change has been attempted to little avail. The American Water Resources Association worked on several meetings to determine the federal water policy and gave the report to Congress where little came of it. Prompted by a devastating flood in 2008, the Army Corps’ Mississippi Valley Division sought to initiate change by working with decisionmakers in the Midwest. They developed *America’s Watershed: A 200-year Vision* as a guide to sustaining the Mississippi River Basin system. It was delivered to Congress as well but very little happened. The Army Corps also issued a *National Report: Responding to National Water Resources Challenges* in an attempt to spur action but it did not make much progress. Galloway detailed these numerous examples to illustrate the significant uphill battle to advancing change in this area.

What’s Needed

Galloway recommended numerous reforms needed to effectively improve management of the Mississippi River Basin including:

- ◆ Administration and congressional recognition of the need for leadership and coordination and action to manage and chart a path forward
 - Establish a federal coordinating activity in the Executive Office of the President with minimal staff (perhaps the Water Resources Council) to ensure horizontal and vertical integration
 - Integrate federal agency actions on water on a national basis – develop a watershed approach
 - Conduct a national assessment
- ◆ Collaborative development of national (not federal) vision, plan, or framework that addresses tough issues
 - Integrate states into action (potentially similar to the European Union Water Framework)
 - Develop realistic action plan with priorities
- ◆ Development of realistic long-term investment strategy

Galloway acknowledged that the United States will face many difficult water resources challenges in the decades to come and that it is operating without a plan to manage and sustain these resources. The federal and state governments need to clearly define the role they believe they should play in dealing with water issues and collaborate on moving forward. Galloway believes the states have a role to play.

In closing, Galloway pointed to previous instances when reform efforts resulted in positive change. After the 1927 Great Mississippi River flood, the Mayor of Chicago William Thompson organized a convention and took 800 people to Washington, D.C. to push for flood control action. The Flood Control Act was passed the next year. In 2014, President Obama created a task force charged with preparing recommendations on climate preparedness and resilience. He selected governors, mayors, and tribal leaders so that he could make decisions that account for those people who would be impacted the most. Gathering people together toward a common goal makes a difference. Galloway urged us to believe that change is possible. But, remember, nature bats last.

Reports discussed in Galloway's presentation include the following:

- ◆ *The Hoover Commission Report* (Commission on Organization of the Executive Branch of the Government, 1949), available [here](#).
- ◆ *Report on Water Resources and Power* (Commission on Organization of the Executive Branch of Government, 1955), available [here](#).
- ◆ *Water Policies for the Future: Final Report to the President and to the Congress of the United States* (National Water Commission, 1973), available [here](#).
- ◆ *The Nation's Water Resources: Second National Water Assessment* (U.S. Water Resources Council, 1978), available [here](#).
- ◆ *White Paper on Federal Water Policy Coordination* (Western Governors' Association, 1989)(digital copy not readily available).
- ◆ *Sharing the Challenge: Floodplain Management into the 21st Century* (Interagency Floodplain Management Review Committee, 1994), available [here](#).

To view the PowerPoint associated with this presentation, click [here](#).

Additional Observations

Editor's Note

During development of the program for this congress, we gained deeper appreciation of the complexity and difficulty of fashioning governance solutions for the Mississippi River watershed. Creative and brilliant professionals have been solving various facets of ever-evolving river-management challenges for decades.

To supplement the curated wisdom that we had engaged for the congress program, we surveyed the literature for an additional forward-looking perspective on management and governance that reflected an informality borne of general, practical experience. We discovered observations of John Briscoe, Gordon McKay Professor of the Practice of Environmental Engineering at Harvard University. Briscoe wrote a solicited paper in 2012 as a contribution to a discussion of integrated management of the Mississippi River Basin for The Nature Conservancy's Great Rivers Partnership.

Below are selected excerpts of Briscoe's observations, followed by a link to his original "paper," "Fluid prejudice: Some (disputable and somewhat disjointed) observations on what global experience and changing national well-being might mean for the management of the Mississippi River":

"The intention of this paper is to outline, in my experience, what has actually worked (and what has not) and take a stab at making some suggestions which can be of practical use as those with responsibility move forward in managing the Mississippi.

1. Beware of hydrocentrism

We give water a political primacy which it does not in reality have. And when the management of water does not place in accord with our water-centric principles, we denounce the shortcomings and venality of bureaucrats and politicians.

If we step back a bit we see that water is, in fact, just one of dozens of priority issues—some of greater immediate importance—which have to be taken into

account when governments develop the rules of the game and instruments which govern water management.

2. Initiate reforms only when there is a powerful need and demonstrated demand for change

Those whose nose is close to the water grindstone often advocate reforms because practices do not conform to universal ideal forms of water management.

An effective change will take place only when a sufficient number of major interested parties perceive the need for change, and participate in the elaboration of options which will preserve or enhance their interests.

3. Water reform is a dialectic, not mechanical process

First, all water management solutions are . . . "provisional." That is, a particular set of hard (infrastructure) and soft (institutions) arise to deal with problems which society wants to solve at a particular time.

But as with every intervention in a hydrological system, there are reactions to every action, and each generation has to learn how to respond to a new set of challenges while not jettisoning the benefits derived from prior actions. In the case of the Mississippi, the list is (and it probably always has been), long and sobering.

4. Values are dependent on income and change over time

The point here is not that environmental considerations are not important (which they evidently are in the Mississippi) or that there are not other villains contributing to gridlock. The point is that the legal and administrative framework put in place during a time when ever-growing economic prosperity was taken for granted, and tradeoffs did not have to be considered, is unlikely to be a framework appropriate for making complex decisions in a period of likely long-term national economic stagnation.

5. Beware of moral hazards

Moral hazard arises when an individual or institution does not bear the full consequences and responsibilities of its actions, and therefore has a tendency to act less carefully than it otherwise would, leaving another party to hold some responsibility for the consequences of those actions. Moral hazards abound in water management in general and in the Mississippi in particular.

First is the moral hazard arising when an agency like the EPA gives priority to concerns of constituencies with no presence in the basin and precludes local actions which are widely supported.

Second is the problem which arises when benefits are entirely local but there is an effort to shift the costs to national taxpayers. This has long been the strategy of local actors in the Mississippi, who have managed to get almost all of the costs of river management infrastructure paid for by the federal government on the logic that navigation and flood control benefits are public goods and therefore appropriately paid for by public sources. This argument is more defensible in some cases than in others.

Finally, there are the pervasive governance problems in an increasingly indulgent, indignant and selfish society.

6. Beware of concepts which have not encountered practice

In the development stage of the U.S. economy, there was an intimate relationship between the practice of water management and academia. Today where there is academic interest in water management it is almost entirely driven by environmental concerns (including climate change) and very little by concerns with maintenance of the platform of water infrastructure and institutions.

A major task facing managers of the Mississippi (and other rivers) is to identify a few willing academics to re-establish academic work which will focus on key issues such as “the water platform for economic well-being” and “water security,” and incorporate key elements of environmental concern (including climate change) into such a framework.

7. Avoid the rigidities which come from formalization

Reflecting a broader phenomenon, recent decades have seen an inexorable increase in the number of water-related laws and regulations.

One of the overwhelming conclusions of the recent Harvard conference on managing federal rivers was unanimity that resort to the courts should be a last, not first, resort in managing the inevitable conflicts between different stakeholders.

8. Financing matters, a lot

Public financing in the United States faces grave challenges. It is clear that the future will be nothing like the past, for infrastructure in general and water infrastructure in particular. It is clear that there will never be another MRT project, and unlikely that federal funding for the remainder of the project will be forthcoming.

This reality is of immediate and grave importance for the lower Mississippi where, prosaic as it is, the inability to finance the maintenance of existing infrastructure arguably constitutes the single greatest challenge in the lower basin.

It is very unlikely that the states and communities will be able and willing to pay for the current level of security and therefore important to reformulate policies and operating procedures that will provide the level of security that can and will be paid for.

9. Instruments matter more than organization

My experience with water management reforms is that far too much attention is given to organizational forms (“should there be a single basin agency?”) and far too little on the instruments (both within and outside the water sector, including legal, financial and knowledge instruments) which determine behavior. At this stage I

would argue that an effort on the Mississippi should defer the question of organizational form (and have a strong bias in favor of building on existing organizations when the time comes) and focus heavily on outcomes and instruments.

10. It's implementation, stupid

As with so much in life, once achieved, implementation capacity is taken for granted and considered unimportant and uninteresting. This complacency is a grave danger, for the people who live in the Mississippi basin and for the broader society. This reality is slowly entering public awareness—whereas Hoover Dam was, in recent decades, castigated as folly in a Cadillac Desert, opinion-makers like Tom Friedman and Paul Krugman now hold such works up as examples of what America could do in its glory years!

In this context the Mississippi basin is blessed, with some world-class agencies that have an extraordinary capacity to implement, both under normal and abnormal circumstances. Maintaining, strengthening and modernizing this capacity (which is different in different parts of the basin) is a priority of the highest order.”

Briscoe's original discussion paper can be accessed by clicking [here](#).

Information about America's Great Watershed Initiative's 2012 summit can be found by clicking [here](#).

Appendix A: Congress Delegates

Dan Barrie
Program Manager, Modeling,
Analysis, Predictions, and
Projections Program
NOAA Climate Program Office
Silver Spring, MD

Chad Berginnis
Executive Director
Association of State Floodplain
Managers
Madison, WI

Donald Boesch
Professor of Marine Science
University of Maryland Center for
Environmental Science
Annapolis, MD

Todd Bridges
Senior Research Scientist,
Environmental Science
U.S. Army Corps of Engineers
Vicksburg, MS

Tom Chase
Director, Coasts, Oceans, Ports, &
Rivers Institute
American Society of Civil Engineers
Reston, VA

Betsy Cody
President-Elect
American Water Resources
Association
Arlington, VA

Craig Colten
Carl O. Sauer Professor,
Department of Geography &
Anthropology
Louisiana State University
Baton Rouge, LA

Robert Day
Executive Director
Renewable Natural Resources
Foundation
N Bethesda, MD

John Durrant
Sr. Managing Director, Engineering
& Lifelong Learning
American Society of Civil Engineers
Reston, VA

Gerry Galloway
Glenn L. Martin Institute Professor
of Engineering
University of Maryland
College Park, MD

Ryan Haupt
Science Policy Fellow
Geological Society of America
Washington, DC

Kris Johnson
Associate Director for Science and
Planning, North America
Agriculture Program
The Nature Conservancy
Minneapolis, MN

Jeff King
Deputy National Lead, Engineering
with Nature Initiative
U.S. Army Corps of Engineers
Washington, DC

Sara Lytle
Graduate Student
Columbia University/ERDC
Brooklyn, NY

Norma Jean Mattei
Professor
University of New Orleans
Commissioner
Mississippi River Commission
New Orleans, LA

Sharon McBreen
Officer
The Pew Charitable Trusts
Orlando, FL

Andy Miller
Policy Fellow, AMS Policy Program
American Meteorological Society
Washington, DC

Julie Minerva
Partner
Carpi & Clay
Washington, DC

Dale Morris
Director, Strategic Partnerships
Water Institute of the Gulf
Baton Rouge, LA

Anna Normand
Analyst in Natural Resources Policy
Congressional Research Service
Washington, DC

Hans Pietersen
Senior Advisor, International Affairs
Rijkswaterstaat
Utrecht, Netherlands

Howard Rosen
Public Interest Member
Renewable Natural Resources
Foundation
N Bethesda, MD

Mark Rupp
Director, State-Federal Policy and
Affairs, Ecosystems
Environmental Defense Fund
Washington, DC

Eileen Shader
Director, River Restoration
American Rivers
Camp Hill, PA

Nancy Somerville
Governance and Sustainability
Consultant
N C Somerville Consulting
Washington, DC area

Carol Strohecker
Dean
College of Design – University of
Minnesota
Minneapolis, MN

Evonne Tang
Associate Executive Director
National Academies of Sciences,
Engineering, and Medicine
Washington, DC

Ahmad Tavakoly
Research Hydraulic Engineer
U.S. Army Engineer Research and
Development Center
Vicksburg, MS

Giuliana Torta
Environmental Councilor
EU Delegation to the US
Washington, DC

Kristin Tracz
Senior Program Officer
Walton Family Foundation
Washington, DC

Grace Tucker
Program Coordinator, Coastal
Resilience
Environmental Defense Fund
Washington, DC

Robert Twilley
Executive Director
Louisiana Sea Grant
Baton Rouge, LA

Madeline Voitier
Senior Program Manager
Renewable Natural Resources
Foundation
N Bethesda, MD

Juliet Walsh
US Government Relations Policy
Coordinator
The Nature Conservancy
Arlington, VA

Jingxin Wang
Professor
West Virginia University
Morgantown, VA

Laura Windecker
Program Officer
National Academies of Sciences,
Engineering, and Medicine
Washington, DC

Stephen Yaeger
Program Manager
Renewable Natural Resources
Foundation
N Bethesda, MD

Appendix B: Congress Program

Tuesday, December 3, 2019

8:10 am – 8:30 am

Registration and Continental Breakfast

8:30 am – 8:35 am

Welcome

John Durrant

RNRF Chairman

American Society of Civil Engineers

Reston, VA

8:35 am – 8:40 am

Opening Remarks

Tom Chase

Chair, RNRF 2019 Congress Program Committee

Director, ASCE Coasts, Oceans, Ports, and Rivers Institute

Reston, VA

8:40 am – 9:00 am

The Mississippi River Watershed – As We Found It and Today

The congress will begin with an overview of the Mississippi River watershed, past and present. Our speaker will discuss how managing resources in the Mississippi River watershed has been a complicated challenge since the 1800's. The river has resisted being tamed and its management has been comprised of numerous piecemeal measures through the decades.

Craig Colten

Carl O. Sauer Professor, Department of Geography & Anthropology

Louisiana State University

Baton Rouge, LA

9:00 am – 9:10 am

Questions and Discussion

9:10 am – 9:30 am

Observed and Projected Physical Climate Change

Significant climatic changes are coming to the Midwest and Mississippi River watershed. Climate change is warming our atmosphere and leading to more frequent and intense precipitation events, a trend that is projected to increase through the end of this century. Our speaker will describe what we may anticipate in terms of total precipitation, seasonal variation, and impacts on lakes, rivers and aquifers.

Dan Barrie

Program Manager, Modeling, Analysis, Predictions, and Projections Program
Climate Program Office
National Oceanic and Atmospheric Administration
Silver Spring, MD

9:30 am – 9:40 am

Questions and Discussion

9:40 am – 9:55 am

Break

9:55 am – 10:25 am

Flood Control and Risk Reduction

Flooding is a major issue in the Mississippi River watershed. To combat this flooding, the U.S. Army Corps of Engineers uses various flood control and risk reduction measures. Our speaker will describe the legacy of a century of building structure, including funding and maintenance issues, as well as the role of structure moving forward. How will the Corps prepare for more water in the watershed?

Todd Bridges

Senior Research Scientist, Environmental Science
National Lead, Engineering with Nature Initiative
U.S. Army Corps of Engineers
Vicksburg, MS

10:25 am – 10:55 am

Questions and Discussion

10:55 am – 11:25 am

Floodplain Management

The Mississippi River has always flooded, but flooding has become more problematic due to continuing unwise development in the floodplain. The construction of levees along the river as well as federal flood insurance policies encourage people to live, work, and farm in risky flood-prone areas. How can we break free from this cycle of repeated, devastating flooding? Our speaker will examine potential ways to rectify our legacy of land-use choices.

Chad Berginnis

Executive Director
Association of State Floodplain Managers
Madison, WI

11:25 am – 11:55 am

Questions and Discussion

11:55 am – 12:35 pm

Lunch (provided)

12:35 pm – 1:05 pm

Analytical Tool Guides Protection & Restoration of Ecological Resources

The Mississippi River Basin is America's iconic watershed and supports vast ecological resources. Yet development, loss of natural habitats and conversion of lands for agriculture have degraded these ecological resources. Excess nutrients and sediments from cities and farms and the loss of tens of millions of acres of floodplains along the Mississippi River and its tributaries diminish habitats and impact water quality both throughout the Basin and all the way to the Gulf of Mexico. This presentation will examine the potential for floodplain protection and restoration to help restore the health of the Mississippi River Basin and provide multiple benefits for people and nature. Our speaker will showcase innovative science and tools that can be used to achieve this objective.

Kris Johnson

Associate Director for Science and Planning, North America Agriculture Program
The Nature Conservancy
Minneapolis, MN

1:05 pm – 1:35 pm

Questions and Discussion

1:35 pm – 2:05 pm

Lessons in River Management from the European Union: Governance and Legislative Framework

How can successful elements of international river management be applied to the Mississippi River watershed? What lessons related to governance can Europe share from its experiences with the Danube and Rhine Rivers? Are there insights for America in the Floods Directive adopted by the EU Parliament?

Giuliana Torta

Counselor for Environment, Fisheries and Ocean Policies
European Union Delegation to the U.S.
Washington, DC

2:05 pm – 2:35 pm

Questions and Discussion

2:35 pm – 2:55 pm

Break

2:55 pm – 3:25 pm

Lessons in River Management from the European Union: The Dutch Perspective and the Rhine

Hans Pietersen

Senior Advisor, International Affairs
Rijkswaterstaat
Utrecht, Netherlands

3:25 pm – 3:55 pm

Questions and Discussion

3:55 pm – 4:25 pm

Longstanding Impediments to Effective Management

The stubborn and longstanding impediments to effective river management have been the absence of a national vision of how the river should be managed and thus no agreed upon federal role to coordinate interstate actions, a lack of consensus about management among the 31 states along the river, and no effective process for securing funding for the maintenance and operation of the river and associated infrastructure. These political barriers will be examined.

Gerry Galloway

Glenn L. Martin Institute Professor of Engineering
University of Maryland
College Park, MD

4:25 pm – 4:55 pm

Questions and Discussion

4:55 pm

Closing

Robert Day

Executive Director
RNRF

Renewable Natural Resources Foundation

6010 Executive Boulevard, Suite 700
N Bethesda, Maryland 20852 USA