MIND your business

Institute for Catastrophic Loss Reduction
Building resilient communities

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SPECIAL BUSINESS RESILIENCE SERIES

Severe weather events and climate change: Conducting risk assessments and using technology to protect your organization's value chain

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How to use the risk assessment processes and various digital solutions to understand your organization's natural hazard and severe weather exposures and to deploy solutions to mitigate loss and protect your supply/value chain revenue.

In the three previous *Mind your business Special Business Resilience Series* bulletins (Business Interruption, April 2023; CBI & Interdependencies, September 2023; Supply Chain, October 2024), we explored the impact of severe weather events to better understand Business Interruption (BI), Contingent Business Interruption (CBI), Interdependency and Supply Chain insurance exposures and how to better protect your value chain. Part four, the final bulletin in this series, will explore the insurance risk assessment process and digital solutions, to protect your organization's value chain.

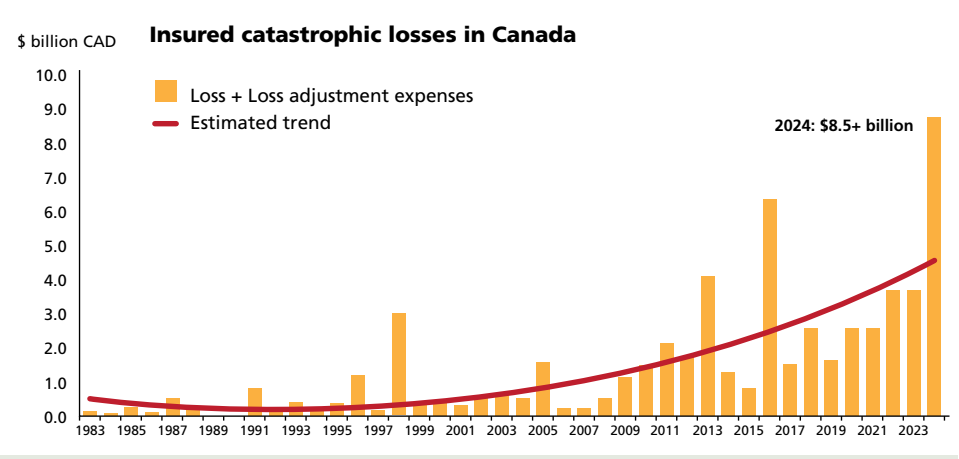
To understand the insurance risk assessment process, the assessment steps, and target result, it is necessary to gain a full understanding of how natural hazards and severe weather events impact your organization from the perspective of physical damage to property/goods as well as interruption to revenue generation through goods and services. The Insurance Bureau of Canada (IBC) maintains statistical data on the insurable losses due to natural hazards and severe weather in Canadian regions, captured by event and by year. To appreciate the evolving landscape of catastrophic insurable losses, insurers paid out an average of $701 million CAD annually between 2001-2010, whereas insurable losses in the first three quarters

IBC data for Q1 to Q3 2024 show a total of $7.7 billion CAD in insurable losses with the main drivers being flood, wildfire, hail & windstorms. Most of the $7.7 billion can be attributed to four events:

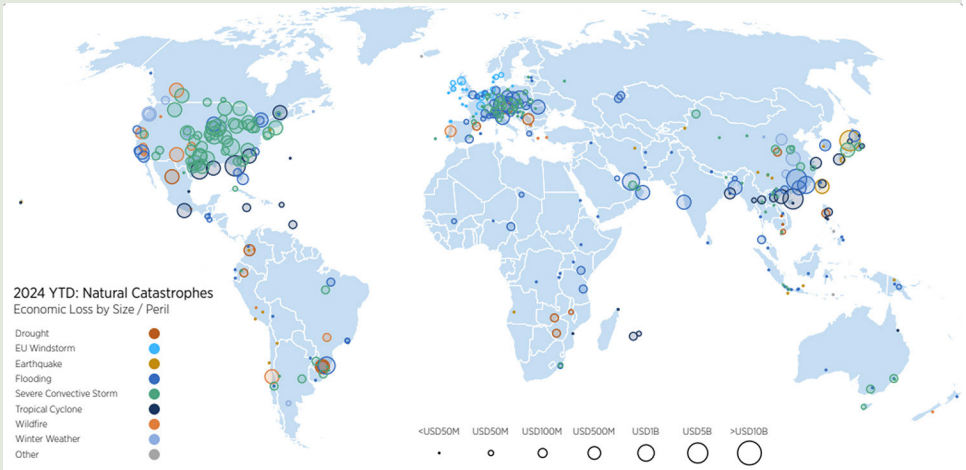
1) **Toronto flooding – $940 million**
2) **Jasper wildfire – $880 million (and growing)**
3) **Calgary hailstorm – $2.8 billion**
4) **Quebec flooding – $2.5 billion**

Looking globally at the first three quarters of 2024, based on data provided from Gallagher RE, catastrophic severe weather losses reached approximately $258 billion USD in economic losses, with only $102 billion USD being insurable, equating to more than 60% of the economic losses not covered by insurance. Of those losses, more than 85% can be attributed to flooding, cyclones/hurricanes and severe convective storms.

This loss data contributed to the insurance councils of the U.K., New Zealand, Australia and Canada, during the October 2024 Commonwealth Heads of Government Meeting (CHOGM), requesting that Commonwealth countries, heighten climate risk within their respective countries.



Source: IBC Facts Book, PCS, CatIQ, Swiss Re, Munich Re & Deloitte. Since 2008, only events that cost $30 million or more in insured losses ($25 million prior to March 2022) are included.



(Image credit to Insurance Bureau of Canada and Gallagher Re: Natural Catastrophe and Climate Report Q3 2024)

of 2024 amounted to approximately $7.7 billion CAD, a tenfold increase in 14 years, and this number is growing in Q4 2024. Between 1994 and 2024, the six costliest losses from catastrophic events totalled over $27 billion CAD (IBC – September 2024 Article).

With the dramatic increase in catastrophic insurable losses related to severe weather, the insurance industry has undergone a variety of changes, making insurance coverage harder to acquire and more expensive. These events (i.e., wildfires, floods, windstorms, etc.) can cause damage to entire communities, displace consumers and workforce staff, increase the cost of labour and recovery of building materials, not to mention the emotional impact on communities and individuals. As an organization with property and/or revenue at risk in these loss event locations, the ability to recover, operate remotely and maintain market share can be insurmountable, leading to difficult decisions on how, or even if, to move forward with recovery.

For insurance carriers, post-loss event reflection can lead to changes in underwriting decisions. such as deployed capacity of coverage, reevaluation of insurance rates leading to higher premiums, and potentially exiting the market area or type of coverage. These inward-facing risk assessments can take time to evolve/decide and enact but can also be influenced by their customers' preparedness for potential losses and their reaction time to minimize property and revenue losses. As an organization with values at risk in such catastrophic loss events, performing your own risk assessment and developing robust protection and recovery plans can be key positives to your insurance carrier.

Understanding and performing an effective self-risk assessment that includes an insurance risk component: What are the proper steps in the process and what can an organization expect from the risk assessment.

While several types and styles of risk assessments can be used by an organization to identify exposures, the most effective is a hazard analysis (see appendix for other types of risk-assessment processes). This type of analysis includes a six-step process with a mix of employees contributing to the development of a risk registry that highlights credible risk to the organization, what can trigger losses, how to effectively recover, and who would be responsible for actioning. The end result of the assessment is a pathway forward to resilience of both property and revenue and seeking to balance cost of risk vs severity of risk.

Six steps to an effective self-risk assessment, with a focus on the role of insurance risk transfer.

The following key components should be in place before beginning a self-risk assessment, to allow for a smooth and focused process:

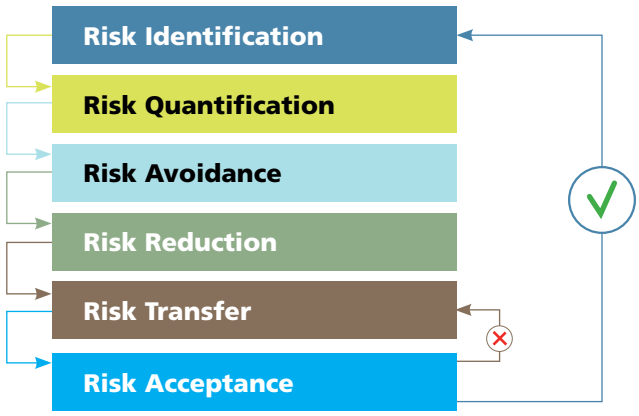
- The assessment team should include appropriate staff and management from the organization and within the areas of assessment. While not all contributors are required at each stage of the process, it is important that each participant be considered equal throughout the assessment. If staff members are concerned about highlighting specific risks due to the presence of management, the process will suffer.
- If needed, hiring a third-party facilitator is an acceptable approach. They can ensure the focus of the process and equality of the participants are maintained, and various risk scenarios are kept credible. Some facilitators will also act as a scribe to develop the rough draft of the risk registry.
- The assessment process should be broken down into manageable components, such as by location or by process. The development of the assessment will likely dictate what is within and outside of scope. When assessing severe weather and catastrophic loss events, the process may look at any/all locations at risk in the same geographical area, as they could all be impacted by the same event.
- Commitment by management and staff to complete the process is very important. Some assessments can take several weeks to complete due to schedules and risk complexity. Furthermore, the process is considered to be circular in nature (i.e., a living process) and should be reviewed regularly, though likely not more than annually. From an insurance perspective, if the review occurs prior to renewal, the carrier can be updated on the status of implemented risk reductions, which could result in better insurance terms.

- Development of a risk registry document will help catalogue the process. There are a variety of risk registries available on the Web, essentially spreadsheets with column headings that can include risk number, risk name, description, risk probability, risk severity, owner, mitigation, progress, status, resources. The registry would be developed as the six following steps are completed.

1. **Risk Identification** ▶ After assembling the risk-assessment team and identifying the scope, the first task is to identify credible risks to either that location or process, including physical damage and revenue interruption risks. This can include a variety of risks from fire, power loss, severe weather events and loss to a supplier or customer. The focus is to identify the risk exposure: Can it happen? Where could it happen? What would be impacted? Can the exposure have different severities? Agreed-upon risks are entered into the risk registry.

2. **Risk Quantification** ▶ Quantification of the identified risks is generally based on the probability of the loss occurring and the severity of a loss if it does occur. This can include monetary loss due to physical damage or business interruption, liability of loss to staff or others injured at the location, and reputational risk. The combination of Risk Identification and Risk Quantification allows an organization to plot the individual number of risks into a two-axis heat map, which will help to identify which risk to focus on, given their higher exposure to loss and consequence.

3. **Risk Avoidance** ▶ This phase focuses on the identified risks that can be completely avoided and the steps to execute that avoidance. For example, a critical supplier that produces an adhesive used in your product manufacturing is identified. Their proprietary blend has worked well, but they are consistently exposed to flood losses and delays. If you find another adhesive that is just as effective, you can switch suppliers and avoid/eliminate the delays from your current supplier. Permanently removing the risk is "risk avoidance."



4. **Risk Reduction/Control** ▶ Once all possible risks have been avoided, the next steps are to implement either mechanical controls or human element controls (or both). This can be accomplished by adding permanent flood protection (mechanical) or implementing operational controls enacted by staff to reduce potential flood losses (i.e., temporary flood barriers or sandbags). A balance between both types of controls could be necessary, as mechanical controls can require expensive capital expenditure, and management controls can place staff at higher safety risk.

5. **Risk Transfer** ▶ This stage of the assessment process has two components: The first is assessing an organization's ability to transfer the risk onto another business entity, such as a supplier or customer. For example, FOB (**F**ree **O**n **B**oard/**F**reight **O**n **B**oard) can be used to ensure the risk of transport shifts to the product buyer and, conversely, if the organization has leverage, it can transfer the freight exposure to their supplies as well. This shifts the loss cost of previously owned risk to an external entity.

   The second component, and the last piece in any risk assessment process, is to transfer the remaining possible risk to insurance. Risks that cannot be avoided, controlled, reduced or transferred elsewhere, should be transferred to an insurance carrier. Risks that cannot be transferred to insurance, or where the cost is prohibitive, prompt either a revision of the above-noted risk assessment process steps to ascertain additional areas of risk control/avoidance or moving to the next step, risk acceptance.

6. **Risk Acceptance** ▶ More a reflection of the risks that could not be avoided, reduced, controlled or transferred elsewhere, risk acceptance is generally regarded as the insurance policy deductible and uninsurable acceptance. This step is always the last to be considered, as it is more cost effective (in the long run) to avoid, eliminate, control or transfer a risk before seeking insurance, so that the cost of insurance is truly being applied to the required risk areas. If an organization assumes insurance is a solve-all risk control/transfer piece, the likelihood that the earlier steps have been taken is reduced, leaving the organization at serious threat of loss.

As noted, this process is circular and ongoing as old risks disappear, and new ones appear. The corresponding graphic depicts the six steps in descending order. It should be noted that the reassessment process that moves from Risk Acceptance back to Risk Transfer is incorrect. Typically, organizations without a well-structured self-risk assessment take this route and therefore bring the same risk perspective to the insurance carrier at renewal, missing any improvements or risk reductions that could have occurred. The correct process, then, is to revert back to the initial step of Risk Identification and cycle through the six steps again.

How technology and digital tools can help manage an organization's risks to property and business interruption loss.

Over the last ten years, the evolution of technology, the Internet of Things (IoT), AI and real-time monitoring and tracking of severe weather events and/or international cargo has begun to surpass an organization's ability to adapt, utilize and benefit from the technology. Regardless of the threat that might cause a loss event, organizations can now use technology to plan and execute defense strategies and alternatives to protect their revenue stream and their physical property… provided they recognize which solutions are best for their operations/services and can adapt to the speed of the technological growth for their own purposes.

Digital technology falls into two categories. There are digital tools that can be used to speed up production/services as well as pivot to alternatives in advance of potential losses or at the inception of a loss event. This category can be broken down into three parts:

1. Planning and testing digital tools, such as digital twins (i.e., a computerized twin of your organization's operations/services that can be used to run simulations that mimic loss events and plan effective avoidance or recovery strategies).
2. Logistics efficiency tools that help manage everything from marine and in-land marine shipping to maximizing warehouse operations.
3. Real-time monitoring of various global bottlenecks, such as traversing the Suez or Panama Canals, threat of a strike at a port, or a devastating loss to a shipping yard across the globe.

The second category of digital technology, specifically relevant to this bulletin, is real-time monitoring and warnings of severe weather and catastrophic loss events that can impact an organization's supply line, purchasing of goods/services, operations facilities, end-user customers and employees. Tools used and deployed today include following storms on the weather channel or watching 24-hour news with storm updates, but other technologies exist that can show earlier warning signs, thereby allowing organizations more time to prepare and protect their assets, revenue and, above all, the people who make and buy the goods and services. Examples of such technology include, but are not limited to:

1. Hurricane and typhoon tracking. Several insurance carriers use these early warning systems to identify the path of the storm and its anticipated devastation, and to cross reference to their insured customer list. This allows the insurance carrier to advise customers in the storm's path of best practices to, not only prepare to minimize damage, but how to assess and process potential claims expeditiously following the event, allowing for speedier recovery.
2. Private and government-funded organizations with tracking tools for early identification of tsunami threats from the ocean, deep water earthquakes and potential volcano activity/eruption (the Eyjafjallajökull eruption of 2010 in Iceland caused serious air quality concerns as well as lengthy delays to air shipping between Europe and North America).

3. For fluvial (body of water/river) and pluvial (rainfall) flood risks, several academic institutes, government bodies and NGOs are working towards better early warning systems than currently exist. One base theory is understanding the volume of rainfall and its impact on the threatening flood water source, combined with topographical data to project the approximate timing and severity of a flood. Other technology exists to run simulations of topographical flooding to understand the various severities of risk but are not early warning systems.

Logistics, Supply Chain, Environmental Health & Safety and Sustainability Digital Tool Examples

Following are examples of digital tools that provide real-time monitoring, thereby improving logistics and organizational transparency to climate targets and sustainability:

- TraceX ▶ Sustainability Solutions for Food & Agri Supply Chains
- Dassault Systems ▶ Virtual Digital Twin solutions
- Oracle ▶ Supply Chain Management; Human Capital Management; AI and Machine Learning, etc.
- DHL, FedEx, UPS and Amazon Web Services (AWS) ▶ Various supply chain and logistic digital solutions for regional and international needs
- Resilinc ▶ Various supply chain and logistic digital solutions
- Adapt Ready ▶ Supply chain and business resilience solutions
- Sphera ▶ EH&S, Sustainability and Supply chain real-time monitoring of bottlenecks

Natural Hazard and Catastrophic Event Digital Tools

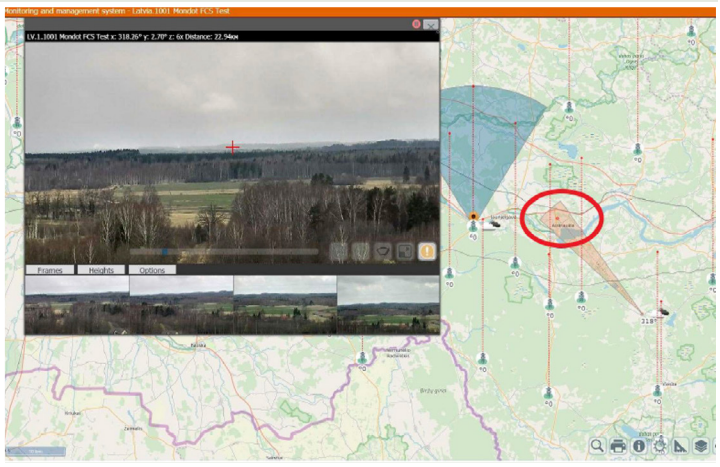
Following are examples of digital tools that can be used to monitor and view various natural hazard events from a more "real-time" position.

- Institute for Catastrophic Loss Reduction (ICLR) ▶ Information, solutions, understanding of natural hazards and severe weather events in Canada.
- Global Disaster Alert & Coordination System (GDACS) ▶ UN and European Commission cooperative platform with real-time access to global disaster information.
- Natural Resources Canada (NRCan) ▶ Various tools including geospatial data, RETScreen, Canadian Wildland Fire Information and more.
- NOAA-NCEI ▶ A U.S. platform, it also provides global data related to severe weather, climate models, natural hazards, ocean physics, etc.

Wildfire Detection & Early Warning System

Toronto-based Amplicam has an AI-enabled early warning system for wildfire detection. With customers in Canada, USA, Eastern Europe, Africa and South America, their technology uses strategically positioned video cameras capable of detecting small amounts of smoke at great distances. The AI engine analyzes the threat and rapidly begins the process of verification and notification of a potential wildfire, allowing a faster response and potential early control of what could be an uncontrollable wildfire.

While the technology took just over ten years from proof of concept to an effective digital tool, there continues to be new innovators and extensive research and growth in early wildfire detection. Amplicam is one of the pioneers in this space and, as we see more devastating and frequent wildfires/bushfires, there will be better and more advanced iterations of the AI tech, with the continued purpose of early detection and notification.



(Approved images credit to Amplicam)

Improving your organization's risk profile and completing insurance risk reduction recommendations.

As mentioned above, severe weather events resulted in economic losses of $258 billion USD in the first three quarters of 2024, with only about 40% of those losses covered by insurance. This disparity is not necessarily due to a change in insurance coverage or capacity but rather is a function of the catastrophic events or natural hazards drastically increasing in frequency and severity. This drives economic loss up faster than the insurance transfer protection can be obtained. As such, organizations need to become more resilient through planning and loss prevention solutions, instead of increasing their insurance to cover the higher loss potential.

Avoiding, reducing and/or controlling risk, through the risk assessment process, will reduce the need for insurance risk transfer… if done properly. Once an organization has defined the natural hazard and severe weather exposures, there are two basic approaches when applying the assessment process: the first is to develop physical protection and operational awareness (i.e., physical/mechanical controls and early warning preparation to protect physical assets). The second is through resilience preparation and policy (i.e., robust emergency plan and business continuity plan).

Both approaches should be deployed; however, physical controls may require capital expenditure, which requires proper planning. The resilience approach may involve costs of a third-party consultant to assist in developing the emergency and continuity plans.

Based on a Public Safety Canada report, "Evaluation of the National Disaster Mitigation Program," data collected from 2008 to 2018 indicates that, on average, for every $1 invested in mitigation efforts, $7 to $10 are saved on post-disaster recovery costs. This data indicates that preparation and prevention are less costly than recovery, and provides some explanation for the earlier-noted data that only 40% of Q1-Q3 2024 disaster losses were covered by insurance.

Physical Controls and Operational Awareness

Once the exposure is identified (e.g., flood), following are items to consider when planning which physical controls to put in place and how to develop the operational awareness of the exposure:

- Are you aware of the known flood zone being used by your insurance carrier as their exposure of severity and frequency? Are you in agreement with the flood zone? Does your insurance carrier indicate your location in a flood zone that may be worse than your assessment or better than your assessment?
- Are there physical defenses already created and/or deployed by the community or region? Are they seen as effective and reliable?
- Are there natural defenses in place around your organization's facility? Does the topography naturally drain water away from the building? Are you located on an upper floor without any critical equipment/services at or below grade?
- What additional protection should your organization deploy? Should it be permanent or removable?
- Are staff aware of the exposure and risks? Does the organization know what equipment or commodities are at risk and that they are potentially hard to repair, acquire, or save from the exposure?
- Does the organization know how a loss or delay will impact suppliers? Customers? Market position/share?

Part of the risk assessment will help source out the answers to these questions. They can drive organizational decisions related to physical protection or organizational changes that could be implemented in the next approach of resilience.

Avoiding, reducing and/or controlling risk, through the risk assessment process, will reduce the need for insurance risk transfer… if done properly.

Resilience Preparation and Policies

In conducting the risk assessment under the first approach, still using flood as the exposure example, solutions or cross-over items may find their way into the second approach via emergency planning and/or added continuity planning. Physical protection and operational awareness of the exposures may not be enough to reduce the risk, and the ability to quickly pivot can dramatically reduce longer and costlier losses. Generally speaking, for every day your organization is inoperable, the recovery time increases exponentially, meaning a one-day outage may take three days to resume full operation, but full recovery from a two-day outage may take eight or nine days (note the sidebar example of the concertina effect).

- Are you aware of the known flood zone being used by your insurance carrier as their exposure of severity and frequency? Are you in agreement with the flood zone? Is there a history of flooding of the property and, if so, has it ever caused a delay or loss to operations?
- Does your organization have an emergency plan taking into consideration the natural hazard exposures? Is it updated as severe weather events increase? Has the plan been developed to take the organization through the immediate event and up to the first 72 hours of the event occurrence?
- Based on findings of assessing the physical controls, does the emergency plan translate the steps into actions?
- Is there a longer-term business continuity plan that indicates the steps needed to bring the organization back to full recovery?
- Have you identified key suppliers and customers that would require top-tier attention in order to maintain market share? Are any of them subject to the same flood loss event, and are you aware of their continuity planning?

With evolving climate change and more frequent severe weather events, it is even more important to assess your organization's physical risk to loss events and ensure proper controls and resilience planning. Staff need to be made aware of physical and mechanical controls and how/when they are to be operated or deployed. A deployment training program should be developed and practiced regularly. Ensure the facility's emergency plan is designed to operate at immediate event loss and is focused on the first 72 hours. Roll the longer-term recovery into a business continuity plan: plan for alternatives that may be at other locations; for services, investigate remote working and how that can be deployed; for goods, alternative locations, reserve stock and the ability to deploy will be critical. Most importantly, remember that in the event of a loss, your staff may need to manage their own personal recovery from the event and may need to prioritize, possibly leaving the organization with a smaller group to aid in the recovery.

Concertina Effect

The Concertina Effect (also known as the Accordion Effect) has been used to describe the compression and expansion of an entity (such as supply chain transportation) with the intent to explain how these entities expand then compress.

Supply chain transportation example:

- **When the Suez Canal was blocked by the Ever-Given ship in 2021, both ends of the canal, which managed a consistent flow of ships upstream and downstream, now had several hundred ships compressed at each end of the canal.**
- **The Ever Given was moved after 6-7 days and was out of the canal within 13-14 days; however, due to the compression at both ends, the standard flow in the canal was severely interrupted. It took several weeks to clear all of the ships and return to the regular flow of ship traffic.**
- **The concertina effect then moved the congestion to the shipping yards where the lack of ships received resulted in a lack of products flowing to final destinations.**
- **Clearing the backlog at the shipping yards took well over a year (globally), but the concertina effect had then already manifested itself at the final cargo destination where the goods were delayed for so long that logistically receivers were unprepared for the dramatic increase in flow.**

The relatively short 6-to-14-day blockage of the Suez Canal caused a backlog of goods that took well over 12 months to recover from (noting that Covid-19 did not help the recovery).

Bringing it all together

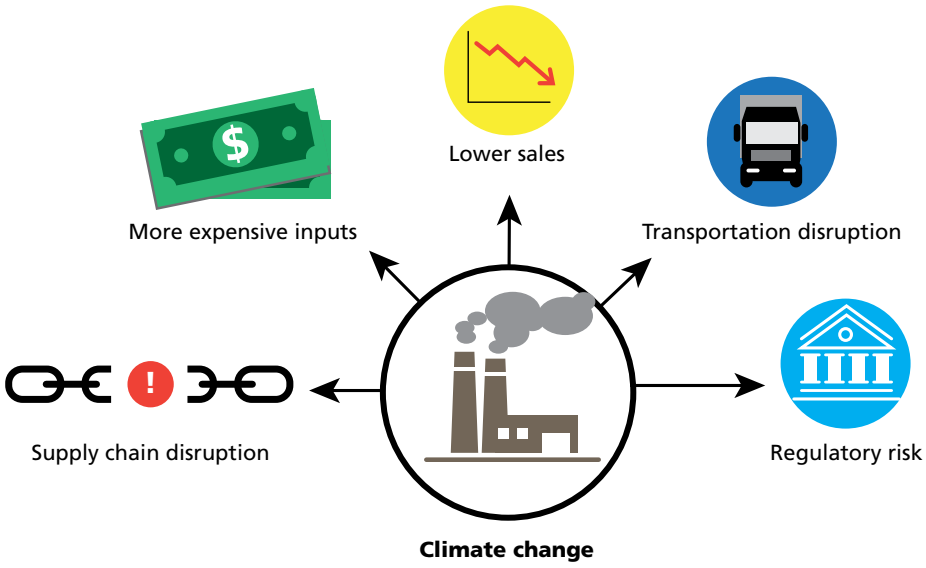
In the first three bulletins of this four-part *Mind your business Special Business Resilience Series*, the focus was on understanding business interruption, interdependencies, contingent business interruption and supply chain exposures to your organization's ability to generate revenue, the culprit for the loss being natural hazards and severe weather events. Guidance from this information and deploying a thorough risk assessment will not only help your organization identify potential losses but also gain a perspective of the coverage that may be possible from your commercial insurer. Not everything is easily insurable (due to loss frequency/severity or coverage cost) and therefore it is critical for organizations to use the means at their disposal to identify these risks and develop a plan to help avoid or minimise their impacts.

Through the risk assessment process, your organization should be consistently assessing the potential threats to generating revenue. Threats will change over time, as will the organization (i.e., staff, operational size, location, etc.). Using the appropriate risk assessment process and including digital tools, AI or monitoring services will help manage the assessment process, deliver needed results in real time, and help identify previously unknown risks. An industry specialist can help identify the risks to your organization faster and help select the digital solutions to use. Remember, industry specialists who provide resilience services have been involved in various industries, conducted assessments in a variety of locations, and can bring their gained knowledge to the table to help your organization implement practical solutions to protect your business, sister facilities, suppliers and customers. They can help increase your organization's knowledge base related to natural hazards and severe weather events, and, in the event of a loss, they can help prepare you for the successful recovery of your organization's revenue. The right specialist might also help choose the best solutions to resonate with your insurance carrier, which could potentially improve your coverage policy.

In the end, it will take time and effort to begin the process of understanding your organization's natural hazard threats, assess the actual exposure and loss potential, and deploy the most effective solutions to minimise revenue loss. Over time, the process will become easier and faster, and can be adapted to changes within and outside (i.e., customers and suppliers) the organization.

For additional information and perspective on organizational decisions related to natural hazard protection, you are encouraged to read the "Cost-Effective Business Resilience Decision Making" article published for **The Oxford Research Encyclopedia of Natural Hazards Science**.

Five ways climate change impacts business



Source: C. Hicks Webster (2022)

LiDAR technology and its uses in flood mapping, digital twin development and wildfire exposure and mitigation

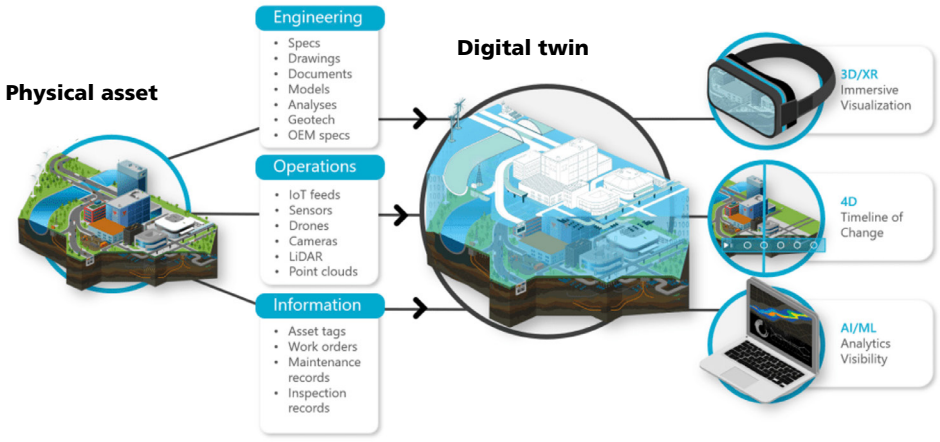
LiDAR (Light Detection And Ranging) technology was first used in the aerospace industry in the early 1960s with its first commercial use around the early 1980s. Now LiDAR technology can be found on more modern mobile smart phones, tablets and cameras mounted to drones, as well as on some of the autonomous vehicles currently used in test markets.

With the commercialization of LiDAR technology, one of the most common uses is elevation mapping an organization's properties and, using that 3D topographical data, to assess flood potential (based on known flood height limits). It is also used to model the flow of water over the topography towards a property. This provides an organization with more reliable flood potential data, including the areas of the property that would be impacted first, thus allowing resources to be deployed first to the critical boundary areas of the property.

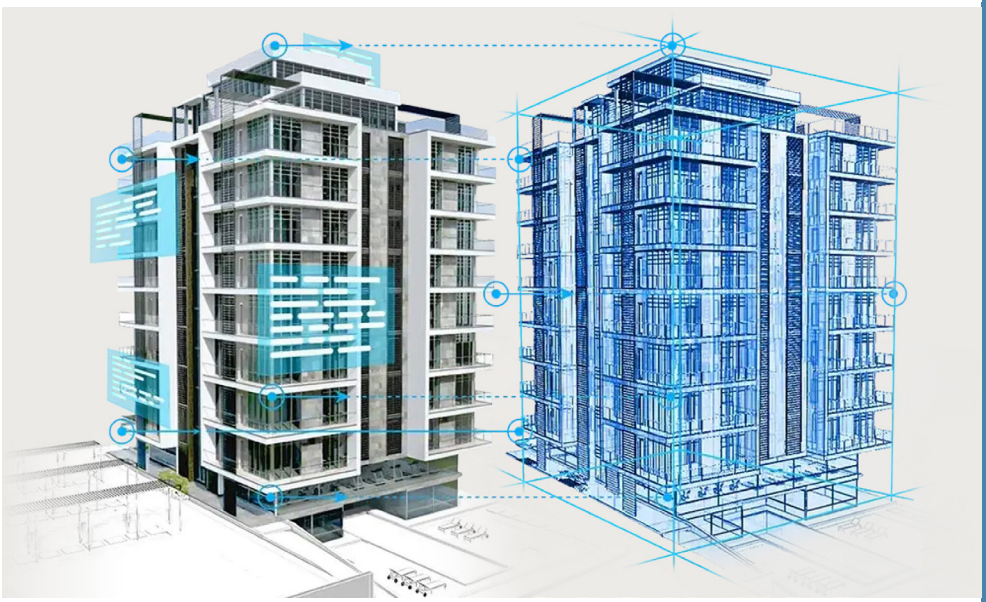
With wildfire-prone areas, LiDAR is used to help understand the natural topography of the forested area and the ladder fuel volume (ladder fuel = fuel load of trees from forest floor to canopy). Knowing the ladder fuel volume can help determine areas with more fuel for a wildfire and areas that could be targeted for mitigation measures to reduce fuel load or remove ignitable debris from the forest floor.

Another quickly emerging commercial use of LiDAR is developing a digital twin of your organization's location(s). Whether during the planning and construction phase or after occupancy, LiDAR imagery can be used to develop a digital twin (whole property/building or production line). Using the digital twin to run scenarios, the "what if?" questions, an organization can see the impact and damage of a flood event based on LiDAR elevation. In addition, digital twin technology can be used to assess the impact on employee safety or if a change in a fabrication line flow will improve production and increase revenue for the organization.

Bentley Systems – Digital Twin



◀ Digital twins are continuously updated with data from the physical asset. This data is used to understand and model the asset's performance.



◀ usBIM – Digital Twin BIM

Project Risk Register example – Advanced

REF ID	DATE RAISED	RISK CATEGORY	RISK DESCRIPTION (INCLUDING IF / THEN STATEMENT)	PROBABILITY 1 – 5	IMPACT 1 – 16	RISK SEVERITY SCORE Prob x Impact	LIKELY TIMING OF RISK	RISK TRIGGER	MITIGATION / RESPONSE PLAN	STATUS OF MITIGATION / RESPONSE	OWNER	OTHER NOTES
10001	MM/DD/YY	Materials	If there are changes in architectural plans that require additional or different resources, then there will be delays.	1	8	8	The risk is present throughout the process of finalizing architectural plans.	There are changes in the architectural plans.	A designated team member will continually monitor any proposed changes in architectural plans and ensure communication between architectural and construction teams about proposed changes.	No current issues	Joe Smith; architectural liaison	
10002	MM/DD/YY	Contracts	If contractual issues among contractors, subcontractors, or vendors arise, then there will be delays or cost overruns.	2	4	8	The risk is present before most contract work commences. However, the risk will also be present when additional contracts are added in the early phases of construction.	The contracts manager reports any potential contract issues.	The contracts manager will continually monitor contracts, alert the team when there are issues, and ensure that the team addresses and resolves contract issues before they cause delays.	Working on one unresolved issue with the electrician's contract; meeting set for May 2nd	Sue Johnson, contracts manager	
10003	MM/DD/YY	Permits / Regulations	If obtaining appropriate construction permits takes longer than planned, then there will be delays.	2	8	16	The risk is present throughout the construction phase of the project, including when securing required permits at the beginning of construction.	Construction permits do not arrive within the required timeframe.	The construction manager, or another designated team member, will monitor the project schedule and deadlines and ensure that all permits can accommodate the project's construction schedule.	All deadlines currently being monitored	Dale Swenson, construction manager	
10004	MM/DD/YY	Construction Site	If unexpected hazardous waste is found on the property, it will require mitigation or cleanup.	1	8	8	The risk is present throughout the project, especially toward the beginning when conducting site preparation work.	On-site managers report an issue, especially during site preparation.	The construction manager will assign a team member to monitor and explore any possible issues with hazardous waste.	No issues found to this point	Jeff Baker, construction assistant	
				1	1	1						
				1	2	2						
				1	4	4						
				1	8	8						
				1	16	16						
				2	16	32						
				3	16	48						
				4	16	64						
				5	16	80						

PROBABILITY | 1 – 5	IMPACT | 1 – 16	PI SCORES | 1 – 80
1 - RARE	1 - INSIGNIFICANT	1 – 2 • NEGLIGIBLE
2 - UNLIKELY	2 - MINOR	3 – 8 • LOW
3 - POSSIBLE	4 - MODERATE	10 – 16 • MEDIUM
4 - LIKELY	8 - MAJOR	20 – 32 • HIGH
5 - ALMOST CERTAIN	16 - SEVERE	40 – 80 • EXTREME

IMPACT \ PROBABILITY	1	2	3	4	5
1	1	2	3	4	5
2	2	4	6	8	10
4	4	8	12	16	20
8	8	16	24	32	40
16	16	32	48	64	80

smartsheet

How to create a Project Risk Register | Smartsheet

Appendix: Additional material

Additional well-known risk analysis methods for use in different occupancies/operations:

1. Quantitative Risk Analysis – numerical likelihood vs impact
2. Qualitative Risk Analysis – numerical with qualitative description to prioritize risk improvement
3. Failure Mode & Effects Analysis (FMEA) – Considers severity, occurrence, detection and failure
4. Bowtie Risk Analysis – Relationship between potential hazards, possible causes and consequences
5. Fault Tree Analysis – Graphical representation to illustrate how various failures can lead to a system-wide breakdown
6. HACCP – Hazard Analysis Critical Control Point. Common for the food industry.

Institute for Catastrophic Loss Reduction

Mission

To reduce the loss of life and property caused by severe weather and earthquakes through the identification and support of sustained actions that improve society's capacity to adapt to, anticipate, mitigate, withstand and recover from natural disasters.

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