

Climate Adaptation Workshop

Washington Public Ports Association Spring Meeting

Emilie Mazzacurati, Founder and CEO
Four Twenty Seven

Suncadia, WA
May 17, 2017



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- Portfolio screening and scoring
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Industry

Manufacturing,
Services, Healthcare



Financials

Banks, Asset Owners
& Managers



Government

Federal Agencies,
Municipalities



Nonprofit

Think Tanks, Foundations,
Associations



Agenda

- Climate change, an economic and business risk
- Climate change and ports
- Adapting to climate change: Tools & resources



+

Climate Change: an Economic
and Business Risk

Climate change #1 global economic risk

	2011	2012	2013	2014	2015	2016
1st	Fiscal crises	Major systemic financial failure	Major systemic financial failure	Fiscal crises	Water crises	Failure of climate-change mitigation and adaptation
2nd	Climate change	Water supply crises	Water supply crises	Climate change	Rapid and massive spread of infectious diseases	Weapons of mass destruction
3rd	Geopolitical conflict	Food shortage crises	Chronic fiscal imbalances	Water crises	Weapons of mass destruction	Water crises
4th	Asset price collapse	Chronic fiscal imbalances	Diffusion of weapons of mass destruction	Unemployment and underemployment	Interstate conflict with regional consequences	Large-scale involuntary migration
5th	Extreme energy price volatility	Extreme volatility in energy and agriculture prices	Failure of climate-change mitigation and adaptation	Critical information infrastructure breakdown	Failure of climate-change mitigation and adaptation	Severe energy price shock

■ Economic
 ■ Environmental
 ■ Geopolitical
 ■ Societal
 ■ Technological

And also in top #3 most likely..

	2011	2012	2013	2014	2015	2016
1st	Storms and cyclones	Severe income disparity	Severe income disparity	Income disparity	Interstate conflict with regional consequences	Large-scale involuntary migration
2nd	Flooding	Chronic fiscal imbalances	Chronic fiscal imbalances	Extreme weather events	Extreme weather events	Extreme weather events
3rd	Corruption	Rising greenhouse gas emissions	Rising greenhouse gas emissions	Unemployment and underemployment	Failure of national governance	Failure of climate-change mitigation and adaptation
4th	Biodiversity loss	Cyber attacks	Water supply crises	Climate Change	State collapse or crisis	Interstate conflict with regional consequences
5th	Climate Change	Water supply crises	Mismanagement of population ageing	Cyber attacks	High structural unemployment or underemployment	Major natural catastrophes

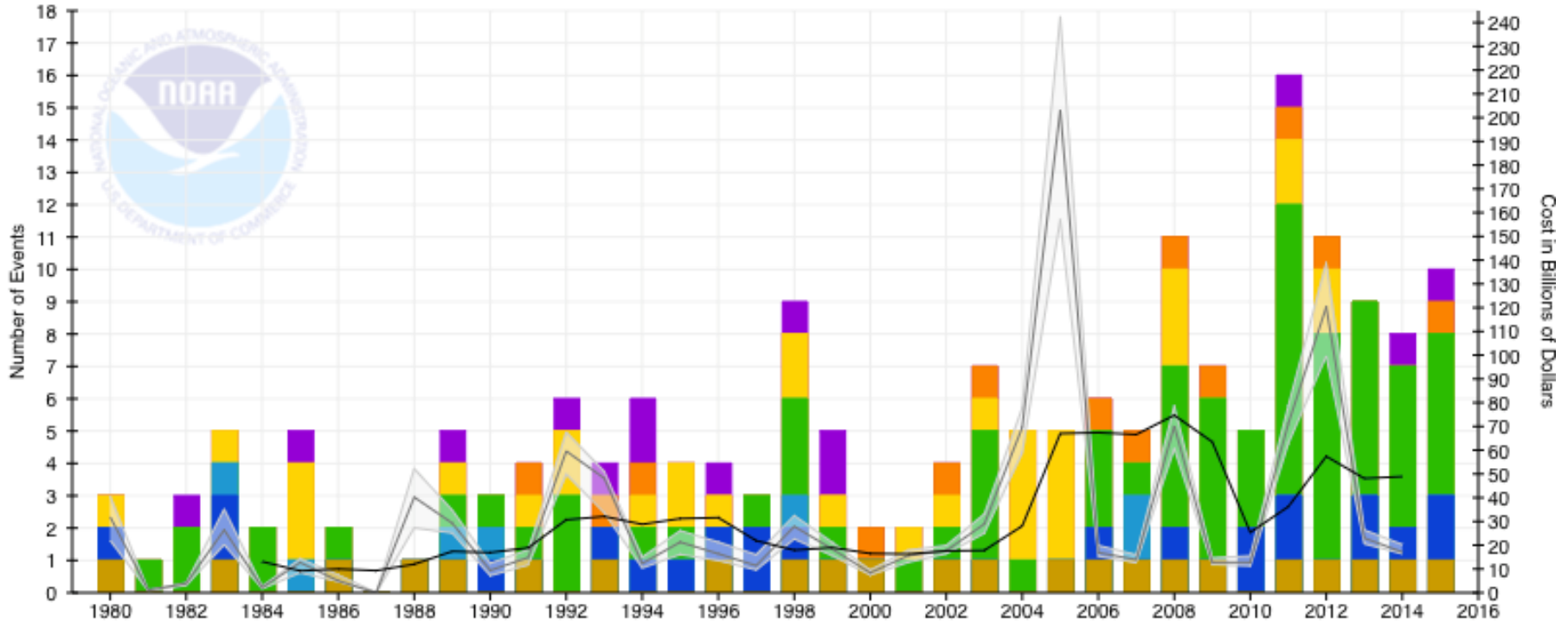
■ Economic
 ■ Environmental
 ■ Geopolitical
 ■ Societal
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U.S.: Billion-Dollar Disasters Trending Upwards

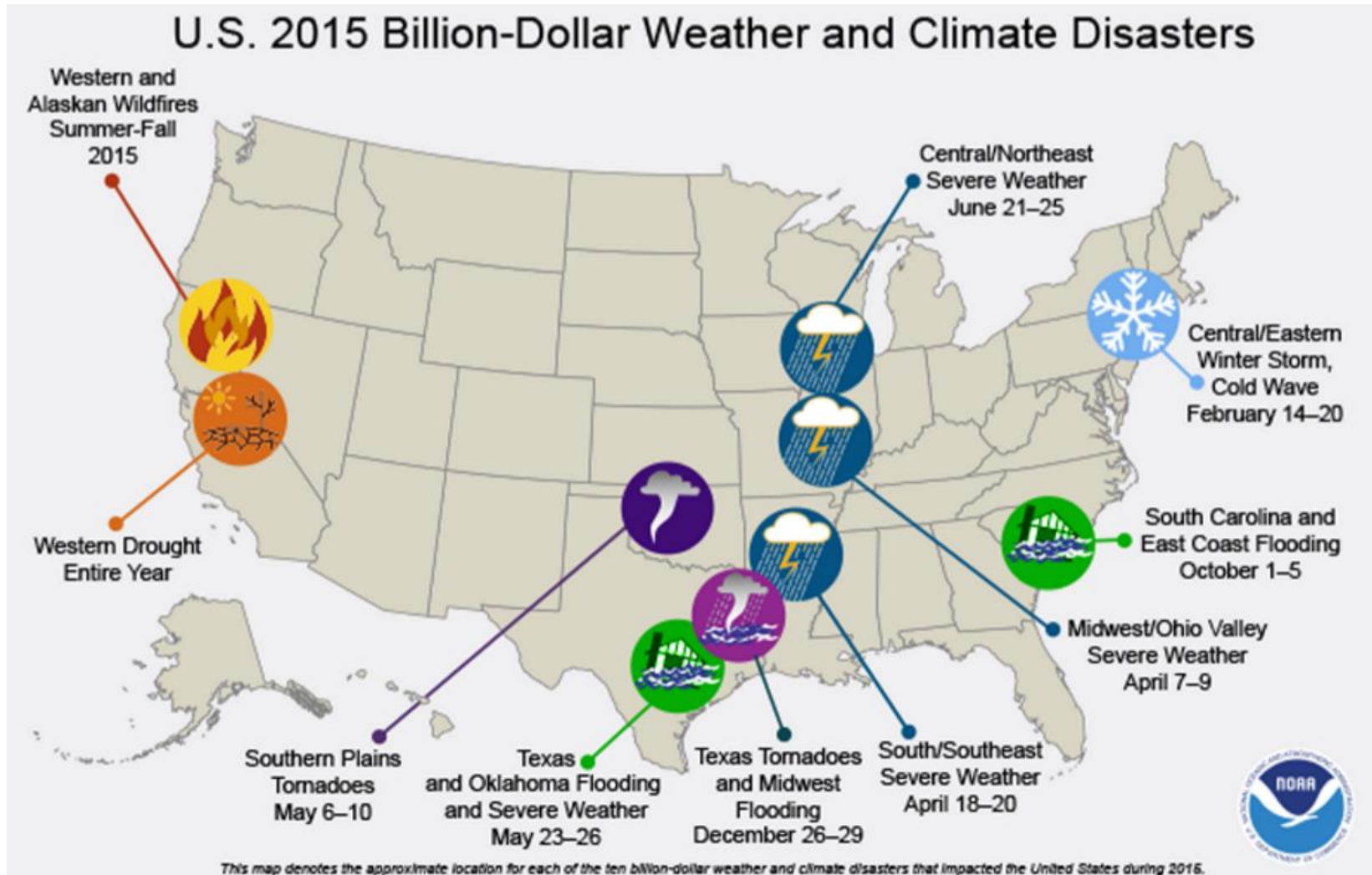
Billion-Dollar Disaster Event Types by Year (CPI-Adjusted)

- Winter Storm
- Wildfire
- Trop Cycl
- Severe Storm
- Freeze
- Flooding
- Drought
- Cost w/ 95% CI
- 5-Year Mean



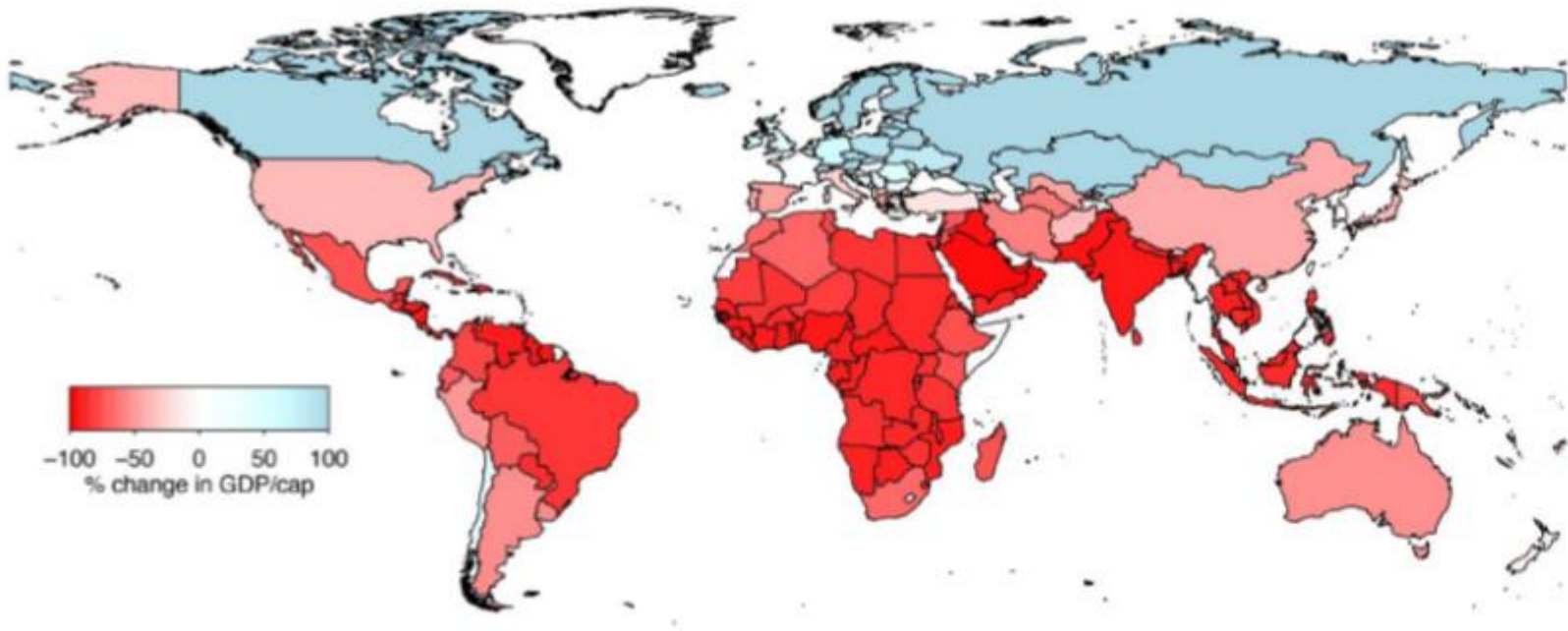
<https://www.ncdc.noaa.gov/billions/time-series>

+ 2015 Billion-Dollar Climate Disasters





Global Economic Impacts



Change in GDP per capita by country by 2100, compared to a world without climate change; Burke, Hsiang, and Miguel (2015)



1.3B People and \$158T at Risk

Climate change puts 1.3bn people and \$158tn at risk, says World Bank

Organisation urges better city planning and defensive measures to defend against rapid rise in climate change-linked disasters



<https://www.theguardian.com/business/2016/may/16/climate-change-puts-13bn-people-and-158tn-at-risk-says-world-bank>

Climate change a threat to security, food and humankind - IPCC report

Warming is leading to more volatile weather patterns that are already reducing crop yields, the IPCC has warned

[Reaction to the IPCC report on climate change - live](#)

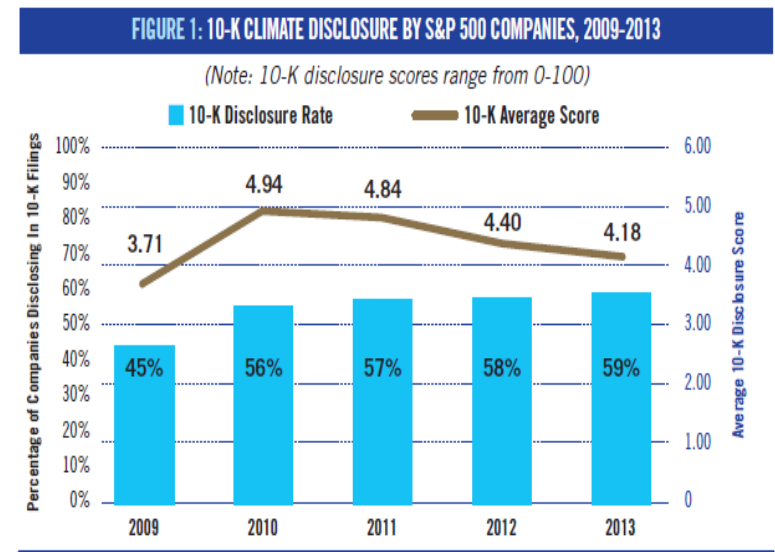


<https://www.theguardian.com/environment/2014/mar/31/climate-change-threat-food-security-humankind>

+ Climate Risk in the Line of Fire from Regulators and Investors



<https://www.youtube.com/watch?v=V5c-eqNxeSQ>



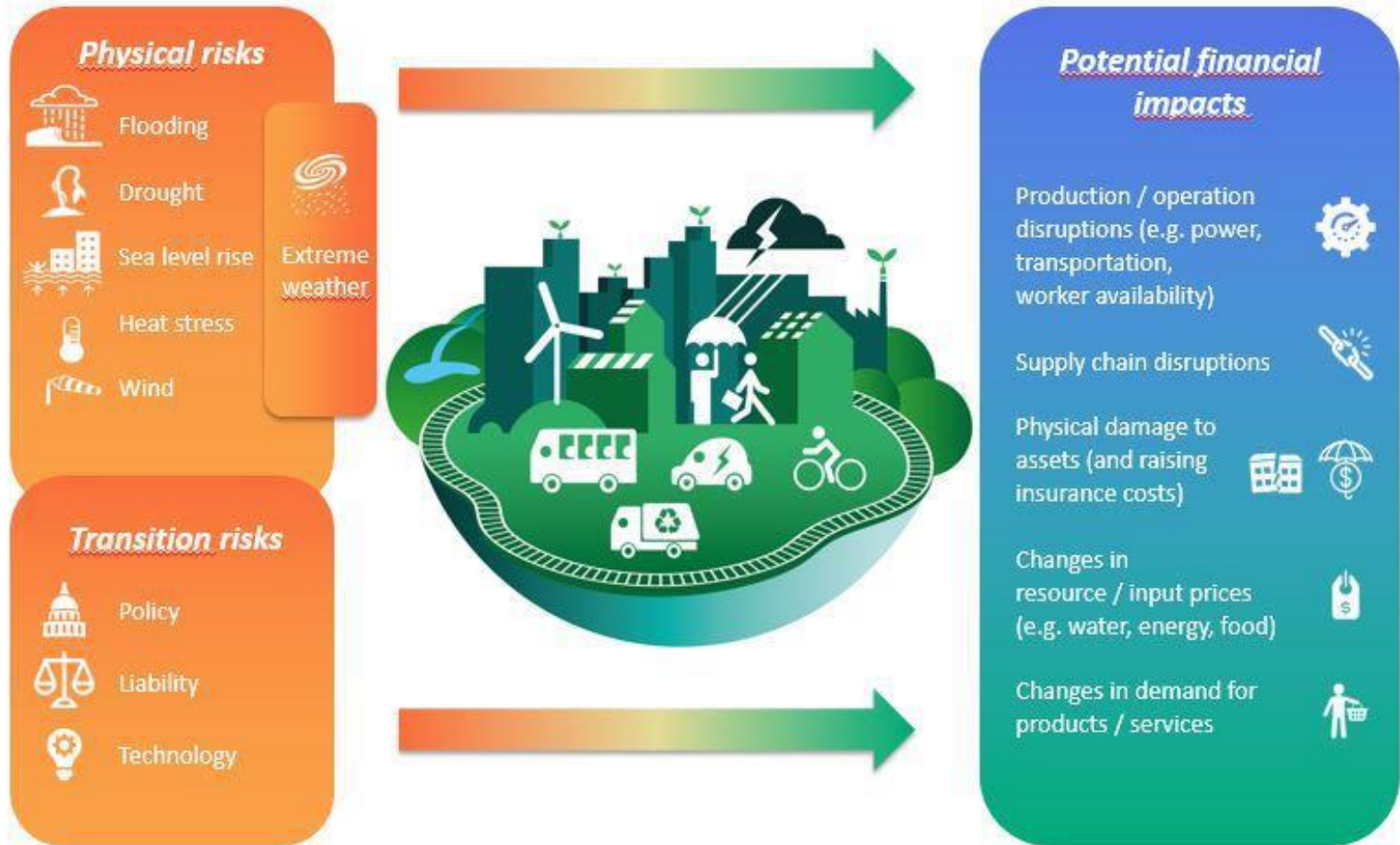
Source: *Cool Response*, Ceres 2015

See also: Four Twenty Seven, *The evolving regulatory landscape of financial climate risk disclosure*, April 2016

http://427mt.com/2016/04/tfcd_disclosure_of_climaterisk/



Broad range of economic impacts from climate change



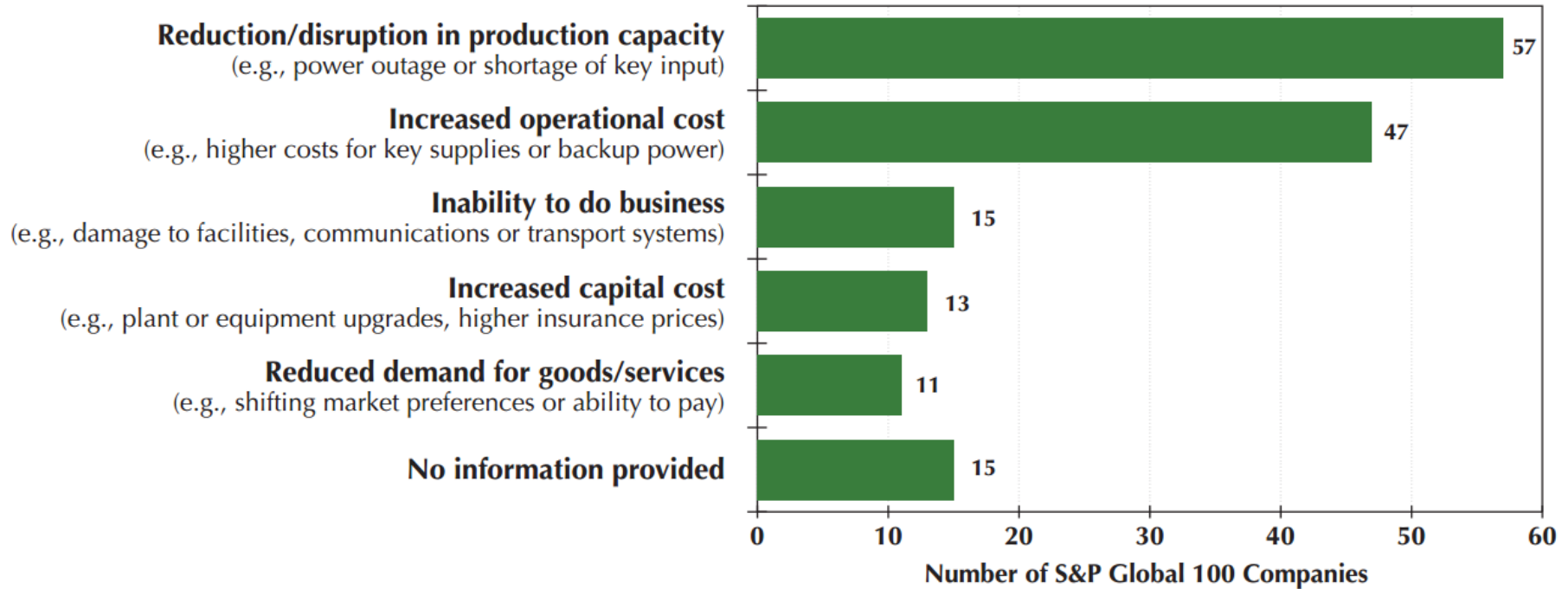
Cicero: Shades of Climate Risk

<http://www.cicero.uio.no/en/climateriskreport>



What Businesses Worry About

FIGURE 7: Top Five Current or Expected Impacts from a Changing Climate



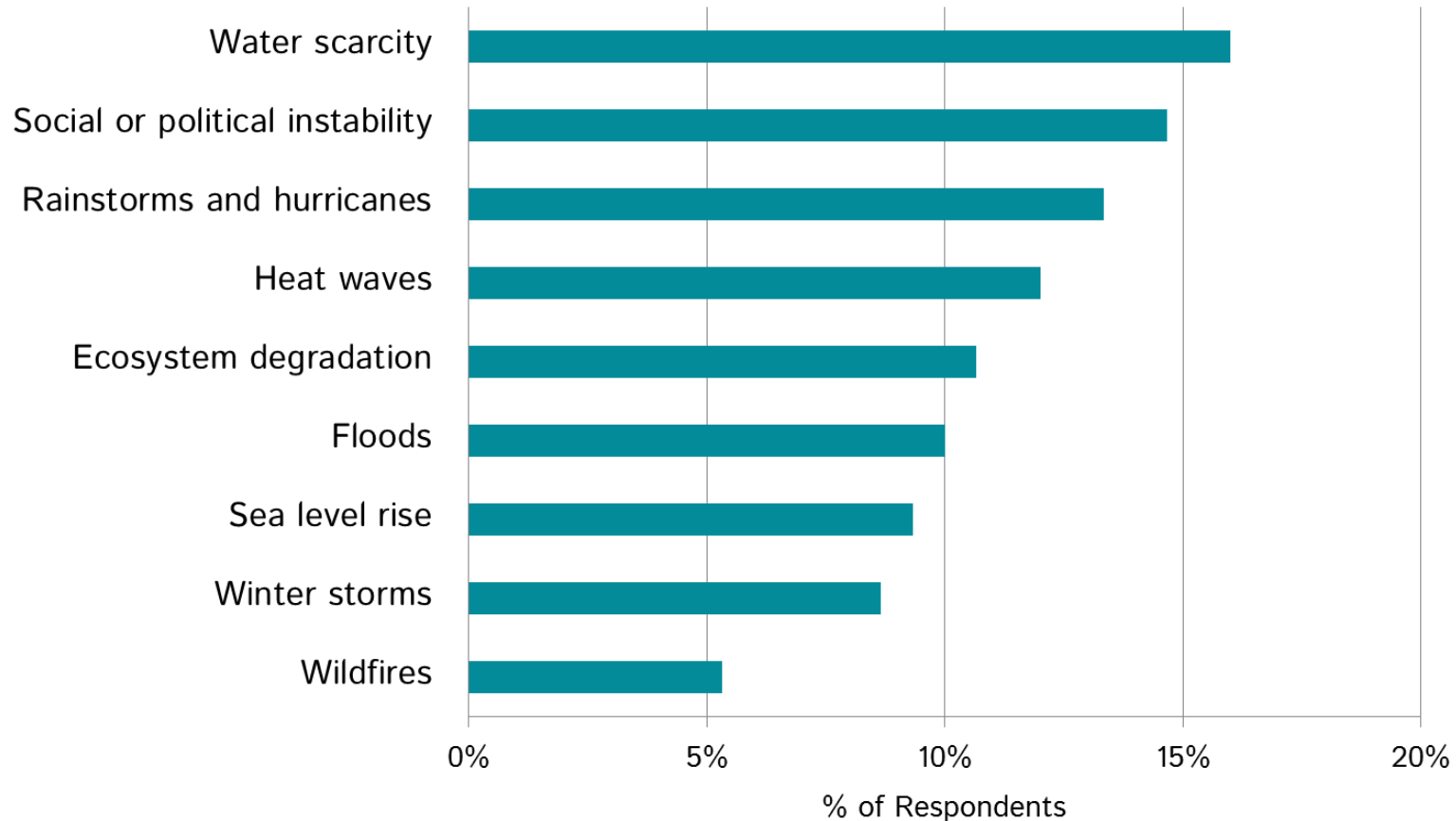
Source: C2ES research based on Carbon Disclosure Project and other information sources (2012).

Source: C2ES, Weathering the Storm – Building Business Resilience to Climate Change, July 2013
<http://www.c2es.org/docUploads/business-resilience-report-07-2013-final.pdf>



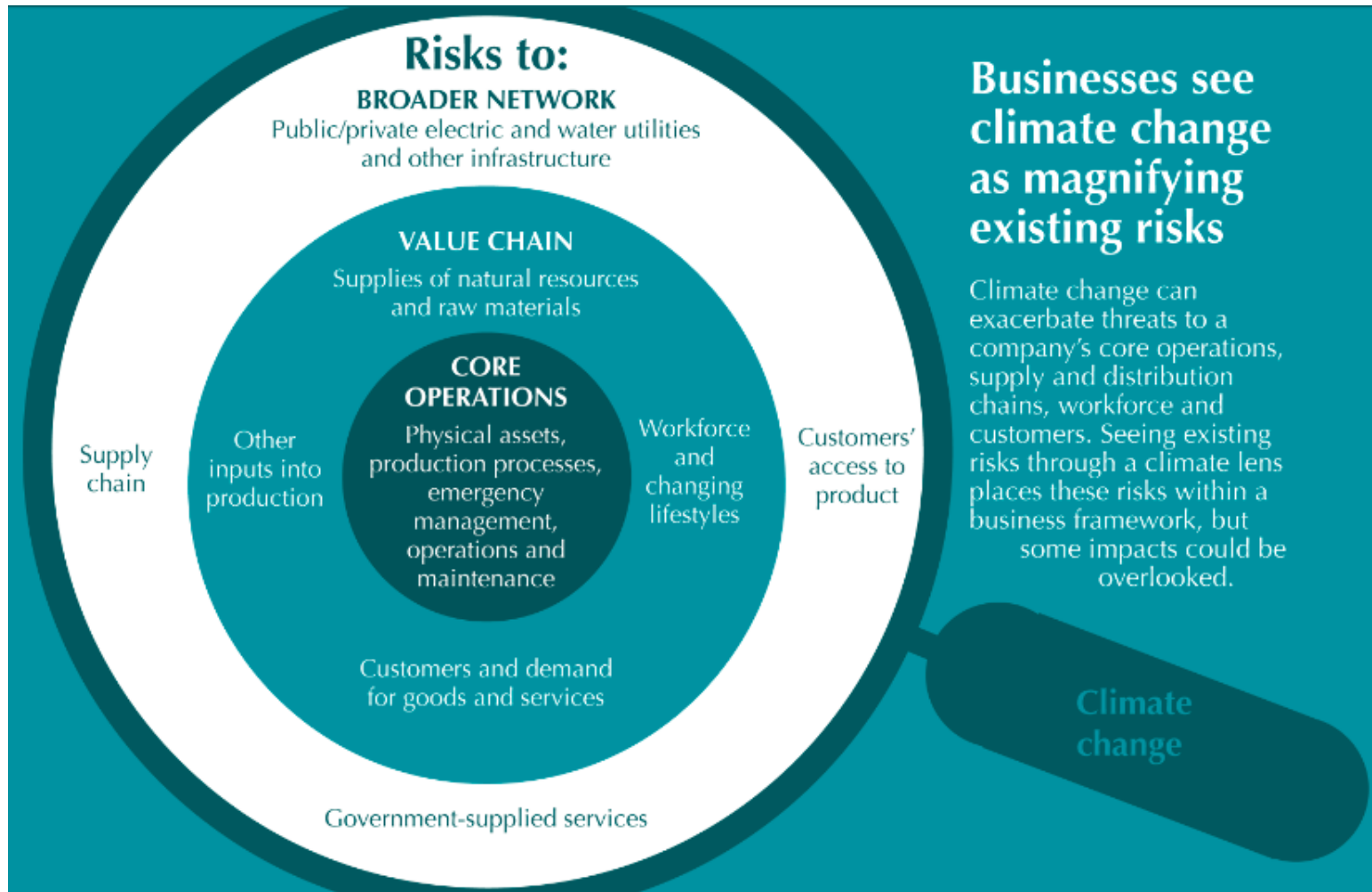
Water Scarcity and Political Instability are Key Risk Drivers

In your view, which of the following direct or indirect impacts of climate change present a risk to your company?



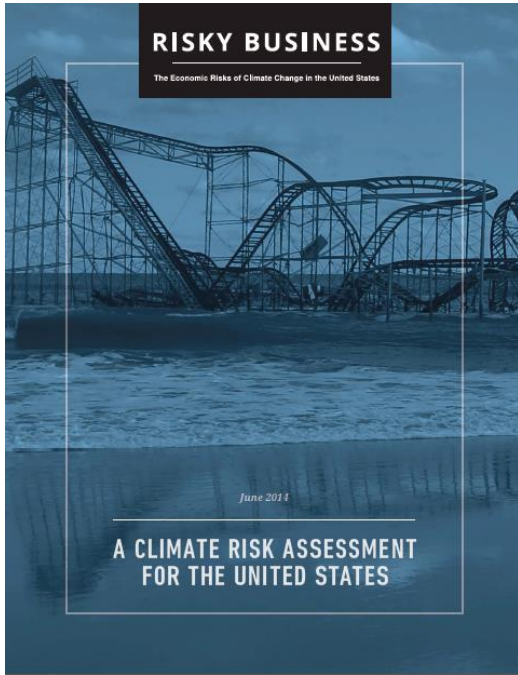


Climate Risk Beyond the Fence

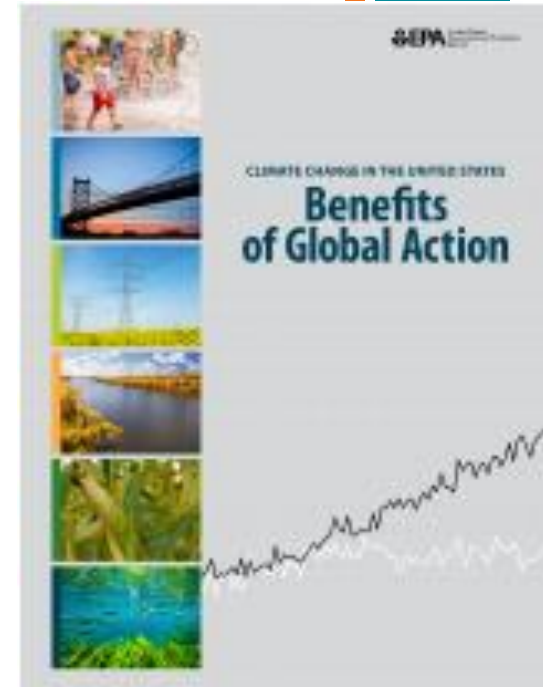




Economic & Financial Risks



- Business interruptions
- Cost of repairs
- Lost sales
- Increase insurance premium
- Higher cost of capital
- Defaults in loan or investment portfolio
- Loss in share value
- New/increased taxes
- Macroeconomic impacts



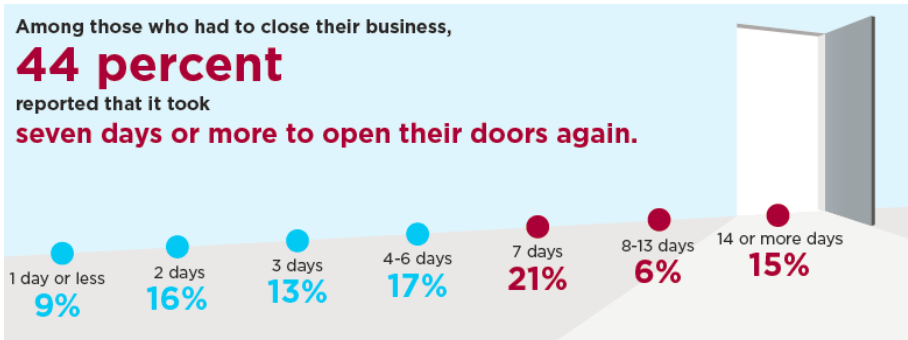
<http://www2.epa.gov/cira>
<http://www.riskybusiness.org>

Among those who had to close their business,

44 percent

reported that it took

seven days or more to open their doors again.



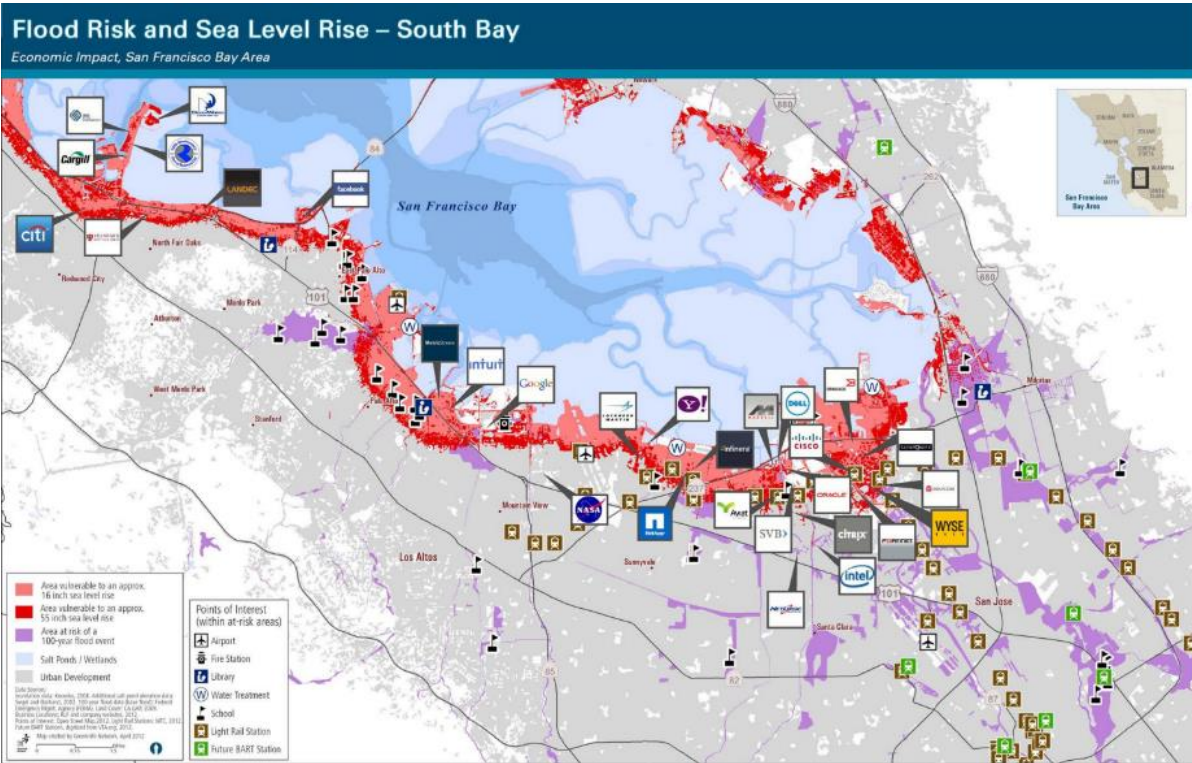
Source: *The Hartford 2013 Small Business Pulse Survey: Storm Sandy*. All rights reserved.

+ Regulatory Risks



- Change in land use zoning and/or loss of property value
- New building/construction standards
- New business continuity or insurance requirements
- More stringent disclosure requirements

+ likely discrepancies between states/cities (domestic) or countries on all the above



Source: USGS



Litigation Risks

- Improper or insufficient disclosure, breach of fiduciary duty
- Negligence in allowing or encouraging exposure to climate change
- Having caused/contributed to climate change
- Conflicts with insurer (see box)
- Conflict with suppliers (e.g. Wording of force majeure contracts)

Litigation & Extreme Weather Lessons from Hurricane Sandy

Sources of conflicts between insurer & insured:

- Meteorological definition of the event (hurricane or storm)
- Specific nature of the damage (wind or flood)
- Speed of assessment and payment
- Improperly denied claims
- Unreasonable delays in payment
- Undervalue claims and unfair settlement offers
- Improperly calculated deductibles, etc.



Source: Johnston, GS, Burton, DL & Baker-Jones, M 2013 *Climate Change Adaptation in the Boardroom*, National Climate Change Adaptation Research Facility.

+ Reputational Risks

Damned if you do, damned if you don't?



Hold the guac? A customer places her order at a Denver Chipotle restaurant in this December, 2011 Denver Post file photo. (John Leyba, The Denver Post)



© EPA



Ken Shadford
@kenshadford

Follow

The fact that the NYU hospital is dark but Goldman Sachs is well-lit is everything that's wrong with this country.

8:08 PM - 29 Oct 2012

2,951 RETWEETS 595 FAVORITES



THE DENVER POST BUSINESS

CONSUMER NEWS

Chipotle: Guacamole supply is secure, despite California drought

Denver-based Chipotle Mexican Grill went into damage-control mode Wednesday, countering reports that the fast-casual restaurant chain might remove guacamole from its menu.

"The sky is not falling," said Chipotle spokesman Chris Arnold, dismissing national media reports that the company was about to strip the green dip from its offerings.

MailOnline



Sony blames Thai floods that stopped production for the predicted DOUBLING of its losses for this year

By ADRIAN LOWERY
UPDATED: 07:37 EST, 2 February 2012



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Climate Change and Ports

+ Key Take-Aways

- US\$3 trillion in port infrastructure assets in 136 of the world's largest port cities are vulnerable to weather events
- Top 3 climate impacts for maritime industry
 - Sea level rise and floods
 - Increased intensity of storms and extreme weather events
 - Shifts in global trade patterns and routes
- Climate impacts can affect all parts of the value chain:
 - Physical environment, legal and regulatory environment, market conditions and customer expectations
 - supply chain, distribution channels, infrastructure & energy supply
- Climate change brings both short-term and long-term risks and opportunities
 - Some long-term risks are best addressed with simple short-term measures



Shipping companies take climate change seriously

- Horizon Lines discloses risks from climate change impacts in its 2014 Annual Report (10-K)
- Maersk's discusses climate risks & opps at lengths in its 2014 response to Carbon Disclosure Project investor questionnaire

We are susceptible to severe weather and natural disasters and global climate weather conditions more severe or frequent.

Our operations are vulnerable to disruption as a result of weather and natural disasters, hurricanes, typhoons and earthquakes. Such events will interfere with our scheduled service our customers demand resulting in increased expenses and potential loss of business with such events. In addition, severe weather and natural disasters can result in operational downtime, and may cause serious damage to our vessels, loss or damage to cargo, equipment and loss of life or physical injury to our employees. Terminals on the East and in the Caribbean are particularly susceptible to hurricanes and typhoons. In Puerto Rico was seriously damaged by a hurricane, resulting in damage to cranes and other equipment. Earthquakes in Anchorage have also damaged our terminal facilities resulting in operational downtime and increased expenses. Any such damage will not be fully covered by insurance.

The risk of adverse weather conditions is enhanced by the potential for global climate change. Scientists believe may increase severe weather patterns. The EPA has found in its endangerment finding that global climate change would result in more severe and frequent weather conditions. If this is the case, the above mentioned risks would be expected to increase. For example, increased or more powerful weather events could result in damage to our shipping terminals and vessels or disrupt port operations.

CC5.1b
Please describe your risks that are driven by change in physical climate parameters

Risk driver	Description	Potential impact	Timeframe	Direct/ Indirect	Likelihood of impact	Magnitude of impact
Sea level rise	The rise of sea levels may affect our ports of call. Some ports may be inaccessible, while the accessibility of others may improve.	Inability to do business	>6 years	Direct	More likely than not	Medium-high
Other physical climate drivers	The changing weather patterns may affect our routing of ships whereby the distance of transport legs may increase as we try to avoid bad weather. Furthermore, the increasing frequency and magnitude of storms and extreme weather conditions may: (i) Entail significant upgrades to our existing fleet, changes in the design of new vessels or restrictions on what trades we operate at different times of the year. (ii) Restrict the areas in which we can operate our oil and gas activities and also entail strict requirements to the safety and durability of our assets. (iii) Affect routing for our air cargo. Large and prolonged forest fires may also lead to closed air spaces in certain regions. Additionally, melting polar ice caps may increase the amount of ice bergs in the polar regions, which may affect our operations and safety routines.	Increased capital cost	>6 years	Direct	Likely	Low-medium
Induced changes in natural resources	Any events that disrupt the global supply of fuel (e.g. refineries destroyed by flooding in the USA) can result in significant direct costs due to elevated fuel prices, but also by disrupting our trade if fuel is not available in certain countries or regions.	Increased operational cost	Up to 1 year	Direct	Likely	High
Change in precipitation extremes and droughts	Extreme weather, drought and flooding may disrupt the supply chains. This can directly affect the revenue of our business, but also have a negative impact on our reputation.	Reduction/disruption in production capacity	Up to 1 year	Indirect (Supply chain)	Likely	Low-medium

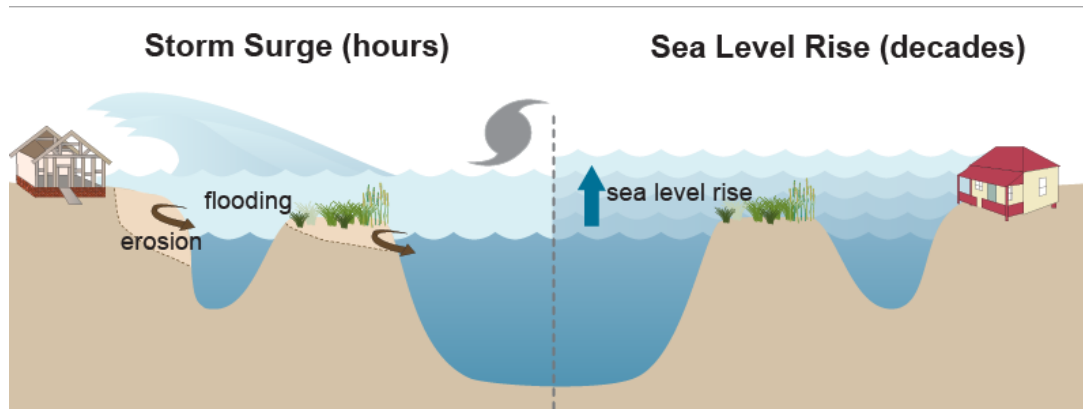
Maersk's CDP Investor Report – Climate Change - 2014

<https://www.cdp.net/sites/2014/76/276/Investor%20CDP%202014/Pages/DisclosureView.aspx>

Horizon Lines 2014 Investor Annual Report SEC 10-K filing
<http://ir.horizonlines.com/phoenix.zhtml?c=188937&p=irol-sec#9994436>

+ Disruptions go beyond local floods

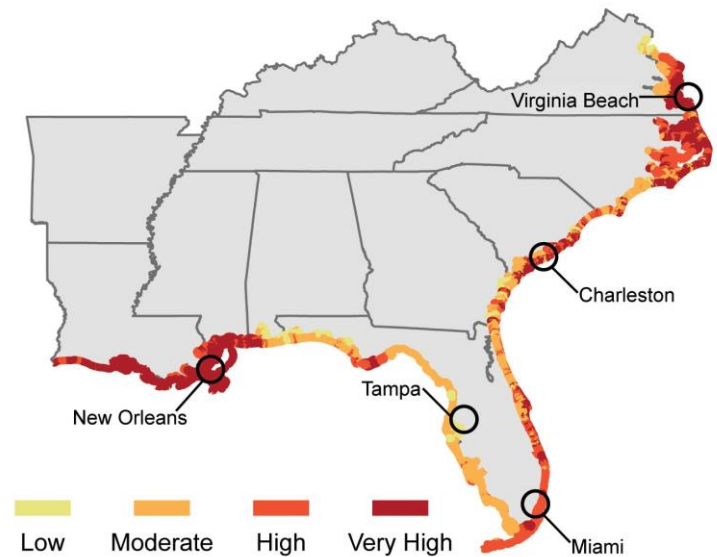
- Long term SLR is permanent (vs temporary nuisance floods or storm surges)
- Vulnerability comes from infrastructure and population in low-lying areas.



Flooding from strong storms, such as hurricanes, results in erosion and expensive property damage. Sea-level rise, which occurs over a long period of time, threatens to flood buildings in coastal areas. As sea level creeps up islands may disappear and land will be lost.

Adapted from Maryland Commission on Climate Change Adaptation & Response Working Group. 2008. Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change. Phase I: Sea-level rise and coastal storms. Chapter 5 in: Maryland Commission on Climate Change Climate Action Plan.

Source: Maryland Commission on Climate Change



Source: US Global Change Research Program, 2014 National Climate Assessment



Sea level rise: short term impacts, long term planning

- Nuisance impacts are felt today
- Impacts on operations & maintenance costs
- Long term impacts are significant
- Can (and should) be integrated in new infrastructure development



King Tide in Miami, Feb 2015



Port of Miami Tunnel was designed to withstand 10 feet of sea-level rise



Extreme Weather Events & Storms: Hazards



Containers scattered following Hurricane Katrina in Gulfport, MS. Source: katrinadestruction.com

- The frequency of Category 4 and 5 hurricanes is expected to increase. Combined with relative sea level rise, a larger portion of port infrastructure will be vulnerable to flooding and wind damage.
- This results in higher maintenance and replacement costs from damaged equipment and infrastructure
- Following Hurricane Katrina, Gulfport allocated more than \$250 million in repairs



Extreme Weather Events & Storms: Financial Risks

- Financial liability from delayed shipments. Delays will be more likely for a variety of reasons:
 - More intense storms and precipitation events leads to congestion and delays
 - Increased storminess could force vessels to take longer routes
- Wording on liability clauses in contracts and insurance will matter – a lot.



Congestion at ports could become more common with climate change. Source: zero hedge.com



Heat: Operational Risks and Opportunities

- Increased frequency of days above 90°F: longer, hotter, more frequent heat waves.
- Increase cooling costs for refrigerated containers and air-conditioned units / Increases ROI for energy efficiency investments
- Higher temperature cause pavement to get damaged faster, increases corrosion rates -> impact on maintenance





Indirect Impacts: Transportation Infrastructure

- Bottlenecks with inland transportation systems (rail connections, highways) impacted by increased temperatures, flooding, landslides, power outages, particularly in less developed countries
- Low water levels in the Great Lakes and Mississippi River Basin may result in more delays for barges along the lower basin





Indirect Impacts: Trade Patterns



Image credit: Andrew McConnell/Panos

Jamaica aims to rebuild banana industry

Government allocated J\$172m to breathe new life into the business

Jamaica's government had lent its backing to the country's banana industry by allocating J\$172m in funding to help boost the business for the 2015/16 campaign.

The project, which will involve the planting of fruit, developing export opportunities, providing infrastructure support for farmers and the implementation of a new credit scheme, will run until 17 arch, Fox News Latino reported.

The funds will be added to those allocated to Jamaica by the European Union, a move which first began in September 2013 in a bid to help revitalise the industry.



- Agriculture crops are first hit by climate change impacts
- Many tropical crops, like bananas, are sensitive to small changes in temperature and precipitation
- Climate change affects yields, diseases & pests, and may shift growing regions altogether
- Over time, trade flows for agricultural goods may shift → both a risk and an opportunity



Impacts on Ports: Maritime Transport Company - US Gulf Coast

	Hazards	Financial	Operational	Strategic	Opportunities
Liner shipping and cargo carrying services	More intense storms resulting in delays from port closure and congestion	Financial liability for delayed shipments	Increased cooling costs on refrigerated containers, air-conditioned units	Difficulty maintaining contractual obligations in risky ports	Reduced dredging costs as sea levels rise
Logistics and Port Infrastructure	Higher temperatures may cause port structures (cranes, warehouses) to become inoperable	Increased cost of terminal construction or retrofitting	Higher rates of corrosion from saltwater and changes in temperature and humidity	Insurance business may be impacted negatively by more frequent storms	New markets and new routes, new product needs
Indirect Impacts	Drought in Panama could result in inoperability or reduced operation capacity of Panama Canal, resulting in massive delays	Increased insurance premiums or degradation in insurance terms reflecting future climate change risks	Bottlenecks with inland transportation systems (rail, highways) impacted by climate change	Change in quantity and type of products shipped through region due to climate change	Change in quantity and type of products shipped through region due to climate change



+ Tools and Resources to
Adapt



What to do?

- NOAA Steps to Resilience: <https://toolkit.climate.gov/#steps>
- EPA Adaptation Planning Workbook: <https://www.epa.gov/cre/risk-based-adaptation>





Resources: Online Tools

- Climate Resilience Toolkit (NOAA):
 - <https://toolkit.climate.gov> – data, guidance / manuals, case studies, videos, third-party tools.
- Surging Seas Finder (Climate Central):
 - <http://sealevel.climatecentral.org/> - detailed data and scenarios for sea-level rise
- US Heat and Social Equity Tool (Four Twenty Seven):
 - <http://427mt.com/heat-vulnerability/>

+ Case Study: Port of Cartagena, Colombia

Source: International Finance Corporation and Acclimatise Ltd.

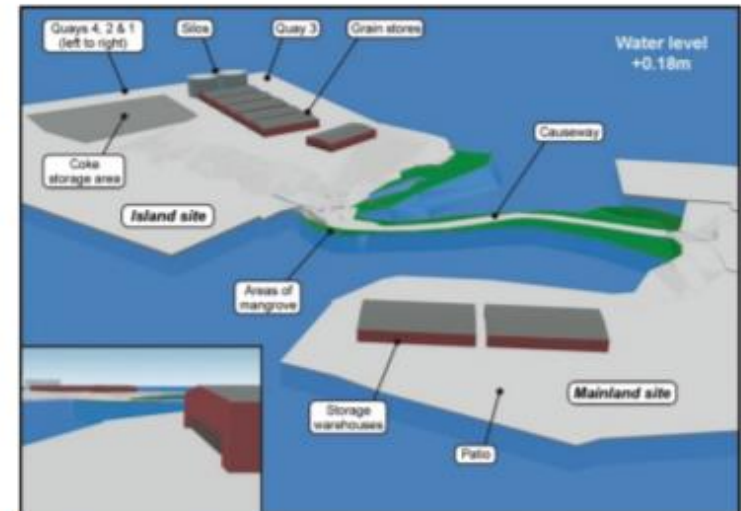
Area	Example
Demand, trade levels and patterns	Supply and demand for products traded through ports will be influenced by climate change
Navigation, shipping and berthing	Navigation depths can be affected by sea level rise and changing river runoff
Goods handling and storage	Wind speed increase, heavier rainfall and higher storminess can affect ship (un)loading
Vehicle movements inside ports	Increased risk of coastal or surface flooding
Infrastructure, building and equipment damage	Sea level rise can exacerbate coastal erosion and under-scouring
Inland transport beyond ports	Reliability of inland transportation can be disrupted by storminess and rainfall extremes leading to landslides
External stakeholders	Climate change will influence the behaviour or expectations of port stakeholders, such as insurers
Social performance	Occupational hazards due to extreme weather conditions can increase
Environmental performance	Risk of water, land and air pollution can increase, for instance due to flooding overwhelming drainage and pollution control systems

Interruptions to vehicle movements due to seawater flooding of the port

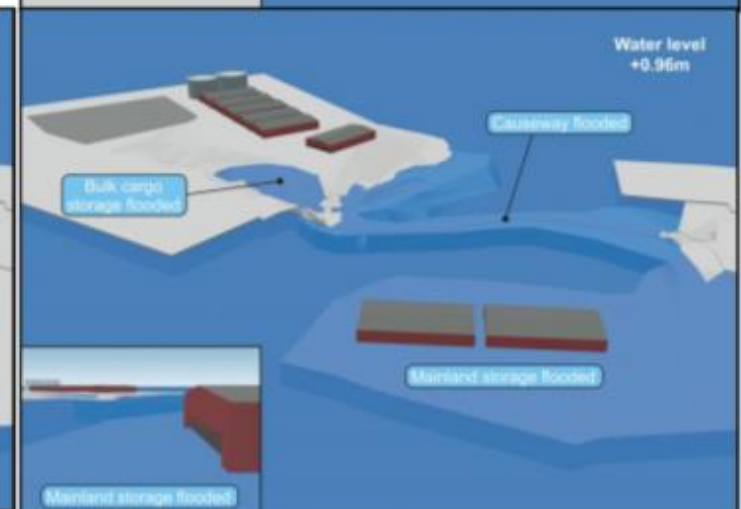
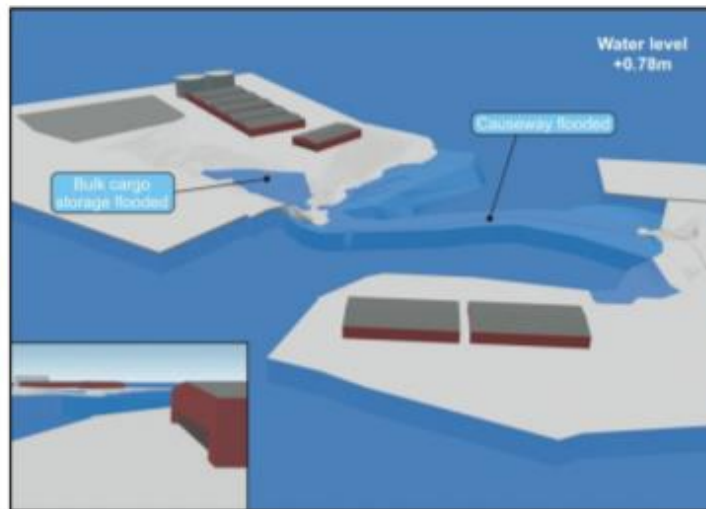


- Lowest area: causeway linking mainland and island sites (0.6m above port plan datum)
- **Causeway projected to flood at highest tides by 2018 and 2015** (observed and accelerated SLR scenarios)
- **Mainland patio and storage warehouses projected to flood at highest tides by 2070 and 2050** (observed and accelerated SLR scenarios)
- Quays not projected to flood

Mean sea level at MEB in 2000



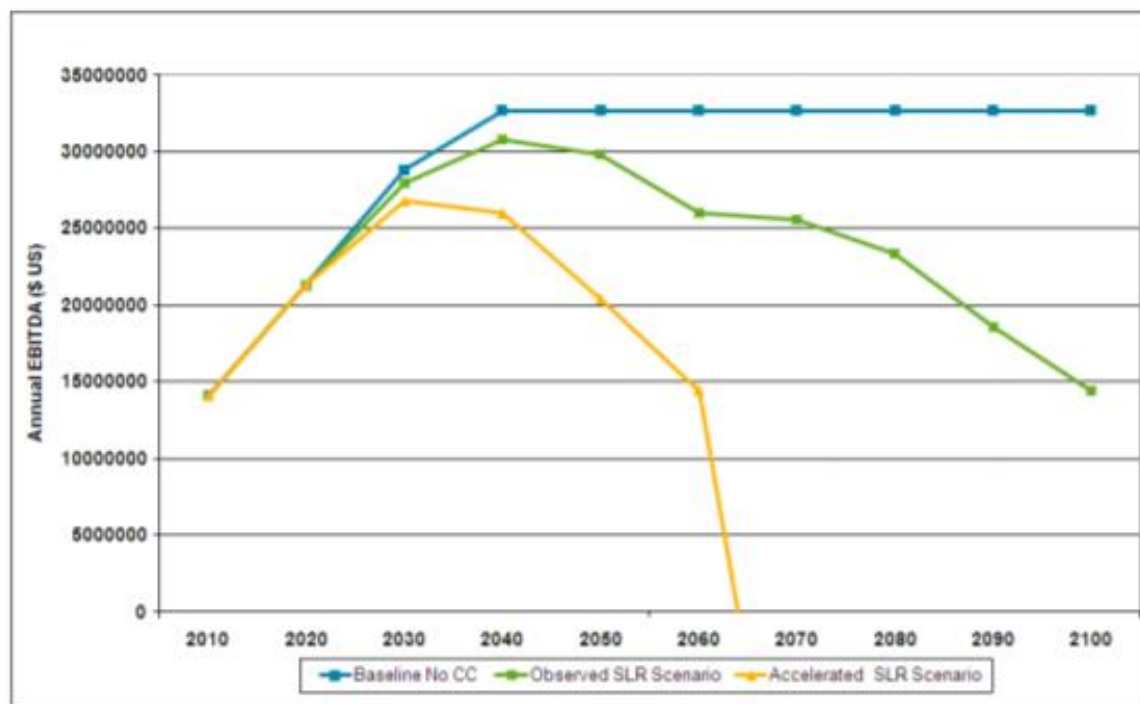
Projected flooding (areas in blue) during highest spring tides and highest water level in 2050 in the observed (left) and accelerated (right) scenarios



Business cost of vehicle movement interruptions

- Flooding greater than 30cm deep causes interruptions to vehicle movements along causeway
- **Frequent flooding of more than 30cm expected from 2080 or 2050 onwards** (observed and accelerated SLR scenarios)
- If no adaptation is undertaken, loss of revenue projected to be between **3 and 7% of MEB's annual projected earnings by 2032**. From 2060 losses could represent 10% or more of MEB's annual projected earnings

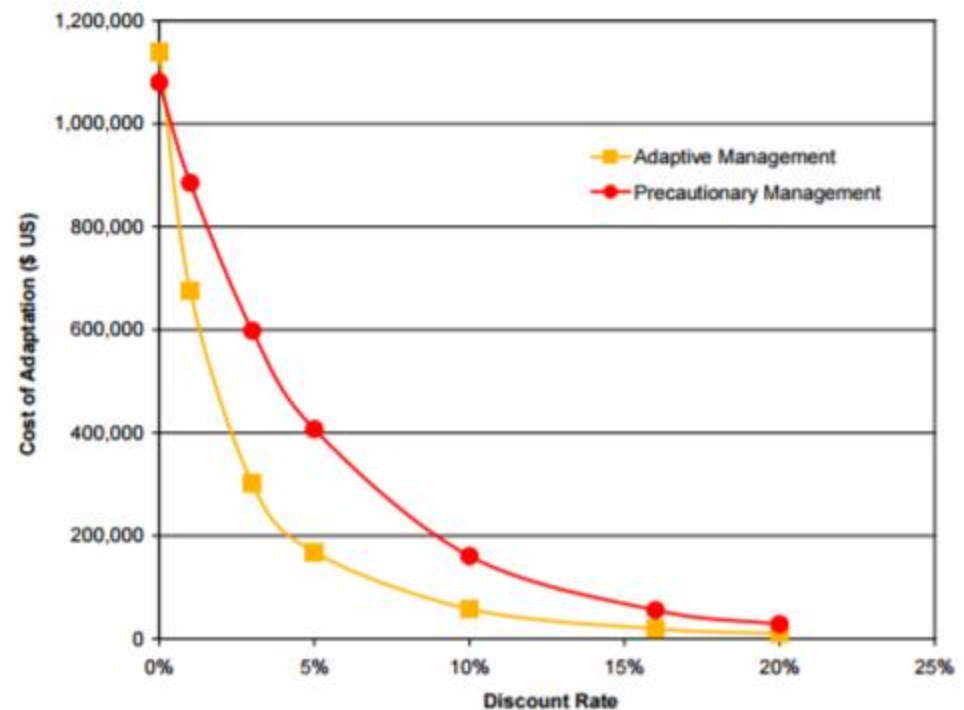
MEB's earnings under three scenarios. The costs associated with climate change assume no adaptation



Raising the causeway road to adapt to rising sea levels

- Raising the causeway road height by 60-120cm necessary this century
- **Relatively low cost:** US\$180,000 /30cm increase (US\$250,000 /day of closure)
- 2 adaptation options: raise once or raise by increments (adaptive management)
- For discount rate $>0.2\%$, **adaptive management is economically more efficient**
- Adaptive management also allows MEB to adjust adaptation decisions according to the observed rate of SLR

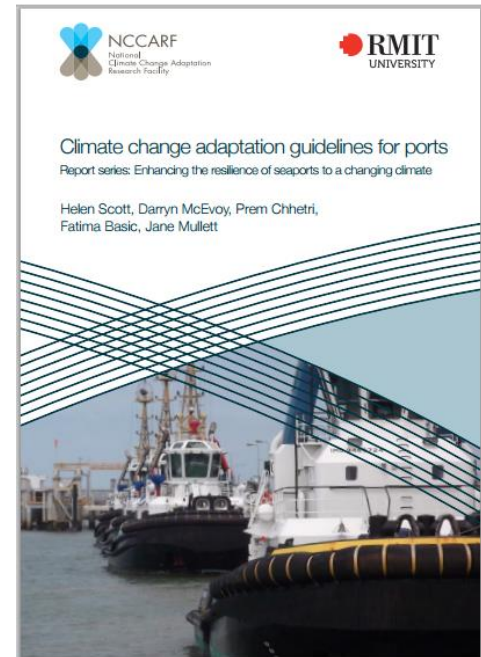
The cost of adaptation investments in causeway to 2100 under the observed sea level rise scenario



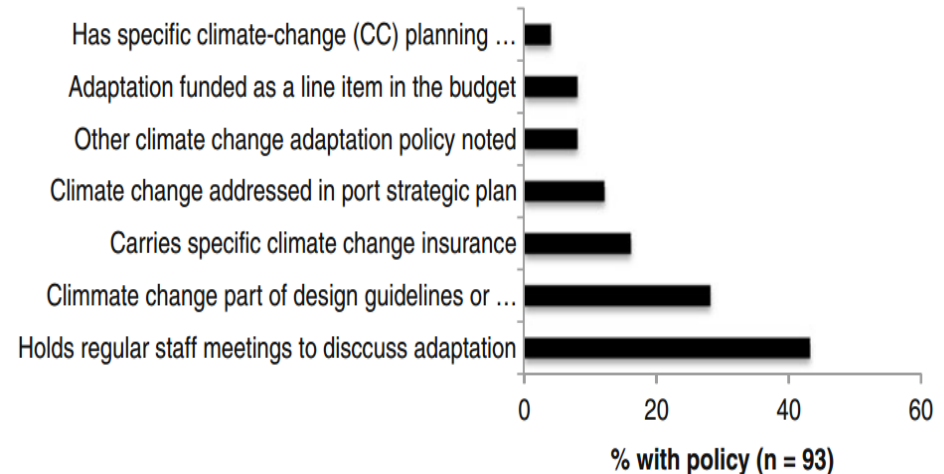


Ports & climate change

- Current initiatives include risk & vulnerability assessments, and developing strategies to build resilience
 - Port of Houston conducted a study to inventory at-risk facilities, identify high risk and high consequence operations, and prioritize adaptation measures
 - Gulfport is planning to elevate their port from 10m above sea level to 25m above sea level (Becker 2014)
- Port of Miami, Los Angeles, Long Beach, San Francisco, Oakland, New York, Boston, San Diego, Portland, and others are actively assessing risks and developing adaptation plans
- Extensive literature on climate change risks for maritime industry



Climate adaptation policies in place



Survey of port administrators measuring climate adaptation policies in place at major ports around the world. Source: Becker 2011

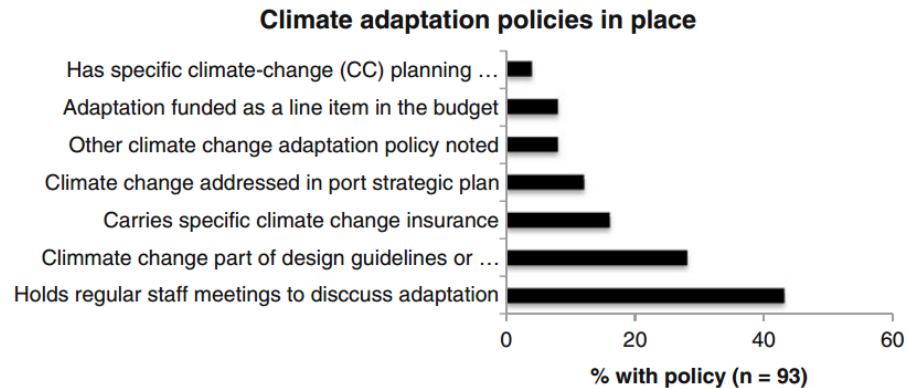


Adaptation – State of Play

- Surveyed port authorities about how administrators felt climate change might impact their operations, what sea-level change would create operational problems, and how they planned to adapt to new environmental conditions
- Respondents typically discuss mitigation more often
- privatized ports and tool ports appear to be discussing issues of adaptation less frequently
- Most ports plan on a 5-10 year horizon, and the majority are planning for some level of expansion of their facilities (50+ lifespan of most port infrastructure)
- Those with planned projects indicated that most plans were for more terminals and berths or for land acquisition.
 - Only a small percentage of ports have upcoming projects like new breakwaters or storm barriers that would increase defenses against flooding and wave damage
- Most ports face some amount of wind, wave, and flooding risk already and have already built infrastructure to protect port operations.
 - Most ports in Europe, NA, and Oceania (75% of all) followed a 100-year return period planning standard. This means that a structure will be designed to withstand a storm that has a 1% chance of occurring in any given year.



Port Adaptation: Perception and Attitude



- 52% say SLR is primary concern, 45% climate-change related storm impacts
- 66% say they do not feel informed about climate change
- 60% of planners feel informed, other departments did not feel informed at all
- 86% agreed that “climate change should be addressed by the ports community as a whole”
- 29% engineers disagreed, 24% CEOs disagreed, 17% environmental managers disagreed
- About half thought climate change would bring new opportunities.
- 42% foresee direct negative consequences



Resources: Bibliography

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Emilie Mazzacurati, Founder and CEO
emazzacurati@427mt.com - 415.420.0074
www.427mt.com