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Economic Impact Analysis of Artificial Draft Restriction on the Lower Mississippi River Port Complex

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TABLE OF CONTENTS

LIST OF FIGURES 4
LIST OF TABLES 4
ABSTRACT 5
1.0 BACKGROUND & LITERATURE REVIEW 6
1.1 Congressional Authority over Funding for Aids to Navigation 8
1.2 Importance of Congressional Funding for the Lower Mississippi River Port System 8
1.3 Reasons for the Lack of Prioritization in Funding 9
1.4 Recent Efforts to Improve Funding 11
1.5 The Southwest Pass: Mid-America's Gateway to the World 11
1.6 Importance and Value of eATON Systems 13
2.0 METHODOLOGY 15
2.1 Research Approach 15
2.2 Data Sources and Justifications 15
2.3 Key Assumptions 17
2.4 Economic Impact Modeling 18
3.0 ANALYSIS 19
3.1 Vessel Delays and Cost Implications 19
3.2 Economic Impact of Draft Restrictions 20
3.3 Supply Chain Disruptions and Additional Transport Costs 21
3.4 Total Economic Impact Summary 22
4.0 DISCUSSION, CONCLUSION & RECOMMENDATIONS 23
REFERENCES 26

LIST OF FIGURES

Figure 1. Lower Mississippi River Port Complex: Five Major Ports of Louisiana 6
Figure 2. The Impact of Draft Restrictions on Cargo Capacity 7
Figure 3. Reduced Investment Can Increase Risk 10
Figure 4. Location of the Southwest Pass 12
Figure 5. Industry-Specific Impact of Vessel Delays 19
Figure 6. Economic Loss by Industry Due to Draft Restrictions 20
Figure 7. Additional Logistics Costs by Transport Mode 21
Figure 8. Total Economic Impact Summary 22

LIST OF TABLES

Table 1. Data Sources, Estimates, and References Used in Economic Analysis 16
Table 2. Industry-Specific Impact of Vessel Delays 19
Table 3. Economic Loss by Industry Due to Draft Restrictions 20
Table 4. Additional Logistics Costs by Transport Mode 21
Table 5. Total Economic Impact Summary 22

ABSTRACT

The Lower Mississippi River Port Complex is a critical hub for U.S. and global trade, handling over 500 million tons of cargo annually, including grain, petroleum, and chemicals. In August 2021, Hurricane Ida severely disrupted maritime operations, knocking out electronic aids to navigation (eATON) at the Southwest Pass, a vital shipping corridor. This study examines the potential economic impact of eATON failure, focusing on vessel delays, draft restrictions, and supply chain disruptions. A model-based economic impact analysis was conducted, utilizing industry estimates, historical disruptions, and expert assumptions to quantify financial losses. The findings reveal that the loss of eATON resulted in a conservative estimate of $46.4 million in economic losses for a specific number of vessels over a given period, with draft restrictions accounting for 94% of the total impact. Vessel delays led to port congestion and increased operational costs, while reduced draft capacity forced vessels to carry an estimated 72,800 tons less cargo, significantly impacting U.S. grain, oil, and chemical exports. Additionally, supply chain disruptions required cargo to be rerouted via rail and trucking, further increasing transportation time and costs and reducing U.S. trade competitiveness. The study highlights the vulnerability of inland waterway navigation to weather events, emphasizes the urgent need for resilient aid to navigation systems infrastructure, and offers some next steps for securing and maintaining up-to-date and resilient systems.

Keywords: Mississippi River; Southwest Pass; Electronic Aid to Navigation; Economic Impact; Draft Restrictions; Vessel Delays; Supply Chain Disruptions; Hurricane Ida

1.0 BACKGROUND & LITERATURE REVIEW

Louisiana's 14,500-mile waterway system serves as a crucial link between America's agricultural and industrial heartland and the global market. Anchored by the Mississippi River, the Lower Mississippi River Port Complex (LMRPC), comprising the ports of New Orleans, Plaquemines, St. Bernard, Baton Rouge, and South Louisiana, forms the largest port complex in the world, handling over a quarter of all U.S. waterborne commerce (Figure 1). The LMRPC handles over 60 percent of the nation's grain exports, as well as a substantial share of energy and chemical shipments, making it essential for both the domestic and national economies (Louisiana Department of Transportation and Development, 2024). With such high volumes of traffic, reliable navigation aids are crucial for preventing accidents, delays, and bottlenecks that could impact entire supply chains.

Figure 1. Lower Mississippi River Port Complex: Five Major Ports of Louisiana

Source: Green (2013)

One of the primary challenges in the LMRPC is the limitation of drafts. The river's naturally fluctuating water levels, combined with sediment deposition, reduce the available depth in certain areas, limiting the size of vessels that can safely navigate the channel. For larger vessels, especially those carrying bulk goods such as grain or coal, even slight reductions in draft capacity can have significant economic implications. Each foot of lost draft can result in a vessel carrying several thousand tons less cargo, which reduces the overall efficiency of transport and increases per-unit shipping costs (Figure 2) (Amorim, Villarini, Veacth, & White, 2023; Notteboom, Pallis, & Rodrigue, 2025).

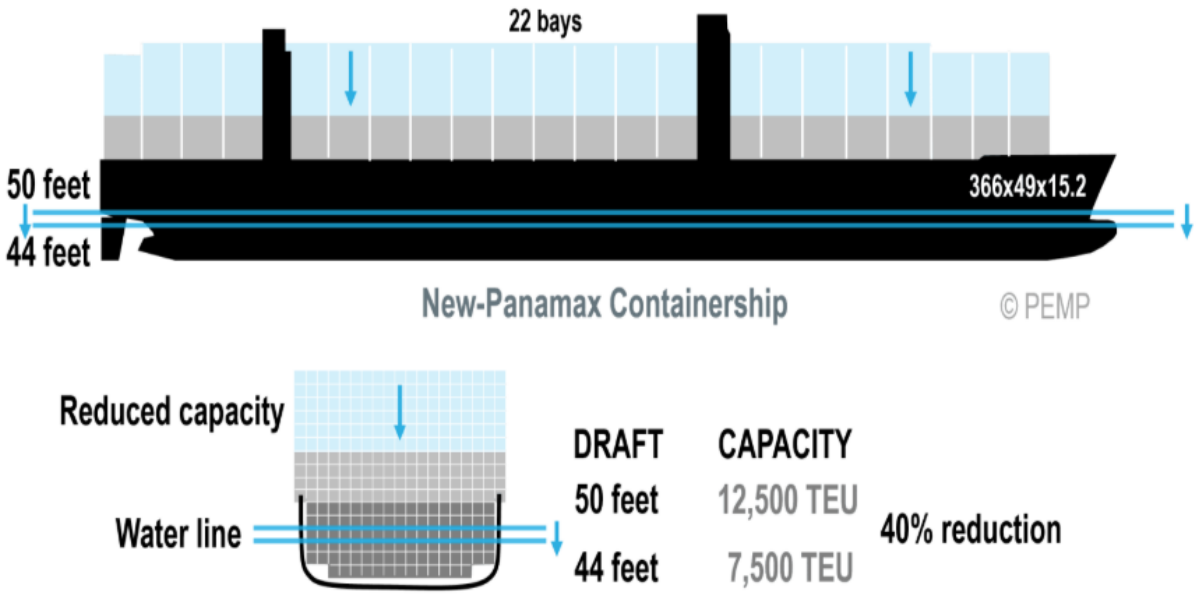

Figure 2. The Impact of Draft Restrictions on Cargo Capacity

Source: Notteboom, Pallis, & Rodrigue (2025)

Artificial draft restrictions are increasingly influencing the efficiency and competitiveness of this vital port complex due to a lack of proper aid-to-navigation devices, specifically Electric Aid to Navigation (eATON), which provide ships with real-time information on the river's navigation conditions. In late August 2021, Hurricane Ida, a Category 4 hurricane with sustained winds exceeding 150 mph, struck Louisiana, causing widespread destruction and severe damage to the infrastructure in Southwest Pass, the primary shipping channel in the Mississippi River Delta. The hurricane knocked out the majority of the eATON in the area, removing a crucial layer of safety for vessel navigation through this vital corridor. With electronic systems disabled, the Coast Guard had to rely almost exclusively on traditional aids and slower, more cautious navigation practices such as beacons, buoys, lights, and dayboards, as well as increased Coast Guard patrols to guide traffic. (Maritime Executive, 2021; Plume & Huffstutter, 2021; Eberhardt, 2025).

Traditional navigational aids are still commonly used throughout the Mississippi River system; however, in recent years, the Coast Guard has incorporated electronic aids to navigation (eATONs) along major shipping routes, such as Southwest Pass. Unlike physical buoys and markers, eATON provides virtual markers on electronic charts that are accessible to vessels equipped with the necessary digital equipment, typically the Electronic Chart Display and Information System (ECDIS). These electronic aids enable mariners to visualize navigation routes even in conditions where physical aids may not be visible, such as during storms or fog,

and are especially helpful in remote or hazardous areas where maintaining physical aids is challenging (Judice, 2018; 33 CFR § 62, 2025).

Inadequate or unavailable eATON systems can lead to draft restrictions- limitations on the depth of vessels that can safely navigate the river. Draft restrictions are a serious concern for shippers, as they directly impact the volume of cargo that vessels can carry. When ships are forced to reduce their drafts due to uncertainties about water depths or navigational hazards, they must carry less cargo to avoid the risk of grounding. This reduction in cargo volume translates to higher transportation costs per ton of goods, making U.S. exports less competitive in global markets. (EBP U.S., 2021; Amorim, Villarini, Veacth, & White, 2023). For industries that rely on thin margins, such as agriculture, even small increases in transportation costs can have significant effects on profitability and market share.

In addition to increasing transportation costs, draft restrictions can also cause delays at ports, as vessels may need to wait for higher water levels or for dredging operations to be completed before they can safely enter or leave the port. These delays disrupt the timing of shipments and can lead to missed delivery windows, further reducing the competitiveness of U.S. exports. In a competitive global market, inefficiencies such as the lack of proper aids to navigation on the Mississippi River put U.S. grain and other exports at a disadvantage compared to those of other countries with more stable inland waterway systems. For example, competitors like Brazil have been making significant investments in their river transport systems, ensuring that they can move goods efficiently from inland regions to global markets. (Hunt, et al., 2022). The ability to maintain an efficient and reliable transportation system on the Lower Mississippi River is, therefore, essential for preserving the U.S. position in global markets, particularly in sectors where transportation costs represent a significant portion of the total cost of goods and services.

1.1 Congressional Authority over Funding for Aids to Navigation

The U.S. Congress plays a pivotal role in funding and overseeing the infrastructure that supports inland waterway navigation, including the eATON systems that ensure the safety and efficiency of navigation along rivers like the Mississippi. The Commerce Clause, Article I, Section 8, Clause 3 of the U.S. Constitution gives Congress the power to regulate interstate commerce, which includes maintaining navigable waterways for the transportation of goods. The U.S. Army Corps of Engineers (USACE) is responsible for dredging, channel maintenance, and navigation aid systems in U.S. rivers. Funding for these activities typically comes from federal appropriations to USACE made through the annual budget process. (Carter & Frittelli, 2020). The U.S. Coast Guard (USCG) administers the U.S. Aids to Navigation System, including eATON, buoys, and other markers, and similarly relies on congressional appropriations to carry out these duties. (U.S. Government Accountability Office, 2020; 33 CFR § 62, 2025).

1.2 Importance of Congressional Funding for the Lower Mississippi River Port System

The Lower Mississippi River is one of the most vital inland waterways in the United States, and the proper functioning of aids to navigation, including eATON systems in this region, is crucial for preventing accidents, reducing delays, and ensuring that the river remains competitive as a transportation corridor. Funding for eATON is therefore essential for the overall efficiency and safety of the LMRPS. However, maintaining infrastructure along the Lower Mississippi River requires ongoing investments due to the river's highly dynamic nature. Strong currents, seasonal flooding, and heavy sediment deposition contribute to rapidly changing navigational conditions

that can impede the safety and reliability of navigation. In addition to the upkeep of traditional navigation aids, such as buoys and lights, Congressional funding is also needed for investment in modern technologies such as electronic navigation aids and real-time water depth monitoring systems (Judice, 2018; Hartman, et al., 2022; Eberhardt, 2025).

1.3 Reasons for the Lack of Prioritization in Funding

Despite the critical importance of the Lower Mississippi River to the U.S. economy, funding for this region from the U.S. Army Corps of Engineers (USACE) has not always been a high priority for Congress in recent years. Several factors have contributed to the lack of consistent prioritization for funding eATON systems in the Lower Mississippi River:

i. Competing Budget Priorities:

One of the main reasons for the inconsistent prioritization of eATON funding by Congress is the existence of numerous competing budget priorities. Federal infrastructure funding is divided across various sectors, including highways, bridges, airports, and railways, all of which have significant needs. The broader infrastructure debate often emphasizes these other sectors more prominently, leaving waterways and riverine transport as secondary considerations. Additionally, in times of budget cuts or fiscal constraints, funding for inland waterway navigation often receives less attention (Transportation Research Board, 2015; Carter & Frittelli, 2020). As a result, while Congress recognizes the importance of maintaining navigable rivers like the Mississippi, pressing needs in other areas—such as defense spending, healthcare, and education—have often pushed inland waterway maintenance to the periphery of budget discussions.

ii. Deferred Maintenance and Infrastructure Backlog:

Deferred maintenance is a persistent issue in U.S. infrastructure, and the inland waterway system, including the Lower Mississippi, is no exception. Both the USACE and the USCG, which manage navigational aids, are facing significant backlogs in maintenance and capital investment projects. The cost of addressing these backlogs runs into billions of dollars. As the backlog grows, routine maintenance for eATON systems becomes increasingly difficult to prioritize, leading to further delays and potential further deterioration of the infrastructure. (Transportation Research Board, 2015; Carter & Frittelli, 2020). Congress has occasionally increased funding for waterways as part of broader infrastructure bills, but this funding is often short-term and insufficient to address the full scope of maintenance needs. Without long-term investment, the Lower Mississippi River has seen gaps in funding for eATON maintenance, with funds often diverted to projects considered more urgent. For example, the Bipartisan Infrastructure Law of 2021 included funding for waterway infrastructure; however, much of it was allocated to projects addressing immediate safety concerns rather than long-term maintenance needs. While some funding was directed toward dredging and navigation improvements, it did not establish long-term funding for eATON or other essential navigation aids. (Maritime Administration, 2024). Similarly, the Post-Hurricane Ida Emergency Funding allocated by Congress between 2021 and 2022, following Hurricane Ida, included funding intended to address immediate infrastructure damage along the Lower Mississippi River. While this funding was crucial for urgent repairs, it was primarily directed toward levee reconstruction and flood control measures, rather than the eEATON system, which was equally impacted by the hurricane. (Louisiana Office of Community Development, 2025).

iii. Focus on Larger Infrastructure Bills:

Over the past decade, Congress has increasingly sought to address infrastructure needs through large, comprehensive infrastructure bills rather than through incremental, targeted appropriations. These bills, such as the 2021 Bipartisan Infrastructure Law (BIL), often include substantial funds for transportation and infrastructure. However, the focus tends to be on high-visibility projects, such as highways, airports, and broadband, with inland waterway navigation receiving a smaller portion of the total funding. (Tomer, 2023; American Society of Civil Engineers, 2025). For instance, the BIL allocated approximately $17 billion for ports and waterways, while highway funding within the bill totaled around $350 billion over a five-year period. (Ponciano, 2021; Federal Highway Administration, 2025). This dynamic has led to river systems, such as the Lower Mississippi, being underfunded relative to their economic importance.

iv. Perception of Adequate Functionality:

Another factor contributing to the lack of prioritization for eATON funding is the perception that the Lower Mississippi River, despite its challenges, continues to function adequately. The river remains a vital artery for commerce, handling a large portion of the nation's bulk cargo, leading some policymakers to believe that it does not require immediate intervention. As a result, there is a tendency to defer necessary upgrades and maintenance until a significant problem, such as a grounding incident or economic disruption, occurs. (U.S. Government Accountability Office, 2018). This reactive approach to funding has left the Lower Mississippi River vulnerable to periods of neglect, with eATON systems suffering from underinvestment until a crisis arises. While the USACE and USCG have managed to keep the system operational, the lack of consistent funding leaves the river's navigation infrastructure susceptible to failures that could have broader economic consequences, including increased safety risk for navigators. Figure 3 illustrates how reduced funding for maintenance, repair, and resilience can lead to increased vulnerability and risk.

Figure 3. Reduced Investment Can Increase Risk

v. Regional Political Considerations:

Lastly, despite its importance to the broader national economy, the Lower Mississippi River primarily serves a specific geographic region. It does not always receive the same level of attention as infrastructure projects that serve larger population centers or have national visibility.

Political dynamics in Congress often prioritize projects with broader appeal or that impact a greater number of constituents across multiple states. Given the Lower Mississippi River's regional focus, its funding needs can sometimes be overlooked, especially when there is no immediate crisis to draw attention to its importance (Transportation Research Board, 2015; Carter & Frittelli, 2020).

1.4 Recent Efforts to Improve Funding

The U.S. Congress plays a crucial role in funding and overseeing the infrastructure that supports navigation on the Lower Mississippi River. However, as already noted, competing budget priorities, deferred maintenance backlogs, a focus on broader infrastructure bills, and the perception that the river is functioning adequately have all contributed to inconsistent prioritization of eATON funding. The Inland Waterways Trust Fund (IWTF) is a U.S. Treasury fund dedicated to financing construction and major rehabilitation projects on the nation's inland waterways and was established to provide additional resources for the maintenance and modernization of U.S. waterways. The IWTF is funded through a tax on commercial barge fuel used on these waterways, ensuring that those who rely on the infrastructure contribute to its maintenance and improvement. (Carter & Stern, 2018). Although IWTF has helped fund some critical projects on the Mississippi River, it still falls short of providing the consistent, long-term funding required to ensure the continuation of eATON systems and others. (Transportation Research Board, 2015; EBP U.S., 2021).

Despite these funding challenges, there has been growing recognition in Congress that more investment in inland waterway infrastructure is needed. The 2025 Inland Waterway Report Card indicates some recent improvement in federal funding for the waterway systems; however, inland waterways still score a low "C-" grade, and there is no specific budgetary allocation for eATON along the Mississippi River (American Society of Civil Engineers, 2025). To ensure that the Lower Mississippi River remains a safe and efficient transportation corridor, Congress will need to allocate long-term funding to address the needs of eATON systems and other vital infrastructure. Without this investment, the river's competitiveness, economic productivity, and safety will remain at risk.

1.5 The Southwest Pass: Mid-America's Gateway to the World

Southwest Pass, located at the mouth of the Mississippi River, is one of the most critical maritime channels in the United States, serving as a gateway for both international and domestic commerce (Figure 4). As a central shipping channel leading into the Gulf of Mexico, it provides a deep-water route for the steady flow of goods, especially agricultural exports, from the U.S. heartland to international markets, that support economies both domestically and abroad (Hartman, et al., 2022). The channel's unique geographic features, strategic position, and economic importance underscore its essential role in U.S. maritime commerce and the global supply chain.

The channel is approximately 35 miles long and is situated at the southernmost point of the Mississippi River, just south of Venice, Louisiana, where the river empties into the Gulf of Mexico. It is part of a complex and dynamic deltaic system, where river currents, sediment deposits, and tidal movements constantly alter the waterway, posing natural challenges to navigation (Hartman, et al., 2022). The channel's depth, maintained through regular dredging efforts, allows large vessels with drafts over 45 feet to navigate safely—a necessity given the

significant sediment loads carried by the Mississippi River from the central United States. Without these interventions, sediment accumulation would obstruct this channel and threaten the continuing economic viability of the waterway. Due to these conditions, Southwest Pass has long required regular maintenance and dredging, as well as a sophisticated system of navigational aids to ensure safety. The USCG and the USACE play key roles in maintaining the channel and supporting safe vessel transit, deploying both physical and electronic navigational aids to mark safe pathways through the Pass (Maritime Executive, 2021; Hartman, et al., 2022).

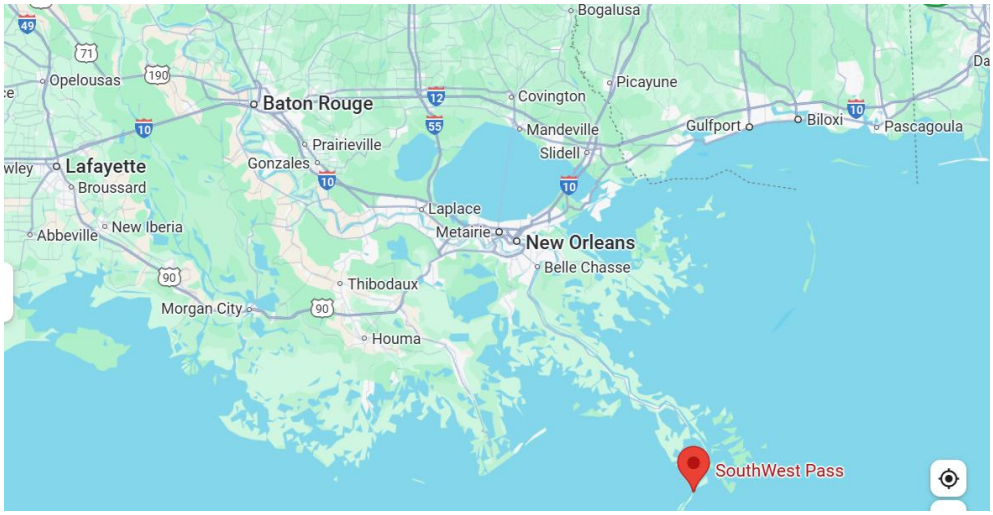

Figure 4. Location of the Southwest Pass

Source: Google (2025)

As one of the most heavily trafficked waterways in North America, Southwest Pass is critical for facilitating international trade. The port system surrounding the Mississippi River handles more than 60% of U.S. agricultural grain exports, including soybeans, corn, and wheat, underscoring the channel's significance to both the U.S. economy and global food markets. In addition to agricultural exports, Louisiana's inland waterway system and Southwest Pass also serve as an import-export hub for petroleum and energy resources, accounting for 20% of the nation's coal shipments and enabling the movement of oil, gas, and refined products to and from refineries along the Gulf Coast. (Louisiana Department of Transportation and Development, 2024). Disruptions in Southwest Pass have direct and immediate impacts on food and energy markets and prices, underscoring the channel's role in supporting economic resilience on both national and international scales (Hartman, et al., 2022).

Southwest Pass is one of the few Gulf Coast channels that can accommodate deep-draft vessels, supporting the high cargo volumes required by the U.S. shipping industry. However, ensuring navigability requires ongoing dredging and sediment management, tasks handled by the USACE and funded by federal and state agencies. The high costs and challenging conditions make the Southwest Pass a very resource-intensive shipping channel to maintain. The pass requires over

$100 million annually for maintenance dredging due to frequent and extensive sedimentation (Scully & Young, 2021). As the Mississippi River Delta is prone to erosion and sediment shifts, navigation aids play an essential role in guiding vessels through this complex and dynamic terrain (Miner, et al., 2023). Damage to these aids from weather events, such as hurricanes, poses a severe risk to vessels, which rely on real-time navigation data to navigate the channel safely (Maritime Executive, 2021).

In 2021, Hurricane Ida caused extensive damage along the Louisiana coastline, including the infrastructure within Southwest Pass. The hurricane's intense winds and storm surges compromised hundreds of critical navigation aids essential for directing vessel traffic (Maritime Executive, 2021; MarineLog, 2021; Eberhardt, 2025). This disruption forced a temporary reliance on manual navigation, slowing traffic and highlighting the vulnerability of the Pass to weather events. These disruptions also had cascading effects on the U.S. supply chain, delaying shipments of goods, energy resources, and agricultural commodities vital to both domestic and international markets. (Strongin & Jovanovic, 2021). Southwest Pass faces growing challenges related to the frequent and severe storms expected to impact the Gulf region. (Masters & Henson, 2021). This increased risk highlights the need for resilient infrastructure and modernized navigation aids that can withstand weather events and continue to operate effectively. Investments in new technology, such as automated and remotely controlled navigation systems, could mitigate future risks and reduce the likelihood of additional disruptions such as those which occurred following Hurricane Ida. Enhanced cooperation between the federal and private sectors is also essential for managing and protecting this vital artery for U.S. commerce. (Transportation Research Board, 2015).

1.6 Importance and Value of eATON Systems

Aids to Navigation are physical or electronic devices that guide mariners in safely navigating waterways. These aids can be categorized into traditional, physical structures (e.g., buoys, beacons, daymarks, and lighthouses) and modern, digital systems such as radar, Automatic Identification Systems (AIS), and Global Positioning Systems (GPS) (U.S. Coast Gaurd, 2018; Judice, 2018). AIS improves navigation by transmitting information about vessels and aids to navigation, enabling ships to detect others and identify buoys or hazards beyond visual or radar range. AIS ATONs can be real (physical aids with onboard transmitters), synthetic (a physical aid with its AIS signal broadcast from shore or another location), or virtual (sign marking points without physical aids) (National Oceanic and Atmospheric Administration, n.d.).

The effectiveness of inland waterway navigation depends heavily on the accuracy and reliability of navigation aids such as the Electronic Chart Display and Information Systems (ECDIS). An early report by the National Research Council (1999) identified the need for improved navigation information systems such as eATON as critical for the future of maritime transportation safety. Rivers like the Mississippi are prone to constant changes in their navigational conditions due to varying water levels, sediment buildup, and weather conditions (Amorim, Villarini, Veacth, & White, 2023). These dynamic conditions require constant monitoring and up-to-date eATON infrastructure to maintain navigability. In this context, eATON systems help mitigate the risks posed by such variables by providing mariners with accurate real-time information and visual guidance.

The effectiveness of aid to navigation systems has a direct impact on draft restrictions on the Lower Mississippi River. Silt and sediment deposition in the river can quickly reduce the depth of navigational channels, forcing vessels to reduce their loads to avoid grounding. (Hartman, et al., 2022). Without proper navigation aids, mariners face difficulties identifying the deepest parts of the channel, which can result in vessels running aground in shallow areas. The USACE works to dredge the river and maintain navigational depths, but this effort is not always sufficient, especially in the absence of robust eATON systems to guide vessels. Buoys, markers, and electronic aids that provide real-time data on water depth and channel conditions are crucial for enabling captains to make informed decisions about the cargo their vessels can safely carry (Wolfe, Pacheco, & MacFarland, 2024). The lack of such systems forces vessels to operate more conservatively, resulting in reduced cargo volumes and increased trip frequency to move the same amount of goods, thereby reducing overall transport efficiency.

The economic implications of inadequate navigation systems on river navigation can be profound. Inland waterway transport is widely recognized as a cost-effective mode of moving goods, especially for bulky cargo such as grain, coal, and petroleum products. However, the lack of reliable navigational aids can erode these economic advantages by increasing operational inefficiencies, raising costs, and reducing the competitiveness of river transport compared to other modes, such as road and rail. A report by the American Society of Engineers on inland waterways highlighted that inefficiencies in river transport, resulting from inadequate navigation infrastructure, can disrupt supply chains and lead to delays in the delivery of goods. (EBP U.S., 2021). In turn, this causes ripple effects in global trade networks, with suppliers facing increased storage and inventory costs.

Just as drought can lower water levels and disrupt inland waterway transport, inadequate aids to navigation can have a similar effect by making waterways unpredictable and unsafe. Chen and Cheng (2023) note that when river navigation becomes unreliable due to drought, farmers often turn to alternative, more expensive modes of transport, such as trucking and rail, to offset the uncertainty of waterborne shipping. This shift increases freight costs for businesses, narrows profit margins, and reduces overall economic productivity in regions that heavily rely on river-based logistics.

In addition to safety and economic concerns, the lack of sufficient navigation systems has profound safety implications. Navigational incidents such as vessel groundings or collisions can result in fuel spills, the release of hazardous materials, and damage to sensitive systems, particularly in regions where rivers flow through wetlands, estuaries, or protected areas. (Byrnes & Dunn, 2020). When vessels deviate from established navigation routes due to the absence of reliable aids, they may inadvertently damage sensitive habitats.

In summary, the literature shows that inadequate ATONs can significantly hinder safe and efficient river navigation. Consequences ranging from increased accidents and delays to reduced economic productivity highlight the urgency of investing in modern navigation infrastructure. Innovative technologies and coordinated policy actions can address these challenges and keep rivers as essential and cost-effective transport routes. Policymakers and industry stakeholders must prioritize the deployment and maintenance of eATON systems to support safe navigation and economic growth in inland waterways.

This report examines the economic impact of artificial draft restrictions resulting from the lack of efficient aid to navigation systems on the Mississippi River. It examines a scenario where the loss of eATONs on the river, due to Hurricane Ida, resulted in draft restrictions for a specified number of high-draft vessels within a given timeframe, transporting cargo across the Mississippi River through the Southwest Pass. The following section discusses the methodological approach used. Section three presents the analysis, while Section four discusses the findings, conclusions, and provides recommendations for approaching the challenges to draft restrictions caused by the lack of efficient aid to navigation systems on the Mississippi River.

2.0 METHODOLOGY

This section details the approach, assumptions, and analytical framework used to estimate the economic impact of the loss of electronic aids to navigation (eATON) in the Southwest Pass of the Mississippi River following Hurricane Ida in 2021. The process follows a clear framework, including problem definition, data collection, assumption formulation, economic modeling, and interpretation of results. Due to the absence of direct empirical data, the analysis relies on a model-based economic approach that incorporates industry benchmarks, historical disruptions, and well-founded assumptions. Furthermore, Microsoft Excel was used to analyze the data and generate visual representations, including funnel and bar charts, to support the interpretation of results and highlight industry-specific impacts.

2.1 Research Approach

The analysis incorporated the following key variables:

1. Vessel Delays: Estimating the costs incurred due to slowed navigation and congestion.
2. Draft Restrictions: Assessing economic losses from reduced cargo capacity.
3. Supply Chain Disruptions: Estimating additional costs for alternative transport and market effects.

Since real-time navigational and financial data were unavailable, the analysis was based on industry reports, expert estimates, and assumptions, and calculated inferences validated against historical disruptions.

2.2 Data Sources and Justifications

1. Vessel Traffic Estimates: Based on historical reports of vessel movement through the Southwest Pass.
2. Economic Costs of Vessel Delays: Derived from industry studies on demurrage, fuel consumption, and labor costs.
3. Cargo Impact Estimates: Sourced from the various publications as seen in Table 1; provides industry-standard values for cargo loss per foot of draft reduction, also benchmark for assumptions.
4. Supply Chain Costs: Assumptions based on cost differentials between river transport, rail, and trucking, using benchmarks from logistics industry reports.

Table 1. Data Sources, Estimates, and References Used in Economic Analysis

Criteria	Data/Assumption	Estimates/Assumptions	Reference(s)
Vessel Traffic	Daily deep draft vessel traffic through Southwest Pass.	13 vessels/day drafting at least 35 feet	Hartman et al. (2022)
eATON Outage Duration	Time taken to restore full eATON functionality.	Approximately 14 days[1]	Bleyer (2021) and U.S. Coast Guard (2005)
Vessel Delay per Ship	Extra time spent navigating without eATON.	11 hours (non-daylight hours),[2] rounded up to 0.5 day/ship (12 hours) for modelling purposes	Marine Log (2021)
Cost of Vessel Delay	Additional daily cost due to delay (including fuel, crew, and demurrage).	$29,060/day[3]	USDOT Maritime Administration (2011)
Draft Reduction	Estimated loss in draft depth due to navigational uncertainty.	2 feet[4]	Scully (2015)
Cargo Lost per Foot of Draft	Average cargo reduction per vessel per foot of draft loss.	200 tons/foot/vessel[5]	Hightower (2024)
Value per Ton of Cargo	Estimated per-ton value of key cargo types.	Grain: $167[6] Oil: $514[7] Chemicals: $1,410[8]	Deliberto (2025) Trading Economics (n.d.) Independent Commodity Intelligent Services (2011)

[1] This assumption is based off on the number of days it took to restore the functionality of ATON after Hurricane Katrina as well as a consideration of the processes, procedure and criteria for ATON repairs per the U.S. Coast Guard ATON Manual.
[2] After Hurricane Ida's devastation that led to sunken vessels, there was restriction for deep draft vessels to only transit the Mississippi River during daylight hours which is about 13 hours around the New Orleans area in late August/early September. There is therefore an average of a 11-hour delay for cargo movement.
[3] The actual figure obtained from the cited source is $20,053/day in 2010 dollars. When adjusted for inflation, the figure is equivalent to approximately $29,060 in 2025 dollars.
[4] In 2015 the Louisiana Maritime Association recommended a reduction in draft of the Mississippi River's Southwest Pass from 47 to 45 feet due to silting caused by storm.
[5] These figures are for shallow draft barges which may be different than for deep draft vessels.
[6] Corn is $4.25/bushel, and 39.3679 corn bushels makes a ton. Therefore 4.25*39.3679= $167.
[7] A ton of crude oil is equal to 7.46 barrels, and a barrel of oil according to Trading Economics is about $69, therefore the value of a ton of oil is 7.47*69= $514.
[8] For chemicals, the price of propylene per pound is between $0.58 to $0.83, while the average of this range is $0.705. Converting that value to tons: $0.705*2000= $1,410.

Percentage of Affected Vessels	Draft limitations impact deep-draft vessels.	100%[9]	Hartman et al. (2022)
Additional Rail Costs	Extra per-ton cost of using rail instead of river transport.	$1.56 per ton mile[10]	Arkansas Waterways Commission (2025)
Additional Truck Costs	Extra per-ton cost of using trucking instead of river transport.[11]	$4.38 per ton mile[12]	Arkansas Waterways Commission (2025)
Percentage of Cargo Rerouted	Estimated share of disrupted cargo rerouted by rail vs. truck.	37% rail, 20% truck[13]	Henderson et al. (2024)

2.3 Key Assumptions

Vessel Delays:

1. Traffic Affected: 13 vessels per day pass through the Southwest Pass.
2. Duration of Disruption: 14 days before eATON restoration.
3. Average Delay per Vessel: 0.5 days due to slower navigation.
4. Cost per Vessel per Day: $29,060 covering fuel, labor, and demurrage fees.

Draft Restrictions:

1. Reduction in Draft: 2 feet due to navigation uncertainty.
2. Lost Cargo per Foot of Draft: 200 tons per vessel.
3. Percentage of Affected Vessels: 100% (deep-draft vessels primarily impacted).
4. Commodity Value per Ton:
    i. Grain: $167
    ii. Oil: $514
    iii. Chemicals: $1,410

Supply Chain Disruptions (Percentage of rerouted cargo):

    i. 37% moved by rail

[9] Hartman et al. estimated that 13 ocean ongoing vessels with at least 35ft draft pass through the Southwest Pass daily. We assume that each of these vessels could be affected by reduction in draft due to storms or loss of aids to navigation.
[10] Figure used is the difference between cost of moving cargo by waterway and by rail.
[11] The cross over potential between river and road is low compared to the cross over potential from river to rail.
[12] Figure used is the difference between cost of moving cargo by waterway and by truck.
[13] As an estimate, we used the 2021 export tonnage and modal share percentages for all U.S. grains, given that Hurricane Ida made landfall in the New Orleans area during that same year.

ii. 20% moved by truck

2.4 Economic Impact Modeling

A three-step quantitative model was developed to estimate financial losses.

Step 1: Estimating the Cost of Vessel Delays

i. Total vessels affected = (Vessels per day) × (Duration of disruption)

ii. Total cost of delays = (Total vessels affected) × (Average delay per vessel) × (Cost per vessel per day)

Step 2: Estimating Economic Loss Due to Draft Restrictions

i. Total affected vessels = (Total vessels affected) × (Percentage of deep-draft vessels impacted)

ii. Total lost cargo = (Affected vessels) × (Draft reduction) × (Cargo loss per foot of draft)

iii. Cargo loss by commodity = (Lost cargo) × (Commodity percentage) × (Commodity value per ton)

iv. Total cargo loss value = Sum of all affected commodities.

Step 3: Estimating Supply Chain Disruptions & Additional Costs

i. Rail transport extra costs = (Lost cargo) × (Percentage shifted to rail) × (Extra cost per ton).

ii. Truck transport extra costs = (Lost cargo) × (Percentage shifted to trucking) × (Extra cost per ton).

iii. Total additional logistics costs = (Rail costs) + (Truck costs).

Step 4: Industry-Specific Breakdown

i. Economic losses were divided across three major industries based on cargo distribution:
   - Agriculture (Grain Exports)
   - Oil & Energy (Crude & Refined Products)
   - Chemical Industry (Petrochemicals, Industrial Chemicals)

ii. Delay costs were distributed evenly across these industries, while draft restrictions and supply chain costs were weighted based on commodity volumes.

3.0 ANALYSIS

The analysis focuses on quantifying the economic impact of eATON loss due to Hurricane Ida, using a model-based economic approach.

3.1 Vessel Delays and Cost Implications

The loss of eATON forced vessels to rely on traditional navigation methods, leading to reduced speeds, increased waiting times, and a backlog of vessels at Southwest Pass. The study estimated that 13 vessels per day passed through this critical waterway, with an average delay of 0.5 days per vessel.

Quantitative Breakdown of Vessel Delays

- Total affected vessels = 13 vessels/day × 14 days = 182 vessels
- Average delay per vessel = 0.5 days
- Cost per vessel per day (fuel, labor, demurrage, insurance costs) = $29,060
- Total cost of vessel delays = 182 × 0.5 × $29,060 = $2,644,460

These financial losses were borne by shipping companies, port operators, and cargo owners who had to pay higher demurrage fees and fuel costs due to inefficient transit.

The delay costs were distributed across industries based on the type of cargo typically moving through the Southwest Pass:

Table 2. Industry-Specific Impact of Vessel Delays

Industry	Estimated Percentage of Affected Vessels	Delay Cost Allocation
Agriculture (Grain exports)	40%	$1,057,784
Oil & Energy	35%	$925,561
Chemical Industry	25%	$661,115
Total Impact of Vessel Delays		$2,644,460

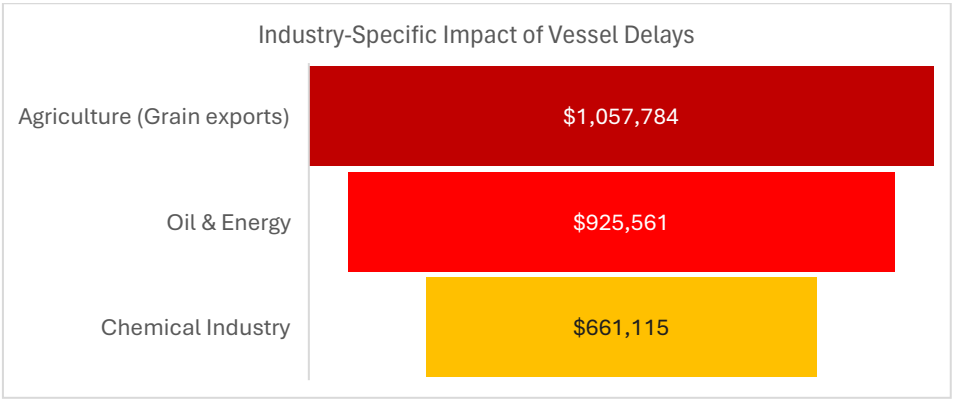

Figure 5. Industry-Specific Impact of Vessel Delays

Key observations as depicted in Table 2 and Figure 5:

- Agricultural exporters suffered the most, as grain shipments rely on tight schedules for delivery to global markets.
- Oil & energy shipments were delayed, potentially causing minor fluctuations in crude supply chains.
- Chemical industries faced increased transport costs, affecting downstream manufacturing operations.

3.2 Economic Impact of Draft Restrictions

One of the most significant consequences of eATON loss is the imposition of conservative draft restrictions due to uncertainty about water depth. This forces deep-draft vessels to reduce cargo loads to avoid grounding, leading to substantial financial losses.

Quantitative Breakdown of Draft Restriction Losses

- Draft reduction estimate = 2 feet
- Lost cargo per vessel per foot of draft reduction = 200 tons
- Total affected vessels = 100% of 182 = 182 vessels
- Total lost cargo = 182 × 2 × 200 = 72,800 tons
- Cargo value per ton:
- Grain: $167/ton
- Oil: $514/ton
- Chemicals: $1,410/ton

Table 3. Economic Loss by Industry Due to Draft Restrictions

Industry	Lost Cargo (Tons)	Value per Ton	Total Losses
Agriculture (Grains)	29,120	$167	$4,863,040
Oil & Energy	25,480	$514	$13,096,720
Chemical Industry	18,200	$1,410	$25,662,000
Total Losses	72,800	-	$43,621,760

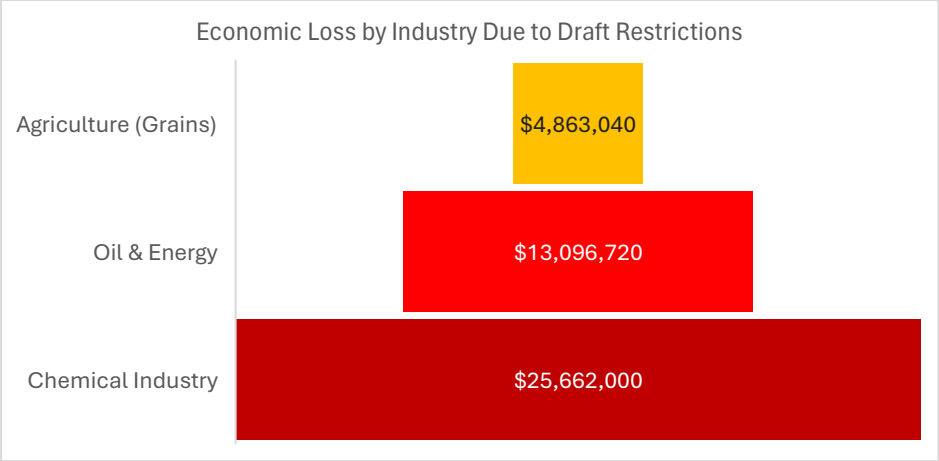

Figure 6. Economic Loss by Industry Due to Draft Restrictions

Key observations as depicted in Table 3 and Figure 6:

- Agriculture suffered the lowest losses ($4,863,040), as reduced vessel capacity may have directly impacted U.S. grain exports.
- Oil & energy cargo losses ($13,096,720) were substantial, which could have affected both crude oil and refined product shipments.
- The chemical industry was most impacted ($25,662,000) and was affected by export disruptions, which could delay supply chains for downstream manufacturing.
- The combined impact of delays and draft restrictions could create a cascading effect, worsening congestion at ports and terminals.

3.3 Supply Chain Disruptions and Additional Transport Costs

With reduced river transport capacity, some cargo was rerouted to alternative modes of transportation, primarily rail and trucking. However, these modes are significantly more expensive per ton-mile, leading to additional economic losses.

Quantitative Breakdown of Additional Transport Costs

- Total lost cargo requiring rerouting = 72,800 tons
- Percentage of cargo rerouted to rail = 37%
- Percentage of cargo rerouted to truck = 20%
- Rail cost increase per ton = $1.56
- Truck cost increase per ton = $4.38

Table 4. Additional Logistics Costs by Transport Mode

Transport Mode	Cargo Shifted (Tons)	Extra Cost per Ton	Additional Cost
Rail (37%)	26,936	$1.56	$42,020.16
Truck (20%)	14,560	$4.38	$63,481.60
Total Logistics Cost Increase		-	$105,501.76

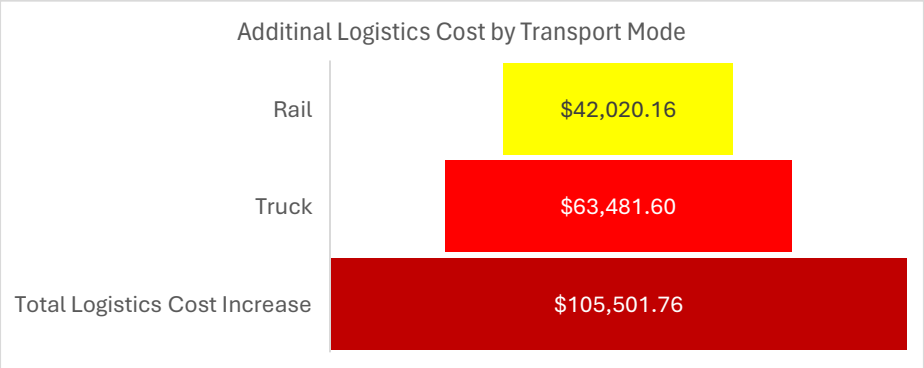

Figure 7. Additional Logistics Costs by Transport Mode

Key observations as depicted in Table 4 and Figure 7:

- Rail transport absorbed the bulk of the displaced cargo, but at a higher cost per ton compared to maritime transport.
- Truck transport, while more flexible, incurred significantly higher costs, contributing to additional transportation expenses.
- The increased reliance on alternative transport raises overall shipping costs, which makes U.S. exports less competitive in global markets.

3.4 Total Economic Impact Summary

The total financial losses due to eATON failure were $46,371,721.76, with draft restrictions accounting for the largest share at $43,621,760 (94%), as vessels were forced to reduce cargo loads due to uncertain water depths. Vessel delays resulted in $2,644,460 (5.70%) in losses, primarily due to increased fuel consumption, labor costs, and demurrage fees resulting from congestion. Additionally, increased transportation costs from rerouting cargo via rail and trucking added $105,501.76 (0.23%) to overall losses. The total economic impact summary is depicted in Table 5 and Figure 8.

Table 5. Total Economic Impact Summary

Impact Category	Total Loss	Percentage of Total Impact
Vessel Delays	$2,644,460	5.70%
Draft Restrictions	$43,621,760	94.07%
Supply Chain Disruptions	$105,501.76	0.23%
Total Economic Losses	$46,371,721.76	100%

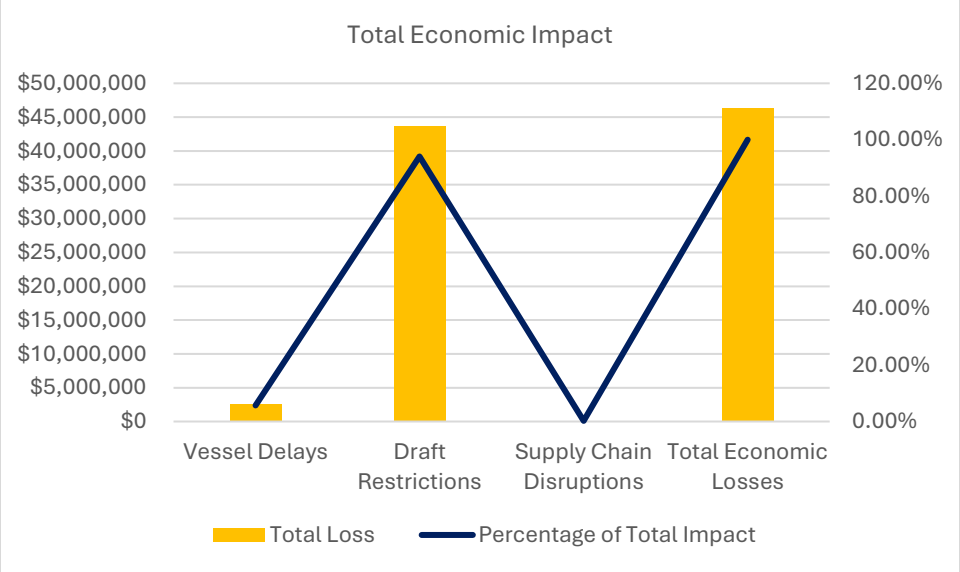

Figure 8. Total Economic Impact Summary

4.0 DISCUSSION, CONCLUSION & RECOMMENDATIONS

The findings from this analysis illustrate a potential severe economic consequence that may result from the loss of eATON in the Southwest Pass of the Mississippi River following a weather event like Hurricane Ida. Findings indicate that disruption may cause significant vessel delays, impose draft restrictions, and result in costly supply chain inefficiencies, ultimately incurring an estimated $46.4 million in economic losses across multiple industries. The analysis highlights how an absence of real-time navigation data can force vessel operators to adopt more conservative navigation practices, slowing vessel movements and increasing operational costs. Please note that this scenario is based on the data estimations presented in Table 1.

One of the most immediate and noticeable impacts was vessel delays, which may result in port congestion and additional operational costs. Without eATON, ships were forced to navigate more cautiously, leading to an average delay of 0.5 days per vessel. This delay created a ripple effect, increasing fuel consumption, labor costs, and demurrage fees, which together amounted to an estimated $2.6 million in economic losses. The industries most affected by these delays were agriculture, oil and energy, and chemicals, as they rely on timely shipments to meet export commitments and production schedules.

According to the analysis, the most significant economic impact was due to draft restrictions, which accounted for 94.07% of total estimated financial losses. The inability to accurately assess real-time water depths meant that authorities and vessel operators needed to impose conservative draft limitations to minimize the risk of grounding. In the analysis, an average of 2 feet of draft reduction was implemented, which was observed to result in ships carrying significantly less cargo per voyage. This led to a total estimated cargo reduction of 72,800 tons, affecting major bulk commodities such as grain, oil, and chemicals that transit through the Lower Mississippi River. The chemical industry suffered the most significant losses, estimated at $ 25.66 million, as the region's chemical industry relies heavily on the Mississippi River for international shipments. The energy and agriculture sectors also faced major setbacks, with financial losses estimated at $13.1 million and $4.9 million, respectively, as supply chain disruptions increased operational costs and may lead to temporary shortages in domestic and global markets.

In addition to reduced cargo capacity, disruptions can force some cargo to be rerouted via alternative transportation modes such as rail and trucking, which may further escalate transportation costs. The inability to move goods efficiently on the river required businesses to pay higher rates for rail and trucking services, leading to an estimated $105,502 in additional transportation costs. While rail was able to absorb most of the displaced cargo, trucking, which is significantly more expensive per ton-mile, had to be utilized for a substantial portion of shipments, further driving up costs. These increased costs place U.S. exporters at a competitive disadvantage, as higher freight rates make their goods more expensive in the international markets.

The broader implication of this disruption extends beyond direct financial losses. The increased uncertainty surrounding river navigation in the aftermath of a weather event like Hurricane Ida highlights vulnerabilities in U.S. maritime infrastructure. The reliance on physical aids to navigation (such as buoys, beacons, and dayboards)- which can be damaged or displaced by extreme weather- demonstrates the critical need for enhanced digital navigation systems that can continue to provide real-time data during and after significant storms. The analysis suggests that

the lack of resilient eATON infrastructure may lead to cascading supply chain inefficiencies, prolonging recovery efforts, and increasing overall economic losses.

The findings suggest that the most significant contributor to these financial losses is the implementation of draft restrictions, which leads to reduced cargo capacity and higher per-unit transportation costs. Without precise depth measurements, authorities may reasonably choose to err on the side of caution, restricting vessel drafts to prevent grounding. This conservative approach, while necessary, results in millions of dollars in lost revenue as vessels are unable to transport their usual cargo volumes. Additionally, vessel delays may further exacerbate economic inefficiencies, as congestion at the Southwest Pass delays shipments and increases operational expenses for maritime companies. The reliance on alternative transportation methods, such as rail and trucking, drives up costs, making U.S. goods less competitive in global markets.

To mitigate the economic risks associated with navigation disruptions, several strategic actions should be implemented. Investing in the modernization and expansion of eATON infrastructure is a top priority. By enhancing digital navigation capabilities, vessels can continue to receive real-time information on water depth, channel conditions, and navigational hazards, even during weather events. This would reduce uncertainty and prevent unnecessary draft restrictions, ensuring that trade flows remain efficient and uninterrupted. Additionally, integrating AI-powered depth monitoring systems would provide continuous updates on riverbed changes, allowing for more accurate and dynamic draft management.

Another key recommendation is to improve emergency response protocols for restoring navigation systems after weather events. The delayed recovery of eATON in Southwest Pass after Hurricane Ida, for instance, prolongs supply chain disruptions, emphasizing the need for a faster, coordinated response system. The USCG and maritime authorities should develop contingency plans to rapidly deploy mobile navigation aids in affected areas, ensuring that vessels can resume operations as quickly as possible. Most importantly, establishing a Congressional emergency fund with streamlined access for restoring critical infrastructure, such as eATON, in the aftermath of natural disasters or other disruptions would significantly reduce funding obstacles and accelerate recovery efforts. Unfortunately, much of the emergency funding allocated for such events is often expended immediately in response to the crisis or on less pressing matters, leaving limited reserves for future needs. It is therefore essential to establish formal guidelines to ensure that funds are allocated and managed appropriately for emergencies affecting U.S. waterways. Additionally, strengthening public-private partnerships between the Coast Guard, port authorities, and private shipping companies is essential for improving navigation resilience. Increased collaboration would enable shared investments in digital infrastructure and facilitate better coordination during emergencies. Furthermore, policy incentives should be introduced to encourage the adoption of advanced navigation technologies, such as automated charting systems and remote monitoring tools, which would enhance the overall reliability of maritime trade routes.

Enhancing the overall resiliency of U.S. inland waterway infrastructure is crucial for maintaining global trade competitiveness. Competitor nations, such as Brazil, have been investing heavily in modernizing their river transport networks, which threatens the U.S. market share in key export sectors, including agriculture. Failure to address systemic vulnerabilities in navigation infrastructure will likely lead to long-term economic disadvantages for U.S. industries. By taking proactive steps to modernize navigation aids, improve emergency preparedness, and foster

greater industry collaboration, the economic risks associated with future navigation disruptions can be significantly reduced. These efforts will ensure that the Mississippi River remains a reliable and competitive trade route, safeguarding billions of dollars in economic activity and supporting the broader U.S. economy.

Lastly, while the methodology for this study provides a structured estimation for a given scenario, it has certain limitations. The analysis relies on industry-standard assumptions rather than real-time empirical data, which may introduce some uncertainty. Additionally, broader economic ripple effects, such as fluctuations in commodity prices, were not directly modeled, which may have potentially underestimated the full impact of the event. Furthermore, the study does not account for seasonal variations in cargo movement, which could influence the extent of delays and financial losses. To enhance accuracy and refine the model, future research should incorporate real-time AIS vessel data, USCG reports, and detailed port financials.

REFERENCES

33 C.F.R. § 62 (2025). United States Aids to Navigation System. Retrieved from https://www.ecfr.gov/current/title-33/chapter-I/subchapter-C/part-62

American Society of Civil Engineers. (2025). *A Comprehensive Assessment of America's Infrastructure: 2025 Report Card for America's Infrastructure.* Reston: American Society of Civil Engineers. Retrieved from https://infrastructurereportcard.org/wp-content/uploads/2025/03/Full-Report-2025-Natl-IRC-WEB.pdf

Amorim, R., Villarini, G., Veacth, W., & White, K. (2023). Reduced and More Fragmented Mississippi River Navigability by Rising Flow. *Geophysical Research Letters, 50*(19), e2023GL104619. https://doi.org/10.1029/2023GL104619

Arkansas Waterways Commission. (2025). *Why Waterways?* Retrieved from https://waterways.arkansas.gov/education/why-waterways/

Bleyer, W. A. (2021, June 25). The Long Blue Line: In to the eye of chaos--River Tender Pamlico in Hurricane Katrina, Part II. The Clean Up. *MyCG*. Retrieved from https://www.mycg.uscg.mil/News/Article/2659829/the-long-blue-line-in-to-the-eye-of-chaos-river-tender-pamlico-in-hurricane-kat/

Byrnes, T. A., & Dunn, R. J. (2020). Boating- and Shipping-Related Environmental Impacts and Example Management Measures: A Review. *Journal of Marine Science and Engineering, 8*(11), 908. doi:https://doi.org/10.3390/jmse8110908

Carter, N. T., & Frittelli, J. (2020). *Inland and Intracoastal Waterways: Primer and Issues for Congress.* Library of Congress: Congressional Research Service. Retrieved from https://www.congress.gov/crs-product/IF11593

Carter, N. T., & Stern, C. V. (2018). *Inland Waterways Trust Fund.* Library of Congress: Congressional Research Service. Retrieved from https://www.congress.gov/crs-product/IF10020

Chen, Z., & Cheng, J. (2023). Regional Economic Impacts of Inland Waterways Failure in the Mississippi River and The Role of Transportation Resilience. *SSRN*. doi:https://dx.doi.org/10.2139/ssrn.4719260

Deliberto, M. (2025). *January Market Update: Corn, Soybeans, Rice, and Cotton.* Baton Rouge: Louisiana State University Agricultural Center. Retrieved from https://www.lsuagcenter.com/~/media/system/2/7/5/3/275377358e238811fe47f1b0c7c82f9b/january%202025%20crop%20market%20update%20pdf.pdf

Eberhardt, R. (2025, March 12). MVTTC Highlights Strengths, Opportunities On The Lower Miss. *Waterways Journal*. Retrieved from https://www.waterwaysjournal.net/2025/03/14/mvttc-highlights-strengths-opportunities-on-the-lower-miss/

EBP U.S. (2021). *Failure to Act: Ports and Inland Waterways– Anchoring the U.S. Economy.* Reston: American Society of Civil Engineers. Retrieved from https://infrastructurereportcard.org/wp-content/uploads/2021/01/failure-to-act-2021-ports-inland-waterways.pdf

Federal Highway Administration. (2025). *Infrastructure Investment and Jobs Act - Funding.* Washington: U.S. Department of Transportation Federal Highway Administration. Retrieved from https://www.fhwa.dot.gov/infrastructure-investment-and-jobs-act/funding.cfm

Google. (2025). *SouthWest Pass.* Retrieved from https://www.google.com/maps/place/SouthWest+Pass/@29.0413884,-89.3320916

Green, J. (2013, July 1). *Map of Ports Along the Mississippi River Located In Louisiana.* Retrieved from Mississippi River Cruises - Map of the Mississippi River: https://www.mississippiriverinfo.com/map-of-the-mississippi-river/

Hartman, M. A., Mitchell, K. N., Dunkin, L. M., Lewis, J., Emery, B., Lenssen, N. F., & Copeland, R. (2022). Southwest Pass Sedimentation and Dredging Data Analysis. *Journal of Waterway, Port, Coastal, and Ocean Engineering, 148*(2), 05021017. doi:https://doi.org/10.1061/(ASCE)WW.1943-5460.0000684

Henderson, R., Gastelle, J., & Caffarelli, P. (2024). *Transportation of U.S. Grains: A Modal Share Analysis 1984-2022 Update.* U.S. Dept. of Agriculture, Agricultural Marketing Service. doi:http://dx.doi.org/10.9752/TS049.09-2024

Hightower, M. (2024, September 5). Mississippi River continues to trend lower; draft restrictions in place for shipping. *University of Arkansas Division of Agriculture News*. Retrieved from https://www.uaex.uada.edu/media-resources/news/2024/september2024/09-05-2024-ark-miss-river-trends-lower.aspx

Hunt, J. D., Pokhrel, Y., Chaudhari, S., Mesquita, A. L., Nascimento, A., Filho, W. L., . . . Lopes, M. A. (2022). Challenges and opportunities for a South America Waterway System. *Cleaner Engineering and Technology, 11*, 100575. doi:https://doi.org/10.1016/j.clet.2022.100575

Independent Commodity Intelledent Services Chemical Business. (2011, December 16). *Indicative Chemical Prices A-Z.* Retrieved from ICIS, Archived on Archive.org: https://web.archive.org/web/20111216144726/http:/www.icis.com:80/chemicals/channel-info-chemicals-a-z/

Judice, C. (2018, October 17). The USCG RDC & Electronic Aids To Navigation. *MarineLink*. Retrieved from https://www.marinelink.com/news/uscg-rdc-electronic-aids-navigation-442752

Louisiana Department of Transportation and Development. (2024). *2024 Louisiana State Freight Plan.* Baton Rouge: Louisiana Department of Transportation and Development. Retrieved from https://www.dotd.la.gov/media/efchfwrt/2024-louisiana-state-freight-plan.pdf

Louisiana Office of Community Development. (2025). *State of Louisiana Substantial Action Plan for the Utilization of Community Development Block Grant Funds in Response to 2020 and 2021 Federal Declarations in Louisiana, and Amendments.* Baton Rouge: Louisiana Division of Administration. Retrieved from https://locddr.la.gov/action-plans/2020-2021-disaster-events-action-plans

MarineLog. (2021, September 4). USCG opens Lower Mississippi River to all vessel traffic following Hurricane Ida. *MarineLog*. Retrieved from https://www.marinelog.com/news/uscg-opens-lower-mississippi-river-to-all-vessel-traffic-following-hurricane-ida/

MarineLog. (2021, September 17). Post-Ida response efforts continue. *MarineLog*. Retrieved from https://www.marinelog.com/inland-coastal/post-ida-response-efforts-continue/

Maritime Executive. (2021, September 7). U.S. Coast Guard Works Overtime to Manage Post-Hurricane Cleanup. *The Maritime Executive*. Retrieved from https://maritime-executive.com/article/u-s-coast-guard-works-overtime-to-manage-post-hurricane-cleanup

Masters, J., & Henson, B. (2021, August 29). Catastrophic Hurricane Ida hits Louisiana with 150 mph winds. *Yale Climate Connections*. Retrieved from https://yaleclimateconnections.org/2021/08/catastrophic-hurricane-ida-hits-louisiana-with-150-mph-winds/

Miner, M., McMann, B., Courtois, A., Andrus, M., Romaine, Z., Forman, K., . . . Prejean, S. (2023). *Lowermost Mississippi River Management Program: Regional Sediment Management Below Venice.* Baton Rouge: The Water Institue. Retrieved from https://water-institute.files.svdcdn.com/production/Projects/Lowermost-Mississippi-River-Management-Program-Regional-Sediment-Management-Below-Venice.pdf

National Oceanic and Atmospheric Administration. (n.d.). *Portrayal of AIS Aids to Navigation*. Retrieved July 11, 2025, from Office of Coast Survey, National Oceanic and Atmospheric Administration, U.S. Department of Commerce: https://nauticalcharts.noaa.gov/publications/portrayal-of-ais-aids-to-navigation.html

National Research Council. (1999). *Applying Advanced Information Systems to Ports.* Washington: The National Academies Press. doi:https://doi.org/10.17226/6451

Notteboom, T., Pallis, A., & Rodrigue, J.-P. (2025). *Effect of the Panama Canal Draft Limitation on Containership Capacity.* Retrieved from Port Economic, Management and Policy: https://porteconomicsmanagement.org/pemp/contents/part1/interoceanic-passages/panama-canal-draft-limitation-containership-capacity/

Plume, K., & Huffstutter, P. (2021, September 2). More Grain Terminals Found Damaged by Ida, Exports May Stall for Weeks. *MarineLink*. Retrieved from https://www.marinelink.com/news/grain-terminals-found-damaged-ida-exports-490343

Ponciano, J. (2021, November 15). Everything In The $1.2 Trillion Infrastructure Bill: New Roads, Electric School Buses And More. *Forbes*. Retrieved from

https://www.forbes.com/sites/jonathanponciano/2021/11/15/everything-in-the-12-trillion-infrastructure-bill-biden-just-signed-new-roads-electric-school-buses-and-more/

Scully, B., & Young, D. (2021). Evaluating the Underkeel Clearance of Historic Vessel Transits in the Southwest Pass of the Mississippi River. *Journal of Waterway, Port, Coastal, and Ocean Engineering, 147*(5), 05021008. doi:https://doi.org/10.1061/(ASCE)WW.1943-5460.0000655

Scully, D. (2015, August 11). Mississippi River maximum recommended draft reduced because of silting. *Splash247*. doi:https://splash247.com/mississippi-river-maximum-recommended-draft-reduced-silting

Strongin, J., & Jovanovic, A. (2021). *Hurricane Ida Landfall Causes Major Damage, Disruptions to Supply Chains and Infrastructure along the US Gulf Coast as Peak Atlantic Storm Season Begins.* Burlington, MA: Everbridge. Retrieved from https://www.everbridge.com/wp-content/uploads/NC4-SitRep-Hurricane-Ida-8-30-2021.pdf

Tomer, A. (2023, November 15). At its two-year anniversary, the bipartisan infrastructure law continues to rebuild all of America. *Brookings Institution Research*. Retrieved from https://www.brookings.edu/articles/at-its-two-year-anniversary-the-bipartisan-infrastructure-law-continues-to-rebuild-all-of-america/

Trading Economics. (n.d.). *Crude Oil*. Retrieved June 11, 2025, from Trading Economics: https://tradingeconomics.com/commodity/crude-oil

Transportation Research Board. (2015). *Special Report 315: Funding and Managing the U.S. Inland Waterways System: What Policy Makers Need to Know.* Washington: National Academies Press. doi:https://doi.org/10.17226/21763

U.S. Coast Guard. (2005, March 2). *Aids to Navigation Manual - Administration.* Retrieved from U.S. Coast Gaurd: https://www.navcen.uscg.gov/sites/default/files/pdf/waterways/shallow_draft/CIM_16500_7a%20(Admin%20manual%20w%20CH1%20&%20CH2).pdf

U.S. Coast Guard. (2018). *U.S. Aids To Navigation System.* Seattle: 13th Coast Gaurd District. Retrieved from https://www.pacificarea.uscg.mil/Portals/8/District_13/dpw/docs/usaidstonavigationbooklet.pdf

U.S. Government Accountability Office. (2018). *Inland Waterways: Actions Needed to Increase Budget Transparency and Contracting Efficiency.* Washington: U.S. Government Accountability Office. Retrieved from https://www.gao.gov/assets/gao-19-20.pdf

U.S. Government Accountability Office. (2020). *Coast Gaurd: Initiatives to Address Aids to Navigation Challenges Could be Enhanced to Better Ensure Effective Implementation.* Washington: U.S. Government Accountability Office. Retrieved from https://www.gao.gov/assets/gao-20-107.pdf

USDOT Maritime Administration. (2011). *Comparison of U.S. and Foreign-Flag Operating Costs.* Washington: U.S. Department of Transportation Maritime Administration. Retrieved from https://www.maritime.dot.gov/sites/marad.dot.gov/files/docs/resources/3651/comparisonofusandforeignflagoperatingcosts.pdf

USDOT Maritime Administration. (2024). *Bipartisan Infrastructure Law: Maritime Administration.* Washington: U.S. Department of Transportation Maritime Administration. Retrieved from https://www.maritime.dot.gov/about-us/bipartisan-infrastructure-law-maritime-administration

Wolfe, K. E., Pacheco, P., & MacFarland, D. (2024). *Estimated Gross Benefits Provided by Navigation Charts in The United States.* Washington: National Ocean Service, National Oceanic and Atmospheric Administration. Retrieved from https://nauticalcharts.noaa.gov/about/docs/about/Estimated+Gross+Benefits+Provided+by+Navigational+Charts+in+the+US.pdf