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IFRC

TECHNOLOGICAL & BIOLOGICAL HAZARD (CBRN[1]) PREPAREDNESS

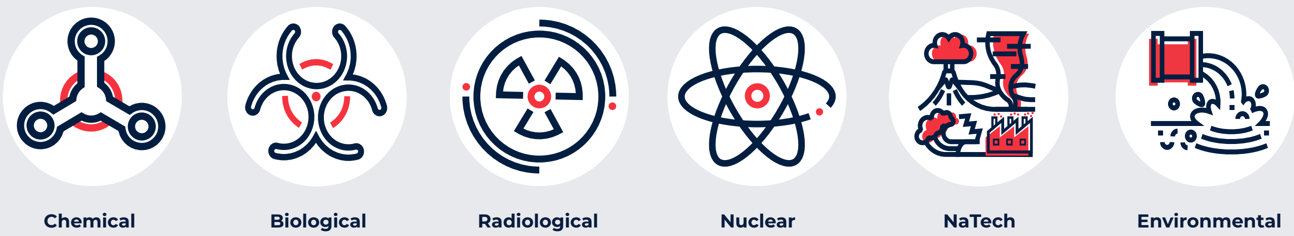
Background information

Draft for consultation*
October 2020

INTERNAL USE

*** This draft Background Information document is intended for internal use within the IFRC. It complements a Roadmap document which provides an overview and recommendations on this issue.***

TECHNOLOGICAL AND BIOLOGICAL (CBRN) HAZARD PREPAREDNESS PROGRAMME



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Overview

This document provides additional background information to complement the ***'IFRC Roadmap on Technological and Biological (CBRN) Hazard Preparedness - Towards 2030: An enhanced multi-hazard approach***', (October 2020).

Taken together, these documents invite National Societies and the IFRC Secretariat to reflect on the current status of Red Cross Red Crescent preparedness to meet emergencies in a multi-hazard environment – and how to move from the current focus on natural and climate-induced hazards to one which incorporates a wider range of hazards, and more specifically those linked to technological and biological (CBRN) disasters.

As stated by the UN's Office for Disaster Risk Reduction [2]: "There is an urgent need to investigate further the direct and indirect linkages and effects of natural, biological, technological and other human-induced hazards to identify better and understand cascading and complex hazards and risks in a systematic way."

"" (...) The successful reduction of disaster risk emerging from man-made and technological hazards can only be achieved when the risk is comprehensively understood, acknowledged and addressed through a multi-hazard, multi-stakeholder and fully integrated approach."

Words into Action Guidelines, Implementation Guide for Man-made and Technological Hazards, UNISDR 2020 (p.10)

1. *CBRN is the commonly used acronym for Chemical, Biological, Radiological and Nuclear hazards.*
2. *'Asia-Pacific Framework for NATECH Risk Management', UNDRR 2020 (p.8)*

I. Multi-hazard Risk Management

© Genoa Bridge Collapse. Italian Red Cross, 2018

The UN's Sendai Framework for Disaster Risk Reduction (2015-2030) expanded the traditional scope of disaster risk reduction by adding a range of other hazards, which specifically includes man-made hazards and related environmental, technological and biological hazards and risks. By taking a "multi-hazard approach", it provides a major opportunity to integrate man-made hazards into the overall DRR agenda. As stated by UNDRR: **"In practical terms, and at all geographic levels, man-made hazards can and should be included in ongoing DRR activities"** [3].

There has also been a growing recognition within the IFRC – particularly following the Fukushima disaster of 2011 - of the need to incorporate technological and CBRN hazards into its disaster management remit. Furthermore, the complexities associated with increased urbanization and the effects of climate change have in turn hastened the adoption of a multi-hazard approach. Yet, despite this, there remains **a lack of understanding and buy-in within the organization** with regard to technological and biological (CBRN) hazards, and there is some way to go before this area is fully integrated into IFRC policies, programmes and activities.

3. *Words into Action Guidelines: Implementation Guide for Man-made and Technological Hazards, UNISDR, 2020 (p.50).*

Hence the recommendations presented in the **'Roadmap for Technological and Biological (CBRN) Hazard Preparedness – Towards 2030: An enhanced multi-hazard approach**' (October 2020), which accompanies this document. The overall aim is to ensure that we have the necessary knowledge and expertise to respond to any kind of emergency - no matter how new, large, unexpected, or technologically complicated. As a next step, the Roadmap recommends developing a five-year plan of action, so that technological and biological (CBRN) hazards are fully incorporated into IFRC's multi-hazard approach to disaster risk reduction, response and recovery, at all levels and across all sectors and regions.

Multi-hazard approach

What exactly do we mean, when we speak of a **multi-hazard approach to disaster management in the context of technological and biological (CBRN) hazards?** Specifically, we are referring to:

- Different hazardous events threatening the same exposed elements (with or without temporal coincidence).
- Hazardous events occurring at the same time or shortly following each other (compound and/or cascade effects), known as NATECH events.
- The totality of relevant hazards in a defined geographical area and their interrelations.

The approach determines overall risk based on multiple hazards (including natural, technological, health, economic, ecological, social, etc.), and takes into account potential hazard and vulnerability interactions.

II. Technological and Biological (CBRN) Hazards - Terminology

© *Fukushima Nuclear Disaster. Japanese Red Cross, 2011*

It is important to understand exactly what we mean by technological and biological (CBRN) hazards. The terminology can be complicated and confusing, with some variations across organizations. It is perhaps easiest to define this area by contrasting it to what it is not. The distinction we are making is one between natural hazards and so-called 'man-made hazards' – although of course, in real life events are never that simple. Indeed, natural hazards may provoke technological ones, causing compound or cascading disasters, as occurred for example in Japan in 2011.

The immediate question is why make such a distinction and how does it impact the IFRC and National Societies? The quick answer is that it is relevant to the way in which we work – requiring some adaptation to our preparedness, response and recovery strategies, so that we are fit for purpose. Perhaps most crucially, it is also relevant if we are to ensure the safety of those most immediately involved – the victims of the disaster. Furthermore, RCRC staff and volunteers need to have sufficient awareness of the hazards involved, and the necessary protocols and equipment for responding to disasters in potentially contaminated environments.

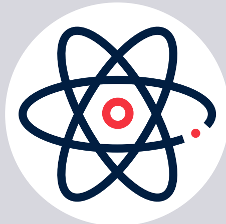
GENERAL DEFINITIONS

Briefly, **man-made hazards** are defined as those “induced entirely or predominantly by human activities and choices” [4]. **Technological hazards** are a subset of man-made hazards, and include events such as industrial spills, transport accidents, or factory explosions. Technological hazards may also arise directly from the impacts of a natural event. A technological accident caused by a natural hazard is known as a **NATECH** event.

The acronym **CBRN** refers broadly to chemical, biological, radiological, and nuclear hazards.


CHEMICAL


RADIOLOGICAL


NUCLEAR

Chemical, radiological, and nuclear hazards (including transport hazards) are defined as those which originate from technological or industrial conditions, dangerous procedures, infrastructure failures or specific human activities. Examples include industrial pollution, release of ionizing radiation, toxic waste, dam failures, fires, and chemical spills.

Biological hazards, on the other hand, originate from natural sources such as bacteria, viruses, fungi, and parasites. Exposure in sufficient quantities and over a given duration may result in illness or injury to human health, and this can happen either through natural exposure, or via the release (intentional or unintentional) of micro-organisms.

Another distinction being made is that relating to **environmental hazards.** These can be due to environmental degradation, physical or chemical pollution, and may affect the air, water and/or soil. However, many of the processes and phenomena that fall into this category may be termed ‘drivers of hazard and risk’ (such as soil degradation, deforestation, loss of biodiversity, salinization, and rises in sea-level), rather than hazards per se.

4. *UN Office for Disaster Risk Reduction (UNISDR). The term is very broad, and includes conventional industrial accidents such as oil spills, dam ruptures, fires etc. Although technological hazards can be used in conflict situations and for adverse purposes, the term relates primarily to non-deliberate events, as other terminology exists to describe deliberate acts.*

WHY THESE DISTINCTIONS ARE IMPORTANT

Technological and biological (CBRN) emergencies generally involve the use and dispersal of explosives, flammable and combustible substances, poisons, and radioactive materials. Hazards can occur during the production, storage, transportation, use or disposal of such materials, and they are therefore referred to as **hazardous materials**, or **HazMats**.

HazMats

Acronym for hazardous materials. HazMats (also referred to as dangerous/ hazardous substances or goods), are solids, liquids, or gases that can harm people, other living organisms, property, or the environment. They not only include materials that are toxic, radioactive, flammable, explosive, corrosive, oxidizers, asphyxiates, biohazards, pathogen or allergen substances and organisms, but also materials with physical conditions or other characteristics that render them hazardous in specific circumstances, such as compressed gases and liquids, or hot/cold materials [5].

© Environmental sampling. German Red Cross, 2019

5. *Fire and Rescue Service Operational Guidance – Incidents involving hazardous materials, UK Department for Communities and Local Government – Chief Fire & Rescue Adviser (CFRA); 2012*

It is true that technologies generally come with risks. However, many of these may be considered acceptable by governments and consumers. As an example, air travel is part of everyday life and considered to be one of the safest methods of transportation. When accidents do occur, authorities undertake in-depth analyses intended to lead to enhanced preparedness for future events.

Technical advances together with improvements in national regulatory frameworks aim to address this delicate balance of acceptable risk versus consequences. This is also the aim of multi-hazard disaster risk assessment and preparedness.

CBRN Emergencies

CBRN emergencies involve hazardous materials, either naturally occurring or artificially produced, which can have significant adverse effects on human health, including severe illness and death, depending on the nature of the agent and the circumstances of exposure.

The umbrella term CBRN is commonly used because there are distinct similarities between these hazards, making some of the emergency preparedness, response, and recovery measures common (or very similar) for all of them, involving:

1. A need for **specialised training and equipment** to assess the danger and protect responding staff and volunteers.
2. A **narrow timeframe** in which to administer lifesaving intervention/treatment.
3. **Longer-term psychosocial support and medical follow-up** for the affected population and responders.

Although the probability of large-scale technological and biological (CBRN) disasters is generally low, their potential impact is high - on humans, the environment, infrastructure, and the economy of specific areas, or indeed of a whole country or region. Furthermore, smaller-scale and localized technological and CBRN disasters, even if more limited in impact, are occurring with increased frequency, due to accelerating industrialization throughout the world.

Many national and local authorities are now developing frameworks for multi-risk governance. As an auxiliary to national authorities, this is of particular relevance to the RCRC, and underlines the importance of incorporating technological and biological (CBRN) disaster preparedness, response and recovery measures at all levels within IFRC.

TYPES OF EMERGENCIES LINKED TO CBRN AGENTS

CBRN agents differ in their physical and chemical nature, their origin, and their properties. There are also significant differences in the type of injury or illness they produce, and the period of time involved between exposure and the appearance of signs and symptoms.

CHEMICAL AGENTS

© Oil spill. Mauritius Red Cross, 2020

HAZARD

Chemical hazards [6] refer to chemical elements and compounds either in their natural or processed states (including by-products), and which may lead to illness or injury if exposure is in sufficient quantities and duration.

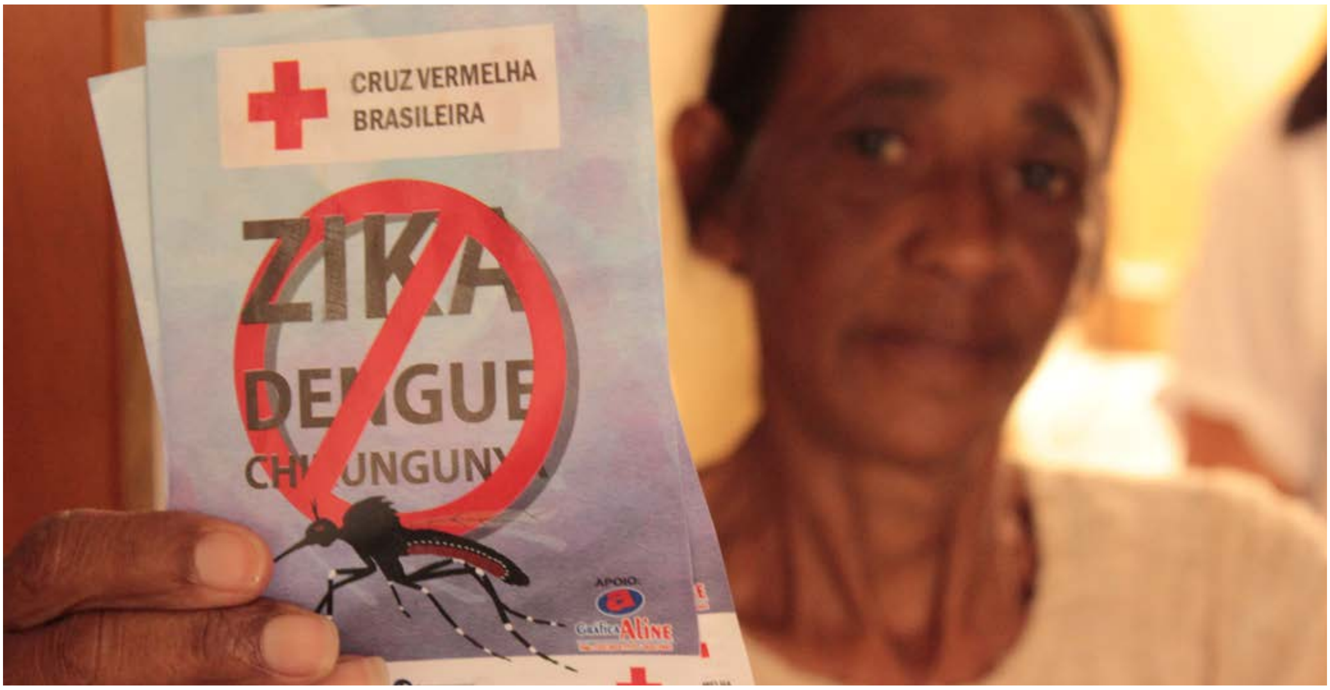
EMERGENCY

A chemical emergency is defined as "any unplanned event involving hazardous substances that cause or are liable to cause harm to health, the environment or property, such as accidental release of hazardous substances, explosions, and fires. [7]". While earthquakes, hurricanes, tsunamis and typhoons are typically much greater in both geographic extent and magnitude, the impact at local level of a chemical or industrial accident can be just as significant for the surrounding community, and may also lead to substantial contamination with a long-term impact on the environment and livelihoods.

6. *Note: Although it is prohibited by international law to use chemicals for warfare, some chemical weapons programmes still exist. For more information about the Chemical Weapons Convention, please see https://www.opcw.org/chemical-weapons-convention/*

7. *OECD Guiding Principles on Chemical Accidents Preparedness, Prevention and Response, 2003*

BIOLOGICAL AGENTS



© Information campaign on the spread of Zika virus. Brazilian Red Cross, 2'016

HAZARD

Biological hazards (or biohazards) include bacteria, viruses, fungi, and parasites (or parts thereof), and their by-products. Exposure in sufficient quantities and duration may result in illness or injury to human health. It is impossible to eliminate the risk from thousands of different pathogens (smallpox being one notable exception), however risk reduction measures have achieved a degree of control in many developed countries, coupled with active measures to reduce the risk of spread globally. A sub-set of pathogens, such as influenza, can cause large epidemics or even pandemics, affecting both animals and people (COVID-19 being a stark example).

EMERGENCY

Biological emergencies can occur when there is a major epidemic outbreak of disease (e.g. Avian influenza, Severe Acute Respiratory Syndrome (SARS), Middle East Respiratory Syndrome (MERS), COVID-19, etc.). These are caused by plant or animal contagion, insect bites, other animal plagues and infestations, or human-to-human transmission. These can be limited by geography (e.g. island communities), the presence of necessary vector controls (e.g. for dengue and malaria) or via active measures taken by health authorities in prevention, early detection and response. Unlike many natural hazards, pathogens move when animals or people move. For example, SARS was initially spread within hospitals and through health workers, and then via international travel.

RADIOLOGICAL AND NUCLEAR AGENTS

© Mobile medical laboratory providing free thyroid and breast screenings for communities in Belarus most affected by the Chernobyl accident. IFRC, 2016

HAZARD

Nuclear and radiological hazards are characterized by their ability to release ionizing radiation which, in sufficiently high doses, is hazardous to humans and most other living organisms, and has a devastating impact on the environment.

EMERGENCY

Radiological emergencies can involve a range of sources of radiation (e.g. radiography machines, radioactive material for use in industry, lost equipment, etc.). Radiological accidents are usually not mass-casualty events, as they commonly occur when people are irradiated by misplaced or misused radioactive equipment. They can however cause widespread fear within the population, as occurred in Goiania, Brazil (1987), where 10% of the population subsequently requested screening.

Nuclear emergencies involve or emerge from nuclear chain reactions. Such chain reactions normally take place under controlled circumstances, for instance in nuclear power plants and research reactors. Nuclear chain reactions can also occur in an uncontrolled manner in nuclear weapons, creating the enormous blast and heat effects associated with nuclear detonations. An emergency occurs for example when multiple physical (e.g. containment structures, cooling systems, etc.) and systemic safety measures fail, and radiation is released from a reactor core to the external environment.

LINK BETWEEN NATURAL AND MAN-MADE HAZARDS

A final word on compound and/or cascading disasters. It is increasingly evident that the interaction of natural and man-made emergencies is on the rise [8].

NATECH EMERGENCIES

© Disinfection in several areas severely affected by the earthquake, tsunami and liquefaction in Central Sulawesi. Indonesian Red Cross, 2018.

When a natural event leads to a technological accident, it is known as a 'natural-hazard-triggered technological' or NATECH event. NATECH emergencies can be triggered by a host of natural hazards such as floods, earthquakes, lightning strikes, cyclones and/or extreme temperatures. A technological accident results in damage to infrastructure such as fixed installations, oil and gas pipelines, storage sites, transportation links, waste sites and mines, etc. The subsequent release of chemicals or other hazardous substances exacerbate the overall impact of the disaster, seriously affecting human health and well-being, as well as the environment as a whole.

Risk managers have been looking into the causes and consequences of NATECH events. Although this is a relatively recent area of study, it has already become clear that prevention and preparedness measures, as well as response and recovery plans, **rarely integrate** the risks associated with technological and natural hazards.

8. *Sendai DRR Framework records data from several global disaster-loss databases (i.e. Centre for Research on the Epidemiology of Disasters: EM-DAT, MunichRe: NatCatSERVICE, and SwissRe: Sigma).*

Fuel storage sites, tank farms

- kerosene
- petroleum
- propene
- butane

Waste storage sites

- oil
- solvents
- polychlorinated biphenyls

Gas and oil pipelines

- natural gas (methane)
- crude oil

Tailing dams

- toxic sludge
- mine tailings containing cyanide and arsenic

Petroleum or petrochemical industries

- ammonia
- benzene
- crude oil
- hydrogen sulfide

Acid mine drainage (abandoned mines)

- aluminium
- arsenic
- cadmium
- lead
- manganese

Chemical factories

- alkale
- acrolain
- methanol
- organic peroxides

Transport: railways, roads, rivers, sea

bulkchemicals e.g.:

- ammonia
- chlorine
- petroleum
- methanol

Food processing plants

- ammonia

Hospitals, laboratories pharmacies

- reagents
- disinfectants
- medicines
- gases
- radiological material

Pesticide storage depots

- carbomates
- organophosphates
- organochlorines

Metallurgical industries

- toxic metals
- cyanide
- sulfuric acid
- ammonia

Figure 1. Examples of vulnerable sites for chemical release caused by natural hazards and examples of the types of chemicals that might be released.

III. Data & Figures

© IFRC and Pakistan Red Crescent Society (PRCS) colleagues analyse the risk areas after floods in Charsadda, KPK Province. PRCS, 2010

The most recent report from the Centre for Research in the Epidemiology of Disasters (CRED) [9] shows that **technological disasters account for about a third (36.4%) of all disasters since 1900**, as reported by the international disaster database (EM-DAT). Unfortunately, we do not yet have complete aggregated data for all the types of CBRN disasters.

Technological disasters can be further divided into industrial (chemical spill, collapse, explosion, fire, gas leak, poisoning, radiation and other), transport (air, rail, road and water), and miscellaneous accidents (fire, infrastructure collapse, explosions, and other). Between 2000-2019, EM-DAT recorded 5,143 technological disasters - of which approximately two thirds (3,532 disasters) were transport accidents. Although industrial accidents accounted for only 16% of reported technological accidents during that timeframe, their impact was disproportionately large, affecting more than 1.4 million people (64% of total population affected by technological disasters).

9. *CRED Crunch, September 2020, Centre for Research on the Epidemiology of Disasters (CRED) – University of Louvain, Belgium.*

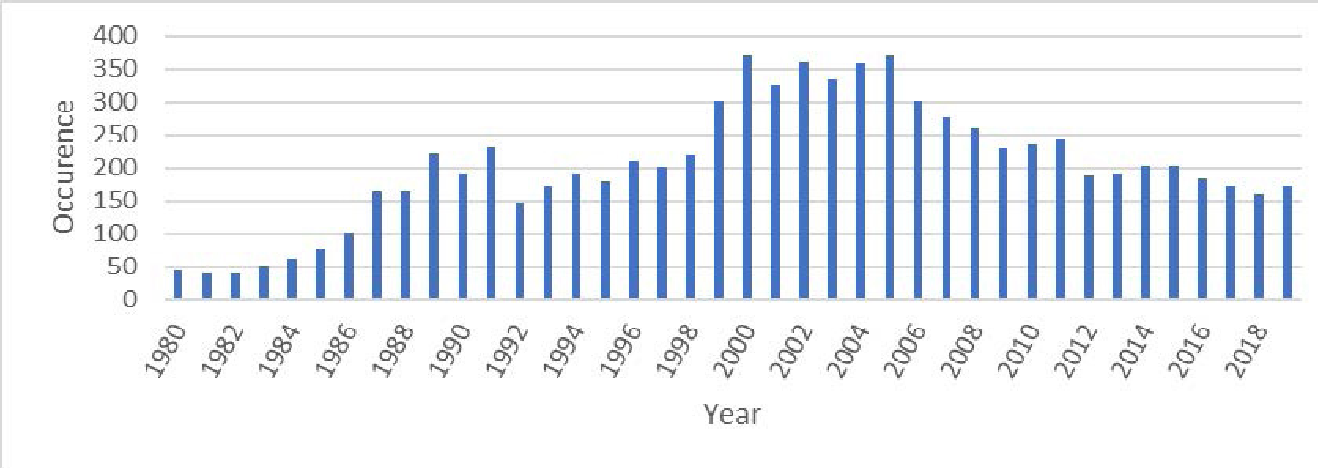


Figure 2. Occurrence of Technological Disasters 1980-2019 (EM-DAT Database)

Figure 3. Type of technological disaster 2000-2011 per (a) Overall occurrence / (b) Number of people affected.

In terms of geographical distribution, CRED data indicates that Asia and Africa have been the most affected areas. Over the period 2000-2019, a total of 2,251 technological disasters were recorded in Asia, affecting 986,282 people; Africa recorded 1,690 events, affecting 419,256 people. Together, these accounted for more than 75% of all reported events, 80% of reported deaths and 65% of those affected (CRED Crunch, September 2020).

The top ten countries with the highest occurrence of technological disasters from 2000-2019 are dominated by emerging and newly industrialized countries.

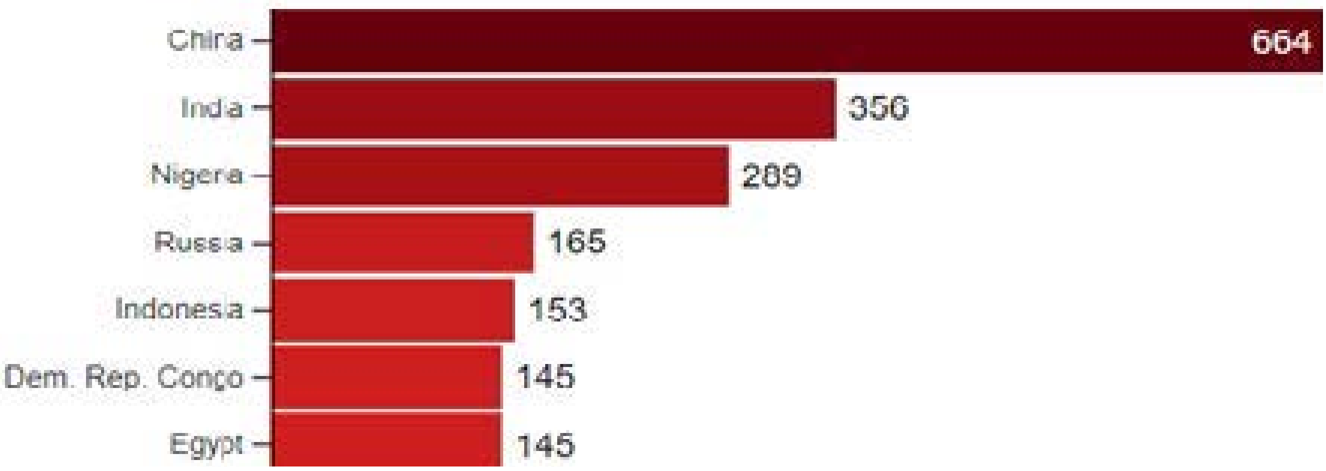


Figure 4. Top 10 countries, occurrence Technological Disasters 2000-2019 (EM-DAT Database)

Furthermore, a recent UNDRR Report [10] on NATECH risk management (focusing on the Asia Pacific region) underlines the growing risk of compound disasters. It states: "The Asia-Pacific region faces a varied continuum of natural hazards creating greater complexity and deep uncertainty in the face of changing climate and rapid industrialization. Considering (that) the number of chemical industries and units handling hazardous materials has increased, the NATECH risk is growing in the region." The report goes on to predict an increase in the frequency of chemical and NATECH disasters, given the tremendous and unchecked growth of chemical industries over the past 25 years in a number of countries (e.g. Indonesia, Thailand, Vietnam and the Philippines), and where, in many instances, such industries are only lightly regulated.

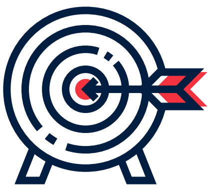
Of course, technological and NATECH events are not only linked to chemical industries, nor are they solely linked to major disasters. Various other infrastructure sectors (e.g. water reservoirs, power stations, mines, barges, etc.) are vulnerable to NATECH disasters, large or small, thereby highlighting the changed nature and complexities of these events.

"Any kind and size of natural hazard can trigger a NATECH accident. It does not necessarily require a major natural hazard event, like a strong earthquake or a major hurricane, to cause a NATECH accident. With increasing industrialisation and urbanisation coupled with climate change, NATECH risk is expected to increase in the future."

(Asia Pacific Regional Framework for Risk Management (2020) p.15)

Overall, the risk of technological and biological (CBRN) disasters is growing due to increased industrialization, more complex urban environments and the unpredictable threats posed by climate change. According to CRED, 160 technological disasters were reported worldwide in 2016 (compared to 297 natural disasters in the same period) [11]. These figures are expected to rise over the coming years.

Underlying all of this is a greater need for the disaster management community to:



- Better understand the potential for technological/CBRN and NATECH accidents to develop into large-scale disasters.
- Recognize that technological/CBRN and NATECH preparedness levels are low, even in countries which are generally considered to be well-prepared for such events.
- Fully integrate this area into multi-hazard disaster risk management strategies.

10. *Asia Pacific Regional Framework for NATECH Risk Management, UN Office for Disaster Risk Reduction (UNDRR) 2020 (p.4)*
11. *These figures are based on models from the International Disaster Database (EM-DAT database), Centre for Research on the Epidemiology of Disasters (CRED). Retrieved 31 August 2015 from: http://www.emdat.be/disaster_trends/index.html*

IV. Case Studies: Why this is relevant to the RCRC

Let's think about it...

Imagine that your country experiences a strong impact from a natural hazard, which destroys critical infrastructure, as well as a number of industrial facilities. You are informed that an unknown, air-borne and potentially toxic substance was released from one of these facilities. This "toxic cloud" is now spreading due to meteorological conditions, and could potentially affect neighbouring countries. Your National Society, as part of the national disaster response system, is being urged to provide much-needed humanitarian assistance. Your relief teams, with well-trained staff and volunteers, are about to be deployed according to their usual protocols and training. How do you react? What do you do to ensure your duty of care? How do you deal with the humanitarian dilemma of either ensuring their safety or delivering much-needed humanitarian assistance in an uncertain and potentially unsafe environment?

© Beirut Explosion. Lebanese Red Cross, 2020

Although disasters linked to technological and biological hazards may seem, at first glance, to be rare enough not to warrant any specific measures on our part, experience from a range of disasters shows that this is far from being the case. The following examples serve to illustrate this.

EXAMPLES OF DISASTER EVENTS RELATED TO MAN-MADE HAZARDS [12]

- **Disaster related to radiological hazard:** The Great East Japan Earthquake and Tsunami of 2011 caused severe damage at the Fukushima Daiichi Nuclear Power Plant, resulting in a major release of radioactivity. More than 100,000 were evacuated because of the release of radionuclides into the environment.

- **Disaster related to chemical hazard:** On 9 December 2014, an oil tanker accident in the Sundarbans of Bangladesh led to the release of approximately 350,000 litres of heavy fuel oil into the river and mangrove ecosystem which is listed as a UNESCO World Heritage site.

- **Disaster related to chemical hazard:** In December 1984, a major gas leak at a pesticide plant in Bhopal, India resulted in the release of 40 tons of methyl isocyanate gas. The incident caused an estimated 3,800 deaths in the immediate aftermath and a significantly higher morbidity for the exposed population - reported as being more than 500,000 people.

- **Disaster related to transport hazard:** In July 1978, a road tanker transporting liquefied propylene sprang a leak as it passed a camping site at Los Alfaques in Spain. The leak resulted in the release of liquefied gas into the site, where it immediately ignited. The explosion killed more than 200 people and the devastation spread over a radius of 400 yards (approx. 370 meters).

12. *Excerpted from 'Words into Action Guidelines, Implementation Guide for Man-made and Technological Hazards', UNISDR 2020 (p.14)*

The following technological & biological (CBRN) hazard **case studies** illustrate the wide spectrum of disasters with which **IFRC and National Societies** have been confronted in recent years.

- **INDUSTRIAL ACCIDENTS - CHEMICAL AGENTS**
  Nairobi pipeline fire, Kenya (2011)

The 2011 Nairobi pipeline fire was caused by an explosion linked to a fuel spill. A fuel tank, located in an industrial area of Nairobi (and part of a pipeline system operated by the state-owned Kenya Pipeline Company), sprang a leak. People in the adjacent and densely populated shanty town of Sinai were collecting leaking fuel when a massive explosion occurred at the scene. Fire spread to the Sinai area. Approximately 100 people were killed by the fire, and at least 116 others were hospitalized with varying degrees of burns. The Kenya Red Cross (KRC) focused on providing counselling to the victims, as well as reconciling actual casualty figures with those reported missing. Nairobi hospitals were hard-pressed to meet the surge in need for medical care and provisions. Extra tents had to be erected for blood donations.

- **INDUSTRIAL ACCIDENTS - TOXIC SLUDGE**
  Red sludge, Ajka, Hungary (2010)

© Toxic chemical red sludge. Hungarian Red Cross, 2010

The Ajka alumina sludge spill was an industrial mining accident which occurred when the corner of a caustic waste reservoir collapsed, dispersing approximately one million cubic metres (35 million cubic feet) of liquid waste. The wave of toxic red mud flooded streets in nearby villages, and the flow was powerful enough to move cars and vans. Thirteen people were killed. The high-pH mud caused an alkaline reaction on contact: as a result, an estimated 120 people were hospitalized with chemical burns. The waste also extinguished all life in the nearby river, and eventually reached the Danube, prompting other downstream countries (including Croatia, Serbia, Romania, Bulgaria and Ukraine) to develop emergency plans in response. The Hungarian Red Cross, working closely with the local regional administration, assisted with evacuation, and provided emergency assistance in response to the disaster. Staff and volunteers supported the affected population, with the immediate provision of supplies and shelter, and engaged in the clean-up operations, as well as providing long-term assistance in recovery and the reconstruction of the affected settlements.

- **NATECH – HAZMAT SUBSTANCES (Asbestos Debris Removal)**
  Earthquake and Tsunami, Indonesia (2018)

© Debris of the earthquake and tsunami in Indonesia. Finnish Red Cross, 2018

Asbestos [13] has been widely used in the construction industry around the world due to its heat-resistant and insulating properties. It is often encountered in its various forms during humanitarian response, particularly during search and rescue operations, in damaged buildings, debris clean-up, and as part of transitional settlement and reconstruction activities.

In post-disaster activities (particularly debris removal and shelter construction), RCRC staff and volunteers have often risked exposure to asbestos dust, which requires specific handling and the use of specialised personal protective equipment (PPE).

13. *All forms of asbestos are classified as known human carcinogens by the International Agency for Research on Cancer (IARC). According to global estimates, 100,000 people die of asbestos-related diseases each year. Its use has consequently been banned in over 40 countries worldwide. However, the need for cheap materials, the lack of alternatives, and a general lack of awareness of the health risks account for continued and increased use of asbestos in the developing world, where there is little or no control or legislation.*

The IFRC provides specific safety and health guidance to National Societies, most recently following the 2018 earthquake and tsunami in Lombok and Sulawesi, Indonesia. Similar scenarios involving asbestos exposure occurred in 2019, after the tropical cyclone in Mozambique, and the hurricane in the Bahamas.

- **INDUSTRIAL ACCIDENTS – EXPLOSION AND RELEASE OF TOXIC SUBSTANCES**
  Tjanjin, China (2015)

© An estimated 17,000 households were affected after the double explosion shook the streets of Tianjin, China. Red Cross Society of China, 2015

A series of explosions killed 173 people and injured hundreds of others at a container storage station at the Port of Tianjin, in 2015. The company owning the storage facility handled hazardous chemicals, such as flammable and corrosive substances, oxidizing agents, and toxic chemicals.

Two explosions occurred within 30 seconds of each other, the second of which involved the detonation of about 800 tonnes of ammonium nitrate. Fires caused by the initial explosions continued to burn uncontrolled for some days, resulting in eight additional explosions. There was extensive destruction in and around the warehouse. Multiple buildings surrounding the blast site were declared “structurally unsafe”. Over 6,000 area residents were relocated to temporary shelters, after the government issued an evacuation order over concerns about further explosions. The cost to businesses of the disruption in the supply chain caused by the explosions was estimated at USD 9 billion. The Red Cross Society of China provided relief items, temporary shelter, blood donation services, and psycho-social support activities to the affected population and responders.

- **RADIOLOGICAL DISASTER**
  Goiânia Brazil (1987)

© Contaminated items being removed. Brazilian National Nuclear Energy Commission (CNEN), 1987.

A radioactive contamination accident occurred in 1987, at Goiânia, in the Brazilian state of Goiás, when a discarded radiotherapy source (cesium-137 (Cs-137) radiation therapy device) was stolen from an abandoned clinic. After removing the radioactive Cs-137 source from its lead casing, the thieves took the capsule containing fluorescent blue powder home with them. They showed the capsule to friends and relatives, then sold it on to a scrap dealer. Over the course of the following days, those who had come into contact with the powder began to fall ill, presenting with diarrhoea, vomiting and faintness.

Doctors were eventually able to identify the radioactive nature of the substance, and a large-scale screening operation was initiated. About 112,000 people were examined for radioactive contamination, and 249 of those were found to have significant levels of radioactive material in or on their bodies. Four people died after having handled the device. Many parts of the city were found to have been contaminated, and people were evacuated to the local stadium. More than 3,500 m³ of radioactive material had to be disposed of, during the subsequent clean-up operation. Topsoil was removed from various sites, and several houses were demolished. The International Atomic Energy Agency called the incident “one of the world’s worst radiological incidents”.

• CASCADING DISASTERS (NATECH) – NUCLEAR AGENTS
Fukushima, Japan (2011)

© *Radiation at a safe level but still much higher than before the nuclear meltdown at the Fukushima Daiichi Nuclear Power Plant. IFRC, 2015*

The classical case of a NATECH or cascading disaster is the 2011 Great Eastern Japan Earthquake and Tsunami (GEJET), which triggered the accident at the Fukushima-Daiichi Nuclear power plant. Although the probability of such a disaster may have seemed so low as to be virtually impossible, it nevertheless did occur, and had extensive and long-term impacts on the population, as well as the environment. As a direct result of the earthquake and tsunami, a reported 19,418 people died, and 6,220 were injured, along with 2,592 missing. Over 1,144,495 buildings were destroyed (fully or partly). Four nuclear reactors were damaged due to the initial disasters, with a number of explosions occurring between 12-15 March 2011. This led to the evacuation of 154,000 people, from a restricted area/evacuation zone with a radius of between 20 to 55 kms.

Immediately after the earthquake and tsunami, the Japanese Red Cross Society (JRCS) [14] initiated relief activities throughout the affected areas. The nuclear power plant accident occurred in the midst of the emergency response operation, and JRCS had to decide whether to continue its relief activities, or withdraw from the evacuation area in order to ensure the safety of staff and volunteers. At the time, JRCS did not have a code of conduct covering relief activities under conditions of radiological contamination. In addition, personal protective equipment (PPE) and tools for operating in an environment contaminated by radiation were not readily available. JRCS hospitals and medical centres focused on providing general medical treatment to the disaster-affected population and some 500 Emergency Medical Response Teams (EMRT) provided first aid, vaccinations, and psycho-social support in the field and at evacuation centres. A Radiation Adviser Team was eventually dispatched to support the Emergency Relief Teams and provide guidance on radiation protection.

14. *Case Study: 'Japanese Red Cross Society disaster response and the Fukushima Daiichi nuclear power plant accident'. Link. Japanese Red Cross / IFRC 2011 .*

- **CHEMICAL DISASTER**
  Megantic train derailment, Canada (2013)

© Canadian Red Cross provides assistance after the accident. Canadian Red Cross, 2013.

The **Lac-Mégantic rail disaster** occurred when an unattended 74-car freight train carrying crude oil rolled down a 1.2% grade and derailed in the middle of the town, resulting in a fire and the explosion of numerous tank cars. Forty-two people were confirmed dead, with five more missing and presumed dead. More than 30 buildings in the town's centre, roughly half of the downtown area, were destroyed, and all but three of the thirty-nine remaining downtown buildings had to be demolished due to petroleum contamination. The Canadian Red Cross provided immediate assistance to the more than 2.000 people evacuated, through humanitarian reception centres and the provision of temporary shelters. In addition, the affected population was supported with cash vouchers and other supplies over a period of several months.

As these examples demonstrate, the ability to respond to technological and CBRN incidents requires **unique planning, key partnerships, effective tools, appropriate resources, and responsive leadership** on the part of the RCRC and its partners.

The following hypothetical examples illustrate the kind of issues RCRC personnel may encounter in responding to such disasters:

- A Disaster Management Delegate is faced with a situation similar that which occurred in Fukushima (2011). Team members are responding to an emergency, supporting victims from an earthquake / tsunami. Suddenly an explosion occurs, and they are informed of an accident at a nearby nuclear power plant.
What instructions should the delegate give the team? Stay and assist the victims, or evacuate to ensure their own safety and security?

- A National Society-operated ambulance service is called to the scene of an accident. The victim is discovered to have been contaminated with an unknown substance.
What should the first responders do? Where should they take the victim?

- A number of people in the suburbs of a large city present to emergency departments, complaining of similar symptoms - loss of appetite, nausea, vomiting and diarrhoea. Suspecting a piece of equipment handled by many of them, and which could be a radioactive source, the device is taken to the local hospital, before being moved again. After some delay, the public health authorities remove the device, and screening is organized.
What advice should be given to the NS where this event takes place?

- An explosion in a factory releases an unknown substance and a number of people need to be evacuated. Public authorities ask the local RC to assist with the evacuation. The Head of the Branch Office seeks advice regarding risks posed by contamination, particularly given its duty of care towards staff and volunteers being tasked to take part in this evacuation.
What specific considerations and measures need be taken into account?

- A National Society is operating a hospital. A patient with severe traumatic injuries from a traffic accident is brought into emergency and taken to the operating theatre. Moments later, the hospital is informed that radioactive material was involved in the accident and that the patient might be contaminated.
How should the hospital staff / doctors / nurses proceed? What guidelines does the NS have for such a situation?

V. IFRC Action - Progress to date

© COVID-19 response operations. Syrian Red Crescent Society, 2020

The case studies outlined above are just a few of the many instances of technological and biological (CBRN) disasters that the RCRC has had to contend with over the course of its history. The question is not whether or not the RCRC can respond to such events – it most certainly can and has done so. The question is what else NSs need to do in order to fulfil their mandate as auxiliaries to the public authorities, in light of the existing and growing threat of technological and biological (CBRN) hazards – and how best the IFRC Secretariat can support them.

The establishment of a global IFRC Programme on Nuclear Emergency Preparedness in 2013 was driven by the 2011 nuclear accident in Fukushima. Its primary aim has been to capture existing expertise within the Movement and establish basic guidance for the IFRC Secretariat and National Societies on nuclear and radiological emergencies.

This was broadened into the Technological and Biological (CBRN) Hazards Preparedness Programme, coordinated by a Senior Officer acting as the programme's Global Focal Point within the IFRC's Disaster and Crises Department. The programme is supported by a Technical Working Group (TWG), made up of a network of National Society experts, with a view to sharing experiences, aligning operational approaches, and developing relevant tools, workshops, and training sessions.

The IFRC's Technological and Biological (CBRN) Hazard Preparedness Programme has evolved since its inception, and currently focuses on the following areas:

1. Integration: Raising awareness through communications, establishing collaborative partnerships, and mainstreaming technological and biological (CBRN) hazard preparedness, response and recovery in RCRC policies, programmes, and operations
2. Capacity-building: Strengthening operational capacity and enhancing RCRC expertise, as part of a multi-hazard approach. This includes adjusting current tools, guidance, systems, and processes to facilitate appropriate and timely response to CBRN events.
3. Advocacy: Promoting specialized technical preparedness through advocacy, public awareness, and partnerships.

How do we achieve the objectives

Knowledge creation and sharing

- Increase knowledge and enhance readiness and resilience.
- Provide guidance and support alignment of operational procedures.
- Raise awareness in communities of potential humanitarian consequences from technological and biological hazards.

Capacity building / Technical assistance

- Provide technological & biological hazard preparedness training (in person or virtually) on equipment use, technical safety procedures, drill exercises.
- Support the proper use of personal protective equipment, shelters, and detection equipment.
- Peer to peer support.

Policy / Advocacy / Outreach

- Enhance humanitarian response following extreme events.
- Pursue greater international cooperation for technological and biological emergency planning, preparedness, and response.
- Advocate for stronger humanitarian considerations within safety standards and frameworks in international networks.

In summary, the IFRC Technological and Biological (CBRN) Hazard Preparedness Programme has been working with National Societies to enable them to:

- Address the humanitarian consequences of technological and biological (CBRN) emergencies.
- Strengthen their role as an auxiliary to public authorities and their ability to work in coordination with specialised actors.
- Ensure their duty of care to their staff and volunteers.
- Ensure the integrity of their organisation and the continuity of its activities.
- Raise awareness within their communities and enhance readiness and resilience.
- Advocate for greater local, regional, and national cooperation in planning, preparedness and response with governmental authorities, local organizations, and the private sector.

SPECIAL NOTE 1
BIOLOGICAL HAZARDS

© COVID-19 response operations. Syrian Red Crescent, 2020

The IFRC has been working for many years to help communities prepare for and respond to health emergencies and biological hazards – be it through specialized health programmes focusing on HIV or malaria, or through support to targeted vaccination campaigns (e.g. influenza, mumps, measles). IFRC preparedness and response programmes to most naturally-occurring biological hazards (such as local epidemics of Ebola, Zika virus, SARS, and the current COVID-19 pandemic), are already fully-integrated into the Emergency Health Department at IFRC Secretariat level, and dealt with by National Societies as part of their established emergency health response activities.

SPECIAL NOTE 2
DELIBERATE USE (nuclear, biological or chemical substances):

While IFRC has a limited role in armed conflict situations and other malicious acts involving CBRN devices, National Societies and the ICRC may be confronted with the challenges of operating in hazardous environments or with hazardous substances (such as anthrax or sarin). While the RCRC Movement as a whole emphasizes the need for determined and long-term action on the part of governments to ensure that nuclear, chemical and biological weapons are never again used, there is nevertheless an increased recognition that CBRN weapons pose a potential risk which needs to be addressed in RCRC preparedness and response planning.

A Chatham House study for 'Lloyd's Emerging Risks Report (2016) [15] indicates that the global threat of CBRN weapons use is evolving, driven by such factors as an increase of potential perpetrators, changing technological and scientific capabilities, and the potential mis-use of dual-use materials.

In addition, riot control agents used by law enforcement agents in certain countries for crowd control can also affect RCRC first responders and first aid teams.

15. *See the full report with more details on the CBRN Threat Matrix on the Lloyds website: https://www.lloyds.com/news-and-insight/risk-insight/library/society-and-security/cbrn*

VI. Partnerships

© Presentation at the International symposium for Risk communication with the public in a Nuclear Emergency, hosted by IAEA. Austrian Red Cross, 2018

The IFRC programme has a range of internal (RCRC Movement) and external partners and stakeholders with which a regular exchange and collaboration has been established.

Key partners include:

ICRC: Sharing experience in development and implementation of ICRC's CBRN Response Framework and its dedicated role in situations of conflict and violence, especially as linked to the use of CBRN weapons.

External Partners

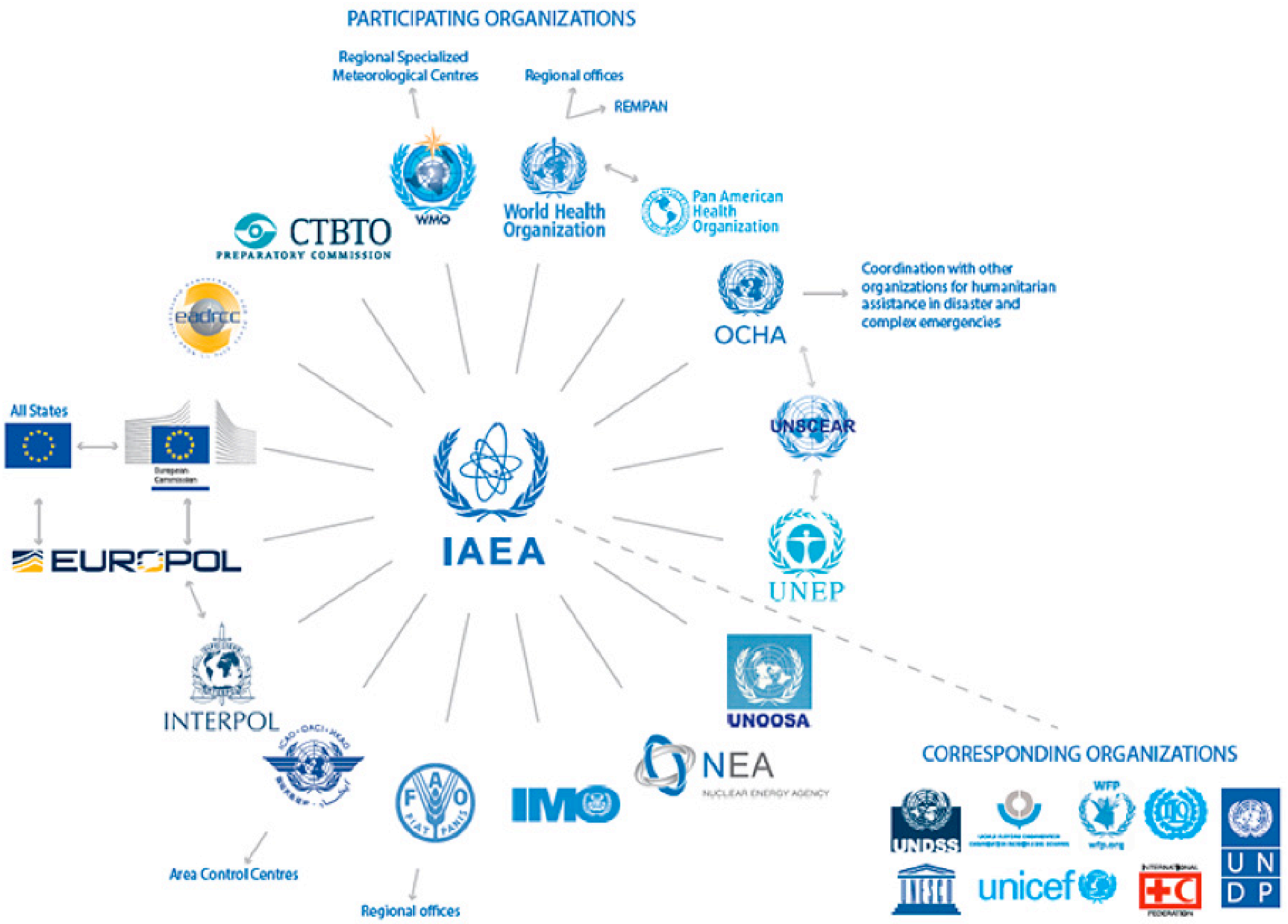
- **National and local governments:** Advocacy and contingency planning with governments and relevant national nuclear oversight authorities on the specific auxiliary role of RCRC in multi-hazard preparedness, response and recovery. Coordination and close collaboration with civil protection systems and actors, and exchange of information regarding events dealing with technological and biological (CBRN) hazards.

- **Public sector:** Advocacy and awareness-raising on issues of technological hazards / CBRN preparedness.

- **Civil society organizations, research institutes and academia:** Promotion of partnerships at global and national level.

- **International Organisations and other external stakeholders:** Enhanced collaboration with international organizations - in particular the International Atomic Energy Agency (IAEA) and other relevant UN agencies (e.g. UNDRR, UNEP, OCHA), OECD, OECD Nuclear Energy Agency, European Commission, INGOs - and in international fora. Close collaboration and information exchange with relevant international actors have been established through IFRC's membership of the Inter Agency Committee on Radiological and Nuclear emergencies (IACRNE).

- **Private sector:** Making use of existing community preparedness programmes to raise awareness and establish links with businesses at local and national levels in relation to technological hazards and CBRN emergency preparedness.



© IAEA, 2018

VII. Final Word

The 'IFRC Roadmap on Technological and Biological (CBRN) Hazard Preparedness – Towards 2030: An enhanced multi-hazard approach' recommends developing a cost-effective and resource-light five-year plan of action, which focuses on:

I. Increasing knowledge-sharing within the IFRC.
II. Developing mechanisms to enhance coordination and foster greater expertise.
III. Integrating technological and biological (CBRN) hazard response into policies, programmes, and day-to-day operations within National Societies and the IFRC Secretariat.

IFRC aims to have the necessary knowledge and expertise to respond to any kind of emergency - no matter how new, large, unexpected, or technologically complicated. For this reason, technological and biological (CBRN) hazards must be fully incorporated into IFRC's multi-hazard approach to disasters, at all levels of the organization, and across all sectors.

"The Beirut Port explosion of August 2020 was a stark reminder of how suddenly and unexpectedly disasters linked to hazardous substances can occur. It would be easy to think of this as a unique event, unlikely to ever happen again. Sadly, our experience in disaster risk management has taught us that not all hazards can be fully anticipated, and that we must plan and prepare for the improbable, as well as the more predictable.

In fact, it is precisely because of its experience in dealing with the unexpected that the Lebanese Red Cross was able to respond quickly and effectively to the situation, whilst maintaining its duty of care to volunteers and staff, at a time when the disaster itself was compounded by the COVID-19 pandemic.

The International Red Cross Red Crescent Movement has a long history of responding to technological and man-made emergencies. Over the years, we have absorbed the many lessons learned from these experiences. However, with the additional challenges posed by population density, greater urbanization and industrialization, ageing infrastructure and a wider use of hazardous materials, the risks and complexities of such disasters are increasing. Moreover, these are being exacerbated by the extremes of climate change.

We need to do better, and we can. Simply put, it is time to fully integrate the specific knowledge and specialized equipment required for technological and CBRN disasters into our multi-hazard approach to disaster risk management.

It is expected of us. And we expect it of ourselves."

Jagan Chapagain, IFRC Secretary General
(October, 2020)

Annex 1
WHO Classification of hazards [16]

GENERIC GROUPS[1]	1. NATURAL						2. HUMAN-INDUCED[2,3]		3. ENVIRONMENTAL
GROUPS	1.1 GEOPHYSICAL[4]	1.2 HYDRO-METEOROLOGICAL			1.3 BIOLOGICAL[5]	1.4 EXTRATERRESTRIAL[4]	2.1 TECHNOLOGICAL	2.2 SOCIETAL	3.1 ENVIRONMENTAL DEGRADATION[17]
SUBGROUPS		1.2.1 HYDROLOGICAL[4]	1.2.2 METEOROLOGICAL[4]	1.2.3 CLIMATOLOGICAL[4]					
Main types - *subtypes* *(italics)* [sub-subtypes]	Earthquake: - *ground-shaking* Tsunami Mass movement (geophysical trigger): - *landslide* - *rock fall* - *subsidence* Liquefaction Volcanic activity: - *ash fall* - *lahar* - *pyroclastic flow* - *lava flow*	Flood: - *riverine flood* - *flash flood* - *coastal flood* - *ice jam flood* Mass movement (hydro-meteorological trigger): - *landslide* - *avalanche (snow)* - *mudflow* - *debris flow* Wave action: - *rogue wave* - *seiche*	Storm: - *extratropical storm* - *tropical cyclone* [cyclonic wind, cyclonic rain, cyclone (storm) surge] - *convective storm* [tornado, wind, rain, winter storm, blizzard, derecho, lightning, thunderstorm, hail, sand/dust storm] Extreme temperature: - *heatwave* - *coldwave* - *severe winter condition* [e.g. snow/ice, frost/freeze, dzud][6] Fog	Drought Wild fire: - *land fire [e.g. brush, bush, pasture]* - *forest fire* Glacial lake outburst (flood)	Airborne diseases Waterborne diseases Vector-borne diseases Foodborne outbreaks[7] Insect infestation:[4] - *grasshopper* - *locust* Animal diseases Plant diseases Aeroallergens Antimicrobial resistant micro-organisms Animal-human contact - *venomous*	Impact: - *airburst* - *meteorite* Space weather: - *energetic particles* - *geomagnetic storms* - *shockwave*	Industrial hazards:[8] - *chemical spill* - *gas leak* - *radiation* [radiological, nuclear] Structural collapse: - *building collapse*[8,9] - *dam/bridge failures* Occupational hazards - *mining* Transportation:[8,11] - *air, road, rail, water, space* Explosions Fire[8] Air pollution:[9] - *haze*[10] Infrastructure disruption: - *power outage*[11] - *water supply* - *solid waste, waste water* - *telecommunication* Cybersecurity Hazardous materials in air, soil, water:[12,13] - *biological, chemical, radiological* Food contamination[7]	Acts of violence Armed conflicts:[14] - *international* - *non-international* Civil unrest Stampede Terrorism: - *chemical, biological, radiological, nuclear, and explosives*[15,16] Financial crises: - *hyper-inflation* - *currency crisis*	Erosion Deforestation Salinization Sea level rise Desertification Wetland loss/degradation Glacier retreat/melting Sand encroachment

16. *Health Emergency and Disaster Risk Management Framework.Geneva: World Health Organization; 2019*

Annex 2
Technological & Biological (CBRN) Hazards Toolkit

	Existing tools	Specific Tools / Interventions (CBRN CRISES TOOLKIT)
Preparedness	• General preparedness and contingency planning tools (on national and regional level); • General public health tools and guidelines (e.g. CBHFA); • General communication guidelines.	• Community information • National and branch preparedness • Business continuity plans • Communication guidelines • E-learning tool on Tech Hazards Preparedness.
Response	• Health, WatSan ERUs • Logistics • Shelter • Risk Communications & Community engagement / GOplatform • DRM tools on national, regional, and global levels.	• Network of experts • CBRN-related equipment for possible response.
Recovery	• Social welfare • Livelihoods programmes • Psychosocial support programmes	• Long-term medical interventions • Specific psychosocial interventions • Community information • Radiation and environmental monitoring.


© Nurse takes care of a child after the Fukushima Nuclear Disaster. Japanese Red Cross, 2011

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