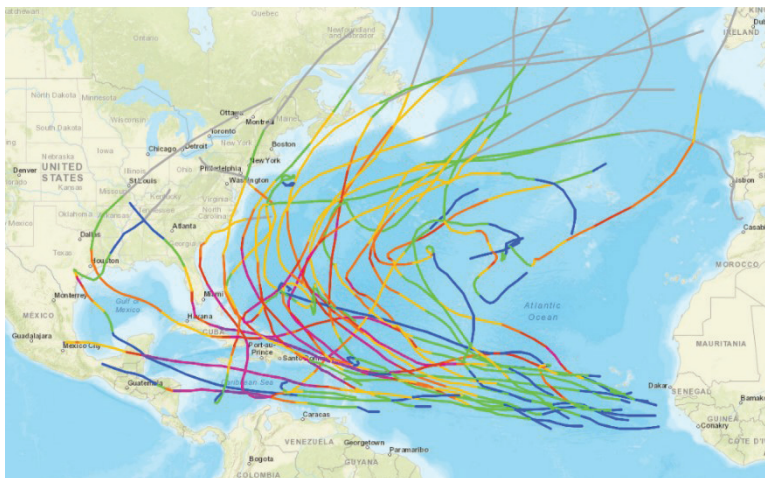


Supply Chain Risks 75% Higher in Coastal Regions

Hurricane Impact: More Than Wind and Rain Damage

Most often during and after hurricane landfall events the focus of media attention is on wind and flooding damage and, in the case of Hurricane Harvey's lingering rain deluge on Houston in 2017, the enormity of flooding is worthy of that focus. However, a hurricane's impact upon business interests extends far beyond the obvious damage from flood waters and wind. This white paper examines both near-term and medium-term effects on operational interests, particularly those associated with logistics and the supply chain.

The map below shows all Category 3-5 hurricanes that occurred during 2007-2017. According to the National Oceanic & Atmospheric Administration (NOAA), about three major hurricanes impact the U.S. coast every five years. Further, 80% of major hurricanes affecting the U.S. strike either Texas or Florida.



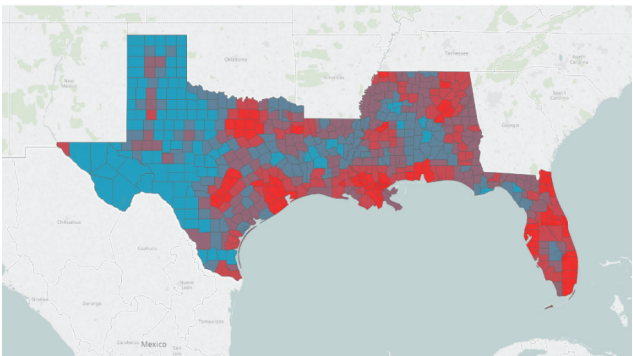
All Category 3-5 hurricanes during 2007-2017

Key Findings

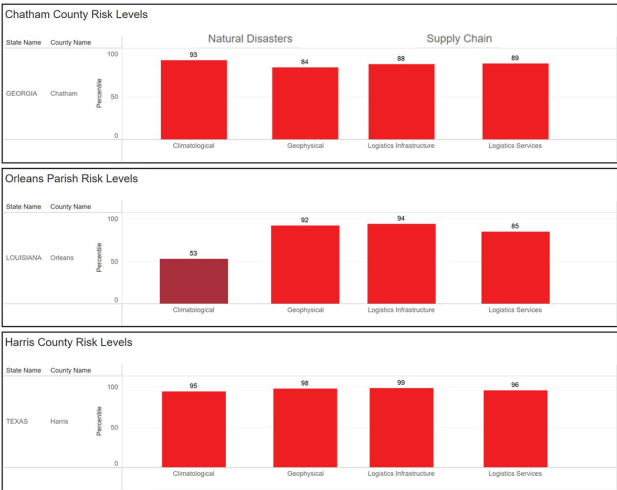
The damage threat to cargo ports' primary infrastructure is minimal, although storm surge and severe winds will damage or destroy ground-level buildings, unsecured equipment and vehicles, and containers. Post-hurricane operational recovery suffers most from manpower shortages, power outages, fuel shortages, intermodal transport accessibility, and truck shortages. Second-order effects to the supply chain often include erosion or destruction of large portions of the region's transportation infrastructure from flooding; long-term truck and chassis shortages; and, cascading delays that extend well into the interior of the U.S., particularly when the New Orleans ports are unable to take in riverine cargo from ports throughout the Mississippi River System and its tributaries. Costs spike in the logistics sector – particularly over-the-road trucking – from truck shortages, and wholesale and retail fuel prices. Third-order effects include increased insurance premiums and long-term electricity rate increases that impact operational costs.

Supply Chain Risks

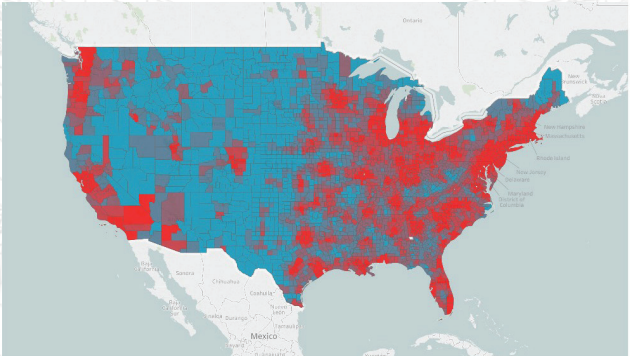
Using the Pinkerton Risk Index, the overall supply chain risk in the U.S., at the county level, is shown on the map below. Overall the national supply chain risk score is low, at 9 out of 100. However, the supply chain risk is significantly elevated in the Gulf Coast region, where the average supply chain risk is around 70 in coastal counties where port infrastructure and logistics services have elevated risk associated with meteorological factors including hurricanes..



Supply chain risk by county for Gulf Coast states; Pinkerton Risk Index



Natural Disaster and Supply Chain risk in Chatham, Orleans Parish, and Harris counties; Pinkerton Risk Index



Overall Supply Chain risk in the U.S. by county; Pinkerton Risk Index

Port Closures, Structural Damage, and Power Outages Disrupt Supply Chain After Storms

Maritime Port Closure & Damage

Depending upon the severity of an approaching hurricane, the direction and speed of its travel, and contributing influences of upper-level weather patterns, the U.S. Coast Guard officially will close a maritime port 2-3 days before expected landfall – which is typically 24 hours in advance of storm-force winds beginning to impact a region. Any ships that are berthed must leave port and head out of the path of the storm and out to open water where they can best ride it out; and the captains of inbound ships choose whether to wait out the storm out of harm's way or make for an alternate port.

Interestingly, even major hurricanes do minimal damage to a bulk or container port's primary infrastructure. The Port's reinforced concrete are as thick and robust as a major airport's runways and tarmacs, leaving a port's operational surfaces and berths largely impervious to damage or erosion. The gantry cranes and other massive iron superstructures that support loading and unloading containers have minimal profiles for hurricane-force winds to catch, and the wind cannot twist or break them except in the rarest of cases. Wind and rain damage to the gantry cranes' operator shacks occasionally requires replacement of the structure and controls, as their elevation above the ground places them in much stronger winds than at ground level. Bulk and breakbulk terminals' cranes and conveyor systems are not as stout as container terminals' cranes, but reports indicate that the infrastructure tends to come through hurricanes well. For example after Hurricane Harvey, a Cargill spokesman reported that the company's bulk facilities at the Port of Houston were undamaged.

Buildings, offices, warehouses, and other small structures on a port's wharves are vulnerable to partial or complete destruction; however, they are easier to replace. Hurricane-force winds and

strong storm surge – particularly when it occurs in conjunction with a high tide or a super tide – will likely scatter and demolish containers, intermodal trucks and chassis, and other port equipment that is not thoroughly secured.

Wide-spread power outages from major storm damage will impede the recovery and repair processes at major ports. Impassable roads and closed bridges after a storm, and large-scale evacuations before it, create unavoidable manpower shortages that also slow the process of ports returning to operational status.

In August 2005, when Hurricane Katrina demolished large swaths of New Orleans and roughly 30% of the Port of New Orleans, it was two weeks before the port received its first cargo ship, and over three months to achieve about 50% operational capacity. The greatest damage to the sprawling port complex occurred along the walls of the Industrial Canal, which connects the Mississippi River with Lake Pontchartrain. The broad power outages hit port-dependent companies with cold storage operations particularly hard; according to media reports at the time, an exporting company lost its on-port inventory of 26,000 tons (23,587 tonnes) of frozen chicken that could not be maintained at temperature. The Port of New Orleans took a large hit in manpower as well; three months after Katrina, port operators and businesses remained short on longshoremen, cargo handlers, and truck drivers to move the cargo transiting the port at the time. Reports after Katrina and other major hurricanes later indicate that companies that brought in temporary housing trailers for their homeless workers and their families were able to regain operational status more quickly.

Supply Vehicles Support FEMA Efforts, Result Can Be Truck Shortage

Before and after a hurricane makes landfall, the Federal Emergency Management Agency (FEMA) makes use of thousands of over-the-road trucks (semi-rigs) to shift resources and stage food, water,

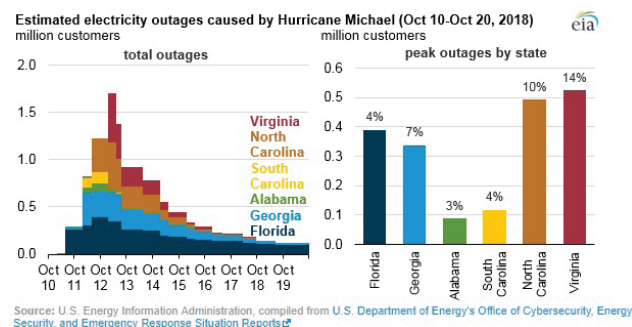
medical supplies, and other response material, impacting the availability of ground transportation far beyond the state(s) affected by a hurricane. The inability to pull in trucks and drivers from other states, due to their own shortages via FEMA, compounds the lack of intermodal transportation resources at ports after a hurricane has demolished fleets of trucks and chassis at a coastal port's intermodal terminals.

In Houston, Hurricane Harvey (August 17, 2017 – September 1, 2017) quickly dropped from a Category 4 storm at landfall down the coast to a persistent tropical storm, then meandered around just on and offshore from the city for days before it moved inland as a tropical depression. Harvey dropped an average of 54in (137cm) of rain on the city and the Port of Houston, and the city of Nederland officially reported receiving 60.58in (154cm) of rainfall. The massive flooding throughout the city brought all transportation to a halt. Freight trains and semi-rigs were not available to the port's intermodal terminals, and reports indicate that truckloads departing the port dropped by just under 1,000 for the month following Hurricane Harvey. Meanwhile, during and after Harvey the major refinery complexes near Houston had to shut down operations, strongly affecting Texas' 30% of the domestic U.S. refining capacity. Offshore oil and gas production also shut down at the time.

Katrina's landfall and demolition of New Orleans brought significant second- and third-order consequences deep into the heart of the continental U.S. The port's closure and slow recovery affected the supply chain from Minneapolis to the Gulf of Mexico, and at port cities on the Mississippi River's major tributaries that include the Ohio, Illinois, and Missouri Rivers. Bulk cargo shipment via river barges has been inexpensive and efficient since agriculture developed in the heartland, and significant operational halts at the Port of New Orleans – or any blockages or closures of the Lower Mississippi River – create risk to supply chain sectors from grains and coal to cotton and bulk iron, as well as containerized cargo and manufactured goods.

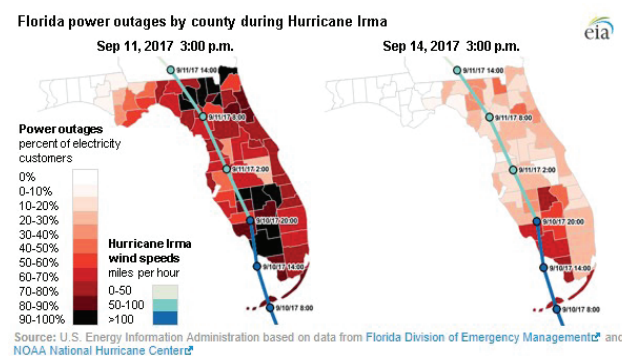
Power Outages

Wide-spread power outages from major storm damage will impede the recovery and repair processes at major ports. Data compiled and visualized by the U.S. Energy Information Agency displays widespread power outages caused by Hurricane Michael (October 10-20, 2018) across six states, reaching a peak of approximately 1.7 million customers.



Estimated electricity outages caused by Hurricane Michael; U.S. Energy Information Agency

Further data compiled by the Energy Information Agency displays the extreme power outage threat posed by Hurricane Irma (August 30-September 13, 2017) to Florida, with some counties reporting 90-100% of electricity customers without power.



Florida power outages by county during Hurricane Irma; U.S. Energy Information Agency

Recurring Cost Increases

Regardless of the coastal port affected by a hurricane, spot prices for truckload, rail, and barge freight movement jump during a hurricane event, and, the post-storm recovery time that can last for a year or more. Fuel prices typically jump by 15-20%, trucks come at a premium while in short supply, and delays always are costly. The situational costs can then trigger higher insurance costs, and supply chain interruptions increase production costs.

Fuel Pricing Surges

As the majority of hurricanes affecting the U.S. impact the Gulf Coast states. This area is responsible for 57% of crude oil imports and 20% of domestic crude oil production. Disruptions to oil production and import delivery are common during a hurricane and highly likely to result in surge pricing. Following the landfall of Hurricane Katrina, Gulf Coast oil production declined by 88%, and two major pipelines were rendered non-operational through early September. Retailers noted a wholesale price increase of up to USD 1 per gallon overnight. When Hurricane Rita made landfall a month later, an additional 10% of the region's refining capacity was shut down – triggering an additional 10% price increase to retail prices. Not only are shipping costs affected by price surging, but many shippers are also diverted due to route closures – which creates further elevated fuel expenditures.

Analyst Comment

Hurricane-driven risk is not entirely avoidable in today's global trade system and supply chain sourcing. It can, however, be mitigated to some extent by shifting supply chain routes away from the Southeast and Gulf Coast during the peak months of hurricane season: August, September, and early October. However, cost-benefit analysis of such a shift may not always make the argument to shift established movement routes away from the Florida and Gulf Coast ports every year for the hurricane season's peak months. Nonetheless, the substantial

losses sustained in a massive event such as Hurricanes Katrina, Harvey, Michael, Ike, or Matthew, however, likely raise the value of the argument for such a move.

If shifting supply chain routes during the hurricane season peak time is not a viable solution, Pinkerton recommends that companies consider revising their continuity and contingency plans to include short-notice supply chain sources and route changes during the hurricane season to enable a shift before a hurricane begins to impact operations. Companies that proactively map all of their facilities and supply chain maritime and over-the-road shipping routes likely will be better prepared to forecast supply chain impact for them in the days prior to the expected hurricane arrival. Pinkerton further recommends that clients identify secondary and tertiary supply chain routes and suppliers to minimize the impact that a hurricane could have on operations.

As hurricanes cause widespread power outages when near shore or during landfall, Pinkerton recommends clients include alternative energy sources, such as generators, in their emergency preparedness plans. Generators should be regularly serviced and tested. If possible, the use of alternative fuel sources is likely to lessen the impact of surge fuel pricing on supply chains. Even with proper planning, the impact of hurricanes on the U.S. supply chain cannot be wholly predicted or mitigated. Pinkerton recommends clients operating in the Gulf states incorporate potential disruptions from weather-related events in their performance outlooks.

Pinkerton World Risk Index

The Pinkerton Risk Index draws from a large number of distinct information sources, including proprietary and publicly available sources to analyze business risk around the world. Pinkerton calculates risk through the unique formula of Threat x Probability x Business Impact. This formula provides a holistic examination of risk, safeguarding companies from disruptions to business objectives. The goal of this report is to enable clients to mitigate risk through in-depth analysis of risk-factors. Through Pinkerton's risk analysis, clients are able to move beyond cost risks to see the totality of business impact.

Using this definition, historical data, and forward-looking expert judgment, we devised an aggregation strategy that accounts for the most important considerations of multi-national firms. These considerations and risks are calculated to produce a set of 11 identifiers that are averaged to produce a country's overall risk. The Pinkerton Risk Index findings can be found in our detailed report titled, [The Pinkerton Risk Index: A World Ranking of Business Risk](#).

The risk levels are easily decoded using the simplified color indicator, with blue representing countries with lower overall risk and red representing countries with higher levels of overall risk. [Pinkerton Risk Index Map](#)



Pinkerton's Intelligence Division is a security intelligence service that tracks and interprets rapidly changing world events, alerting you to local developments that could affect the safety and security of your corporate operations and assets.

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