DISASTERS HANDBOOK

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Contents

This Handbook aims to give a basic knowledge to a range of disasters, hazards, shocks, threats, stresses etc, and to help you consider and implement your daily routines and means of living in a way that helps you to reduce vulnerability.

The Handbook consists of brief overviews of the most common disasters, either natural or human-induced, organised in chapters. Each one examines a specific disaster describing its types and characteristics, and suggesting potential copying strategies. It delivers summarized texts based on collaborative work with Mr Atanas Krastanov who gained information and shared experience, topics and articles in specialized publications and conference meetings. Additionally, sources from Internet and social media conversations have been acquired for the purpose this handbook to be a convenient and useful read.

Designed as to serve for raising awareness on it provides understanding of different types of disasters, their intricate interplay and potential impact on communities. Simultaneously, it seeks to suggest viable strategies at different levels for prediction, prevention, protection and recovery. Given the scope and intent of the Handbook, it is suitable for wide audiences, including non-specialists and communities at risk, but also for disaster managers.

DISASTER

An occurrence disrupting normal conditions of existence and causing a level of suffering that exceeds the capacity of the affected.[1]

HANDBOOK

A book that contains instructions or advice about how to do something or the most important anduseful information about a subject.[2]

[1] World Health Organization
[2] The Cambridge English Dictionary

FLOOD

Description

A flood is an overflow of water that submerges a dry land terrain. They are the most common and widespread natural severe weather event. Floods can look very differently because flooding covers anything from a few inches to several feet of water and also can come on quickly or gradually. There are several specific flooding events.

Characteristics

Coastal floods (Fig. 1)[3] occur in areas near the seas or oceans. They usually occur as a result of extreme tides caused by bad weather. A raging storm, hurricane-force winds are pushing huge masses of water ashore. This is the main cause of coastal flooding and is often the biggest threat associated with a tropical storm. In this type of flood, water floods low-lying land and often causes devastating loss of life and property. Coastal floods are categorized into:

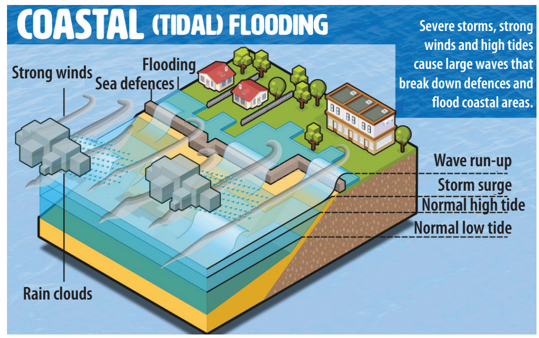


Fig. 1. Costal floods

- ❖ INSIGNIFICANT: There is a slight erosion of the beach, but no major damages.
- ❖ MODERATE: Significant erosion and damages to some homes and outbuildings.
- ❖ STRONG: Serious threat to life and property. Large-scale erosion, structures damaged.

River floods occur when the water level in a river, lake or stream rises and overflows onto the surrounding banks, shores and neighboring land. The water level rise could be due to excessive rain or snowmelt. The damage (Fig. 2)[4] can be widespread as the overflow affects smaller rivers downstream, which can cause dams and dikes to break and swamp nearby areas. The severity is determined by the duration and intensity (volume) of rainfall in the catchment area of the river. Other factors include soil water saturation due to previous rainfall, and the terrain surrounding the river system. In flatter areas, floodwater tends to rise more slowly and be shallower. It often remains for days. In hilly or mountainous areas, floods can occur within

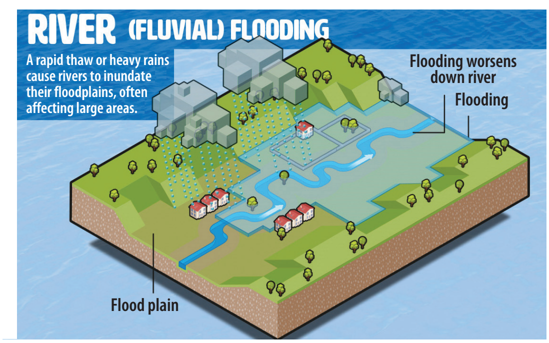


Fig. 2. River floods

[3] https://nerc.ukri.org/planetearth/stories/1856/
[4] https://nerc.ukri.org/planetearth/stories/1856/

minutes after a heavy rain, drain very quickly, and cause damage due to debris flow. To determine the probability of river flooding, models consider past precipitation, forecasted precipitation, current river levels, and well as soil and terrain conditions.[5]

Surface floods (Fig. 3)[6] come due to heavy rain, especially if it is prolonged. Such floods can occur in any area, even in higher places. Urban zone are vulnerable to it even if there are far from water reservoirs. The quality design of the drainage shafts, their cleaning and the condition of the canals in the settlement is of essential importance. During a storm and heavy rain, there are broken branches of trees, fallen leaves, garbage carried by rainwater.

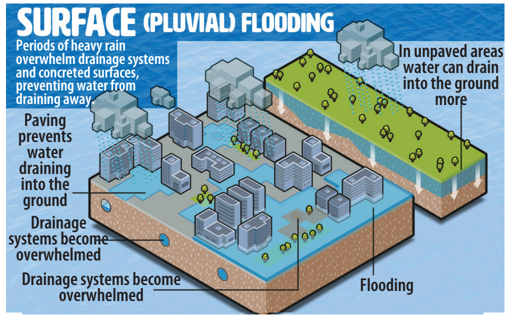


Fig. 3. Surface floods

Surface flooding may happen after a collapse of dam walls. A dam failure or dam burst is a catastrophic, sudden, rapid, and uncontrolled release of impounded water or the likelihood of such an uncontrolled release.[7]

Moreover there is flooding caused by high tidal waves is the temporary flooding of low-lying areas, especially on streets, during extremely high tides, such as full and new moons.

Protection

Before the Flood

- ✓ Follow the forecast.
- ✓ Move to a higher location, away from streams, rivers and canals.
- ✓ Explore the safest route from home or workplace to a safe place away.
- ✓ Keep your vehicle upright and ready.
- ✓ Move the animals to a higher location. Lock pets at home.
- ✓ Fill clean plastic bottles with fresh water if you live in a flood-prone area.
- ✓ Move your valuables and furniture to the highest possible place.
- ✓ Check your gutters to make sure they are not clogged with leaves and branches.
- ✓ Check your emergency kit with basic consumables for at least three days.
- ✓ Review your family emergency and communication plan.
- ✓ Do not use electrical appliances that are wet.
- ✓ Be careful not to touch exposed wires.

[5] https://www.zurich.com/en/knowledge/topics/flood-and-water-damage/
[6] https://nerc.ukri.org/planetearth/stories/1856/
[7] https://en.wikipedia.org/wiki/Dam_failure

Flood Preventive Engineering Equipment:

Fig. 4. Dike

Depending on the expected rises in the level of rivers and canals, a dike (Fig. 4)[8] could be erected over the entire area at risk of flooding. Its height must ensure protection against overflow of the water mass. Clay-sandy soils, sands and gravel are most often used for the construction of dikes and embankments. Whether the dike is low or high, it must meet some basic requirements:

- Fast construction using local materials - gravel, sand, clay, etc.
- Resistance of the embankment to static and hydraulic loading.
- Creation of a watertight barrier on the water slope or inside the embankment.
- Good sealing and no deformations.
- Good drainage! With good drainage, the slope may be higher and steeper.

Embankment structures (walls) are usually performed with sandbags or flexible pipes with water from the source, or forced filling of the water dike (Fig. 5)[9]. Even if there are pre-erected dikes, it may be necessary to upgrade an existing dike in an emergency. Sand is most often used to fill plastic or tarpaulin bags measuring 65 x 35 cm, filled to half and weigh no more than 15 kg. However, tons of sand must be poured into them in a short time. During transportation, they are tied, and if they are filled on the spot, they overlap with each other so that they do not spill. The arrangement is along the current, as the first layer is laid on a solid foundation without grass and ice. The overlap occurs when the filled part of one bag rests on the unfilled part of the already placed bag.

Fig. 5. Construction of dikes

!!! Never start filling from the middle to both ends of the problem area. Work from one end to the other or from the middle to both ends at the same time. The height of the constructed wall must exceed by 30 cm the estimated height of the flood !!!

[8] https://en.wikipedia.org/wiki/Levee
[9] http://ntemc.org/documents/disaster_assistance/Sandbag%20Dike%20Construction%20-%20MB-CA.PDF

During the Flood

Streams flow from different places, which further raises the level of the dam. In case of storm and precipitation over 100 liters per m2 the water drags various sediments, branches, trees, clogs the drainage channels, causes huge pressure on the dam wall or dam. The wall or the dike may break and huge bodies of water may flow down the riverbed, destroying the banks. The front of the river widens over a long distance, and the speed of the tidal wave can reach tens of meters per second. The kinetic energy of the water mass is capable of tearing down trees, tearing down bridges and buildings.

TIDAL WAVE

has enormous kinetic energy and moves at high speed.
It affects the buildings by:

- Hydrostatic Pressure – at a height of the outer water column of 2 m, the pressure on the base of the wall of the building is 0.624 tons / m2. It can cause wall collapse inwards.
- Vertical Hydrostatic Pressure – water "creeps" from the foundations up the walls and can reach a height of 1 meter or more.

Water at a speed of 16 km / h exerts a pressure on a building equivalent to the pressure

Along the way, floating debris turns into dangerous shells that can sow death and destruction. Infrastructure is collapsing, people's houses are sinking in water, and moisture can rise to the upper floors. The whole disaster can last from a few minutes to several hours. That is why dams, rivers, lakes must be under constant monitoring and the population must have minute-by-minute information about the condition of water basins and the measures to be taken.

After the Flood

After the withdrawal of waters within their normal, following are activities as:

- Search for missing people.
- Removal of dead bodies and debris.
- Drainage of buildings.
- Disinfection.
- Clearing affected roads.

RISK AFTER THE FLOOD

Lack of clean drinking water. Development of bacteria and pollution. Panic and mental disorders.
Potential of biological contamination as a cause of an epidemic.

FIRE

Description

Fire (Fig. 6)[10] is the rapid oxidation of a material in the exothermic chemical process of combustion, releasing heat, light, and various reaction products.[11] It is hot because the conversion of the weak double bond in molecular oxygen, O2, to the stronger bonds in the combustion products carbon dioxide and water releases energy (418 kJ per 32 g of O2). The bond energies of the fuel play only a minor role here.[12]

Fig. 6. Fire

At a certain point in the combustion reaction, called the ignition point, flames are produced. The flame is the visible portion of the fire and consists primarily of carbon dioxide, water vapor, oxygen and nitrogen. If hot enough, the gases may become ionized to produce plasma.[13]

Depending on the substances alight, and any impurities outside, the color of the flame and the fire's intensity will be different. In its most common form can result in conflagration, which has the potential to cause physical damage through burning. Fire is an important process that affects ecological systems around the globe.

Positive Effects – fire includes stimulating growth and maintaining various ecological systems.

Negative Effects – hazard to life and property, atmospheric pollution, and water contamination.

If fire removes protective vegetation, heavy rainfall may lead to an increase in soil erosion by water.[14] Also, when vegetation is burned, the nitrogen it contains is released into the atmosphere, unlike elements such as potassium and phosphorus which remain in the ash and are quickly recycled into the soil. This loss of nitrogen caused by a fire produces a long-term reduction in the fertility of the soil.

[10] https://forestsnews.cifor.org/28396/best-predictor-of-severe-fires-in-the-western-amazon-drought?fnl=
[11] "Glossary of Wildland Fire Terminology". National Wildfire Coordinating Group. November 2009. Retrieved 2008-12-18
[12] https://pubs.acs.org/doi/10.1021/acs.jchemed.5b00333
[13] https://www.thoughtco.com/what-state-of-matter-is-fire-604300
[14] Morris, S. E.; Moses, T. A. (1987). "Forest Fire and the Natural Soil Erosion Regime in the Colorado Front Range". Annals of the Association of American Geographers

Characteristics

Every day, people all over the world experience the horror of fire. However, most of them do not understand it. Fire deaths can be reduced by teaching people the basic facts about them. Below are some simple facts that explain the particular characteristics of fire.

FIRE IS FAST

In less than 30 seconds, a small flame can get completely out of control and turn into a major fire (Fig. 7). It only takes seconds for a thick black smoke to fill a room and in minutes flames to engulf a house. Most fires occur in homes when people are out or asleep. If you wake up to a fire, you won't have time to grab valuables, because fire spreads too quickly, and the smoke is too thick. There is only time to escape.

Fig. 7. Burning house

FIRE IS HOT

Heat is more threatening than flames. A fire's heat alone can kill. Room temperatures in a fire can be 100 degrees Celsius at floor level and rise to 600 degrees at eye level. Inhaling this super-hot air will scorch human lungs. This heat can melt clothes to skin. In five minutes, a room can get so hot that everything in it ignites at once. This is called flashover.

FIRE IS DARK

Fire is not bright, it is pitch black (Fig. 8)[15]. Fire starts bright, but quickly produces black smoke and complete darkness. If you are into to a fire, you may be blinded, disoriented, and unable to find your way around the home you have lived in for years.

Fig. 8. Dark smoke

FIRE IS DEADLY

Smoke and toxic gases kill more people than flames do. Fire uses up the oxygen you need and produces smoke and poisonous gases that kill. Breathing even small amounts of smoke and toxic gases can make you drowsy, disoriented, and short of breath. The odorless, colorless fumes can lull you into a deep sleep before the flames reach your door. You may not wake up in time to escape.

[15] https://www.plymouthherald.co.uk/news/plymouth-news/fire-service-confirms-cause-blaze-4316460

FIRE SAFETY TIPS

In the event of a fire, remember time is the biggest enemy and every second counts!

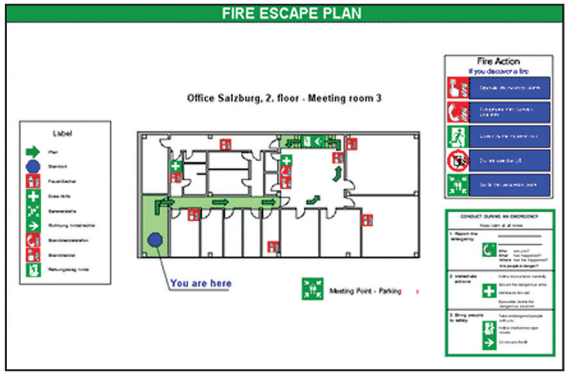


Fig. 9. Escape plan

Escape First

Escape first! Then call for help. Develop a fire escape plan (Fig. 9)[16] and designate a meeting place outside.

Smoke Alarm

Having a working smoke alarm dramatically increases your chances of surviving a fire. Remember to practice the escape plan frequently with your family, friends or colleagues (Fig.10).[17]


Fig. 10. Smoke alarm

Make sure everyone knows two ways to escape from every room.
Practice!
Never stand up, crawl low under the smoke and keep your mouth covered.
Never return to a burning building for any reason; it may cost you your life.

Disaster Assessment and Classification

Fires could be classified in several groups in relation to their place of ignition:

Urban Areas
buildings, houses, offices, shops, social places

Wild Areas
fields, forests, bushes

Industrial Zones

Vehicles

[16] https://www.cadvilla.com/en/fire-escape-plan_software/
[17] https://www.tuv.com/world/en/smoke-detector-testing-and-certification.html

Fires could be:

Intentional There are different reasons to cause a deliberate fire. It could be because of a revenge or to hide clues – burning vehicles, crime scene, insurance frauds or terrain clearances for new building. All these are criminal acts.

Same category are fires in agricultural areas for clearing desolate terrains or when a forest is set on fire with the aim to steal wood. These fires in addition to the direct loss of the forest and trees could rapidly grow without any control for a short period causing huge damage to large areas, threating life and property of many people.

By Accident Welding, smoking, throwing a cigarette butt to unsuitable places, not observing technical discipline, through vehicles or failures of the electric power grids, of vehicles ‘engines or gas installations

Excluding People’s Activity Fires can also happen with the lack of direct attendance of people on the place of fire – when there is short circuit of the electric power grid, or when induced by the nature – lightning, volcanos, etc.

Fires at Home There is open fire or ignition within closed space – electric heaters, ovens, toasters, cookers, fry pans, and microwave ovens. Predominantly, these are the main reasons for home fires.

Most cooking induced fires begin with the ignition of ordinary kitchen equipment, walls’ coverage, paper or plastic bags, curtains, etc. These fires are caused most often by leaving unattended devices or putting flammable substances very close to a fire source. In case of open cooking, barbecues or festive bonfires, the wind could blow out ember and set dry surface on fire.

Heating equipment and systems are very likely agents for fires at home. To avoid fires caused by heating equipment, it should be maintained, cleaned and checked out regularly by a qualified specialist.

Caused by Smoking Tobacco products, including cigarettes, pipes and cigars, caused much of the domestic fires. In order to avoid this type of fire, people do not have to throw cigarettes and cigarette butts in grass and planted areas, especially where there is moss, dried grass, leaves and other easily flammable substances.

IMPORTANT

Never to smoke in premises where the oxygen is used to work with – industrial halls, hospital rooms. It is possible there that oxygen leakage could cause an explosion or fire.

Protection

PRECAUTIONARY

If the fire arose in premises, it is very likely the evacuation to be done in the dark due to a blackout. Plan your withdrawal routes in advance to avoid any obstacles during evacuation – objects, furniture, broken and destroyed floor or other things that may hinder you. Many home fires occur during the night.

The fire could rapidly disseminate and cover a large area when there are flammable liquids (spirt, petroleum) in houses, offices, and industrial buildings.

In gasified premises, the fire could occur when there is a gas leakage preceded by an explosion.

Usually at closed space, the fire starts with a little flame, preceded by a longer period of residual heat dissipation or hard flammable materials. Smells of overheated materials and a thin smoke are first slight signs of the incoming.

Sometimes people may hear whipping noises or see a lightening in case there are open windows or balcony doors in the room where the fire is set.

Accurate information about the fire will allow the fire fighters to navigate the situation, plan their activities and make the necessary decisions to counteract the fire.

Here are some simple things you should do to protect yourself and your family from fire:

- Switch off all electrical appliances for which is not intention for permanent use.
- Turn off all gas appliances.
- Make sure you do not leave smoldering cigarettes.
- Turn off the temporary heaters.
- Install a fence around an open fire (stove, fireplace).
- If the combustion has just started, you can easily extinguish it with water, cover with a thick blanket or tablecloth covered with sand, soil.
- Never extinguish burning electrical cables and electrical appliances with water, which are under voltage (this is life threatening).
- If you see you cannot put out the fire and it threatens to spread, leave the room immediately.
- Never hide in a smoke-filled environment in secluded places.

If a TV or computer lights up:

- Unplug the appliance.
- Report a fire to the fire fighters.
- If burning continues after turning off, fill it with water or cover it with a thick blanket.
- If the burning still continues, the last thing is to throw the TV/PC out the window on the street…but before you do, be sure to look down!
- If the TV has exploded and the fire has intensified, do not endanger your life by staying in the room. Close the door and windows and leave the room.
- Do the same if this happens with other electrical appliances.

Ignition of Lithium batteries in electronics are almost everywhere (Fig. 11)[18] - in laptops, cameras, mobile phones and electric cars. Although accidents are rare, those that do occur can be impressive, causing an explosion or fire. To understand why these batteries, explode and ignite and how to minimize the risk of an accident, you need to understand, how they work.

Fig. 11. Laptop batteries

- If the battery is damaged, a short circuit occurs. A spark can ignite highly reactive lithium.
- The battery can heat up to a critical point. It puts pressure, which can cause an explosion.

How to minimize the risk of fire or explosion?

- Avoid storing the battery at high temperatures.
- Do not store batteries in hot cars.
- Do not cover your laptop with blanket.
- Do not keep your mobile phone in a hot pocket.
- Avoid storing all batteries containing lithium-ion batteries together. *When you travel, especially on a plane, you will have all the electronic items in one bag. This is inevitable, but you can usually save a little space between rechargeable items. Although lithium-ion batteries in the immediate vicinity do not increase the risk of fire in an accident, other batteries may catch fire and worsen the situation.*
- Avoid recharging the batteries.
- Using a re-charger other than the one intended for the battery may increase the risk of damage.

[18] http://myjanani.blogspot.com/2014/04/laptop-battery.html

What to do if the battery is still in flames?

Common fire extinguishers are ineffective against igniting lithium-ion batteries. LITH-EX (Fig. 12[19], and Fig. 13[20]) solves this problem by easily dealing with small fires that can occur in electronic devices with lithium.

This ecological water solution is applied in the form of a mist, creating a film on the fire. This strong film dries instantly, creating a barrier between the fire and the atmosphere, which leads to extinguishing the fire.

Fig. 12. Special fire extinguisher

IMPORTANT

Never flood a burning Lithium-Ion battery with water!

ɔs://www.safelincs.co.uk
ɔs://www.kmagroupbv.com/blog/2018/02/01/kiwa-certificate-lith-ex-avd/

In case of fire in closed spaces

- Call the fire fighters.
- Remember that the fire and smoke in the staircase spread only in one direction from the bottom up to the top.
- Remember for the BACKDRAFT! Breaking and opening a door increases the flow of oxygen and the fire can burst seriously.
- If the smoke is light, try to find out where the source is. If you manage to find the hearth, try to extinguish it. Anyway, call the fire fighters!
- If it is not possible to put out the fire, without panic try to escape using the emergency exits or follow the instructions of the fire fighters.
- Going through smoke areas, try to overcome them by holding your breath or covering your mouth and nose with a wet handkerchief.

GET TO KNOW[21]:

'The Backdraft' stands for an explosive burst of superheated gasses in a fire, caused when oxygen rapidly enters an oxygen-depleted closed space.

IMPORTANT

Never fight the flames yourself without calling for help!

[21] ISO 13943:2017 – Fire Safety Vocabulary, International Organization for Standardization.

If a human is burning

Do not allow the person to run.

If necessary, knock down the running person on the ground and cover with a blanket, thick cloth or snow, sand, water.

If possible, discard the burning garment within the first few seconds after ignition. Cloths in flames for 1-2 minutes lead to severe injuries and sometimes a fatal outcome.

If you cover the body with a thick blanket, the head should be out as not suffocate.

In case of fire in open space

GET TO KNOW

The speed of spread of ground fire is from 0.1 to 3 meters per minute.

The crown of trees – up to 100 meters per minute in the direction of the wind.

When burning peat and plant roots, underground fires can spread randomly.

Peat can burn spontaneously without access to air or even underwater.

IMPORTANT In case of danger of tree fires in settlements – cleaning of soil strips between buildings and adjacent bush and forest areas with a width of 5-10 meters in deciduous forests and up to 50 meters in coniferous forests.

If you are in the range of a wild forest fire:

Leave the danger zone. Organize the evacuation to open areas,

Exit the danger zone perpendicular to the direction of movement of the fire.

If there is a lake or river, quickly enter the waters or cover yourself with wet clothes.

After leaving the area, inform the authorities about the place, size and nature of the fire.

IMPORTANT Flames in small and local fires near the ground are extinguished with the help of branches, to be watered, to trample with feet and etc. Breathing is easier and safer very close to the ground. Use a towel or garment as a filter when breathing.

EARTHQUAKES

One of the most devastating natural disasters due to the extreme power of the phenomenon, which in a short time releases incredible energy over a large area on Earth and can affect thousands of people.

Where. How. When.

While the answers to the questions where a potential earthquake would occur and how powerful it could be can be determined with some accuracy, to predict when it will happen remains vague despite being a crucial query.

Description

Earthquake is a term used to describe any sudden shaking of the ground caused by the passage of seismic waves through Earth's rocks – caused by a sudden slip on a *fault* and radiated seismic energy caused by the slip, by volcanic or magmatic activity, or other sudden stress changes in the earth.[22]

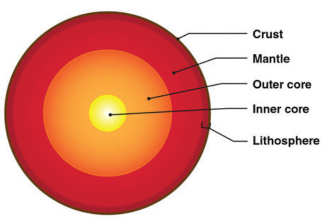


Fig. 14. A diagram of Earth's layers.

The solid crust and top, stiff layer of the mantle make up a region called the lithosphere (Fig. 14). The lithosphere is not a continuous piece that wraps around the whole Earth. It is actually made up of giant puzzle pieces called tectonic plates. Tectonic plates are constantly shifting as they drift around or slowly flowing on the viscous mantle layer below but they get stuck at their edges due to friction.

When the stress on the edge overcomes the friction, an earthquake releases energy in waves that travel through the earth's crust, leads to cracks called *faults* and cause the shaking. When tectonic plates move, it also causes movements at the faults. The major fault lines are located at the fringes of the huge tectonic plates that make up Earth's crust.[23]

[22] https://earthquake.usgs.gov/learn/glossary/?term=earthquake
[23] https://spaceplace.nasa.gov/earthquakes/en/

Characteristic – an illustrative description in Fig. 15[24], Fig. 16[25] and Fig. 17[26].

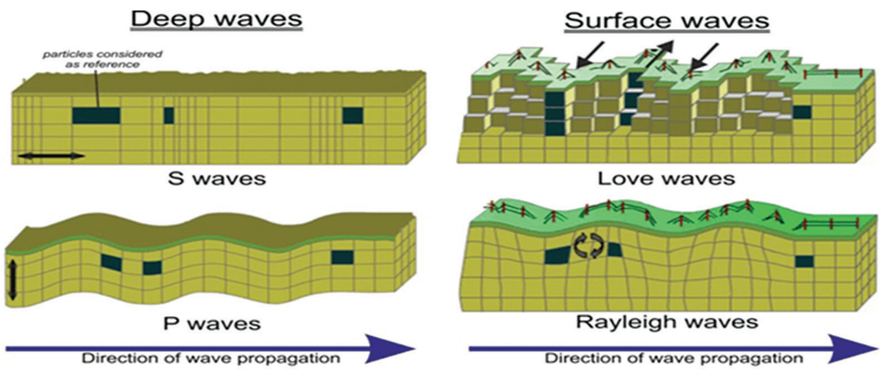


Fig. 15. Types of seismic waves

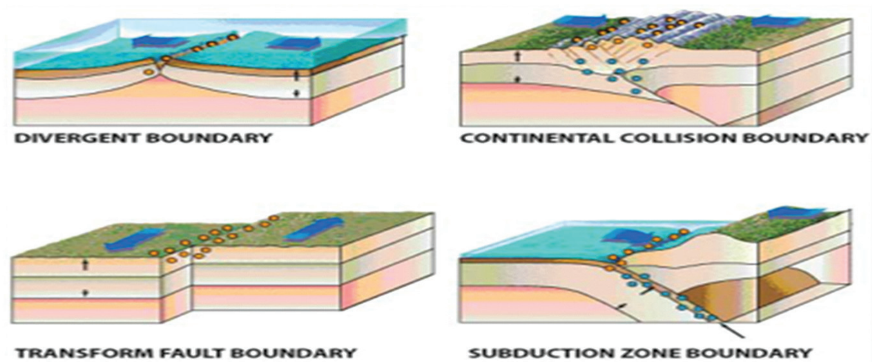


Fig. 16. Plate boundaries

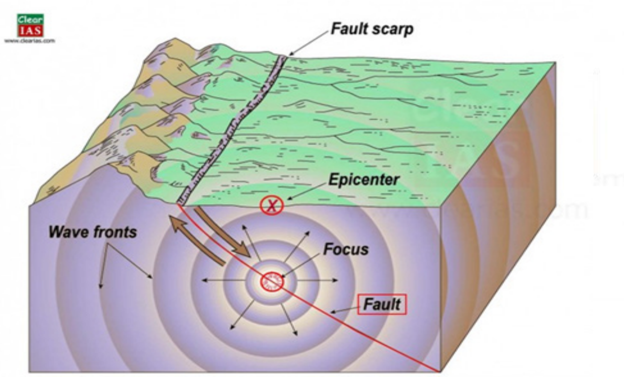


Fig. 17. Epicenter

[24] https://www.researchgate.net/figure/Types-of-seismic-waves-Deep-waves-P-and-S-waves-and-surface-waves-Love-and-Rayleigh_fig9_317427371
[25] http://academic.brooklyn.cuny.edu/geology/grocha/plates/platetec16.htm
[26] https://www.clearias.com/earthquakes/

Epicenter (Fig. 17)
The location where an earthquake begins is called the epicenter. The earthquake is most intense shaking there.

Seismic waves (Fig. 15)
Elastic waves emitted by an earthquake and propagating in the earth's environment.

Magnitude
An instrumentally derived numerical estimate that characterizes the energy released by an earthquake.

Attenuation of seismic waves
Reduction of the amplitudes of seismic waves as they propagate from their seismic center to a site at a certain distance from the center.

Macroseismic intensity (degree)
Subjective (not instrumental) indicator of the strength of earthquake impacts on the earth's crust, buildings and the natural environment (e.g. the 12-point Medvedev-Sponhoyer-Karnik scale)

Seismic hazard
The probability that seismic earthquakes will exceed a given seismic level over a period of time

Hypocenter
The starting point of radiation (and destruction of the environment) in the epicenter of an earthquake, located at a depth of kilometers below the epicenter.

IMPORTANT

Earthquakes can strike any location at any time, but history shows they occur in the same general patterns year after year, principally in three large zones (Fig. 18)[27], called belts.

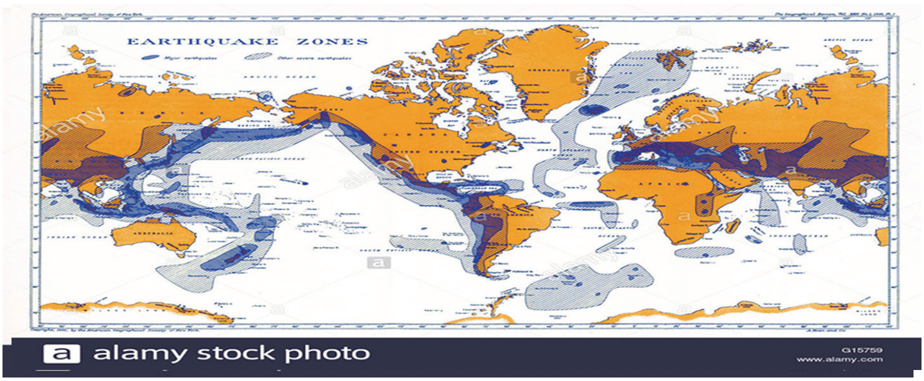


Fig. 18. Earthquake zones

World's greatest earthquake belt –

Circum-Pacific Seismic Belt

From Java to Sumatra through the Himalayas, the Mediterranean, and out into the Atlantic, 17 percent of the world's largest earthquakes and some of the most destructive –

Alpide Earthquake Belt

Deep underwater and far from human development –

Mid-Atlantic Ridge

[27] https://www.alamy.com/stock-photo-a-map-showing-earthquake-zones-this-world-seismicity-map-clearly-shows-103992261.html

The marks (Fig. 19)[28] where tectonic plates are spreading apart (a divergent plate boundary).

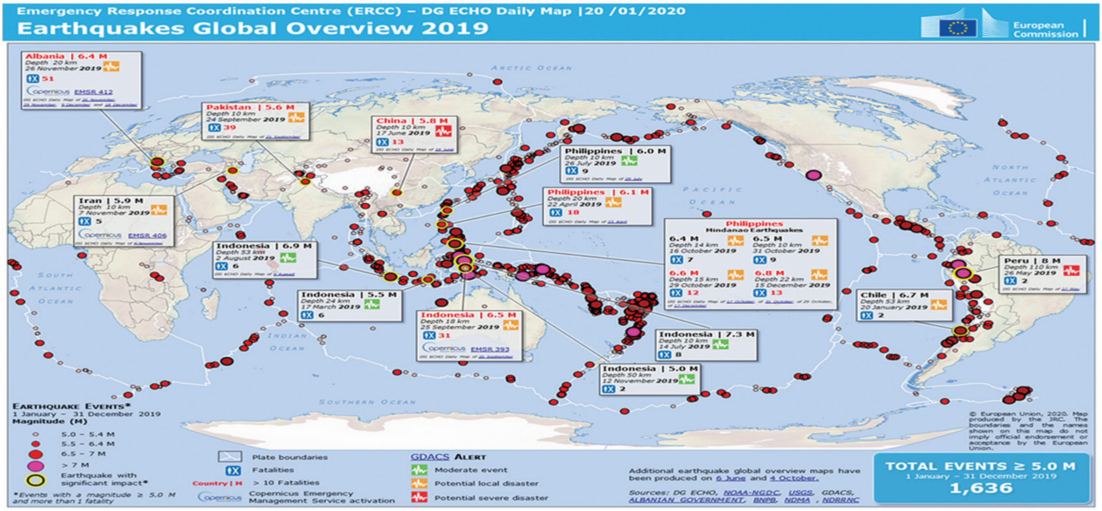


Fig. 19. Earthquakes Global Overview.

Assessment, Classification Methodologies and Scales

Seismic Risk Assessment

In order to make an accurate risk assessment, multidisciplinary coordination is needed.

- After the earthquake significant amount of information (e.g. buildings, casualties, debris, shelter needs) is to be shared.
- An update is provided two hours after the event, when additional data is available. To avoid overloading with information, updates are minimized.

Assessment of Victims and Injured

To determine the number of victims due to structural damage, mathematical dependences are applied.

Intensity Scales

The strength of the shaking is commonly estimated by reference to intensity scales that describe the effects in qualitative terms.

[28] http://academic.brooklyn.cuny.edu/geology/grocha/plates/platetec16.htm

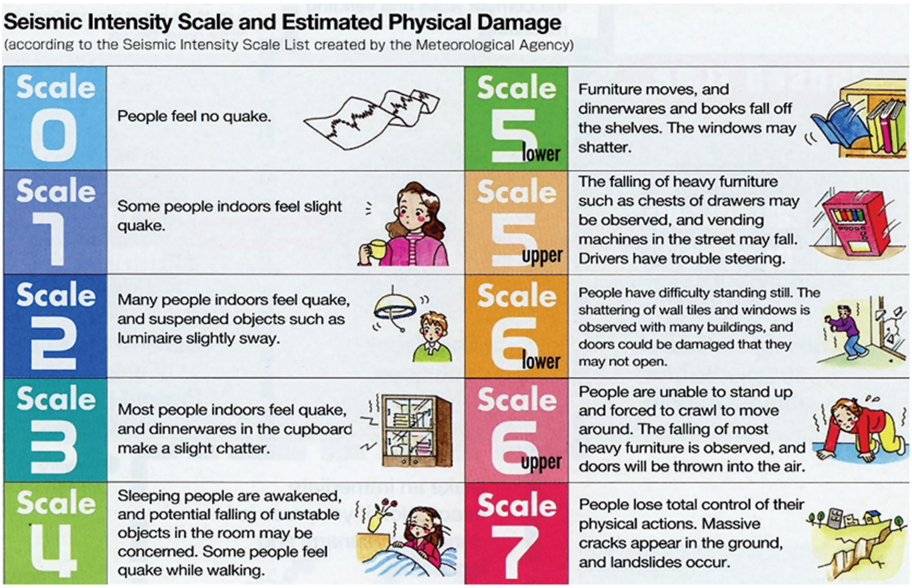


Fig. 20. Seismic intensity scale and estimated physical damage.

Example: Scales have been developed in Japan (Shindo) and Europe (MSK) for local conditions. Seismic Intensity Scale and Estimated Physical Damage (Fig. 20).

Earthquake Magnitude

It is a measure of the ‘size’ or amplitude of the seismic waves generated by an earthquake source and recorded by seismographs. Because the size of earthquakes varies enormously, it is necessary for purposes of comparison to compress the range of wave amplitudes measured on seismograms by means of a mathematical device.

Example: In 1935 the American seismologist Charles F. Richter set up a magnitude scale[29] of earthquakes as the logarithm to base 10 of the maximum seismic wave amplitude recorded on a standard seismograph (Fig. 21).

[29] https://link.springer.com/referenceworkentry/10.1007%2F978-3-319-12127-7_100-1

Magnitude	Description	Mercalli intensity	Average earthquake effects	Average frequency of occurrence (estimated)
Less than 2.0	Micro	I	Micro earthquakes, not felt, or felt rarely. Recorded by seismographs	Continual/several million per year
2.0–2.9	Minor	I to II	Felt slightly by some people. No damage to buildings	Over one million per year
3.0–3.9		II to IV	Often felt by people, but very rarely causes damage. Shaking of indoor objects can be noticeable	Over 100,000 per year
4.0–4.9	Light	IV to VI	Noticeable shaking of indoor objects and rattling noises. Felt by most people in the affected area. Slightly felt outside. Generally, causes none to minimal damage. Moderate to significant damage very unlikely. Some objects may fall off shelves or be knocked over	10,000 to 15,000 per year
5.0–5.9	Moderate	VI to VIII	Can cause damage of varying severity to poorly constructed buildings. At most, none to slight damage to all other buildings. Felt by everyone	1000 to 1500 per year
6.0–6.9	Strong	VII to X	Damage to a moderate number of well-built structures in populated areas. Earthquake-resistant structures survive with slight to moderate damage. Poorly designed structures receive moderate to severe damage. Felt in wider areas, up to hundreds of miles/kilometers from the epicenter. Strong to violent shaking in epicentral area	100 to 150 per year
7.0–7.9	Major	VIII or greater	Causes damage to most buildings, some to partially or completely collapse or receive severe damage. Well-designed structures are likely to receive damage. Felt across great distances with major damage mostly limited to 250 km from epicenter	10 to 20 per year
8.0–8.9	Great		Major damage to buildings, structures likely to be destroyed. Will cause moderate to heavy damage to sturdy or earthquake-resistant buildings. Damaging in large areas. Felt in extremely large regions.	One per year
9.0 and greater			Near or total destruction – severe damage or collapse to all buildings. Heavy damage and shaking extend to distant locations. Permanent changes in ground topography	One per 10 to 50 years

Fig. 21. The Richter magnitude scale and the Mercalli intensity scale.

Protection

What to do during an earthquake

THE MOST IMPORTANT DO NOT PANIC AND KEEP CALM!

- ✓ If the quake is weak, which often happens, there is no need to worry.
- ✓ If you feel a strong tremor, be prepared that in the next 15-20 seconds other even stronger tremors may appear. They may be longer in duration.
- ✓ Attenuation can be expected in the next 20-30 seconds
- ✓ If you are indoors**.** If the quake finds you on the 1^{st} or 2^{nd} floor, leave the building immediately and go outdoors.
- ✓ If you are on the 3^{rd} and higher floors, do not rush to the elevators. They can be a deadly trap.
- ✓ Usually the safest places in an apartment are under the door jambs, near the load-bearing walls of the building.
- ✓ It is relatively safe to hide under massive chairs, tables, near the headboards, baths.
- ✓ Stay away from windows. Curiosity to see what others are doing, looking out the window or balcony, can hurt or kill you.
- ✓ If you are in the kitchen, get out of it – it is a dangerous place because of the variety of falling objects.
- ✓ If you are in bed, stay there and cover your head and neck with a pillow.
- ✓ If you are outdoors, get into the open, away from buildings, power lines, chimneys, and anything else that might fall on you.
- ✓ Do not stay in front of the entrance or on the street in front of the building.
- ✓ Keep a distance of once and a half of the height of the building. Parks are the most suitable areas.
- ✓ If possible, turn off the sockets, gas supply, and lighting.
- ✓ Take away only the most necessary.

IMPORTANT

If such a catastrophic event happens, there will be destruction, falling objects, broken glass and debris. You need to have a clear prearrangement in case you split with your family how to find each other and where to wait for each other.

Probably no more than 1% of the world population has prepared items and documents that can take within the first 10 seconds. That is why it is useful for every household to have –

AN ESSENTIAL KIT

- ✓ Small first aid kit
- ✓ Water, at least one liter per person per day
- ✓ Food
- ✓ A set of suitable for the season clothes
- ✓ Flashlight, batteries, charger (especially if it uses mechanical or solar charging), knife
- ✓ Individual sanitary materials
- ✓ Blanket
- ✓ Whistle to signal in case you are buried under remains or debris
- ✓ Money and documents

Keep personal documents, money and valuables in such a place, which allows easy access.

Keep this kit in a designated place and prepare it in case you need to leave your home in hast. Make sure all family members know where the kit is kept.

WHAT ELSE:

- All members of the family should know in advance what to do and who will take what, as well as where to go.
- Learn the perfect route for a possible evacuation and retrieval.
- With your relatives and friends, provide that you will be looking for each other and give information about your condition and whether you stay together.
- Everyone should have some specific information about his/her self - blood type, allergies, implanted pacemaker and everything that would help a rescue team for the first aid.
- On the street, avoid being under power lines, near gas installations, bridges, subways.
- If you are cycling – stop the engine, place the motorcycle or bicycle on the ground. Keep a safe distance from buildings to avoid falling objects.
- If you are driving, pull up as far out of traffic as possible and stop the car, turn off the engine and open the doors. Stay inside your car and wait for the quake to pass. Do not stop on or under a bridge or overpass or under trees, light posts, power lines, or signs.[30]
- In public places - it is most dangerous to panic and run with the crowd. Quickly draw away from the flow. Be careful not to fall and be crushed by panicked runners. If there are signs for evacuation exits and an evacuation plan, take a few minutes and study them carefully in advance.
- If you are in a mountainous area - watch out for falling rock, landslides, trees, and other debris that could be loosened by quakes.
- If the quake did not cause damage and you are healthy, refrain from using cell phones. The lines will be congested and it will be difficult to connect.

After the Earthquake

- When the quake stops, look around.
- If the building is damaged and there is a clear path to safety, leave the building and go to an open space away from the damaged areas.
- If there are unsecured objects and debris in a secondary, even weaker quake, there is a danger that they will break off and the building will collapse completely.
- If you are trapped, do not move.
- If you have a cell phone with you, use it to call or send help text. Knock on a pipe or wall or use a whistle, if you have one, so that rescuers can find you.
- Move away from damaged buildings as quickly as possible because the structure is unstable and there can be further destructions.
- Do not try to remove heavy debris yourself.
- When the primary devastating quake is over, many aftershocks will follow. As a rule, they are weaker than the first, but not always.
- If you can do it safely, help rescuers and first responders.
- Help, but do not disturb the rescue teams.

TSUNAMI

Description

A tsunami is a series of ocean waves that sends surges of water onto land causing widespread destruction when crashing ashore. Tsunamis may reach over 30-meter height and travel at a speed of 720 to 960 km/h in deep ocean.

Tsunami waves are barely felt in deep ocean because of the length of the wave (hundreds of kilometers) and the small amplitude (a couple of meters). However, when the tsunami approaches the coast, i.e. shallower waters, the length decreases (i.e. waves slow down) and the amplitude (height) increases. The tops of the waves move faster than their bottoms do, which causes them to rise precipitously.

Tsunamis are typically caused by large, undersea earthquakes at tectonic plate boundaries. When the ocean floor at a plate boundary rises or falls suddenly, it displaces the water above it and launches the rolling waves that will become a tsunami. Tsunamis may also be caused by underwater landslides or volcanic eruptions (Fig. 22)[31].

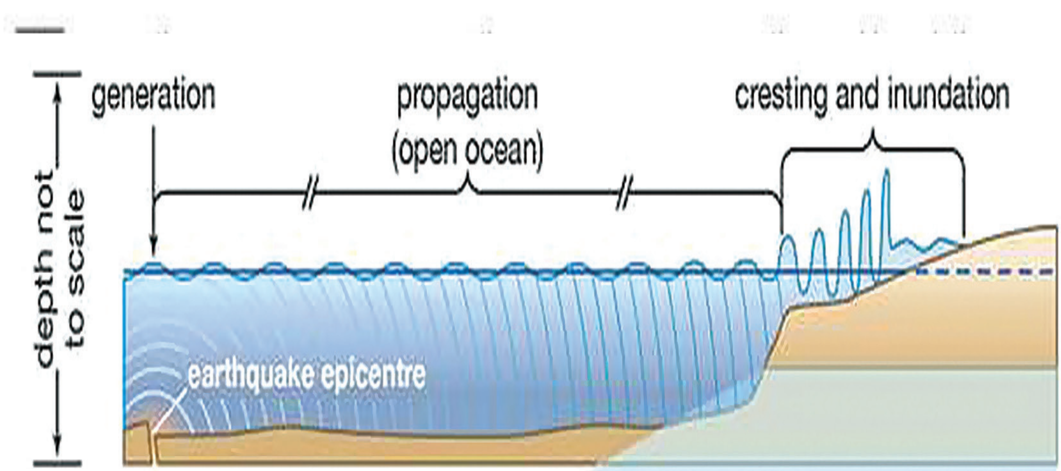
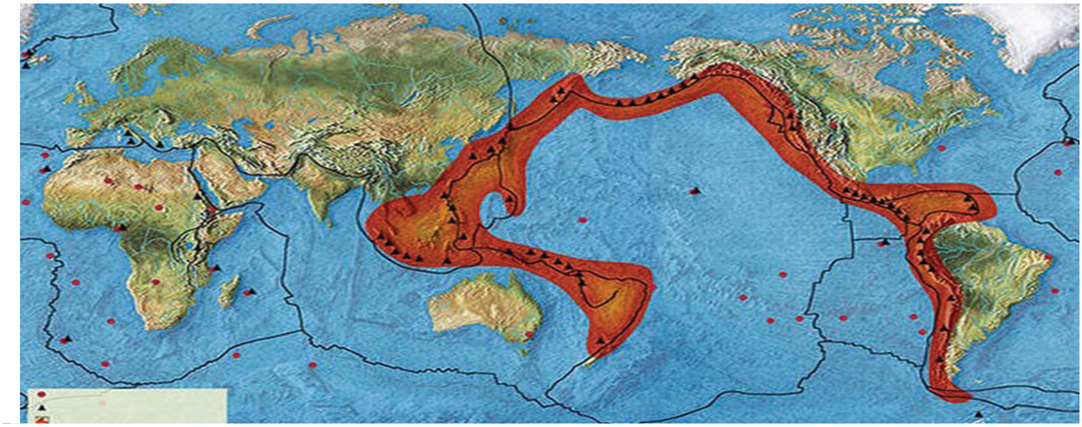


Fig. 22.

[31] Encyclopedia Britannica

Most tsunamis (bout 80 percent) happen within the Pacific Ocean's 'Ring of Fire' (Fig. 23)[32]:



: Fig. 23

From the initial area of generation, tsunami waves spread in all directions, much like the waves produced by a pebble falling into a shallow pool (Fig. 24)[33].

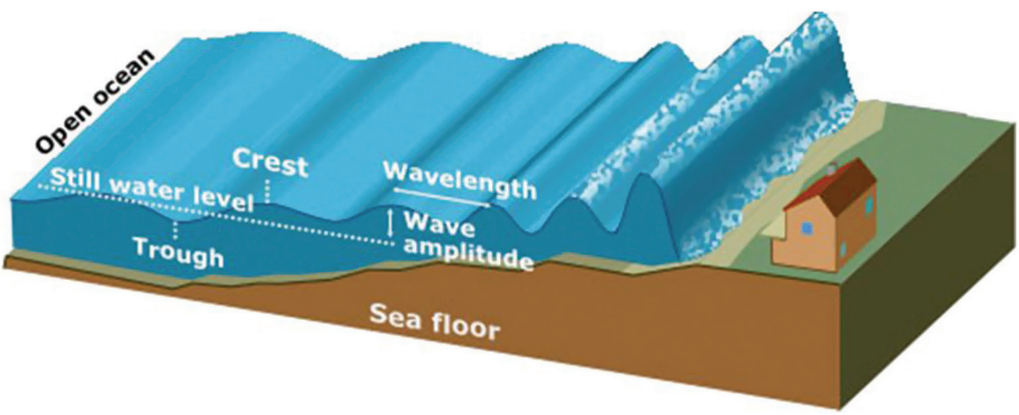


Fig. 24

[32] https://www.express.co.uk/news/world/1019490/ring-of-fire-earthquakes-tremors-pacific-basin-earthquake-solomon-islands-japan
[33] http://tsunami.org/tsunami-characteristics/

Characteristics

- A tsunami's trough, the low point beneath the wave's crest, often reaches shore first. When it does, it produces a vacuum effect that sucks coastal water seaward and exposes harbor and sea floors.
- A tsunami is usually composed of a series of waves, called a wave train, so its destructive force may be compounded as successive waves reach shore.
- The first wave is usually neither the biggest nor the most devastating in the sequence therefore, people experiencing a tsunami should remember that the danger may not have passed with the first wave and should await official notification that it is safe to return to vulnerable locations.
- Frequently the succeeding outflow of water is just as destructive as the run-up or even more so. In any case, oscillations may continue for several days until the ocean surface reaches equilibrium.
- Some tsunamis do not appear on shore as massive breaking waves but instead resemble a quickly surging tide that inundates coastal areas.
- Large earthquakes (magnitude 7.0 or higher) and unusual changes in sea level - retreating of seawater, are therefore essential signs of a tsunami, because the wave's crest and its enormous volume of water typically hit shore approximately five minutes later.

Protection

The best defence against any tsunami are tailored awareness-raising and early warning (Fig. 25)[34] that enable people to fend for themselves and seek higher ground.

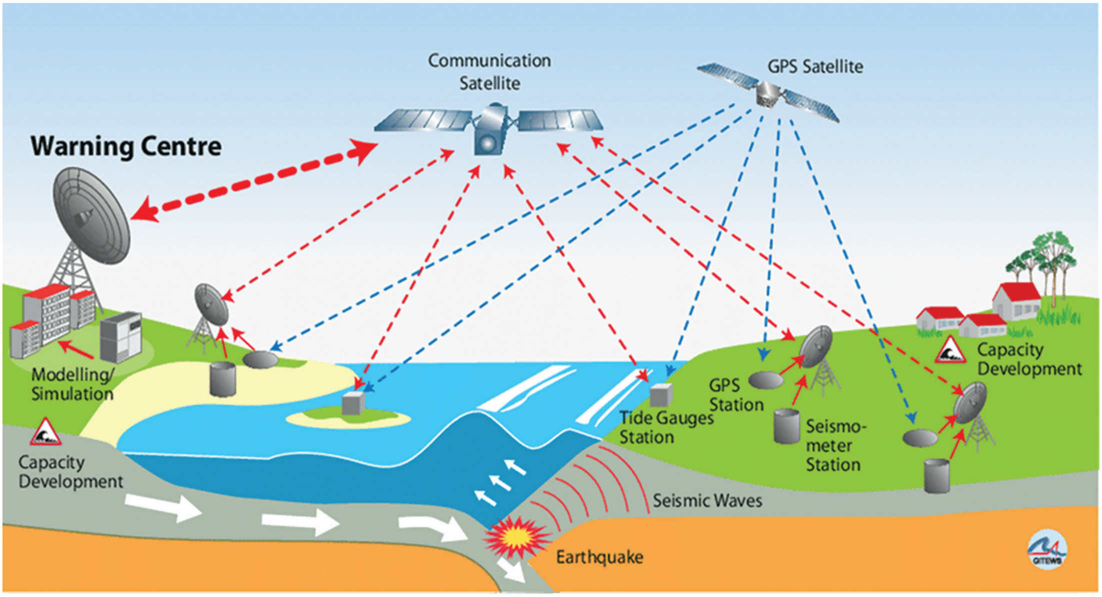


Fig. 25: Early warning

Initial warning is usually based on seismic activity information.

Example: An earthquake of magnitude 7.0 Richter triggers a warning for the coastal areas with an average of 2 hours evacuation notice, depending on the distance from the seismic disturbance.

Meteorological agencies report unusual changes in sea level, and then the warning centre combine this information with topographic data of the ocean floor in order to estimate the path, magnitude, and arrival time of the tsunami.

As data on the water level is recorded, the warning is either gradually lifted, limited, or increased to include additional areas in cases of extremely strong tsunami.

[34] https://www.researchgate.net/

Here are some protection measures[35,36]

Before Tsunami

- Awareness and knowledge in order to decrease levels of fear and stress.
- Be aware of the level of impact for your area and of existing evacuation plans.
- Plan evacuation routes from your place – home, campus, working place – to safe locations.
- Be prepared to seek high areas in vicinity in a case of flooding, ideally in 15-minute walking distance.
- Insure your home against tsunami impacts. Prepare to secure your property and livestock. Turn off electricity and gas.
- Make sure you have access to radio stations.
- Have an emergency kit – list of items of first need which to easily collect and take in the evacuation.

During Tsunami

Should you feel a coastal earthquake:

- If you can see the wave, you are dangerously close to it.
- Seek a refuge and go to a high in-land area.
- When the quake is over, a tsunami might ensue.
- Use local radio station or TV station for update of information.
- Follow your authorities' instructions as recommended evacuation routes might be different from those initially planned.
- Take you emergency kit. Take your pets with you.
- Move away from buildings and bridges, and from the way of floating objects.
- Stay at a safe location until you receive information from local authorities that you may return to your home.

IMPORTANT

- Tsunami waves may continue with hours – do not assume that after one wave the danger is over.
- The next wave might be bigger and more devastating.
- If caught by a tsunami wave, it is better not to swim, but rather to grab a floating object and allow the current to carry you.[37]

[35] https://www.ready.gov/tsunamis
[36] https://www.redcross.org/get-help/how-to-prepare-for-emergencies/types-of-emergencies/tsunami.html
[37] https://www.dosomething.org/us/facts/11-facts-about-tsunamis#fn6

After Tsunami

- Stay at a safe place.
- If available and possible, register with tracking systems to indicate your location and condition.
- If you have been evacuated, follow local authorities' safety instructions.
- If someone has been injured or trapped, call emergency services.
- If you know how to do first aid properly, help the emergency services.
- Be ready for secondary quakes, which might trigger tsunami waves again.
- Manage stress and assist others in managing it, particularly children.
- Go back home when the situation allows and permission received from authorities:
- Make sure your home is not damaged to an extent, which poses a danger – do not enter if you see deep cracks or if parts of the building have collapsed.
- Beware of damaged power and gas lines and alarm the emergency services.
- If you smell gas or hear a hissing sound, immediately open windows and vacate the premises.
- Mind that water might be contaminated.
- Do not eat food, which has been in contact with potentially contaminated water.

VOLCANOS

Description

Volcano is a vent in the crust of the Earth or another planet or satellite, from which issue eruptions of molten rock, hot rock fragments, and hot gases.[38]

Fig. 26. Volcano

It is a geological formation, individual elevations above channels and cracks in the earth's crust, through which the products of the eruption are released from deep magma chambers.

Volcanoes usually have the shape of a cone with a crater at the top (Fig. 26)[39].

Volcanoes usually have depth of several to hundreds of meters and a diameter of up to 1.5 kilometers.

During activity, the volcanic eruption sometimes collapses with the formation of the caldera - a large cavity with a diameter of up to 16 km and a depth of up to 1000 m.

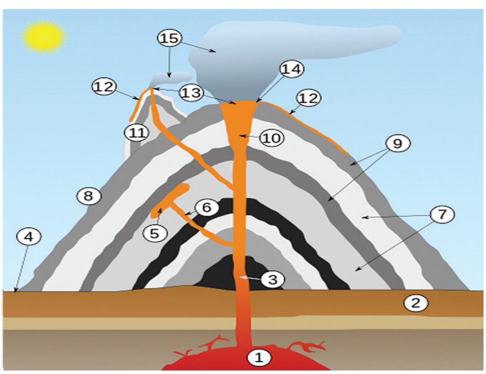


Fig. 27. Scheme of a volcano

Scheme of a volcano	
1. Large magma chamber	*9. Layers of lava*
2. Hard ground	*10. Throat*
3. Channel	*11. Parasitic cone*
4. Basis	*12. Lava flow*
5. Layer intrusion	*13. Mouth*
6. Branched channel	*14. Crater*
7. Layers of ash	*15. Cloud of ashes*
8. Slope	

[38] https://www.britannica.com/science/volcano/Stratovolcanoes
[39] http://voyapon.com/

Characteristics

Volcanoes are CLASSIFIED BY

- FORM
- LOCATION
- ACTIVITY

Volcanoes are conditionally DIVIDED INTO

- ACTIVE
- DORMANT
- EXTINGUISHED

The division is conditional because the 'life' of a volcano can vary from several to millions of years.

IMPORTANT

There are signs by which we can judge whether a volcano is active. If it erupts at the moment or shows signs of eruption – earthquake activity, intense gas evolution, etc.

Types by Form

Fig. 28. Conical crater

Stratovolcanoes

(stratum - geological layer, stratum)
Most often of a conical shape of the crater rising from the foot of the mountain, spewing gases and lava from the crater at the top of the cone.

Classic examples of stratovolcanoes[40] are Fujiyama in Japan, Vesuvius and Stromboli in Italy.

Shield Volcanoes

A broad, low-profile characteristic with diameters ranging from a few kilometers to over 100 kilometers (e.g. Mauna Loa, Hawaii).
Heights are usually about 1/20 of the width.
The lower slopes are often sloping (2-3 degrees), but the middle slopes become steeper (~ 10 degrees) and then flatten at the top.
This shield shape protrudes upwards. Their common broad forms are the result of the extrusion of very liquid basalt lava (low viscosity) which extends outwards from the top zone

Lava Dome Volcanoes

Built by slow eruption or lava with high internal resistance.

Like stratovolcanoes, they can cause violent explosive eruptions, but their lava does not flow far from the original mouth. [41]

Fig. 29. Lava dome Volcano

Fig. 30. Ash cones

Ash Cones Volcanoes

A result of eruptions that spew up mostly small pieces of slag and pyroclastics both resembling ash, hence the name of the volcano type.
Most ash cones erupt only once.

Paricutin (Mexico) and Sunset Crater (Arizona, USA) are examples of ash cones.[42]

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[40] https: //www.nationalgeographic.org
[41] si.edu
[42] W.F. Foshag/U.S. Geological Survey

Types by Location

Fig. 31. Volcano under the ice

Volcanoes Under Ice

are formed by eruptions under glaciers or under the ice caps of the North and South Poles. The hot lava melts the ice and creates a lake.[43] Due to the presence of water, the cooled formations are similar to those of underwater volcanoes. If over time the ice disappears from this region, the volcano has the shape of a mountain with a flat top.

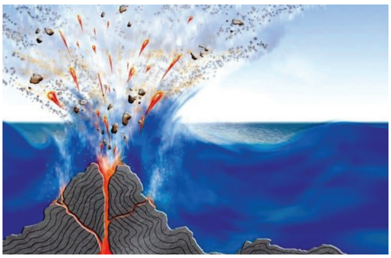

Fig. 32. Submarine volcano

Submarine Volcanoes

are common formations on the seabed. Some are active and emit steam and rock debris high above the sea surface.[44] They are visible in shallower waters. Many others lie at great depths, and it is almost impossible to see the explosive release of steam and gases above sea level. They can be detected by hydrophones and discolorations of water by volcanic gases.

Fig. 33. Mud volcanoes

Mud Volcanoes

are formations created by geothermal liquids and gases released to the surface. More than a thousand mud volcanoes are known to exist in the world, and about 400 of them are in the coastal zone of Azerbaijan.[45] Mud volcanoes are closely linked to underground hydrocarbon and petrochemical reservoirs, causing gas to reach the surface. Some of these gas leaks are constantly ignited, firing small flames into the air.

Supervolcanoes

A super volcano [46] is a massive volcano that usually has a large caldera and the potential to cause destruction on a continental scale. Such eruptions could cause a significant drop in global temperatures for hundreds and thousands of years due to the large volume of sulfur and ash. This is also the most dangerous type of volcano. Supervolcanoes cover vast areas and are difficult to identify and locate. About 30 supervolcanoes are now known. The main danger is the possibility not to erupt, but to explode the supervolcano itself.

Fig. 34. Yellowstone Supervolcano

[43] https: //guidetoiceland.is
[44] www.givingspace.org
[45] www.givingspace.org
[46] Daily Research Editor

Protection

Volcanic Hazards Defined as an event that can occur in a given area or location, such as a lava flow or a volcanic earthquake, along with the probability of the event's occurrence.

It is important to know the hazards, but it is difficult to reduce because most effects of the eruptions are beyond human control.

Hazard refers to the annualized probability of the specific volcanic event (tephra[47] fall, pyroclastic flows, lahars, etc.) occurring in the area under consideration. Various types of volcanic activity can affect people and property in close proximity to and far from a volcano.

Nowadays about 500 million people are at risk from volcanic hazards (Tilling, 1991 & 2005). The reason is not due to increased volcanism, but to the amount of people populating the area surrounding active volcanoes. [48]

IMPORTANT Although most volcanic hazards are triggered directly by an eruption, some occur when a volcano is in a state of peace.

Indirect Volcanic Hazards with Their Physical Characteristics

Indirect Hazards	Characteristics Pertinent to Risk	Example
Earthquakes and ground deformation	Limited damage; subsidence may affect hundreds of km²	Sakurajima, 1914, Usu, 2000
Tsunami	Can travel great distances; exceptionally, waves to 30+ m	Krakatoa, 1883
Secondary debris flows	Can continue for years	Santa Maria, 1902-1920
Post-eruption erosion and sedimentation	Can affect extensive areas for years after eruption	Irazu, 1963-64, Pinatubo, 1991-2000
Atmospheric effects	Limited effects	Mayon, 1814
Air shocks, lightning		Agung, 1960
Post-eruption famine and disease	Limited effects at present	Lakagígar (Laki), 1783

[47] Rock fragments and particles ejected by a volcanic eruption.
[48] https://www.researchgate.net/publication/259891707_Actions_due_to_volcanic_eruptions

Direct Volcanic Hazards with Their Physical Characteristics

Direct hazards	Characteristics pertinent to risk	Example
Fall processes: Tephra falls	Downwind transport velocity < 10 to < 100 km/h, can extend 1000+ km downwind, and can produce impenetrable darkness; surface crusting from tephra fall encourages runoff.	Vesuvius, 1631, 1906 Rabaul, 1994
Ballistic projectiles	Can affect a 10+ km radius from the vent; projectiles have high-impact energies; fresh bombs above ignition temperatures of many materials.	Soufrière St Vincent, 1812
Lava flow: Lava flows Domes	Bury or crush objects in their path; follow topographic depressions; can be tens of kilometers long; and produce a noxious haze from sustained eruptions.	Kilauea, 1960, 1983-present Merapi, Soufrière Hills Montserrat, 1995-present
Pyroclastic flow: Pyroclastic flows Pyroclastic surges	Concentrated gas-solid dispersion; small flows can travel to a distance of 5-10 km within topographic lows, whereas large flows can travel a distance of 50-100 km; large flows can mount topographic obstructions.	Pinatubo, 1991, Unzen, 1991-93, Mount Pelée, 1902, Taal, 1960
Laterally directed blast	Destroy all constructions	Bezymianny, 1956, Mount St Helens, 1980
Debris flow: Primary (eruption-triggered) debris flows (lahars	Velocities may exceed 10 m/s; rapid aggradations, incision or lateral migration may occur; the hazard may continue for months or years after eruption.	Nevado del Ruiz, 1985, Kelud, 1919
Sector collapse and flank failure: Debris avalanche Magmatic origin Phreatic origin No eruption, seismogenic	Emplacement velocities of up to 100 m/s; can create topography, pond lakes; and produce tsunamis in coastal areas.	Mount St Helens, 1980 Bezmianny, 1956 Bandaï-san, 1883, Ontake, 1984 Shimabara, 1792
Other eruptive processes: Phreatic explosions Volcanic gases and acid rains	Damage limited to proximal areas but can be lethal; corrosive, reactive; low pH in water; CO2 in areas of low ground.	Soufrière de Guadeloupe, 1976 Dieng plateau, 1979

Volcano Forecasting and Warning

IMPORTANT Most volcanoes provide warnings before an eruption!

- Magmatic eruptions involve the rise of magma toward the surface, which normally generates detectable earthquakes.
- It can also deform the ground surface.
- It can cause anomalous heat flow or changes in the temperature and chemistry of the groundwater and springs waters.
- Steam-blast eruptions can be with no warning as superheated water flashes to steam.

Notable precursors to an eruption:

- An increase in the frequency and intensity of felt earthquakes.
- Noticeable steaming or fumarolic activity and new or enlarged areas of hot ground.
- Subtle swelling of the ground surface.
- Small changes in heat flow.
- Changes in the composition or relative abundances of fumarolic gases.

IMPORTANT

- Precursors do not indicate the type or scale of the expected.
- Precursors can continue for weeks, months, or even years before eruptive activity begins.
- They can subside at any time and not be followed by an eruption.[49]

A major problem is that most explosive volcanoes have such long repose periods that people living nearby consider them extinct rather than dormant.

[49] Source: https://www.usgs.gov/faqs/how-can-we-tell-when-a-volcano-will-erupt?qt-news_science_products=0#qt-news_science_products

Vulnerability, Risk, and Damage Assessment

Elements to be accounted for in vulnerability, risk, and damage assessment in case of eruptive crisis:

Vulnerable elements	Description	Meaning
Housing / Land Use Residential; educational (primary, secondary, university); commercial (supermarkets, shops); institutional (city hall, district, region) ; religious sites, cultural and sporting facilities	**Type** Construction material; construction quality, number of floors, roof type, wall (principal), doors, windows ; number of dwellers; cost of construction	**Role** Value with respect to local and regional development; role in district or in city block; role of authorities, as perceived, as exerted; communication network and decision making process
Infrastructure Roads (sealed and unsealed), bridges, railway, airport, control points	**Types and Tests** Material type to be identified (size), mechanical tests: impact strain (uniaxial, punctual, dynamic pressure), yield strength	**Role** Value with respect to local material and to mitigation procedures in case of expected or measured damage
Networks Fluids (gas, electricity, phone, oil), Internet, network of decision making process and chain of command (council, authorities, city hall and region council)	**Dysfunctions** In case of eruptive or non-eruptive crisis: failure of networks, missing or ill-given orders for evacuation	**Factors** Physical: e.g. effects of pyroclastic flows Technical: dilapidated, defects Political: failing authorities or failing chain of command
"Natural" Areas Gardens and parks Sporting areas (golf, tennis court, fields and running tracks)	**Public Use** Distinct effects according to season, weekdays, day and/or night time	**Factors and Consequences** Temporary or almost permanent occupation, physical abilities of dwellers in case of alert: consequences on injuries and deaths
People Men, women, children, elderly, social and professional categories.	**Characteristics** Pattern of spatial distribution, social and economic pattern, age, level of education and culture	**Assessment Method** Survey and interviews for assessing knowledge and perception of risk and level of preparedness and consciousness
Civil authorities National institutions, decentralized state services (actions for mitigation or emergency procedures), territorial and city councils, civil defence bodies	**Characteristics** Existing tools for management and education: procedures, policies, relief planning, warning dissemination to exposed people, information for mitigation procedures	**Assessment methods** Social survey and interviews among the decision makers and civil religious authorities, and local leaders

Passive and Active Actions

Passive Protection	Active Protection
Educating people how to behave in the case of eruption or earthquake. Preparing people to evacuate in advance of a threatening eruption. Increasing the knowledge of volcanic activity (educational programs at school) and awareness of danger.	Designing civil works against the effects of volcanic flows: diverting lava flows, shelters or bunkers against pyroclastic flows, long-lasting, reinforced (steel roof) shelters for protecting people away from the harmful effects of tephra fallout, etc.

Action and Behavior in Case of Volcanic Eruption

Evacuation of large numbers of people is difficult and expensive. A major evacuation not followed by any major eruption would be a serious mistake, but not evacuating people from a threatening volcano that then erupts catastrophically would be a much worse mistake. It is not a simple issue, but let’s have a look at one’s reasonable behavior:

- Follow the information provided by local authorities. It is best to leave the danger zone as soon as possible.
- Mind that flights will be cancelled, roads will be closed or destroyed by the eruption.
- If an eruption does occur, there is a danger of earthquakes and volcanic ash.
- Versus volcanic ash, close the windows and doors tightly. Cover all gaps with wet towels. The ash is fine and will pass through the smallest cracks. Put dust masks on your face.
- If you have a car, park the car in a covered garage. If you have to use the car, clean the radiator often. Periodically pour water on the windshield. Provide a container with more water for cleaning the windows and for washing. The wipers will not work. Fine ash will smudge the windshield and nothing will be visible. Drive slowly. Even during the day, it can get dark enough and make it difficult to move.
- It is pointless to use a car after the volcanic ash has fallen. The engine will block.
- Take care of your pets. Provide fresh water and food for you and the animals for a minimum of 5 days.
- Avoid river banks. If you are on the beach, find out about the danger of a tsunami and react adequately.
- Mind that a roof may collapse due to the weight of the deposited ash.
- The volcano is often accompanied by an earthquake, which can also trigger landslides.

LANDSLIDES

Description

Landslides (Fig. 35)[50] are a downward movement of huge masses of soil and rocks resulting from natural phenomena or human activities.[51]

Fig. 35. Landslide at La Conchita, California, USA, 2005.

Landslides, in their movement, can perform various types of displacements: subsidence, sliding, bending and flows.

Landslides can be a side effect of severe storms with torrential rains, volcanic eruptions and earthquakes.

Other factors that can cause landslides are erosion and abrasion, fluctuations in groundwater and surface water, suffusion and liquefaction of sand.

IMPORTANT In order to have a movement of the earth masses, it is necessary to have a sloping terrain and so that with the force of gravity to overcome the adhesion of the slopes in depth. These are usually river-valley slopes, sea shores, hilly lands, plateau peripheries, foothills and mountain elevations. Landslides occur most often in the presence of water-permeable layers of dispersed soils on water-impermeable rocks, as well as in sloping layers of sedimentary rocks.

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[50] Photograph by Mark Reid, U.S. Geological Survey.

[51] Krastanov, A., 2020, Disasters and survival

Characteristics

Landslides are usually recognized by certain basic features like appearance of cracks in the soil, cracks in the buildings, presence of swamps, disturbed relief of sloping surfaces, springs at different levels on the slope and etc.

By its Cause, Landslide can be:

Physical	Natural	Human caused[52]
Intense rainfall Rapid snowmelt Prolonged intense precipitation Rapid drawdown (of floods and tides) or filling Earthquake Volcanic eruption Thawing Freeze-and-thaw weathering Shrink-and-swell weathering Flooding	Weak materials Susceptible materials Weathered materials Sheared materials Jointed or fissured materials Adversely oriented mass discontinuity (bedding, schistosity, and so forth) Adversely oriented structural discontinuity Contrast in permeability Contrast in stiffness (stiff, dense material over plastic materials)	Excavation of slope or its toe Use of unstable earth fills, for construction Loading of slope or its crest, such as placing earth fill at the top of a slope Drawdown and filling (of reservoirs) Deforestation—cutting down trees/logging and (or) clearing land for crops; unstable logging roads Irrigation and (or) lawn watering Mining/mine waste containment Artificial vibration such as pile driving, explosions, or other strong ground vibrations Water leakage from utilities, such as water or sewer lines Diversion (planned or unplanned) of a river current or longshore current by construction of piers, dikes, weirs, and so forth

[52] Cruden, D.M., 1993, The multilingual landslide glossary: Richmond, British Columbia, Bitech Publishers, for the IUGS Working Party on World Landslide Inventory in 1993.

Elements

The position and the most common terms used to describe the unique parts of a landslide (Fig. 36)[53]

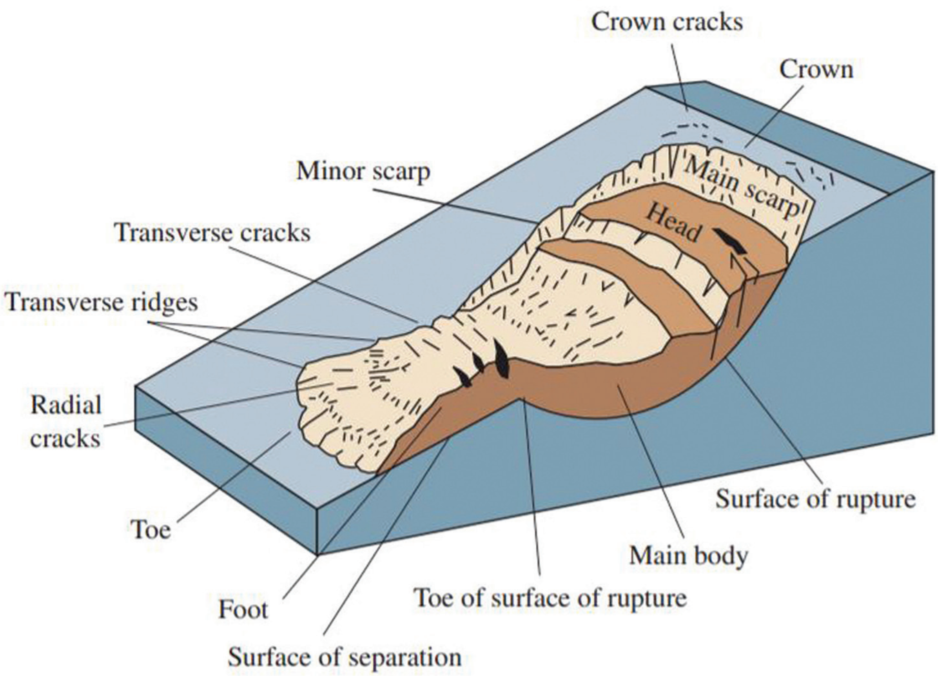

Fig. 36. A simple illustration of a rotational landslide that has evolved into an earthflow. Image illustrates commonly used labels for the parts of a landslide

[53] Varnes, D.J., 1978, Slope movement types and processes

ELEMENTS	
Crown	The practically undisplaced material still in place and adjacent to the highest parts of the main scarp
Depletion	The volume bounded by the main scarp, the depleted mass and the original ground surface.
Depleted mass	The volume of the displaced material, which overlies the rupture surface but underlies the original ground surface.
Displaced material	Material displaced from its original position on the slope by movement in the landslide. It forms both the depleted mass and the accumulation.
Flank	The undisplaced material adjacent to the sides of the rupture surface. Compass directions are preferable in describing the flanks, but if left and right are used, they refer to the flanks as viewed from the crown.
Foot	The portion of the landslide that has moved beyond the toe of the surface of rupture and overlies the original ground surface
Head	The upper parts of the landslide along the contact between the displaced material and the main scarp.
Main body	The part of the displaced material of the landslide that overlies the surface of rupture between the main scarp and the toe of the surface of rupture.
Main scarp	A steep surface on the undisturbed ground at the upper edge of the landslide, caused by movement of the displaced material away from the undisturbed ground. It is the visible part of the surface of rupture.
Minor scarp	A steep surface on the displaced material of the landslide produced by differential movements within the displaced material.
Original ground surface	The surface of the slope that existed before the landslide took place.
Surface of separation	The part of the original ground surface overlain by the foot of the landslide.
Surface of rupture	The surface that forms (or which has formed) the lower boundary of the displaced material below the original ground surface.
Tip	The point of the toe farthest from the top of the landslide.
Toe	The lower, usually curved margin of the displaced material of a landslide, it is the most distant from the main scarp.
Top	The highest point of contact between the displaced material and the main scarp.
Toe of surface of rupture	The intersection (usually buried) between the lower part of the surface of rupture of a landslide and the original ground surface.
Zone of accumulation	The area of the landslide within which the displaced material lies above the original ground surface.
Zone of depletion	The area of the landslide within which the displaced material lies below the original ground surface.

Classification

Depending on shape and spatial location According to Pavlov`s classification there are two main types		According to depth	Varieties of landslides
Detrusive	Delapsive	Surface landslides – up to 1 m Shallow – 1-5 m Deep – 5-20 m Very deep – over 20 m	Consistent landslides Formed in slopes of clays that have become too wet after prolonged precipitation or snowmelt. This type does not have a specific sliding surface. Creeping slopes Surface movement of up to 0.5 mm per day. Landfalls Sudden violations of steep slopes stability.
Formed at the top of the slopes due to pressure from above. Landslides tear off parts of the slope in different sizes, accumulated in its lower part in form of domes.	Occur in lower part of slopes, where gradually spread up due to detachments of new pieces from the slope. Usually formed by river erosion or by artificial destruction of the base of the slopes		

Protection

IMPORTANT

Landslides occur when the water is quickly absorbed into the soil during a rainstorm or sudden melting of snow. In that case, the soil becomes oversaturated with water and turns into a muddy stream.

The surrounding nature and the engineering facilities can give you preliminary information about the beginning of the landslide process:

- Alternation of different types of soil at a short distance.
- Progressive drying of vegetation, especially trees.
- Incomprehensible changes vertical and horizontal in the drainage system.
- Creaking and jamming of doors and windows.
- Cracks in the plaster, tiles or bases of the houses.
- Sloping walls and doorsteps of the house,
- Occurrence of cracks in paths or roads,
- Violations and accidents in underground communications,
- Protrusions of soil appear on the slopes.
- Appearance of water in unusual places.
- Tilting of fences, trees, etc.
- Breaking tree or creaking rock masses can mean the beginning of a landslide.
- The increase babbling indicates the approach of a landslide.

Prior to Intense Storms [54]

- Become familiar whether debris flows have occurred in your area. Slopes where debris flows have occurred in the past and are likely to experience them again.
- Buildings should be located away from steep slopes, streams and rivers, intermittent-stream channels, and the mouths of mountain channels.
- Watch the patterns of storm water drainage on slopes near your home and note especially the places where runoff water converges, increasing flow over soil-covered slopes.
- Watch the hillsides around your home for any signs of land movement, such as small landslides or debris flows or progressively tilting trees.

[54] Lynn M. Highland, United States Geological Survey, and Peter Bobrowsky, Geological Survey of Canada, 2008, The Landslide Handbook— A Guide to Understanding Landslides

During Intense Storms

- Be aware that intense short bursts of rain may be particularly dangerous, especially after longer periods of heavy rainfall and damp weather.
- Stay alert and stay awake! Many debris-flow fatalities occur when people are sleeping.
- If you are in an area susceptible to landslides and debris flows, consider leaving if it is safe to do so.
- Remember that travel during an intense storm is hazardous.
- Listen for any unusual sounds that might indicate moving debris, such as trees cracking or boulders knocking together. A trickle of flowing or falling mud or debris may precede larger flows.
- If you are near a stream or channel, be alert for any sudden increase or decrease in water flow and for a change from clear to muddy water. Such changes may indicate debris-flow activity upstream, so be prepared to move quickly. Don't delay! Save yourself, not your belongings.
- Be especially alert when driving. Embankments along roadsides are particularly susceptible to landslides. Watch the road for collapsed pavement, mud, fallen rocks, and other indications of possible debris flows.

After Landslides Processes

IMPORTANT

- It is risky to take independent rescue measures, especially if you do not have the necessary training.
- If you are in a populated area, be careful and check for broken water pipes, electrical equipment or gas pipelines. They can cause secondary injuries, floods or fires that are fatal and but can also trigger new landslides.
- In landslides in mountainous areas, be careful for secondary landslides and encounters with animals especially snakes, which may be buried or dragged.
- Do not enter the site of debris or a dilapidated house if you smell gas or smoke. It is also dangerous if there is an accumulation of water - puddles, clay soil or if rescue teams have declared it unsafe

HURRICANE

Description

It`s a huge storm!
Strong winds are spiraling inward and upward!
Speed is from 120 to 300 km per hour!
Usually lasts for over a week.
It can reach up to 1000 km across.

- Hurricane gather heat and energy through contact with warm ocean waters.
- Evaporation from the seawater increases their power.
- Hurricanes rotate in a counter-clockwise direction around an "eye" in the Northern Hemisphere and clockwise direction in the Southern Hemisphere.
- The center of the storm or "eye" is the calmest part.
- It has only light winds and fair weather.
- When they come onto land, the heavy rain, strong winds and large waves can damage buildings, trees and cars.

Characteristics

This is a rapidly rotating storm system characterized by 1) a low-pressure center, 2) a closed low-level atmospheric circulation, 3) strong winds, and 4) a spiral arrangement of thunderstorms that produce heavy rain or squalls. [55]

Term HURRICANE traditionally is referring to storms in the western Atlantic and northeastern Pacific.

Actually, it is a TROPICAL CYCLONE as

- *Tropical* refers to the geographical origin of these systems, which form almost exclusively over tropical seas.
- *Cyclone* refers to their winds moving in a circle, whirling round their central clear eye, with their winds blowing counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.

How hurricanes occur? (Fig. 37)[56]

Hurricanes come only over very warm water (27°C and higher) in the ocean.

The air must cool off very quickly vertically from the ocean surface.

The wind must be blowing in the same direction at the same speed to force air upward.

Winds flow outward above the storm allow the air below to rise.

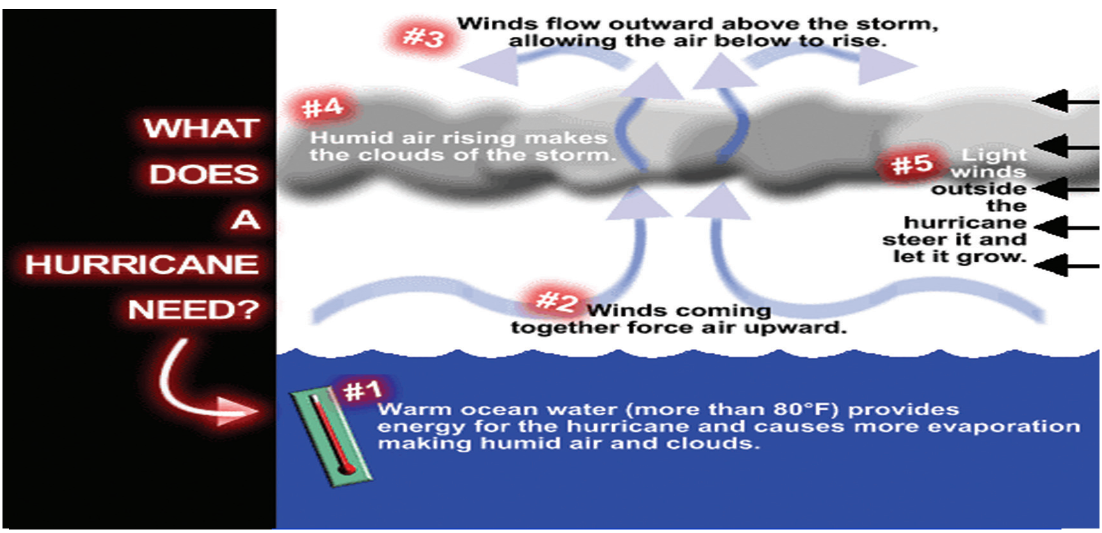

Fig. 37.

[55] https://www.nhc.noaa.gov/aboutnames.shtml
[56] https://project-hurricane.weebly.com/how-are-hurricanes-created.html

IMPORTANT

Hurricanes typically form between 5 to 15 degrees latitude north and south of the equator.

The spin in the hurricane needs the Coriolis Force[57] to create itself.

That inertial force is too weak near the equator, so hurricanes never can form there.

Hurricane Stages

Tropical Wave	*A low pressure trough moving generally westward with the trade winds.*
Tropical Disturbance	*An organized area of thunderstorms that usually forms in the tropics. Typically, they maintain their identity for 24 hours and are accompanied by heavy rains and gusty winds.*
Tropical Cyclone	*A generic term for any organized low pressure that develops over tropical and sometimes sub-tropical waters. Tropical depressions, tropical storms, and hurricanes are all example of tropical cyclones.*
Tropical Depression	*An organized area of low pressure where sustained winds are 60 kmph or less.*
Tropical Storm	*A tropical cyclone with maximum sustained wind speeds that range 60-120 kmph.*
Hurricane	*A tropical cyclone with sustained winds of at least 120 kmph.*

Depending on locations and strength, these tropical cyclones are named differently adding besides ‘hurricane’, ‘typhoon’, ‘tropical storm’, or simply ‘cyclone’. Comparable storms are referred to as "tropical cyclones" or "severe cyclonic storms".[58]

[57] An inertial force that acts on objects in motion within a frame of reference that rotates.
[58] Landsea, Chris. "Why doesn't the South Atlantic Ocean experience tropical cyclones?. Atlantic Oceanographic and Meteorological Laboratory

Interesting

- A hurricane is a tropical cyclone that occurs in the Atlantic Ocean and northeastern Pacific Ocean,
- A typhoon occurs in the northwestern Pacific Ocean; in the south Pacific or Indian Ocean

Protection

The primary energy source for these storms is warm ocean waters. These storms are therefore typically strongest when over or near water, and weaken quite rapidly over land.

Coastal regions are particularly vulnerable to the impact of a tropical cyclone, compared to inland regions.

As a hurricane's winds spiral around and around the storm, they push water into a mound at the storm's center (Fig. 38)[59]. This mound of water becomes dangerous when the storm reaches land because it causes flooding. A hurricane will cause more storm surge in areas where the ocean floor slopes gradually. Storm surges are frequently the most devastating element of a hurricane.

Fig. 38

IMPORTANT

Tropical cyclones concentrate atmospheric moisture and moisture evaporated from water into precipitation over a much smaller area. This continual replacement of moisture-bearing air by new moisture-bearing air after its moisture may cause multi-hour or multi-day extremely heavy rains up to 40 kilometers from the coastline. This in turn can lead to flooding across a large area.

[59] Henderson-Sellers, A.; Zhang, H.; Berz, G.; Emanuel, K.; Gray, W.; Landsea, C.; Holland, G.; Lighthill, J.; Shieh, S.L.; Webster, P.; McGuffie, K. (1998). "Tropical Cyclones and Global Climate Change: A Post-IPCC Assessment". Bulletin of the American Meteorological Society.

Before Hurricane

- Have a disaster plan and a contingency plan. Before a storm threatens, contact your local authorities for information on preparing you for an emergency.
- Board up windows and bring in outdoor objects that could blow away.
- Make sure you know where all the evacuation routes are.
- Prepare a disaster supplies for your home, pets and car.
- Prepare a first aid kit, canned food, bottled water, flashlight, protective clothing.
- Be aware on how to turn off electricity, gas, and water.
- Use smartphone or portable radio to receive updated information by authorities.
- Have some cash handy as well, because following a hurricane, banks and ATMs may be temporarily out of service.

During Hurricane

- Stay away from low-lying and flood prone areas. Always stay indoors during a hurricane, because strong winds will blow things around.
- If your home is not on higher ground, go to a shelter.
- If emergency managers say to evacuate, then do so immediately.

After Hurricane

- Stay indoors until it is safe to come out.
- Check for injured or trapped people, without putting yourself in danger.
- Watch out for flooding which can happen after a hurricane.
- Do not attempt to drive in flooding water.
- Stay away from standing water. It may be electrically charged from underground or downed power lines.
- Do not drink tap water until officials say it is safe to do so.

TORNADO

Description

This is a violent rotating column of air extending from a thunderstorm to the ground.

Violent tornadoes are capable of tremendous destruction.

Wind speeds of up to 500 kmph.

Damage paths can be in excess of one kilometer wide to 70 km long.

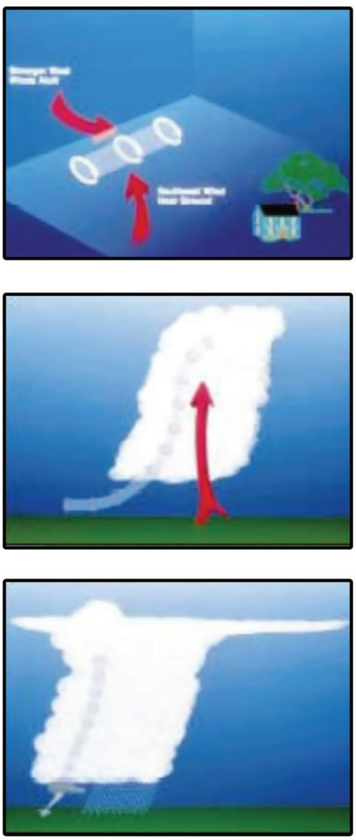

Fig. 39

Tornadoes (Fig. 39) need warm, moist air from one area and cool, dry air from other.

When these two air masses meet, they create instability in the atmosphere.

A change in wind direction and an increase in wind speed with increasing height creates an invisible, horizontal spinning effect in the lower atmosphere.

Rising air within the updraft tilts the rotating air from horizontal to vertical.

Characteristics

Tornadoes can appear as a traditional funnel shape (Fig. 40), or in a slender rope-like form.

Even may be nearly invisible, with only swirling dust or debris at ground levels as the only indication of the tornado's presence.

The funnel cloud is a rotating cone-shaped column of air extending downward from the base of a thunderstorm, but not touching the ground. When it reaches the ground it is called a tornado.

Fig. 40

IMPORTANT It is not fully understood about how exactly tornadoes form, grow and die. Tornado researchers are still trying to solve the tornado puzzle, but for every piece that seems to fit they often uncover new pieces that need to be studied.

Protection

Before Tornado

- Have a disaster plan.
- Make sure everyone knows where to go in case a tornado threatens.
- Prepare a kit with emergency food for your home.
- Have enough food and water for at least 3 days.

During Tornado

- Go to a basement. If you do not have a basement, go to an interior room without windows on the lowest floor such as a bathroom or closet. If you can, get under a sturdy piece of furniture, like a table.
- If you live in a mobile home get out. They offer little protection against tornadoes.
- Get out of automobiles. Do not try to outrun a tornado in your car, leave it immediately.
- If you're outside, go to a ditch or low lying area and lie flat in it.
- Stay away from fallen power lines and stay out of damaged areas.
- If you're at public place during a tornado crouch down on your knees and protect your head with your arms.

After Tornado

- Stay indoors until it is safe to come out. Watch out for downed electricity wires.

LIGHTNING, THUNDER AND FLASHES

Description

The nature of this phenomena is electric current. To get this electricity, a cloud is needed. When the earth is hot, it heats the air above it. This warm air rises. As the air rises, water vapours get cooler and forms clouds. As the air continues to rise, the cloud grows larger.

In addition to the concentration of water vapour, condensation nuclei are the other needed element which form clouds. Around these nuclei, water vapour thickens, condenses, and water droplets are formed. The conversion of water vapour into water droplets, their growth and in general the further development of clouds depends on the physical properties of condensation cores and their quantity.

At sub-freezing temperatures, water vapour turns to ice. At this point the cloud darkens, we observe forming of storm clouds. Many small pieces of ice collide with each other as they move around in the cloud. All these collisions lead to the accumulation of electric charge. Finally, the whole cloud is electrically charged (Fig. 41). Positively charged particles stack at the top of the cloud and negatively charged particles sink to the bottom of the cloud.

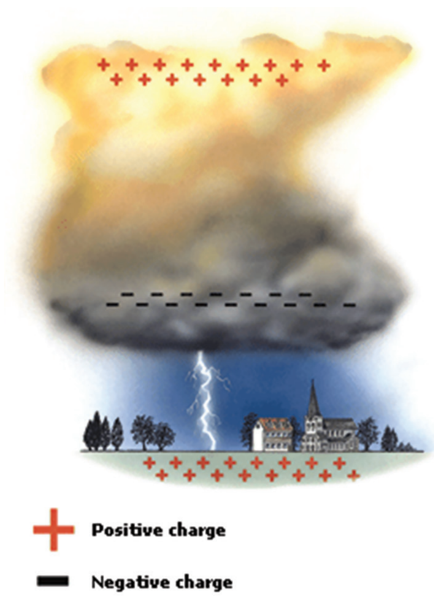

Fig. 41

When the positive and negative charges increase enough, a huge spark of lightning appears between the two charges in the cloud.

Most known phenomena is formed when the negative charge grows inside a thunderstorm's base, positive charge begins pooling within the Earth's surface below. When the positive charge from the ground connects with the negative charge from the clouds, lightning occurs.

The flash is a sudden, short, temporary burst of light.

When a lightning bolt travels cloud-to-ground it opens up a little hole in the air, a *channel*. Once then light is gone the air collapses back in and creates a sound wave – the thunder.

IMPORTANT

Sometimes lightning can strike where it is not raining, or even before rain reaches the ground.

Characteristics

Lightning is a powerful electrical discharge. The average longevity is about 1500 meters.

The speed at which lightning can reach the ground is 200,000 kmph.

The temperature in the channel reaches about almost 30,000 degree Celsius (6 times the surface temperature of the Sun!).

Classification

There are three primary types of lightning:

- Cloud-to-Ground (most known type)
- Cloud-to-Air
- Cloud-to-Cloud

Signs of upcoming nearby Cloud-to-Ground lightning:

- A rapidly growing in height cumulonimbus cloud - they're the beginning stage of a developing thunderstorm.
- Increasing winds.
- Darkening sky.
- Observe audible thunders.
- If thunder is heard immediately after the flash it means that the storm is exactly above us.

Protection

DON'T DO THAT IN CASE OF LIGHTNING

Staying under bus shelters and rafters

Ridin a motorcycle or a bicycle

Standing in an open field or near water

Crowding in the opened fields

Crossing rivers

Using metal objects and mobile phones

Hiding under a tree

- Turn off cell phones!
- Do not take cell phones out of your pocket!
- Do not touch electrical appliances!
- Do not stand under an open umbrella;
- If you have a backpack, take it off, there are often metal objects on it.

IMPORTANT

METEORITES

Description

What is the difference between an asteroid, a meteor and a meteorite?

ASTEROIDS (Fig. 42) are rocky space objects smaller than planets. The terms planetoids or small planets are also used for them. They are thought to be remnants of the protoplanetary disk from which the planets in the solar system were formed. Millions of asteroids orbit the Sun, about 750,000 of them in the asteroid belt between Mars and Jupiter. Some have their own satellites.

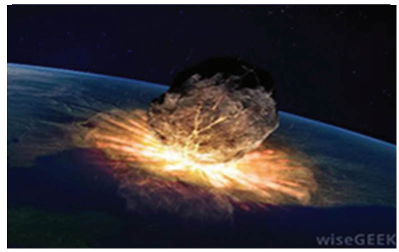

Fig. 42.

METEORITE (or 'meteor body', Fig. 43) is a relatively small solid that moves in interplanetary space. It becomes a meteor if it enters the Earth's atmosphere. When the meteor is larger, visible in daylight (and, according to some definitions, makes a sound) - the fireball obtained by the explosion.

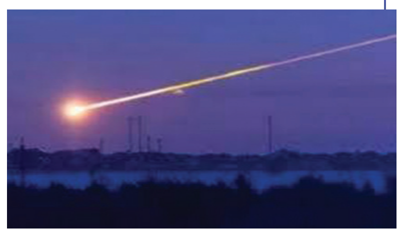

Fig. 43.

COMETS (Fig. 44) are the result of the collision of large meteorites with asteroids, accompanied by an explosion. Numerous pieces of different sizes and speeds are detached from the asteroid, some of which can approach the Sun. The gases it emits during combustion form the comet's huge tail, on which it and the swarm of small debris form the head. A bright comet of considerable size consists of core, chapter and a tail. Sometimes the comet has two or several tails forming a fan.

Fig. 44.

Fig. 45.

METEOR (Fig. 45) is an asteroid or other object that burns when it enters the Earth's atmosphere. They call them "shooting stars". If a meteor does not burn completely in the atmosphere, that part of it that hits the surface is called a meteorite – iron or stone.

Characteristics

Class	Scale	Assessment
No danger (White zone)	0	The probability of a collision is zero. It also applies to small objects such as meteorites and bodies that burn in the atmosphere, as well as rare meteor showers that rarely cause damage.
Normal (Green zone)	1	A routine observation that predicts passage close to the ground, which does not create an unusual level of danger. Current calculations show that the chance of a collision is extremely small without cause for public attention or concern. New telescopic observations are very likely to lead to a redefinition at level 0.
Increased danger	2	A discovery that can become routine with advanced searches for an object that passes not very close to Earth. As long as it deserves the attention of astronomers, there is no cause for public attention or concern, as the real collision is very unlikely. New telescopic observations are very likely to lead to a redefinition at level 0.
	3	A close encounter worthy of attention on the part of the astronomers. Current calculations give a chance of a collision with a 1% or greater probability of local destruction. Most likely, the new telescopic observations will most likely lead to a redefinition at level 0.
	4	A close encounter worthy of attention on the part of the astronomers. Current calculations give a chance of a collision with a 1% or greater probability of local destruction. Most likely, the new telescopic observations will most likely lead to a redefinition at level 0. The attention of the public and civil servants is decisive if the possible collision is within a decade.
Threat (Orange zone)	5	A close meeting that poses a serious but still uncertain threat to regional devastation. Critical attention is needed on the part of astronomers to determine definitively whether a collision will occur. If the collision is within a decade, government emergency planning may be justified.
	6	A close meeting that poses a serious but still uncertain threat to regional devastation. Critical attention is needed on the part of astronomers to determine definitively whether a collision will occur. If the collision is within a decade, government emergency planning may be justified.
	7	A very close encounter with a large object that, if this century happens, poses an unprecedented but still uncertain threat of global catastrophe. For such a threat in this century, international contingency planning is justified, especially to determine urgently and convincingly whether a collision will occur.
Collision	8	The collision is certain and capable of causing localized destruction. Such events occur on average every 50 years and once every few thousand years.
	9	The collision is certain and could cause an unprecedented regional catastrophe for ground impact or the threat of a major tsunami from its impact on the ocean. Such events occur on average once every 10,000 years and once every 100,000 years.
	10	The collision is certain, it could cause a global climate catastrophe that could threaten the future of civilization, whether it affects land or the ocean. Such events occur on average once every 10,000 years or more.

Occurrence

In its movement, our planet constantly meets countless small dark bodies – meteor bodies, some weighing less than a gram. They enter the atmosphere at high speeds and as a result of their interactions with air molecules, at a certain height in the atmosphere, luminous traces can be observed. Commonly people call this phenomenon a ‘shooting star’ or ‘falling star’.

The relationship between the diameter of the meteorite, its power and damage caused, as well as the period of time in which the specified devastating event may occur:

Diameter	Power	Years	Consequences and fatalities
< 50	< 10	<1	Most decompose in the upper atmosphere and do not reach the surface on the ground
75	10-100	1000	Iron meteors make a crater, stone meteors burn like the Tong meteorite. They can destroy small area.
160	100-1000	5 000	As the above, but can destroy big area.
350	1000 – 10000	15 000	An area of a small country can be destroyed.
700	10000 – 100000	63 000	Destruction of vast areas and big waves tsunami.
1 700	100 000 – 1 000 000	250 000	Destroys a big territory like France.

Precautionary measures

The consequences of a collision with a large meteorite can be modeled. Also the duration and scale of the disaster are subject of prediction. According to Michael Payne model’s simulation, in the next 10,000 years, space meteorites could kill 13 million people and possibly cause wars, famine and chaos. Hardly anyone can offer effective measures to prevent such catastrophic events. Several options are globally agreed on how to deal with threats of near-Earth asteroids (NEAs).

- Nuclear attack - there is a danger that thousands of debris will bombard the Earth and space will be saturated with debris that will destroy many of the satellites.
- "Kinetic interceptor" of NASA, which will deflect the invading asteroid. The idea is just to push the asteroid off course.
- Change in the reflectivity of the asteroid by painting it white and reading it the solar wind to change its trajectory.
- Laser sublimation. Heating part of a meteorite to change its weight by evaporation and thus change its orbit.

Different methods, some strange, but eager to fight the real danger of meteorite bombing.

AVALANCHES

Description

A mass of material is moving rapidly down, typically triggered when the material on a slope breaks loose from its surroundings and then quickly collects and carries additional material down the slope. This is an avalanche.

A relatively common phenomenon is the snow avalanche (Fig. 46)[60] in many mountainous areas. Its size can range from a small shifting of loose snow (called sluffing) to the displacement of enormous slabs of snow[61].

Fig. 46

The wide variety of origin, nature of motion, and size reflects the highly changeable nature of snow avalanches.

Their fundamental classification is based on conditions prevailing at the point of origin, or the release zone.

There are two BASIC TYPES:

LOOSE SNOW

SLAB AVALANCHE

SUBDIVIDED BY

SNOW	Dry	Damp	Wet
SLIDE	Surface layer	Whole snow cover	
MOTION	Ground	Air	Mixed

[60] https://www.britannica.com/science/avalanche
[61] Avalanches 2020

Characteristics

LOOSE SNOW AVALANCHES

form in the snow with little internal cohesion among individual snow crystals. When such snow lies in a state of unstable equilibrium on a slope steeper than its natural angle of repose, a slight disturbance sets progressively more and more snow in a downhill motion. If enough momentum is generated, the sliding snow may run out onto the level ground, or even ascend an opposite valley wall. Such an avalanche originates at a point, growing wider as it sweeps up more snow in its descent. The demarcation between sliding and undisturbed snow is diffuse, especially in dry snow.

IMPORTANT

Very numerous, most dry loose snow avalanches are small and few achieve sufficient size to cause damage. With the advent of spring, melting, wet loose snow avalanches also are common. Most of the latter, too, are small, but they are more likely to develop occasional destructive size, especially when confined to gulley.

SLAB AVALANCHES

originate in the snow with sufficient internal cohesion to enable a snow layer, or layers, to react mechanically as a single entity. The degree of this required cohesion may range from very slight in fresh, new snow (soft slab) to very high in hard, wind drifted snow (hard slab), according to circumstances of layer attachment to the external environment. A slab avalanche breaks free along a characteristic fracture line, a sharp division of sliding from stable snow whose face stands perpendicular to the slope. The entire surface of unstable snow is set in motion at the same time. A slab release may take place across an entire mountainside, with the fracture racing from slope to slope to release adjacent or even distant slide paths.

The mechanical conditions leading to slab avalanche formation found in a wide variety of snow types, both new and old, dry and wet[62].

[62] LaChapelle 2012

IMPORTANT Slab avalanches are often dangerous and unpredictable in behaviour. Providing most of the winter avalanche hazard, they are the primary object of avalanche defence and control measures.

DRY SNOW AVALANCHES

generate a dust cloud as part of the sliding snow is whirled into the air. Such slides, called powder snow avalanches, most frequently originate as soft slabs. Under favourable circumstances, enough snow crystals mixed with the air to form an aerosol, which behaves as a sharply bounded body of dense gas rushing down the slope ahead of the sliding snow. This windblast can achieve high velocities to inflict heavy and capricious destruction well beyond the normal bounds of the avalanche path.

WET SNOW AVALANCHES

move more slowly than dry ones and seldom accompanied by dust clouds. Their higher snow density can lend them an enormously destructive force despite lower velocities. As wet slides reach their deposition zones, the interaction of sliding and stagnated snow produces characteristic channeling.

DIRECT ACTION AVALANCHES

fall as the immediate result of a single snowstorm. They usually involve only the fresh snow. Climax avalanches caused by a series of snowstorms or a culmination of weather influences. Their fall is not necessarily associated with a given current storm or weather situation.

European Avalanche Danger Scale (2018/19)				
	Danger level	**Icon**	**Snowpack stability**	**Likelihood of triggering**
5	very high		The snowpack is poorly bonded and largely unstable in general.	Numerous very large and often extremely large natural avalanches can be expected, even in moderately steep terrain*.
4	high		The snowpack is poorly bonded on most steep slopes*.	Triggering is likely, even from low additional loads**, on many steep slopes*. In some cases, numerous large and often very large natural avalanches can be expected.
3	considerable		The snowpack is moderately to poorly bonded on many steep slopes*.	Triggering is possible, even from low additional loads**, particularly on the indicated steep slopes*. In certain situations some large, and in isolated cases very large natural avalanches are possible.
2	moderate		The snowpack is only moderately well bonded on some steep slopes*; otherwise well bonded in general.	Triggering is possible, primarily from high additional loads**, particularly on the indicated steep slopes*. Very large natural avalanches are unlikely.
1	low		The snowpack is well bonded and stable in general.	Triggering is generally possible only from high additional loads** in isolated areas of very steep, extreme terrain*. Only small and medium natural avalanches are possible.

Fig. 47

The European Avalanche Danger Scale (Fig. 47)[63] is a five-level, ordinarily ascending, categorical scale. The scale consists of classes, which – even if they expressed with the numbers 1-5– may not simply be processed mathematically.

Example: The danger level 3-Considerable is not simply higher by one than danger level 2-Moderate, because the avalanche danger probably increases disproportionately. In other words, danger level 3-Considerable is not one level higher than 2-Moderate, but probably twice as high. The danger levels must not be added either.

DANGER SCALE:

The characteristics of avalanche dangers defined for each level are the parameters:

- SNOWPACK STABILITY
- SPATIAL DISTRIBUTION
- AVALANCHE SIZE

[63] https://www.avalanches.org/wp-content/uploads/2019/05/European_Avalanche_Danger-EAWS.pdf

Changes or combinations of these three input variables determine the avalanche danger 5-level matrix (Fig. 48). [64]:

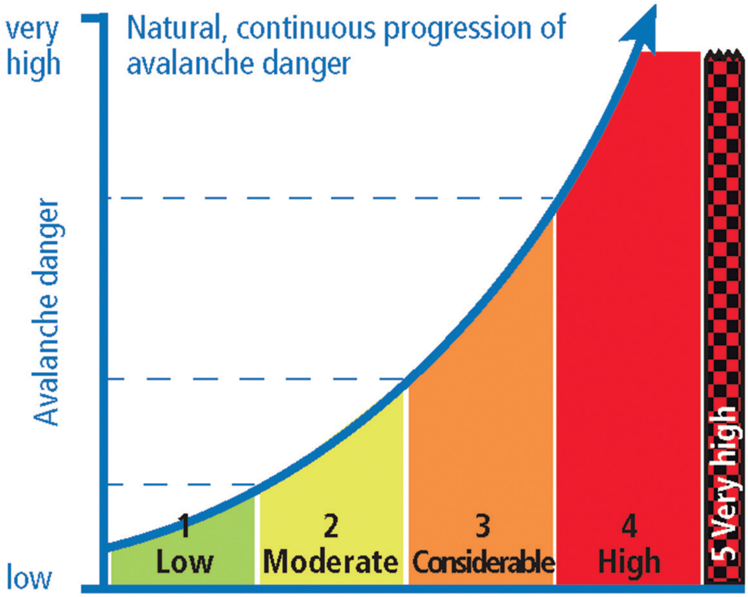

Fig. 48. The European avalanche danger level scale

Occurrence

Most avalanches of dangerous size originate on slope angles between 30 degrees and 45 degrees. They seldom occur below 30 degrees and hardly ever below 25 degrees. Above 45 degrees to 50 degrees' sluffs and small avalanches are common, but snow seldom accumulates to sufficient depths to generate large slides.

IMPORTANT Avalanches are often dislodged by external triggers.

An overload of new snow may dislodge an existing slab. Falling cornices or chunks of snow from trees are common natural triggers. Artificial triggers in the form of mechanical disturbance may be intentionally introduced for control purposes.

Unintentional triggers are a major cause of accidents; most skiers who fall victim to an avalanche trigger the slide, which traps them.

[64] Avalanche Danger Scale 2020

Protection

TERRAIN MODIFICATION
is a fundamental method of avalanche control. It deflects the sliding snow away from fixed facilities. Deflecting structures are snowsheds used to protect railways and highways. These must be strong enough to support the dynamic load of sliding snow; hence most modern snowsheds are built of reinforced concrete.

SNOW MODIFICATION
This control does not give a high degree of protection as the Terrain Modification but is much cheaper. Commonly is used to reduce hazards to mobile entities, such as skiers or road traffic. The technique is an artificial release, which brings down avalanches at a chosen safe time.

BREAK UP SLABS
A snow modification technique applying mechanical intervention to break up soft slab formation and induce stabilization through age hardening. Skier traffic is the commonest, while deliberate snow packing by foot is sometimes used. Depth hoar can be stabilized only by intensive foot packing. Thus oversnow vehicles, can seldom be used.

IMPORTANT Before venturing into snowy wilderness, take the extra time to prepare for the conditions, by checking forecasts and acquiring safety gear.

Before a trip, the experts recommend some essential gear items for mountains snow travel:

- ✓ An avalanche probe for locating a partner in the snow
- ✓ Shovel for digging out
- ✓ Transceiver that can transmit and receive signals when buried under snow
- ✓ An avalanche airbag
- ✓ If possible, a device GPS to accelerate rescue if coordinates are provided

IMPORTANT

Do not stop in an exposed area on a slope.

Don not separate from the group so that you can see each other.

Travelling immediately above a partner risks triggering an avalanche.

Do not distract by taking photos or videos that you lose sight of risks.

What to do if you are caught in an avalanche

- ➢ Remain calm!
- ➢ Deploy your airbag, it helps you stay on top of the slide.
- ➢ Get off the snow slab, aim 45 degrees down the slope and move across the flow.
- ➢ Grab trees or branches to pull you out of the slide.
- ➢ Try to keep your head above the surface.
- ➢ If stuck, create an air pocket around your face by clearing snow.

Rescue

- ➢ Try to track the ones caught in a slide to narrow the search and rescue area;
- ➢ Call the emergency, if possible.
- ➢ Evaluate the avalanche hazard before attempting a rescue.
- ➢ Use avalanche transceiver to get incoming signals from the trapped member.
- ➢ Use the avalanche probe at a 90-degree angle to the slope to locate the buried.
- ➢ When digging do not stand on the snowpack over the buried.
- ➢ Mind that time is critical! Chance of survival drops steeply after 18 minutes.

IMPORTANT Ultimately, do respect the nature of mountains!

EXTREME WEATHER

Description

Extreme weather stands for measured irrelative temperatures to the usual in a geographical area or irrelative to normal conditions for one season.

IMPORTANT

Temperatures that in one climate zone are considered as normal can be called ‘extreme’ in other zone if they are outside its normal pattern.

HEAT WAVE
is excessively hot air condition, accompanied by high humidity. Usually the term is applied both to hot weather variations and to extraordinary spells of hot which may occur only once a century.

COLD WAVE
is an excessively harsh weather accompanied by high winds and chills. It is distinguished by the invasion of very cold air over prolonged period and preceded or accompanied by significant winter events, such as blizzards or ice storms.

IMPORTANT

Both are considered extreme phenomena that can turn a natural disaster. Extreme weather waves cause catastrophic agricultural failures, hyperthermia, and widespread power outages.

Characteristics

The extreme weather is characterised by the human body exposure to ultra low or high temperatures.

IMPORTANT

The damages caused by other natural disasters are mostly results from external physical forces such as flooding and collapse. The extreme weather affects predominantly human daily routines and damages occur not only due to the phenomena itself, but by the health status of individuals, residential and working conditions, even local policy. It cause serious public health and economic problems including worker absenteeism and productivity losses, burdening of health care services due to hospitalisation, and in the worst case, deaths

From the perspective of natural phenomena, extreme weather occur more slowly and over a wider period than others as typhoons, earthquakes, avalanches, fire.

Hypertermia

Hypothermia

HEAT	COLD

HEAT

HYPERTHERMIA

also known as heat stroke, becomes commonplace during periods of sustained high temperature and humidity. Older adults, very young children, and those who are sick or overweight are at a higher risk for heat-related illness. The chronically ill and elderly are often taking prescription medications that interfere with the body's ability to dissipate heat.

HEAT EDEMA

presents as a transient swelling of the hands, feet, and ankles and is generally secondary to increased aldosterone secretion, which enhances water retention. When combined with peripheral vasodilation and venous stasis, the excess fluid accumulates in the dependent areas of the extremities.

HEAT RASH

aka 'prickly heat', is a maculopapular rash accompanied by acute inflammation and blocked sweat ducts. If this continues for a duration of time it can lead to the development of chronic dermatitis or a secondary bacterial infection.

HEAT SYNCOPE

is believed to result from intense sweating, which leads to dehydration, followed by peripheral vasodilation and reduced venous blood return.

HEAT EXHAUSTION

is considered by experts to be the forerunner of heat stroke (hyperthermia). Symptoms may include diarrhea, headache, nausea and vomiting, dizziness, tachycardia, malaise, and myalgia.

COLD

HYPOTHERMIA

occurs when the body loses heat faster than it can be produced. Prolonged exposure to cold will eventually use up the body's stored energy. The body temperature that is too low affects the brain, making the victim unable to think clearly or move well. Hypothermia is most likely at very cold temperatures, but it can occur even at cool temperatures (above 0° C) if a person becomes chilled from rain, sweat, or submersion in cold water.

FROSTBITE

is an injury to the body that is caused by freezing. It most often affects the nose, ears, cheeks, chin, fingers, or toes. Frostbite can permanently damage the body, and severe cases can lead to amputation. The risk of frostbite is increased in people with reduced blood circulation and among people who are not dressed properly for extremely cold temperatures

INFLUENZA

Both low temperature and low humidity may independently or jointly contribute to the risk of influenza A and B virus infections.

RISK OF HEART ATTACK

At very low temperatures, blood vessels will constrict and this can cause spasms

DRY SKIN AND MUCUS MEMBRANES

Dry air can suck the moisture out of human body

Protection

The number-one thing you can do as protection against the extreme weather is to plan ahead and prepare long before it hits. The type and extent of preparation depends on your location and the types of extreme weather that occur there.

Recommended protective actions to prevent illness or death:

- ❖ Stay in air-conditioned buildings as much as you can.
- ❖ Do not rely on a fan as your main cooling device during an extreme heat event.
- ❖ Don't use the stove or oven to cook—it will make you and your house hotter.
- ❖ Limit your outdoor activity, especially midday when the sun is hottest.
- ❖ Pace your activity. Start activities slow and gradually.
- ❖ Drink more water than usual and don't wait until you're thirsty to drink more. Muscle cramping may be an early sign of heat-related illness.
- ❖ Wear loose, lightweight, light-colored clothing.
- ❖ Schedule workouts and practices earlier or later in the day when the temperature is cooler.
- ❖ Take cool showers or baths to cool down.
- ❖ Never leave children or pets in cars.
- ❖ Check the local news for health and safety updates.

Extreme cold weather preparedness:

- ❖ A general emergency kit or disaster preparedness, but with a few specific items that may not generally be included.
- ❖ Prepare your home for winter.
- ❖ Prepare your car for winter. You can avoid many dangerous winter travel problems by planning ahead. Have maintenance service on your vehicle as often as the manufacturer recommends. In addition, every fall
- ❖ Pay attention to your body.
- ❖ Mind outdoor winter activities safety.

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ENCLOSURES

Disasters - physical protection, risk, second order effect, precautions and protection

ENCLOSURE 1

FLOODING

Physical Impact	Risk		Second Order Effect	Precautions		Protection	
Tidal Wave	Personnel	High	Loss of life. Destruction of property.	Personnel	Relocation	Personnel	Strong shelters
	Equipment	Medium	Damaged equipment	Equipment	Relocation	Equipment	Strong shelters
	Infrastructure	Medium	Recharge dry area	Infrastructure	Dikes, Flood walls, Tide gates	Infrastructure	
Cover surface with water	Personnel	Medium	Limits access. Pollution of fresh water sources. Recharge dry area. Destruction of property.	Personnel	Relocation	Personnel	Water pumping
	Equipment	Low		Equipment	Relocation	Equipment	
	Infrastructure	Low		Infrastructure	Straightening and Deepening	Infrastructure	
River overflow	Personnel	Medium	Limits access. Pollution of fresh water sources. Destruction of property.	Personnel	Flood walls. Levees and embankments. Straightening and Deepening. Dikes.	Personnel	Water pumping
	Equipment	Medium		Equipment		Equipment	
	Infrastructure	Medium		Infrastructure		Infrastructure	
Collapse of dam walls	Personnel	High	Destruction of naturel ecosystem. Destruction of property. Destruction of property. Destroy crops. Impacts interruption of electricity and communications, and road blockages.	Personnel	Relocation	Personnel	Strong shelters
	Equipment	High		Equipment	Relocation	Equipment	Strong shelters
	Infrastructure	High		Infrastructure	Dry dam creation.	Infrastructure	Diversion canals

Physical Impact	Risk		Second Order Effect	Precautions		Protection	
Heavy rains	Personnel	Low	Slippery roads and eventual accumulation of ground water. Possibility of flash floods in urban areas, by accumulation of rainwater or inadequacy of drainage systems. Possibility of overflowing of water lines/rivers in areas historically most vulnerable. Flooding of underground urban structures with drainage deficiencies. Damage to structures mounted or suspended. Possibility of falling branches or trees.	Personnel	Dikes, flood walls	Personnel	Diversion canals. Self-closing flood barrier. Floodplains and groundwater replenishment.
	Equipment	Medium		Equipment		Equipment	
	Infrastructure	Medium		Infrastructure		Infrastructure	

FIRE

Physical Impact	Risk		Second Order Effect	Precautions		Protection	
Conflagration	Personnel	High	Loss of life. Destruction of property.	Personnel	Escape; Call the fire brigade	Personnel	Follow evacuation orders indoors and outside
	Equipment	High	Severely damaged equipment	Equipment	Call the fire brigade	Equipment	Smoke alarms, switch off the electric equipment
	Infrastructure	High	Burnt buildings	Infrastructure	Call the fire brigade	Infrastructure	Smoke alarms, Fire evacuation plans
Explosion	Personnel	High	Loss of life. Limits access. Destruction of property.	Personnel	Escape; Call the fire brigade	Personnel	Avoid storage of battery at high temperature; Avoid storage of lithium-ion batteries together
	Equipment	High		Equipment	Call the fire brigade	Equipment	
	Infrastructure	High		Infrastructure	Call the fire brigade as soon as possible	Infrastructure	
Fire in a building	Personnel	High	Loss of life. Limits access. Destruction of property.	Personnel	Call the fire brigade; Find out the source of burning; Escape via the emergency stairs.	Personnel	Follow evacuation orders indoors; Smoke alarms; Switch off the electric equipment
	Equipment	High		Equipment		Equipment	
	Infrastructure	High		Infrastructure		Infrastructure	
Fire in a vehicle	Personnel	High	Loss of life. Destruction of property.	Personnel	Stop the car Call the fire brigade	Personnel	Follow evacuation orders.
	Equipment	High		Equipment	Turn off the engine	Equipment	First aid kit with medicines; Fire extinguisher; non-synthetic towel
	Infrastructure	Low		Infrastructure	Put a sign on the road.	Infrastructure	Parking brake; Lock the wheels
Wildfire	Personnel	High	Loss of life.	Personnel	Call the fire brigade;	Personnel	
	Nature	High		Equipment		Equipment	

Physical Impact	Risk		Second Order Effect	Precautions		Protection	
	Infrastructure	Medium	Destruction of nature.	Infrastructure	Warn all people to leave the danger area; Evacuation through a lake or river (if possible) perpendicular to the fire direction. After leaving the fire area, inform the local population.	Infrastructure	Cleaning of soil strips between buildings and adjacent forest areas with a width of 5-10 meters in deciduous forests and up to 50 meters in coniferous forests; Extinguish fire pits and fire camps when done; Don't throw lit cigarettes out of your moving car; Pay attention to local ordinances for trash burning; Only use fireworks in clear areas with no woods nearby; Pay attention to the risk of forest fires in your area; Follow evacuation orders.

EARTHQUAKES

Intensity		Physical Impact	Risk		Second Order Effect	Precautions		Protection	
Richter scale	Mercalli scale								
< 2.0	I	Micro Not or rarely felt Recorded by seismographs	Personnel	Low	None	Personnel	Training personnel	Personnel	N/A
			Equipment	Low		Equipment	N/A	Equipment	
			Infrastructure	Low		Infrastructure	N/A	Infrastructure	
2.0 – 2.9	I - II	Minor Felt slightly by a few persons at rest, especially on upper floors of buildings No damage	Personnel	Low	None	Personnel	N/A	Personnel	N/A
			Equipment	Low		Equipment		Equipment	
			Infrastructure	Low		Infrastructure		Infrastructure	
3.0 – 3.9	II - IV	Minor Felt indoors by many, especially on upper floors of buildings, outdoors by few Rarely cause any damage Indoor objects, windows, doors disturbed Duration estimated	Personnel	Low	None	Personnel	Training personnel	Personnel	N/A
			Equipment	Low	Standing motor vehicles may rock slightly Vibrations	Equipment	Identification of hazards	Equipment	Securing space
			Infrastructure	Low	N/A	Infrastructure	N/A	Infrastructure	N/A
4.0 – 4.9	IV - VI	Light Noticeable shaking of indoor objects Rattling noises Felt by most people	Personnel	Low		Personnel	Training personnel	Personnel	N/A
			Equipment	Medium	Standing motor vehicles rock noticeably	Equipment	Identification of hazards Provide information on	Equipment	Securing space and storages

Intensity		Physical Impact	Risk		Second Order Effect	Precautions		Protection	
Richter scale	Mercalli scale								
		Minor breakage of objects Damage slight			Unstable objects overturned Some heavy furniture/objects moved		structural retrofitting		
			Infrastructure	Medium	Walls make cracking noise Windows broken	Infrastructure	Identification of hazards Provide information	Infrastructure	Securing space
5.0 – 5.9	VI - VII	Moderate to strong Felt by all, many frightened Considerable damage in poorly built or badly designed structures Slight to moderate damage in well-built structures Negligible damage in buildings of good-design and construction	Personnel	Medium	Danger of falling, overturned and broken objects	Personnel	Develop a plan for mobilization and deployment Follow procedures	Personnel	Protection of personnel, equipment and critical facilities and infrastructure Undertake reconstruction actions if necessary
			Equipment	Medium	Danger of possible damage	Equipment	Securing equipment	Equipment	
			Infrastructure	Medium	Varying damage to buildings Some chimneys broken Heavy objects and furniture overturned	Infrastructure	Vulnerability assessment of buildings and facilities Inspections of building and infrastructure safety	Infrastructure	
6.0 – 6.9	VIII - IX	Strong Moderate damage in populated areas Damage slight to considerable in specially	Personnel	High	Personnel transfer Involvement in reconstruction and search and rescue operations,	Personnel	Contingency planning Developing action plans and scenarios Establish coordination for action before,	Personnel	Strong shelter Identifying safe spaces and camp locations Displacement camps

Intensity		Physical Impact	Risk		Second Order Effect	Precautions		Protection	
Richter scale	Mercalli scale								
		designed structures Considerable damage in ordinary substantial buildings with partial collapse Great damage in poorly built structures Buildings shifted off foundations Fall of chimneys, factory stacks, columns, monuments, walls Possible liquefaction, ground displacement, landslides, flooding, tsunamis, fire			firefighting, securing area Provide support Distribution of goods Support for clean up and recovery Medical support and facilities Prevention of CP and GBV Dead body and injured management		during and after disasters Anticipate requests for assistance Training exercises and simulation Civil-military coordination mechanisms Develop guidelines and handbooks Develop standards for shelter package for earthquake context (stove, fuel, utensils etc.)		Repair and reconstruction of health facilities Rehabilitation of injured persons Psychological support Implement the relocation and evacuation plan
			Equipment		Danger of damage Relocation Mobilization of vehicles Needed for reconstruction activities Use of cargo capacity Use of cargo aircraft, ships, rotary aircraft, motor vehicles for delivery of supplies, SAR and transport	Equipment	Protection measures applied Preparation for disaster relief operations Identify and map available resources Develop a mobilization plan of equipment, vehicles and resources during emergency	Equipment	Strong shelter

Intensity		Physical Impact	Risk		Second Order Effect	Precautions		Protection	
Richter scale	Mercalli scale								
					Water, sanitation and hygiene				
			Infrastructure		Infrastructure disruption Power failures Water supply system breakages Emergency shelter and settlement	Infrastructure	Best maintenance of facilities and infrastructure Rapid infrastructure rehabilitation Debris management guidelines	Infrastructure	Engineer operations Providing roof covering materials On-site sorting and removal of debris
7.0 – 7.9	VIII <	Major Felt across great distances. Major damage mostly limited to 250 km from epicenter Strong to violent shaking in epicentral area Bridges destroyed Pipelines broken Loss of life	Personnel	High	Deployments to the struck area Provide humanitarian assistance and disaster relief	Personnel	Response and operational capacity preparedness Safety audit Safe facilities identification CP and GBV Staging safe areas of storage Preparation of logistic hubs Safe warehouses	Personnel	Dislocation Logistics engagement Staff safety and security measures Importation of equipment Operationalization of roads, airports and ports Construction of transportation facilities On-site sorting and removal of debris and reusable material
			Equipment	High	Relocation Involvement in humanitarian assistance and disaster relief activities/operations	Equipment		Equipment	
			Infrastructure	High	Great damages Clean up and reconstruction Communications	Infrastructure	Management of rescue equipment Management of rescue of equipment	Infrastructure	

Intensity		Physical Impact	Risk		Second Order Effect	Precautions		Protection	
Richter scale	Mercalli scale								
					maintenance and restoration Reopening of bridges, airports, ports				Establish dumping sites Supply chains restoration
8.0 – 8.9	X	Great Severe destruction and loss of live over large areas Can totally destroy communities near epicenter Most masonry and frame structures destroyed with foundations Some well-built wooden structures destroyed Rail bent	Personnel	High	All of the above	Personnel	All of the above	Personnel	All of the above
			Equipment			Equipment		Equipment	
			Infrastructu re			Infrastructu re		Infrastructure	
9.0 – 9.9	XI -XII	Extreme Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly Damage total.	Personnel	High	All of the above	Personnel	All of the above	Personnel	All of the above
			Equipment			Equipment		Equipment	

Intensity		Physical Impact	Risk		Second Order Effect	Precautions		Protection	
Richter scale	Mercalli scale								
		Loss of life over large areas	Infrastructure			Infrastructure		Infrastructure	

VOLCANO

Physical Impact	Risk		Second Order Effect	Precautions		Protection	
Tephra fall	Personnel	High	Death, Injury	Personnel	Early warning. Relocation	Personnel	Strong shelters
	Equipment	Medium	Damaged equipment	Equipment	Reinforcement of roofing systems in order to increase the load carrying capacity	Equipment	Clean roofs to prevent excessive tephra loads on buildings
	Infrastructure	Medium	Roads, bridges, railway, airport, destruction	Infrastructure	Utilize underground electrical supply	Infrastructure	Removal of debris on transport networks
Lava flows	Personnel	High	Death, Injury	Personnel	Relocation	Personnel	Strong shelters
	Equipment	High	Damaged equipment	Equipment	Relocation, Spray water on advancing lava fronts	Equipment	Strong shelters
	Infrastructure	High	Roads, bridges, railway, airport, destruction	Infrastructure	Divert lava flows using bombing with guidance systems	Infrastructure	Built earth barriers and artificial channels
Lahars	Personnel	Low	Injury	Personnel	Use lahar flow warning systems, Relocation	Personnel	Strong shelters
	Equipment	Medium	Damaged equipment	Equipment	Drainage of crater lakes.	Equipment	Strong shelters
	Infrastructure	Medium	Roads, bridges, railway, airport, damage	Infrastructure	Drainage of crater lakes. Reconsider bridge clearances	Infrastructure	Install crossing gates on roads across lahar channels
Pyroclastic flows	Personnel	High	Death, Injury	Personnel	Increase awareness on lethal effects of decoupled pyroclastic surges from flows. Relocation	Personnel	Strong shelters
	Equipment	Medium	Damaged equipment	Equipment	Relocation	Equipment	Strong shelters
	Infrastructure	Low	Roads, bridges, railway, airport, damage	Infrastructure	Divert distal flows using earth barriers	Infrastructure	Create refuges in air-tight bellow-ground cellars

LANDSLIDE

Physical Impact	Risk		Second Order Effect	Precautions		Protection	
Subsidence	Personnel	High	Limits access. Loss of life. Destruction of property.	Personnel	Relocation	Personnel	Evacuation
	Equipment	Medium		Equipment	Relocation	Equipment	Evacuation
	Infrastructure	High		Infrastructure	None	Infrastructure	None
Sliding	Personnel	High	Land movement. Progressively tilting trees. Limits access. Loss of life. Destruction of property.	Personnel	Relocation	Personnel	Evacuation
	Equipment	Medium		Equipment	Relocation	Equipment	Evacuation
	Infrastructure	High		Infrastructure	None	Infrastructure	None
Debris flow	Personnel	Medium	Collapsed pavement. Mud. Fallen rocks.	Personnel	It is recommended that people consult a qualified civil engineer or geologist as soon as possible.	Personnel	Create levees and embankments using sandbags, tools, and sheets of plastic.
	Equipment	Low		Equipment	None	Equipment	
	Infrastructure	Low		Infrastructure	Applying mitigation techniques.	Infrastructure	

SEVERE STORMS

Physical Impact	Risk		Second Order Effect	Precautions		Protection	
High Speed	Personnel	High	Loss of life. Destruction of property.	Personnel	Relocation	Personnel	Strong shelters
	Equipment	High	Damaged equipment	Equipment	Relocation	Equipment	Strong shelters
	Infrastructure	Medium	Recharge dry area	Infrastructure	Fortification, Dikes,	Infrastructure	
Cover surface with water and mud	Personnel	Medium	Limits access. Pollution of fresh water sources. Recharge dry area. Destruction of property.	Personnel	Relocation	Personnel	Water pumping
	Equipment	Low		Equipment	Relocation	Equipment	
	Infrastructure	Medium		Infrastructure	Straightening and Deepening	Infrastructure	
Heavy rains	Personnel	Low	Possibility of flash floods in urban areas, by accumulation of debris and rainwater. Possibility of overflowing of water lines/rivers in areas historically most vulnerable. Destruction of key facilities. Damage to structures mounted or suspended. Possibility of falling branches or trees.	Personnel	Dikes, flood walls	Personnel	Diversion canals. Self-closing flood barrier. Floodplains and groundwater replenishment.
	Equipment	Medium		Equipment		Equipment	
	Infrastructure	Medium		Infrastructure		Infrastructure	

LIGHTNING

Physical Impact	Risk		Second Order Effect	Precautions		Protection	
Lightning hits open field	Personnel	High	Severe burning or death	Personnel	If the weather forecast calls for thunderstorms, postpone your open field activities.	Personnel	Enclosed shelters If no shelter is available, crouch low, with as little of your body touching the ground as possible
	Equipment	High	Fire, Out of order	Equipment	Relocation	Equipment	Enclosed shelters
	Infrastructure	High	Fire	Infrastructure		Infrastructure	Installing lightning protection system (lightning conductors, downconductors, earthing systems)
Lightning hits building	Personnel	Low	Burning, Injury	Personnel	Avoid water, electronic equipment, concrete floors and walls.	Personnel	Avoid any conducting path leading outside, such as electrical appliances, wires, TV cables, plumbing, metal doors or metal window frames
	Equipment	Medium	Out of order, fire	Equipment	Unplug from the electricity	Equipment	Unplug from the electricity
	Infrastructure	Low	Fire	Infrastructure	Installing lightning protection system (lightning conductors, downconductors, earthing systems)	Infrastructure	Installing lightning protection system (lightning conductors, downconductors, earthing systems)
Lighting hits vehicles	Personnel	Medium	Burning, Injury	Personnel	Stop and find enclosed shelter	Personnel	Stay away the metal parts and windows
	Equipment	Medium	Out of order, fire	Equipment	Switch off	Equipment	Switch off
	Infrastructure	Medium	Fire	Infrastructure		Infrastructure	

METEORITE IMPACT

Physical Impact - Meteorite diameter /m/	Risk		Second Order Effect	Precautions		Protection	
<= 50	Personnel	Medium	Most decompose in the upper atmosphere and do not reach the surface on the ground Damaged equipment Recharge dry area	Personnel	Observation Situational awareness	Personnel	Not required
	Equipment	Low		Equipment		Equipment	
	Infrastructure	Low		Infrastructure		Infrastructure	
75	Personnel	High	Iron meteors make a crater, stone meteors burn. They can destroy a small town. Area of imminent impact – up to 100 sq.km.	Personnel	Observation Situational awareness. Relocation	Personnel	-Deflecting the trajectory; -Nuclear attack; -Kinetic interception; -Change in the reflectivity; -Laser sublimation.
	Equipment	High		Equipment		Equipment	
	Infrastructure	High		Infrastructure	Not applicable	Infrastructure	
160	Personnel	High	They can destroy a large town /like Paris or New York/. Area of imminent impact – up to 10 000 sq.km.	Personnel	Observation Situational awareness. Complete evacuation and relocation	Personnel	-Deflecting the trajectory; -Nuclear attack; -Kinetic interception; -Change in the reflectivity; -Laser sublimation.
	Equipment	High		Equipment		Equipment	
	Infrastructure	High		Infrastructure	Not applicable	Infrastructure	
350	Personnel	High	An area or state can be destroyed. They provoke tsunami waves. Area of imminent impact – up to 30 000 sq.km.	Personnel	Observation Situational awareness. Complete evacuation and relocation	Personnel	-Deflecting the trajectory; -Nuclear attack; -Kinetic interception; -Change in the reflectivity; -Laser sublimation.
	Equipment	High		Equipment		Equipment	
	Infrastructure	High		Infrastructure	Not applicable	Infrastructure	

Physical Impact - Meteorite diameter /m/	Risk		Second Order Effect	Precautions		Protection	
700	Personnel	High	Destruction of large areas. They cause big waves tsunami. Area of imminent impact – up to 100 000 sq.km.	Personnel	Observation Situational awareness. Complete evacuation and relocation	Personnel	-Deflecting the trajectory; -Nuclear attack; -Kinetic interception; -Change in the reflectivity; -Laser sublimation.
	Equipment	High		Equipment		Equipment	
	Infrastructure	High		Infrastructure	Not applicable	Infrastructure	
1700	Personnel	High	Destroys entire countries - like France. Area of imminent impact – up to 500 000 sq.km.	Personnel	Observation Situational awareness. Complete evacuation and relocation	Personnel	-Deflecting the trajectory; -Nuclear attack; -Kinetic interception; -Change in the reflectivity; -Laser sublimation.
	Equipment	High		Equipment		Equipment	
	Infrastructure	High		Infrastructure	Not applicable	Infrastructure	

AVALANCHE

Physical Impact	Risk		Second Order Effect	Precautions		Protection	
Snowpack movement	Personnel	High	Loss of life. Destruction of property.	Personnel	Be aware of weather forecast.	Personnel	Winter Equipment.
	Equipment	High	Damaged equipment	Equipment	A sufficient density of trees. Artificial barriers: Snow net; Snow fence; Avalanche dams.	Equipment	A sufficient density of trees. Artificial barriers: Snow net; Snow fence; Avalanche dams.
	Infrastructure	High	Destruction of property. Destruction of natural ecosystem. Impacts such as the interruption of electricity and communications, and road blockages.	Infrastructure	Artificial barriers: Snow net; Snow fence; Avalanche dams. A sufficient density of trees.	Infrastructure	Artificial barriers: Snow net; Snow fence; Avalanche dams. A sufficient density of trees.

EXTREME WEATHER

Physical Impact	Risk		Second Order Effect	Precautions		Protection	
Extreme temperatures	Personnel	High	Physical disorders. Life/health threatening incidents. Loss of life.	Personnel	Awareness. Preparations.	Personnel	Survival Kit. Shelters. Clothing. Survival measures. Avoid body exposure
	Equipment	Low	Damaged equipment	Equipment	Preparations	Equipment	
	Infrastructure	Medium	Electricity Failures, Closed roads	Infrastructure	Preparations	Infrastructure	