

Climate Change Preparedness Toolkit

FOR BUSINESS DEVELOPMENT ORGANIZATIONS

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LISC

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CONTENTS

Purpose of this guide	7
Introduction	7
Overview of climate change trends	11
Translating climate risk into resilience for small businesses	18
Creating a culture that allows for innovation	29
Checklist for building resilience into your business plans to address climate change	32
Additional resources: Leveraging your community’s networks and resources	33
Climate change projections data: national, county, state, and local	36
Supply chain and supporting infrastructure considerations	41

EXHIBITS

Exhibit 1	The percentage of small businesses that do not reopen following a natural disaster	7
Exhibit 2	Cities that have been identified or have self-identified as climate destination or climate haven cities	8
Exhibit 3	Criteria that are used by investors, developed and others to assess the overall climate resilience of a particular geography, specifically as it relates to the climate migration potential of that area	9
Exhibit 4	The number of individual weather and climate disasters that resulted in at least a billion dollars' worth of damage in 2021	11
Exhibit 5	How Americans were impacted by extreme weather and climate change impacts in 2020	12
Exhibit 6	A generalized workflow of progressing from hazard identification to vulnerability assessment and impact analysis	13
Exhibit 7	Examples of Shocks and Stressors associated with Climate Change	14
Exhibit 8	Scales of resilience and strategies associated with each	14
Exhibit 9	Example of how impacts at a site level can compound and cascade to impact other sectors	15
Exhibit 10	Definitions of risk, resilience, hazard mitigation and climate change and how they relate to one another	18
Exhibit 11	Sample worksheet from SBA's Business Resiliency Guidebook	20
Exhibit 12	Example from SBA's Business Resiliency Guidebook	20
Exhibit 13	Sample form from IBHS-Open for Business Workbook to record key business functions and how they will be supported during disruptions	21
Exhibit 14	Standardized risk matrix that can be used to prioritize areas of focus and action.	23
Exhibit 15	The Rural Capacity Index	24
Exhibit 16	Preliminary market assessment criteria and indicators to assess climate migration risk	24
Exhibit 17	Projected economic impacts of climate change for 2080-2099	25
Exhibit 18	Projected economic impacts of climate change for 2080-2099	25
Exhibit 19	FEMA's Community Lifelines	27
Exhibit 20	How people and organizations experience an event from an emotional perspective and the implications for resilience planning	29
Exhibit 21	A description of the typical areas of focus and types of activities associated with each phase of an event, based on Exhibit 20	30
Exhibit A-1	National-level overview of key climate risks per geography	36
Exhibit A-2	Sea level rise	37
Exhibit A-3	Hurricane and typhoon risk	37
Exhibit A-4	Extreme rainfall risk	38
Exhibit A-5	Water stress	38
Exhibit A-6	Heat stress	39
Exhibit B-1	Example of how businesses might assess the climate vulnerability of their supply chain based on key considerations and variables	42
Exhibit B-2	Images showing Houston overpass before and during the flooding associated with Hurricane Harvey	44
Exhibit B-3	Projected increase in traffic delays along the I-95 corridor as a result of nuisance flooding under different climate emission scenarios and planning horizons	45
Exhibit B-4	U.S. airports ranked the most vulnerable to sea level rise	46
Exhibit B-5	The Port of Los Angeles	47
Exhibit B-6	The range of potential digital infrastructure solutions at a city scale.	49

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1 PURPOSE OF THIS GUIDE

This guide is intended to support small business owners in both developing a business continuity plan, as well as creating a culture that allows for innovations and transformations. Recognizing that business owners have a lot to consider in their daily operations, the guide has been organized to be accessible and concise. Additional resources are provided in the appendix for those who may wish to do a deeper dive on particular subjects. It is also accompanied by a training module, including a slide deck with talking points, that can be used to educate and train others.

In this guide, we will focus our discussions on climate change as the main hazard as a way to frame the overall process. Similar processes can be used for other types of hazards and Section 7 outlines additional resources that users can consult for an all-hazards assessment.

2 INTRODUCTION

The importance of business continuity

99.9 percent of all businesses in the US are classified as “small businesses” (U.S. Small Business Administration, 2020). Small businesses often operate out of a single location and, in 2013, nearly 90 percent of all business was generated within two miles of that location (Small Business Majority and American Sustainable Business Council, 2013). Because of their localized presence, small businesses can struggle to bounce back following a disaster. Recent statistics from a FEMA-sponsored study (FLASH, 2020) show that natural disaster result in the failure of 40 percent of small businesses immediately following the event and as high as 75 percent of all small businesses three years later. Those businesses without a continuity plan are particularly at risk.

Exhibit 1 The percentage of small businesses that do not reopen following a natural disaster

Natural disaster impact		
IMMEDIATE 40% of small businesses won't reopen	ONE YEAR LATER 25% more small businesses will close	THREE YEARS LATER 75% of businesses without a continuity plan will fail

Source: 2014 data from the Federal Emergency Management Agency (FEMA) and U.S. Department of Labor

Making the business case for climate resilience

Climate disasters — combined with the lingering economic stress of the pandemic — present immediate challenges to the survival of small businesses and the outlook for long-term recovery and growth. Climate change has created a new challenge to business continuity. Some of this may

result as direct physical damage to facilities and assets resulting from severe weather events. Other impacts may be due to disruptions in supply chains, key infrastructure systems or other essential networks that have been impacted by climate events.

In 2020, at least 1.7 million people in the United States were displaced as a result of weather-related disasters (NLC, 2022; Bilak, 2021). As the intensity and frequency of extreme weather events increase, in tandem with an increase in nuisance events, these numbers are likely to increase.

Climate change will impact local economies and dictate where people live and work

It has been estimated that climate change impacts in the US could amount to as much as four percent of the GDP per year. That would equate to nearly \$840 billion per year (Lustgarten, 2021). Preparing communities for climate change preserves local economies and the businesses that both feed and depend on them. Yet, only 600 of the nearly 89,000 local governments in the U.S. have completed a climate action plan. This represents only 0.007 percent of all municipalities (US Census Bureau, 2017; Pulver et al., 2021).

Cities and towns are already being ranked based on their perceived preparedness for climate change (Marandi and Main, 2021). **Vulnerable cities** are those which will see an out-migration because of increasing and inadequate preparation for climate impacts. **Receiving communities** will be places that people move to but the receiving community itself might not be fully prepared for that sudden influx. The third type of cities are self-identified **climate havens or destination cities** where the communities have marketed (and presumably prepared) themselves to receive these climate migrants. Inland legacy cities — those with existing infrastructure and institutions — have been identified as potential climate havens.

Exhibit 2 Cities that have been identified or have self-identified as climate destination or climate haven cities

These are cities where it is believed that people will want to move to be less impacted by climate change.

Recently identified climate haven cities	
Ann Arbor, MI	Madison, WI
Asheville, NC	Milwaukee, WI
Buffalo, NY	Minneapolis, MN
Burlington, VT	Orlando, FL
Detroit, MI	Pittsburgh, PA
Duluth, MN	Rochester, NY

Small business owners will need to have a growing awareness of the level of resilience within their communities and how that could impact their own business models. This has been an area of focus for developers and investors as of late. A recent report from the Urban Land Institute (2002) included a listing of indicators, developed in consultation with the larger investor and real estate market, that could be used to assess a city's overall resilience to climate change — with a primary focus on predicting areas that could be prone to climate migration risk.

Exhibit 3 Criteria that are used by investors, developed and others to assess the overall climate resilience of a particular geography, specifically as it relates to the climate migration potential of that area

Source: Urban Land Institute, 2022 and U.S. Housing and Urban Development and LISC, 2022.

Criteria	Indicators
Economic fundamentals	<ul style="list-style-type: none"> • Levels of protection offered by existing infrastructure • Area median income; disposable income • GDP sectoral composition • Corporate and/or anchor institution presence • Inequality • Housing affordability
Physical risk exposure	<ul style="list-style-type: none"> • Exposure of assets and market, including value at risk
Transition risk exposure*	<ul style="list-style-type: none"> • Assets and primary tenants • Key economic sectors
Market-level adaptive capacity	<ul style="list-style-type: none"> • Credibility of resilience plans • Fiscal capacity of relevant public-sector agencies • Track record of local institutions addressing resilience

* Includes potential shifts in underwriting practices related to insurance and credit ratings, as well as energy burden considerations.

Table based on ULI's Initial Market Screening tool for climate migration risk.

CASE STUDY – POST-SANDY COSTS IN NEW YORK AND NEW JERSEY

Source: Small Business Majority and American Sustainable Business Council, 2013

New York City suffered \$19 billion in losses, following Sandy. Recovery costs between New York State and New Jersey amounted to nearly \$70 billion. The costs to the economy were measured at \$50 billion. Within that, the private sector lost 86,000 jobs — most of which came from small businesses. The sectors most impacted included manufacturing, retail, leisure, hospitality and temporary help agencies.

As the frequency and intensity of extreme weather events increases, so will the potential disruptions to small businesses. These disruptions may include direct impacts, impacts to the business’s home community, or may be the result of impacts in other parts of the businesses support network, including supply chain considerations and infrastructure systems. At the end of the day, small business owners need to have a good understanding of how climate change impacts might impact the various aspects of their business model and what they can do to proactively avoid and minimize those impacts, or even develop new business lines in response to an emerging need.

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3 OVERVIEW OF CLIMATE CHANGE TRENDS

Climate change is the result of an increase in the concentration of greenhouse gasses (GHG) that have entered our atmosphere. This increase in GHG has caused the planet to warm resulting in both shifts and disruptions to historic weather patterns. It is possible to track the changes in precipitation, temperature and storm events, as well as being able to attribute some of those shifts — especially the intensification of discrete events — directly to climate change (Sabin Center for Climate Change Law, 2022).

Climate change solutions fall within two buckets. Mitigation is the piece that focuses primarily on the reduction of GHGs in the atmosphere, as a way to slow or reverse the global warming trends. Adaptation focuses on solving for the physical impacts of climate change, recognizing that even if GHG emissions came to a standstill tomorrow — there are still decades worth of warming (and associated climate disruptions) that will lead to ongoing climate impacts. In short, mitigation highlights our impact to the planet, whereas adaptation highlights the planet’s impact on us. For this work, we will focus mostly on the adaptation piece but will remain opportunistic about including mitigations considerations as well.

2021 was an active year for extreme weather events. NOAA has been tracking the incidence of weather disasters that result in a billion dollars or more of damage. Since 1980, 323 weather disasters have reached that magnitude, with a combined cost exceeding \$2.195 trillion dollars (NOAA, 2022). And that number is likely an underestimate of the true costs since it fails to account for indirect, cumulative, or longer-term economic impacts associated with recovery, displacement, uninsured losses, downtime, permanent closure of businesses, and other less easily tracked information.

Exhibit 4 The number of individual weather and climate disasters that resulted in at least a billion dollars’ worth of damage in 2021

Source: NOAA, 2022.



There has also been a trend of increasing frequency of billion-dollar disaster events. From 1980 to 2021, the average number of billion-dollar events was 7.7 per year. The average number of events in the last five years (2017-2021) is now 17.8 events (NOAA, 2022).

The contingencies that were in place to cover these events, including insurance and disaster relief funding, are already becoming inadequate to fully address these needs. And since climate change impacts every aspect of our environment – built, social, natural and economic – all sectors are undergoing these same pressures at the same time. Any “slack” in the system is quickly disappearing meaning that how we conduct business is also going to need to shift. Resilience offers a way to address that needed change, incentivizing proactive interventions over reactive ones. And that will be the focus of this work.

Exhibit 5 How Americans were impacted by extreme weather and climate change impacts in 2020

Source: National League of Cities, 2022.

Facts and figures



Disasters

In 2020, **1.7 million Americans** were displaced by weather-related disasters.¹⁵



Climate change

Nearly **1 in 3 Americans** directly experienced climate-related impacts in 2020.¹⁶



Extreme heat

More Americans die from heat exposure than any other weather-related event. Four to six times more people could be exposed to extreme heat by 2050.¹⁷



Sea level rise

40 percent of the population of the U.S. lives in coastal areas, with over half a million square kilometers in the Low Elevation Coastal Zone (LECZ), threatening as many as **63 million people** by 2100.¹⁸



Flooding

By the end of the 21st century, nearly 2.5 million residential and commercial properties (**\$1.07 trillion total estimated value**) will be at risk of chronic flooding.¹⁹



Extreme precipitation

2019 was the second wettest year in U.S. recorded history with the Midwest bearing the brunt with **\$6.2 billion in damages**.²⁰



Wildfires

1 in 7 Americans experienced dangerous levels of air quality from wildfire smoke in 2020.²¹

Understanding the key climate concerns for your business

Sometimes, it can be overwhelming to know where to start with climate change. The first question that people usually ask is what they can expect in their community. There are several sources of information that can be accessed to address that question. We have included some of the more accessible, publicly- available, peer-reviewed ones here, recognizing there may be more detailed assessments for some municipalities that could be used to further amend this information. See Appendix A for sources of this information.

Identification of potential hazards and a business' level of exposure to them is the first step in identifying key risks to business continuity (see Exhibit 6). While this work focuses on climate change in particular, a business will need to consider a range of hazards (see listing below). It can be difficult to find sources of information for some of these, but the Ready.gov website (U.S. Department of Homeland Security, 2022) and the Small Business Resilience Hub websites (SCORE, 2022) are good resources to help assess these various hazards with respect to particular business types and locations.

Exhibit 6 A generalized workflow of progressing from hazard identification to vulnerability assessment and impact analysis

Source: Small Business Development Centers and Small Business Association, 2020.

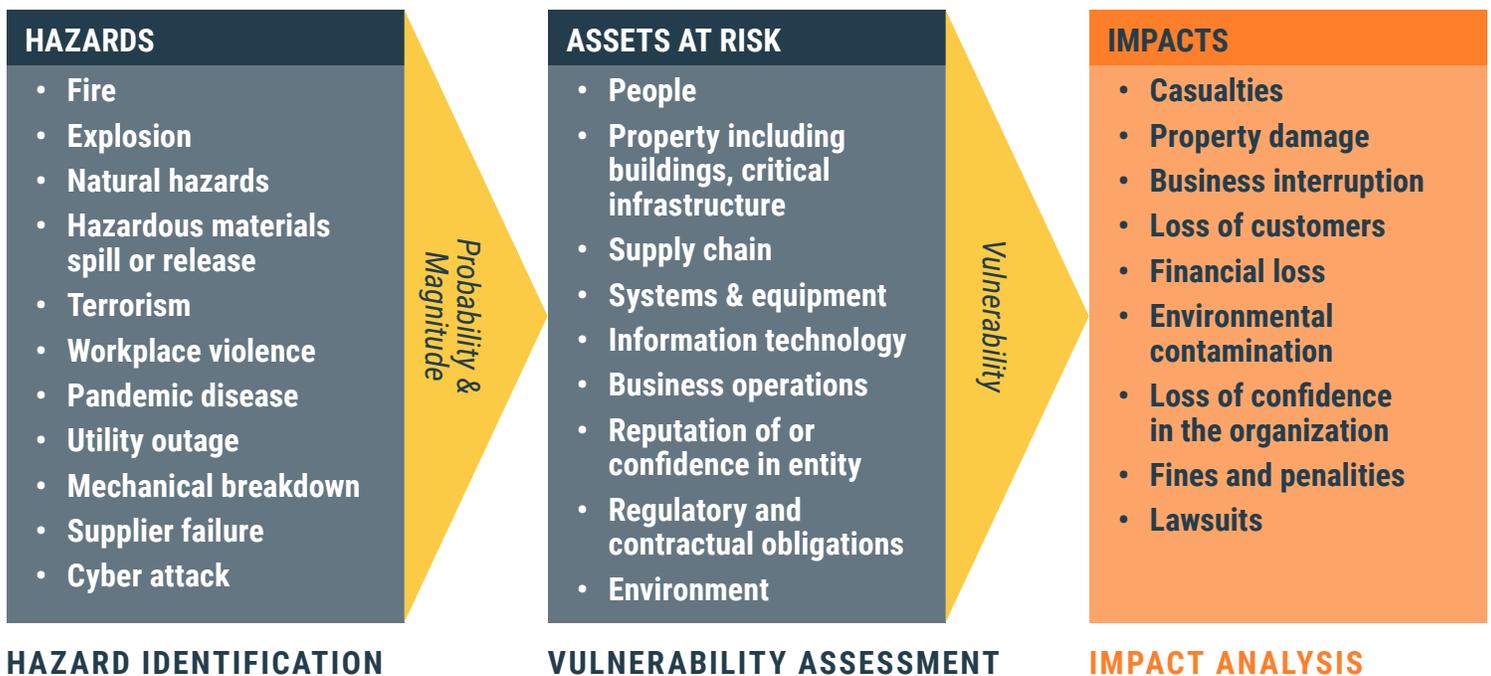


Exhibit 7 Examples of Shocks and Stressors associated with Climate Change

Shocks	Stresses
Flooding	Drought
Hurricanes	Sea level rise
Wildfires	Shifts in precipitation and temperature patterns
Heat waves	Environmental degradation
Cold snap	Aging infrastructure
Blizzards	Affordability
Nor'easter	Climate migration
Tornado	Transitional risks such as changes in technology, carbon pricing, devaluation of properties, insurance coverage, impacts to local revenues
Derecho	
Water shortage	

Other considerations

THE SCALES OF RESILIENCE

While an assessment of risk and resilience often starts at a very local level, it is important to recognize how external drivers will also influence a business' overall readiness. Aspects related to supply chains, regulations and even the general resilience of the community in which the business is located will have important ramifications for the larger business continuity plan.

Exhibit 8 Scales of resilience and strategies associated with each

Source: Churchill et al. 2021.

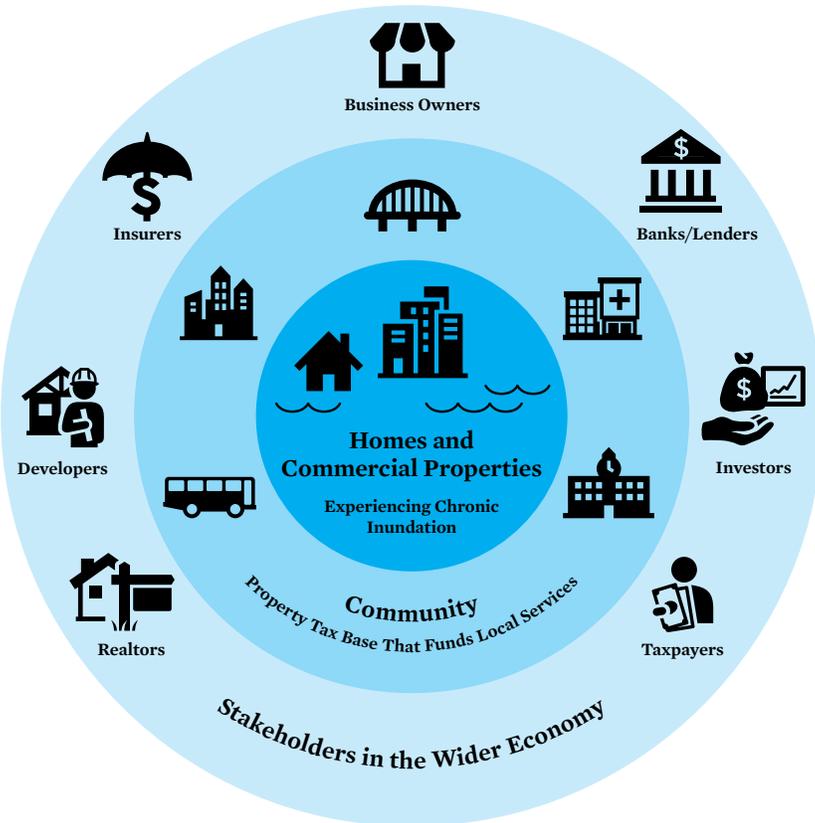


CONSIDERING CASCADING AND COMPOUNDING RISKS

It is human nature to focus on the risks that seem most immediate and direct – both in terms of location and timing. However, compounding and cascading events can result in cumulative changes that present as “shocks” once a certain capacity is exceeded. It is important to consider both “outside the fence” vulnerabilities that could impact your business, as well as how cumulative stressors might eventually present themselves as an acute shock. Below is an example of those types of impacts under flooding.

Exhibit 9 Example of how impacts at a site level can compound and cascade to impact other sectors

Source: Union of Concerned Scientists, 2018.



Assessing the resilience of your supply chain and supporting infrastructure

All businesses are vulnerable to disruptions in their supply chains and dependent on the reliability of the supporting infrastructure that serves their needs. The major infrastructure that should be assessed by all businesses include the energy, transportation, water, wastewater and telecommunications systems that operate both locally and nationally. Trends such as “just-in-time” deliveries, the outsourcing of manufacturing, and general consolidation of businesses (leading to less diversity within the supply chain) have introduced both efficiency and more vulnerability into the larger supply chain. Likewise, the increasing stresses associated with aging infrastructure and the growing backlog of deferred maintenance needs have further affected the overall resilience of the services that those systems provide and, by association, the resilience of businesses that rely on those. See Appendix B for a more nuanced assessment of potential supply chain impacts.

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Training Module 1: Facilitate exercises with small businesses to identify key climate hazards and potential barriers to preparedness

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The outcome of this module and exercise will result in a completed table with climate data specific to each geography/business. Depending on the availability of data sources, future time horizons may be slightly different than shown here. In addition, key supply chain impacts should also be noted here.

4 TRANSLATING CLIMATE RISK INTO RESILIENCE FOR SMALL BUSINESSES

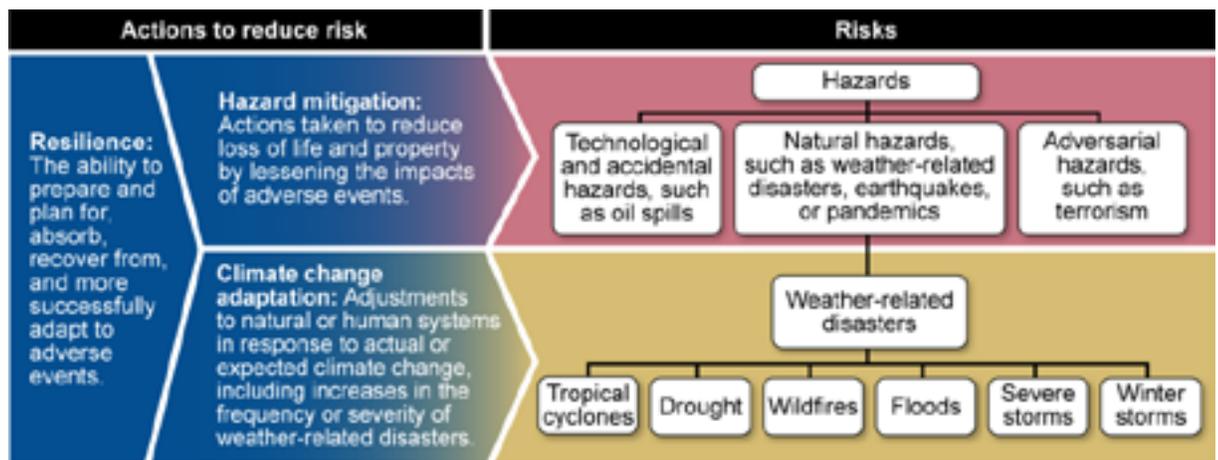
Resilience can be defined as maintaining the critical functions of an operation in the midst of various disruptors. It includes accounting for both acute shocks and chronic stressors, as well as short-term and long-term planning horizons. When framing resilience discussions, it is also important to be cognizant of the various scales and what key indicators (and solutions) might look like for each.

There can be some confusion around how resilience, risk and mitigation all relate to one another — this is especially true in the realm of climate change. In short, resilience focuses on the ability to maintain critical functionality (or rapid recovery) in the midst of various disruptors. In order to achieve resilience, there are hazard mitigation and adaptation strategies that can be used to prepare entities and communities to become more resilient. The category of risks focuses mainly on identifying the type, extent and expected intensity and likelihood of occurrence for specific hazards and disaster types (see Exhibit 10).

Exhibit 10 Definitions of risk, resilience, hazard mitigation and climate change and how they relate to one another

Source: GAO, 2016.

Relationship among Risks, Resilience, Hazard Mitigation, and Climate Change Adaptation



What are the core tenets of your business?

A risk assessment requires a clear and shared understanding of the key elements of your business. This includes not only the main objectives and goals but an understanding of what critical functionality looks like and what assets and resources must be in place to make sure business operations can continue in the midst of various disruptors. Below are the types of questions and information that a business needs to address to be able to identify those core tenets. Example worksheets are also provided.

The core tenets of your business

- 1 What are the key services and/or products your business provides?
 - a What is your mission statement for the business?
 - b Who is your key client base?
 - c Can these services be delivered remotely?
 - d What type of expertise do you need to have on your team to operate your business?

- 2 What are your business goals and objectives?
 - a What do you hope to achieve with your business?
 - b What are your growth projections? Minimal or maximum size?
 - c What do metrics of success look like for you?

- 3 What are the critical assets and functions needed to meet those?
 - a Key piece of equipment or asset(s) – core to main functions of business
 - b Personnel – what are the key roles that must be enabled to ensure continuity?
 - c Meeting payroll and other legal and financial obligations
 - d Preserving your business’s reputation and presence in the marketplace
 - e What key aspects of your supply chain do you need to rely on? Are any of those prone to climate change impacts?

EXAMPLE MISSION STATEMENTS FROM PATAGONIA

Previous mission statement:

“Build the best product, cause no unnecessary harm, use business to inspire and implement solutions to the environmental crisis.”

Current mission statement:

“Patagonia is in business to save our home planet.”

Exhibit 11 Sample worksheet from SBA's Business Resiliency Guidebook

Source: SBDC and SBA, 2020.

What are your goals that drive your business forward?

BUSINESS GOALS:	
Goals	
E.g.	Expand manufacturing operations by buying new machines, new software, and new computers
1.	
2.	
3.	
4.	

NOTES:

Exhibit 12 Example from SBA's Business Resiliency Guidebook

Source: SBDC and SBA, 2020.

Critical Business Function	Supporting Resource(s)	Function of Resource	Backup Resource(s)
Machinery for Manufacturing	Employee	Employee has specialized training to use the machine	Trained 2 extra employees in case he/she gets sick or leaves
	Electricity	Allows us to run the machine	Backup generator
	Internet Connection	Allows processing of orders, tells how much our production should be	Certain employees can work from home with internet, our backup location has internet too

Exhibit 13 Sample form from IBHS-Open for Business Workbook to record key business functions and how they will be supported during disruptions

Source: IBHS, 2020.

USE THIS FORM TO DOCUMENT KEY BUSINESS FUNCTIONS AND PROCESSES CRITICAL TO THE SURVIVAL OF YOUR BUSINESS.

BUSINESS FUNCTION:

Recovery Priority: Extremely High High Medium Low

Responsible Employee: _____

Alternate Employee: _____

Training required for alternate employee: _____

Timeframe or Deadline: _____

Obligation: None Legal Contractual Regulatory Financial

Money lost (or fines imposed) if not done: _____

Who performs this function?
(List all that apply)

Employees: _____

Suppliers/vendors: _____

Key contacts: _____

(For additional space, use the Notes area below)

What is needed to perform this function? (List all that apply)

Equipment: _____

Special Reports/Supplies: _____

Dependencies: _____

(For additional space, use the Notes area below)

Who helps perform this function? (List all that apply)

Employees: _____

Suppliers/vendors: _____

Key contacts: _____

(For additional space, use the Notes area below)

Who uses the output from this function? (List all that apply)

Employees: _____

Suppliers/Vendors: _____

Key Contacts: _____

(For additional space, use the Notes area below)

Brief description of how to complete this function:

Workaround Methods: (Consider temporary/manual processes that can be implemented until a permanent solution is available. Document detailed procedures for these workarounds, including any additional resources required, in a separate document.)

Overlaying climate risk

Using the climate hazard information identified in the previous section, assess the overall vulnerability of key assets and operations. Below is a sample worksheet that could be used to guide that process.

Critical assets / resources	Impacted by:	Consequence of event	Likelihood of event	Resilience strategies
Asset 1	Coastal flooding			
	Inland flooding			
	Precipitation			
	Temperature			
	Wildfire			
	Wind			
Asset 2	Coastal flooding			
	Inland flooding			
	Precipitation			
	Temperature			
	Wildfire			
	Wind			

Depending on the preferred level of detail, some businesses may choose to differentiate across the various time horizons. This could be useful in that time horizons could be used for proxies of probability when determining risk (probability of event * consequence of failure). See subsequent section for additional details.

In addition, it may be that Resilience Strategies are not fully developed at this point, but it is useful for businesses to start to list preliminary concepts that can be further fleshed out following the prioritization of risk. At the end of this exercise, the business will be able to identify key vulnerabilities to its business and carry those forward to prioritize risk based on the consequence of failure and, when available, probability metrics.

Assessing the consequence of failure

Risk is the product of the likelihood (or probability) that an event will occur, combined with the overall severity of the event (consequence of failure). In general, most businesses will prioritize their actions based on those events which exhibit the highest probability of occurring and the highest consequence if they were to occur. As shown in Exhibit 14, those events cluster in the upper right-hand corner of a risk matrix. However, it is important to note that there may be situations in which low likelihood, high consequence events are also prioritized since the consequence may be severe enough to bring about the failure of a business. These are individualized decisions based on a variety of considerations, including other potential mitigating strategies (such as insurance, availability of other funding) and the risk tolerance of the business decision-makers.

Exhibit 14 Standardized risk matrix that can be used to prioritize areas of focus and action.

Source: SBDC and SBA, 2020.

	1	2	3	4	5
5	Moderate	Moderate	Major	Critical	Critical
4	Minor	Moderate	Major	Major	Critical
3	Minor	Moderate	Moderate	Major	Major
2	Minor	Minor	Moderate	Moderate	Moderate
1	Minor	Minor	Minor	Minor	Moderate

-Minor: Acceptable, Unlikely to require specific application of resources, manage by routine procedures. Monitor and review.

-Moderate: Acceptable, Unlikely to cause damage and/or threaten efficiency. Manage by specific monitoring and response plans

-Major: Generally, not acceptable, likely to cause some damage or breach of controls. Management attention needed and management responsibility specified. Response plans need to be developed.

-Critical: Not acceptable, Likely to threaten the survival or continued effective functioning of the business. Immediate action required. Need a response plan.

As mentioned previously, it may be challenging to find probability data for specific climate hazards and/or geographies. If that is the case, the projected timing of the impact can be used as a proxy for probability. For example, if a facility is already located within a FEMA-designated 1 in 100-year flood zone, then flooding can happen today. We would, therefore, assign that with a likelihood of 5. If the flooding were not projected to occur until 2050, we'd assign a likelihood of 1 and a likelihood of 3 for flooding expected to occur by 2030. These are relative rankings and should be accompanied by a general explanation outlining the key criteria used.

What is the resilience of the community where your business is located?

- a Has the municipality/region/state engaged in a Climate Vulnerability Assessment and/or Climate Action Plan? Are there aspects that could be leveraged here?
- b Is there a risk for potential climate migration either away from or to your community? Leverage the recent work from the Urban Land Institute (ULI) to assess that risk.
- c Supplement that assessment, leveraging the recent work by the National League of Cities (2022) to determine whether your community is likely to become a vulnerable municipality, a receiving one or a climate haven. This may require discussions with the local Planning Board or Town Council for their insights.
 - **Vulnerable Cities:** those that will suffer significant losses in population and taxes
 - **Recipient Cities:** those that serve as unsuspecting or unwilling “receiving communities” from sudden-onset disasters without preparation
 - **Climate Destination Cities:** cities seeking to rebrand their communities as “climate havens” that welcome displaced residents through equitable planning and preparation
- d What is the basic economic outlook for your area based on climate change? Below are two possible sources that could be used to answer that question at a high level.

Exhibit 15 The Rural Capacity Index

The Rural Capacity Index assesses a jurisdiction's ability to prepare for climate risk based on local revenues and overall capacity

Source: Headwater Economics, 2022.

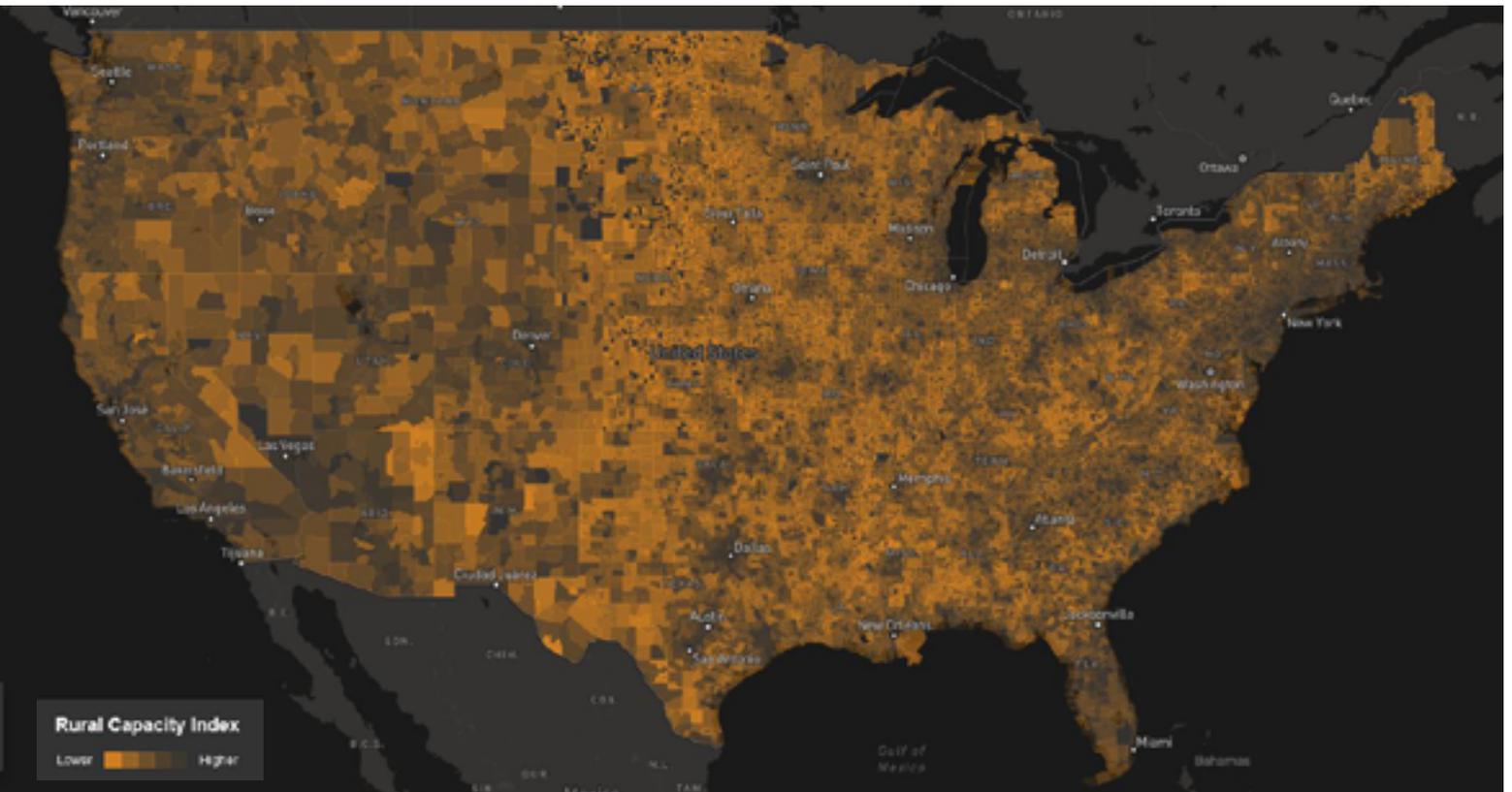


Exhibit 16 Preliminary market assessment criteria and indicators to assess climate migration risk

This index relies on market-based indicators to assess the overall financial and economic resilience of a geography based on assessed capacity.

Source: Urban Land Institute, 2022 and US Housing and Urban Development and LISC, 2022.

Criteria	Indicators
Economic fundamentals	<ul style="list-style-type: none"> • Levels of protection offered by existing infrastructure • Area median income; disposable income • GDP sectoral composition • Corporate and/or anchor institution presence • Inequality • Housing affordability
Physical risk exposure	<ul style="list-style-type: none"> • Exposure of assets and market, including value at risk
Transition risk exposure*	<ul style="list-style-type: none"> • Assets and primary tenants • Key economic sectors
Market-level adaptive capacity	<ul style="list-style-type: none"> • Credibility of resilience plans • Fiscal capacity of relevant public-sector agencies • Track record of local institutions addressing resilience

* Includes potential shifts in underwriting practices related to insurance and credit ratings, as well as energy burden considerations.

Table based on ULI's Initial Market Screening tool for climate migration risk.

Exhibit 17 Projected economic impacts of climate change for 2080-2099

Source: Hsiang et al. 2017.

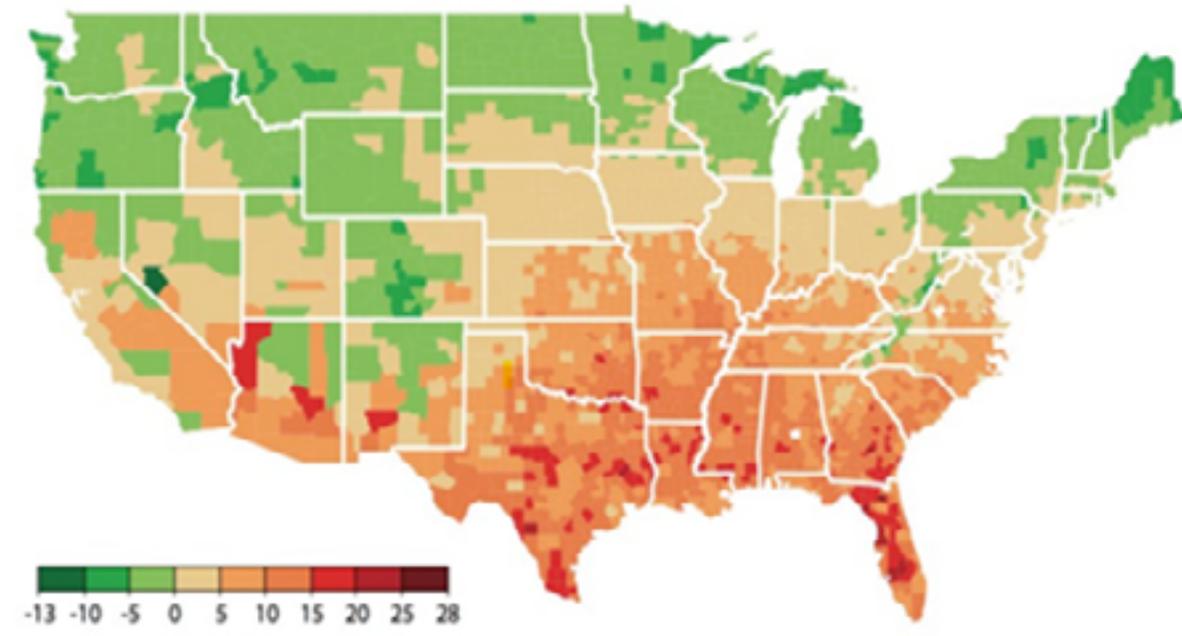
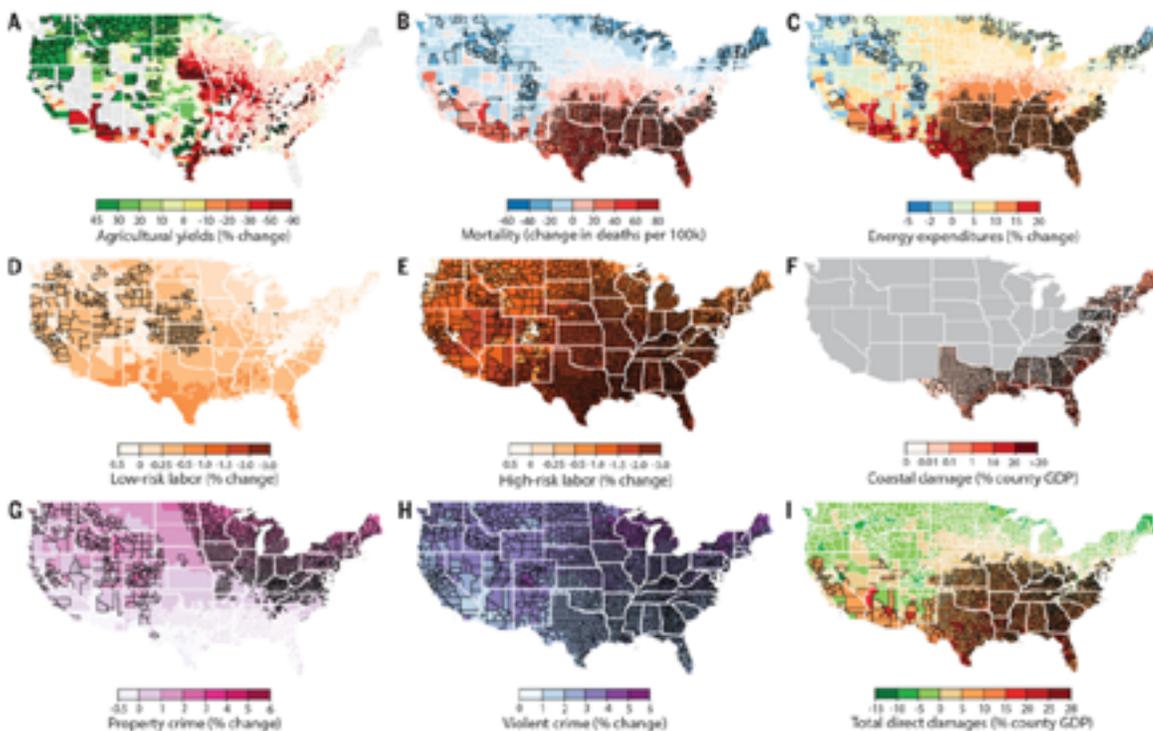


Exhibit 18 Projected economic impacts of climate change for 2080-2099

Those same results broken out by the following categories: agricultural yields, mortality change, energy expenditures, low-risk labor, high-risk labor, coastal damage, property crime, violent crime, total direct damages (shown above as well).

Source: Hsiang et al. 2017.



Conducting a stress test

Conducting a stress test and/or desk-based scenario-planning exercise is useful in assessing a business's level of preparedness, vetting key assumptions (e.g., power backups are adequate) and identifying potential gaps and areas of improvement. Representative prompts could include the following considerations.

How able am I to remain operational if:

- a Power were to fail?
- b Employees were not able to make it onsite?
- c If the water supply became less reliable?
- d If wastewater/waste disposal was interrupted?
- e If telecommunications and/or broadband were unavailable?

An efficient way to conduct this assessment is to design a scenario that would stress the system in multiple ways over a period of several days. For example, imagine an intense thunderstorm which results in regional power outages, interruption to the broadband infrastructure, and localized flooding, followed by a multi-day heatwave. Power would be restored to 90 percent of the community at the end of day three but the other 10 percent (which could include your business) could be out for an additional 1-2 weeks. Since the event was regional in scale, mutual aid would not be likely and many employees (including those working at support facilities) may not be able to make it into work because of flooding at their own homes and/or heat emergencies.

With that scenario in mind, go back and answer the questions above day by day. For example, what happens on day 1 of a power failure? Is there back up power? How long will that last? Is it enough to feed all systems? What does that look like for days 2 and 3, and out for one to two weeks? Continue that analysis through the other questions. You will likely discover gaps, areas that will require you to reach out to others to test your assumptions (e.g., that the energy company is aware of any critical power needs at your facility) and likely identify key stakeholders and partners who should be engaged PRIOR to the event to minimize downtime during and following an event.

FEMA and DHS have more formalized assessments and can be invited to lead a community-wide (or sector specific) assessment. As part of that work, they often refer to FEMA's Community Lifelines as a way to organize the discussions and outputs. It is a useful prompt even at the individual business level. Ready.gov provides similar resources for specific hazards.

Exhibit 19 FEMA's Community Lifelines

These categories are used to help frame FEMA's larger assessment of risk, necessary stakeholders and solutions within and across those individual lifelines.

Source: FEMA, 2022.



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GAO, 2016. Selected governments have approached adaptation through laws and long-term plans. GAO Highlights of GAO-16-454. <https://www.gao.gov/assets/gao-16-454-highlights.pdf>

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Hsiang, S. et al. 2017. Estimating economic damage from climate change in the United States. Science 356, 1362-1369. www.science.org/doi/pdf/10.1126/science.aal4369

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Urban Land Institute, 2022. Climate Migration and Real Estate Investment Decision-Making. <https://knowledge.uli.org/en/Reports/Research%20Reports/2021/Climate%20Migration%20and%20Real%20Estate%20Investment>

U.S. Housing and Urban Development and LISC, 2022. Resilient Building Codes Toolkit. <https://www.hudexchange.info/resource/6701/resilient-building-codes-toolkit>

Training Module 2: Conduct a risk assessment (threat, hazard, vulnerability, impact) and prioritize investments and attention accordingly

5 CREATING A CULTURE THAT ALLOWS FOR INNOVATION

An organization's ability to think about resilience will be informed by the environment in which it is currently operating. Exhibit 20 and Exhibit 21 illustrate how people experience extreme events from a behavioral perspective and how that influences whether resilience is approached reactively or proactively. Although this graphic was originally designed with people in mind, similar concepts also apply to organizations including small businesses.

Exhibit 20 How people and organizations experience an event from an emotional perspective and the implications for resilience planning

During the response phase, the immediate focus will be on health and safety needs. There is more space to consider enhancing resilience during the recovery phases, with the potential for truly new and innovative approaches being developed during both the recovery and reconstruction (including planning) phases.

Modified from graphic produced by U.S. Dept. of Health & Human Services, Substance Abuse and Mental Health Services Administration.



Exhibit 21 A description of the typical areas of focus and types of activities associated with each phase of an event, based on Exhibit 20

Current state	Focus	Activities
Response (during the event)	immediate; triage; primary operations; employee-focus	Immediate health and safety needs; modifying and prioritizing operations; communicating with staff and public in crisis
Recovery (after the event)	near-term; re-opening; larger business operations (customers, suppliers, employees)	transitioning to business as usual; accessing funding, loans to re-establish; shifting operations to an alternative location or setting temporarily or permanently; focus on "building back better"
Planning period (before the event)	forward thinking; future considerations; potential expansion of business (customers, suppliers, employees, services, products)	assessing risks, vulnerabilities and lessons learned; optimizing for uncertainty and redundancy; innovating; increasing resilience by reducing exposures and dependencies; succession or devolution planning (shifting decision-making authorities to ensure continued operations)

In the midst of an event, an organization is operating within a response mode. The focus of those efforts is on immediate needs of the business and people, including addressing urgent health and safety concerns. During the Recovery period, that focus shifts to rebuilding and there is an ability to reflect on lessons learned and to spend more time thinking about changes that could enhance the resilience in the midst of future disruptions. There can be a tendency to build back to the same physical footprint and operational model. However, in doing so, there is a missed opportunity to enhance the overall resilience of the business to future disruptions. As well as retaining the same vulnerabilities moving forward. It can be difficult to think differently in the response phase — the best time to do that is before, as part of business continuity and preparedness planning. In doing so, businesses are able to transform their business models into a more resilient state.

That said, opportunities exist for transformational changes in the midst of the event, or in the early response phases. Examples of those types of changes during the COVID pandemic included using 3-D printing to solve for the shortage of swabs that were needed for testing, as well as developing new UV treatment practices that allowed for masks to be reused, and, of course, the technical and collaborative innovations that came about (e.g., regulators, competing pharmaceutical companies and private and public organizations working together in very new ways) that led to the development of the vaccines themselves. These transformations came about through a banding together of many individuals and entities at a scale that is outside of the network of a typical small company. Small businesses can increase their resilience by being aware of these larger networks and how they might plug into them proactively — before being presented with the challenges of the event itself.

Creating a resilient business

Two key themes are essential in building both flexibility and resilience into small businesses. The first is to establish strategies to be able to immediately leverage networks, resources, and funding sources before, during, or right after an event. The second is setting up a governance structure within your organization that enables change management — for both short-term needs and longer-term strategies.

By prioritizing the key challenges to business continuity through the vulnerability assessment, a business is able to focus the necessary effort in further developing detailed continuity plans for those assets, resources and operations that are vital to its core survival. The third training module will take the information gathered in modules 1 and 2 to develop those detailed resilience and business continuity strategies.

To ensure that those strategies can be acted on – and to allow for additional innovation that may be required during specific events and/or unforeseen stressors (COVID is a good example of the latter) – it is also vital to organize the business in a way that enables change management during and prior to disruptions. These organizational changes can be immediate and transformational and/or more gradual and iterative. In general, there are five steps that are important in establishing a change management process in organizations (Miller, 2020):

- 1 Preparing the businesses for change (and to be open and responsive to change)
- 2 Developing strategies, performance indicators and identifying who will need to be involved
- 3 Implementing the plan, including empowering employees
- 4 Integrating those changes into the company culture and practices
- 5 Using the performance indicators to review progress and make adjustments as needed

These all require a potential change in governance, how the business operates and empowering employees to take a more active role in both the daily and more strategic aspects of the business itself. Succession planning is an example of this but is only one piece. Other considerations include making sure that not all decision-making sits with one or two people, that there is adequate redundancy within certain functions, and that businesses will need to build additional partnerships (with their vendors, providers, their municipality, SBA, BDOs and others) to ensure that both short- and longer-term goals can be realized. All of these considerations should also be part of the larger continuity plan.

SOURCES CITED

Miller, K. 2020. Five critical steps in the change management process. Harvard Business School Online. <https://online.hbs.edu/blog/post/change-management-process>

U.S. Dept. of Health & Human Services, Substance Abuse and Mental Health Services Administration

Training Module 3: Develop strategies that facilitate reconstitution, rapid innovation, and adaptation to both short-term and long-term changes in their environments

The focus is on completing Resilience Strategies column in first table (which has been introduced in **Training Module 2**) and completing the Business Function form (second graphic — also introduced in **Training Module 2**) for each of the strategies identified.

6 CHECKLIST FOR BUILDING RESILIENCE INTO YOUR BUSINESS PLANS TO ADDRESS CLIMATE CHANGE

.....

1 What are the key climate hazards for your business? (page 22)

Use the results from this table to determine the most relevant, urgent and consequential climate hazards.

.....

2 What are the core tenets of your business? (page 19)

- a What is the mission of your business?
 - b What are they key services and/or products your business provides?
 - c What are your business goals and objectives?
 - d What are the critical assets and functions needed to meet those?
-

3 Overlaying climate risk (page 22)

- a How will the critical assets and functions be impacted by climate hazards?
 - b What are your resilience strategies?
 - c What is the resilience of the community that your business is located in?
-

4 Conducting a stress test (page 26)

Could your business remain operational if:

- a Power were to fail?
 - b Employees were not able to make it onsite?
 - c Water supply was interrupted?
 - d Wastewater/waste disposal was interrupted?
 - e Telecom was interrupted?
-

5 Other considerations

- a Is your business organized to allow for innovation and transformational change?
- b What keeps you up at night, and will climate change exacerbate those concerns?
- c Is there a business opportunity for you with climate change?

7 ADDITIONAL RESOURCES: LEVERAGING YOUR COMMUNITY'S NETWORKS AND RESOURCES

Small businesses are part of the larger community in which they operate and, likewise, are dependent on the overall resilience of the community itself. The overall resilience of your business will only be as strong as the weakest link. And some of those key dependencies — especially reliance on external infrastructure systems — will be outside of your jurisdiction. As part of the internal assessment process, you will learn where some of those key vulnerabilities may lie and who to reach out to form pre-event partnerships, agreements and strategies for enhanced resilience and rapid recovery. Below are some examples of what those efforts could look like.

A **Work in partnership with ongoing efforts and networks at the community, regional and national levels**

More municipalities and states are undertaking climate change vulnerability assessments. If your community has already conducted one, this is a good place to start to understand what the key vulnerabilities are at the community level, who the key stakeholders are and where your small business may fit within the larger solution set.

If no assessment has been undertaken, this could be an opportunity for you to advocate for one, leveraging your own network and working in concert with others to present a multi-stakeholder endorsed and targeted as to the community government or perhaps seeking funding through the Small Business Administration to conduct an assessment. The SBA offers Business Resiliency online materials and more formal training opportunities that would have significant relevance when preparing for climate change.

B **Provide a voice for small businesses in these discussions**

A climate change vulnerability assessment at the community scale is a large undertaking which involves soliciting input and participation from a variety of stakeholders — including residents, key businesses, utility providers and others. Small businesses do not often figure prominently in these types of assessments, which can likely be ascribed to a number of reasons, including needing to keep the groups manageable and the time commitment required for these types of advisory panels. One way for small businesses to become more involved is by banding together – either in an ad hoc way (e.g., creating a small group of business owners concerned about climate change to share the engagement responsibilities) and/or advocating that pre-established business networks such as the local and regional Chambers of Commerce develop a set of recommendations for climate change resilience which apply directly to small businesses and could be easily incorporated into the community-level assessments.

C **Encourage local Chambers of Commerce to develop committees, resolutions and active campaigns related to climate resilience for small businesses**

In addition to developing the overarching recommendations described above, Chambers of Commerce and other local business development organizations could be tapped to develop more involved climate change programs that include training, education and outreach directly to the small businesses, as well as ongoing support with respect to climate change preparedness. The intent of this work is to provide those materials to local BDOs to kick start that process.

Another possibility is to have these organizations take on an advocacy role, developing committees and board memberships tasked with this issue, creating resolutions as to how the issue will be addressed for small businesses and their role in advancing those goals, creating metrics of success for what climate preparedness and resilience looks like for each business as well as a collective, and even developing public awareness campaigns to better delineate the links between a climate resilient businesses and the economic health of a community.

Additional resources available online

GUIDES AND TOOLKITS

Agility, 2019. The Definitive Guide to Disaster Planning. <https://www.agilityrecovery.com/resources/definitive-guide-disaster-planning>

America's Small Business Development Centers, 2020. Small Business Resiliency Guide. Keeping the Lights on. <https://americassbdc.org/wp-content/uploads/2020/04/Business-Resiliency-Guidebook-4-10-2020.pdf>

Cisco, 2020. Beyond Survival: A Small Business Resiliency Guide. <https://www.content.shi.com/SHIcom/ContentAttachmentImages/SharedResources/PDFs/Cisco/cisco-111220-smbrecovery-mini-ebook.pdf>

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Federal Alliance for Safe Homes, Inc. (FLASH) 2020. Ready Business Toolkit for Hurricanes. www.ready.gov/sites/default/files/2020-04/ready_business_hurricane-toolkit.pdf

FEMA, 2019. Community Lifelines Implementation Toolkit. <https://www.fema.gov/sites/default/files/2020-05/CommunityLifelinesToolkit2.0v2.pdf>

FEMA, 2021. Comprehensive Preparedness Guide 101: Developing and maintaining emergency operations plans. <https://www.fema.gov/emergency-managers/national-preparedness/plan>

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Institute for Business & Home Safety (IBHS) 2020. Open for Business: A Disaster Planning Toolkit For the Small to Mid-Sized Business Owner. <https://disastersafety.org/business-protection/ofb-ez/>

TRAINING

DRI INTERNATIONAL

Business Continuity Review. <https://drii.org/education/BCP-501>

FEMA

Preparedness Training for Community-Based Organizations. https://community.fema.gov/PreparednessCommunity/s/open-training?language=en_US;

Critical Concepts of Supply Chain Flow and Resilience. <https://training.fema.gov/is/courseoverview.aspx?code=IS-238>

HARVARD BUSINESS SCHOOL

Leadership & Management (including change management and organizational leadership). <https://online.hbs.edu/subjects/leadership-management/>

IDEO

Business Innovation Training. https://cdn.shopify.com/s/files/1/0259/7876/5396/files/Business_Innovation_Full_Syllabus.pdf?v=1584549771

SBA

Ready Business Workshop “How-To” Guide and Ready Business Videos. <https://www.ready.gov/business>

Small Business Resilience Resource Library — including numerous webinars and other trainings related to resilience and business continuity. <https://www.score.org/recovery/small-business-resilience>

THE CENTER FOR RURAL DEVELOPMENT

Business Continuity Planning. <https://ruraltraining.org/course/mgt-381-v>

FUNDING

FEMA

How to apply for SBA FEMA Assistance Loans

<https://www.fema.gov/press-release/20220124/complete-sba-disaster-assistance-loan-application-advance-your-recovery#:~:text=Apply%20in%2Dperson%20at%20the,877%2D8339%20> (TTY).

<https://www.fema.gov/fact-sheet/true-or-false-setting-record-straight-sba-loans-and-fema-assistance-0>

<https://www.fema.gov/press-release/20220124/complete-sba-disaster-assistance-loan-application-advance-your-recovery#:~:text=Apply%20in%2Dperson%20at%20the,877%2D8339%20> (TTY).

<https://www.fema.gov/fact-sheet/true-or-false-setting-record-straight-sba-loans-and-fema-assistance-0>

SBA

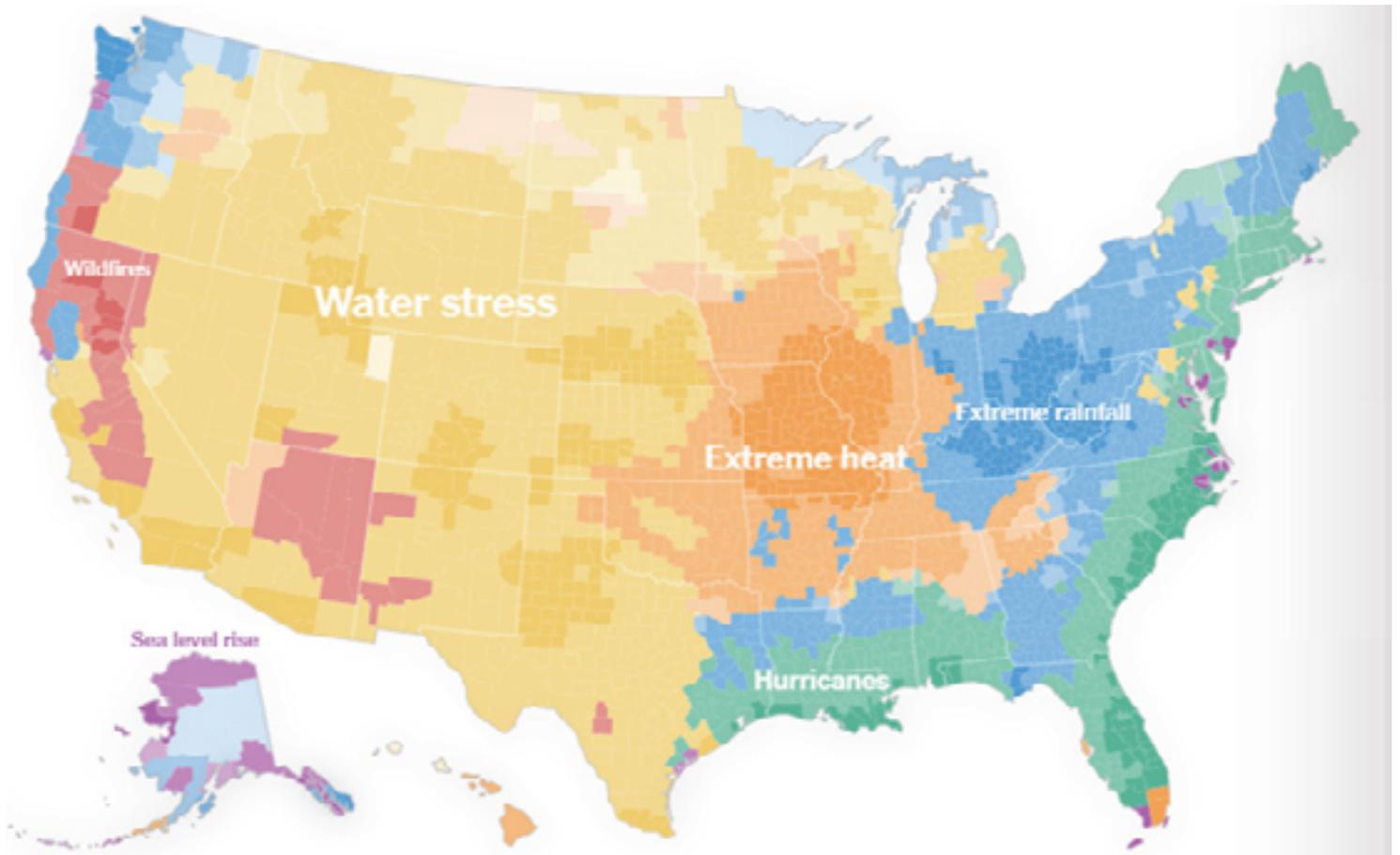
Direct support from local experienced mentors: <https://www.sba.gov/funding-programs/disaster-assistance/recovery-hub/business-resiliency>

APPENDIX A: CLIMATE CHANGE PROJECTIONS DATA: NATIONAL, COUNTY, STATE, AND LOCAL

Exhibit A-1 National-level overview of key climate risks per geography

Intensity shows risk level from low (lighter) to very high (darker)

Source: Thompson, S.A., & Serkez, Y. (2020, September 18). Every place has its own climate risk. What is it where you live? New York Times. <https://www.nytimes.com/interactive/2020/09/18/opinion/wildfire-hurricane-climate.html>



Assessing hazard-specific risks at the county level

Source: <https://www.americancommunities.org/mapping-climate-risks-by-county-and-community>

Exhibit A-2 Sea level rise

Risk Threshold

No Risk Low Medium High Red Flag

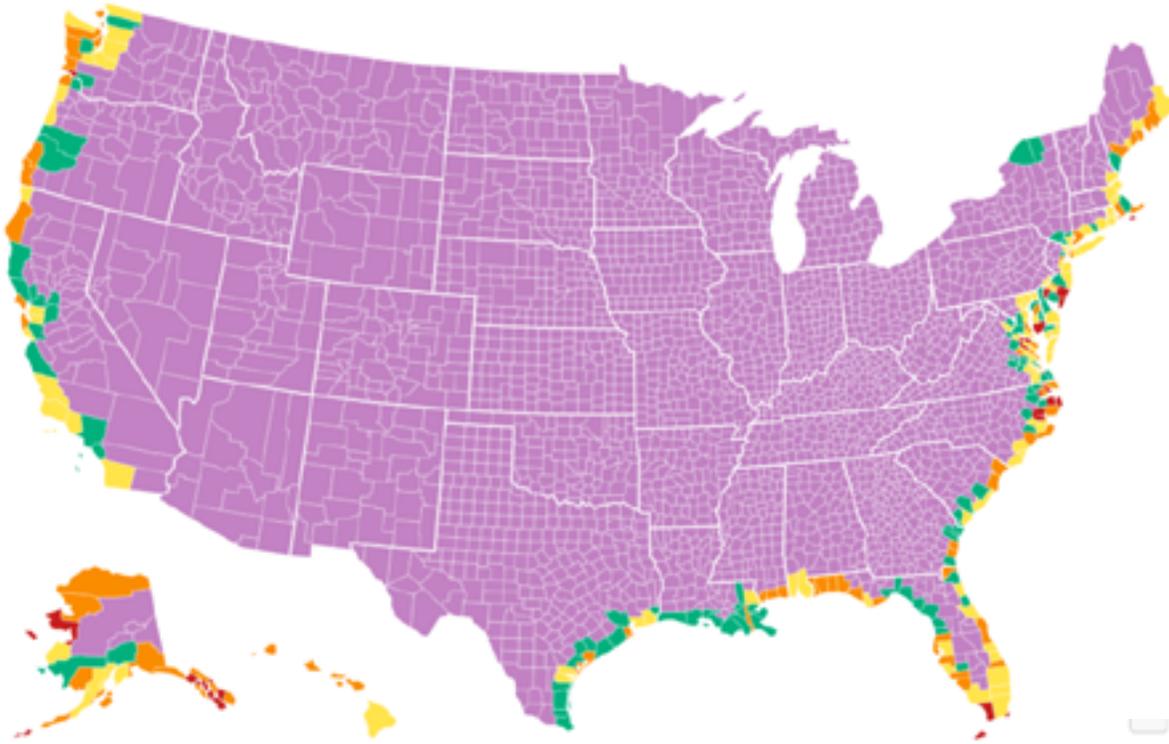


Exhibit A-3 Hurricane and typhoon risk

Risk Threshold

No Risk Low Medium High Red Flag

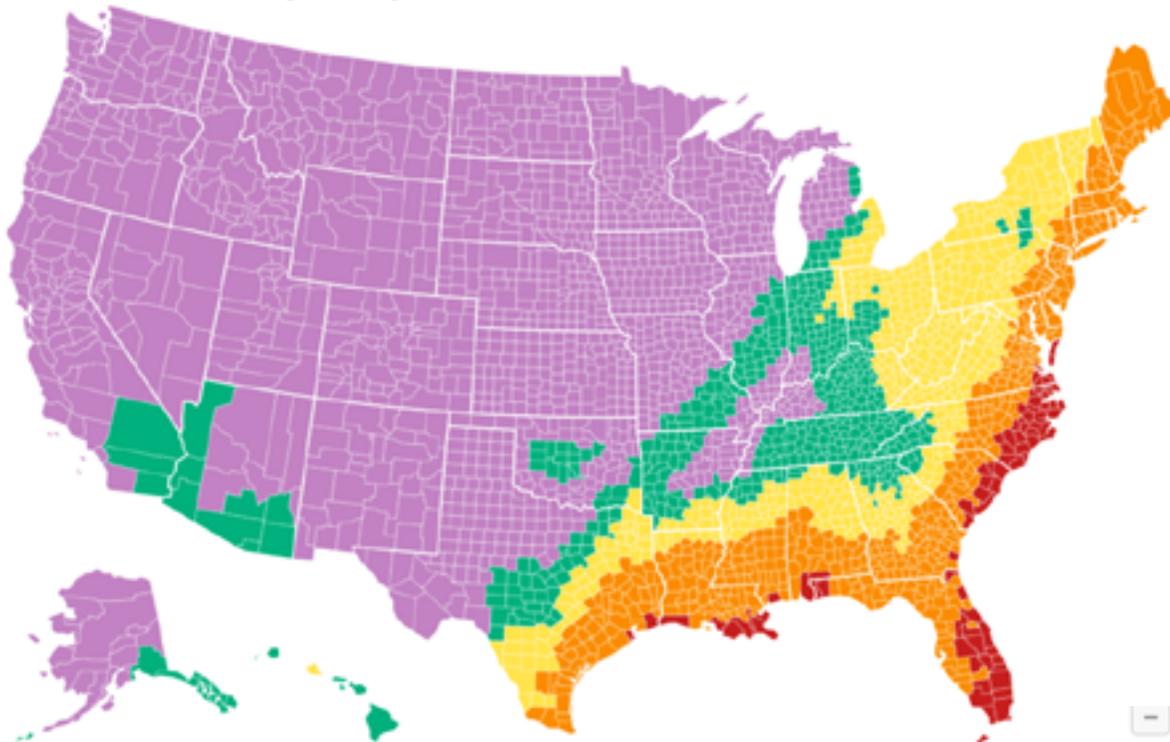


Exhibit A-4 Extreme rainfall risk

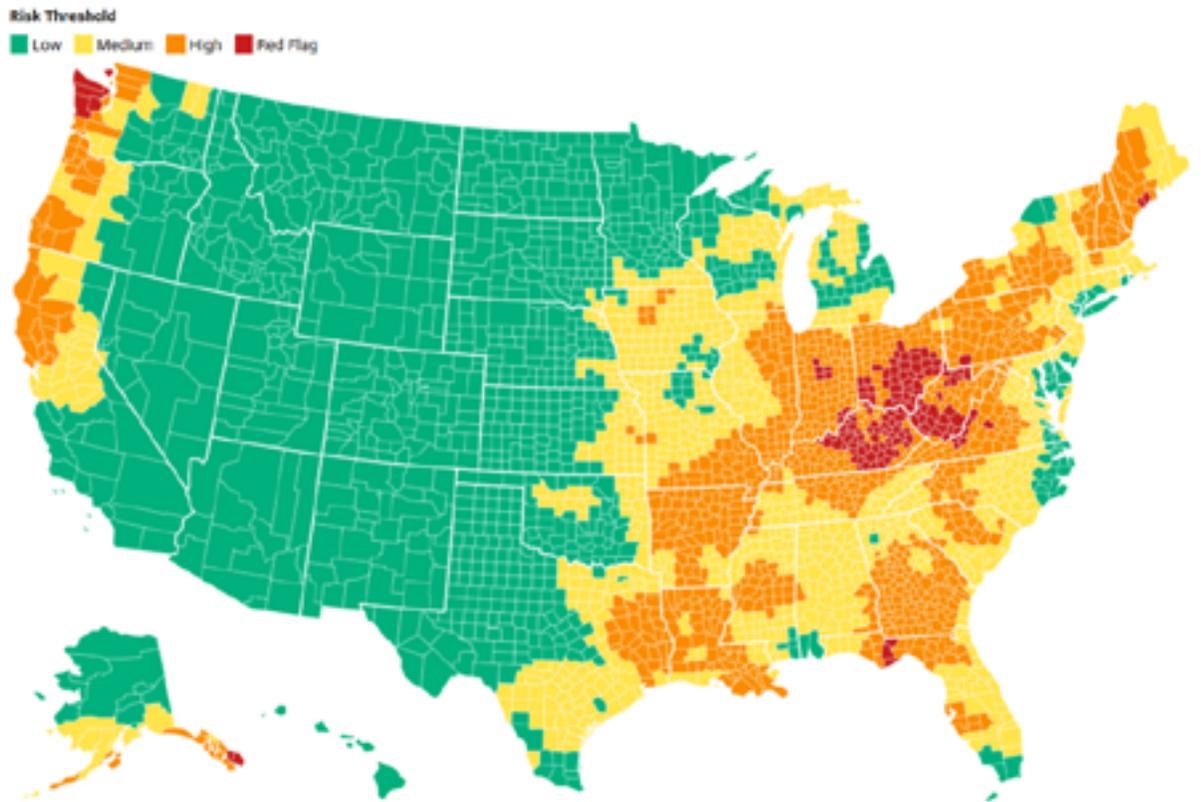


Exhibit A-5 Water stress

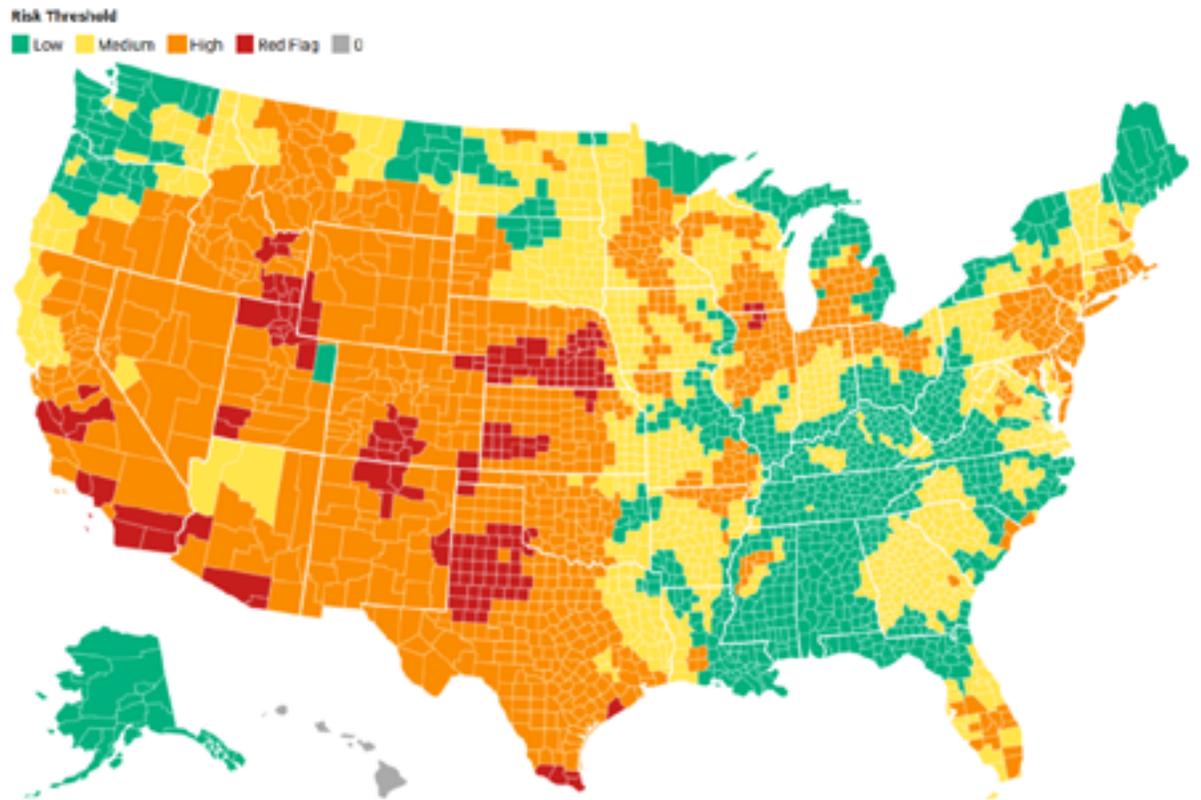
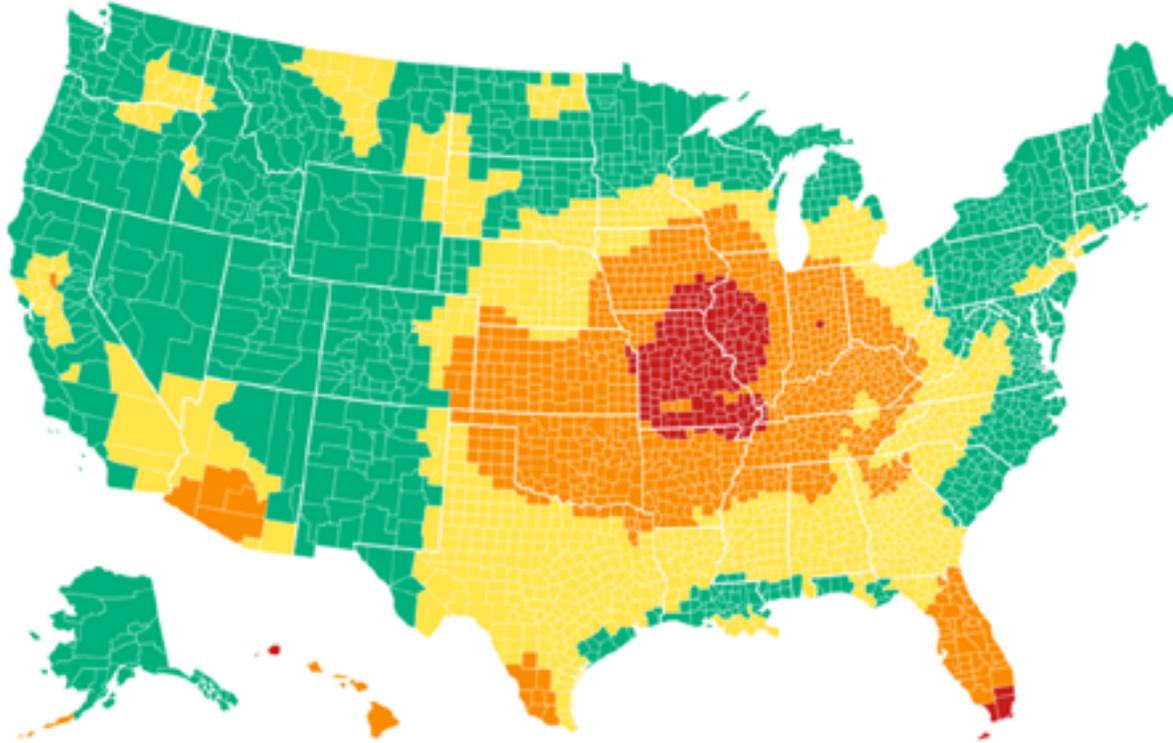


Exhibit A-6 Heat stress

Risk Threshold

Low Medium High Red Flag



State-specific climate assessments

Alabama

HEAT, SLR, PRECIP

Louisiana

HEAT, SLR, HURRICANES

New Jersey

HEAT, SLR, PRECIP

New York

HEAT, SLR, PRECIP

Texas

HEAT, PRECIP, DROUGHT, HURRICANES

Where to find climate projections data for your ZIP code

For flooding

- <https://riskfactor.com>
- <https://coast.noaa.gov/slr>
- <https://crt-climate-explorer.nemac.org>

For precipitation

- <https://climatetoolbox.org/tool/Future-Climate-Dashboard>

For temperature

- <https://climatetoolbox.org/tool/Future-Climate-Dashboard>

For wildfire

- <https://riskfactor.com>

Heating degree days & cooling degree days

- <https://crt-climate-explorer.nemac.org>

Where to find current weather data for your ZIP code

For flooding

- <https://riskfactor.com>
- <https://msc.fema.gov/portal/home>

For precipitation:

- <https://crt-climate-explorer.nemac.org>
- <https://hdsc.nws.noaa.gov/hdsc/pfds>

For temperature

- <https://crt-climate-explorer.nemac.org>
- <https://www.energy.gov/eere/buildings/building-america-climate-specific-guidance>

For wildfire

- USFS - <https://wildfirerisk.org>

For wind

- FLASH, <https://flash.org/resilientdesignguide.pdf>
- ASCE <https://asce7hazardtool.online>

Heating degree days & cooling degree days

- <https://crt-climate-explorer.nemac.org>

APPENDIX B: SUPPLY CHAIN AND SUPPORTING INFRASTRUCTURE CONSIDERATIONS

How supply chains will be impacted by climate change

- 1 Declining natural resources and supplies.** The quality and availability of natural resources are already being impacted by climate change. This is especially obvious with agricultural-based products and food supplies, but are showing up in other sectors as well. For example, wildfires have impacted lumber supplies in the Northwest, putting additional strains on the building industry and a 98 percent decrease in lobster landings in New York, attributed to warming oceans, has greatly impacted fishermen and other related industries in that area (Berger, 2021).
- 2 Workplace disruptions.** It is anticipated that, within the US, there will be a doubling in the number of days with a heat index above 100 degrees F over the next decades and that, by mid-century, more than a third of the United States will experience extreme heat days that are greater than the indices that the National Weather Service currently tracks (Dahl et al. 2019). It has been projected that for every one degree (Celsius) increase in average annual temperatures, there would be a significant uptick in temperature related worker exhaustion and illness. By 2030, those impacts have been estimated to result in the equivalent of 80 million job losses, with a projected global loss of \$2.4 trillion (Berger, 2021). Sea level rise and extreme weather events will also lead to a displacement of the workforce. Some of these might be temporary displacements, others could be permanent. In the worst-case scenarios, some of these events could even lead to serious injuries and death.

TORNADO HITS AMAZON WAREHOUSE IN ILLINOIS 2021

On December 11, 2021, an EF-3 tornado, with a top wind speed of 155 mph hit the town of Edwardsville, Illinois (NBC Chicago, 2021). The tornado caused the partial collapse of an Amazon warehouse located within that town, resulting in the death of six employees. This area, and adjacent towns throughout the larger St. Louis areas, are attractive to locate warehouses for companies such as Amazon since they are centrally located and usually have lower construction and development costs in those regions (O'Brien, 2021). However, these are also located in areas prone to tornadoes. Since tornadoes are so localized, it is difficult to project necessarily how they may evolve with climate change. Early evidence suggests tornado outbreaks – a cluster of tornadoes that occur within several days of one another – are becoming more common and that the outbreaks themselves are becoming larger (Henson, 2021). Likewise, there seems to be an eastward shift in where some of the more intense tornadoes are occurring, as compared to historic patterns (Henson, 2021). The warehousing sector is just one of many that will need to take this into consideration when planning for resilience.

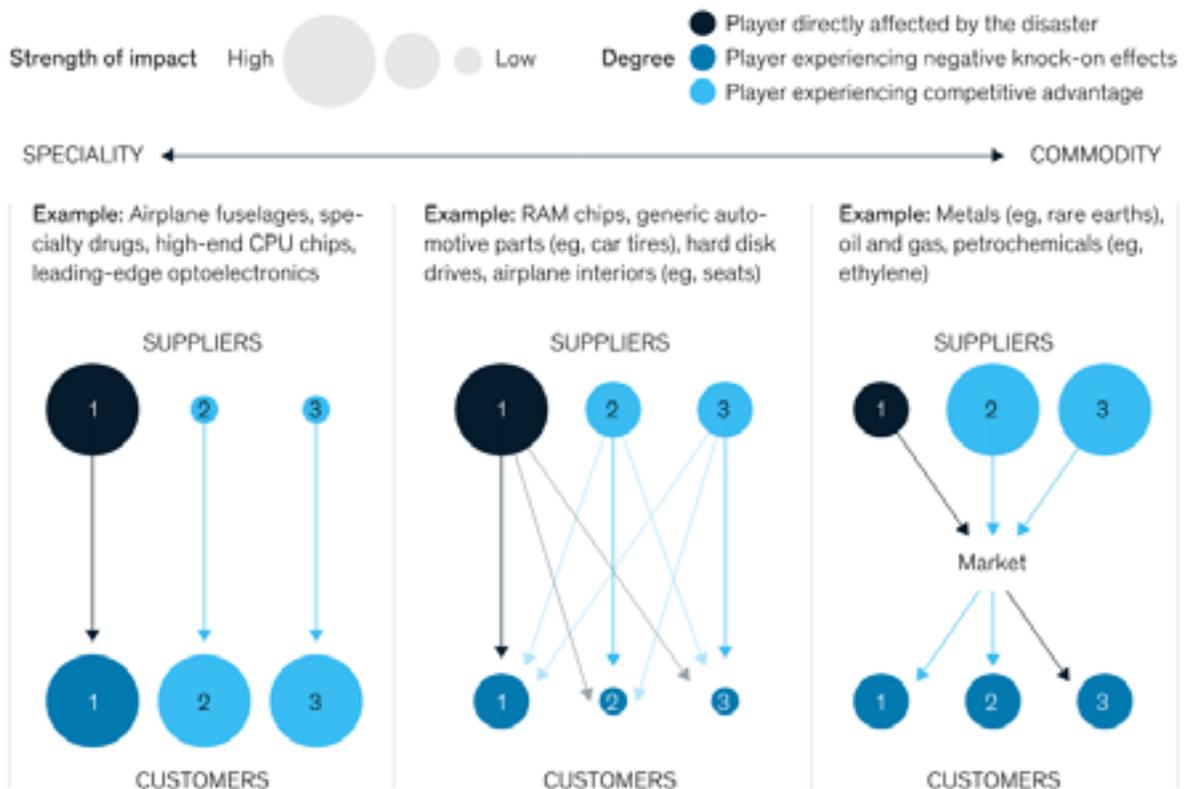
- Rising costs.** Disruptions in the supply chain will lead to rising costs, as well as a delay in being able to meet demand on both the products and services fronts. Some of these disruptions will have a direct link to climate change. For example, recent droughts in Brazil, led to a doubling of the price of coffee futures in July 2021 (Berger, 2021). As mentioned above, extreme weather events have the potential to lead to long-term displacement of the workforce. This could fuel a worker-shortage which could potentially impact a businesses' overall performance and perhaps even the ability to continue its operations. Since most small businesses are located in one geographic location and often source their labor from local markets, worker displacement has the potential to significantly impact these companies.

Exhibit B-1 Example of how businesses might access the climate vulnerability of their supply chain based on key considerations and variables

Source: McKinsey, 2020.

Supply chains face different knock-on effects from production disruption depending on the degree of commoditization.

Strength of impact on suppliers and customers, by degree of commoditization (illustrative)



- Transitional risks.** An increasing focus on carbon neutrality and emerging technologies associated with that initiative could also result in increased cost of business expenses — at least in the near-term. These anticipated changes are referred to as “transitional risks” and, while beyond the scope of this particular project, they have relevance. Transitional risks could include aspects related to a rising cost of insurance coverage related to certain hazards — or even insurance companies withdrawing from certain markets altogether (Deloitte Center for Financial Services, 2019; Petru, 2014; Reuters, 2020). Other examples of potential

transitional risks include the need to invest in electric vehicles and/or the supporting infrastructure (e.g., charging stations), the potential for carbon pricing, tariffs and/or taxes, as well as responding to increasing climate change disclosure requirements – both customer and shareholder requests for this, as well as potential regulatory requirements, such as the SEC’s proposal to require more rigorous and standardized disclosure of climate risk (United States Securities Exchange Commission, no date). And while the SEC’s authority currently extends to publicly owned companies, it is anticipated that many public companies will likely require similar reporting requirements from their larger networks of providers and suppliers.

Infrastructure impacts

- 1 Energy systems.** There has been significant discussion regarding the reliability of the grid from a number of angles, including aging infrastructure, increasing demands related to extreme heat (and cold) weather events, the extra demand that is being put on it from the growing digital infrastructure, its overall vulnerability to failure from storms (both wind and flooding issues) and its role in contributing to wildfire events. The push to transition to a carbon-free grid, associated with the need to onboard new technologies and systems at scale (e.g., solar, wind, battery-back up systems, etc.) has resulted in major disruptions throughout the sector.

The focus of this toolkit is on the resilience piece as it related to extreme weather and climate change impacts. In terms of immediate impacts, storms with significant winds and/or icing often result in downed powerlines. While some localities may have underground utilities, the majority of the electrical grid transmission and distribution is still carried above ground making them vulnerable to these events. Weather was cited as the predominant cause of transmission outages from 2014 to 2018 (ASCE, 2021a). The impacts of these outages to the U.S. economy have been estimated to cost \$28 to \$169 billion annually (ASCE, 2021a).

An increase in average summer temperatures, extreme heat days and heatwaves, will lead to an increased demand in cooling loads and potential brownouts during certain times of the season. Similar strains on the energy system could develop in response to extreme cold events, such as what happened in Texas during the winter of 2021. Depending on business needs, and the sensitivity of equipment and instruments, even small blips can cause the equipment to shut down temporarily. Some of these more sensitive instruments may require a complete reboot and, depending on complexity, could require outside technicians to come in to reset the instruments before bringing it back online. In these cases, additional back up measures — such as a battery-powered uninterruptable power supply (UPS) — might be advisable in addition to a generator.

- 2 Transportation systems.** The transportation system is a lynchpin to the larger supply chain and is often a critical component in the larger operations of a small business. This is especially true for businesses that manufacture and/or distribute goods and services, whether onsite or across the country. Potential customers need to be able to easily access the business to receive these goods and services and/or have the good and services easily delivered to them. While some of those needs may be met via online/remote options (which will require the development of a robust digital and telecommunications infrastructure), the majority of business transactions are still highly dependent on a well-functioning, reliable AND resilient transportation system. Climate change has the potential to further disrupt some of the vulnerabilities that are already present within that system. Below are

representative ways in which climate change could impact the current transportation system and is offered as a way for small businesses to think about how these (and other related climate impacts) might impact their transportation system needs.

- a **Roadways.** Floods, winter weather and even extreme heat events have the potential to impact the both the short-term and longer-term resilience of roadways. Sometimes, these impacts are acute and readily obvious – such as with the flooding of the highways in Houston during Hurricane Harvey.

Exhibit B-2 Images showing Houston overpass before and during the flooding associated with Hurricane Harvey

Source: Alamy/Rueters and The Guardian, 2017. www.theguardian.com/us-news/2017/aug/29/before-and-after-images-show-how-hurricane-harvey-swamped-houston



In other instances, compounding annual stresses can result in significant operational and physical losses. A recent study (Jacobs et al. 2018) of nuisance tidal flooding along the East Coast I-95 corridor revealed a 90 percent increase in flooding within that corridor from 1996 to 2015, which translated into more than 100 million hours of traffic delays. That number is expected to increase to 160 million vehicle hours of delay by 2020 and 1.2 billion hours by 2060. Some areas of I-95 could experience almost daily nuisance flooding by 2060, including sites in Connecticut, New Jersey, Maryland, the District of Columbia, North Carolina, and Florida. I-95 is a critical shipment route and impacts such as these would have tremendous implications for supply chain logistics and shipping efficiencies.

Exhibit B-3 Projected increase in traffic delays along the I-95 corridor as a result of nuisance flooding under different climate emission scenarios and planning horizons

Source: Jacobs et al. 2018.

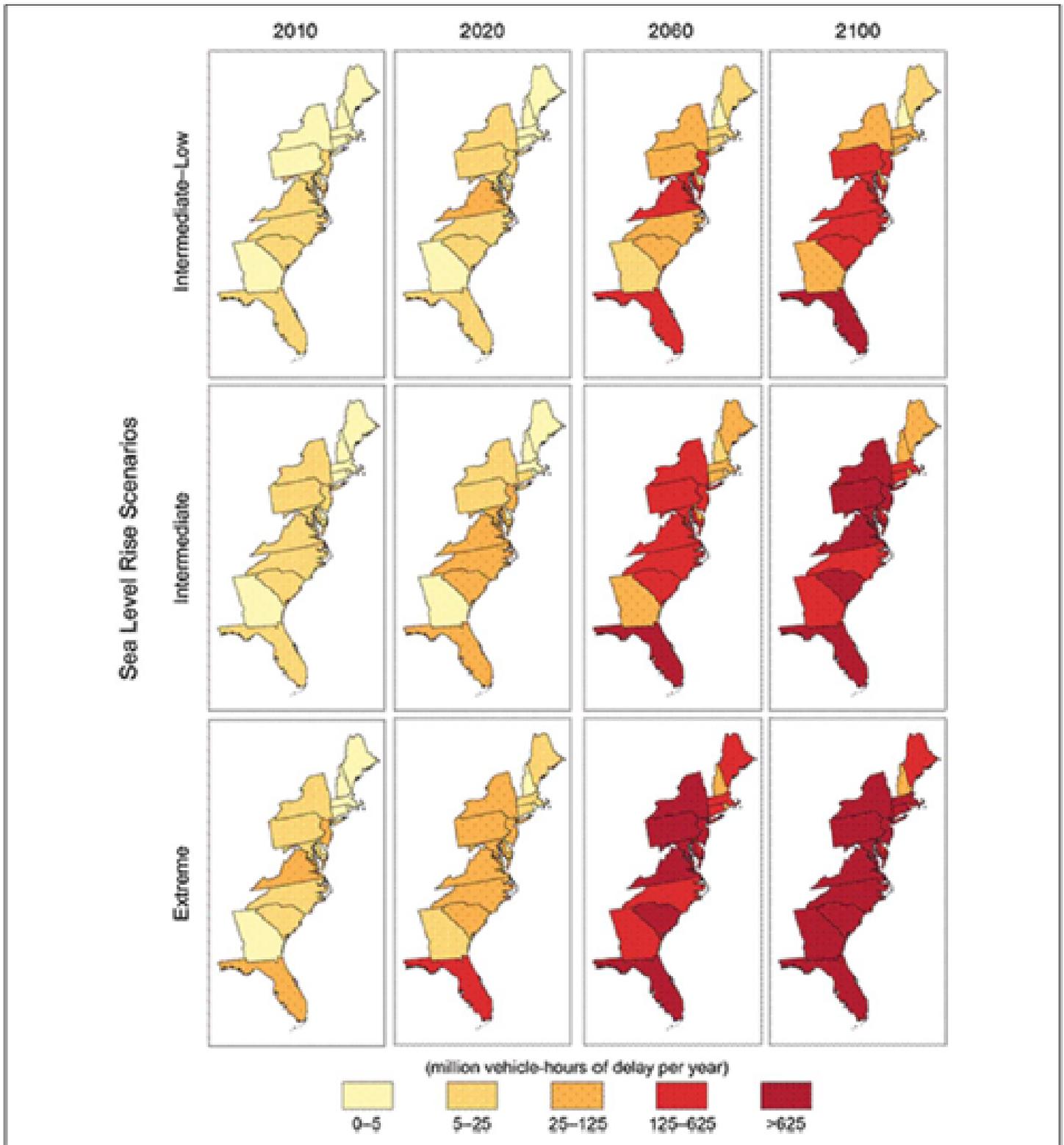


Figure 3. Annual vehicle-hours of delay for FC 1–5 roads due to tidal nuisance flooding by state, year (2010, 2020, 2060, 2100) using decadal average decadal (10-year) values except 2100, which is a 5-year average (2096–2100) and intermediate low, intermediate, and extreme sea-level-rise scenarios of Sweet et al. (6).

- b Airports.** Airport operations can be impacted by a variety of hazards, including high winds, icing events, flooding and heat. There are already signs of shifts in extremes at some of these areas. For example, Qantas airlines noted that both an increase in wind speeds (with velocities more than 30 percent higher than the average of the last 30 years) and a shift in prevailing wind patterns have forced some runways to close and resulted in an increase in flight delays (Lo, 2021). With increasing heat, the air becomes less dense and lift coefficients can be impacted. Longer runways may be needed to overcome that challenge. In 2017 and 2018, Phoenix cancelled several flights because the temperatures exceeded the safety operating criteria of some of the aircraft. However, those safety factors were reviewed by FAA and the manufacturers and re-adjusted to allow for travel at higher temperatures (Ruelas, 2018). This seems to be an interim fix for Phoenix, but heat will also continue to present issues for outside airport workers, pavements and those airports which may have shorter runways.

Exhibit B-4 U.S. airports ranked the most vulnerable to sea level rise

Source: Freedman, 2013.

U.S. airports most vulnerable to sea level rise
San Francisco International (SFO)
Oakland International (OAK)
Honolulu International (HNL)
New Orleans Louis Armstrong International (MSY)
Tampa International (TPA)
Miami International Airport (MIA)
Ft. Lauderdale (FLL)
Ronald Reagan Washington National (DCA)
Newark Liberty International (EWR)
LaGuardia (LGA)
Philadelphia International (PHL)
John F. Kennedy International (JFK)

Flooding has been an issue already for several airports and a recent report projects that eighty airports are at risk of being flooded by sea level rise (SLR). In the US, six would be impacted at a half meter of SLR and twelve with one meter of SLR (Huang and Maghsadi, 2020). Some of these impacts might be due to direct flooding of sea level rise itself, but by increasing the overall vulnerability to storm surges and extreme events because of this shift in overall sea level. For example, LaGuardia, JFK and Newark airports would NOT be directly inundated by 1 meter rise in sea level, but their operations would be affected as described above.

- c Ports.** By their very nature, ports exist at the boundary of the water and built environment and are thereby inherently vulnerable to changes in the water and land which bounds it. Because most ports are coastal, they will be susceptible to a rise in sea level and to increasing intensity, frequency, and duration of storm events, including both hurricanes and nor'easters. Access to the ports from the land could be further impeded by coastal and/or precipitation-based flooding. Ports are key transportation hubs and play an important role in linking local, regional and national supply chains with the global market.

Tracking the supply chains at the ports has become an issue of national security and is being monitored closely by the White House. A dashboard has been developed to check on the recovery of the supply chain post-COVID, but it also provides meaningful context as to just how much the domestic economy is dependent on imports (The White House, 2021). Climate change impacts will present differently in other parts of the world. Combined with the inherent variability in where and how extreme events will present, that means small businesses should become more familiar with where critical items are sourced and the larger resilience to both climate change and supply chain interruptions.

Exhibit B-5 The Port of Los Angeles

The Port of Los Angeles is the largest shipping port in the US and one of the largest in the world. Below is a 2021 summary of the types of imports that are received and the top trading partners. Climate change is a major potential disruptor within all of that.

Source: Port of Los Angeles, 2022.

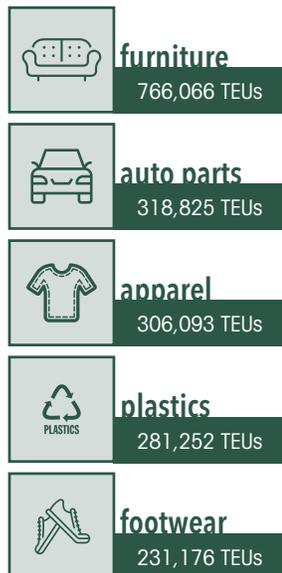


Trade Volume

	CY 2021	CY 2020
Containers (TEUs)	10.7 million	9.2 million
Vessel Arrivals (All Types)	1,863	1,654
Cruise Ship Calls / Passengers	61/151,837	34 /173,947
Automobiles (Units)	102,767	103,453

TOP 5 IMPORTS

Containerized CY 2021



TOP 5 EXPORTS

Containerized CY 2021



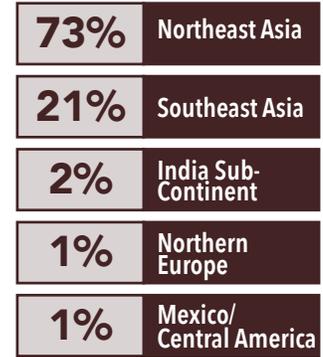
TOP 5 PARTNERS

IN 2021



TOP 5 FOREIGN TRADE ROUTES

IN 2021



Finances

	FY 2020/2021	FY 2019/2020
Cargo Value	\$294 billion (CY21)	\$259 billion (CY20)
Adopted Budget	\$1.5 billion	\$1.6 billion
Operating Revenue	\$572 million	\$468 million
Operating Expenses	\$274 million	\$274 million
Capital Improvement Program	\$112 million	\$80 million

Economic Impacts

Port of Los Angeles



- #17 in the World
- 134,000 (1 in 14) jobs in Los Angeles
- 480,000 (1 in 17) regional jobs
- 1.45 million (1 in 101) jobs throughout the U.S.

San Pedro Bay Port Complex

Port of Los Angeles + Port of Long Beach



- #9 in the World
- 181,000 (1 in 12) in Los Angeles / Long Beach
- 951,000 (1 in 9) jobs in five-county region
- 2.7 million (1 in 54) jobs throughout the U.S.

portoflosangeles.org



2022-0072

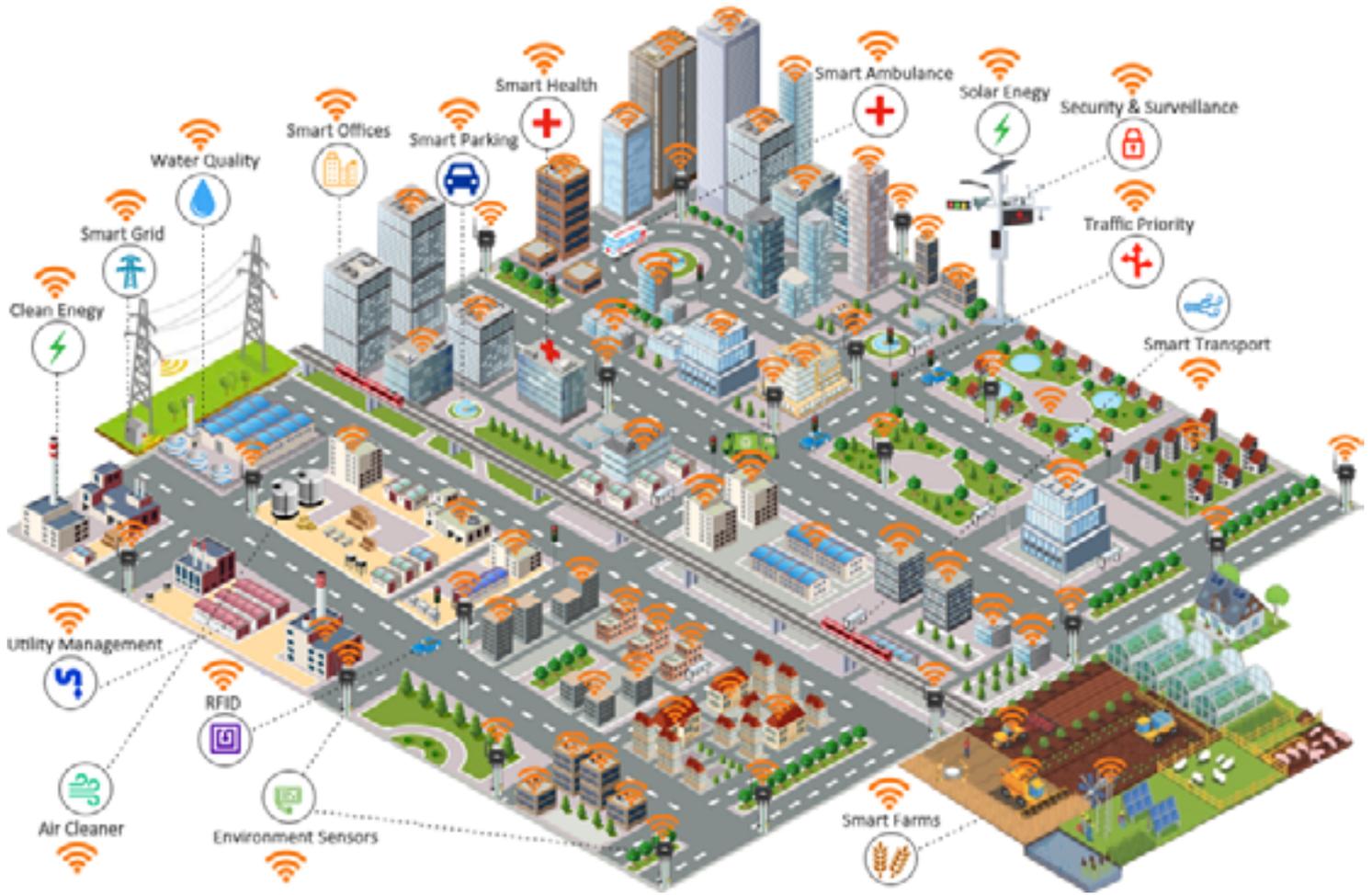
- 3 Water and wastewater systems.** Water vulnerability will differ depending on the focus of the small business, including whether manufacturing processes require water for processing and/or cooling, and whether it is a restaurant business that requires reliable and consistent potable water supplies or more of an office setting with lower water requirements than the previous two examples. Wastewater treatment requirements will also vary depending on the type of small business. Despite this, all businesses (and their larger network of customers and suppliers) will have dependencies on both the water and wastewater systems.

A significant backlog already exists of necessary deferred maintenance in our water and wastewater systems. The American Society of Civil Engineers issues an Infrastructure Report Card every three years, grading each sector. Currently, the US Drinking Water sector is ranked as a C- and the Wastewater sector has received a D+ (ASCE, 2021b). Small businesses should become familiar with how each system works within their state (scores are also assigned at that level) and, if there are significant business ties to either the water and/or wastewater sectors, should engage with local utilities to understand more about the resilience of those systems – both currently and with respect to climate change. For example, some of these facilities may be located within a flood zone, may be undersized for the anticipated extreme precipitation events, may be vulnerable to drought and/or may have processes that do not function as well during extreme temperature events.

- 4 Telecommunications, including broadband.** How we are connected to the world is changing rapidly. Many have described the digital revolution as the fourth Industrial Revolution. The first Industrial revolution occurred in the 18th and 19th centuries when a larger agrarian society became more industrial and urban. The second took place just before World War I and was defined as the growth of significant industries such as steel, oil and electricity. The third happened in the 1980s and included the advent of the personal computer and the internet. And the fourth — today — is a continuation of the third focused on breakthroughs in a number of fields including AI, nanotechnology, the IOT, AV and 3D printing (Schwab, 2016). How will our transport system and supporting infrastructure (and societal connections) be redefined within all of this? How will supply chains shift to accommodate the new products that will be needed? And how will small businesses both navigate this new landscape, as well as potentially capitalize on the emerging opportunities? For example, from a climate perspective, the ability to work remotely both allows businesses to reduce their own carbon footprint, as well as those of their vendors and customers (depending on the goods and services being offered), as well as increasing the overall resilience as a business may have flexibility in where it is located.

Exhibit B-6 The range of potential digital infrastructure solutions at a city scale.

Source: RKTPL, 2022.



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