RESILIENT COMMUNITIES THROUGH AWARENESS AND PREPAREDNESS AGAINST THE RISKS OF FIRE, FLOOD, AND LANDSLIDE

CHAPTER 5. RESCUE AND RESCUE EQUIPMENT
(for floods, landslides and fires)

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5.1   Introduction to rescue procedures

Rescue operations play a vital role in mitigating the impact of disasters, accidents, and emergencies, ensuring the safety and well-being of individuals and communities. These operations encompass a wide range of activities, from saving lives in disasters aftermath such as earthquakes and hurricanes, to responding to man-made incidents like industrial accidents and terrorist attacks. The fundamental objective of rescue operations is to extract individuals efficiently and effectively from hazardous situations, providing them with the necessary medical attention and support to facilitate their recovery. This introduction will delve into the multifaceted world of rescue operations, examining their historical context, the challenges they face, and the evolving strategies and technologies employed to enhance their efficacy.

The concept of rescue operations has deep historical roots, dating back to ancient civilizations. Early records of organized rescue efforts can be traced to ancient Rome, where the "Vigiles" served as a firefighting and rescue force. These historical examples highlight the enduring human instinct to help those in distress and protect communities from harm. However, it was in the 19th and 20th centuries that modern rescue operations began to take shape. The development of technologies such as the steam engine and the telegraph significantly improved the speed and efficiency of rescue efforts.

Rescue operations are fraught with numerous challenges, often exacerbated by the unpredictable nature of disasters and emergencies. One of the primary challenges is the need for rapid response and coordination among various agencies, including fire departments, law enforcement, medical professionals, and volunteer organizations. Dynes (2005), Kapucu (2007) and Comfort (2007) highlight the importance of interagency cooperation and effective communication in addressing these challenges.

Resource constraints and the allocation of assets also pose significant dilemmas. Limited resources, including personnel, equipment, and funds, must be judiciously allocated to maximize impact. Balancing these resources while responding to multiple concurrent incidents is a complex task explored in-depth by Kelly (1995). Additionally, the dynamic nature of disasters necessitates adapting to changing circumstances, which can strain response teams and require innovative solutions (Dinas et al., 2015).

This chapter will introduce rescue operations for each of the hazards, highlighting key features, processes and challenges. Common topics, such as teamwork, shelter operations and first aid, will be discussed at the end of the chapter.

In recent years, the landscape of rescue operations has witnessed significant advancements in strategies and technologies. The development of Geographic Information Systems (GIS) has revolutionized disaster management, allowing for precise mapping and real-time data analysis to aid in decision-making. Unmanned Aerial Vehicles (UAVs) or drones have become indispensable tools for search and rescue missions, providing aerial views of affected areas and reaching inaccessible locations.

Artificial intelligence (AI) and machine learning algorithms have made it possible to analyze vast datasets to predict disaster patterns, allocate resources more efficiently, and even automate certain aspects of rescue operations. Improved medical technologies and field hospitals have enhanced on-site treatment and triage, reducing the mortality rate of victims (World Health Organization, 2013). These innovations have not only improved the effectiveness of rescue operations but have also contributed to the safety of rescue personnel.

Rescue operations represent a crucial component of disaster management and emergency response. The historical evolution of these operations, the challenges they face, and the innovative strategies and technologies employed to address them demonstrate the dynamic nature of this field. As we delve deeper into the world of rescue operations, it becomes evident that continuous research, collaboration, and adaptation are essential for saving lives and safeguarding communities in an ever-changing world.

One of the primary reasons why rescue operations are of paramount importance is their ability to mitigate the loss of human lives during disasters and emergencies. When natural calamities strike, such as hurricanes, tornadoes, or earthquakes, people may find themselves trapped under debris or stranded in perilous situations. In such scenarios, timely rescue efforts become

a matter of life and death. Highly trained rescue teams, often comprising firefighters, paramedics, and volunteers, are equipped with the skills and tools necessary to extricate individuals from dangerous situations, administer life-saving medical aid, and transport them to safety. These operations are a beacon of hope amidst chaos, and their prompt execution can significantly reduce fatalities.

Moreover, rescue operations extend beyond individual salvation and encompass the preservation of entire communities. In the aftermath of a major disaster, the well-coordinated efforts of rescue teams can prevent further damage by containing fires, securing hazardous materials, and ensuring access to essential services. This not only safeguards the physical infrastructure but also helps maintain order and security, preventing secondary disasters and the breakdown of social systems. In essence, rescue operations act as a stabilizing force that facilitates recovery and reconstruction, enabling affected areas to bounce back from adversity more swiftly.

Additionally, the importance of rescue operations lies in their capacity to provide psychological support and instill a sense of hope among survivors. Disasters and emergencies often leave individuals traumatized, disoriented, and in a state of shock. The presence of rescue personnel and their efforts to save lives offer a ray of hope and reassurance to those affected, fostering resilience and unity within communities. The knowledge that skilled professionals are working tirelessly to help them can alleviate panic and anxiety, contributing to a more effective response to the crisis.

Rescue operations also exemplify the spirit of solidarity and human compassion. They showcase the selflessness of individuals who risk their lives to save others, emphasizing the importance of community and mutual support. These operations often involve collaboration among various agencies, including government organizations, non-governmental organizations (NGOs), and volunteers, reflecting a collective effort to mitigate the impact of disasters. Such collaboration not only amplifies the reach and effectiveness of rescue operations but also demonstrates the power of cooperation in times of adversity.

Furthermore, the significance of rescue operations extends to the lessons they provide for disaster preparedness and risk reduction. Each rescue operation serves as a valuable opportunity to evaluate the response and identify areas for improvement. These insights are instrumental in refining emergency response plans, enhancing training programs, and

developing better technologies and equipment. By learning from past operations, communities and governments can become more resilient and better equipped to handle future crises.

Rescue operations are not limited to a specific geographic location or type of disaster. They are a global necessity, as disasters can strike anywhere, at any time. Thus, investing in rescue capabilities is a fundamental responsibility of governments and organizations worldwide. Adequate funding, training, and resources must be allocated to ensure that rescue teams are well-prepared and equipped to respond swiftly and effectively to emergencies. This commitment to preparedness is an essential component of disaster risk reduction, as it helps minimize the impact of disasters on communities and economies.

In summary, the importance of rescue operations cannot be overstated. These operations are a lifeline for individuals in distress, a safeguard for communities facing disaster, a source of hope and reassurance, and a testament to human compassion and solidarity. Beyond their immediate life-saving function, rescue operations contribute to disaster preparedness, risk reduction, and the overall resilience of societies. As we continue to face the unpredictable forces of nature and unforeseen emergencies, the significance of well-executed rescue operations remains a cornerstone of our collective safety and well-being.

5.2 Rescue Procedures

5.2.1 Floods

Flood rescue operations involve the provision of assistance and aid to individuals facing imminent danger or distress in a flooded environment. Within the broader field of search and rescue, various specialized sub-fields emerge, often dictated by the specific terrain of the search area.

The primary purpose of flood rescue services is to ensure the safety of individuals and conduct rescues when people are trapped or endangered in flood situations. As global instances of flooding continue to rise, many countries prone to recurrent floods are recognizing the advantages of having dedicated flood rescue services. These services not only enhance community safety but also bolster a nation's emergency response capabilities.

Effectively managing a flood rescue service necessitates a profound understanding of the operational environment, access to weather forecasting data, and proficiency in various

related disciplines. This encompasses tasks such as risk assessment and planning, recruitment, training, and logistical coordination.

5.2.1.1   Developing a plan

Floods wreak havoc and can have devastating consequences on communities, causing loss of life, property damage, and economic disruption. Developing a well-structured plan for flood rescue operations is crucial to ensure that resources are utilized efficiently, response times are minimized, and coordination among various stakeholders is seamless.

Operating within a flood-prone environment poses significant hazards. Prior to entering such areas, it is crucial to assess the team's capabilities for working in this challenging environment. Moreover, it's essential for the team to have a comprehensive understanding of the potential dangers they might encounter.

To effectively manage flood-related incidents, a well-thought-out plan should be devised in advance and actively employed during the incident itself. The initial step involves defining the scope of the response area. This is followed by identifying any existing hazards and formulating a detailed plan. Several critical questions must be addressed in this process, including:

- What is the geographical extent of the area under consideration?
- Are there any terrestrial hazards present?
- Are there any aquatic hazards to contend with?
- If the area encompasses agricultural and industrial zones, do potential hazards include livestock, chemicals, or slurry?
- Who resides in the area, and is there a need for evacuation? Is there a pre-established evacuation plan in place?

Because flood response planning is a complex and multifaceted endeavor that demands careful consideration of various factors to ensure the safety and resilience of communities and infrastructures, there is the need to delve into the essential components that should be integrated into flood response planning to effectively mitigate the impact of floods and safeguard the well-being of affected regions.

To begin, one of the fundamental pillars of flood response planning is the identification and assessment of specific hazards within the area prone to flooding. These hazards encompass a

range of elements, including fords and frequently flooded roads. Mapping out such hazard-prone zones is crucial for devising evacuation routes, designating high-risk areas, and formulating contingency plans to minimize harm during flood events.

Hydrology and potential hydrology represent the second critical component of flood response planning. Understanding the hydrological characteristics of a region, such as river basins, watershed areas, and drainage patterns, is vital for predicting the behavior of water bodies during flooding. Hydrological data enables authorities to anticipate the extent and severity of flooding, allowing for informed decisions on resource allocation and emergency response strategies.

Local infrastructure assessment is the next vital step in comprehensive flood response planning. This entails a meticulous evaluation of the region's infrastructure, including roads, bridges, utility networks, and critical facilities. By identifying vulnerable points in the infrastructure, planners can prioritize reinforcement efforts, maintenance schedules, and potential relocation of critical assets to minimize damage during floods.

Previous incident data plays a pivotal role in flood response planning. Analyzing historical flood events, their impacts, and response efforts provides valuable insights for future planning. This retrospective examination helps planners identify recurring issues, develop more effective strategies, and allocate resources where they are most needed. In addition, incorporating data on previous floods is equally fundamental. Examining past flood events, their duration, and their aftermath can provide crucial information for understanding the potential consequences of future floods. This historical context informs emergency response strategies, resource allocation, and the development of more resilient infrastructure.

Tide charts or timetables constitute another indispensable element of flood response planning, particularly in coastal regions. The tides' ebb and flow significantly influence flood timing and intensity. By integrating tide information, planners can anticipate when floodwaters are likely to peak and plan their response accordingly.

Climate change impact assessments are increasingly crucial in contemporary flood response planning. As climate change exacerbates the frequency and intensity of extreme weather events, including floods, understanding the potential long-term effects on a region is paramount. These assessments inform adaptation strategies, such as elevating structures,

implementing nature-based solutions, and revising land-use policies to reduce vulnerability to future floods.

Water depth markers serve as practical tools for flood response and preparedness. These markers provide real-time information on water levels during flooding, aiding both emergency responders and the general public in assessing the severity of the situation. By strategically placing water depth markers, planners enhance situational awareness and enable more effective decision-making.

A clear command structure is fundamental to effective flood rescue operations. The *Incident Command System (ICS)* is often used in emergency management. It delineates roles and responsibilities, ensuring that there is a designated incident commander, operations chief, logistics chief, and other key positions. This hierarchy streamlines decision-making and communication during the response.

Finally, *preplanning documents*, such as flood risk plans established by emergency planning groups, play a central role in flood response planning. These documents provide a structured framework for coordinating response efforts, delineating roles and responsibilities, and specifying resource allocation. They serve as a blueprint for mobilizing resources, managing logistics, and ensuring a coordinated response among multiple agencies and stakeholders.

Rescue teams need to be *adequately trained* and prepared to respond to flood emergencies. This includes swift-water rescue training, first aid and medical training, and familiarity with specialized equipment such as boats, helicopters, and rescue gear. Regular drills and exercises should be conducted to ensure that responders are well-prepared for real-world scenarios.

Community engagement is a critical component of flood rescue planning. Local residents should be educated about flood risks, early warning systems, and evacuation procedures. This can help reduce the number of people requiring rescue during a flood event and promote community resilience. Additionally, involving community leaders and organizations in the planning process can enhance cooperation and coordination during emergencies.

Early warning systems play a vital role in flood rescue operations. Timely and accurate information about impending floods allows for proactive evacuation efforts and resource mobilization. Monitoring river levels, weather forecasts, and rainfall data are essential

components of an effective early warning system. Emergency alerts and communication channels should be established to disseminate warnings to the public.

Evacuation is often necessary in flood-prone areas. Developing evacuation plans that consider the needs of vulnerable populations, such as the elderly, disabled, and those without transportation, is crucial. Identifying safe evacuation routes and establishing shelters can save lives during a flood event. It is also essential to coordinate with transportation authorities to ensure the smooth flow of evacuees.

Search and rescue (SAR) operations are a core element of flood response. Teams trained in water rescue techniques should be ready to deploy at a moment's notice. These teams may use boats, helicopters, and specialized equipment to locate and rescue individuals trapped by rising floodwaters. Coordination between SAR teams and the incident command structure is vital to ensure a well-organized response.

It is also important to recognize that floods are multi-jurisdictional and multi-agency incidents, underscoring the necessity of effective collaboration among various entities. Inter-agency liaison at all levels is essential, ensuring seamless cooperation and the sharing of resources and expertise.

Establishing agreed-upon standards and competences provides a solid foundation for a coordinated response. A key element of flood response planning is the creation of a mechanism for coordinating response efforts, allowing for swift and well-organized actions. Lastly, having predetermined attendance plans – or predetermined prepositioning plans - based on accurate and timely warnings helps mobilize resources efficiently when a flood threat is imminent.

In summary, flood response planning is a multifaceted process that encompasses numerous critical elements to efficiently mitigate the impact of floods. It involves considering specific hazards, analyzing hydrology and local infrastructure, studying previous incidents, consulting tide charts and flood data, conducting climate change impact assessments, utilizing water depth markers, and utilizing preplanning documents. These measures enable communities to develop resilient strategies aimed at safeguarding lives, property, and the environment during flooding events. Effective flood response planning transcends mere preparedness; it represents an indispensable means of ensuring the safety and well-being of vulnerable regions in the unpredictable face of nature's destructive forces.

Moreover, the development of a comprehensive flood rescue operations includes strategic resource allocation, extensive training, and active community engagement. A well-prepared and seamlessly coordinated response has the potential to significantly curtail the adverse effects of floods on communities while saving precious lives. It is of utmost importance that emergency management agencies proactively formulate and regularly update these plans to adapt to evolving flood risks and enhance response capabilities.

5.2.1.2 Safety and Security

Safety and security are two fundamental aspects of our daily lives, often intertwined yet distinct in their objectives and applications. While both strive to protect individuals, assets, and systems, they do so from different perspectives—safety from physical harm and accidents, and security from intentional threats and breaches. In emergency management and more particularly in response operations, safety and security are foundational to the wellbeing of first responders and to the conduction of operations. For the purpose of this manual, here will be outlined a general definition of safety and security, and for each hazard, a more specific application of the concepts of safety and security.

As said, safety primarily revolves around safeguarding individuals, assets, or systems from physical harm, accidents, and hazards. It encompasses a wide array of preventive actions and procedures that aim to reduce the likelihood of accidents or injuries. Safety measures are crucial in preserving the physical well-being and health of individuals and communities. These measures encompass a spectrum of practices, from safety inspections and training programs to the development and adherence to safety guidelines.

The importance of safety cannot be overstated. It serves as the foundation for accident prevention and risk reduction in various domains, including industries, transportation, healthcare, and everyday activities. Safety initiatives not only save lives but also protect property and promote overall well-being. For instance, in the workplace, safety measures such as personal protective equipment, safety protocols, and regular safety audits ensure that employees can perform their tasks without undue risk.

On the other hand, security is primarily concerned with protecting assets, information, and systems from intentional threats, which may include unauthorized access, theft, sabotage, and cyberattacks. Unlike safety, which focuses on preventing accidents, security measures are proactive and designed to detect, deter, and respond to threats. The domain of security

encompasses a wide range of technologies and strategies, including surveillance systems, access control mechanisms, encryption, and cybersecurity measures.

While safety and security may appear as distinct concepts, they often intersect and complement each other in various scenarios. Consider, for instance, the safety measures implemented at an airport. Passengers undergo security screenings to prevent unauthorized individuals from carrying dangerous items onto an aircraft. These security measures are integral to ensuring the safety of passengers during their flight.

Moreover, safety and security often converge in critical infrastructure and industrial settings. Chemical plants, nuclear facilities, and power generation stations employ stringent security protocols to prevent unauthorized access and sabotage, thereby ensuring both the safety of workers and the integrity of the facilities. In such cases, safety and security are inseparable elements of risk management.

The hazards present in floodwaters constitute a critical aspect of both safety and security in flood response efforts. These hazards are diverse and can include sewage, household chemicals, cleaning solutions, petroleum products, hazardous industrial chemicals, pesticides, and flammable liquids. The presence of these contaminants poses a significant risk to both responders and affected communities. In the wake of a flood event, the first responders are tasked with navigating through this complex matrix of hazards.

First and foremost, responders must be acutely aware of the dangers posed by the various contaminants present in floodwaters. Sewage and household chemicals can introduce harmful pathogens and toxins into the environment, posing a health risk to those exposed. Meanwhile, petroleum products and flammable liquids introduce the potential for fires and explosions, adding another layer of complexity to the response efforts. Hazardous industrial chemicals and pesticides further compound the challenge, demanding careful handling and containment to prevent widespread contamination.

Beyond the chemical hazards, first responders must also contend with physical hazards concealed by the floodwaters. Storm debris, submerged obstacles, depressions, drainage openings, and ground erosion all lurk beneath the surface, posing risks of injury or entrapment. Additionally, displaced reptiles and other animals can add an element of unpredictability to the response, requiring precautions to avoid confrontations that could further strain resources and escalate the danger.

Considering these multifaceted hazards, it is imperative that workers and volunteers engaged in flood response prioritize their safety and well-being. Avoiding direct skin contact with floodwaters whenever possible is a fundamental precautionary measure. This can be achieved through the use of appropriate personal protective equipment (PPE) and clothing designed to shield against contamination and injury. The selection of PPE is a nuanced process that depends on site-specific conditions, the nature of hazards present, and the specific tasks at hand.

For example, responders dealing with potentially contaminated floodwaters may require impermeable suits, gloves, and eye protection to prevent direct contact with the hazardous substances. In contrast, those involved in debris removal and search-and-rescue operations may require rugged attire and specialized equipment to navigate the physically challenging and dynamic environment.

In essence, the management of safety and security in flood response extends beyond the immediate actions taken in the aftermath of a flood event. It necessitates comprehensive risk assessment, appropriate training, and the provision of the right protective gear to those on the front lines. By recognizing and addressing the diverse hazards present in floodwaters, responders can carry out their operations more effectively, safeguarding their own well-being while ensuring the security of the affected communities.

5.2.1.3 Assessment and Evaluation

Central to any successful response and rescue operation is a clear and thorough understanding of the flooded area. Response teams must conduct a comprehensive assessment and evaluation of the flooded area to gather critical information about the extent and severity of the flooding, including the affected regions, water levels, population at risk, and the potential for further inundation, to prevent any complications to the relief efforts. In order to effectively carry out response and rescue activities, teams must undertake preliminary assessment and evaluation of several key elements. These include:

- *General overview of flooded area*: The team needs to have a general understanding of the extent, severity, and characteristics of the flooded area. This can help the team to identify the priority areas, allocate resources, and plan strategies. The team can use various sources of information, such as satellite images, aerial photos, maps, or reports

from local authorities or communities, to obtain a general overview of the flooded area.

- *Population at risk*: The team needs to estimate the number and location of people who are affected by the flood or who are in need of assistance. This can help the team to determine the scale and scope of the response and rescue operations, and to provide appropriate services and support. The team can use demographic data, census records, or surveys to estimate the population at risk.

- *Identification of critical infrastructure to evacuate*: The team needs to identify the critical infrastructure that is at risk of being damaged or destroyed by the flood, or that is essential for the survival and well-being of the population. This can include buildings, roads, bridges, power lines, water supply systems, hospitals, schools, or shelters. The team needs to evacuate the people who are in or near these critical infrastructures, and to protect or repair them if possible.

- *Hazard identification*: The team needs to identify the potential hazards that are associated with the flood or that may arise during the response and rescue activities. These can include waterborne diseases, electrocution, landslides, debris, chemical spills, or explosions. The team needs to assess the likelihood and impact of these hazards, and to take preventive or mitigating measures to reduce their effects.

- *Risk assessment, including urban risk assessment*: The team needs to assess the overall risk level of the flooded area, considering the hazards, vulnerabilities, and capacities of the population and the infrastructure. The team also needs to conduct an urban risk assessment if the flood affects a densely populated and complex urban area. This can help the team to identify the specific challenges and opportunities that are related to urban settings, such as high population density, social diversity, economic inequality, environmental degradation, or governance issues.

- *Risk treatment through control measures*, if necessary: The team needs to implement control measures to reduce or eliminate the risks that are identified in the previous steps. These can include structural measures, such as building dams, levees, or drainage systems; non-structural measures, such as raising awareness, providing education, or enforcing regulations; or emergency measures, such as evacuating people, distributing relief items, or providing medical care.

- *Access to scene and road structural situation*: The team needs to evaluate the accessibility and condition of the roads and routes that lead to the flooded area. This can help the team to determine the best mode of transportation and equipment that can be used for the response and rescue activities. The team also needs to consider the safety and security issues that may affect their access to the scene.

- *Infrastructure interventions*: The team needs to perform infrastructure interventions to restore or improve the functionality and resilience of the critical infrastructures that are affected by the flood. These can include repairing damages, clearing debris, restoring power supply or water supply systems; building temporary shelters; or installing early warning systems.

- *Communication systems and procedures*: The team needs to establish communication systems and procedures that can facilitate information exchange and coordination among the team members and with other stakeholders. These can include radio communication devices; mobile phones; internet access; social media platforms; or standard operating procedures.

These are some of the key elements that response and rescue teams need to assess and evaluate before conducting their activities in flood settings. By doing so, they can enhance their efficiency and effectiveness in providing assistance and relief to the affected populations and infrastructures.

5.2.1.4 First Aid

In every emergency response and rescue operations there might be the need to provide basic care and first aid, whereas first responders are not trained as paramedic or emergency physicians. Every first responder must undergo basic first aid training as complementary to their general training. Moreover, first aid training serves as the foundation for effective response efforts, enabling individuals involved in rescue operations to deliver critical care when it matters most. The ability to provide immediate care and support to those in distress can make all the difference between life and death. The following section highlights general concepts of first aid and basic care; in addition, a more specific overview of first aid is described for each of the hazards of these chapter: floods, landslides and fires.

Basic First Aid Skills for All Rescuers

In any rescue operation, whether it involves disasters, accidents of any kind, or medical emergencies, the priority is to ensure the safety and well-being of those affected. This begins with providing immediate care to those in need. During the critical moments following an incident, such as a car accident, earthquake, or medical emergency, trained first responders can be the difference between life and death. They are equipped to assess the situation, administer cardiopulmonary resuscitation (CPR), and use automated external defibrillators (AEDs) to restart a person's heart. While first aid is a fundamental skill, it is important to recognize its limitations. First responders can provide initial care for common injuries, such as cuts, fractures, burns, and bruises, as they are not all trained as paramedics. Moreover, they can offer comfort and reassurance to those in distress. However, the treatment of more complex medical conditions or severe trauma requires the expertise of advanced trained personnel and paramedics.

Basic Life Support (BLS) and Automated External Defibrillator (AED) training are fundamental components of first aid for rescuers. BLS training allows individuals perform CPR, initiate chest compressions, and provide rescue breaths, skills that are critical for reviving someone in cardiac arrest. Moreover, given the evolution of BLS practice, pediatric BLS is essential for rescuers when children are involved in accidents or in any other dangerous situation.

First aid also includes the treatment of minor injuries, which are common in various rescue scenarios. This encompasses wound care, the application of bandages and dressings, splinting for fractures, and providing pain relief. Being able to address minor injuries promptly prevents them from worsening and ensures the comfort of those affected.

Rescuers are taught how to assess the condition of individuals they encounter. This includes checking vital signs, identifying signs of distress, and determining the appropriate course of action. The ability to make quick and informed decisions is crucial for prioritizing care and allocating resources effectively.

First Aid for Specific Rescue Scenarios: Floods

Floods are among the most devastating natural disasters, causing widespread damage and posing significant risks to human life. First aid in flood rescue operations is critical due to the unique challenges presented by these events:

- *Water Safety*

In flood scenarios, water safety is a top priority. Rescuers must be trained to assess water conditions, including currents and contamination levels, to ensure their own safety as well as that of the victims. Additionally, they should know how to use personal flotation devices and watercraft safely when necessary for rescue efforts.

- *Swift Water Rescue*

Swift water rescue is a specialized skillset required for flood response. It involves techniques for safely navigating fast-moving water, often using ropes, harnesses, and flotation devices. First aid for swift water rescue includes:

a) **Immersion Hypothermia:** Recognizing and treating hypothermia in victims exposed to cold floodwaters.

b) **Drowning Prevention:** Identifying and responding to drowning victims promptly by performing water rescues and providing immediate life support.

c) **Waterborne Illness:** Awareness of the risk of waterborne diseases and providing prophylactic treatment or referrals for potential infections.

- *Flood-Related Injuries*

Floodwaters carry various hazards, including submerged debris, sharp objects, and the risk of electrocution from downed power lines. First aid for flood-related injuries includes:

a) **Wound Care:** Treating wounds and lacerations sustained during flooding, which may be contaminated by dirty water.

b) **Electrocution:** Recognizing electrical injuries and ensuring the safety of the victim and rescuers by de-energizing the source or using appropriate rescue techniques.

c) **Dehydration and Exposure:** Addressing issues related to exposure to floodwaters, such as dehydration and heat or cold-related illnesses.

- *Mental Health Support*

Disasters victims often experience extreme stress and trauma. Rescuers trained in first aid should be equipped to provide psychological first aid, offering comfort, reassurance, and referrals for mental health support when needed. Recognizing signs of distress and offering a compassionate response can help mitigate the long-term psychological impact of the disaster.

Overall, in the realm of rescue operations, first aid training is the bedrock upon which efficient and lifesaving responses are built. It equips rescuers with essential skills to provide immediate care, stabilize patients, and make informed decisions in high-pressure situations. However, it is crucial to acknowledge the limitations of first aid and recognize when advanced medical assistance is required.

5.2.1.5 Evacuation and Rescue

Evacuation and rescue are two critical aspects of emergency response that involve saving lives and moving people away from danger. First responders are trained and equipped to perform rescue and evacuation operations in various scenarios, such as disasters, industrial accidents, urban fires, or terrorist attacks.

To carry out evacuation and rescue effectively and safely, first responders should organize their operations based on a general principle that for certain hazards, rescue operations can be undertaken in a more prolonged time with a forecast situation.

There are several critical factors to consider when organizing rescue and evacuation operations. *A) Planning*: planning for evacuation may be necessary in some situations. If the evacuation operation is likely to be large or complex, it may be wise to have a separate plan for it. Alternatively, evacuation can be included in the main emergency management plan or in an annex or a sub-plan. Sometimes, evacuation may be needed urgently in disaster situations that were not anticipated or planned for. The decision to evacuate may have to be made quickly during rescue operations, with limited time and information. The decision-making process and the execution of the decision will depend on the existing evacuation powers and whether evacuation can be enforced or not. When determining the necessity of evacuation, several factors should be considered:

1. The number of individuals requiring evacuation.

2. The impact of the hazard on the affected area.

3. The condition of the evacuation routes.

4. Current and future weather conditions.

5. Vulnerable people and demographics.

6. The estimated duration for the evacuation.

7. The available timeframe for completing the evacuation.

8. Required resources for the evacuation.

9. The availability of resources for the evacuation.

10. The adequacy of shelter and support services for evacuees.

11. The safety of both evacuees and emergency service personnel.

12. The necessity of relocating and caring for companion animals and pets.

B) Training: first responders should have adequate and regular training on rescue and evacuation techniques, equipment, protocols, and safety measures. Training should include both theoretical and practical exercises that simulate realistic scenarios and challenges. Training should also involve collaboration and coordination with other agencies and organizations that may be involved in rescue and evacuation operations.

C) Implementation: first responders should execute the rescue and evacuation plan according to the established procedures and protocols. They should follow the command structure and the communication system that are designated for the operation. They should use the appropriate equipment and tools that are suitable for the type and scale of the emergency. They should also follow the safety rules and precautions that are necessary to protect themselves and others from harm.

D) Evaluation: first responders should evaluate the rescue and evacuation operation after it is completed or terminated. They should collect data and feedback from various sources, such as reports, records, observations, interviews, surveys, or debriefings. They should analyze the data and feedback to identify the strengths, weaknesses, opportunities, and threats of the operation. They should also make recommendations for improvement and learning for future operations.

Whereas these considerations are mainly applicable to flood rescue and landslides, fire rescue cannot put in place a more detailed planning given the unpredictability of fires, specifically urban and industrial fires.

5.2.1.6   Search and Rescue

Search and rescue operations (SAR) are the essence of disaster relief operations, as they are designed and put in place to identify, recognize, extract and evacuate people affected by disasters and other calamities. SAR operations (SAR-OPS) are thoroughly and carefully planned, organized, and tested during peace times. First responders involved in specialty SAR, such as floods, landslides, and earthquakes, undergo complex training, that includes a diverse range of activities. Here, it will be discussed general concepts that apply throughout the diverse types of SAR operations. A more specific SAR for floods will be discussed at the end of the paragraph.

One of the fundamental principles of SAR is proper assessment. Time is often of the essence in these situations, and a swift and accurate evaluation of the circumstances can mean the difference between life and death. The first step in any SAR operation is to collect vital information about the extent of the damage and the potential for further harm. This information can be obtained through visual inspection and communication with the local community. Effective communication with survivors and witnesses is paramount, as it helps SAR teams understand the situation better and plan their response accordingly.

Time is a critical factor in search and rescue missions. Unlike many other emergency situations, SAR operations often involve individuals who are in immediate and life-threatening danger. This urgency stems from various scenarios, such as survivors trapped under debris after a disaster, or individuals swept away by fast-flowing flood waters.

In these situations, the clock is ticking, and every passing minute can mean the difference between life and death. The longer it takes to locate and reach the missing person, the greater the risk to their safety and survival. Consequently, SAR teams must mobilize rapidly, deploy resources efficiently, and employ well-honed search techniques to maximize their chances of success.

Another factor to consider when operating SAR is the terrain in which SAR missions unfold. It is highly variable. Diverse landscapes pose unique challenges to SAR teams, often requiring

specialized skills, equipment, and strategies. Terrain-related challenges can significantly slow down SAR operations. Factors such as limited visibility, harsh weather, and rough terrain may hinder the progress of search teams. In such cases, technology, including drones, GPS, and thermal imaging, has become invaluable in enhancing search capabilities and improving overall mission efficiency.

Search and rescue demand coordination and meticulous planning among its members. Effective communication and collaboration are essential components of a successful SAR operation. Each team member plays a crucial role, from those on the front lines conducting searches to those overseeing logistics and support. An incident action plan, developed based on the assessment of the situation, serves as the roadmap for the operation. This plan outlines objectives, resources, and timelines, ensuring that all aspects of the rescue effort are accounted for.

Phases of a Rescue Operation

To facilitate a systematic approach to SAR, rescue operations – therefore flood SAR-OPS - are typically divided into various phases:

1. Locating the Surface Casualty: This initial phase involves identifying the general location of individuals in distress. It serves as the starting point for the operation.

2. Searching in slightly damaged buildings (Immediate Rescue): In situations where buildings are partially damaged, SAR teams must enter these structures cautiously to search for survivors.

3. Searching of Possible Survival Points (Specialized Rescue): In more complex scenarios, specialized teams may be required to search for individuals in areas where they are likely to seek refuge or safety.

4. Selected Debris Clearance (Specialized Rescue): when survivors are trapped under debris, specialized teams are responsible for clearing specific sections to access and rescue them.

5. General Debris Clearance (Specialized Rescue): in situations where extensive debris needs to be cleared to reach survivors, specialized teams are deployed to manage this critical task.

In SAR operations, team find great support in Drones. Drones provide unique capabilities that are leveraged by emergency service providers all over the world. They are already saving thousands of lives through participation in various public emergency and safety operations. Here are the main benefits:

- **Speed of Response:** Drones can reach a location a lot faster than ground-based vehicles

- **Situational Awareness:** drones allow responders to map the entire search zone and pinpoint possible places where the missing person might be trapped.

- **Detection and Identification:** Drones can carry different sensors, including thermal cameras, which are extensively used in search and rescue missions

- **Communication:** Drones equipped with a loudspeaker can broadcast a message repeatedly, making the missing person aware that a search is underway.

- **Illumination:** Drones can carry spotlights to light up target areas, providing additional visibility during night operations.

When responding to floods, SAR teams typically confront a harsh environment, surrounded by stagnant waters that represent a challenge when moving with vehicles. Most of the SAR operations are carried out on foot - whereas the water depth is not too high – or with the support of special boats designed for SAR operations.

Central to flood SAR is the deployment of teams in evaluating the number and location of people in their houses (on higher levels); the number and location of people that need to be evacuated to shelters; the number and location of people that need medical assistance; people declared missing; the presence of pets. Most of the SAR operations are conducted on land and from the air, with the support of helicopters.

Flood SAR-OPS encompass a pre- and post- relief operations. During floods, the most urgent priority is to quickly and effectively rescue people who are in danger. This involves moving

them from the risk zone to a safe place, providing them with food, water, medicine, and shelter, and monitoring the flood situation. The goal of the rescue operation is to reduce the likelihood and impacts of floods on people, the economy, and the environment.

After floods, the main task is to help the affected people recover from the disaster. This requires careful planning and coordination of relief operations that can ease their suffering. Relief operations can include setting up emergency facilities, distributing aid, transporting injured people, restoring public facilities and houses in the affected areas.

Figure 5.1. SAR operations after Emilia Romagna floods, Italy 2023.

Figure 5.2. SAR operations after Emilia Romagna floods, Italy 2023.

5.2.2   Landslides

Landslides and debris flows are natural hazards that can strike with little warning, leaving devastation in their wake. These geological events are influenced by a complex interplay of natural factors, such as earthquakes, heavy rainfall, volcanic activity, and human-induced alterations to the landscape. Often occurring in mountainous regions where loose materials are abundant, landslides and debris flows pose significant threats to both human settlements and the environment. In this section, several important topics on landslides rescue operations will be introduced. The chapter will the critical importance of preparedness and planning for SAR operations; safety and security of first responders, and what is important to know in search and rescue.

5.2.2.1   Developing a plan

Landslides are another natural hazard that require emergency management agencies and rescue organizations to be prepared and ready to assist the affected communities. Landslides can cause more damage than floods, as they have a high speed and force of impact. They also have a short warning time, which means that first responders have to act quickly and efficiently. Therefore, it is essential to have a clear and comprehensive plan for landslides rescue operations, which ensures the rapid deployment of resources, the continuous monitoring of the affected area, and the smooth coordination of rescue activities.

One of the key aspects of preparing for landslides is to identify the resource needs of agencies involved in emergency management and response. These needs should be based on the actual situation and not limited by the available resources. A thorough assessment should be conducted to determine the physical assets and human expertise that are required for an effective response to landslides. Then, various potential sources of resources should be explored, as landslides may require external support from other agencies or regions. As part of preparedness, emergency plans should also include an updated 24-hour contact list of landslide experts and resource providers, as well as a close collaboration with other emergency management and rescue agencies.

Another important aspect of responding to landslides is to have an operational plan that outlines the critical factors that influence the response and rescue operations. These factors include the risk assessment, the communication system, the command structure, the roles and responsibilities, the safety procedures, the evacuation plan, the recovery plan, and the

evaluation process. An operational plan should be developed in advance and implemented during the incident itself.

Responding in a landslide-prone areas involves many hazards. Before sending resources and personnel into such areas, it is vital to evaluate their capacity to function effectively in this challenging context. Moreover, it is imperative that rescuers have a thorough awareness of the possible risks they could face and how to mitigate them.

To begin, central to landslides response planning is the identification and assessment of specific hazards within the area prone to landslides. These hazards encompass a range of elements, including ground cracking, ground movements, slope instability, road damage, etc. For this reason, it is important that emergency planners and rescue organizations start drafting the plan by understanding the geographical area that might interests the possible rescue operations. Moreover, in order to prepare a well-rounded plan, several critical questions must be addressed in this process, that will allow planners to understand peculiar characteristics of the area. This includes:

- What is the geographical extent of the area under consideration?
- What is the geological profile of the area?
- Is there any historical database of landslides for the area under consideration?
- What are, if any, the critical infrastructures in the area?
- How large is the population at risk?
- What characteristics has the population at risk?
- What are the likely evacuation routes?

To start, a foundational element of landslide response planning involves knowing the *geological history of the area* and the previous events, is crucial for landslide response planning. Analyzing historical landslides events, their impacts, and response efforts provides valuable insights for future planning. This retrospective examination helps planners identify recurring issues, develop more effective strategies, and allocate resources where they are most needed. In addition, incorporating data on previous landslides is equally fundamental. Examining past landslides events, their duration, and their aftermath can provide crucial information for understanding the potential consequences of future landslides. This historical context informs emergency response strategies, resource allocation, and the development of more resilient infrastructure.

The next crucial phase in comprehensive landslide response planning involves conducting a thorough examination of the *local infrastructure*. This includes a careful assessment of various elements such as roads, bridges, utility systems, and essential facilities within the region. This assessment aims to pinpoint weak points in the infrastructure so that planners can give priority to activities like strengthening, scheduling maintenance, or even considering the relocation of vital assets. These measures are intended to reduce the impact of floods and minimize damage.

Early warning systems are designed to detect and warn emergency management agencies and rescue organizations of potential landslides. They can be used to evacuate people from danger areas and to reduce the loss of life and property. There are a number of different types of early warning systems for landslides. Some of the most common types include:

- *Geotechnical monitoring***:** This involves monitoring the ground for changes that could indicate a landslide, such as ground cracks, soil movement, and changes in water levels.

- *Remote sensing***:** This involves using satellites and other sensors to monitor landslide-prone areas for changes in land cover, vegetation, and other factors that could increase the risk of a landslide.

- *InSAR***:** This stands for Interferometric Synthetic Aperture Radar. It is a remote sensing technique that can be used to measure changes in the ground surface over time. This can be used to detect landslides that have already occurred or that are about to occur.

- *Humanitarian early warning systems***:** These systems rely on people to report signs of landslides, such as unusual ground movement or the sound of trees cracking.

Rescue planning must identify a *clear command structure* that will be established to coordinate the rescue operations. In most of the cases, landslides are local, and do not require multi-agency, multi-jurisdictional interventions. However, there are cases when this is necessary, and there will be the need to put in place a structure under a unified command. Coordination between SAR teams and the incident command structure is vital to ensure a well-organized response. In addition, *preplanning documents* delineate roles and responsibilities, and specify resource allocation and deployment procedures.

Search and rescue (SAR) operations are a core element of landslide response. Teams trained in searching on slopes, debris, and impervious environments, should be ready to deploy at a moment's notice. These teams may use drones (UAV), K-9 units, helicopters for air-rescue, special technological equipment to locate and rescue individuals trapped in cracked houses, or in other dangerous places. To carry out such SAR operations effectively, rescue teams need to undergo periodical training to be better prepared to respond to landslides emergencies. This includes slope climbing with safety equipment; K-9 training; specialized first aid; helicopter rescue.

Evacuation is often necessary in landslides-prone areas. Developing evacuation plans that consider the needs of vulnerable populations, such as the elderly, disabled, and those without transportation, is crucial. Identifying safe evacuation routes and establishing shelters can save lives during a flood event. It is also essential to coordinate with transportation authorities to ensure the smooth flow of evacuees. Evacuation planning must also consider that landslides may bring massive disruption to infrastructures, with heavy damages to roads. For this reason, a thorough planning must consider what type of damage landslides may induce. Based on the type of landslide, here are some of the possible effects are:

- Subsidence: this is when the ground beneath the road sinks or collapses, creating cracks, holes, or uneven surfaces on the road. Subsidence can be caused by the removal of soil or rock by landslides, or by the infiltration of water into the ground. Subsidence can make roads unsafe or impassable for vehicles and pedestrians.
- Debris flow: this is when a mixture of soil, rock, water, and vegetation moves rapidly down a slope, carrying along anything in its path. Debris flows can cover roads with mud, rocks, trees, or other materials, blocking or destroying them. Debris flows can also damage bridges, culverts, guardrails, or other structures along the road.
- Rockfall: this is when individual rocks or boulders detach from a steep slope and fall or roll down. Rockfalls can hit or crush vehicles, damage road surfaces, or create obstacles on the road. Rockfalls can also trigger other landslides or debris flows.
- Road cut failure: this is when the slope above or below a road that has been excavated to create a flat surface collapses or slides. Road cut failures can undermine the stability of the road, cause cracks or fissures on the road surface, or bury the road with soil or rock.

Community participation is equally important in landslides planning. community is of utmost importance. It is essential to inform residents about flood hazards, early warning systems, and evacuation protocols. This proactive approach can lead to a decrease in the number of individuals needing rescue during a flood event and foster greater resilience within the community. Furthermore, engaging community leaders and organizations in the planning phase can improve collaboration and coordination during emergency situations.

Figure 5.3. Aerial view of a landslide.

5.2.2.2 Safety and Security

The concepts of safety and security have been already introduced in point 5.4.2. In the case of landslides, here it will be described the major threats to safety and security when working in landslides rescue operations.

1. *Environmental hazards*

- o *Falling Debris and Rocks*: One of the most immediate dangers faced by landslide responders is the potential for falling debris and rocks. Landslides can dislodge large boulders and rocks that may pose a threat to the safety of rescue workers. These falling objects can cause injuries or fatalities if responders are not adequately protected or positioned strategically.

o *Instability of Terrain*: Landslide sites are characterized by unstable terrain. Rescuers often must navigate through treacherous and unpredictable ground conditions, including loose soil, mud, and slippery surfaces. The risk of tripping, slipping, or getting trapped in the unstable terrain is a constant concern.

o *Rapid Changes in Weather Conditions*: Landslide response operations can take place in various weather conditions. Responders may encounter heavy rain, snow, or extreme temperatures that can compromise their safety and well-being. Exposure to harsh weather can lead to hypothermia, heat exhaustion, or other weather-related health issues.

o *Water Hazards*: Landslides can lead to the formation of temporary water bodies such as ponds or lakes, posing a drowning risk for responders. The sudden rise of water levels in these areas can catch responders off guard and make it challenging to escape.

o *Toxic Chemicals and Pollutants*: Landslides can cause the damage to landfills with the subsequent release of hazardous chemicals and pollutants into the environment. Responders may come into contact with contaminated soil, water, or air, leading to potential health risks, including chemical burns or respiratory problems.

2. **Structural Hazards**

o *Building and Infrastructure Damage*: Landslides can cause extensive damage to buildings and infrastructure in affected areas. Responders entering damaged structures risk encountering unstable or collapsed buildings, which can lead to injuries or fatalities.

o *Utility Hazards*: Landslides can disrupt utility services such as gas, electricity, and water supply. Responders may encounter live electrical wires, gas leaks, or contaminated water sources, posing risks of electrocution, fires, or exposure to harmful substances.

Mitigating these risks requires a multifaceted approach, including comprehensive training, access to appropriate PPE, well-defined safety protocols, and the provision of psychological support. It is imperative that response agencies and organizations prioritize the safety and

well-being of their personnel to ensure effective and efficient landslide response operations while minimizing the risks to responders.

5.2.2.3 Assessment and Evaluation

Landslides are natural geohazards that pose significant threats to communities, infrastructure, and the environment worldwide. Understanding and assessing landslides is crucial for mitigating their impacts and safeguarding lives and property. Conducting thorough landslide assessments is essential to ensure the safety and effectiveness of rescue teams, improve response times, and increase the chances of saving lives. In this essay, we will delve into the crucial role of landslide assessment in rescue operations.

Agencies and response organizations must assess the landslide conditions for several reasons:

1. *Rescue Team Safety*: Before rescue teams can be deployed to landslide-affected areas, it is imperative to assess the stability of the terrain. This assessment ensures the safety of rescue personnel, preventing further casualties.

2. *Target Identification*: Accurate landslide assessments help pinpoint the exact locations where people may be trapped or stranded. This information is vital for rescue teams to prioritize their efforts effectively.

3. *Resource Allocation*: Assessment data aids in resource allocation, enabling rescue operations to deploy the right equipment, personnel, and supplies to the affected areas promptly.

4. *Response Planning*: The information gathered from landslide assessments forms the foundation for creating effective response plans, optimizing rescue efforts and minimizing response time.

Several methods are employed for landslide assessment in the context of rescue operations, each tailored to the urgency and complexity of the situation:

1. *Visual Inspections*: Initially, visual assessments are conducted by rescue personnel to identify visible signs of instability, such as cracks, soil movement, or debris accumulation.

2. ***Aerial Surveys***: Helicopters or drones equipped with cameras are used to conduct aerial surveys of landslide-affected areas. This provides an overview of the extent of damage and can help locate potential survivors.

3. ***Ground-Based Reconnaissance***: Ground teams equipped with geotechnical tools assess the stability of the ground and the presence of hazards like unstable slopes or debris flows.

4. ***Remote Sensing***: Satellite imagery and advanced remote sensing technology can provide real-time information on ground movement, aiding in the assessment of evolving landslide situations.

5. ***Geological Data***: Geological data, including historical records of landslides and soil composition, are crucial for understanding the underlying factors contributing to the landslide event.

Once landslide assessments have been conducted, rescue operations can be organized and executed efficiently. Strategies for effective rescue operations in landslide-affected areas include:

1. ***Establishing Safe Zones***: Based on assessment findings, create safe zones for rescue teams to operate from, minimizing the risk to responders.

2. ***Communication and Coordination***: Effective communication and coordination between rescue teams, emergency services, and local authorities are essential to streamline operations and avoid duplication of efforts.

3. ***Utilizing Specialized Equipment***: Equip rescue teams with specialized tools and equipment for landslide-specific scenarios, such as shoring materials and ground-penetrating radar.

4. ***Search and Rescue Protocols***: Implement search and rescue protocols tailored to landslide conditions, including strategies for debris removal, victim extraction, and medical care.

5. ***Continuous Assessment***: Regularly reassess the landslide-affected area to monitor stability and adapt rescue strategies accordingly.

5.2.2.4 First Aid

- *First Aid for Landslides*

Landslides pose unique challenges for rescuers due to the inherent dangers of unstable terrain and potential mass casualties. First aid for landslides involves a combination of general first aid skills and specialized knowledge:

a) **Scene Safety:** Ensuring the safety of rescuers and victims is important. Rescuers must assess the stability of the terrain to avoid further risks.

b) **Initial Assessment:** Quick evaluation of victims to determine the severity of injuries and prioritize treatment. This may include extracting individuals trapped beneath debris or mud.

c) **Airway Management:** Clearing airways of victims who may have difficulty breathing due to mud or debris inhalation.

d) **Hemorrhage Control:** Treating bleeding injuries and applying pressure bandages, tourniquets, or hemostatic agents as needed.

e) **Shock Management:** Recognizing and addressing shock symptoms in victims and providing appropriate care.

f) **Evacuation Planning:** Coordinating with rescue teams to safely transport injured individuals to medical facilities.

- *Mental Health Support*

Disasters victims often experience extreme stress and trauma. Rescuers trained in first aid should be equipped to provide psychological first aid, offering comfort, reassurance, and referrals for mental health support when needed. Recognizing signs of distress and offering a compassionate response can help mitigate the long-term psychological impact of the disaster.

Overall, in the realm of rescue operations, first aid training is the bedrock upon which efficient and lifesaving responses are built. It equips rescuers with essential skills to provide immediate care, stabilize patients, and make informed decisions in high-pressure situations.

However, it is crucial to acknowledge the limitations of first aid and recognize when advanced medical assistance is required.

5.2.2.5 Evacuation and Rescue

Evacuation after landslides is a crucial step to ensure the safety and survival of people who are affected by the disaster. Communities who live in areas that are prone to landslides should learn about the local emergency response and evacuation plans, and prepare an emergency kit that includes food, water, flashlight, radio, first aid kit, and other essential items.

If a landslide occurs or is likely to occur, people should evacuate and be evacuated by first responders immediately, and if possible, other communities and authorities should be informed. People affected by landslides should be evacuated to the nearest safe high ground away from the path of the landslide or debris flow. Driving should not be permitted, or walking through areas that are affected by landslides or flooding must not be allowed, as they might pose threat to human safety and lives.

Evacuation procedures for first responders after landslides are essential to ensure the safety of the rescuers and the victims. Landslides can be triggered other several times and can pose major threats. For these reasons, evacuation operations must be carried out following the highest standards of safety and according to the established national or international protocols and procedures.

In the aftermath of a landslide, first responders provide immediate assistance to the affected people. First responders must follow established guidelines and protocols when evacuating themselves and others from a landslide area. Some of the key steps are:

✔ Communicate immediately with the local or state EOC and provide information about the location, type, size, and extent of the landslide; the number and condition of the victims; the accessibility and safety of the site; and the availability of resources and equipment.

✔ Assess the situation and determine the level of risk and urgency. Consider the potential for additional landslides or flooding; the stability of the ground, structures, and utilities; the presence of hazardous materials or substances; and the weather conditions.

✔ Establish a command post and a staging area away from the landslide zone. Coordinate with other agencies and organizations involved in the response. Communicate clearly and frequently with other responders and authorities.

✔ Follow the established evacuation signal to alert other responders and victims of an imminent danger or a need to evacuate. The evacuation signal can consist of a specific sound or visual sign.

✔ Assist physically impaired individuals to a secure area and notify emergency responders. Do not leave them alone or in danger. Use blankets, wheelchairs, crutches, or other aids if available.

✔ Stay away from the slide area until it is declared safe by the authorities. Other additional landslides or flooding may occur after the initial event and might increase the level of risk and induce secondary hazards, such as gas leaks, electrical hazards, water contamination, or structural damage.

After this through evaluation, first responders and emergency management agencies should also have a clear view of the roads and evacuation routes conditions. This is the most critical aspect when organizing an evacuation. Main roads can be damaged, and organizations might not be able to transport affected people to recovery centers (see 5.8).

5.2.2.6 Search and Rescue

Search and rescue operations after landslides are complex because there is an interplay of critical factors that emergency management agencies and first responders must consider:

● Landslides are unpredictable and can occur suddenly again, after a first landslide, leaving little time for preparation and evacuation.

● Landslides can cause extensive damage and destruction to the environment, infrastructure, and properties. They can also bury or trap people under tons of debris, making it difficult to locate and reach them. Landslides can also be accompanied by flooding, which can worsen the situation and hamper the rescue efforts.

- Search and rescue operations after landslides require a large number of personnel, equipment, and resources from different agencies and organizations. They also require a high level of coordination, communication, and cooperation among the responders and authorities. The rescue operations must follow certain guidelines and protocols to ensure the safety and efficiency of the intervention.

- Search and rescue operations after landslides involve various challenges and risks for the rescuers and the victims. The rescuers must deal with hazardous conditions, such as unstable ground, falling rocks, sharp objects, gas leaks, electrical hazards, water contamination, or structural damage.

- The rescuers also must use appropriate personal protective equipment (PPE), tools, and techniques to assess, search, extricate, and evacuate the victims. The victims may suffer from injuries, dehydration, hypothermia, infection, or psychological trauma.

- Search and rescue operations after landslides are time-sensitive and lifesaving. The chances of survival for the trapped victims decrease rapidly as time passes. The rescuers must act quickly and efficiently to save as many lives as possible. The rescuers also have to prioritize the rescue sites and the victims based on their condition and location.

- Search and rescue operations after landslides are often affected by external factors, such as weather conditions, accessibility issues, resource availability, or public response. The rescue operations may be delayed or suspended due to bad light, inclement weather, or additional landslides or flooding. The rescue operations may also face difficulties in reaching or entering the landslide area due to damaged roads or bridges. SAR operations may also depend on the availability of resources and equipment from local or international sources.

- The rescue operations may also encounter challenges in managing the public response, such as crowd control, media coverage, or local assistance.

Prior to the beginning of SAR operations, first responders and emergency management agencies must do the following:

✔ Follow the established assessment, search and rescue (ASR) levels to determine the type and extent of intervention needed for each zone. The ASR levels are:

- o Level 1: Reconnaissance. A quick survey of the site to identify hazards, victims, access points, resources, and needs.

- o Level 2: Light search and rescue. A systematic search of accessible areas using basic tools and techniques to locate, extricate, and evacuate victims with minor or moderate injuries.

- o Level 3: Medium search and rescue. A more intensive search of partially accessible areas using specialized tools and techniques to locate, extricate, and evacuate victims with serious or life-threatening injuries.

- o Level 4: Heavy search and rescue. A complex search of inaccessible areas using advanced tools and techniques to locate, extricate, and evacuate victims who are trapped or buried under debris.

✔ Follow the established prioritizing strategy to determine the order of rescue for each victim based on their condition and location. The prioritizing strategy is:

- o Immediate: Victims who have life-threatening injuries but are responsive and have a chance of survival if treated quickly.

- o Delayed: Victims who have serious injuries but are stable and can wait for treatment without further deterioration.

- o Minor: Victims who have minor injuries that do not require immediate treatment or evacuation.

- o Dead: Victims who are unresponsive and show no signs of life.

✔ Follow the established marking system to indicate the status of each structure or area searched. The marking system consists of an X symbol with four quadrants that contain information such as date, time, team name or number, hazards present or encountered, number of victims found or removed, etc.

✔ Assist injured personnel or notify emergency responders of the medical emergency. Provide first aid or basic life support if trained and qualified. Do not move seriously injured victims unless they are in immediate danger or instructed by a medical professional.

Some of the techniques used in search and rescue operations after landslides are:

- Using search dogs to locate the scent of trapped victims.

- Using sensitive sound location equipment to detect any noises made by the victims or the movement of debris.

- Using camera systems that investigate voids to visually inspect the condition and location of the victims.

- Using drones and ground penetrating radar to map the extent and depth of the landslide and identify any potential voids or cavities.

- Using diggers and hydraulic jacks to shift rubble and pull aside large concrete slabs that block the access to the victims.
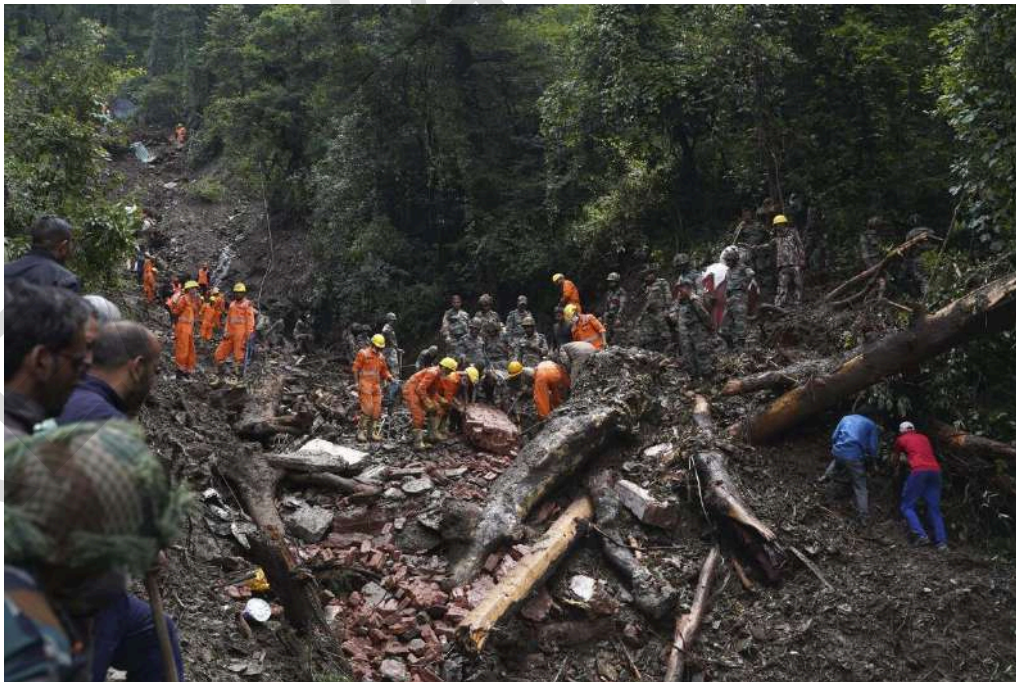

Figure 5.4. Search and rescue after a landslide.

Figure 5.5.Search and rescue after a landslide.

5.2.3 Fire-related disaster

Fire hazards and risks are serious threats to human lives, properties, and the environment. Fire can cause injuries, deaths, damages, and losses that are often irreversible. Fire can also have negative impacts on the ecological balance, air quality, and climate change. Therefore, it is important to understand the diverse typologies of fires and how to prevent and control them.

Fires can be classified into different types based on their fuel sources, such as wood, paper, flammable liquids, electrical equipment, metals, etc. Each type of fire has different characteristics, behaviors, and extinguishing methods. For example, a fire involving wood or paper can be extinguished by water, but a fire involving flammable liquids or electrical equipment can be aggravated by water and require other agents such as foam or carbon dioxide. Similarly, a fire involving metals such as magnesium or sodium can react violently with water and require special agents such as sand or dry powder.

Another way to classify fires is based on their stages of development, such as incipient, growth, fully developed, and decay. Each stage of fire has different indicators, such as heat, smoke, flames, and oxygen levels. For example, an incipient fire is the initial stage of fire where the combustion is localized, and the heat and smoke are minimal. A fully developed

fire is the stage where the fire has spread to all combustible materials in the room and the heat and smoke are at their peak.

Fire hazards and risks can be reduced by implementing various measures, such as fire prevention, fire protection, fire detection, fire suppression, and fire evacuation. Fire prevention involves eliminating or minimizing the sources of ignition and fuel in the environment. Fire protection involves installing or maintaining passive or active systems that can prevent or limit the spread of fire and smoke. Fire detection involves using devices or sensors that can alert people of a fire occurrence. Fire suppression involves using manual or automatic methods to extinguish or control a fire. Fire evacuation involves planning and executing a safe escape from a fire scene.

Fire rescue is primarily carried out by professional firefighters (paid), although there is an increasing number of volunteer firefighters that are trained and equipped to respond to calls, in those areas where communities are less accessible or are far away from central command stations. The numbers across of firefighters across the globe are extremely varying. EU estimated almost 360.000 professional firefighters (see picture, EUROSTAT); NFPA (2022) estimates there were an estimated 1,041,200 career and volunteer firefighters in the United States in 2020; the total number of firefighters were 364,300 (35%) as career firefighters and 676,900 (65%) were volunteer firefighters.
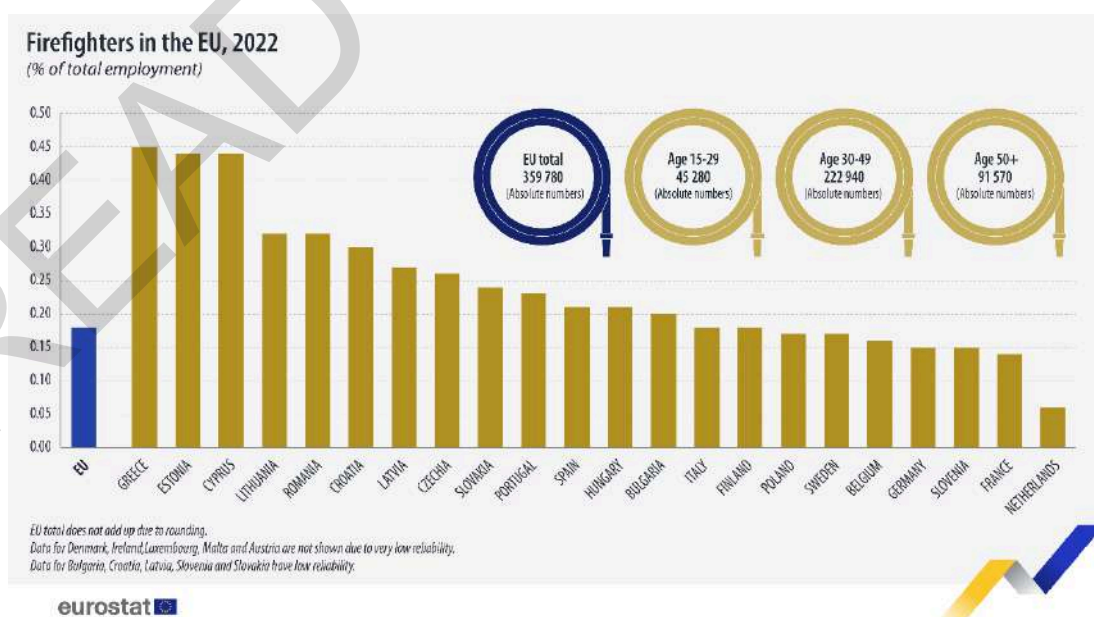

Figure 5.6. EU data on firefighters - EUROSTAT

Every year, thousands of fires occur in urban and industrial areas, not to mentions the very "hot" summers when wildfires spread and burn thousands of hectares. In 2022, 468 289 hectares of forests were burnt.

5.2.3.1 Developing a plan

Developing a fire rescue plan is more complex than developing a rescue plan for other hazards. Fires cannot be easily predicted compared to other hazards, excluding wildfires, where environmental conditions can be monitored, and large response operations can be standardized and prepared; or industrial fire, where first responders within the company have a detailed response plan for emergencies. Most of the fire rescue interventions are urban fires (structural and non-structural), industrial fires, car accidents. Fire departments can though undergo constant training and be ready to respond to calls. It is sometimes easy to find fire departments that develop so-called pre-fire plans. These are typically created for complex locations within the station's response area. They are particularly beneficial to the responding fire departments and can help prevent the wastage of valuable time when an incident occurs. For instance, a complex site may have multiple access points from various streets or roads. The site access map also highlights the different entrances to the buildings situated on the site. Given that there might be several buildings on the site, and an incident could occur in any one of them, it is crucial to swiftly identify the relevant building. Complex site access details are usually presented in the form of a large-scale map depicting the site area, along with clearly marked access points and routes. Besides these plans, fire departments and fire commands may develop several guidelines and operational protocols (called SOPs – standard operating procedures) that consider the following elements:

1. *Preparation and Training*: firefighters undergo extensive training in fire behavior, rescue techniques, equipment operation, and emergency response protocols. This training ensures they have the necessary knowledge and skills to handle various types of fire-related emergencies.

2. *Risk Assessment*: before responding to a fire rescue call, firefighters assess the situation's potential risks and hazards. They consider factors such as the type and size of the fire, the building's construction, the presence of hazardous materials, weather conditions, and the number of occupants involved.

3. *Communication*: effective communication is crucial in fire rescue planning. Fire commanders, fire boards and firefighters develop efficient communication systems in order to maintain constant communication with incident commanders and other emergency services when responding to fires.

4. *Incident Command System (ICS)*: the ICS is a standardized method for commanding and controlling the response operations. In general, the ICS (NIMS), is utilized by most of the fire departments across the globe. Knowing and testing the ICS will help fire companies to better manage the response operations.

5. *Resource Allocation*: fire departments constantly check their resources and decide how to allocate and when deploy additional resource needed for the rescue operation, including personnel, equipment, and specialized units like ladder trucks, hazmat teams, or technical rescue teams. Moreover, fire departments inspect the location and the functioning of fire hydrants along roads in case they need to attach a fire engine to the public water network. This ensures that resources are available, and everything works perfectly in time of need.

6. *Strategy and Tactics*: firefighters develop on-scene a strategy based on the incident's size, location, and nature. They decide on the best tactics to control the fire, rescue victims, and protect property. Tactics may include fire suppression, ventilation, search and rescue, and establishing safe escape routes.

7. *Safety Measures*: safety is a top priority for firefighters. They establish safety zones, implement accountability systems to track personnel, and use personal protective equipment (PPE) to minimize risks from heat, smoke, and hazardous materials.

8. *Search and Rescue*: firefighters conduct systematic searches of the affected area to locate and rescue trapped or injured occupants. They prioritize victims based on their location, condition, and accessibility (this will be expanded in the dedicated section)

9. *Fire Suppression*: firefighters use various firefighting techniques and equipment, such as hoses, water supply, and extinguishing agents, to control and extinguish the fire. They may also perform fire breaks and create fire lines to prevent the fire from spreading.

10. *Medical Care*: firefighters trained as EMT-B provide first basic medical care to injured victims until paramedics or emergency medical services arrive. This may include administering first aid, CPR, or using automated external defibrillators (AEDs).

11. *Evacuation*: when necessary, firefighters coordinate the safe evacuation of occupants from burning buildings or hazardous areas. They may use ladders, ropes, or specialized equipment for high-rise buildings or confined spaces.

12. *Recovery and Salvage*: after the fire is under control, firefighters assess the extent of damage and may assist with salvage and recovery efforts to minimize property loss.

13. *Debriefing and Evaluation*: following the rescue operation, firefighters participate in debriefings to discuss what worked well and what could be improved. This feedback helps refine their tactics and procedures for future incidents.

Fire rescue planning is a dynamic process that requires adaptability, teamwork, and continuous training and the establishment of SOPs to ensure effective responses to a wide range of emergency situations.

5.2.3.2 Safety and Security

Rescue operations are dynamic and often fraught with hazards. Whether it's a building collapse, a natural disaster, or a hazardous materials incident, the safety of everyone involved is paramount. In these high-stress scenarios, safety cordons emerge as the unsung heroes, establishing order amidst chaos and safeguarding lives. A safety cordon is a designated and controlled area around the incident site. It acts as a protective barrier, delineating zones of varying risk levels. This buffer zone serves multiple crucial functions in the context of rescue operations:

✔ **Protection of Responders:** The foremost role of a safety cordon is to shield rescue personnel from immediate dangers. It creates a safe workspace where responders can focus on their tasks without being exposed to additional risks. In situations involving fire, structural instability, or hazardous materials, this separation can be a matter of life and death.

✔ **Victim Safety:** Beyond responders, safety cordons also safeguard victims. They prevent well-intentioned but untrained individuals from rushing into harm's way. Instead, trained professionals can assess the situation and determine the safest approach to rescue.

✔ **Control of Crowds:** amid an emergency, crowds can gather, hindering rescue efforts and complicating logistics. Safety cordons help maintain order by keeping bystanders at a safe distance, reducing the risk of chaos, and ensuring that responders have clear access to the scene.

✔ **Hazard Mitigation:** Depending on the nature of the incident, safety cordons may serve as a barrier against hazardous materials, falling debris, or fire spread. This containment prevents the escalation of the emergency and reduces collateral damage.

Types of Safety Cordons

Safety cordons come in various forms, tailored to the specific incident:

1. **Inner Cordon:** This closest cordon encircles the immediate incident area and is accessible only to trained rescue personnel. It provides the highest level of protection against immediate hazards.

2. **Intermediate Cordon:** Positioned farther from the incident, this cordon limits access to authorized personnel, including responders and essential support teams.

3. **Outer Cordon:** The outermost cordon restricts access to the public. Law enforcement often manages this zone, ensuring that only authorized individuals can enter.

Establishing and maintaining safety cordons is a coordinated effort. Incident commanders, law enforcement, firefighters, and other responders work together to define and enforce these boundaries. In rescue operations, safety cordons are not just lines on the ground; they are the lifeline that balances urgency with caution.

Firefighters operate in environments where danger lurks at every corner. While their primary mission is to save lives and protect property, they must also safeguard their own well-being. Here are some of the specific risks that firefighters encounter:

▪ **Fire and Heat:** The most obvious danger, fires produce intense heat that can cause severe burns and heat-related illnesses. Inhaling superheated air and toxic smoke is equally hazardous and can lead to respiratory problems.

- **Structural Collapse:** Fires can weaken the structural integrity of buildings, making them prone to collapse. Firefighters risk being trapped or injured under falling debris.

- **Smoke Inhalation:** Smoke contains a cocktail of toxic substances, including carbon monoxide, which can lead to unconsciousness or death if inhaled in high concentrations.

- **Hazardous Materials:** Firefighters often deal with incidents involving hazardous materials, such as chemicals or flammable substances. Mishandling these materials can lead to chemical burns, explosions, or toxic exposures.

- **Equipment Malfunctions:** Firefighting gear, including breathing apparatus and hoses, can fail or malfunction, leaving firefighters vulnerable in the midst of a fire.

- **High-Stress Environments:** The high-stress nature of firefighting can lead to mental and emotional strain, potentially resulting in accidents or long-term psychological issues.

- **Vehicle Accidents:** Responding to emergencies involves navigating through traffic, which can lead to accidents. Vehicle crashes are a significant risk for firefighters.

Safety Measures in Place

Recognizing these inherent risks, fire departments around the world implement rigorous safety measures to protect their personnel:

- ✔ **Training:** Firefighters undergo extensive training to equip them with the knowledge and skills needed to operate safely in hazardous environments. They learn firefighting techniques, equipment uses, and how to manage emergencies.

✔ **Personal Protective Equipment (PPE):** Firefighters wear specialized gear, including helmets, turnout gear, self-contained breathing apparatus (SCBA), and gloves, to shield them from heat and smoke. PPE is critical in minimizing injuries.

✔ **Standard Operating Procedures (SOPs):** Fire departments establish strict SOPs that outline safety protocols and best practices for responding to different types of incidents.

✔ **Accountability Systems:** Firefighters use systems to track the location and well-being of their team members during operations, ensuring no one is left behind.

✔ **Health and Wellness Programs:** Departments emphasize the importance of physical fitness and provide support for mental health issues, recognizing the toll that firefighting can take on well-being.

5.2.3.3 Assessment and Evaluation

Control measures are of paramount importance in ensuring the safety of personnel and the community during firefighting incidents. An incident ground, essentially an operational workplace for fire and rescue services, places a legal obligation on these services to assess and mitigate risks to the best of their ability. Beyond safeguarding their own personnel, there is also a duty to protect others and minimize the impact on the community and the environment.

To establish a safe working area promptly, incident commanders undertake a structured approach. They begin by identifying potential hazards and risks, a crucial first step in risk management. Following this, they select the most appropriate control measures, carefully weighing the benefits of their actions against the associated risks, all while taking into account any time constraints. Safe systems of work are crucial, and personnel must continually develop, maintain, and review these systems throughout the incident to ensure their effectiveness.

In conducting effective risk assessments, incident commanders must comprehend several essential concepts. Hazards, as events or situations with the potential for adverse

consequences such as harm to people, damage to property, or environmental disruption, must be identified. Risks, on the other hand, represent the likelihood that a hazard will lead to its adverse effects, often quantified by measuring the extent of the effect. Control measures play a pivotal role in risk management, as they are designed to reduce the likelihood of exposure to a hazard or mitigate the impacts of such exposure.

The HSE hierarchy of control offers further insight into how control measures can be implemented during incidents. Risk assessment during incidents is a multi-faceted process, breaking down into individual risk assessment, dynamic risk assessment, and analytical risk assessment.

Individual risk assessments are particularly important for personnel working independently, ensuring their safety. Dynamic risk assessments come into play in rapidly changing, often chaotic incident environments where decisions must be made swiftly. These assessments involve evaluating the situation, determining the benefits of actions relative to risks, selecting appropriate systems of work, and declaring tactical modes for effective control.

Analytical risk assessments form the foundation for more detailed risk assessments as incidents evolve or become more complex. These assessments are formally recorded and conducted as soon as feasible, then revisited at suitable intervals. By rigorously adhering to these control measures and risk assessment protocols, fire and rescue services strive to minimize harm and protect both their personnel and the wider community during emergency incidents.

5.2.3.4 First Aid

- *First Aid for Fire Rescue*

Fire rescue situations demand a unique set of first aid skills due to the potential for burns, smoke inhalation, and other fire-related injuries:

a) **Safety Protocols:** Rescuers must prioritize their safety by wearing appropriate gear and using breathing apparatus when entering smoke-filled environments.

b) **Burn Care:** Treating burn injuries, including assessing burn depth, applying sterile dressings, and administering pain relief.

c) **Smoke Inhalation:** Recognizing the signs of smoke inhalation and administering oxygen or performing artificial ventilation when necessary.

d) **Trauma Assessment:** Identifying trauma-related injuries that may occur during fire rescue operations, such as fractures or crush injuries.

e) **Evacuation:** Safely extracting individuals from burning structures while providing necessary first aid.

● *Mental Health Support*

Disasters victims often experience extreme stress and trauma. Rescuers trained in first aid should be equipped to provide psychological first aid, offering comfort, reassurance, and referrals for mental health support when needed. Recognizing signs of distress and offering a compassionate response can help mitigate the long-term psychological impact of the disaster.

Overall, in the realm of rescue operations, first aid training is the bedrock upon which efficient and lifesaving responses are built. It equips rescuers with essential skills to provide immediate care, stabilize patients, and make informed decisions in high-pressure situations. However, it is crucial to acknowledge the limitations of first aid and recognize when advanced medical assistance is required.

5.2.3.5 Evacuation and Rescue

Firefighters follow a well-coordinated and methodical approach when evacuating a building on fire, prioritizing the safety of both occupants and themselves. The evacuation process typically begins with the initial assessment of the fire's location, size, and intensity. Firefighters work swiftly to establish communication with any occupants still inside the building, guiding them to safe exit routes whenever possible.

If the fire conditions allow, firefighters will conduct a systematic search and rescue operation, entering the building with appropriate protective gear and equipment. They move room by room, checking for trapped individuals and guiding them to safety. Firefighters are trained to stay low to avoid heat and smoke, using thermal imaging cameras to navigate through reduced visibility.

In situations where the fire is too intense or the building's structure is compromised, firefighters may shift their focus to defensive operations. This involves creating a protective barrier between the fire and potential victims, often using hoses and water streams to control the flames. Meanwhile, they continue efforts to safely evacuate any remaining occupants.

Throughout the evacuation process, clear communication is essential. Firefighters maintain contact with their team members and command center, ensuring everyone's location and status are known. They also keep occupants informed and reassured, providing instructions and guidance for a safe exit.

In sum, the evacuation of a burning building is a complex and highly coordinated operation, emphasizing the preservation of life above all else. Firefighters' training, equipment, and teamwork are key components in ensuring successful evacuations and minimizing the risks associated with fires.

Figure 5.7. Firefighter training for evacuation. USA.

5.2.3.6 Search and Rescue

To ensure the effective and safe execution of a search and rescue operation, it is imperative to adhere to certain principles and tactical priorities. These priorities, in their order of importance, consist of: first, prioritizing rescue, which involves ensuring the safety of

individuals (life safety); second, focusing on fire control to manage and contain the blaze; and third, considering property conservation.

The search and rescue operation can be divided into two distinct functions: Searching and rescuing. The search component entails locating and finding victims within the affected area, while the rescue involves the separation of victims from the hazards. While rescue is often associated with physically removing victims from a building, it can also be achieved by eliminating or reducing the hazard that threatens them. For instance, applying the first hose stream to extinguish or control the fire, even partially, can buy valuable time and effectively contribute to rescue by removing the hazard, making the eventual removal of victims less perilous. In specific settings such as hospitals or nursing homes, eliminating the hazard before evacuating occupants is often the more successful and safer approach.

There are three primary approaches to initiate a search: starting at the location where rescuers have information that a victim is located, initiating the search from the vicinity of the fire and expanding outward, or beginning the search based on the building's layout, purpose, and the time of day. These approaches help guide search efforts effectively.

Moreover, there are two fundamental types of searches: the primary search, conducted as an initial sweep to locate potential victims, and the secondary search, a more detailed and thorough examination carried out once fire control has been established and conditions have improved. These fundamental principles and procedures form the basis for a successful and organized search and rescue operation.

The primary search is conducted either before or during the process of gaining control over the fire, typically by the first units to arrive at the scene. This search is characterized by its swiftness and systematic approach, with a specific focus on areas where it is most likely that victims are located. The order of search priority typically follows this sequence:

- 1st: fire area/room
- 2nd: adjacent areas/rooms
- 3rd: Floor above fire
- 4th: top floor (this may mean floors between 3rd and 4th priority are skipped)
- 5th: remaining floors: start with second to top floor and work down.

Victims in need of rescue are removed in the following order, based on the level of threat and the greatest benefit to be gained:

- 1st: those in the immediate fire area;
- 2nd: victims most threatened by the fire or smoke spread;
- 3rd: those victims in the greatest number or groups;
- last: removed are those in exposed areas.

Distinguishing between recovery and rescue efforts is also important. In certain situations, it may be evident that discovered individuals are deceased. In such cases, it is advisable to mark the location and inform the Incident Commander rather than immediately moving the body. Doing so could potentially disrupt or compromise the ongoing fire investigation, as only the coroner or medical examiner typically has the authority to authorize the movement of the deceased, unless there is an imminent hazard necessitating immediate action. Furthermore, it's important to prioritize the discovery and rescue of potential survivors over the removal of deceased individuals.

The secondary search, conducted after gaining control of the fire and improving interior conditions, primarily focuses on locating fatalities. This secondary search is an exhaustive and meticulous process where speed is not a priority. Typically, it is assigned to a different company than the one responsible for the primary search to ensure thoroughness.

It's essential to perform a secondary search in all structures affected by the fire, including those where conducting a primary search may have been unsafe or impossible. During each secondary search, firefighters should meticulously examine every area, including bathtubs, showers, closets, spaces under furniture, as well as outdoor areas like bushes, shrubs, and the vicinity of windows and exterior doors.

5.2.4 Teamwork and collaboration among first responders

A well prepared and strong rescue team is only possible if there is consolidated teamwork and collaboration. This is generally acknowledged for every team working in different settings, but particularly true when it comes to rescue teams. Generally speaking, a team is a group of people who work together to achieve a common goal that is beyond the individual or organizational level. A team has clear roles and responsibilities for each member, and they cooperate and coordinate with each other in an interdependent manner. A team is usually

formed for a specific purpose and duration, and it can be composed of people from different backgrounds, skills, and perspectives.

As said, teamwork is essential in rescue teams. Rescue teams are specialized groups of professionals who bravely respond to emergencies. Rescue teams must work under high pressure, uncertainty, and risk, and they must make quick and effective decisions to save lives and minimize damage. Therefore, teamwork is one of the most valuable skills that rescue team members can have, as it can increase their performance, safety, and resilience.

Teamwork is more than just colleagues working together; it involves several aspects that contribute to the success of the team. Some of these aspects are:

- Good communication: Team members need to communicate clearly and frequently with each other, as well as with other stakeholders, such as victims, authorities, or media. Communication helps to share information, coordinate actions, solve problems, and provide feedback. Communication can be verbal or non-verbal, and it can use different channels, such as radio, phone, or face-to-face.

- Awareness of each other: Team members need to be aware of each other's location, status, actions, and needs. Awareness helps to avoid conflicts, duplication, or gaps in the team's work. Awareness can be enhanced by using common terminology, protocols, and tools, such as maps, GPS, or cameras.

- Recognition of strengths and weaknesses: Team members need to recognize their own and each other's strengths and weaknesses, such as skills, knowledge, experience, or personality. Recognition helps to assign tasks according to the best fit, support each other's learning and development, and balance the team's diversity and cohesion.

- Regular reassessment and re-evaluation: Team members need to reassess and re-evaluate their team's goals, strategies, processes, and outcomes on a regular basis. Reassessment and re-evaluation help to monitor the team's progress, identify challenges and opportunities, adapt to changing situations, and celebrate achievements.

Good team working has also many benefits for the team members and the organization. Some of these benefits are:

- People feel valued: Team members feel that their contributions are recognized and appreciated by their peers and leaders. They also feel that they belong to a group that

shares a common vision and mission. This increases their motivation, satisfaction, and commitment to the team.

- Morale is raised: Team members feel more confident, optimistic, and enthusiastic about their work. They also feel more supported, trusted, and respected by their colleagues. This improves their mental health, well-being, and resilience.
- Working environment is improved: Team members create a positive and productive working atmosphere. They also foster a culture of collaboration, innovation, and excellence. This enhances their performance quality and efficiency.

One foundational aspect of good teamwork and collaboration is the recognition of the pivotal role good leaders and leadership play in shaping the dynamics within a team. Leadership is the ability to influence, inspire, and guide others toward a common goal (Northouse, 2018). Leadership is important for teamwork and collaboration because it can:

Provide direction and clarity: A leader can help the team to define and align on the vision, mission, values, and objectives of their work. A leader can also help the team to plan, prioritize, and execute their tasks effectively and efficiently. A leader can communicate clearly and consistently with the team and other stakeholders and ensure that everyone is on the same page. This can reduce confusion, ambiguity, and conflict in the team.

Foster trust and accountability: A leader can build trust and rapport with the team members by being honest, respectful, supportive, and empathetic. A leader can also hold the team members accountable for their roles and responsibilities and provide constructive feedback and recognition. This can increase the team's commitment, engagement, and performance.

Encourage innovation and creativity: A leader can create a culture of collaboration and learning in the team by encouraging the team members to share their ideas, opinions, and perspectives. A leader can also facilitate brainstorming, problem-solving, and decision-making processes that involve the team's input and participation. This can enhance the team's diversity, creativity, and innovation.

Resolve conflicts and challenges: A leader can help the team to overcome obstacles and difficulties that may arise in their work. A leader can also help the team to manage and resolve conflicts that may occur among the team members or with other parties. A leader can use various strategies, such as negotiation, mediation, or compromise, to find solutions that

are acceptable and beneficial for everyone. This can improve the team's resilience, adaptability, and harmony.

In conclusion, teamwork is a crucial skill for rescue teams because it enables them to cope with complex and dynamic situations that require high levels of coordination and cooperation. Teamwork involves several elements that make the team more effective and efficient. Team work also brings many benefits for the team members' personal and professional growth. Therefore, rescue teams should invest in developing their teamwork skills through training programs that simulate realistic scenarios that challenge their abilities.

"In rescue operations there is no I, just WE"

5.2.5   Shelter and settlement

The concept of shelter and settlement will be here discussed. It is not uncommon for first responders and emergency managers to adopt this relief strategy after disasters, be it a flood, a landslide, or a fire.

Shelter and settlement are two interrelated concepts that are essential for human survival, dignity, and well-being. Shelter refers to the process of providing adequate and appropriate housing for people who have been displaced or affected by disasters or conflicts. Settlement refers to the physical, social, and economic environment in which people live, work, and interact. Shelter and settlement are not only physical products, but also complex and dynamic processes that involve people, materials, skills, policies, and institutions.

According to the International Federation of Red Cross (IFRC, 2010) shelter is not just a physical product, but a complex and dynamic process that involves people, materials, skills, policies, and institutions. Shelter goes beyond simply providing tools and tents to help people cope in the short-term after a disaster or a conflict. It also involves enabling communities to improve their homes over time so they are better prepared and protected should another disaster occur. Shelter is a fundamental human right and a basic human need that affects the health, security, and well-being of people. Shelter is also closely linked to other humanitarian sectors, such as water, sanitation, health, education, protection, and livelihoods. Therefore, shelter interventions should be holistic, participatory, context-specific, and coordinated with other actors.

There are different types of shelters that can be provided to people affected by disasters or conflicts. One of the most common types is transitional or temporary shelters (Quarantelli, 1982; Rodríguez et al., 2007). These are shelters that provide immediate and short-term protection for people who have lost their homes due to disasters or conflicts. They are usually made of low-cost, locally available, and easily transportable materials, such as plastic sheets, bamboo poles, or metal frames. They are designed to be durable enough to withstand harsh weather conditions, but flexible enough to be adapted or upgraded by the users according to their needs and preferences. Transitional or temporary shelters are intended to bridge the gap between emergency relief and permanent reconstruction, and to facilitate the recovery and resilience of affected communities. In terms of temporary sheltering, a distinction should be done based on the typology of disasters. For example, in the case of floods, it is possible to evacuate people towards shelters to the extent they are in a safe and dry area, with the certainty some shelters can be kilometers away from the flooded area.

Another type of shelter is permanent or durable shelter. These are shelters that provide long-term and sustainable housing for people who have been displaced. They are usually made of high-quality, locally appropriate, and environmentally friendly materials, such as bricks, concrete, wood, or stone. They are designed to withstand natural hazards, such as earthquakes, floods, or landslides. They are also designed to be culturally sensitive, socially inclusive, and economically viable. Permanent or durable shelters are intended to restore the normalcy and dignity of affected communities. Although permanent shelters are a more expensive solution compared to temporary shelters, several social issues might arise. It is not uncommon to witness people complaining because they want to move back to their houses as soon as possible – to the extent that restoration can be quickly done. But it is also common to see people not wanting to leave the shelter as they feel safer.

When temporary shelter cannot be done by building tent camps, one of the viable ways shelters can be provided to people is by using existing infrastructures and facilities, such as sport buildings, stadiums, schools, public libraries, or hotels. These infrastructures can offer a temporary solution for sheltering large numbers of people in a short time, as they usually have basic facilities such as water, electricity, sanitation, and security. However, there are also some challenges and limitations associated with using infrastructures as shelters. For example, they may not be suitable for long-term use, as they may interfere with the normal functions of the buildings or cause damage to them. Moreover, they may not meet the specific needs or preferences of different groups of people, such as women, children, elderly, or disabled. It is

to be noted that such types of shelters should be used for very brief time. Therefore, it is important to assess the suitability and sustainability of infrastructures as shelters before using them, and to ensure that they are well-managed and coordinated with other relief organizations.

Figure 5.8. Short-term shelter in a public facility.

Figure 5.9. Short-term shelter in tents, Italy.

Figure 5.10. Short-term shelter in a sport building.

Figure 5.11. Long-term shelter after the earthquake in Central Italy 2016.

Figure 5.12. Long-term shelter after the earthquake in Central Italy 2016.

5.3 Rescue Equipment

Rescue equipment is a vital component of emergency response systems, designed to save lives and mitigate risks in a wide range of situations. From firefighters to search and rescue teams, these specialized tools and gear play a crucial role in ensuring the safety of both responders and those in need. Essential rescue equipment includes items like harnesses, ropes, and carabiners for high-angle or confined space rescues, while hydraulic tools such as spreaders and cutters are indispensable for extricating individuals trapped in vehicles during accidents. Water-based emergencies often require inflatable boats and life jackets, while medical professionals rely on advanced medical kits to provide critical care in the field. Along with rescue equipment, rescue teams must wear personal protective equipment. Personal protective equipment (PPE) protect the rescuer against health and safety risks. Due to the large number of hazards, it is important that a rescuer wears appropriate PPE. To be effective, it is important that all PPE is the correct size and adjusted to the individual wearing it. The following paragraphs will list and describe the typical equipment and PPE used by rescue teams.

5.3.1 Flood

5.3.1.1 Personal protective Equipment

Figure 5.13. Dry suit for flood response.

Dry suit: A flood response drysuit is a specialized waterproof garment used by emergency responders during flood-related operations. Constructed from waterproof materials like Gore-Tex or neoprene, it provides full-body protection against immersion in floodwaters. The suit typically includes waterproof zippers, seals at the wrists and neck, and integrated boots to ensure a watertight seal. A neoprene hood and gloves may also be part of the ensemble. The drysuit allows responders to work safely in flooded areas, protecting them from contaminated water, cold temperatures, and potential hazards. It is an essential piece of equipment for swift-water rescue teams and flood response personnel, ensuring their safety and effectiveness in challenging flood conditions.

Figure 5.14. Buoyancy jacket.

Buoyancy Jacket: A buoyancy jacket, also known as a buoyancy aid or personal flotation device (PFD), is a type of water safety garment designed to provide buoyancy and help individuals stay afloat in the water. Buoyancy jackets are typically less bulky than life jackets and are commonly used in activities like kayaking, canoeing, and sailing. They provide buoyancy but are not designed to turn an unconscious person face-up in the water. Buoyancy jackets are more comfortable for extended wear and offer freedom of movement.

Figure 5.15. Life jacket.

Life Jacket: A life jacket, also known as a life vest or life preserver, is a crucial piece of water safety equipment designed to keep a person afloat and their head above water, even if they are unconscious. Life jackets come in various styles, including foam-filled, inflatable, and hybrid designs. They are characterized by their high buoyancy and often include a collar or head support to keep the wearer's head out of the water. Life jackets provide critical flotation and potentially life-saving support in emergency situations.

Figure 5.16. Safety helmet.

Safety Helmet for Water Operations: A safety helmet for water operations is a specialized headgear designed for individuals engaged in water-related activities and rescue operations. Typically constructed from buoyant and durable materials like high-impact plastic or fiberglass, these helmets offer impact protection and buoyancy. They often feature adjustable straps, chin guards, and ventilation systems. Bright and highly visible colors enhance wearer identification in the water, making them suitable for professionals in water rescue, kayaking, and other aquatic endeavors.

Figure 5.17. Safety knife.

Safety Knife: A safety knife for water rescue is a specially designed cutting tool with a rounded or recessed blade to prevent accidental injury to the wearer or the person being rescued. These knives are commonly used by water rescue teams and kayakers to cut through ropes, webbing, or entanglements swiftly and safely. They often feature a blunt tip and a serrated or sharp edge for versatile cutting in emergency situations.

Figure 5.18. Safety boots for water rescue.

Safety Boots for Water Rescue: Safety boots for water rescue are specialized footwear designed to provide protection and support to water rescue personnel. Made from durable and water-resistant materials, such as neoprene or rubber, these boots offer protection against water ingress and hazards in aquatic environments. They typically have non-slip soles for traction in wet conditions and reinforced toes for impact resistance. Safety boots for water rescue are essential for maintaining secure footing and protecting the feet during water-based rescue operations.

Figure 5.19. Wading pole.

Wading pole: Wading poles can be made out of natural or man-made materials. They are used to check for water depth and underwater hazards while wading. They can also be used for reach rescues from the water.

Figure 5.20. Cow's tail.

Some buoyancy aids and lifejackets, also known as personal flotation devices or PFDs, come with a "**cow's tail"**. This allows rescuers to be attached to a rope. The cow's tail *must* be able to be released quickly if necessary.

Figure 5.21. Throw bag.

A **throw bag** consists of a length of rope (a throw line) stored inside a quick-release bag. It is used to rescue casualties in moving water. It is recommended that anybody working in the flood environment has access to a throw bag. Brightly colored rope that will float as this will help the casualty and rescuer see the rope on the surface of the water.

Figure 5.22. Water rescue rope.

5.3.1.2 Rescue Equipment

Communication systems for flood response are vital tools enabling effective coordination among emergency responders, agencies, and affected communities. They encompass a range of technologies such as two-way radios, satellite phones, and mobile networks. These systems facilitate real-time information sharing, allowing responders to relay flood alerts, weather updates, and evacuation instructions. These devices are typically designed to be water-resistant.

Figure 5.23. Waterproof radios

Flood response boats are specialized watercraft used by emergency responders and disaster management teams to provide assistance and carry out various tasks during flood-related emergencies. These boats are designed to navigate through floodwaters and perform rescue and relief operations. Here are some key features and types of flood response boats:

✔ **Inflatable Boats:** These boats are typically made of durable, puncture-resistant materials and can be quickly inflated and deployed. They are often used for swift-water rescues in flooded areas and can transport personnel and equipment.

✔ **Flat-Bottom Boats:** Boats with a flat or shallow hull are suitable for navigating through shallow floodwaters and can transport responders, supplies, and even evacuate stranded individuals.

✔ **Rescue Boats:** These boats are specifically designed for water rescues, equipped with safety features like buoyancy aids, harnesses, and life jackets for both responders and victims. They often have specialized rigging and hoisting equipment for swift and safe rescues.

✔ **Hovercraft:** Hovercraft are amphibious vehicles that can operate on both water and land. They are effective in accessing flood-affected areas with varying water depths and can transport personnel and equipment.

Figure 5.24. Rescue boats.

Special vehicles such as amphibious vehicles are used for their ability to operate in diverse and challenging environments. Amphibious vehicles can navigate both land and water, making them invaluable for missions in areas with flooded terrain or high-rise water levels. They provide essential access and mobility to responders and aid in search and rescue operations, especially during natural disasters like floods, where conventional vehicles may become immobilized in muddy or submerged conditions. These specialized vehicles enhance the capacity to reach and assist those in distress, ensuring more effective emergency responses in a variety of scenarios. These include, ambulances for high rise water, 8wheel-drive ATBs and amphibious trucks.

Figure 5.25. Special ambulances for flood rescue.

Figure 5.26. Amphibious truck.

Figure 5.27. Special vehicle for flood rescue.

5.3.2 Landslide

5.3.2.1 Personal protective Equipment

Figure 5.29. Rescue helmet.

Figure 5.28. Rescue suit.

A **rescue suit**, worn by firefighters and rescue personnel, is specialized protective gear designed for vehicle extrication and rescue operations in dangerous environments. Made from durable materials like Kevlar, it provides full-body coverage, protecting against sharp edges, glass fragments, and other hazards encountered during extrication and rescue tasks. These suits are typically highly visible, featuring reflective strips, and often come with pockets for carrying essential tools. While not as heat resistant as structural firefighting gear, they offer some protection against flames.

A **safety helmet** for rescue operations, distinct from firefighting helmets, is a crucial piece of personal protective equipment (PPE) designed to safeguard the head during various rescue scenarios. These helmets are typically lightweight and durable, constructed from materials like high-impact ABS plastic or fiberglass. They feature an adjustable suspension system for a secure fit, often with padded interiors for comfort. The helmets may include integrated eye protection, such as a face shield or goggles, to shield the eyes from debris and hazards. Additionally, they often have slots for attaching headlamps or communication devices, ensuring versatility and safety in diverse rescue environments.

Figure 5.30. Safety boots

Figure 5.31. Safety Gloves

Safety Boots: Safety boots for rescue operations are sturdy and protective footwear designed to keep feet safe in various rescue scenarios. They are typically constructed from durable materials like leather or synthetic composites, offering protection against sharp objects, electrical hazards, and impact. These boots often feature steel or composite toe caps for added protection against heavy objects and provide slip-resistant soles for traction in challenging environments. Comfort and support are prioritized, making them suitable for prolonged use during rescue operations.

Safety Gloves: Safety gloves for rescue operations are specialized hand protection designed to shield hands from cuts, abrasions, chemicals, and other hazards encountered during rescue tasks. They are crafted from materials like leather, Kevlar, or synthetic blends to provide durability and dexterity. Some gloves may have reinforced palms and fingers for added protection. These gloves allow rescuers to work effectively while maintaining hand safety and tactile sensitivity.

Figure 5.32. Safety harness.

Safety Harness: A safety harness is an integral component of fall protection equipment used in rescue operations, particularly in scenarios involving working at heights or confined spaces. Harnesses are typically constructed from high-strength webbing and include adjustable straps and buckles for a secure and comfortable fit. They feature attachment points for connecting to lanyards, lifelines, or other fall arrest systems. Safety harnesses distribute the force of a fall across the body, preventing injury and allowing rescuers to work safely and securely in elevated or challenging environments.

5.3.2.2   Rescue Equipment

Figure 5.33. Spine board.

Spine Board: A spine board, also known as a backboard, is a rigid, long, and flat medical device used for immobilizing individuals with suspected spinal injuries. It is typically made of lightweight but durable materials like plastic or composite materials. Straps or harnesses are used to secure the patient onto the board while keeping the spine aligned. Spine boards are commonly used during extrication and transportation of trauma patients to prevent further spinal damage.

Figure 5.34. Shoulder-mounted stretcher.

Shoulder-mounted Stretcher: A shoulder-mounted stretcher is a specialized device designed for short-distance transport of injured individuals in lying position. This stretcher is invaluable in moving in confined or challenging spaces where traditional stretchers or backboards are impractical. This medical device is not intended for long-distance transport. Shoulder-mounted stretchers are vital tools in urban search and rescue, mountain rescue and confined space operations.

Figure 5.35. First aid bag.

First Aid Bag: A first aid bag is a portable container designed to hold a variety of first aid supplies and equipment for immediate medical assistance. These bags come in various sizes and configurations, ranging from small, compact kits for personal use to larger, more comprehensive kits used by first responders and healthcare professionals. A well-equipped first aid bag typically contains bandages, dressings, antiseptics, medical tools, and other supplies to treat injuries and medical emergencies.

Figure 5.36. Basket stretcher.

Basket Stretcher: A basket stretcher, often referred to as a Stokes basket, is a rescue device designed for evacuating injured or immobilized individuals from remote or challenging locations. It resembles a rigid, open-weave basket made of materials like metal or plastic. The patient is secured onto the stretcher with straps or harnesses, allowing for safe and stable transportation, especially in confined spaces or rugged terrains. Basket stretchers are commonly used in search and rescue operations and wilderness medicine.

5.3.3   Fire

5.3.3.1   Personal Protective Equipment

(1)   (2)

Firefighters wear **turnout gear (1)** and **helmets (2)** for protection in hazardous environments. Turnout gear consists of flame-resistant pants and jacket. These garments are typically constructed from multiple layers of special materials (Nomex or PBI), offering thermal insulation and protection against heat, flames, and chemical exposure. They also include reflective strips for visibility. Firefighter helmets are made from heat-resistant materials like fiberglass and feature a visor or face shield to shield the face from heat and debris. Both turnout gear and helmets are crucial for safeguarding firefighters from intense heat, flames, falling objects, and respiratory hazards, enabling them to perform their life-saving duties in challenging fire and rescue situations.

(3)

(4)

Gloves (3): Firefighter gloves are made of heat-resistant materials, such as leather or Kevlar, to protect the hands from burns, cuts, and abrasions. They offer dexterity and grip, allowing firefighters to handle tools and equipment while maintaining hand safety.

Hood (4): A fire-resistant hood covers the firefighter's head and neck, providing crucial protection against heat and flames. It also helps to prevent burns and reduces the risk of smoke inhalation. The hood is worn underneath the helmet and turnout gear.

(5)

(6)

Boots (5): Firefighter boots are constructed from heat-resistant leather or synthetic materials and are designed to withstand high temperatures and protect against water and chemicals. They often have steel toes for added foot protection and non-slip soles for traction in slippery conditions.

Self-Contained Breathing Apparatus (SCBA) (6): SCBA is a vital piece of equipment that provides firefighters with a supply of clean, breathable air in smoke-filled or oxygen-deficient environments. It includes a face mask, harness, air cylinder, and regulator. Firefighters depend

on SCBA to breathe safely and maintain clear communication while working in dangerous atmospheres.

5.3.3.2 Rescue Equipment

Figure 5.37. Halligan hook.

Halligan Hook: the Halligan hook, often called a Halligan bar, is a versatile forcible entry tool used by firefighters and rescue personnel. It typically consists of a forked end, a flat adz (prying end), and a tapered pick or point. The tool is designed to force open doors, windows, and other barriers in emergency situations. Firefighters use it to gain access to buildings, vehicles, and confined spaces.

Figure 5.38. Fire Axe.

Fire Axe: a fire axe is a specialized axe designed for firefighting and rescue operations. It typically features a sharp cutting edge on one side of the head and a flat, often serrated, adz on the other side. Firefighters use the sharp edge for chopping, cutting, and breaching, while the adz is used for prying and pulling apart materials like wood, drywall, or roofing.

Figure 5.39. Jaws of Life.

Jaws of Life: the Jaws of Life, also known as hydraulic rescue tools or spreaders, are powerful hydraulic tools used to extricate victims from vehicles that have been involved in accidents, especially when they are trapped due to structural damage. They consist of a hydraulic pump, hoses, and specialized attachments such as spreaders (to push apart vehicle components), cutters (to cut through metal), and rams (to lift or push objects). The Jaws of Life can cut through metal, pry open vehicle doors, and provide the necessary force to free individuals who are trapped.

Figure 5.40. K-12 saw.

K-12 Saw: a K-12 saw, is a portable power tool used by firefighters to cut through a variety of materials quickly. These saws typically have a circular blade that can cut through wood, metal, concrete, and other materials commonly encountered in emergency situations. Firefighters use fire disk saws for tasks such as cutting through walls, roofs, and debris to access victims or create ventilation openings in burning buildings.

Figure 5.41. Fire engine.

A **fire engine**, or fire truck, is a robust and highly visible emergency vehicle primarily used by fire departments. It typically features a spacious cab for the driver and crew, various sirens and lights for alerting and clearing the way, a large water tank, a powerful pump, hoses, and nozzles for firefighting, ladders for access and rescue, equipment compartments, hose reels, safety features, and communication systems. Fire engines come in specialized variations for specific tasks like aerial ladder trucks and rescue vehicles. They are vital in responding to fires, rescues, and emergencies, equipped to handle a range of life-saving situations effectively.

Figure 5.42. Fire ladder - Ladder truck.

A **fire ladder truck**, often known as an aerial ladder truck or ladder company, is a specialized firefighting vehicle equipped with an extendable ladder used for accessing elevated areas and performing rescues. It features a spacious cab, sirens, and lights for emergency response. The extendable ladder, often with a basket or platform, aids in firefighting, search and rescue operations, and accessing high-rise buildings. These trucks may also carry firefighting equipment, tools, and communication systems. Fire ladder trucks play a crucial role in urban firefighting and rescue scenarios, offering critical reach and versatility in emergency situations.

Figure 5.43. Industrial fire engine.

An **industrial fire engine** is a special firefighting vehicle designed for tackling fires in industrial settings, such as factories, refineries, and chemical plants. These vehicles are typically equipped with high-capacity water tanks, powerful pumps, and specialized firefighting foam systems to combat flammable liquid fires. They feature heavy-duty construction, safety measures, and communication equipment tailored for industrial environments. Industrial fire engines may also carry equipment like hose reels, nozzles, and thermal imaging cameras for effective firefighting. Their primary focus is rapid and effective response to industrial fires, emphasizing the unique hazards and challenges presented by these environments.

5.4 Case studies

5.4.1 Flood

Between May 2nd and May 3rd, a heavy rain made downfall in eastern area of Emilia-Romagna region, Italy (ANSA news, see references). Continuous heavy rainfall has resulted in several rivers overflowing, causing floods and landslides in multiple areas within the region, with the provinces of Bologna and Ravenna being the hardest hit. Authorities have confirmed one fatality in Castel Bolognese, Ravenna Province, where an individual was swept away by floodwaters. Additionally, a residence in Fontanelice, Bologna Province, has collapsed due to a landslide, raising concerns that there may be at least one person trapped inside.

Approximately 450 individuals in Ravenna Province have been evacuated due to the imminent flood threat. In the communes of Monzuno and Castel San Pietro in the Metropolitan City of Bologna, several homes have also been evacuated. In Forli-Cesena province, around twelve people have been evacuated from the municipalities of Dovadola and Modigliana, while a landslide has caused damage to a gas pipeline in Predappio Alta. In response to the situation, authorities have made the decision to close schools in many of the hardest-hit regions.

In the impacted regions, railway services have been disrupted, with ongoing suspensions due to flooding in several areas. Furthermore, several roads in the provinces of Bologna, Forli-Cesena, Modena, and Ravenna have been closed because of flooding and landslides.

The National Fire Service, with support from military agencies and volunteer organizations, has reported more than 400 emergency interventions in response to flooding and landslides in the region. News agencies have also documented more than 250 individuals evacuating their residences in affected areas. This includes the town of Faenza in the province of Ravenna, where evacuations were necessitated when an embankment along the Lamone River failed. Additionally, homes in the Monzuno and Castel San Pietro communes in the Metropolitan City of Bologna were evacuated due to flooding. In the Province of Forlì-Cesena, twelve residents in the Dovadola commune were evacuated as a precautionary measure in response to a landslide threat.

Several other rescue operations were conducted in Ponticelli, located in the Metropolitan City of Bologna near the Santerno River, where several individuals were rescued. Notably, one

man had to be rescued from the roof of his vehicle after becoming stranded by floodwaters from the Quaresimi stream in San Bartolomeo in the Reggio Emilia Province.

Furthermore, firefighters were engaged in sifting through the debris of a collapsed house in Fontanelice following a landslide, as there were concerns that one person may have been inside the house at the time of the incident.

Figure 5.44. Aerial view of a flooded town in Emilia Romagna.

5.4.2 Landslides

In May 1998, the picturesque town of Sarno in the Campania region of southern Italy faced a devastating landslide that claimed lives and left a lasting impact on the affected community. This case study delves into the geological, environmental, and human factors that contributed to the Sarno Landslide, examining the response, aftermath, and the importance of comprehensive landslide risk management.

Sarno is situated on the slopes of Mount Sarno, an area characterized by hilly terrain and the presence of loose volcanic soils. The region has a history of geological instability, with previous landslides and soil erosion events documented over the years. The combination of steep slopes weathered volcanic deposits, and human activities such as construction exacerbated the susceptibility of the area to landslides.

The primary trigger for the Sarno Landslide was heavy rainfall that occurred over an extended period. The rainfall saturated the already unstable soil, reducing its cohesion and triggering a

series of landslides in the surrounding hills. The loose volcanic deposits became highly susceptible to movement, resulting in a massive landslide that cascaded down the slopes towards the town of Sarno. Human activities played a significant role in amplifying the impact of the landslide. Over the years, the expansion of urban areas and construction on the hills surrounding Sarno altered the natural drainage patterns and increased the vulnerability of the terrain. Poor land-use planning, inadequate infrastructure, and the lack of effective stormwater management contributed to the heightened risk of landslides during periods of heavy rainfall.

The Sarno Landslide unfolded over several days in May 1998, starting with smaller soil movements and escalating into a large-scale landslide that reached the town below. The speed and force of the landslide caught residents off guard, and emergency responders faced challenges in reaching affected areas due to the difficult terrain and ongoing landslide activity. Tragically, the event resulted in the loss of lives and extensive damage to infrastructure.

Figure 5.45. Aerial view of Sarno.

The Sarno Landslide of May 1998 triggered a swift and urgent response from local authorities, emergency services, and volunteers as they faced the monumental task of searching for survivors amid the devastation and providing aid to the affected community. The

search and rescue operations were characterized by a combination of challenges posed by the difficult terrain, ongoing landslide risks, and the imperative to locate and assist those impacted by the disaster.

1. *Initial Response and Coordination:* In the immediate aftermath of the landslide, emergency services, including firefighters, police, and medical teams, were mobilized to the affected areas. Coordination between local, regional, and national authorities played a crucial role in ensuring a cohesive and effective response. Emergency plans were activated, and resources were quickly deployed to address the unfolding crisis.

2. *Challenges Posed by Difficult Terrain:* Sarno's hilly terrain, compounded by the landslide's impact on accessibility, presented significant challenges for search and rescue teams. Steep slopes, debris-covered landscapes, and the risk of further landslides hampered the movement of personnel and equipment. Specialized rescue teams trained in mountainous terrain and urban search and rescue techniques were deployed to navigate the challenging landscape.

3. *Use of Specialized Equipment:* The nature of the landslide required the use of specialized equipment, including search dogs, sonar devices, and ground-penetrating radar. These tools enhanced the efficiency of search operations by detecting signs of life beneath the rubble. Heavy machinery, such as excavators and cranes, was employed to clear debris and access areas where survivors might be trapped.

4. *Community Involvement and Volunteer Efforts:* The tight-knit nature of the community in Sarno prompted an outpouring of support from local residents and neighboring communities. Volunteers, including civilian first responders and members of search and rescue organizations, joined forces with professional emergency services to expand the search area and provide additional hands in the rescue efforts.

5. *Medical Support and Triage:* Medical teams worked in tandem with search and rescue operations, establishing field hospitals and triage centers to provide immediate medical care to survivors. The urgency of the situation required rapid assessment of injuries, prioritizing those in critical condition for immediate evacuation, and ensuring a coordinated response to medical needs.

6. *Evacuation and Shelter:* Evacuation efforts were crucial to ensuring the safety of residents in areas at risk of further landslides. Emergency shelters were set up to provide temporary accommodation, food, and essential services to those displaced by the disaster. Evacuation plans were continuously adjusted based on ongoing assessments of landslide risks.

7. *Psychological Support:* The trauma experienced by survivors, as well as rescue personnel, necessitated the provision of psychological support. Counselors and mental health professionals were deployed to assist individuals and communities coping with the emotional toll of the landslide. Support services were integrated into the overall response strategy to address the holistic needs of those affected.

The Sarno Landslide highlighted the importance of comprehensive landslide risk management in regions prone to geological instability. Lessons learned from the event emphasized the need for:

1. *Early Warning Systems:* Implementing advanced monitoring systems to detect early signs of slope instability and providing timely alerts to residents and authorities.

2. *Land Use Planning:* Enforcing regulations to guide responsible land use in landslide-prone areas, restricting construction on vulnerable slopes, and ensuring proper stormwater management.

3. *Public Awareness and Preparedness:* Educating residents about the risks of living in landslide-prone areas, establishing evacuation plans, and conducting regular drills to enhance community preparedness.

4. *Infrastructure Resilience:* Designing and constructing infrastructure with resilience to landslides in mind, including slope stabilization measures, retaining walls, and effective drainage systems.

The Sarno Landslide serves as a tragic reminder of the complex interplay between natural factors, human activities, and the vulnerability of communities in landslide-prone regions. By incorporating lessons learned from the Sarno Landslide into comprehensive risk management strategies, communities can work towards reducing the impact of future landslides and fostering resilience in the face of geological hazards.

5.4.3   Fire

The Grenfell Tower fire, an unprecedented tragedy that unfolded on June 14, 2017, not only claimed the lives of 72 individuals but also spotlighted the crucial role of emergency response operations in mitigating the impact of such disasters. This extended case study delves into the immediate response efforts following the Grenfell Tower fire, addressing the multifaceted challenges faced by emergency services, the resilience demonstrated by the local community, and the ongoing efforts to learn from this tragic event for future disaster response.

Immediate Response Efforts

As the flames rapidly consumed Grenfell Tower, emergency services were thrust into an arduous battle to contain the blaze, rescue trapped residents, and provide vital medical care. The London Fire Brigade, alongside police and other emergency responders, faced daunting challenges. The sheer scale of the incident, coupled with the vertical spread of the fire, required a coordinated effort to navigate complexities in accessing certain areas of the building. The immediate response aimed at efficiently evacuating residents, offering medical assistance, and preventing further loss of life.

Challenges in Evacuation and Communication

The high-rise nature of Grenfell Tower presented unique challenges for evacuation, pushing emergency responders to their limits. The difficulties in reaching residents on upper floors underscored the need for specialized training in high-rise firefighting techniques. Communication breakdowns between emergency services and residents added another layer of complexity, emphasizing the importance of clear and effective communication during crises. The lessons learned from these challenges emphasize the ongoing need for improved communication channels and community engagement in the development of comprehensive disaster response plans.

Community-Led Initiatives

In the wake of the Grenfell Tower fire, the local community demonstrated resilience and solidarity through spontaneous, community-led initiatives. Residents played a pivotal role in assisting emergency services, providing shelter, distributing food and supplies, and offering emotional support to those affected. The immediate and organic response from the community highlighted the potential for a collaborative approach to disaster response, showcasing the strength of local bonds in the face of tragedy. This community resilience has become a focal

point for future disaster preparedness efforts, recognizing the invaluable role communities play in times of crisis.

Emergency Shelter and Humanitarian Assistance

With numerous residents displaced by the fire, the establishment of emergency shelters and the provision of humanitarian assistance became paramount. Coordination efforts between local government, non-governmental organizations, and volunteers were crucial to ensuring that affected individuals and families had access to temporary housing, food, medical care, and counseling services. The aftermath of the Grenfell Tower fire emphasized the importance of a swift and comprehensive humanitarian response to address the immediate needs of those impacted by the disaster.

Figure 5.46. Grenfell Tower fire.

Lessons Learned and Continuous Improvement

The Grenfell Tower fire served as a catalyst for a thorough examination of emergency response protocols, leading to a commitment to continuous improvement. Lessons learned from the incident have driven efforts to enhance training on high-rise firefighting techniques, improve communication strategies, and involve the community in disaster preparedness. Authorities and emergency services have embraced a culture of continuous improvement, revising procedures and protocols to better address the unique challenges posed by high-rise incidents.

The Grenfell Tower fire, with its profound impact on the community and emergency response operations, has left an indelible mark on disaster preparedness and response efforts. The challenges faced by emergency services and the spontaneous community-led initiatives provide valuable insights for shaping future disaster response strategies. As ongoing efforts to learn from this tragedy continue, the legacy of Grenfell Tower serves as a catalyst for refining emergency protocols, improving communication strategies, and fostering community resilience, ultimately contributing to a more effective and compassionate response to unforeseen crises.

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