COVID-19 Disruptions: Freight System and Agency Operational Changes Affecting Freight Planning

MID-AMERICA FREIGHT COALITION

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About the Mid-America Freight Coalition (MAFC)

The industries and farms of the Mid-America region can compete in the marketplace only if their products can move reliably, safely and at reasonable cost to market.

State Departments of Transportation play an important role in providing the infrastructure that facilitates movement of the growing amount of freight. The Mid-America Freight Coalition was created to support the ten states of the Mid America Association of State Transportation Officials (MAASTO) region in their freight planning, freight research needs and in support of multi-state collaboration across the region.

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15. Supplementary Notes This project documents and provides an understanding of how COVID-19 disruptions have impacted and continue to impact logistics, route choices, global sourcing and manufacturing, e-commerce, and freight traffic volumes. The project also examines the experiences of agency freight planners, freight operations professionals, and government affairs and communication specialists in these ten state DOTs. Available freight data, along with interviews with key agency personnel from the MAASTO states, are used to identify changes, and best practices, and provide a look at the possibilities in freight transportation in the post-COVID-19 period.		
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INTRODUCTION

The MAASTO states have a long history of dealing with disruptions to the freight transportation system. Flooding, extreme heat, and road closures are a yearly occurrence, often bringing the closure and the destruction of pavements and bridges. Major snowstorms, low water levels, failing marine systems infrastructure, and even earthquakes can quickly impact the ability to move goods and people across the MAASTO region.

A different type of disaster emerged in January 2020, according to the CDC Museum COVID Timeline [1]. The Coronavirus Disease 2019, abbreviated as COVID-19, and referred to as COVID-19 throughout this report, has resulted in significant mortality, impacts on human health, and societal and economic changes across the globe. Transportation modes served as a vector in the transmission of the COVID-19 virus, and when these systems were shut down, the freight system was impacted. This type of disaster resulting from human activities, intentionally or not, ia considered an anthropogenic disaster [2].

Through 2020, 2021, and even into 2022, the MAASTO region and the nation have faced and continue to face logistics challenges due to the COVID-19 pandemic. COVID-19, like natural disasters such as earthquakes or major floods, is a test of freight resiliency in the private sector supply chain and public agency operations. While the pandemic did not damage physical infrastructure, the public agency impacts, and response were and remain critical in returning life to pre-pandemic activity.

COVID-19, in combination with the impacts of a changing climate, has brought the increasing frequency and intensity of these natural disasters to light. The National Oceanic and Atmospheric Administration (NOAA), the federal agency tasked with developing products to understand climate impacts and risks, states [3] that the U.S. has sustained 332 weather and climate disasters since 1980 where overall damages/costs reached or exceeded $1 billion (including CPI adjustment to 2022). The total cost of these 332 events exceeds $2.275 trillion.

The frequency of these events is increasing. During the 1980–2021 period, the annual average was 7.7 events. The yearly average of the most recent five years (2017–2021) is 17.8 events.

The higher frequency and higher costs of these disasters are shown in Figure 1.

Like most disasters, the immediate and urgent needs of COVID-19 have accelerated change and innovation. As shown in Figure 2, e-commerce sales have increased from just under 6 percent to over 13 percent [4] of total quarterly retail sales since 2013, with the largest increases with the onset of COVID.

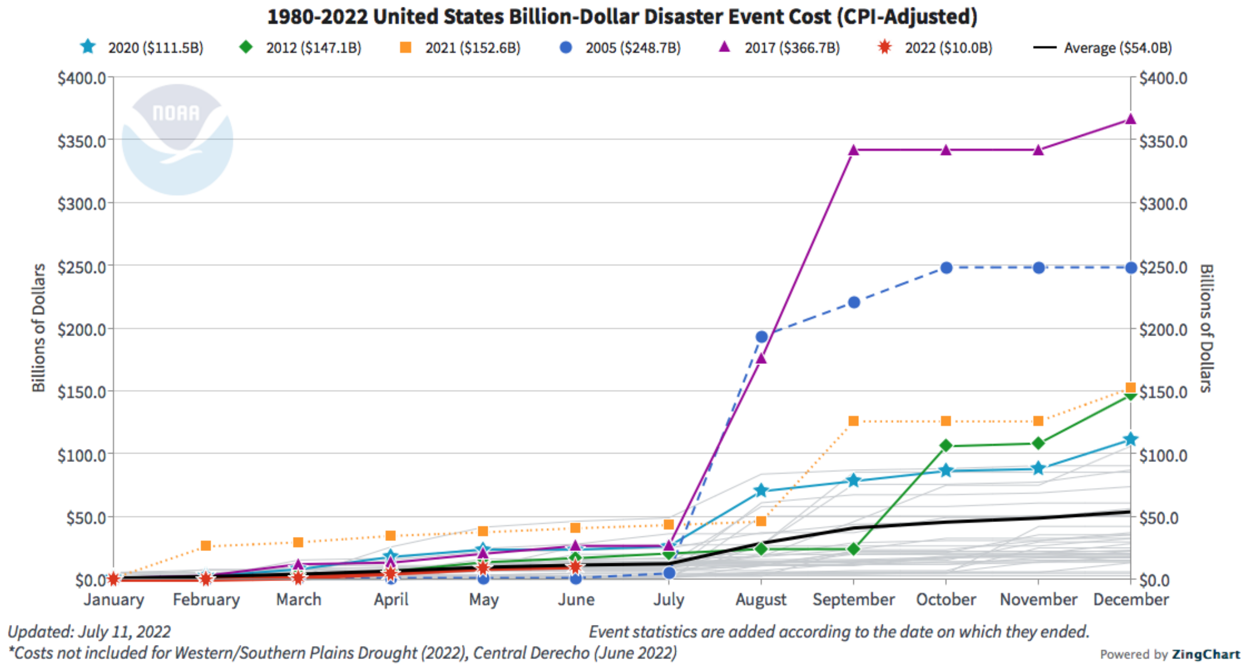

Figure 1: 1980-2022 United States Billion-Dollar Event Cost (CPI-Adjusted)

Source: NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2022).

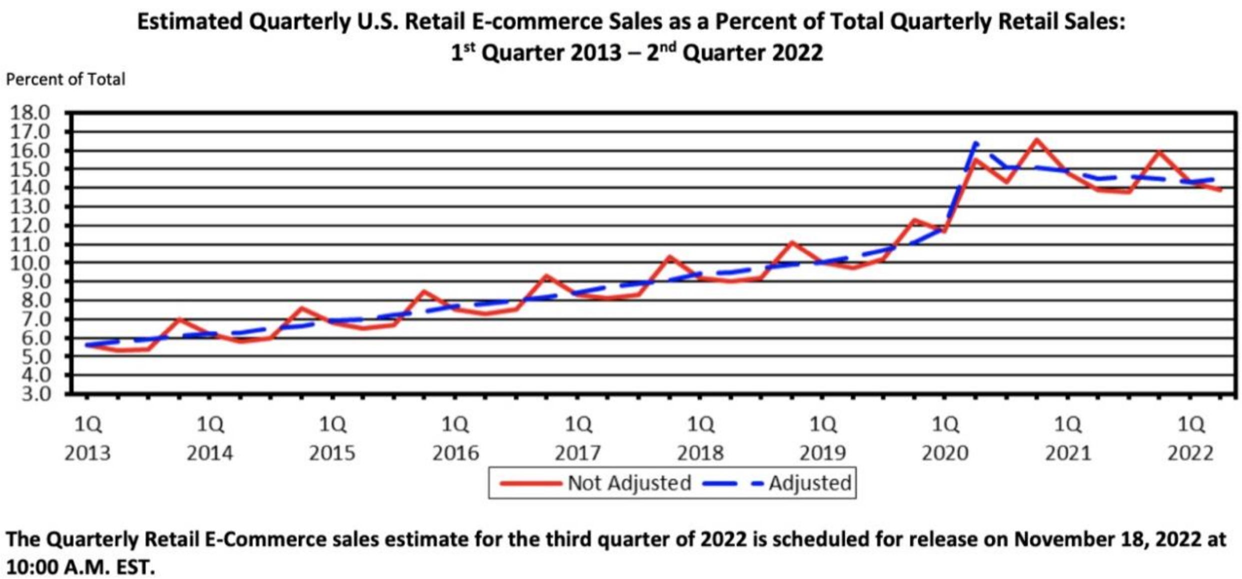

Figure 2: Estimated Quarterly U.S. Retail E-commerce Sales

Most employees experienced a transition from work in the office to the home, and personal services such as restaurants and most non-essential stores were shuttered. Automation in vehicles and services is increasing, and drones and connected and automated vehicles are all undergoing testing and feasibility assessments to support implementation.

In avoiding, mitigating, or remediating the impacts of an increasing number of high-cost disasters, agencies such as State DOTs have proven flexible, creative, and resourceful. MAASTO state relationships and its committee structure support the sharing of experiences and best practices in dealing with these impacts. This report is an example of the MAASTO states' collaborative efforts to ensure the region's freight systems are the best in the world.

Unlike a physical or natural disaster with infrastructure damage, COVID-19 presented, and continues to present the unique challenges of social distancing, isolation, and supply chain disruptions that prevent normal work and day-to-day activities. Additionally, the COVID-19 disaster is a pandemic, so no safe places for staging or organizing relief were available early in the disaster. And the disaster has proven to be open-ended. COVID-19 impacted every social and economic system, including health care, transportation, manufacturing and services, banking, and education. This breadth of impacts increased economic damage as the impacts spread through the manufacturing and logistics sectors.

Project Objective

This project documents and provides an understanding of how COVID-19 disruptions have impacted and continue to impact logistics, route choices, global sourcing and manufacturing, e-commerce, and freight traffic volumes. The project also identifies the state transportation agency's response to these resiliency challenges. Transportation agencies must understand the scope and impact of these changes to support and sustain the supply chains, logistics, and market systems.

Literature reviews, agency interviews, and available data on routing, logistics, trade, and commerce are incorporated to identify and assess significant changes in freight logistics and agency operations in response to or exacerbated by COVID-19. This information will be evaluated to determine best practices in freight planning and operations for adaptation to major disasters.

Scope of Work

This project seeks to answer the questions the MAFC freight personnel have posed regarding logistics and systems changes due to COVID-19:

- Are the region's major freight corridors changing?
- Are there changes in global sourcing that include modal changes in our region?
- How will e-commerce and household deliveries, amplified by pandemic social distancing, affect the freight system?

- What regional adaptations should MAASTO state planners consider in planning goals, strategies, technologies, processes, and operations to support immediate and longer-term advances in freight movement associated with events such as a pandemic?

A range of freight data sources was used to evaluate changes in freight movement during COVID-19. This information is supplemented with a literature review of disasters and disaster planning, along with interviews with MAASTO agency personnel from their freight office, governmental affairs or equivalent unit, communications, and the agencies' permit offices.

Based on the information collected from the data, literature review, and interviews, best practices and strategies are identified are presented. These best practices and recommendations support further development of the agencies and their abilities to plan for and mitigate disasters.

Organization of the Report

This report is organized as follows:

- **Chapter 1** provides background information, including an overview of disaster types, impacts, and response and mitigation strategies for major disasters. Additionally, a literature review of mitigation and emergency planning strategies and publications are listed with a specific focus on the recent responses to COVID-19 in freight planning and operations.

- **Chapter 2** presents baseline information for tracking changes in freight transportation in the MAASTO Region.

- **Chapter 3** reviews freight movement in the region and identifies the impacts on the freight system in relation to COVID-19.

- **Chapter 4** details MAASTO states' experiences during the COVID-19 pandemic.

- **Chapter 5** provides a project summary, COVID-19 strategies, and best practices sourced from MAASTO freight professionals.

1. LEARNING FROM PAST DISASTERS AND DISASTER PLANNING

This chapter examines past disasters and their impacts, as well as adaptation and recovery strategies through a review of the literature. A range of disasters is presented to demonstrate the commonalities and differences in disaster types, impacts, mitigation, and planning.

EM-DAT, an international emergency events database [5], recorded 7,348 disaster events worldwide, amounting to approximately 2.97 trillion dollars in economic losses over the last twenty years. The U.S is the second-most affected country, experiencing 476 disaster events between 2000 and 2019. When a disaster happens to a component of the multimodal freight infrastructure system, the freight flows and standard logistic patterns may change locally, regionally, nationally, and even globally.

Of the two types of disasters relevant to freight systems [2], natural disasters are categorized into four main types: extreme weather events, geophysical, geomagnetic storms, and sea level rise. On the other hand, anthropogenic disasters include accidents, infrastructure failure, conflicts, terrorism and piracy, economic and political shocks, and pandemics.

A pandemic, such as COVID-19, is an epidemic of an infectious disease that has spread across a large region or even worldwide, affecting a substantial number of people. A pandemic mainly impacts and compromises supply chains (food, energy, medical supplies), transportation modes, and origin and destinations, even though it would not directly damage transportation systems. Even without physical damage to infrastructure, the COVID-19 pandemic has had a disruptive effect on supply chains and transportation systems.

The following review of past disasters and disaster planning provides a foundation to understand the increasing frequency and consequences of natural and anthropogenic disasters and past response by agencies.

Disaster Planning and Disasters

The COVID-19 pandemic and increases in the frequency of natural disasters have amplified the focus on disasters and disaster planning within transportation agencies. There is much that we can learn from a review of past disasters and events. It's noteworthy that disaster planning, impacts, and mitigation strategies are ingrained in most transportation planning. The following examples provide a baseline understanding of disasters and disaster planning, mitigation, and recovery strategies. These examples also expand our knowledge of possible scenarios and responses.

The Interstate System

Quoted from the National Archives Prologue Magazine [6]:

> *In the summer of 1919, just months after the end of World War I, an expedition of 81 Army vehicles—a truck convoy—set out from Washington, D.C., for a trip across the country to San Francisco.*
>
> *The convoy's purpose was to road-test various Army vehicles and to see how easy or how difficult it would be to move an entire army across the North American continent. The convoy assumed wartime conditions—damage or destruction to railroad facilities, bridges, tunnels, and the like—and imposed self-sufficiency on itself.*

This article links this six-MPH trip, lasting 62 days, to what Dwight Eisenhower saw in Europe during WWII, to Eisenhower's role as President in persuading Congress to enact the Federal-Aid Highway Act of 1956 that created the Interstate System.

The Interstate system was planned to provide wartime connectedness and support the movement of personnel and supplies. The Strategic Highway Network (STRAHNET) continues the intent of the 1956 Federal Aid Highway Act and is critical to the Department of Defense's (DoD's) domestic operations. The STRAHNET consists of a 62,791-mile system of roads deemed necessary for emergency mobilization and peacetime movement of heavy armor, fuel, ammunition, repair parts, food, and other commodities to support U.S. military operations. Even though the DoD primarily deploys heavy equipment by rail, highways play a critical role.

The Interstate system plays a critical role in freight movement and is increasingly part of disaster planning and evacuation routing as natural disasters become more frequent in the United States.

Earthquake preparedness - The New Madrid Earthquake

Disaster preparedness and resiliency are hallmarks of advanced organizations and transportation systems. One of the longstanding efforts to prepare for disasters includes earthquake preparedness. A 2010 FEMA fact sheet on complex earthquake planning in the New Madrid seismic zone [7] reports that four of the eight states involved in the planning, Illinois, Indiana, Kentucky and Missouri, are in the MAASTO region. Alabama, Arkansas, Mississippi, and Tennessee round out the states included in the planning exercise.

In 1811 and early 1812, three earthquakes decimated the region and, if they occurred today, could paralyze the Midwest and Nation's supply chain. Under FEMA coordination, interagency earthquake disaster plans were created. The plans were developed collaboratively and are connected and all levels of government. According to the FEMA fact sheet, "The initiative is one of the most comprehensive and complex catastrophic disaster planning endeavors undertaken in the United States."

MoDOT has continued its earthquake disaster planning with a 2021 study on evacuation routes. According to the author, "What we're looking at in this project is evacuation, whether roads can handle evacuee traffic and where potential bottlenecks and delays are likely to occur so MoDOT can better plan and manage the evacuation [8]." While this planning effort is focused on natural disasters and not anthropogenic disasters such as COVID-19, the points of organization and effort are similar and reflect several key components of successful collaborative projects: the need for a project champion, resources to support the effort, excellent communication, participation across all potential stakeholders, and a common and known threat.

MAASTO Emergency Divisible Load Management Project

Another proactive and first of its kind project, MAASTO's Emergency Divisible Load Memorandum of Understanding (EDL MOU), represented an effort by all ten MAASTO states to allow increased divisible truck load weights during Presidentially-declared disasters. The purpose of the effort was to increase the speed and capabilities of moving relief supplies traveling in and across the MAASTO region. The project was championed by the MAASTO Board of Directors in response to the COVID-19 disaster. This report can be found at https://midamericafreight.org/wp-content/uploads/2022/03/MAFC26_EDL-0228-e-a1.pdf.

Transportation Reauthorization

Another recent development, the Infrastructure Investment and Jobs Act (IIJA), allocates over $1.4 billion per year for resiliency planning and links the completion of a state resiliency plan to funding access. According to the Statute, §11405; 23 U.S.C. 176(c), the Act "establishes the Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) Formula Program [9] to help make surface transportation more resilient to natural hazards, including climate change, sea level rise, flooding, extreme weather events, and other natural disasters through the support of planning activities, resilience improvements, community resilience, and evacuation routes, and at-risk coastal infrastructure."

While the IIJA is focused on natural disasters, the development of resiliency plans will further enhance those relationships, communications, and practices that also support anthropogenic disasters.

Mississippi River Flooding and Levee Breach

On May 2, 2011, in southeast Missouri, a flood was accumulating as waters rushed down the Missouri, Mississippi, Illinois, and Ohio Rivers. With expected catastrophic flooding in Cairo, IL and through Tennessee and Mississippi, the US Army Corps of Engineers (USACE) made the decision to blow up a portion of the Mississippi River levee on the Missouri side [10], flooding thousands of acres of farmland and property. This event would have certainly been more devasting to communities along the river if it had not been for the planning to create an overflow area for the river that could be accessed by destroying a portion of the levee. This was a difficult position for the USACE as the action would flood previously protected farmland by releasing this flowing water from the leveed corridor. It is important to note that this event and action were anticipated and planned based on USACE hydraulics information and economic analysis.

Mississippi River Flooding, I-40 in Arkansas

According to the Center for Research on the Epidemiology of Disasters (CRED) report [11], flooding has been one of the most common natural disasters in the last twenty years by 44 percent of total recorded events.

The Mississippi River floods in April 2011 were one of the largest along the waterway in the past century. All neighboring states, including Missouri, Illinois, Arkansas, Tennessee, Mississippi, and Louisiana, were affected by the flood waters that proceeded down the lower Mississippi from the St. Louis area. As a result of flooding, I-40, a major corridor in Arkansas, was closed, and regional and national freight traffic changed due to these closures. Figures 3 and 4 show the truck flows on regional roads before and after the disruption. Traffic flow was re-estimated by removing affected highway segments and rerouting over available routes. Providing for system redundancy and alternate routing are a common planning approach for disasters.

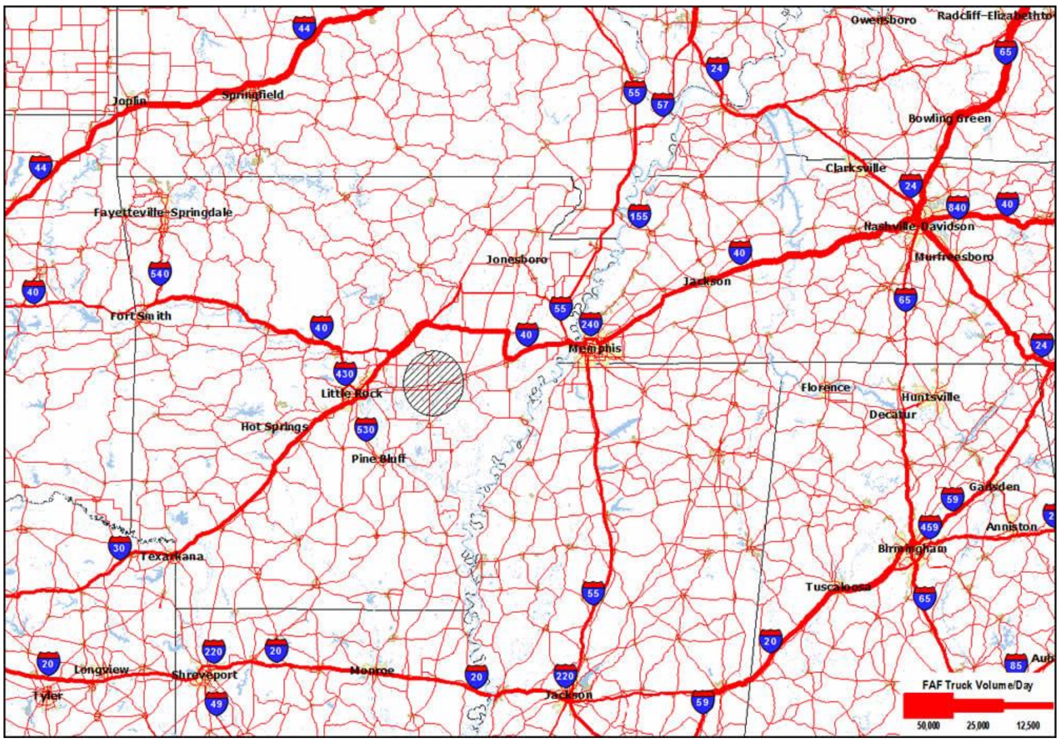

Figure 3: Pre-Disruption Regional I-40 Truck Flow Map

Source: [12] FHWA, https://ops.fhwa.dot.gov/freight/freight_analysis/fd/maps/preregtrkflowmap.htm

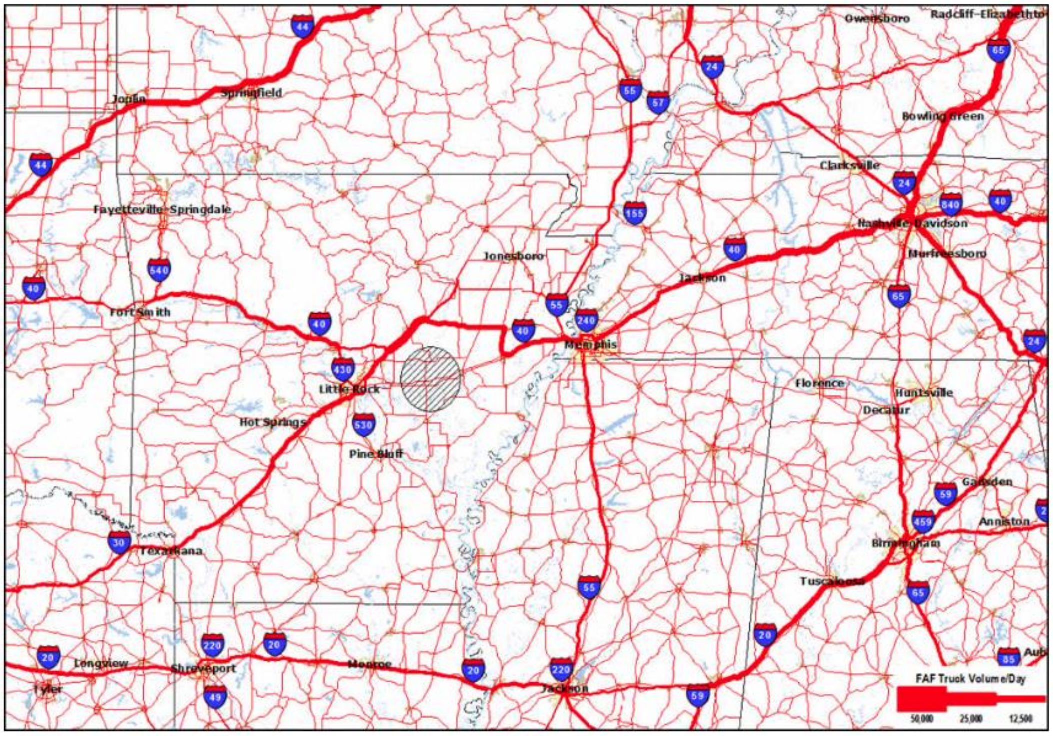

Figure 4: Post-Disruption Regional I-40 Truck Flow Map

Source: [13] FHWA, https://ops.fhwa.dot.gov/freight/freight_analysis/fd/maps/pstregtrkflowmap.htm

Japan Earthquake, Tsunami, and Nuclear Disasters

In March 2011, the Tōhoku earthquake (9.0 magnitude) caused a massive tsunami in Japan and was followed by a meltdown at the Fukushima nuclear plant. This "Triple Disaster [14]," with over 15,000 deaths, produced significant disruptions in Japan's extensive supply chain network and caused a dramatic drop in the country's industrial production. Consequently, other countries linked through these production networks were impacted, particularly the U.S. automobile manufacturing and assembly plants.

This event demonstrates the potential for far-reaching impacts when global supply chains are involved. A disaster event can cripple multiple distant economies when major industries congregate. While the geographic scope of a global marketplace supports alternate sourcing points, economic clustering often precludes this benefit.

Iceland Volcano Cloud

Another example of the far-reaching impacts of distant disasters was the eruption of the Eyjafjallajökull Volcano in 2010, which resulted in the largest air-traffic shut-down since World War II [15]. Almost every country with an international airport, including Canada, Russia, and Kazakhstan, experienced some disruption due to European flight cancelations because of ash clouds in their airspace. According to the international air association (IATA) estimation, the total loss for the airline industry was around 1.7 billion dollars, with 107,000 canceled flights and five million stranded travelers during an eight-day airspace ban. Although freight transportation through air comprised less than one percent of total U.S. international trade in April 2010, this disruption caused significant problems for the high value and perishable goods movement from the affected region, where the volume of U.S.-bound air freight declined by seven percent.

In the aftermath of this disaster, Bloomberg Businessweek [16] cited supply chain flexibility through multiple sourcing and logistics networks, and not just cost, as a consequence of alternative routing.

Hurricane Katrina and Rita

In 2005, the U.S. Gulf Coast was struck by two major hurricanes, Katrina and Rita. These events resulted in significant damage to the road, rail, port, and pipeline infrastructure. Along its path, Katrina caused an estimated 161 billion dollars in damage [17] by affecting more than 900,000 square miles.

Grenzeback and Lukmann [18] document much of Katrina and Rita's impact on the supply chain. During the disaster, the pipeline network transferring oil and natural gas shut down, leading to a nearly 92 percent drop in oil production and, consequently, shortages of natural gas and petroleum products. Moreover, the nation's most extensive and heavily used inland waterway system for the transport of bulk materials, which includes the Ports of New Orleans, South Louisiana, and Baton Rouge, was severely disrupted. Cargos impacted include bulk-farm products (such as grains) and petroleum. The top-two cargoes that use this river system are bulk-farm products (such as grains) and petroleum. Other primary cargoes include coal, crude materials (iron ore), and bulk chemicals. Similarly, Katrina destroyed key railroad bridges and required the rerouting of traffic to different rail segments and even different parts of the system.

Katrina also had a devastating impact on the highway network, especially Interstate I-10 and U.S. 90, which serve as major freight highways carrying trucks through traffic in the central Gulf Coast region. Figures 5 through 7 illustrate the severe damage of Katrina and Rita to transportation systems in the Gulf Coast Region, as documented by Grenzeback and Lukmann [18].

Figure 5: Displaced Segments on I-10 – U.S. 90 Ramp in Mobile Bay

Figure 6: Cranes Used to Right the Rails on the Norfolk Southern Bridge

Figure 7: Damage to the Biloxi-Ocean Springs Bridge (from Ocean Springs, Mississippi)

These hurricanes resulted in impacts on every freight mode and threatened the gateway status of the Gulf. The impacts also affected a range of key industries due to interruptions in fuel movement and also stalled a significant portion of the central U.S. agriculture inputs and products.

COVID-19

With the coronavirus (COVID-19) outbreak, almost every dimension of economic and social life has been affected. Unlike natural disasters and wars, which affect the physical infrastructure of transportation, the pandemic directly affects the users. Freight transportation has been impacted severely due to complex supply and demand trends, workforce adjustments, and increased levels of home shopping and deliveries. The impact of COVID-19 on transportation modes has been different from past physical disasters. According to a McKinsey report issued in June 2020 [19], compared to the previous year, truck traffic initially increased by about 30 percent in 2020, then dropped noticeably, and has since revived again. On the other hand, railroad and waterway tonnage declined by 20 percent and 25 percent and have not fully recovered.

In identifying the broad transportation impacts of COVID-19, the National Cooperative Freight Research Program (NCFRP) project 39 identified six key components of the supply chain that are impacted. The areas identified include physical, logistical, financial, communication - transactional and informational, regulatory/oversight, and institutional factors and relationships [20]. As shown in Figure 8, the broad impacts required emergency funding across all transportation sectors. The aviation industry was the recipient of the largest amount of COVID-19 relief funds [21].

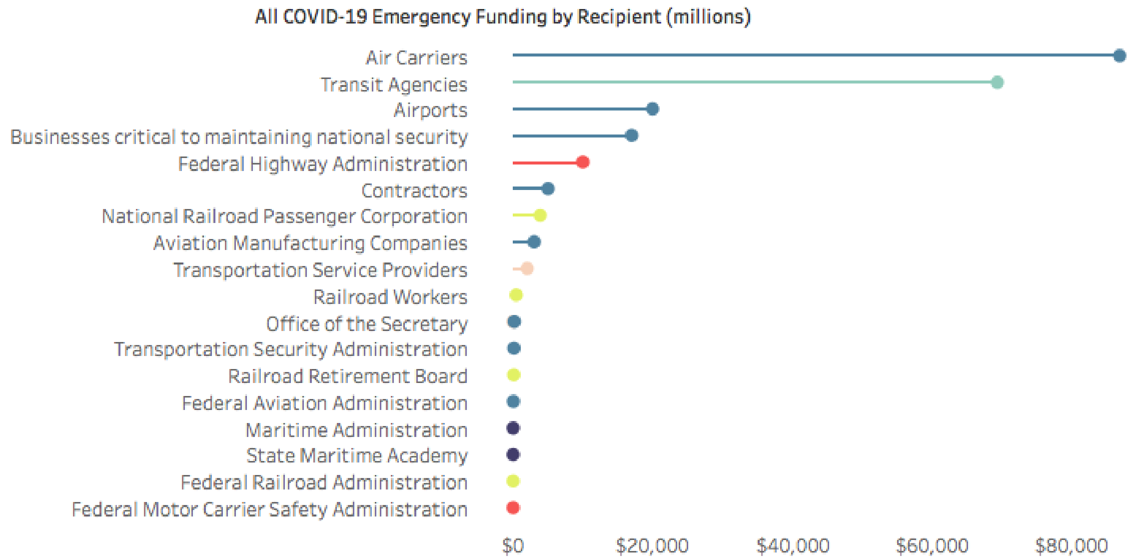

Figure 8: All COVID-19 Emergency Funding by Recipient (millions)
Source: Bureau of Transportation Statistics

The impacts on GDP on a global level were also historic, as documented in the April 2022 Economic Report of the President to Congress [22].

> *"The pandemic was accompanied by historic drops in output in almost all major economies. U.S. GDP fell by 8.9 percent in the second quarter of 2020 (figure 3-3), the largest single-quarter contraction in more than 70 years (BEA 2021c). Most other major economies fared even worse. The GDP of the United Kingdom in 2020: Q2 was 21.4 percent below its average in 2019 (ONS 2022). In the euro area, output fell by more than 12.4 percent (Eurostat 2022c). Closer to home, Canada's GDP was down 12.4 percent, while Mexico's GDP fell by 19 percent (Statistics Canada 2022; INEGI 2022)."*

From toilet paper shortages, record unemployment, limited or no services for truck drivers operating on long-haul routes to a massive transition to home deliveries, COVID-19 has spawned changes in nearly every aspect of social and economic life, and according to reports reviewed, the changes and transitions are not over.

Lessons from Past Planning and Events

Several themes reoccurred in examining a wide range of disaster planning and disasters. First, disaster planning and resiliency are ingrained in transportation development. From the Interstate system to hydraulic studies for bridge clearances to the recent MAASTO Emergency Divisible Load memorandum, expecting and planning for the worst-case scenario have always been ever-present in transportation planning and engineering.

Second, the longer the supply chain, especially if it involves globally sourced and finished inputs and products, the more points of contention or potential disruption. Similarly, the concentration of an industry in only one region increases risk. Both factors point to the greater responsibilities of countries, not supply chain logistics companies, to ensure that critical supplies and technologies can be produced within a country or service area. Fourth, anthropogenic and natural disasters will continue and likely increase in frequency.

Given these contributing dimensions, national-level decisions are needed to decrease the environmental impacts of the supply chain, including potential changes in fuel types, land use, and emissions. While some of these possible steps are significant, the cost of continuing the current freight systems may soon outweigh the cost of the change.

Resiliency and Mitigation Strategies

Communication, Information, Access, and Redundancy

As global trade volumes grow and the supply chain lengthens, vulnerabilities and likelihoods of supply chain disruption increase dramatically. Examples of catastrophes in Japan disrupting the global computer chip supply, events such as Hurricanes Katrina and Rita, the West Coast ports lockout, Mississippi river flooding, and COVID-19 have reinforced the need for greater resiliency in our freight transportation system.

Resilience, according to the U.S. Federal Highway Administration [23] regarding the supply chain and transportation, is defined as the ability to prepare for changing conditions and withstand, respond to, and recover rapidly from disruptions.

And "resilience strategy" is any tactic to mitigate the effects of disruptions and return the supply chain to normal operating conditions [24].

In looking at private sector logistics, Sheffi [25] found that building a resilient enterprise in a company could be a good strategy to reduce the likelihood of disruptions and increase resiliency. By creating redundancy or increasing flexibility, he characterized significant disruptions and a company's responses to eight general phases, as shown in Figure 9. Companies should be prepared for disruption in the preparation phase to minimize effects. However, in some cases, such as terrorist attacks, there is no warning.

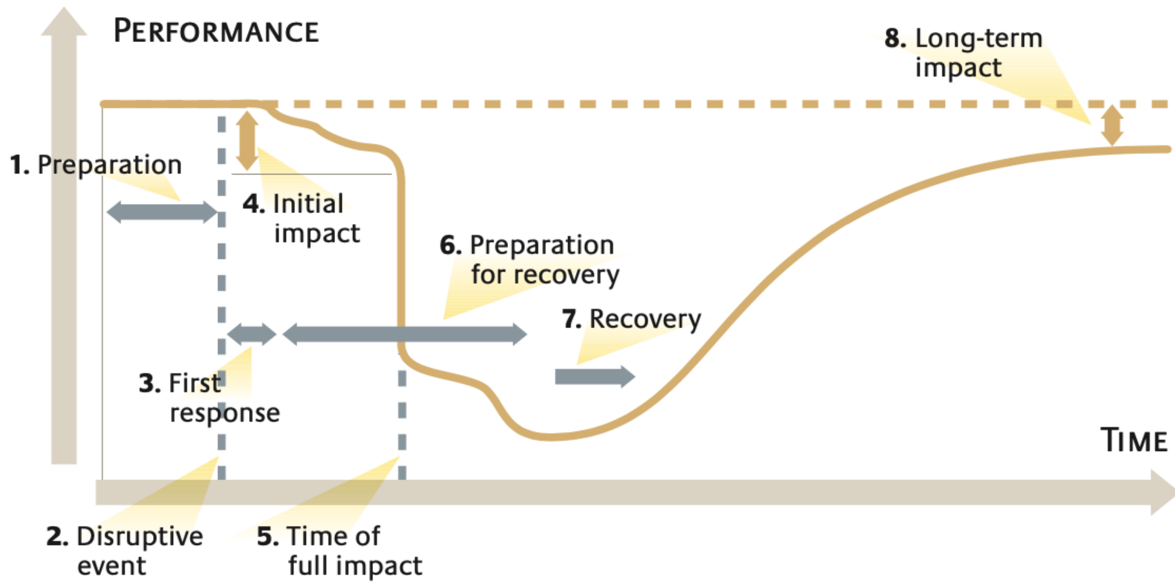

Figure 9: Disruption and Dynamics of the Company's Performance

Source: A Supply Chain View of the Resilient Enterprise, Sheffi, et al.

After the disruptive event, the first response is to control the situation and prevent further damage. The initial and full impact of disruptions vary based on the disruption magnitude, and the company's resilience and redundancy will affect the company, leading to a performance drop. In the subsequent phases, companies move to regular operations. Some example strategies include finding alternative transportation modes, such as the use of air freight during the 2002 West Coast port lockout or establishing new protocols for strengthening the global cargo security regime (after the terrorist attacks of September 11, 2001).

Lanza et al. [26] also proffered that information sharing across the entire supply chain would enhance their preparedness for risks and improve the decision-making process. However, contributing to weakness in a firm's resiliency business models, there are difficulties and reluctance in sharing information that may benefit a competitor. Moynihan cites such behavior during Hurricane Katrina [27].

Likewise, Cohen and Kunreuther [28] envisioned a conceptual framework in three steps to be prepared for high-impact disruptions. The three steps include:

(1) Risk Assessment and Vulnerability Analysis
(2) Risk Management
(3) Evaluation of Strategies

Despite the importance of the risk assessment process in dealing with risks that eventually lead to supply chain disruptions, over 55 percent of firms don't use such a practical risk-based approach. Lack of time was cited as the prominent reason [29].

Within the organizational and enterprise context, numerous researchers have also attempted to measure the vulnerability, reliability, and resilience of freight transportation networks. A disruption in the freight system could have significant negative impacts on the national economy. Given the volume of freight moving in the U.S., any sustained disruption requiring diversion of one mode to other modes could impact timely and secure delivery of products, product availability, and overall transportation system efficiency.

Although the definitions of resilience are more explicit in the business supply chain context, they are not as clear in freight transportation systems due to the broad range of stakeholders and their positions and roles in the supply chain, resiliency takes on many definitions [30], [31].

Ta et al. defined freight transportation system resilience [32] as the ability of the system to absorb the consequences of disruptions, reducing the impacts, and maintaining freight mobility. He assumed 31 properties for complex systems and six properties for freight transportation systems. The six properties are redundancy, the autonomy of components, collaboration, efficiency, adaptability, and interdependence. Supporting these six properties enhances resiliency and maintains adequate freight flows. In Table 1, the definition of each of these properties is summarized. Regarding these definitions and properties, Ta argued that a well-defined framework could be used for strategic planning, strategic investments, and resource allocation to support freight transportation system resilience.

Table 1: Concept Definitions for Resilience and Freight Transportation System

Concept	Definition
Redundancy	Availability of more than one resource to provide a system function
Autonomous components	Parts of a system that have the ability to operate independently
Collaboration	Engagement of stakeholders and users in a freight transportation system to promote interaction, share ideas, build trust, and establish routine communication
Efficiency	Optimization of input against output
Adaptability	System flexibility and a capacity for learning from past experiences
Interdependence	Connectedness of components of a system or the dimensions of a system, including the network of relationships across components of a system, across dimensions of a system, and between components and dimensions

Source: Structuring a Definition of Resilience for the Freight Transportation System, 2009, Ta, et al.

Chen et al. [33] proposed a quantitative, system-level indicator of transport network resilience that considers topological and operational attributes of the network to cope with disruptions. He also suggested a stochastic mixed-integer program for quantifying network resilience and identifying an optimal post-event course of action.

On the applied side, Ta identified low-cost actions [34] that the Washington DOT can implement to improve and support the freight transportation system resilience in this state. These actions can be broken into three major areas: (1) modeling and informed infrastructure capacity management, (2) information dissemination, and (3) organizational processes.

The private and public sectors prepare and experience the same disaster differently, and preparation for disasters is the responsibility of both parties. Further, supply chains for key products and industrial inputs are critical and should be evaluated for products where complex or distant supply chains may threaten the supply. Increased integration of the private sector supply chain data along with their participation in planning processes, could greatly enhance disaster planning and response.

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2. TRACKING CHANGES IN FREIGHT TRANSPORTATION IN THE MAASTO REGION

Efficient and reliable movement of freight is vital to the United States economy and Americans' daily lives. To examine the impacts of COVID-19 on freight movement, current freight trends can be compared to the expected trends or a baseline. The USDOT pre-COVID-19 growth estimates show considerable growth in freight transportation, where the total value of freight is projected to double [35] that of 2012 by 2045.

Tables 2 & 3 illustrate the total tonnage and value of freight moved by each transportation mode. By 2045 the total weight of freight (Table 2) on all transportation modes is expected to reach 25 billion tons, and its value (Table 3) is anticipated to reach $37 trillion.

Table 2: Tonnage by Freight Mode: 2012, 2018, and 2045 (Millions)

Mode	2012				2018				2045			
	Total	Dom.	Exp.	Imports	Total	Dom.	Exp.	Imports	Total	Dom.	Exp.	Imports
Truck	10,700	9,893	462	345	11,920	11,108	437	375	16,415	14,226	1,205	984
Rail	1,797	1,481	182	134	1,781	1,404	200	177	2,250	1,588	332	330
Water	658	502	76	80	839	542	218	79	942	609	201	132
Air	7	2	3	2	6	2	2	2	26	4	13	9
Multiple Modes & Mail	418	309	59	50	504	328	84	92	800	431	176	193
Pipeline	3,031	2,672	105	254	3,345	3,061	88	196	4,766	4,058	350	358
Other /Unknown	42	37	2	3	39	30	7	2	32	16	5	11
TOTAL	16,953	14,895	889	1,169	18,615	16,474	1,037	1,104	25,473	20,932	2,282	2,259

Source: U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 4.5.1, 2019, https://www.bts.gov/faf

Dom = Domestic Exp=Exports

Table 3: Value of Shipments by Freight Mode (Billions 2012$) for 2012, 2015, and 2045

Mode	2012				2018				2045			
	Total	Dom.	Exp.	Import	Total	Dom.	Exp.	Import	Total	Dom.	Exp.	Import
Truck	12,216	10,251	884	1,081	12,975	10,784	910	1,281	24,001	16,219	3,557	4,225
Rail	722	411	137	174	782	434	143	205	1,629	646	469	514
Water	430	270	73	87	546	300	154	92	872	340	281	251
Air	673	135	284	254	593	140	219	234	3,208	324	1,505	1,379
Multiple Modes & Mail	2,121	1,746	97	278	2,265	1,794	114	357	4,970	3,393	418	1,159
Pipeline	1,325	1,150	53	122	1,533	1,387	44	102	1,901	1,546	205	150
Other/ Unknown	40	1	17	22	97	1	74	22	324	-	76	248
TOTAL	17,729	13,965	1,545	2,219	18,908	14,838	1,658	2,412	37,064	22,469	6,511	8,084

Source: U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 4.5.1, 2019, https://www.bts.gov/faf.

Dom = Domestic Exp=Exports

Tables 4 and 5 and display freight shipments by weight and value by state. This data is sourced from FAF data. Figure 10 is a visual representation of the data.

Table 4: Freight Shipments by Weight in MAASTO States, 2017

State	Total Shipment by Weight (Thousands of tons)				
	Air	Truck	Rail	Water	Total
Illinois	863	754,972	226,334	37,442	1,019,611
Indiana	89	434,244	88,110	22,372	544,815
Iowa	68	409,180	91,425	4,659	505,332
Kansas	93	284,063	64,359	12	348,527
Kentucky	698	266,528	57,854	53,711	378,791
Michigan	328	358,971	111,852	45,355	516,506
Minnesota	177	376,158	139,267	18,281	533,883
Missouri	77	299,169	66,608	21,352	387,206
Ohio	276	559,210	561,118	30,316	1,150,920
Wisconsin	104	344,763	72,037	12,190	429,094
TOTAL	2,773	4,087,258	1,478,964	245,690	5,814,685

Source: U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 4.5.1, 2019 https://www.bts.gov/faf.

Table 5: Freight Shipments by Value in MAASTO States, 2017

State	Total Shipment by Value (Millions of Dollars)				
	Air	Truck	Rail	Water	Total
Illinois	88,193	1,026,380	84,347	35,291	1,234,211
Indiana	9,582	587,077	42,574	3,526	642,759
Iowa	3,047	293,606	35,662	2,448	334,763
Kansas	8,503	280,079	23,657	7	312,246
Kentucky	92,374	390,026	20,294	10,353	513,047
Michigan	15,765	722,817	106,460	9,833	854,875
Minnesota	17,019	338,415	41,133	3,177	399,744
Missouri	5,862	344,705	23,343	7,649	381,559
Ohio	22,414	792,305	57,920	5,026	877,665
Wisconsin	6,836	422,085	17,932	5,040	451,893
TOTAL	269,595	5,197,495	453,322	82,350	6,002,762

Source: U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 4.5.1, 2019, https://www.bts.gov/faf.

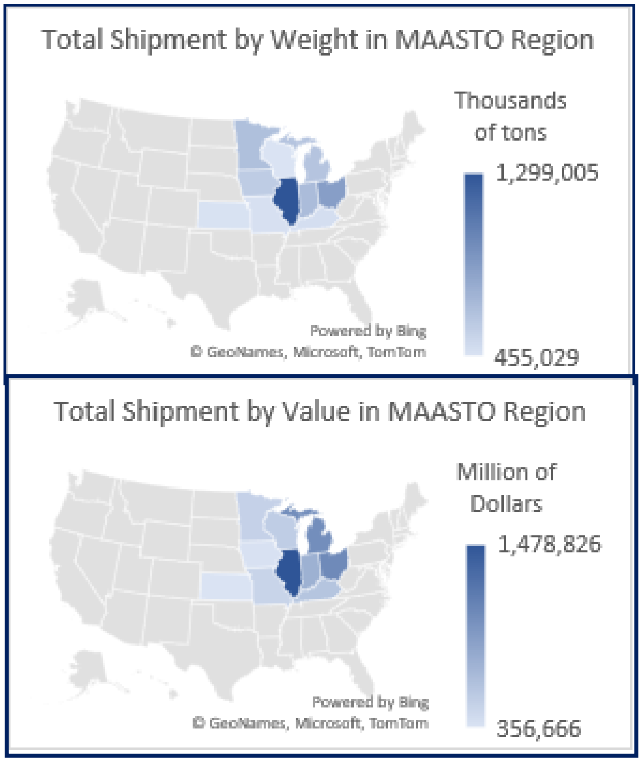


Figure 10: Total Freight by Weight and Value in the MAASTO Region

Source: U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 4. 5.1, 2019, https://www.bts.gov/faf.

Figures 11 and 12 are also visualizations of Tables 4 and 5. In the MAASTO region, similar to the entire U.S., the truck mode has the most significant proportion of total freight weight and value, with 61.7 percent of total tonnage and 72.6 percent of the total value as noted in Tables 4 and 5.

Moreover, in maritime freight, the MAASTO region has extensive access to Inland Waterways System (IWS) and deep-water international waterways. Nine of ten of the MAFC states have access to the Mississippi River System (all except for Michigan). According to the Waterborne Commerce of the United States data, MAFC States move nearly 245 million tons of freight with a total value of 82 billion dollars on the inland waterways and Great Lakes. The rail and air freight systems also play an essential role in freight transportation in the MAASTO region.

Rail moves nearly 14 percent of the total freight tonnage and just over 5 percent of the total freight value. And while air cargo is minimal in terms of tonnage at less than 2 percent, it comprises 3.5 percent of the total value moved.

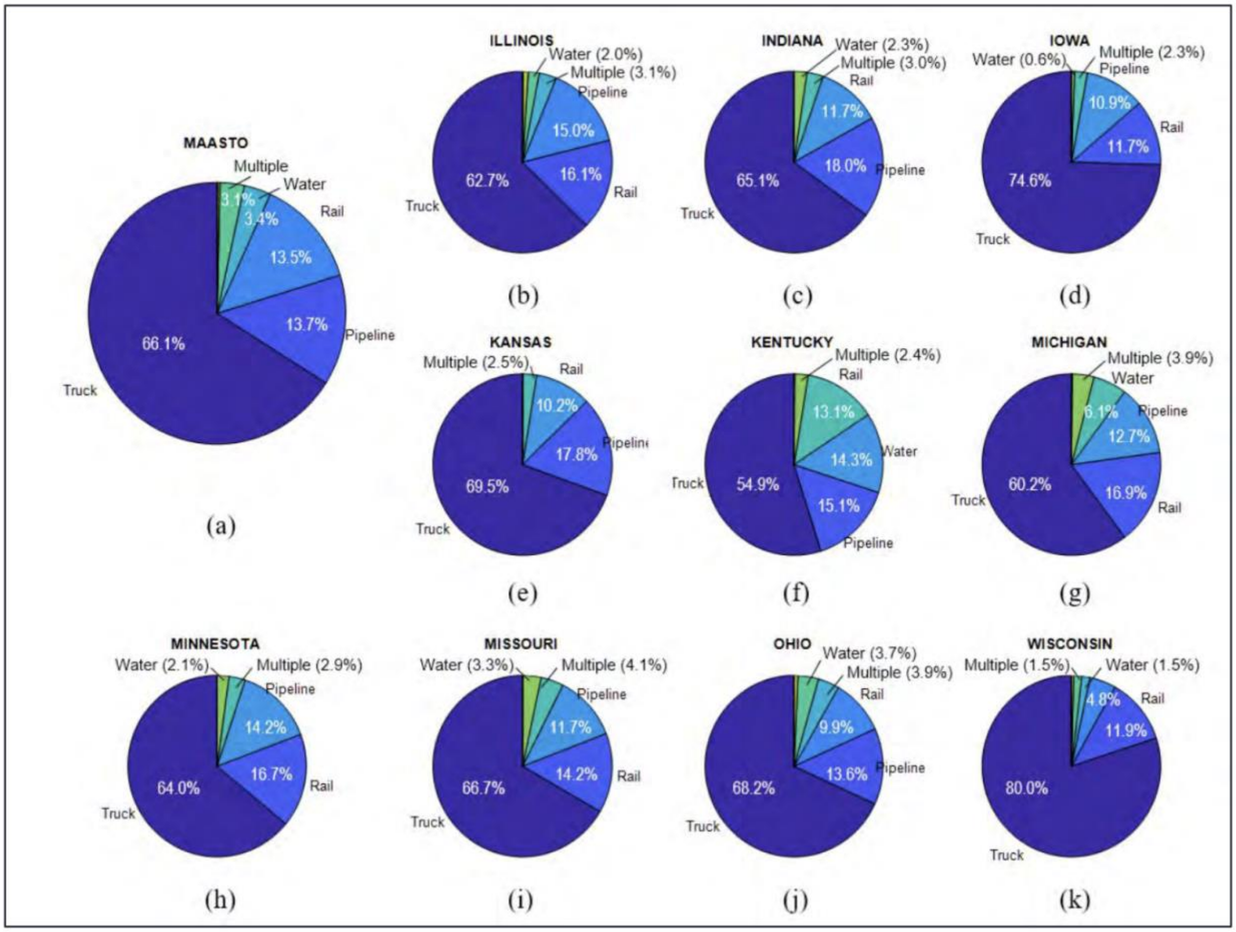


Figure 11: MAASTO States Percent Tonnage by Mode

Source: U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 4.5.1, 2019 https://www.bts.gov/faf., reproduced from, https://midamericafreight.org/wp-content/uploads/2022/08/Final-MAFC_MAASTO_Regional_Freight_Alignment-22.pdf

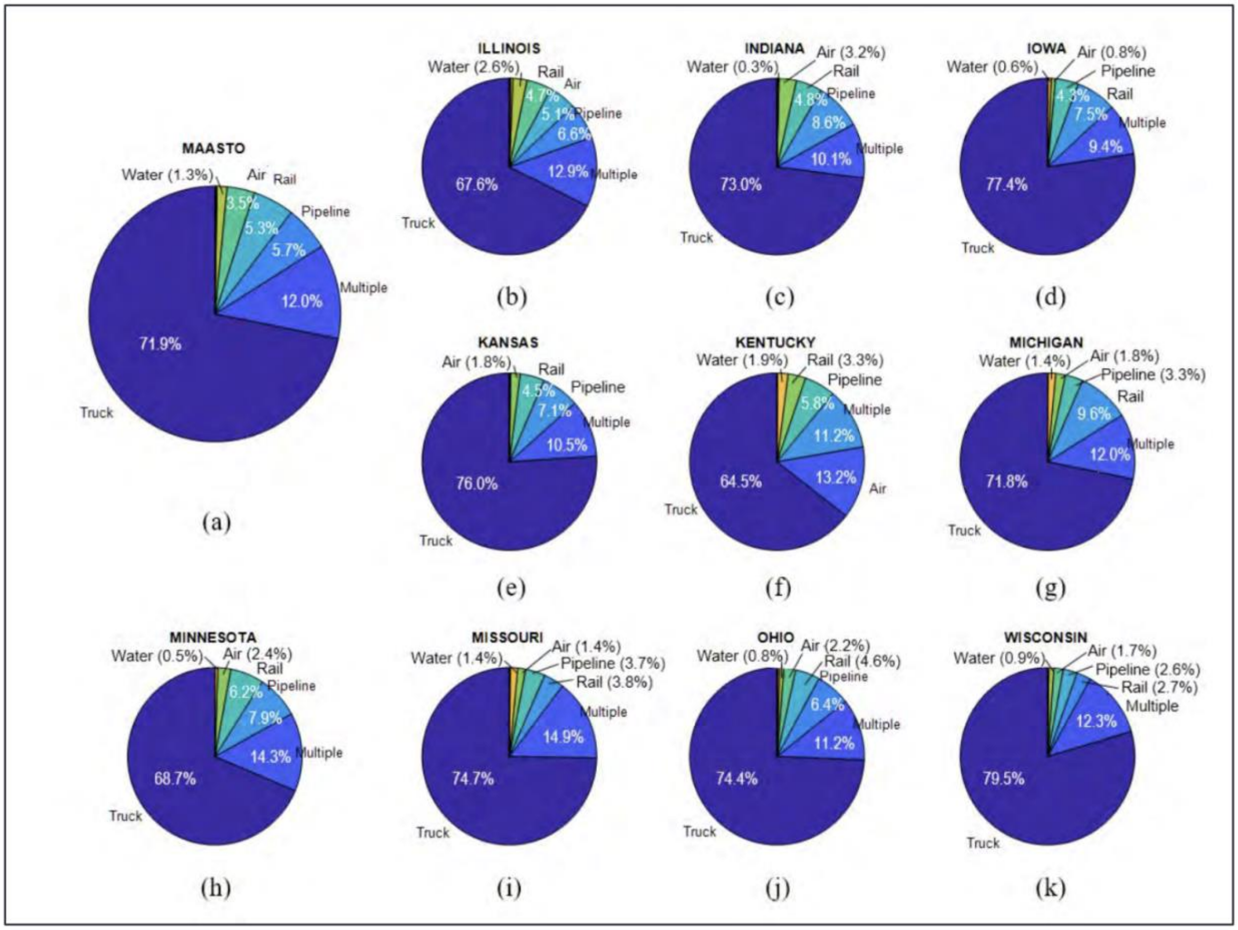


Figure 12: MAASTO States Percent Value by Mode

Source: U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 4.5.1, 2019, reproduced from, https://midamericafreight.org/wp-content/uploads/2022/08/Final-MAFC_MAASTO_Regional_Freight_Alignment-22.pdf.

These tables and charts clearly show the importance of freight in the MAASTO region. The MAASTO region is considered the crossroads of freight activity. Freight rail corridors, waterways, freight aviation hubs, and highway freight corridors all meet and cross in the region. Disasters such as COVID-19, flooding, and any significant resiliency challenges impact the region as well as the nation and global logistics and trade.

Tracking changes in freight systems in the short term is difficult, given the latency of public datasets. During the planner interviews it was noted by several respondents that we will not see the impact of COVID-19 for several years. And it should be noted that the aviation and trucking sectors rose to the challenge to rapidly move emergency supplies.

Several available data resources for tracking the recent changes in freight traffic levels, origin, and destination, and modal loads are reviewed in the following section.

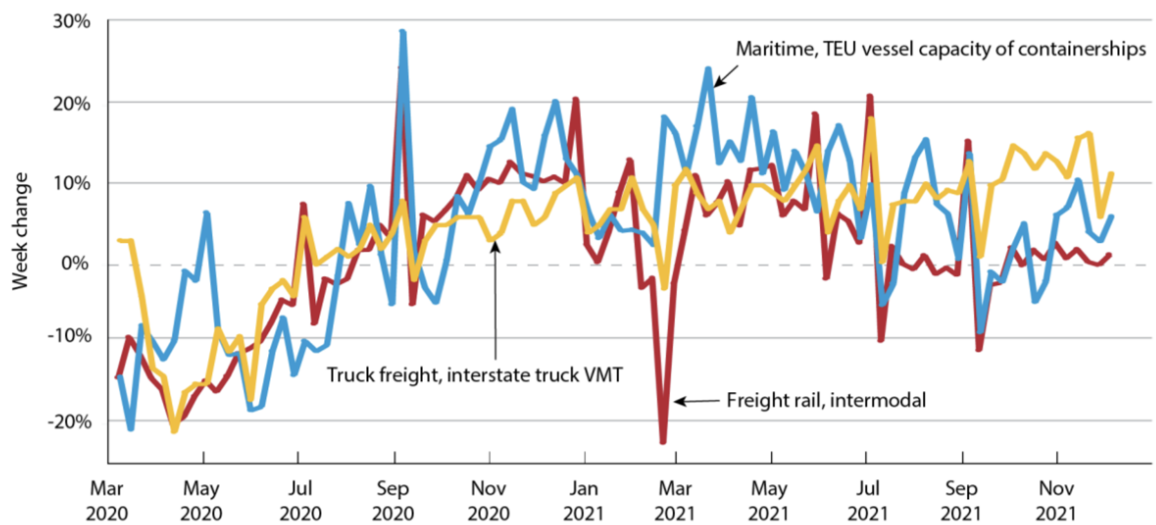
Data Resources

Real-time data can help to improve efficiency, visibility, flexibility, and agility along the supply chain. According to a 2022 report by IBM and Oxford Economics [36], 49 percent of supply chain leaders can capture real-time data and react to changing conditions due to widescale disruptions, while 51 percent use artificial intelligence (AI) and predictive analytics to gain insights.

By accessing real-time data and increasing visibility within the supply chain, management can identify efficiencies and issues immediately and devise the proper solutions in real-time. Secondly, they would gain insights needed to make long-term improvements in the supply chain's operations and resilience. Finally, the fast and effective exchange of data in a cloud-based and collaborative platform allows leaders to improve the quality and speed of decision-making and management. However, freight planners generally do not have access to this detail or visibility of the freight types, tonnages and values moved as compared to the private sector.

Public information to track real-time events is not available. Real-time data sets are available for purchase and special reports are often produced to capture the event, its associated projects, and costs. The Bureau of Transportation Statistics (BTS) provides national and modal updates on trends during COVID-19 at https://www.bts.gov/COVID-19. The data and analysis provide higher-level summaries. Disaggregation of the BTS information is needed to assess the trends on a regional or state level. Figure 13 shows the modal shipping trends during the COVID-19 period.

FIGURE 2-5 Freight Modes Percent Change from Baseline (weekly)



SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, *The Week in Transportation*, www.bts.gov/twit, accessed November, 2021.

Figure 13: Freight Mode Percent Change from Baseline (Weekly)

Source: Bureau of Transportation Statistics, 2020-2021

In addition, weekly transportation statistics are provided along with the latest freight indicators, listed as **Latest Supply Chain Indicators** (https://www.bts.gov/freight-indicators). The available data, accessed Tuesday August 30, 2022, provides a useful snapshot of aggregate trends.

Latest Supply Chain Indicators

Tuesday, August 30, 2022

The U.S. Department of Transportation has convened an interagency working group led by the Bureau of Transportation Statistics to develop timely information on supply chain activity. The working group includes relevant DOT modes and the U.S. Departments of Agriculture, Energy, Commerce, and Labor.

BTS freight information is organized into four sections:

- Port Congestion - Inside the Gate
- Port Congestion - Outside the Gate
- Freight Movement
- Transportation Labor and Capacity Tightness
- Notes & Sources

Port Congestion - Inside the Gate

- Capacity of Containerships at U.S. Ports
- Loaded Import Containers at Select U.S. Ports
- Loaded Export Containers at Select U.S. Ports
- Empty Export Containers at Select U.S. Ports
- Empty Export Containers at Select U.S. Ports by Month and Year
- Number of Containerships Anchored off U.S. Ports
- Containerized Exports at U.S. Ports
- Containerized Imports at U.S. Ports
- Number of Containerships Waiting Berths at U.S. Ports

Within the Freight Movement category of the Supply Chain Indicators, the following data is available:

Freight Movement

- U.S. Total Rail Carloads
- U.S. Total Rail Intermodal
- Containers on Rail Flat Cars
- Trailers on a Rail Flat Car
- Interstate Vehicle Miles Traveled: Percent Change from 2019
- Freight Transportation Services Index: 2019, 2020, 2021

The BTS information is invaluable and, when supplemented with state DOT agency data, can provide a picture of the impacts from the national level to the regional and state levels. Truck traffic estimates, along with truck permit numbers from each MAASTO state, are used in Chapter 3 to provide an assessment and overview of changes during the COVID-19 period.

Other data sources commonly used to track freight movement include the real-time truck probe data from American Transportation Research Institute (ATRI) and INRX.

The **American Transportation Research Institute (ATRI)** provides real-time GPS-based spatial and temporal data from more than a million heavy-duty trucks all over the U.S. These truck GPS data have been collected since 2002. They can be used for tracking freight flows, identifying truck bottlenecks, truck parking studies, and identifying and monitoring the impacts of COVID-19 disruptions on the trucking industry. ATRI's recent research used its truck GPS dataset to identify the top 100 truck bottlenecks in 2021. This type of information empowers the decision-making process in both the private and public sectors. Similarly, another study used this dataset to quantify COVID-19 impacts by converting them to a truck activity index that shows initial signs of a return to normal conditions in most states.

INRIX has also provided a source of nationwide real-time geographic and temporal freight vehicle data since 2007. In their April 2020 report on freight movement during COVID-19, there was a 13 percent decline in commercial truck travel nationwide and significant travel speed increases in freight-heavy corridors in urban areas in the intial period of March 14, 2020 through April 10, 2022. Figure 14 shows the decline in freight vehicle miles traveled by states indicating trucking was hit harder in some regions; for example, Michigan has experienced 37 percent decreases from the pre-COVID-19 period while Minnesota and Wisconsin are down just four percent. The report can be accessed here: https://inrix.com/learn/impact-of-coronavirus-on-freight-movement-study/.

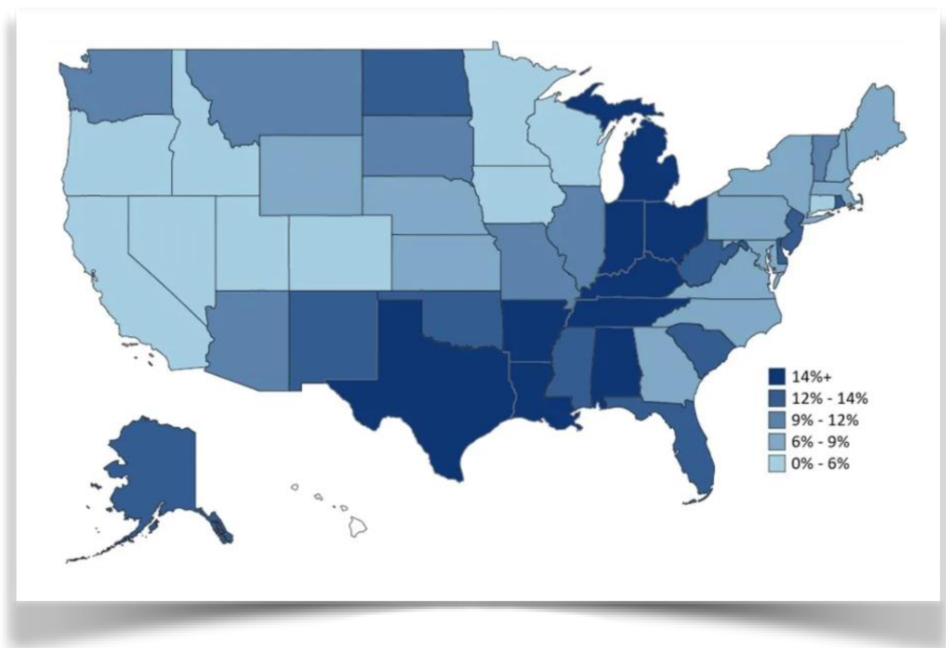


Figure 14: The Decline in Freight Vehicle Miles Traveled by State

Additional analysis approaches include MS2 (https://www.ms2soft.com/), a cloud-based Transportation Data Management System (TDMS) software for mapping, managing, and analyzing vehicle data. This software includes different modules ranging from traffic counts, turning movements, travel time, traffic crashes, road design, asset management, and performance measurement.

Figure 15 shows a 2021 traffic dashboard launched by MS2 to provide timely traffic volume information for monitoring the impacts of the COVID-19 pandemic. Private sector businesses, logistic and service providers collect, analyze and plan strategically based on the real-time data available. However, business security and competition mostly preclude them from sharing that information with public agencies.

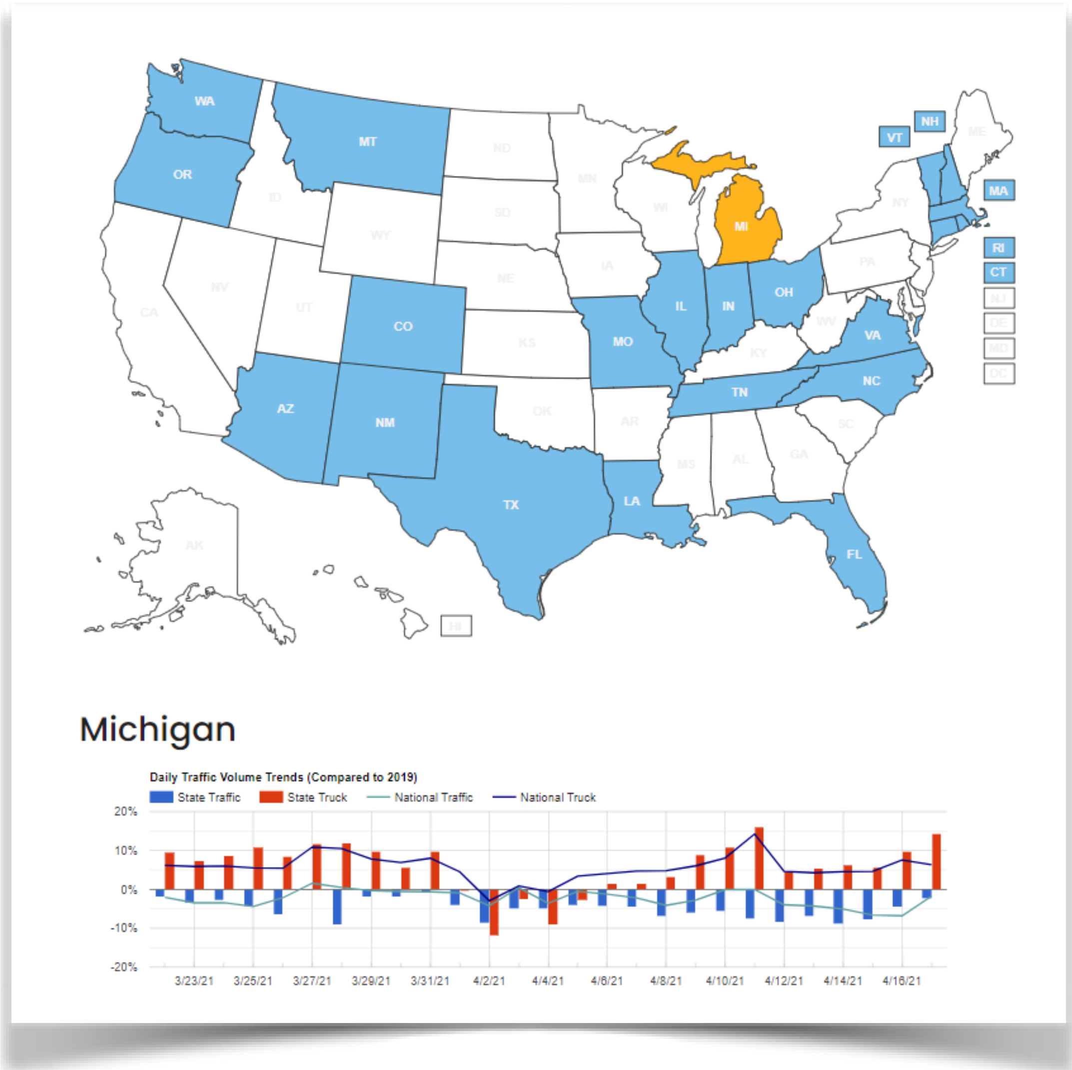


Figure 15: MS2 Traffic Dashboard

In summary, tracking changes in freight and logistics movements during times of disaster is difficult. Aggregated statistics by mode and geography (national) are available. When supplemented with regional and state data, it can provide a reasonable assessment of the impacts, changes, and trends associated with the COVID-19 pandemic.

3. COVID-19 IMPACTS ON FREIGHT TRAFFIC

The COVID-19 pandemic has brought unprecedented disruption to all countries, significantly impacting the world's transportation systems. Figure 16 shows the United Nations Conference on Trade and Development (UNCTAD) graphic for international commerce and the trade flows in 2018-2022, which illustrates a 5 percent drop in merchandise trade in the first quarter of 2020. This report also indicates that the trade slowdown in developing countries has fallen relatively faster than in developed countries and has been slower to rebound in general.

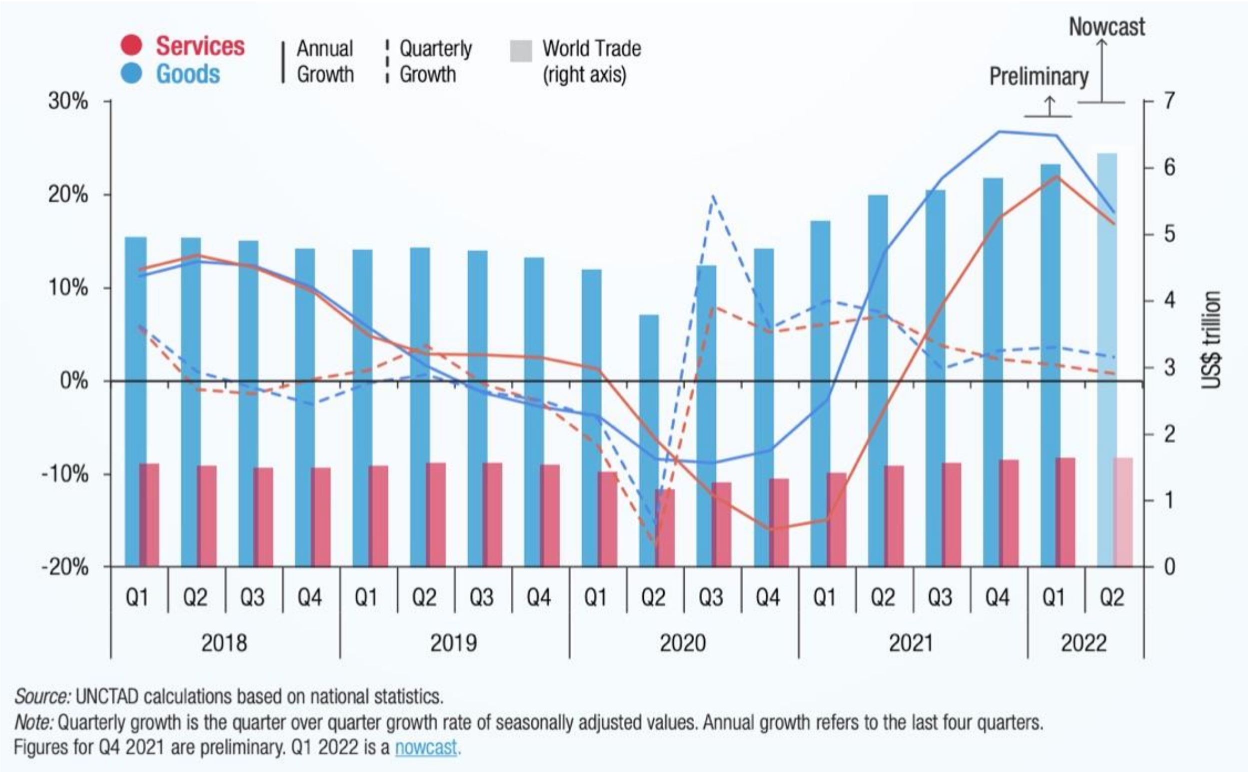


Figure 16: Trade in goods in 2017-2020

Source: UNCTAD calculations based on national statistics https://unctad.org/webflyer/global-trade-update-july-2022

The Bureau of Transportation Statistics COVID-19 Supply Chain indicators document COVID-19's impact on freight services. Figure 17 shows the freight index for the months of 2019 through some of 2022. The most severe decline occurred in April of 2020, followed by a rapid and continuing recovery. Freight levels in 2021 and 2022 demonstrate increased productivity, and both years exceeded the pre-COVID-19 index levels in 2019. Freight levels in 2022 currently exceed the pre-COVID-19 freight levels of 2019.

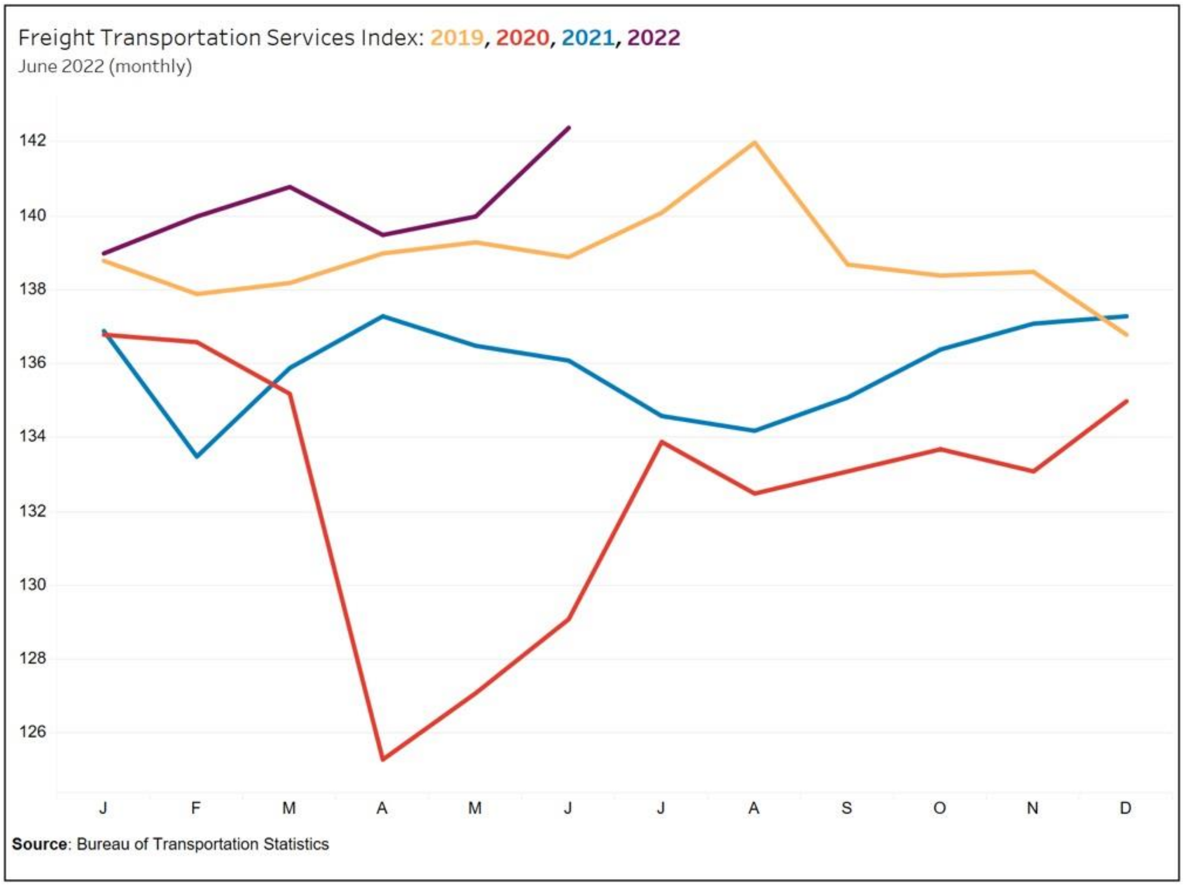


Figure 17: Pre and Post-COVID-19 Freight Levels

Source: https://www.bts.gov/freight-indicators#ftsi

COVID-19 Impact/Changes in Freight Movement in the MAFC States

Truck Traffic Changes

All ten MAASTO states were emailed a survey and data request for truck traffic changes during the COVID-19 period of 2019 through 2021. Uniform truck count data were not available across the states. However, the data submitted and reviewed below suggests that the states' truck activity reflected national truck trends. To compensate for the lack of uniform data, regional data aggregations for the North Central and Southern Gulf regions were used to track truck traffic through COVID-19 (Figure 18). These two regions include all ten of the MAASTO states. The data is derived from the Special Issue of the USDOT Weekly Traffic Volume Counts that can be found at https://datahub.transportation.gov/stories/s/Weekly-Traffic-Volume-Report/3g63-ik4u/. Three snapshots of regional truck traffic and changes in modal use are used to show the impacts and response of the trucking industry due to COVID-19.

In Figure 18, for the period of February 2020 to August 2020, there is a precipitous decline in truck travel with the onset of COVID-19, with a nearly 20 percent decline in truck traffic in the

North Central region before rebounding in June. The impacts were not confined to the MAASTO states. All states were impacted, with the Northeast showing the deepest decline with a nearly 30 percent drop in truck traffic. As a pandemic, the entire globe mirrored this trend.

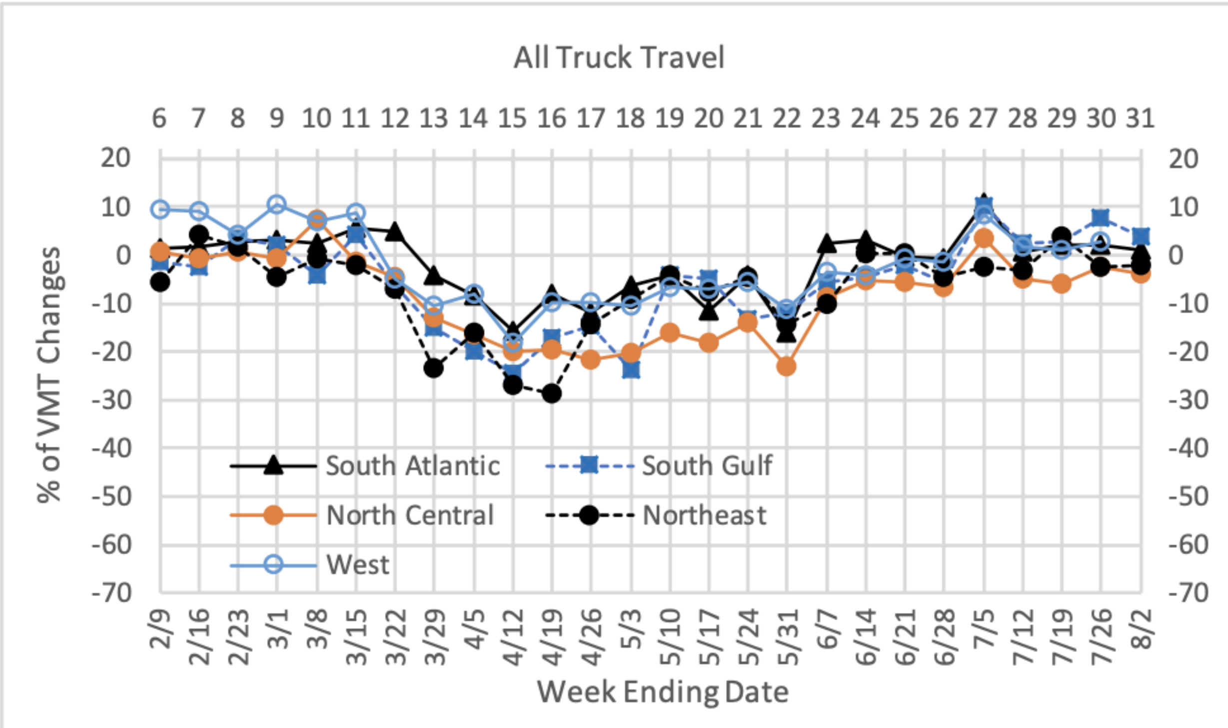


Figure 18: Regional Changes in Truck Traffic, 02/2020 to 08/2020.

In Figure 19, shows changes in all interstate traffic. The truck traffic levels are shown to continue to increase and stabilize as compared to early 2020. There are significant short-term increases the week of 06/20/21 and again in the first week of 2022, with truck traffic demonstrating larger moves on a weekly basis than passenger travel. In summary, truck traffic rapidly rebounded after the onset of COVID-19 and has resumed operations with continued growth.

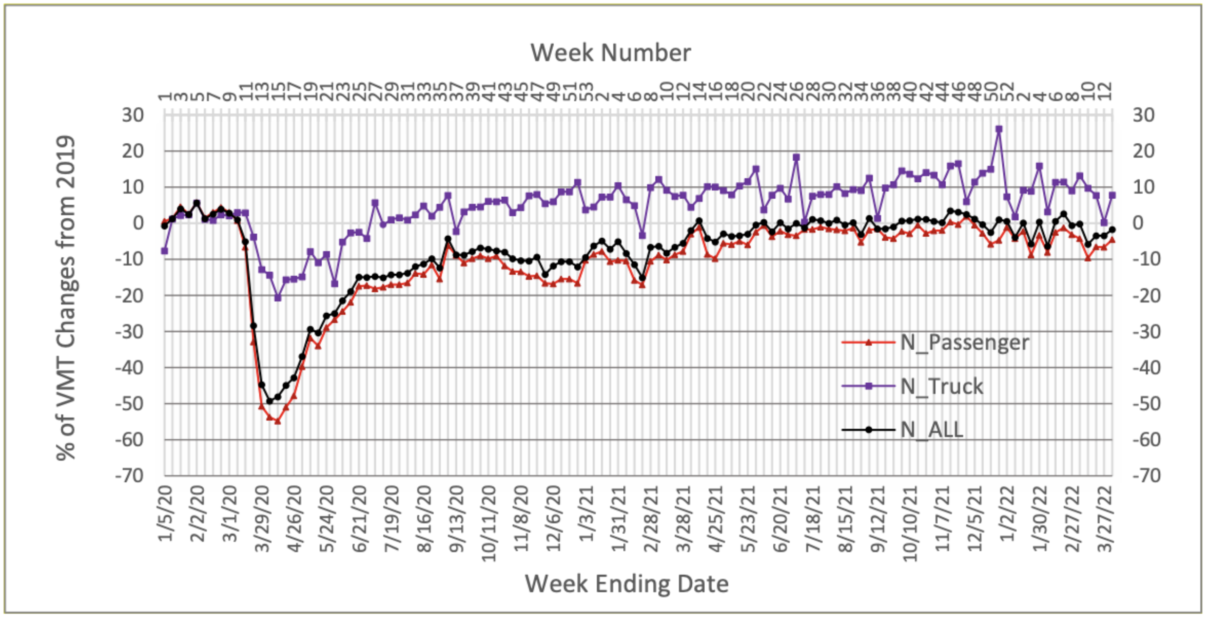


Figure 19: Changes in All Traffic, 01/05/2020 to 03/27/22

Source: https://www.fhwa.dot.gov/policyinformation/weeklyreports/travel/interstate_travel_2022_week_13.pdf

The following charts in Figure 20 demonstrate the COVID-19 pandemic effects on the economy and different freight modes in the United States.

In both the indexes and tonnage measures, the onset of COVID-19 in early 2020 and its virulence through late summer can clearly be tracked. Air cargo-domestic presents an interesting trend with a near constant increase even with the dip at the onset of COVID-19. Anecdotal reports of passenger planes being used for freight and COVID-19 emergency supplies, along with an increasing reliance on passenger service for belly cargo support this consistent increase. This data was sourced from BTS. A link to these measures can be accessed through this link: https://data.bts.gov/stories/s/m9eb-yevh#freight-rail-traffic.

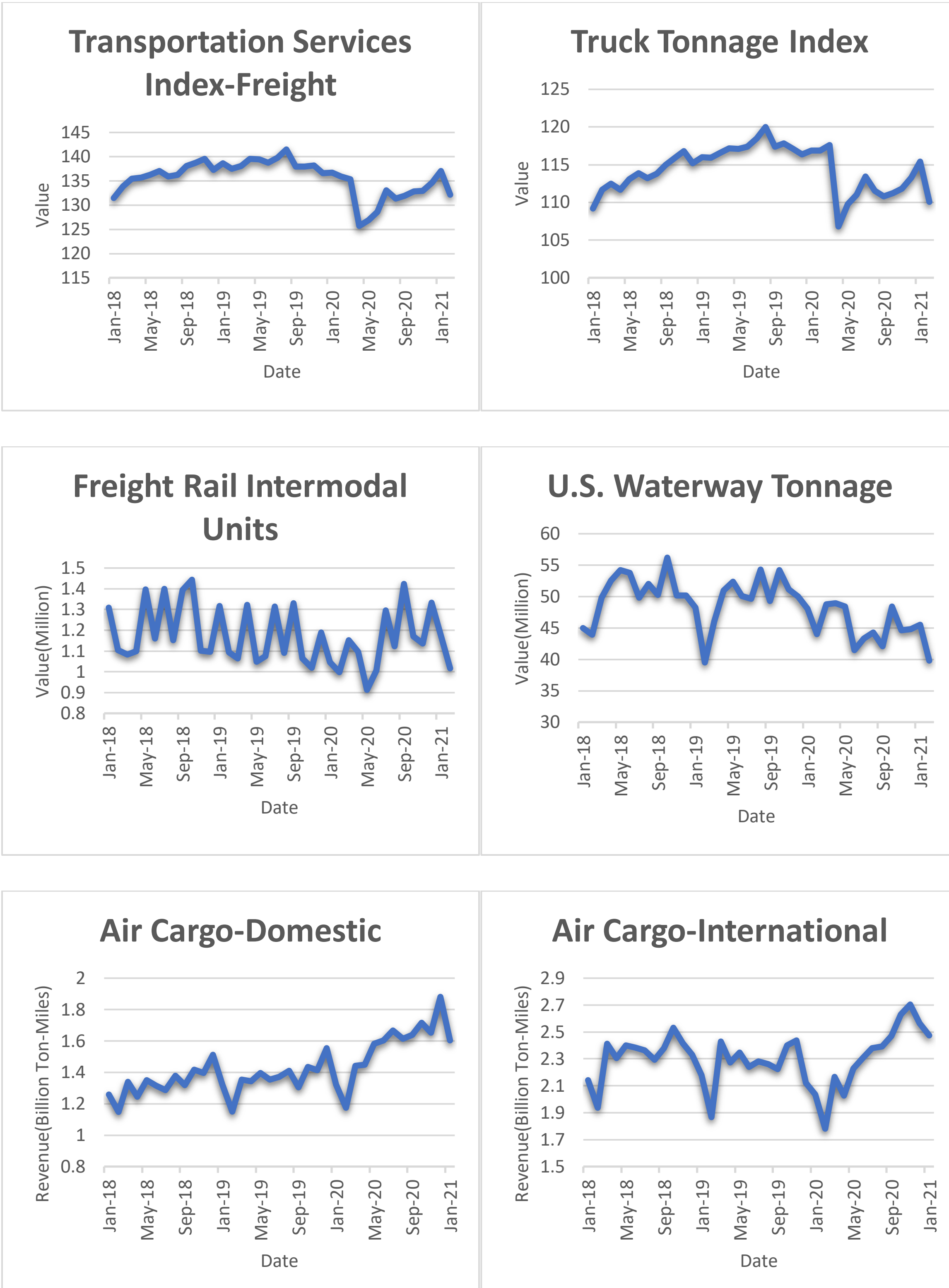


Figure 20: COVID-19 Weekly Freight Index and Tonnages

Source: https://data.bts.gov/stories/s/m9eb-yevh#freight-rail-traffic

State Data Availability

States were able to track the impact of COVID-19 with their in-house data. Table 6 provides a summary of the various ways states track truck traffic.

Agencies supported trucking during COVID-19 The most common were extensive regulatory relief, consistent with FMCSA laws and rules throughout the pandemic resulting in increased truck weights and private services at some rest areas. Moreover, states collaborated closely with the representatives of trucking associations such as the Wisconsin Motor Carriers Association, Owner Operator Independent Drivers Association, and a similar group to mitigate COVID-19 effects for truck operators and the industry. Similarly, Michigan DOT worked with Canadian agencies to keep freight flowing across the borders. These critical actions undoubtedly reduced the potential impacts of COVID-19.

The efforts of the trucking industry were heroic during the peak of COVID-19. Services along major interstates were shuttered, leaving truck operators without the needed facilities and services. While most of the workforce transitioned to work at home or unemployment, truck drivers ensured the groceries shelves were stocked and emergency supplies flowed to where they were needed.

Table 6: Summary of MAASTO States Data Methodology

State	Truck Data
Illinois	Used select counting stations to monitor changes in overall traffic and truck traffic. Moreover, they used MS2 data to validate the trends. Based on their observation, the truck percentage increased during the early part of the pandemic as the number of trucks rebounded quickly. However, the largest decrease in truck counts happened in March and April 2020. Truck traffic in Illinois is improving compared to the national trends.
Indiana	Has approximately 47 active continuous count locations on the interstate system. The number varies month to month as the effects of construction and equipment maintenance causes sites to be out of service often. Wednesday, March 18th, 2020, marked the beginning of the impact, with recovery noticed on April 13th, 2020. Pre-COVID-19 counts were reached in June and have exceeded the previous counts since.
Iowa	Used monthly truck counts from all their interstate sites. The tracking showed that truck volume decreased in March started to increase in July 2020 compared to the same time in 2019.
Kansas	Has limited interstate sites collecting continuous classification data.
Kentucky	Kentucky used 102 sites for Interstate truck count data for 2021. Twenty-three of these were Automatic Traffic Recorder sites. Kentucky noted an overall increase in trucks with increase due to e-commerce.
Michigan	Reported data based on 57 continuous count stations. The largest decrease in traffic volume happened in April 2020, where commercial volume declined by 34.5 percent. However, MDOT started to see an uptick in traffic at the end of April, where commercial volumes recovered quickly and moved closer to 2019 data.
Minnesota	Used detailed traffic data from 157 counters. MnDOT data shows a 10-15 percent decline in overall traffic counts statewide during the pandemic. Although their truck traffic data are insufficient and not limited to the interstate system only, they believe that the general pattern of heavy commercial vehicle counts has increased 5-15 percent compared to the previous three years.
Missouri	Decline began mid-March 2020 with truck counts returning to normal during the first week of June 2020, and consistently exceed pre-COVID-19 levels by mid-September of 2020. MoDOT uses 46 continuous traffic monitoring stations on their interstate routes.
Ohio	Ohio used data based on 180 stations across the state, indicating that, similar to most other states, the largest decline in truck traffic happened in April 2020.
Wisconsin	March 2020 marked the drop in truck counts, with a rebound beginning in May 2020. Counts returned to normal in October 2020 and started to exceed pre-COVID-19 levels in December 2020. WisDOT uses anywhere from 65-73 Interstate counting stations depending on the month.

Source: MAFC Interviews

OSOW Permit Changes

Heavy construction, wind farms, and power plants all require the transportation of oversize and overweight loads, predominantly during construction but also during operation and decommissioning. Over the past 20 years, there has been a consistent pattern of increasing size and numbers of OSOW loads requiring permits. COVID-19 also impacted permit numbers and required adaptation within the agencies. Additionally, the impacts were not even across the MAASTO states.

While some states are transitioning to automated permitting, many permits are complex and require interaction with a DOT agent. In those instances, barriers and social distancing were used to isolate agents from the clients.

Table 7 shows the trend of the total number of OSOW permits issued in 2019, 2020, and 2021 in the MAASTO states.

Table 7. OSOW Permits in MAASTO Region, 2019 - 2021

States	Total Number of OSOW Permits			
	2019	2020	2021	% Change
Illinois	242,529	228,251	231,921	-4.5
Indiana	405,886	147,616	385,934	-5.2
Iowa	159,552	147,938	151,154	-5.5
Kansas	93,990	86,040	77,671	-21.0
Kentucky	105,702	90,062	88,012	-20.0
Michigan	108,711	94,118	97,186	-12.0
Minnesota	81,038	78,525	80,920	-0.1
Missouri	151,890	155,273	164,108	+8.0
Ohio	336,273	291,701	299,605	-12.0
Wisconsin	69,528	72,227	72,207	+3.9
Regional Totals	1,755,099	1,147,349	381,952	-6.84

While most states demonstrate a decline and gradual rebound toward pre-COVID-19 permit numbers, Wisconsin and Missouri did not experience a drop in issued permits during this period. According to Missouri permit personnel, an increase in permit numbers during this period was likely due to the buildout of two major wind farms. In the case of Wisconsin, personnel indicated that the major OSOW corridors in Wisconsin are likely less sensitive to market changes due to their relative isolation compared to major pass-through states such as Illinois or Indiana.

OSOW permit operations were impacted for both the agencies and the industry, and similar to general trucking, the industry performed strongly during COVID-19 and is rapidly coming to a full recovery.

The Cost of the COVID-19 Pandemic

The level of federal disaster funding requested by states for COVID-19 is an additional measure used to assess the magnitude of the disaster. The Federal Emergency Management Agency (FEMA) database on declared disasters was used to collect funding obligations for declared disasters from 2018 to the end of 2021 for each state. There are ongoing obligations and newly declared disasters; thus, the data represents a single point in time. Given the difficulties of collecting a full slate of economic impacts across the transportation sector, the MAFC technical representatives agreed to use the FEMA database as a measure of the economic impact of COVID-19.

The obligated funding amounts for emergency and public works are used as the data source. All disaster costs from 2018 to the end of 2021 were tabulated, and the percent of funding obligated towards the COVID-19 disaster was calculated. This information can be found in Appendix A.

In summary, COVID-19 FEMA funding per state ranged from a low of $69,157,969 to a high of $1,052,856,154. Similarly, COVID-19 funding ranged from a low of 16 percent of all disaster funding to 95 percent of all disaster funding allocated to the States. COVID-19, by far, is the largest disaster in terms of relief funding across the MAASTO region since 2018.

COVID-19 has impacted freight movement and is changing how we will move freight in the future. Traffic in all freight modes was impacted. From trucking to OSOW moves, freight rail, marine freight, and air freight, all modes faced new challenges with social isolation and lack of services. Remarkably the modes adjusted quickly, and the supply chain failures were far less than anticipated. Pipelines were not considered in this project.

4. STATE EXPERIENCES WITH COVID-19

To assess State level COVID-19 impacts, a combination of freight planners, permit personnel, and government affairs/communications personnel for each state were interviewed regarding their experiences with COVID-19. Discussion with the personnel addressed five areas: experiences with disasters, impacts on freight systems and routing, impacts on the agency and work, mitigation and adaptation, and the future of freight after COVID-19.

The discussions with the States are summarized below by survey topic.

Experiences With Disasters

When asked about previous disasters, state respondents identified a common range of disasters with a few outliers. Floods, followed by winds/storms, fires, and extreme winter conditions, were the most prominent natural disasters. Also mentioned were a propane shortage, prairie fires, and straight-line winds. Not all disasters identified by respondents were presidentially declared disasters but required similar levels of mobilization and repair. Respondents' experiences with COVID-19 were much different. The respondents cited the pandemic as unending and different in that it was something they could not fix and move past. Still, several also responded that they felt their work continued without interruption with the move to telework.

Notably, and with increasing frequency, states have full-time employees to plan for resiliency or disaster events. Due to the significant crossroads presence for rail, highway, and marine modes, Illinois sited its Infrastructure Security Unit in the Illinois Emergency Management Agency. Resiliency performance measures are also being developed and used across the region. Additionally, states are completing resiliency plans. And while not focused on COVID-19, much of the coordination and communication in the plans is relevant. And it is expected that the state resiliency plan will eventually address anthropogenic disasters as the planning matures.

One of the prominent outcomes of the COVID-19 disaster was the development and implementation of the MAASTO Emergency Divisible Load Memorandum of Understanding (EDL). To deliver the needed emergency supplies for, such as ventilators, medicines, and Personal Protective Equipment (PPE), states were granting overweight permits for divisible loads carrying emergency cargos. However, the permitted weights were not uniform across the states, which creates inefficiencies for trucks crossing multiple states. The MAASTO states agreed that in all declared disasters, trucks could move 88,000 lbs. or ten percent on an additional axle for the duration of the disaster. This allowed for increased speed and efficiency in disaster response and provided consistency across the region on overweight truck weights during declared disasters.

The respondents were also asked about COVID-19 impacts on agency funding. With the decreased driving, fuel tax income levels would be reduced. This concern was mostly dismissed as federal emergency funding was available, and passenger and freight traffic have rebounded.

Impacts on Freight Systems and Routing

The interviews also included a discussion of changes to freight operations, changes in modes, or other significant changes due to the recent disasters they had cited. When referring to past floods, tornadoes, and other physical disasters, the interviewees responded uniformly that the situations and the infrastructure repair were challenging for everyone. However, when the damage was repaired, the traffic, the economy, the work life, returned to pre-disasters levels. There have been no noticeable, long-lasting changes in modes or on the freight system due to previous disasters.

All respondents were familiar with the shorter-term traffic changes and rebound due to COVID-19. The familiarity was similar regarding long-term impacts on freight systems due to COVID-19 but more open-ended. The respondents replied that little has changed in terms of mode choice or routing, except for significant changes in-home delivery and e-commerce. Uniformly, respondents indicated that this transition to home delivery is not likely to slow. It will eventually lead to adaptations in the planning process to address the increased presence of delivery vehicles in residential areas, new technologies such as driverless deliveries, and potential changes in supply chains.

One potential mode change related to COVID-19 involves international freight shipments between the U.S. and Canada in the MAASTO region. With increased border security to prevent the spread of COVID-19, freight movement was slowed and became problematic for the supply chains linked through these border crossings. In Michigan, the cross-lake ferry options were used to avoid bridge delays and the inability to ship through customs and borders. This modal redundancy provided some degree of resiliency and can be considered a resiliency investment. The respondent cited this approach as similar to the private sector using multiple shipping lanes for delivery to ensure resiliency, as well as competitive shipping options during regular business.

Mitigation and Adaptation Efforts

There are two areas to consider when discussing state DOT mitigation due to the COVID-19 disaster. First, within the agency, various measures were taken to ensure the continuity of operations. Similarly, to ensure continued freight movement, there was agency action and mitigation to reduce impacts across the freight industry and for truck operators. Due to the immediacy of the disaster, and applicability of trucks to deliver COVID-19 relief, mitigation and adaptation efforts focus the truck mode.

Adapting to social distancing requirements to prevent disease transmission required massive changes within the agency. Uniformly across the MAASTO states, all employees able to work from home were transitioned out of the office. Respondents cited few complications with working remotely, and several replied that they did not miss anything in the transfer to working from their home offices.

A potential loss of the agency culture was expressed as one concern with remote work. Additionally, the inability to conduct interviews and hire new employees during COVID-19 was mentioned as an impact. Several states indicated they are still hiring as of the Summer of 2022 to replace employees who left employment during COVID-19.

Several safety practices were also adapted for front-facing and field employees to reduce potential COVID-19 exposure. For front-facing employees, six-foot social distancing, germ barriers, PPE, and hand sanitizer were the norm. Customers were allowed limited and controlled access to facilities and were required to wear a face mask. Some weigh stations and permit offices were temporarily closed due to personnel shortages.

For field crews, the interviewees cite splitting field crews to avoid complete contamination of a crew if one employee was contagious. PPE was also required for all employees when in proximity to others. Except in the case of personnel shortages, permit offices remained open. Rest areas remained opened and maintained. Facilities, however, were closed if personnel were not available. These were cited as short-term closures, multiple days, not weeks before personnel could devise a way to service customers.

Federal exemptions for emergency loads and services at rest areas were sought and granted for truck operations. This allowed increased truck weights for vehicles carrying emergency supplies, spurring the development of the MAASTO EDL MOU. Federal exemptions also allowed food vendors to operate during the disaster at rest areas where no other services were available.

Several states also mentioned communication and cooperation as necessary for fast recovery from a disaster. Sources of partnership and communication during COVID-19 that were cited include representatives of trucking associations, the state emergency management agency and FEMA, FHWA, state police, other levels of government, and media to disseminate information.

When asked about additional ways the agency provided support, one respondent cited the movement of relief supplies with their agency's workforce and vehicles to support hospitals and field hospitals. One state also reported that employees could volunteer their work time to help with COVID-19 and still get paid. Support such as this places MAASTO DOTs and their personnel at the forefront of their communities and states in mitigating impacts.

COVID-19 was very much a different disaster with different impacts and mitigation. The inability to complete work as a team, training, hiring, acculturation, or even be in the same office were not traditional disaster impacts. Moving hundreds and even thousands of employees to a home office and maintaining productivity was an epic challenge, and as nearly every respondent indicated – "We did not miss a beat."

What's Next? The Future of Freight and Freight Planning

Changes to freight systems due to COVID-19 have been limited to relatively short-term declines in traffic levels to date. The most significant change cited by respondents was the dramatic increase in home delivery. State personnel did not identify either long-term mode changes or route changes in the interviews. Additionally, freight data sources point to a recovery rather than modal or routing changes due to COVID-19. Respondents indicated that they eventually expect changes in mode or routes due to climate or anthropogenic disasters. And with the dramatic, sustained increase in home deliveries, combined with vehicle automaton and decarbonization, additional transitions to alternate fueled vehicles, modified supply chains, and increased multimodal freight moves are expected.

Mitigation practices for disasters like COVID-19 naturally lean towards automation as a solution to personal exposure to environments or infected people. All participants responded that truck and vehicle automation, pilotless cargo planes, and even home delivery drones are coming eventually. As one participant suggested, the changes will be based on the need for increased efficiencies and workforce issues. The new freight and logistic systems may transition to electric or another alternate as a step to even safer and cleaner fuels. Routing, scheduling, and delivery service will be adapted to increasing challenges with congestion and natural disasters. The changes could take any number of fuel, logistics, or automation adaptations.

Several respondents also cited the value of automated highway weigh stations that do not require the truck to stop or personnel to interact with customers. This approach increases freight and fuel efficiencies and limits potential disease exposure.

And within state DOTs, new positions such as emergency or resiliency coordinators are being created to better understand and plan for what appears to be an ever-increasing level of natural or anthropogenic disasters. Further, resiliency plans are also underway or completed across the MAASTO states with funding from the IIJA.

Other strategies used and recommended by the interviewees to address traditional and anthropogenic disasters include stockpiling emergency supplies in strategic locations and pre-locating equipment and traffic devices in areas likely to experience a disaster. Another agency action mentioned by several states was the use and expansion of continuity of operations (COO) plans. Initially designed for addressing personnel changes in key areas, this type of plan is ideal for disasters where social isolation is recommended, and personnel may not be available due to disease or isolation.

State representatives recommended two adaptations that support freight and resiliency planning. First, resiliency plans and disaster response plans should include the private sector. They are the primary agents in moving freight, and their jobs become much more complicated during disasters. Integrated private and public sector resiliency planning could be used to identify routes or logistical solutions before the crisis happens and then work together to reduce the impacts and time to recovery.

Similarly, scenario planning for potential disasters was recommended to identify disaster options and outcomes. This planning tool could help agencies be prepared for disasters with pre-stocked supplies or equipment and operating plans. These efforts should include private sector freight and logistics representatives.

While traditional trade lanes have not changed with COVID-19, the increasing frequency of disasters, home deliveries, automation, and decarbonization will likely bring sweeping changes to freight supply chains and transportation planning and operations. Changes in the workplace, such as remote working appear permanent, and the adaptations will likely expand to include a need for new and different employment skills to match emerging technologies.

5. SUMMARY, STRATEGIES, AND BEST PRACTICES

Best Practices and Strategies

Given the contagious nature and need for social isolation associated with COVID-19, the best practices likely address human health and social parameters. While the emergency need for construction materials or equipment is lacking in a disaster like COVID-19, planning for anthropogenic disasters is not that different from planning for contingency routing due to an earthquake, for example. The state respondents identified the best practices, recommendations, and strategies listed below during interviews conducted during the fall of 2021 and winter of 2022.

Recommended Best Practices

- Flexible work, including working from alternate locations, was critical to the agencies and personnel during COVID-19. All continuity, resiliency, and planning documents should include successful practices of moving employees out of their offices while maintaining agency operations.

- Continue to explore alternative team working options such as job sharing, split shifts, and split teams to accommodate social distancing. Automation should also be considered as a solution.

- Agencies should continue to provide sanitizer and PPE and offer isolated workspaces and work from home for concerned or immunosuppressed individuals.

- Increase resiliency of the supply chain for emergency supplies and common materials needed in emergencies by maintaining multiple suppliers across multiple modes or stockpiling.

- Review all agency freight plans, long-range transportation plans, resiliency plans, and continuity plans to integrate freight planning scenarios and work-life strategies during declared disasters.

- Include freight resiliency goals in the agency's overarching goals.

- Develop freight resiliency performance measures for disaster preparation levels, action periods, and recovery.

- Communication with freight stakeholders should be included in the planning process and expected during disasters. Developing communication plans with the private sector provides a degree of certainty during a crisis. Private sector input can help agencies identify bottlenecks and critical areas of vulnerability for both natural and anthropogenic disasters.

- Include the private sector in resiliency and disaster planning. Ensure the private sector understands all transportation options and what the agency can do to ensure mobility through planning, collaboration, and joint action. Likewise, the agency learns of the capabilities and planning of the private sector and is better able to collaborate with and support their efforts.

- Use scenario planning to identify impacts, mitigation, and avoidance strategies for physical and anthropogenic disaster scenarios. Include private sector freight and logistics representatives.

- Communicate the role of transportation as a first responder. Without continued freight transportation and all the individuals who selflessly worked in unknown and unsafe conditions, the economy and society could have been worse.

- Reduce carbon. Stay current with alternative fuels and work strategies that can reduce environmental impacts. Climate change is scientifically linked to our modern carbon-based transportation and manufacturing systems. Changes in fuels are necessary to minimize further damage. A changing climate also opens the door for the introduction of new and more virulent diseases to areas with previously unfavorable host conditions for the disease or disease vector.

- Consider equity in disaster planning and recovery. People experience disasters differently and have different resources to cope. Ensure agency support activities do not disadvantage certain segments of the population or favor certain segments.

Work-life adjustments, home delivery, the increasing frequency and cost of disasters, and new communication and automation technologies are leading to an unknown future for freight transportation. The customer's access to the marketplace is the most visible change seen with the COVID-19 disaster regarding freight transportation. A continuous stream of delivery vehicles and couriers driven by e-commerce has replaced household trips to stores and other venues.

Collaboration in freight planning, disaster response, and recovery will be vital to maintaining any sense of normalcy with the increasing number and types of disasters. As freight planning matures, resiliency, environment, and equity will be critical components of planning and operations. MAASTO states should continue to coordinate and expand regional planning to leverage the capabilities found across MAASTO and provide for regional efficiencies in freight transportation during presidentially declared disasters.

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APPENDIX A. DECLARED DISASTERS 2018 - 2021 MAASTO REGION

MAFC Project Data

Declaration Type - Any - Major Disaster Declaration

Total public assistance includes emergency and permanent work.

Source: https://www.fema.gov/disaster/declarations

Illinois

Illinois COVID-19 Pandemic (DR-4489-IL)
Incident Period: January 20, 2020, and continuing
Major Disaster Declaration declared on March 26, 2020
Total Public Assistance Grants Dollars Obligated $1,052,856,154.87

Illinois Severe Storms and Flooding (DR-4461-IL)
Incident Period: February 24, 2019 - July 3, 2019
Major Disaster Declaration declared on September 19, 2019
Total Public Assistance Grants Dollars Obligated $59,368,614.00

Illinois Total Public Assistance $1,112,224,768.00
Percent COVID 94%

Indiana

Indiana COVID-19 Pandemic (DR-4515-IN)
Incident Period: January 31, 2020, and continuing
Major Disaster Declaration declared on April 3, 2020
Total Public Assistance Grants Dollars Obligated $90,883,777.69

Indiana COVID-19 (EM-3456-IN)
Incident Period: January 20, 2020, and continuing
Emergency Declaration declared on March 13, 2020
Total Public Assistance Grants Dollars Obligated $0.00

Indiana Severe Storms and Flooding (DR-4363-IN)
Incident Period: February 14, 2018 - March 4, 2018
Major Disaster Declaration declared on May 4, 2018
Total Public Assistance Grants Dollars Obligated $14,326,676.95

Indiana Total Public Assistance $105,210,453.00
Percent COVID 86%

Iowa

Sac & Fox Tribe of the Mississippi of Iowa Derecho Midwest
Incident Period: Aug 10, 2020
Major Disaster Declaration declared on September 10, 2020
Total Public Assistance Grants Dollars Obligated $1,219,862.52

Iowa Severe Storms (DR-4557-IA)
Incident Period: Aug 10, 2020
Major Disaster Declaration declared on August 17, 2020
Total Public Assistance Grants Dollars Obligated $135,823,520.36

Iowa COVID-19 Pandemic (DR-4483-IA)
Incident Period: January 20, 2020, and continuing
Major Disaster Declaration declared on March 23, 2020
Total Public Assistance Grants Dollars Obligated $249,306,955.21

Sac & Fox Tribe of the Mississippi of Iowa Severe Storms and Flooding (DR-4430)
Incident Period: March 13, 2019 - April 1, 2019
Major Disaster Declaration declared on April 29, 2019
Total Public Assistance Grants Dollars Obligated $608,245.95

Iowa Severe Storms and Flooding (DR-4421-IA)
Incident Period: March 12, 2019, and continuing
Major Disaster Declaration declared on March 23, 2019
Total Public Assistance Grants Dollars Obligated $168,742,389.10

Iowa Severe Storm and Tornadoes (DR-4392-IA)
Incident Period: Jul 19, 2018
Major Disaster Declaration declared on September 12, 2018
Total Public Assistance Grants Dollars Obligated $2,796,950.79

Iowa Severe Storms, Tornadoes, Straight-line Winds, and Flooding (DR-4386-IA)
Incident Period: June 6, 2018 - July 2, 2018
Major Disaster Declaration declared on August 20, 2018
Total Public Assistance Grants Dollars Obligated $16,018,406.27

Iowa Total Public Assistance $574,516,327.00/
Percent COVID 44%

Kansas

Kansas COVID-19 Pandemic (DR-4504-KS)
Incident Period: January 20, 2020, and continuing
Major Disaster Declaration declared on March 29, 2020
Total Public Assistance Grants Dollars Obligated $254,267,713.69

Kansas Severe Storms, Straight-Line Winds. Tornadoes, Flooding, Landslides, and Mudslides (DR-4449-KS)
Incident Period: April 28, 2019, and continuing
Major Disaster Declaration declared on June 20, 2019
Total Public Assistance Grants Dollars Obligated $39,246,617.45

Kansas Severe Storms, Straight-line Winds, and Flooding (DR-4417-KS)
Incident Period: October 4, 2018 - October 15, 2018
Major Disaster Declaration declared on February 25, 2019
Total Public Assistance Grants Dollars Obligated $3,509,374.38

Kansas Severe Storms, Straight-line Winds, and Flooding (DR-4403-KS)
Incident Period: September 1, 2018 - September 8, 2018
Major Disaster Declaration declared on October 19, 2018
Total Public Assistance Grants Dollars Obligated $4,545,539.42

Kansas Total Public Assistance $301,569,243.00
Percent COVID 84%

Kentucky

Kentucky Severe Storms, Straight-line Winds, Flooding, and Tornadoes (DR-4630-KY)
Incident Period: December 10, 2021 - December 11, 2021
Major Disaster Declaration declared on December 12, 2021
Total Public Assistance Grants Dollars Obligated $9,387,409.26

Kentucky Severe Storms, Flooding, Landslides, and Mudslides (DR-4595-KY)
Incident Period: February 27, 2021 - March 14, 2021
Major Disaster Declaration declared on April 23, 2021
Total Public Assistance Grants Dollars Obligated $77,733,229.67

Kentucky Severe Winter Storms, Landslides, and Mudslides (DR-4592-KY)
Incident Period: February 8, 2021 - February 19, 2021
Major Disaster Declaration declared on March 31, 2021
Total Public Assistance Grants Dollars Obligated $60,054,207.17

Kentucky Severe Storms, Flooding, Landslides, and Mudslides (DR-4540-KY)
Incident Period: February 3, 2020 - February 29, 2020
Major Disaster Declaration declared on April 24, 2020
Total Public Assistance Grants Dollars Obligated $67,926,986.65

Kentucky COVID-19 Pandemic (DR-4497-KY)
Incident Period: January 20, 2020, and continuing
Major Disaster Declaration declared on March 28, 2020
Total Public Assistance Grants Dollars Obligated $69,157,969.00

[Kentucky Severe Storms, Straight-line Winds, Flooding, Landslides, and Mudslides (DR-4428-KY)]
Incident Period: February 6, 2019 - March 10, 2019
Major Disaster Declaration declared on April 17, 2019
Total Public Assistance Grants Dollars Obligated $78,651,394.69

[Kentucky Severe Storms, Tornadoes, Flooding, Landslides, and Mudslides (DR-4361-KY)]
Incident Period: February 21, 2018 - March 21, 2018
Major Disaster Declaration declared on April 26, 2018
Total Public Assistance Grants Dollars Obligated $24,504,831.64

[Kentucky Severe Storms, Flooding, Landslides, and Mudslides (DR-4358-KY)]
Incident Period: February 9, 2018 - February 14, 2018
Major Disaster Declaration declared on April 12, 2018
Total Public Assistance Grants Dollars Obligated $32,280,229.60

Kentucky Total Public Assistance $419,696,254.00
Percent COVID 16%

Michigan

[Michigan Severe Storms, Flooding, and Tornadoes (DR-4607-MI)]
Incident Period: June 25, 2021 - June 26, 2021
Major Disaster Declaration declared on July 15, 2021
Total Public Assistance Grants Dollars Obligated $2,094,750.11

[Michigan Severe Storms and Flooding (DR-4547-MI)]
Incident Period: May 16, 2020 - May 22, 2020
Major Disaster Declaration declared on July 9, 2020
Total Public Assistance Grants Dollars Obligated $27,448,520.51

[Michigan COVID-19 Pandemic (DR-4494-MI)]
Incident Period: January 20, 2020, and continuing
Major Disaster Declaration declared on March 27, 2020
Total Public Assistance Grants Dollars Obligated $579,476,693.94

Michigan Total Public Assistance $609,599,439.00
Percent COVID 95%

Minnesota

[Minnesota COVID-19 Pandemic (DR-4531-MN)]
Incident Period: January 20, 2020, and continuing
Major Disaster Declaration declared on April 7, 2020

Total Public Assistance Grants Dollars Obligated $32,931,829.57

Minnesota Severe Winter Storm, Straight-line Winds, and Flooding (DR-4442-MN)
Incident Period: March 12, 2019 - April 28, 2019
Major Disaster Declaration declared on June 12, 2019
Total Public Assistance Grants Dollars Obligated $80,254,654.63

Minnesota Severe Storms and Flooding (DR-4414-MN)
Incident Period: October 9, 2018 - October 11, 2018
Major Disaster Declaration declared on February 1, 2019
Total Public Assistance Grants Dollars Obligated $9,849,973.82

Minnesota Severe Storms, Tornadoes, Straight-line Winds, and Flooding (DR-4390-MN)
Incident Period: June 15, 2018 - July 12, 2018
Major Disaster Declaration declared on September 5, 2018
Total Public Assistance Grants Dollars Obligated $25,276,041.33

Minnesota Total Public Assistance $148,312,497.00
Percent COVID 22%

Missouri

Missouri Severe Storms, Straight-line Winds, Tornadoes, and Flooding (DR-4612-MO)
Incident Period: June 24, 2021 - July 1, 2021
Major Disaster Declaration declared on September 1, 2021
Total Public Assistance Grants Dollars Obligated $4,934,414.95

Missouri Severe Storms, Tornadoes, Straight-line Winds, and Flooding (DR-4552-MO)
Incident Period: May 3, 2020 - May 4, 2020
Major Disaster Declaration declared on July 9, 2020
Total Public Assistance Grants Dollars Obligated $8,738,171.53

Missouri COVID-19 Pandemic (DR-4490-MO)
Incident Period: January 20, 2020, and continuing
Major Disaster Declaration declared on March 26, 2020
Total Public Assistance Grants Dollars Obligated 437,760,995.82

Missouri Severe Storms, Tornadoes, and Flooding (DR-4451-MO)
Incident Period: April 29, 2019 - July 6, 2019
Major Disaster Declaration declared on July 9, 2019
Total Public Assistance Grants Dollars Obligated $81,700,573.56

Missouri Severe Storms, Straight-line Winds, and Flooding (DR-4435-MO)
Incident Period: March 11, 2019 - April 16, 2019
Major Disaster Declaration declared on May 20, 2019
Total Public Assistance Grants Dollars Obligated $26,445,766.32

Missouri Total Public Assistance **$586,579,921.00/**
Percent COVID **75%**

Ohio

[Ohio COVID-19 Pandemic (DR-4507-OH)]
Incident Period: January 20, 2020, and continuing
Major Disaster Declaration declared on March 31, 2020
Total Public Assistance Grants Dollars Obligated $316,222,121.93

Ohio Severe Storms, Straight-line Winds, Tornadoes, Flooding, Landslides, and Mudslide (DR-4447-OH)
Incident Period: May 27, 2019 - May 29, 2019
Major Disaster Declaration declared on June 18, 2019
Total Public Assistance Grants Dollars Obligated $11,996,043.96

Ohio Severe Storms, Flooding, and Landslides (DR-4424-OH)
Incident Period: February 5, 2019 - February 13, 2019
Major Disaster Declaration declared on April 8, 2019
Total Public Assistance Grants Dollars Obligated $56,389,284.92

Ohio Severe Storms, Landslides, and Mudslides (DR-4360-OH)
Incident Period: February 14, 2018 - February 25, 2018
Major Disaster Declaration was declared on April 17, 2018
Total Public Assistance Grants Dollars Obligated $66,595,216.18

Ohio Total Public Assistance **$451,202,664.0**
Percent COVID **70%**

Wisconsin

Wisconsin COVID-19 Pandemic (DR-4520-WI)
Incident Period: January 20, 2020, and continuing
Major Disaster Declaration declared on April 4, 2020
Total Public Assistance Grants Dollars Obligated $543,987,144.15

Wisconsin Severe Winter Storm and Flooding (DR-4477-WI)
Incident Period: January 10, 2020 - January 12, 2020
Major Disaster Declaration declared on March 11, 2020
Total Public Assistance Grants Dollars Obligated $5,168,656.63

Wisconsin Severe Storms, Tornadoes, Straight-line Winds, and Flooding (DR-4459-WI)
Incident Period: July 18, 2019 - July 20, 2019
Major Disaster Declaration declared on August 27, 2019
Total Public Assistance Grants Dollars Obligated $17,886,376.25

[Wisconsin Severe Storms, Tornadoes, Straight-line Winds, Flooding, and Landslides (DR-4402-WI)]
Incident Period: August 17, 2018 - September 14, 2018
Major Disaster Declaration declared on October 18, 2018
Total Public Assistance Grants Dollars Obligated $36,985,567.36

[Wisconsin Severe Storms, Straight-line Winds, and Flooding (DR-4383-WI)]
Incident Period: June 15, 2018 - June 19, 2018
Major Disaster Declaration declared on August 10, 2018
Total Public Assistance Grants Dollars Obligated $7,375,184.00

Wisconsin Total Public Assistance $611,402,928.39
Percent COVID 89%

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