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JUPITER INTELLIGENCE SPECIAL REPORT

Petrochemical Sites on Texas' Gulf Coast Face Massive, Costly Risk This Decade From Climate-Driven Extreme Weather

An Analysis of Three Bayport Petrochemical Facilities

Executive summary

A Jupiter Intelligence™ analysis of three major petrochemical facilities located on the Texas Gulf Coast near Houston reveals that all three are highly vulnerable to extreme flooding from storm surge, sea-level rise, and prolonged precipitation caused by climate change. The study concludes that the costs of climate-related risk could rise by as much as 800 percent by 2030.

Here are Jupiter's five key findings:

- Physical climate risks represent an imminent challenge for the industrial Gulf Coast
- Asset owners can and should leverage robust science for climate resilience
- Physical climate risks are unprecedented and non-stationary: the flooded area of studied facilities doubles to 80% by 2030
- Physical climate risks are local: facilities face different flood risks even when located closely to each other, calling for high-resolution modeling
- Inaction today will be costly tomorrow, because direct damages balloon by 3 to 8 times in the coming decade

Imminent challenge for the industrial Gulf Coast

The US petrochemical industry across the Gulf Coast is increasingly exposed to multi-billion-dollar threats from severe weather driven by climate change. Petrochemical infrastructure includes assets with multi-decadal lifetimes; the close proximity of these assets to bodies of water for transportation, supply chain, and cooling considerations now poses a serious risk from climate impacts such as sea level rise and shifting precipitation patterns. In the past five years, the region has suffered three "500-year" floods: the Memorial Day flood in 2015, the Tax Day flood in 2016, and Hurricane Harvey in 2017, which by some estimates brought 1,000-year floods to the region.[1]

Asset owners should leverage robust science for climate resilience

Faced with the physical risks of climate change, asset owners and managers must assess their risk based on rigorous climate science, prioritize their responses based on sound economic rationale, and devise and scale a climate resilience plan quickly. Physical climate risks are nonstationary, nonlinear, and local.[2] Therefore, the adaptation response to climate change must be forward-looking, facility-specific, and ultra-high-resolution. Jupiter Intelligence brings together the latest climate modeling methodologies and scientific research to provide actionable insights for climate resilience. Quantitative and probabilistic climate risk information is available for asset owners and service providers to enable them to understand how their climate risks shift over time, which assets are most vulnerable, and the critical time frame for effective resilience intervention.

Nonstationarity: Bayport industrial facilities confront shifting exposure to extreme flooding; 80% of plant area projected to flood by 2030

Jupiter examined three petrochemical facilities in the Bayport Industrial District near Houston (Figure 1) and found that all three facilities are highly vulnerable to extreme flooding. A 100-year flood today inundates 35-40% of these facilities, and a 500-year flood completely swamps the plants. Based on Jupiter models, the climate signal is strong. The area inundated during a 100-year flood increases significantly to above 80% in just a decade—well within the useful life of most petrochemical production assets.[3] Furthermore, today's extreme 500-year flood will become 4-5 times more likely by 2050.

Plant operators and risk managers must make informed capital investments that consider probable, near-term climate impacts. The data and tools that decision-makers rely on should leverage appropriate climate projections based on forward-looking physical models, not statistical projections of historical observations. Jupiter's models utilize a number of different emissions scenarios and offer forecasts that, from the beginning, take into account the impacts of climate change.

Local impact: Because facilities face different flood risks, even when located closely to each other, high-resolution modeling is critical

The two leading causes of flooding at Bayport are precipitation and storm surge. Higher sea levels driven by climate change lead to higher levels of storm surge from the neighboring water bodies connected to Clear Lake and Trinity Bay. The Roger Powell Plant benefits from bordering both Bay Area Boulevard, a transportation artery with large ditches on both sides, and the canal along Port Road; both effectively provide flood defense from storm surge that originates from the southwest side of the plant. The Dixie and Athlon plants, however,

Figure 1 The location and extent of the three petrochemical facilities analyzed.

are not protected and, as a result, suffer from deeper flooding even though the three facilities are located in close proximity.

Accurate, site-specific flood forecasting requires high resolution hydrologic and hydraulic modeling and elevation data. Jupiter's cloud-based model chains integrate the latest available data from cutting-edge remote sensing technology to resolve its climate hazards models at resolutions that are actionable for decision makers.

Physical and economic impacts will be non-linear: inaction now will be costly tomorrow as direct damages balloon 3-8 times in the coming decade

Based on Jupiter projected flood depths and damage functions developed by the US Army Corp of Engineers,[4] the estimated damage of extreme flood events at the three facilities will balloon by 3-8 times within the next decade (see Figure 2 on page 5). The most impacted plant, Dixie Chemical, could see an estimated $16M bill after a 100-year flood event by 2030, with average flood depth almost doubling from 2.1 feet to 4.1 feet; damages from a more severe, 500-year flood event would amount to a hefty $300M with catastrophic flood depths of over 7 feet. These damage estimates don't include potential regulatory fines if critical equipment is compromised. Not only will property damages be significant, the very functionality of the properties will be threatened in the next 10-20 years if the current standard of engineering and designs for flood tolerances are not upgraded.

Because this estimate is limited to only property and equipment damage, the true economic cost is likely to be even higher. Additional impacts—such as supply chain disruptions, lost inventory, reduced productivity, threatened workforce safety, emergency response, and increased toxic release risks, and the associated legal ramifications—will make extreme weather events even more devastating. Beyond the actual facility, further knock-on effects such as impacts on insurability, increased cost of capital, customer confidence, property value, community opposition, and tightened regulatory environment, will also challenge the economic sustainability of these operations.

About Jupiter

Jupiter provides a cloud-based climate analytics platform to help asset owners and managers quantify their physical climate risks at scale. Jupiter works with customers across the industrial, power, and financial sectors to incorporate robust climate science and customized client risk tolerance, engineering, and financial data to inform their climate resilience strategies investments. Contact info@jupiterintel.com to learn more.

1 Ingraham, Christopher. *Houston is experiencing its third '500-year' flood in 3 years. How is that possible?* The Washington Post (2017). https://www.washingtonpost.com/news/wonk/wp/2017/08/29/houston-is-experiencing-its-third-500-year-flood-in-3-years-how-is-that-possible/

2 Woetzel, Jonathan, et al. *Climate risk and response: Physical hazards and socioeconomic impacts*. McKinsey Global Institute (2020). http://www.mckinsey.com/business-functions/sustainability/our-insights/climate-risk-and-response-physical-hazards-and-socioeconomic-impacts/

3 Abdel-Aal, H., Alsahlawi, M. *Petroleum Economics and Engineering*. CRC Press (2013).

4 *HAZUS-MH MR3 Technical Manual*. Mitigation Division, Federal Emergency Management Agency, Department of Homeland Security. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_009806.pdf

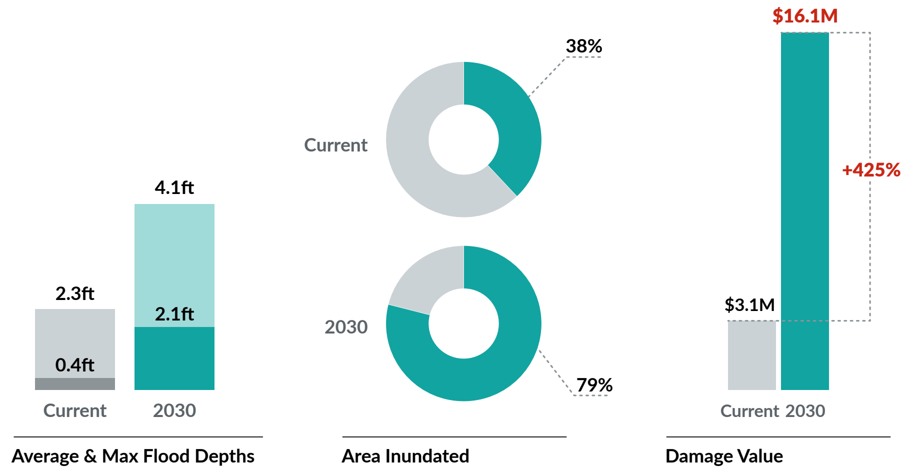
Petrochemical plants in the Bayport Industrial District could experience 3-8 times more damage from extreme flood events within the next decade.

Jupiter analyzed three petrochemical facilities in the Bayport Industrial District and modeled the potential flood effects based on an RCP 8.5 scenario. The model's 100-year flood predictions for today and in 2030 are presented below.

Dixie Bayport Plant

Operational Flood Threshold Reached by 2030

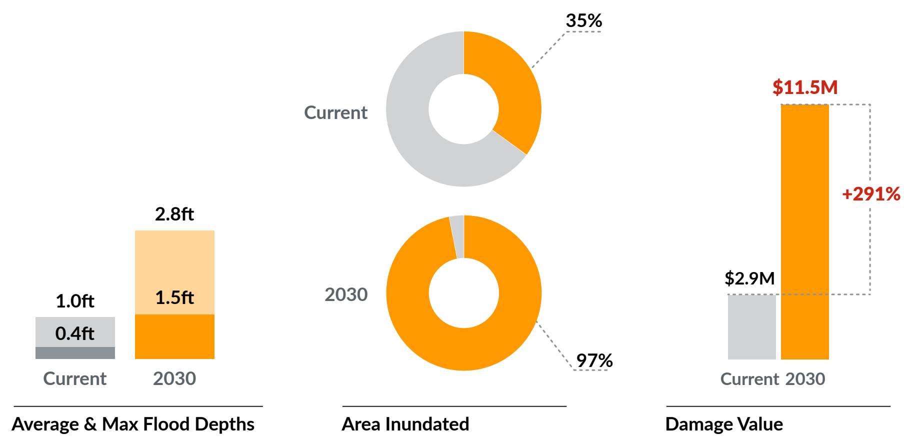
Owner: Dixie Chemical
2.1 million ft²



Roger Powell Plant

Operational Flood Threshold Reached by 2040

Owner: Carpenter Chemical
1.2 million ft²



Athlon Bayport Plant

Operational Flood Threshold Reached by 2040

Owner: Athlon Solutions
1.9 million ft²

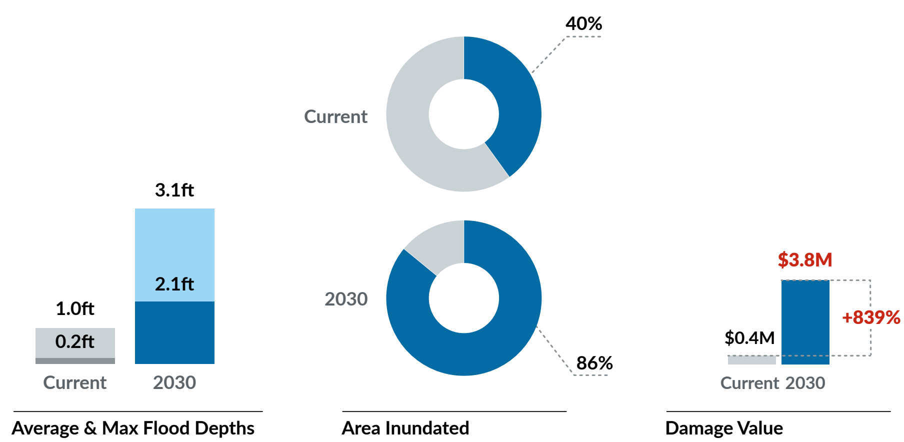


Figure 2 Selected findings from Jupiter's Bayport Industrial District plant analysis.