

The background image shows a dramatic seascape under a dark, cloudy sky. Large, white-capped waves are crashing against a dark pier or breakwater. A small boat is partially visible, caught in the turbulent water. The overall mood is one of intense natural power and potential destruction.

EXECUTIVE SUMMARY

In the Path of Destruction: Preparing for Climate Change in the Chemical Industry

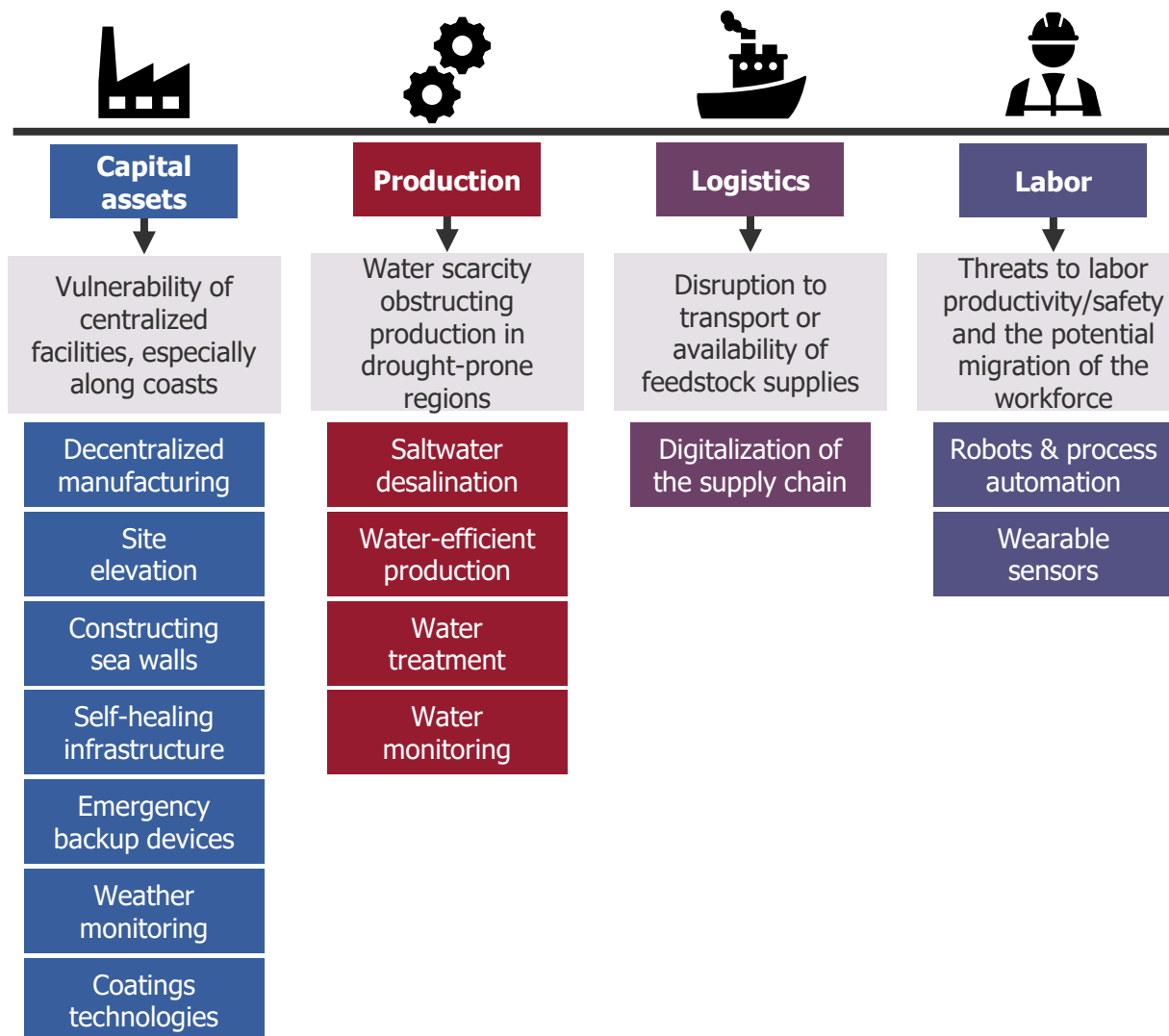
Lead Analyst: Kristin Marshall
Senior Research Associate

Contributors: Anthony Schiavo
Senior Analyst

Executive summary

The implications of climate change have already proven to be significant to the chemicals industry, creating hundreds of millions in damage and lost earnings. Despite uncertainty surrounding the severity and timing of climate-related hazards, the implications will be major – even for those not located along coasts. Companies should prepare now for the challenges that lie ahead.

Our review of the climate change adaptation strategies found that there is no completely effective solution except to move out of the path of destruction. The need to adapt will make small-scale, decentralized operations a growing part of the chemicals industry – even in the face of worse economics – as the impact of climate changes intensifies.



Companies should prepare adaptation strategies to alleviate risk and ensure survival in the long run

Background:

Tropical storm Harvey in 2017 and the Rhine droughts of 2018 have shown that climate change is already impacting the chemicals industry. What's more, extreme events will only grow more frequent as global average temperatures continue to rise. Disruption to chemical production and distribution will be made worse by an increase in climate-related extreme storm events, temperature change, and drought over the next 50 years. These hazards will not only impact day-to-day operations but also have the potential to disrupt the status quo of where and how chemicals are produced.

Scope:

This report aims to help companies, and specifically innovation leaders, prepare for the very real short- and long-term consequences of climate change for the chemicals industry. Here, climate adaptation is distinct from climate mitigation. Climate adaptation involves making fundamental changes to a company's core operations to ensure resilience, whereas mitigation attempts to prevent climate change from occurring. Rather than focusing on individual or temporary fixes to the major challenges that climate change poses (e.g., building sea walls), this report highlights big-picture innovation and discusses how the structure of the industry will be changed by new logistical and production paradigms. It first uses case studies to highlight key climate-related consequences necessitating greater action to be taken and then presents innovation opportunities to reduce risk.

Increasing levels of CO₂ from man-made sources will amplify climate-related hazards

COASTAL STORMS



Coastal storms like tropical cyclones involve heavy precipitation and winds reaching speeds of 155 mph (250 km/h) or more. Warmer conditions make storms more intense, and some studies suggest that climate change may lead to an [increase in the occurrence](#) of Category 4 and 5 storms. In addition, rising sea levels will make the impact of coastal storms even greater.

DROUGHT



[Humans have influenced global drought patterns for nearly a century](#), and rising temperatures will continue to impact the distribution of fresh water around the globe. While some regions are expected to become wetter, other regions are expected to become drier, leading to drought and fire. Some regions will witness megadroughts lasting multiple decades.

INLAND FLOODING



Aside from coastal storms, extreme precipitation events have intensified inland over the past several decades. Climate change is projected to increase the frequency and severity of these events, making worse the damage that flooding causes to property, infrastructure, and natural resources. Land use change can further exacerbate flooding due to lower infiltration capacity.

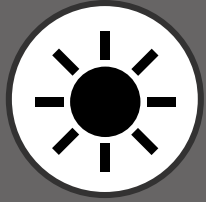
TEMPERATURE CHANGE



A 2 °C increase in the global average surface temperature since the industrial revolution has driven regional and seasonal temperature extremes (both hot and cold). The strongest temperature variations will occur in more northern and southern latitudes. As the global average surface temperature continues to climb, an [increase in the frequency and duration](#) of heat waves is expected, making certain geographies uninhabitable.

DROUGHT CASE STUDY

Low levels in the Rhine cost BASF more than €200 million in 2018 by disrupting barge traffic



OVERVIEW: Approximately 80% of the cargo transported by ship in Germany travels the Rhine, which begins in Switzerland and flows through Germany and the Netherlands, ending at the North Sea. In 2018, one of the longest periods of drought in the region left the river at record-low levels (as low as 30 cm in some locations), disrupting shipping and supplies of industrial commodities for months. The event forced millions of tons of products to be rerouted via other modes of transport, driving up costs. Concerns surrounding persistent droughts in Europe have been expressed since the early 2000s. Climate change – especially shrinking glaciers – will make lower water levels in the Rhine a more common occurrence.

BASF: BASF developed an alternative logistics plan after being impacted by low water levels along the Rhine in 2003 and 2005. Despite being aware of drought-related risks, the company was still forced to shut down its Ludwigshafen plant in 2018, costing it more than €200 million. While the company could still use a larger number of smaller barges to transport goods, the cost of barges fluctuated considerably. BASF is now in [discussion with its customers](#) about shifting to alternative modes of transport.



Image source: Union Pacific

We segment innovations for addressing climate-related consequences into four key categories

As illustrated by the previous case studies, companies do not have to be situated along coasts to be exposed to significant climate-related risk, especially given threats to production and logistics and the vulnerability of suppliers. The financial implications are significant in the short term, costing hundreds of millions in damage and lost earnings. The magnitude of climate risk will depend on the increased costs to or expected duration of stalled operations, as well as the size of losses from damage to capital and other fines/lawsuits that arise. There are four key categories of adaptation technologies to help mitigate this risk:

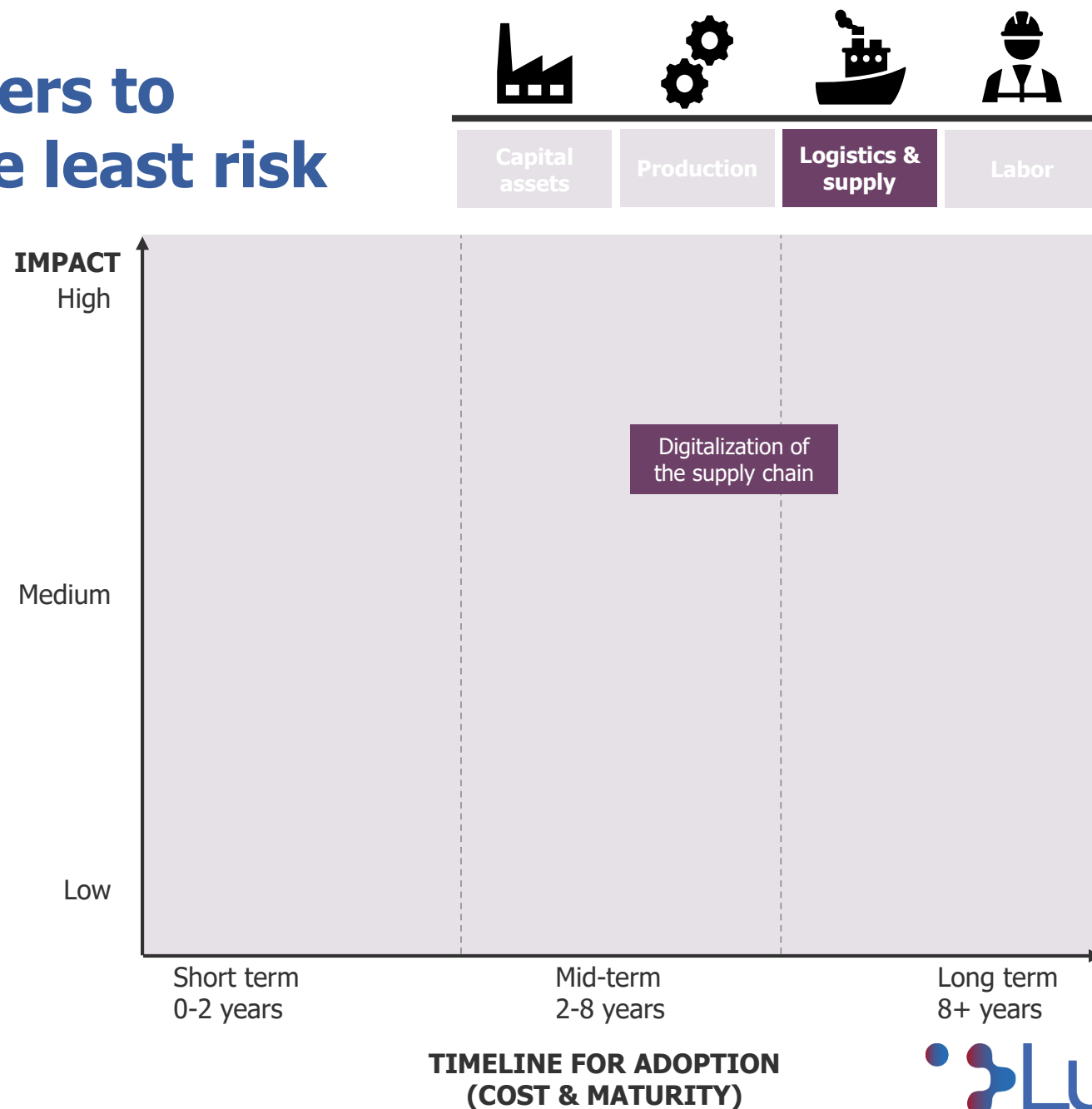


While some in the chemical industry believe climate risk will pose severe threats to their or their suppliers' businesses over the next 10 years, many others do not expect a substantive negative impact largely because of the uncertainty surrounding the severity and timing of future events. Despite there being uncertainty, companies should take climate risk seriously and plan now for the challenges that lie ahead. Customers will want to work with companies proactively acknowledging and working to reduce risk, and the more significant changes will take time to develop, so starting only once the risk is certain may be too little too late.

Digital tools allows customers to identify companies with the least risk

Overview Supply chain and logistics vulnerabilities span from increasing costs of raw materials to disruption in transport and changes in downstream demands. While chemical companies have little control over public infrastructure and utilities, they can control their [suppliers, their own operations, and what they choose to produce](#). Companies can adopt [digital tools](#) to better [monitor and improve their supply chains](#). Moreover, companies can employ advanced forecasting to predict potential disruptions due to climate-related events. Such technologies, however, depend on relevant, reliable, and timely data sources and will take time to implement.

• **LUX TAKE:** The digitalization of the supply chain will lead to greater transparency and allow companies to minimize their own operational risk as well as effectively identify and remediate at-risk partners.



INNOVATION SPOTLIGHT

Digitalization of the supply chain

What is it?

The use of sensors, tracking devices, IoT, analytics, and AI to optimize supply chains. These are used to make more informed decisions surrounding plant locations and capacity, inventory, distribution, and what to produce. Supply chain network optimization [provides a more holistic picture](#) of how and to what extent the impact of specific events will carry across the supply chain.

How does it support climate adaptation?

Currently, digital tools can alert producers of delays in imports and/or exports or inability to meet demand due to an anticipated decrease in production. As these systems improve and begin to incorporate climate models into their analytics, they will become more predictive and enable companies to build better climate resilience into their supply chains.

Innovations

Predictive analytics incorporating climate models can be employed to forecast both upstream supply constraints and future demand. Depending on future supply and demand dynamics, companies may consider shifting production altogether.

More advanced tracking of feedstock assets as they move through the supply chain allows companies to proactively identify alternative assets in the path of disruption. Moreover, enabling real-time tracking can prove useful for companies shipping volatile or other hazardous materials that are willing to take extra measures to [reduce the risk of a spill](#).

CASE STUDY

Dow and MxD

Introduction

Dow announced in September 2019 that it was [building a tool](#) with collaborators (including [MxD](#)) that would warn its manufacturers of supply chain disruptions.

Use case and business impact

The tool, trained using traditional and social media resources, aims to not only flag but also predict disruptions caused by emergencies, weather, and natural disasters. The potential impact of these events will be assessed and recommendations offered. As a result, manufacturers will be equipped to make changes to their supply chains and build greater resilience into their operations.

LUX TAKE

While this project serves as a first of its kind in the chemicals industry, it will not be last in the next five years. In the short term, such tools will be a “nice-to-have,” but, over time, their adoption will be necessary to compete in the industry, with companies like Dow that are building up the know-how today having an advantage. Future systems will be differentiated by the types of data being implemented and analytical models used for prediction.



Many companies face moderate short-term or severe long-term exposure to risk in their operations or supply chain

Step 1: Hazard identification

Step 2: Consequence analysis

Step 3: Risk determination

Step 4: Form a resilience plan

Following the risk assessment framework suggests that different levels of action will be needed for different companies based on their level of risk exposure.

Little to no exposure: Do nothing or “business as usual.”

Small short-term or moderate long-term exposure: Invest in technologies to reduce exposure to more immediate risk while for now passively monitoring those that address longer-term issues.

Moderate short-term or severe long-term exposure: Take strong actions now to address immediate issues, but don’t neglect to start investing now to head off the worst of long-term impacts:

- In *production*, prepare for substantial changes to lessen the impact of climate-related risk (e.g., make substantial investments in new production technologies, consider shifting your business focus, and/or move locations).
- In *supply chain*, overhaul or make changes to spread and mitigate risk and focus on adopting tools to flag supply chain weaknesses.

While any full risk assessment is company-specific, many in the chemicals industry will fall into the final category – the following slides show some of the steps they should be taking based on this analysis.

Mid-term (2-8 years): Those building resilience will begin pulling ahead of competitors

In the mid-term, the impacts of climate change will be increasingly felt, and downstream players will demand greater transparency across their supply chains to begin evaluating supplier risk. Companies taking action to build resilience and anticipate market needs will begin pulling ahead of their competitors.

KEY TECHNOLOGIES

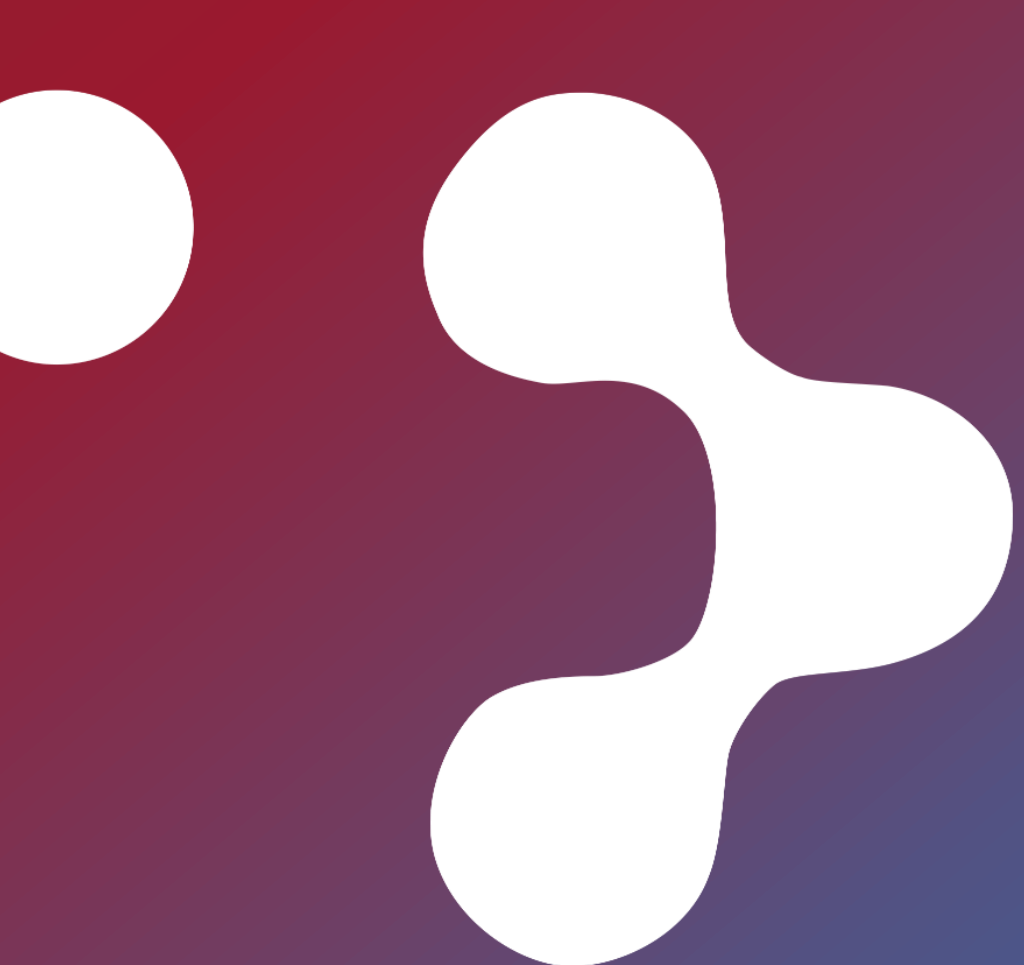
- Site elevation
- Digitalization of the supply chain
- Water-efficient production
- Water treatment
- Robots & process automation
- Self-healing infrastructure
- Wearable sensors

KEY STRATEGIES

- Increase risk management budget for vulnerable operations as higher-impact technologies become available and needed
- Build resilience in supply chain, flagging risky suppliers
- Communicate risk management efforts to customers
- Ensure investments are in place to prepare for more disruptive impacts and changes to come

HOW TO GET INVOLVED?

- *R&D and production* for incorporating high-impact technologies that address the threats most material to day-to-day operations
- *Business units* for using digital tools in procurement and anticipating market needs (i.e., product opportunities) based on climate risk



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Contact us:

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