

TOWARDS CAPACITY BUILDING IN NATECH RISK MANAGEMENT IN CENTRAL AMERICA



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Acknowledgments:

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INTRODUCTION

An intensification in climate disruption at an accelerating and disturbing pace around the world has highlighted impacts at different scales on people, the environment and infrastructure, and specifically a disproportionate impact on the poorest and most vulnerable, raising concerns at local, national and global levels. According to the GAR 2022 report, it is recognised that climate change is creating an increased systemic risk to critical infrastructure, including but not limited to coastal zones that may be directly affected by sea level rise. It is also important to mention that earthquakes constitute the deadliest natural hazard. According to MunichRe, since 1980 they have caused half of all disaster deaths worldwide, as a result of strong tremors or triggered tsunamis. On the other hand, it is estimated that there are currently around 550 active volcanoes around the world. These, due to volcanic eruptions, can devastate large areas of the territory more suddenly and with greater intensity than almost any other event of natural origin, generating direct impacts.

However, the indirect impacts associated with volcanic eruptions can have global repercussions. In addition to the above, it is important to note that global systems including ecosystems, food systems, supply chains, economies and social services are increasingly interconnected, making them more vulnerable to risk's uncertain landscape. As these global natural phenomena related risks represent a major threat to the achievement of the Sustainable Development Goals, it is essential that governments and world leaders move forward in strengthening governance systems that take into account the occurrence and intensity of disasters.

It is important to mention that these disasters cannot be conceived of as “natural” events, but are a construction derived from the interaction of human beings with their environment in the context of insufficient risk reduction measures. Their root causes are associated with different factors including, among others, structural, developmental and growth conditions, as well as social, economic, cultural and political values that develop over time. Therefore, when the impacts of a disaster generate cascading events from one system or sector to another, as with systemic risks, inequality and pre-existing vulnerabilities amplify negative impacts (UNDRR, 2022a). In the case of Central America, according to INFORM's Natural Hazards Risk Index, countries such as Guatemala (6.7), El Salvador (6.6), Nicaragua (6.6), and Honduras (6.5) are among the 20 countries with an average natural hazards risk index of 6.6 or higher. These countries also have a high proportion of the population living below the national poverty line, which implies that they face a high disaster risk. The occurrence of these disasters can lead to income and consumption shortfalls, negatively affect well-being and cause significant human, economic and development setbacks, with long-term consequences.

The UNDRR and the International Science Council recently conducted a hazard review, definition and classification exercise, which described more than 300 types of hazards that can contribute to disasters. This classification includes common events such as storms and floods as well as less frequent events such as pandemics and chemical accidents. The above scenario is even more worrying when the impact of these natural hazards can affect industries that process, store or transport hazardous substances. These scenarios that

combine the joint occurrence of an event of natural origin with a technological accident are known as Natech (natural hazards triggered technological) accidents. Their occurrence in different countries and their short-, medium- and long-term consequences have awakened the interest of different stakeholders to manage them in an integral and holistic manner. Central America has not been immune to these scenarios and despite not having a systematic record of their occurrence, there has been evidence of impacts on the region's industries due to tropical cyclones, floods and other natural hazards.

Due to urban growth and unsustainable development in hazard-prone areas, recent decades have seen a significant increase in the exposure of both populations and infrastructure to natural hazards (Mileti, 1999; UNDRR, 2022a). It highlights the fact that industrial operations and dangerous infrastructure also constitute a risk to their territories, a characteristic that is often overlooked in many disaster situations. This exposure exacerbates the likelihood of cascading events due to the interconnectivity of systems. From this perspective, it is essential that governments are better prepared for global risks, and particularly for Natech events in areas where industrial facilities and neighbouring communities coexist in natural hazard zones. The premise of "being prepared saves lives and money" can be a motivation to strengthen disaster risk management mechanisms and tools, based on knowledge, reduction and management, in the different countries that still have opportunities for improvement. This goes hand in hand with an urgent prioritisation of progress in understanding and reducing disaster risk as a precondition for sustainable development.

Thus, this document is a first approach to understanding the Natech risks in Central America and in general terms in the entire Latin American and Caribbean region, considering its vulnerability to the effects of climate change, geological hazards, multi-hazard scenarios and its exposure to the occurrence of Natech events that may affect business continuity. A simple structure is then proposed, which first analyses the natural events that have historically impacted Central America, as well as the technological accidents reported in some international databases. This document then presents the generalities of Natech risk and some examples of impacts on industries in Latin America, and then shows some initiatives that have been developed in the region to strengthen capacities for Natech risk management. Finally, a roadmap on this issue is presented.

This document is a product of the workshop *Scenarios of technological risk and natural events in Central America. Natech risk management as a tool for disaster risk reduction* held in Honduras led by UNDRR and successfully conducted thanks to the organisation and active participation of the ARISE network in Honduras led by Fundharse, CEPREDENAC and the ARISE networks in the region (Guatemala, El Salvador, Panama, Dominican Republic and Colombia). We would also like to thank the Swiss Agency for Development and Cooperation (SDC) and the German Federal Ministry for Economic Cooperation and Development (BMZ) who contributed to the organisation and implementation of the workshop, as well as to the preparation of this document.

2. A LOOK AT TECHNOLOGICAL ACCIDENTS IN CENTRAL AMERICA

The analysis of natural events, technological accidents, major accidents or disasters worldwide is crucial to support decision-making based on lessons learned from events of different scales that have impacted and affected people, the environment and infrastructure. This information is therefore crucial for making informed disaster risk reduction decisions and strengthening disaster risk reduction systems. However, this type of detailed information on the causes, consequences, losses and damages resulting from the occurrence of an accidental event is often limited in comparison to the statistical information that a country has. This information is usually collected and organised by institutions dedicated to emergency and/or disaster response or civil protection at the national level. There are, however, global initiatives such as EM-DAT, DesInventar, the World Bank and the INFORM Natural Hazards Risk Index, which collect and provide information related to disaster impacts.

In the case of Central America, this information is especially useful for a general overview of the impact that the countries of the region have experienced due to the occurrence of accidental events of different kinds. However, it is important to recognise that these type of international databases tend to focus on disasters, underestimating the occurrence of small-scale events such as localised flooding. The latter is a consequence of the under-reporting of these events on a national scale and the thresholds applied in the global EM-DAT databases, which use a threshold that reflects medium and large-scale intensive events.

These databases have shown a moderate downward trend in the total number of people affected by disasters, i.e., the average number of people affected by disasters has decreased over the past 20 years. In the 2000s there were records of 228 million people affected, while by the 2010s this figure had fallen to just under 200 million affected (UNDRR, 2022a). Despite the above, the occurrence of extreme hurricanes such as Katrina in 2005, Sandy in 2012 and the East Japan earthquake and tsunami in 2011, highlighted the vulnerability of critical infrastructure to these hazards, leading governments to reconsider the resilience of infrastructure¹ and the impacts that can result from these scenarios far from their source of generation. They also highlighted the importance of considering the effects and impacts of climate change, associated with, for example, rising sea levels and increased frequency and severity of hurricanes, on critical infrastructure, including industrial facilities that process, store or transport hazardous materials.

2.1 Natural hazards in Central America

Risk knowledge is a fundamental element of risk management. Knowing the different hazards in our countries and regions is essential to be better prepared, to advocate for prevention and risk reduction measures in accordance with the identified risks. Thus, the identification of hazards in Central America is crucial to determine, in addition to other relevant factors for risk management in the regions, the location of industrial facilities in

hazard zones, which could be impacted and therefore compromise business continuity if an event materialises. From this perspective, the following is an overview of the hazards that have historically affected Central America. This overview is intended to give an idea of these hazards to delve further into their possible correlation with the occurrence of technological accidents and their possible causes.

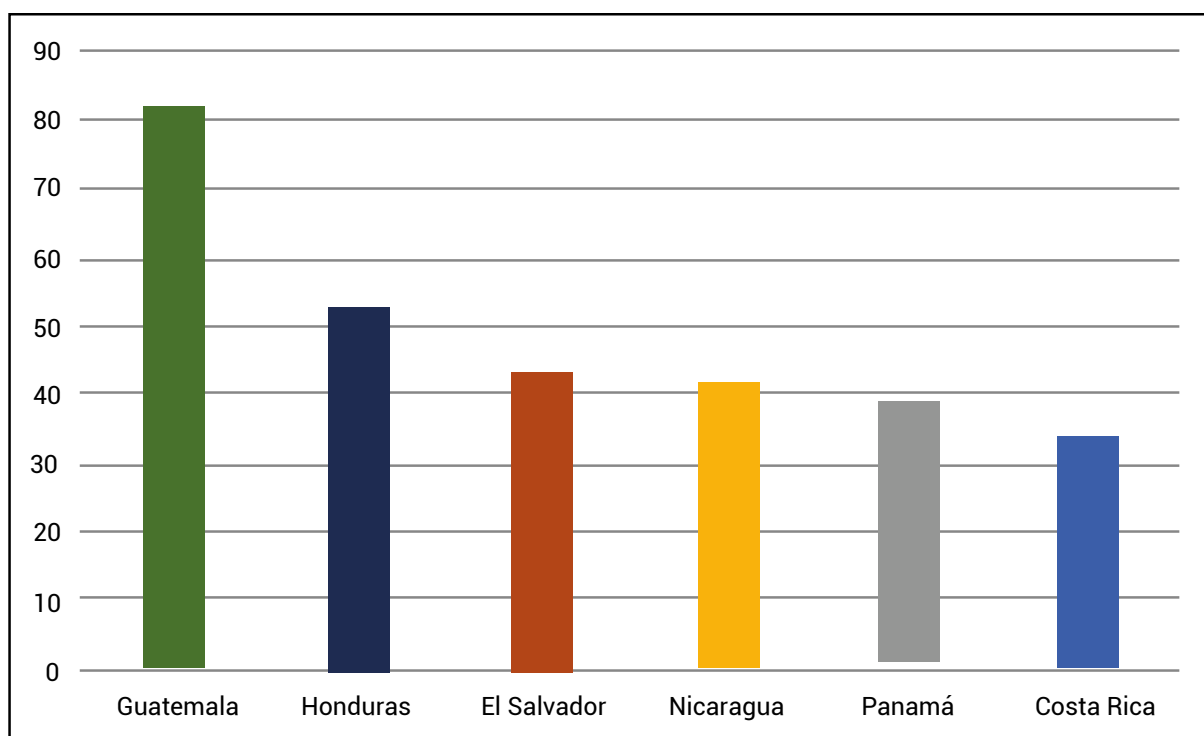


Figure 1. Number of natural events in Central America for the period 2000-2023 (Source: EM-DAT, 2023.)

According to figures from the EM-DAT database, a total of 293 events of natural origin occurred in Central America between 2000 and 2023. As shown in Figure 1, most of these events happened in Guatemala (82), followed by Honduras (53), El Salvador (43), Nicaragua (42), Panama (39), and Costa Rica

(34). Events were linked to a lesser extent to geophysical and climatological hazards, than to hydrological and meteorological hazards, as shown in Figure 2. It is important to consider the possible correlation that this type of event may have with the impacts of climate change.

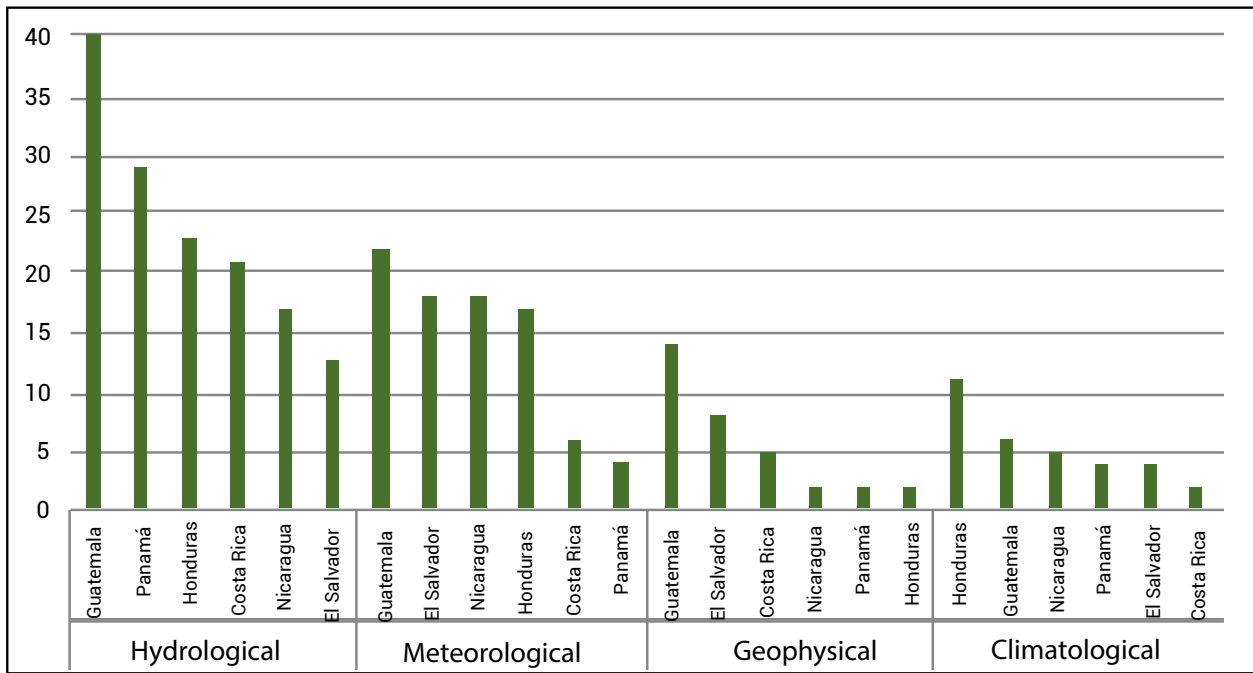


Figure 2. Number of natural events per origin for the period 2000-2023 (Source: EM-DAT, 2023.)

Likewise, Figure 3 shows the types of events, which include floods, earthquakes, droughts, storms, extreme temperatures, mass movements, volcanic activity and wildfires. A wide variety of natural events have hit Central America over the past 23 years, causing different types of damage, including injuries, fatalities, damage to infrastructure, environmental impact and economic losses. To manage this type of risk, these data is used as a basis for identifying natural hazards that

can affect industrial infrastructure in Central America.

In a more detailed view, Figure 4 shows how, out of sub-events of natural origin in the past 23 years, river flooding and tropical cyclones stand out as the main hazards threatening countries in the region (Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama).

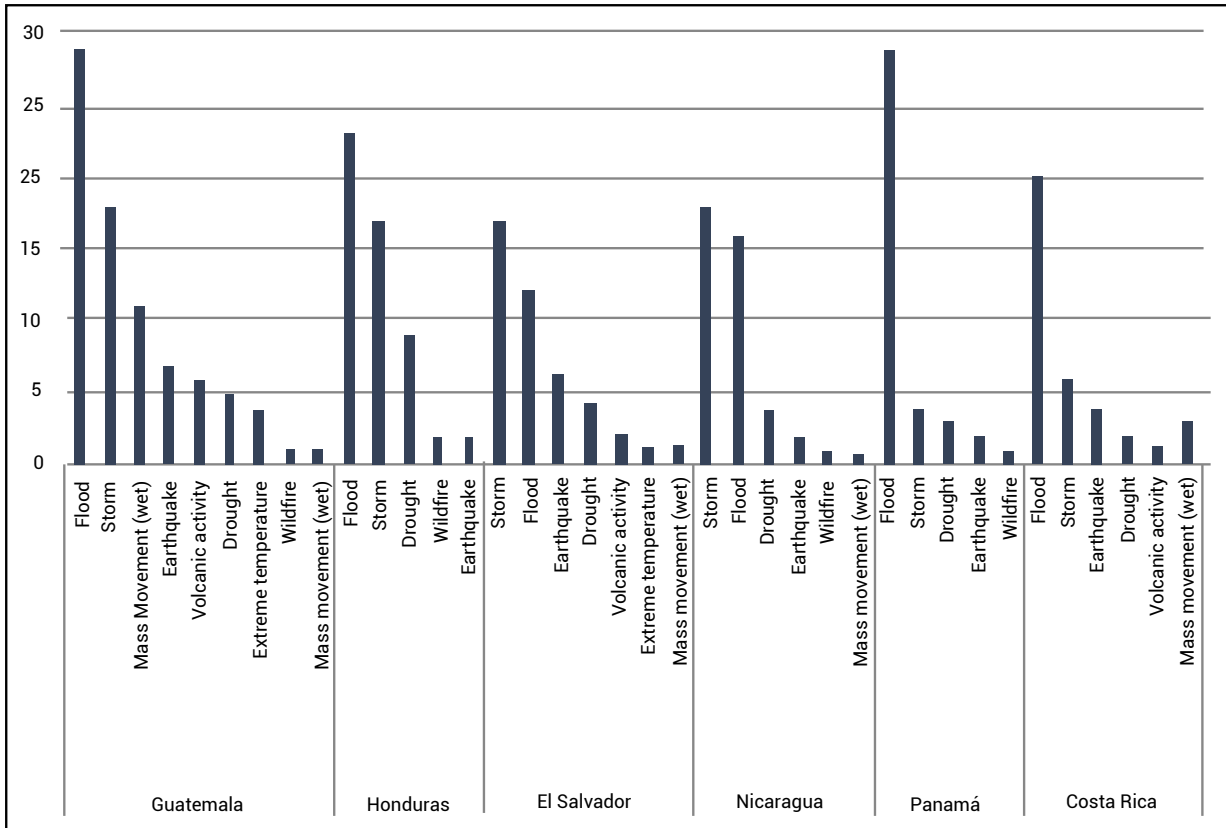


Figure 3. Types of natural events in Central America between 2000 and 2023 (Source: EM-DAT, 2023)

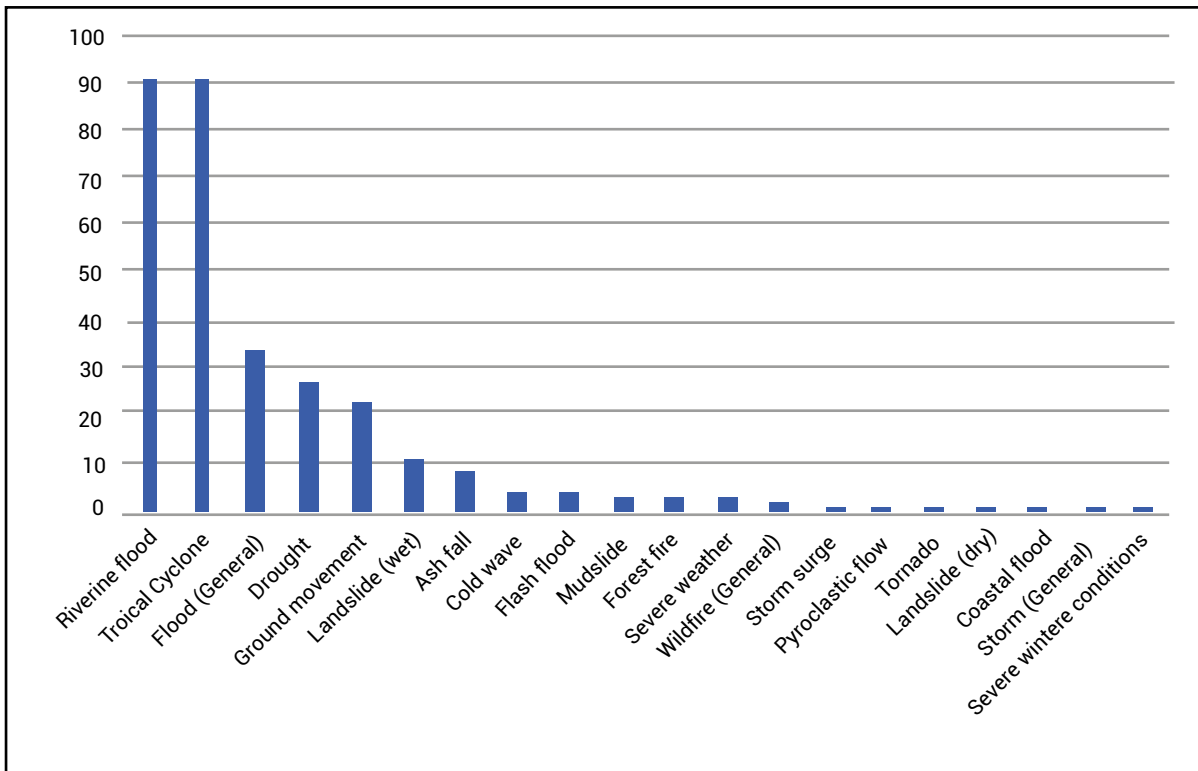


Figure 4. Types of natural sub-events in Central America between 2000 and 2023 (Source: EM-DAT, 2023)

2.2 Technological accidents in the region

Industrial facilities not only are synonymous with countries' progress and economic growth, but they also imply the existence of risks associated with the operation. In this context, risk tolerability becomes relevant, tolerable risk being the risk which one is willing to live with to get certain benefits, trusting that it can be adequately controlled (Marszal, 2001; Muñoz et al., 2014). Accidents in industry,

known as technological accidents, have also happened in Central American countries. Figure 5 shows that during the period 2000-2023, Guatemala registered the highest occurrence of technological accidents with a total of 23 reported events, followed by Honduras (13), Panamá (10), El Salvador (8), Costa Rica (5) and finally Nicaragua (4).

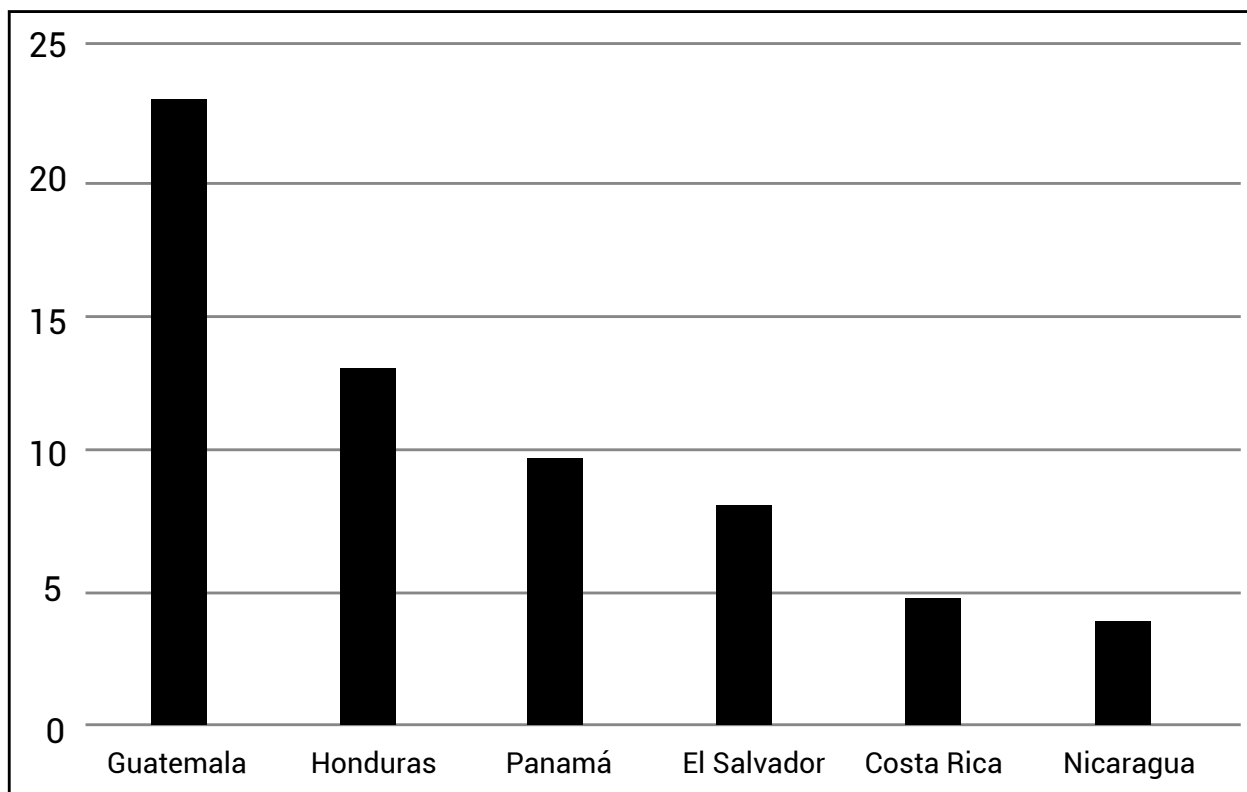


Figure 5. Number of technological accidents in Central America for the period 2000-2023 (Source: EM-DAT, 2023)

It should be noted that this accident rate may be associated with the presence of industries that store, process or transport hazardous chemicals. Therefore, it is important for each of these countries to be clear about the location of their industrial facilities, storage warehouses, hydrocarbon transport pipelines or sectors that commercialise these types of hazardous chemicals (Hazmat). On the other hand, accidents may also be associated with domestic activities involving, for example, the

use of natural gas.

A more detailed review shows that the accidents reported in the EM-DAT database refer to industrial accidents (3), miscellaneous accidents (17) and transport accidents (43). Obviously, most accidents happened in the transport sector, as shown in Figure 6. Guatemala is the country with the highest number of such events reported.

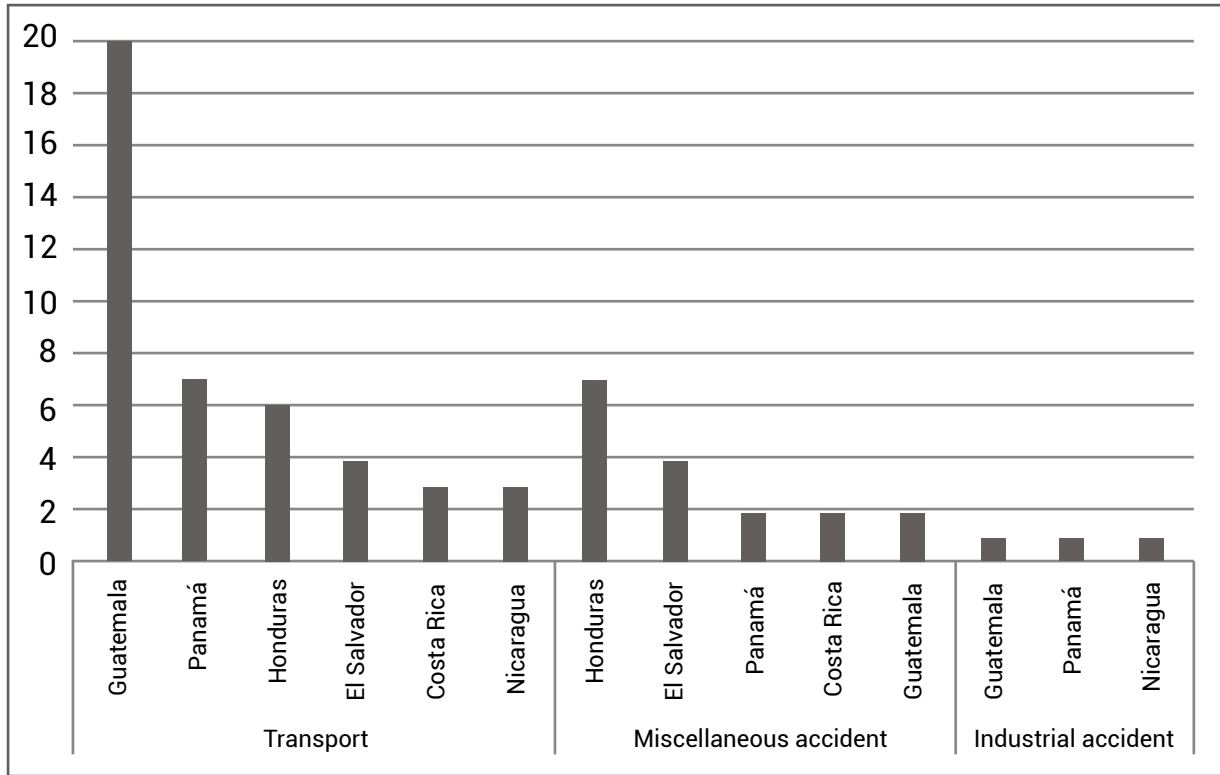


Figure 6. Classification of types of technological accidents in Central America for the period 2000-2023 (Source: EM-DAT, 2023)

Figure 7 shows the differences in the number of events of natural origin (293) and technological accidents (63) reported in the EM-DAT database for Central America. It is important to bear in mind that the total amounts of events may differ due to under-reporting of

this information in the database. Nevertheless, these figures can be a first step to understand the trends associated with the occurrence of natural events and technological accidents in the region.

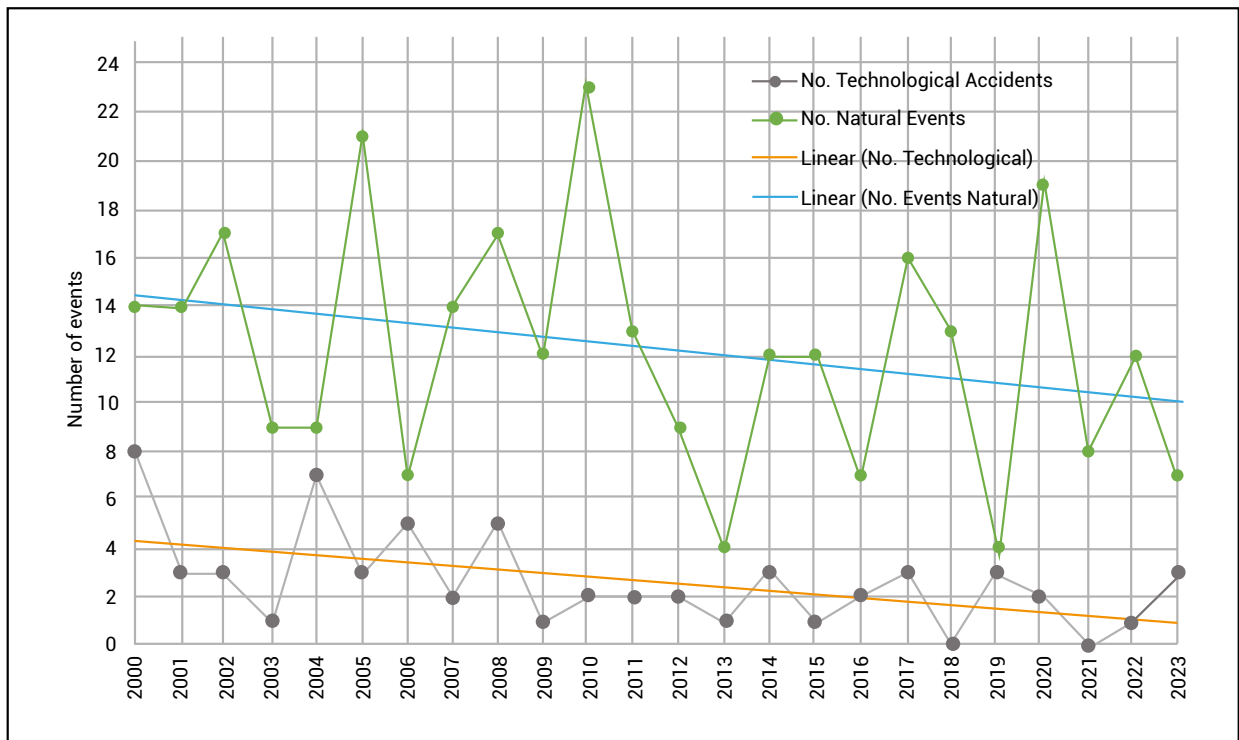


Figure 7. Trends in natural events and technological accidents in Central America for the period 2000-2023 (Source: EM-DAT, 2023)

This possible correlation is relevant when analysing the potential occurrence of Natech events in the region and their impact on industry. In summary, this overview can be

taken as a foretaste of the following section, which presents the joint occurrence of events of natural origin and technological accidents.

3. WHAT IS NATECH RISK?

The previous sections have shown figures of natural events and technological accidents that have occurred in Central America, with the aim of providing an overview and background information that can help identify areas where a natural hazard can impact industrial facilities in different countries. These scenarios in which an event of natural origin triggers a technological accident are known as Natech (*natural hazard triggered technological*) accidents (Krausmann et al., 2017; Showalter & Myers, 1994). They are

usually considered low-probability events, but the fact that they affect large areas means that their fallout can be huge, impacting not only the industrial facility that processes, stores or transports hazardous materials, but also supply lines of services such as gas, electricity, water or telecommunications, as well as the neighbouring population and the environment. These characteristics make Natech events complex scenarios that represent a challenge for response agencies and humanitarian aid.



Figure 8. General characteristics of a Natech event. (Adapted from UNGRD, 2023)

This trait, together with the characteristics listed in Figure 8, have led to Natech risks' becoming a topic of interest and concern both for nations around the world with significant industrial development and countries particularly vulnerable to climate change impact or in the face of geological hazards and even in multi-hazard scenarios. This means that some of these hazards may occur in places where they never happened before,

since climate change has been found to affect the severity and frequency of certain natural hazards, which will be more frequent in the coming decades (Luo et al., 2021; OECD, 2022). It is also important to mention that the human altering of the environment, including river diversion, digging, groundwater intensive exploitation and altering of mountain slope, has led to new risks.

Table 1. Classification of hazards that trigger Natech events. (Adapted from Cruz & Suárez-Paba, 2019)

Group	Natural phenomenon
Geological hazards	Earthquake
	Volcanic eruption
	Tsunami
Hydrometeorological hazards	Storms
	Tropical cyclones
	Hailstorms
	Gales
	Lightning storms
	Extreme temperatures
Socio-natural hazards	Floods
	Mass movements
	Torrential floods
Multiple and cross-cutting hazards	

Natech risk does not usually follow a standardised classification. However, these events can be grouped according to the triggering natural hazard, i.e. into 1) geological hazards, 2) hydrometeorological hazards, 3) socio-natural hazards and 4) multiple and cross-cutting hazards for Natech can also mean multi-hazard events (Cruz & Suárez-Paba, 2019). Table 1 shows this grouping for reference.

As shown, Natech events can be triggered by any type of natural hazard (earthquakes, tsunamis, floods, mass movements, volcanic eruptions, tropical cyclones and even lightning) generating the release of hazardous chemicals and energy that, in turn, can trigger fires, explosions, toxic clouds and contamination of ecosystems, as well as domino effects. Their dynamics are presented in Figure 9.

Illustrating the magnitude of the consequences of a Natech event, the floods in Thailand in 2011 affected 66 of the country's 77 provinces. Flooding affected industrial parks around Bangkok with a high concentration of production plants, where government incentives had promoted the industrial growth of an area located on a flood-prone delta. 70% of the total losses of the 2011 floods were in the manufacturing sector, generating cascading effects on the country's economy, as this industry accounted for about 40% of GDP (UNDRR, 2022a).

In this sense, it is important to point out that impacts on industrial operations and hazardous infrastructure are a recurring but often overlooked feature in many disaster situations (Necci & Krausmann, 2022). Therefore, their inclusion in disaster risk management systems is essential to strengthen disaster risk awareness, reduction and response mechanisms.

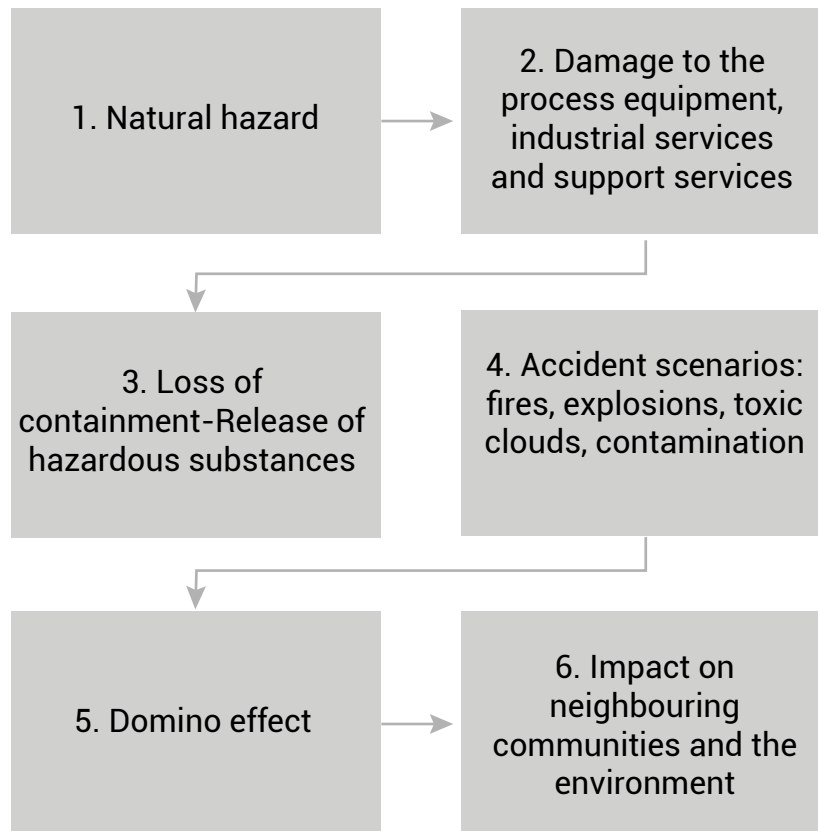


Figure 9. Dynamics of Natech events

3.1 Natech events in Latin America

The impacts of Hurricanes Katrina and Rita in 2005 wreaked havoc on offshore oil and gas infrastructure in the Gulf of Mexico. Subsequently, two Natech events in 2011 arising from the earthquake and tsunami in eastern Japan affected the nuclear plant in Fukushima and an oil refinery in Chiba prefecture. In the same year, damage was caused to industrial parks in Thailand during the 2011 floods. And in 2012, the effects of Hurricane Sandy caused multiple hydrocarbon spills and wastewater discharges. This is how these Natech events established a record in the number of large-scale natural events that generated unprecedented damage to industrial facilities and other infrastructure (Krausmann et al., 2017).

Also, in recent years several studies have confirmed an increase in the recording

and reporting of these types of events in international databases (Kiyohara, 2016; Krausmann et al., 2011; Luo et al., 2020; Sengul et al., 2012), being meteorological hazards the main triggers of Natech events (Ricci et al., 2021). However, there is only one global database exclusively dedicated to the collection of Natech accidents data. This database, called *eNatech*, has a total of 79 records to date, with events occurring at various latitudes (eNatech, 2021). In Latin America, 15 Natech events were reported between 1998 and 2023, affecting countries such as Ecuador, Chile, Argentina, Mexico, Peru and Cuba. Associated causes include lightning, landslides, floods, earthquakes, tsunamis, mudslides and heavy rains. Table 2 shows some examples of these events.

Table 2 . Some Natech events in Latin America (Source: eNatech, 2021)

Country	Year	Event of natural origin	Type of equipment/industry concerned
Ecuador	1998	Landslide	Trans-Ecuadorian Pipeline
Chile	2010	Earthquake	Bio-Bio Oil Refinery National Petroleum Company
Argentina	2013	Storm, rain and floods	Refinery rainwater harvesting tank
Mexico	2017	Flooding due to Tropical Storm Calvin	Antonio Dovali Jaime refinery (a.k.a. Salina Cruz) PEMEX
Cuba	2022	Storm and lightning	Atmospheric storage tank at CUPET State Oil Storage Terminal
Peru	2022	Tsunami triggered by Tonga volcanic eruption	Barrels of oil at Repsol, Refinería La Pampilla S.A.A.

As can be seen, there are no records of Natech events in Central America. This may be due to various factors, including, among others, under-reporting, lack of knowledge of this type of events, lack of robust systems to collect data at the national level once the event has occurred, lack of awareness of this type of risk, and the need to collect data to strengthen the lessons learned. This is why we decided to look into the possible impact of natural events on industry in Central America. In this regard, some examples have been found of the effects on the Honduran industry, such as what occurred during Hurricane Mitch in 1998, where heavy rains caused flooding in several landfills, releasing agricultural chemicals into the environment (WHO, 2019).

On 3rd November 2020, Category-4 Hurricane Eta brought torrential rains and winds of up to 275 km/h to northern Honduras, causing rising river levels, flooding and landslides in the country. Later that year, on 16th November, Category-5 Hurricane Iota downgraded to a tropical depression following much the same

path as Eta, causing even more flooding and wind damage as shown in Figure 10. This resulted in 200 fatalities, dozens of people missing, thousands displaced, destruction of homes, property, bridges, roads, crops, factories, etc. (BBC News World, 2020). Also, loss of productive assets and crops, damage to production areas and supplies, and depletion of food stocks (ReliefWeb, 2021). Overall, losses of more than 15 billion US dollars were reported, according to ECLAC and other government agencies (BBC News World, 2020). Due to these impacts, Hurricanes Eta and Iota were considered the most severe natural phenomenon to affect Honduras in more than 20 years.

The assessment of the effects and impacts of tropical storm Eta and hurricane Iota in Honduras found that they had a negative impact on the sales of manufacturing and commerce establishments in the country.



Flooding at San Pedro Sula airport

Disruption in power supply networks



Figure 10. Hurricanes Eta's & Iota's impact on industry

According to IDB and ECLAC figures, estimated damage amounts to \$USD 314.87 million, corresponding to damage to infrastructure, machinery, equipment, inventory and transport. Regarding manufacturing industries, reported losses amount to \$USD 312.81 million. Additional costs are estimated at \$USD 4.68 million and are mainly associated with clean-up, debris removal and the use of electricity generating plants (IDB & ECLAC, 2021). Between 2016 and 2019, the manufacturing industry in Honduras consisted of 10,587 establishments nationwide, 98% of which were MSMEs. The

main productive activities of the sector include manufacturing of starches and starch-derived products (15.4%), manufacturing of bakery products (11%), manufacturing of carpentry parts and pieces for buildings (10.7%), manufacturing of garments, except leather (8.4%), manufacture of concrete, cement and plaster products (6.6%), manufacture of metal products for structural use (6%), manufacture of furniture (5.6%) and manufacture of mill products (4.7%), which together account for 68.4% of establishments in the sector (IDB & ECLAC, 2021).

4. WHY IS NATECH RISK MANAGEMENT IMPORTANT?

The Natech events that have occurred in the world throughout history have shown that a better understanding, awareness and preparedness of such scenarios are essential to prevent and/or mitigate their consequences, as these three aspects are crucial to successfully counteract their effects. Thus, Natech risk management is a vital tool to strengthen resilience against these risks. Despite initiatives at the global level (ILO Convention 174, European Directive Seveso-III, OECD's Guiding Principles for Chemical Accident Prevention, Preparedness and Response, and the Sendai Framework for Disaster Risk Reduction 2015-2030, among others) that urge industries that process, store and transport hazardous chemicals to implement effective safety measures in the face of these scenarios, chemical accident preparedness and prevention programmes tend to ignore specific aspects associated with the Natech risk (UNGRD, 2023).

The regulations of some countries, taking these initiatives as a reference, require industrial facilities to identify existing hazards and propose risk reduction measures, both during normal operation and in accident situations, as part of the analysis and assessment of the different risks to which they are exposed. In this sense, the potential impacts of natural hazards are generally taken into account to a certain extent in the design and construction of facilities, through compliance with specific codes and standards (Krausmann et al., 2017). However, to reduce Natech risk it is necessary not only to preserve the structural integrity of process equipment, but also to avoid loss of containment (LOC) of hazardous materials. It is therefore crucial that an industrial facility's risk management plans address the direct impacts of natural hazards on its operation.

In this context, Natech risk management is crucial due to its comprehensive and holistic planning nature to effectively manage

complex intersectoral, multi-disciplinary and multi-stakeholder risks. It requires both risk awareness and risk reduction measures as well as disaster management and/or emergency response from both a physical

and administrative point of view. To this end, Natech risk management is based on ISO 31000:2018 and sets out the elements that comprise it, according to Figure 11.

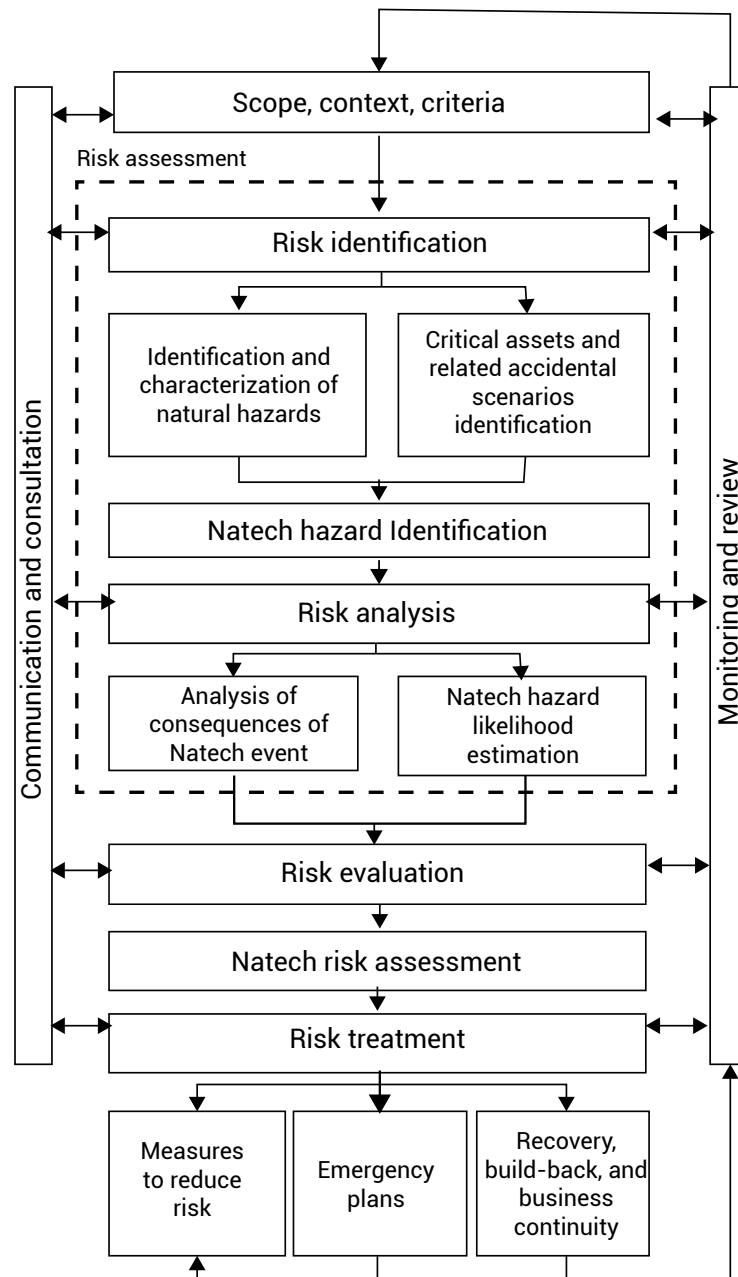


Figure 11. Natech risk management based on ISO 31000:2018 (Adapted from Necci & Krausmann, 2022).

As shown in Figure 11, in order to adapt the conventional approaches to industrial risk analysis, Natech risk assessment requires taking into account its specific characteristics, which were presented in Figure 8 and Figure 9. Thus, based on the structure of the international standard ISO 31000:2018, managing these risks starts by identifying representative Natech scenarios which contemplate the impact of specific natural hazards on a specific facility. In addition, to assess the extent of the potential damage and its consequences, the Natech accident scenarios analysed must consider a natural hazard, the resulting damage or disruption

to potentially affected industrial facilities and the occurrence of a critical event such as the loss of containment of a hazardous chemical (Necci & Krausmann, 2022).

Obviously, Natech risk assessments require a large amount of input data, including information on the natural hazard, vulnerable equipment, damage models and data linking those damages to releases of hazardous substances, probability estimates, consequence analysis models, and information on risk receptors (Krausmann et al., 2017).

5. CAPACITY BUILDING INITIATIVES IN THE REGION

Natech events, as previously mentioned, are categorised as low probability events, but of extremely high consequences due to the effects they usually cause in the impacted environments. For this reason, Natech events are often considered catastrophic events and/or disaster scenarios. Despite the above, recent history has shown that even events of natural origin that were considered “minor”, such as lightning and electric shocks, may also trigger major technological accidents. A clear example of this happened in Cuba in 2022, where lightning struck a crude oil storage tank (at 50% of its capacity) at the tanker base in Matanzas Bay. Due to the lightning strike, the storage tank caught fire and subsequently exploded, generating a domino effect on a neighbouring tank, which, hours after the explosion of Tank 1, exploded due to the spread of the fire (eNatech, 2021).

This and other Natech events around the world highlight the need for better preparedness and therefore better resilience to disasters, to reduce the number of people affected, the

impacts on the ecosystems and the associated economic losses, whose repercussions are not only felt by the industries directly affected, but also lead to indirect impacts in the whole of the countries affected. Joint efforts are therefore required to address the root causes of disasters, through a commitment by all stakeholders, i.e., a political, industrial and social commitment. As stated in the Global Assessment Report 2022 (GAR2022) on disaster risk reduction, “the present and future dimensions of vulnerability, exposure and hazards of communities, sectors and systems are intertwined with the modes of governance and development planning in each geographic area, whether national, regional or local” (UNDRR, 2022a).

Taking this scenario into account, in a joint effort of the United Nations Office for Disaster Risk Reduction, the Honduran Foundation for Corporate Social Responsibility (Fundahrse) and the Coordination Centre for Disaster Prevention in Central America and the Dominican Republic (CEPREDENAC), on

31 October 2023 the workshop “Scenarios of technological risk and natural events in Central America: Natech risk management as a tool for disaster risk reduction” was held in San Pedro Sula, Honduras.

This workshop was part of the activities prior to the Regional Meeting “25 years after Hurricane Mitch” and addressed the importance of Natech risk management in Central America, a region historically vulnerable to natural hazards. This workshop was a first call to conceptualise and highlight the Natech risk that not only affects businesses but can potentially impact communities and the environment.

An initiative to encourage multidisciplinary and multi-stakeholder involvement (see Figure 12), the workshop was attended by representatives of companies that handle, store, process and/or transport hazardous chemicals and/or energy; officers in charge of process safety and disaster risk management; representatives of national disaster risk reduction systems; CEPREDENAC’s Council of Representatives, academia and other civil society stakeholders. Their engagement was spurred through a participatory exercise where attendees exchanged their insights, knowledge and ideas around Natech risk.



Figure 12. Images of active participation during the Natech workshop in Honduras

As a result of this participatory event, participants highlighted the importance of organising workshops, networking, and activities to increase Natech risk awareness in the region. They also mentioned the importance of collaborative work leading to a comprehensive and robust management of Natech risk in Central America.

Likewise, a commitment was announced to set up public-private partnerships between the Central American countries' and the

Dominican Republic's national systems and the ARISE networks, led by Integrarse network members. The workshop was deemed a valuable tool to put together the needs and capacities of companies and systems with a shared goal, and it highlighted the fact that to reduce Natech risk, coordination between companies that are aware of their processes and risks and know the territory where they operate, and the national and local authorities is paramount.

6 ■ ROADMAP FOR IMPROVING NATECH RISK MANAGEMENT IN CENTRAL AMERICA

One of the first aspects to enrich Natech risk management in the Latin American and Caribbean region is the capacity building, so that both the public and private sectors understand the risks present in dangerous facilities, have knowledge about chemical safety and industrial processes. The above, associated with its relationship with natural hazards and Natech risks. That is how increased awareness of the Natech risk and the understanding of the accident dynamics that can lead to the occurrence of short-, medium- and long-term effects are essential elements for the consolidation of a management system for these risks in Central America. From this perspective, the roadmap for improving Natech risk management in the region should be based on a conceptualisation and understanding of these risks and an internalisation of the importance of their inclusion in the management systems of both the private and public sectors. Likewise, the roadmap must conceive multi-hazard early warning systems, monitoring processes, forecasting and prediction, communication and preparedness activities, as essential tools so that communities, governments, and companies can take timely measures to reduce

disaster risk before dangerous events occur. From the private sector point of view, operators are usually required to submit a security report to national authorities to prove that they have included natural hazards in their risk analysis and assessment and have taken all relevant preventive measures. From the public sector point of view, the characterisation of natural hazards on the territory and the provision of this information to the companies is essential to be able to conduct the risk analysis.

However, understanding these complex risks requires investment in data and the development of analyses. Collecting information and data associated with the occurrence of these events feeds the development of measures, practices and policies based on history and lessons learned. It also enables the development of risk management mechanisms based on experience and supports informed decision making, so that Natech risk management systems in the region are strengthened.

To this purpose, a paradigm shift in Natech risk management could be considered, leading to a holistic approach, with an area-

wide perspective that contemplates the correlation between industrial facilities and their environment. This way, interaction between stakeholders (industry, governments, community and academia) could be fostered, with the ultimate goal of having better prepared and more resilient societies and industries (Suárez-Paba & Cruz, 2022). Also, it is worth noting that labor, environmental, and urban planning risk authorities, among others, must be articulated, given that Natech risk management cannot remain solely at the head of national DRM systems. The inclusion of the community as a stakeholder responds to one of the six Guiding Principles of the United Nations Sustainable Development Cooperation Framework, “Leaving no one behind.” This principle represents the commitment of all United Nations Member States to a) eradicate poverty in all its forms, b) end discrimination and exclusion and c) reduce inequalities and vulnerabilities that leave people behind and undermine the potential of individuals and of humanity as a whole.

It would be set within a strategy framework that addresses Natech risk resilience from an

area-wide perspective, that is: an approach that considers population growth and industrialisation in areas exposed to natural hazard impacts as crucial elements to be included in management strategies. Thus, effectively addressing Natech risk requires an analysis scope that covers scenarios beyond industrial facilities’ barriers, as well as the roles, contributions and interactions of all stakeholders involved in the whole Natech risk scenario, from both a proactive and reactive perspective (Suarez-Paba et al., 2020).

As a starting point, the comprehensive Natech risk management framework shown in Figure 13 can be used as a reference. The framework was proposed by researchers at Kyoto University, and considers the interaction between technical and organisational systems, governance, risk communication and community participation (Suárez-Paba & Cruz, 2022). This comprehensive framework seeks to improve the resilience of industries to Natech events by assessing the performance of industrial facilities in industrial parks, considering the broader social and environmental context.



Figure 13. Key elements to consider in the Natech risk management framework: Adapted from the Natech RateME Framework (Suárez-Paba & Cruz, 2022)

To achieve the implementation of these initiatives, a systematic and permanent process must be conducted so that Natech risk knowledge is enriched and allows measures and strategies to be proposed to reduce these types of risks and to manage them when they happen. Therefore, the Natech RateME framework² must also go hand in hand with government strategies that incorporate this type of risks in their

management. In this sense, there are some initiatives in Latin America to incorporate Natech risk into disaster risk management. One example is the initiative developed by Colombia, where a Natech risk management plan was recently proposed, as shown in Figure 14. This plan can serve as a foundation for developing and building similar initiatives throughout Central America.

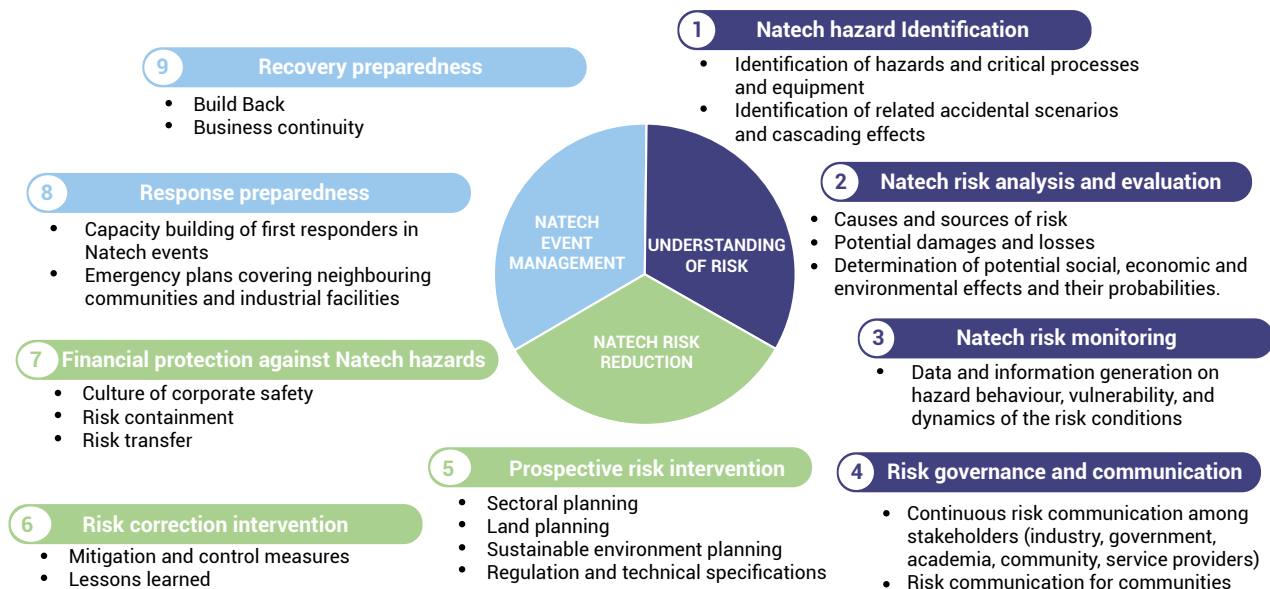


Figure 14. Natech risk management for Colombia. (Adapted from UNGRD, 2023)

2 Suárez-Paba, M. C., & Cruz, A. M. (2022). A paradigm shift in Natech risk management: Development of a rating system framework for evaluating the performance of industry. *Journal of Loss Prevention in the Process Industries*, Vol. 74, 104615. <https://doi.org/https://doi.org/10.1016/j.jlp.2021.104615>

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