Topic summary:

In this topic students are introduced to Mediterranean's basin geological structure and its dynamic system of natural forces. The students can experience the different natural hazards (e.g. earthquakes, volcanoes, landslides, tsunamis, floods, tornadoes, avalanches, fires, hurricanes, thunderstorms etc.) and their impact to human life as well as to animals and plants behavior.

Main concepts covered:

* Natural disasters
* Earthquake / Lithospheric-Tectonic plate
* Mantle / Magma
* Hotspot
* Hydrological stress
* Greenhouse gases (GHGs)
* Mediterranean climate

Transversal competencies acquired:

* Communicating orally / writting in mother/foreign language
* Mobilizing reasoning
* Mobilizing computer / digital skills

Definition of key notions:

Natural hazards:

Natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Tsunami:

Long, high sea waves caused by an earthquake or landslide or other disturbance.

Earthquake:

Sudden violent shaking of the ground, typically causing great destruction, as a result of movements within the earth's crust.

Rock-falls/landslides:

Collapse of material from a cliff or steep slope.

Flood:

Temporary cover of a land by fresh or salt water which under normal conditions is not covered by water. This submersion can be done slowly or suddenly and be repeated regularly or randomly.

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Introduction of the topic:

The Mediterranean region is a territory marked by the presence of many natural hazards, which become risks given the population density all around the basin.

The region is characterized by a temperate climate with a strong sunshine and strong winds. It alternates between hot summers, with temperatures between 25 and 40° - which can cause drought episodes - and mild, wet winters, with variable precipitations. Significant rainfall events occur during the spring and fall, which can lead to violent incidents due to climate change causing flooding and landslides.

Summer drought episodes are the cause of frequent and devastating fires during the aestival period. These are destroying hectares of land, sometimes causing many victims, such as the fire at a seaside resort in Greece in 2018, which killed 102 people.

The geological structure of the Mediterranean basin is also the source of seismic and volcanic hazards: the Mediterranean Sea is a highly fragmented area from a geological point of view. Several tectonic plates exist in the Mediterranean Basin. For example, seismic episodes that occur in the area of Southern Aegean (from West to East) are due to the convergence of African with Eurasian Plates.

All these climatic and geological characteristics tend to make the Mediterranean Basin vulnerable to four main categories of natural hazards, which consequences are accentuated by the density of the population, in particular on the coastline:

- The omnipresent seismic risk from East to West of the Basin which is accompanied in some regions by a volcanic risk

- Torrential floods

- Droughts affecting the Maghreb region in Mashreq and marking an increased extension in Southern Europe

However, these violent events tend to become more severe with global warming, which will be greater in the Mediterranean than in the rest of the world. Indeed, its position between two air masses (arid in North Africa and temperate in Europe) as well as its geographical specificities make the territory particularly vulnerable. Climate change tends to increase the intensity of already dangerous Mediterranean meteorological phenomena. It is therefore important that the regional stakeholders adopt resilience strategies.

Sustainable development issues identified in this topic:

What are the main natural risks in the Mediterranean region?

1. Floods risks

Floods are the most common natural disaster in the Mediterranean. In the period 1990-2010, floods accounted for 35% of all natural disasters that hit the Mediterranean region[1]. They are mainly caused by phenomena called "Mediterranean episodes". The Mediterranean episode results in short thunderstorms, with heavy and localized rainfall. It takes place over a relatively short period of time where the equivalent of precipitation of several months can fall in a few hours or a few days. This leads to a swelling of rivers that can lead to torrential floods with significant overflows.

These Mediterranean episodes are frequent and widespread throughout the region. They occur three to six times a year, usually in the fall, when the sea is warmest. They are caused by hot, humid and unstable air coming from the Mediterranean. The higher the sea temperature is, the greater the risk of violent episodes is.

Some 210 destructive flood events struck 22 countries during the past 20 years affecting 3,220,000 people, causing 4,250 dead, and economic losses. The Southern and Eastern Mediterranean countries recorded the highest number of deaths with 3,820 victims mostly due to sudden flash floods striking intensely populated urban areas built in flood prone zones. On the contrary, the Northern Mediterranean countries[2] registered the highest economic impacts with 21,400 billion euro lost mostly striking touristic coastal towns built without an adequate protection.

2. Coastal flooding risks

Coastal areas are often at risk due to rising of sea levels which could be due to wind waves, freshwater inflows and meteorological tide or stormsurge. The elevation of sea level due to stormsurge is a complex phenomenon, which depends on a number of factors, such as the changes in atmospheric pressure, the intensity, the speed and the orientation of the wind towards the coast, the shape and depth of the coastline, the altitude and the morphological slopes of the area, etc.

The most significant damage often results from the direct impact of the waves on fixed structures. Indirect impacts include flooding and undermining of major infrastructures, such as highways and railroads. Hooding of deltas and other low-lying coastal areas are exacerbated by the influence of tidal action, storm waves, and frequent channel shifts.

3. Drought risks

The Mediterranean climate causes severe droughts that can lead to major fires. The most destructive fires recorded since the 1980s in Europe are mainly located in Portugal, Greece and Spain.

The risk of drought is almost uniform throughout the country, causing fire risks. Their frequency is increased by human activity. Note that Forest fires often come from crimes or accidents, even if droughts are factors facilitating the outbreaks of fires or accentuating their consequences. Their impact on the forest cycle and

1 (Albania, Algeria, Bosnia-Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Jordan, Lebanon, Libya, Malta, Montenegro, Morocco, occupied Palestinian territory, Slovenia, Spain, Syria, Tunisia and Turkey)

2 Italy, France, Spain, Greece, Slovenia and Albania

biodiversity is a subject of debate, some scientists judging the fire necessary for the regeneration cycle of vegetation.

In addition, the high coastal concentration, combined with tourist populations, accentuates the water demand in the territory, which favours the drying up of the groundwater and leads to a hydrological stress in the territory.

The primary effects of a drought are loss of crops, livestock, and water used for consumption. If resulting food shortages become chronic and famine can occur. Secondary effects of drought may include fires, flash flooding, and desertification, the last one results from increased wind erosion of soils. Wind-blown ash and dust can also compromise the air quality of far-distant areas. In these ways, even localized droughts can have global consequences.

4. Seismic risks, volcanoes and tsunami

Seismic episodes are often deadly in the Mediterranean region. The tectonic plates of the Mediterranean area are convergence zones. This means that a plate is pushed under another one. This convergence movement began in the Mediterranean 70 million years ago and is still ongoing.

The Mediterranean region is seismically active, due to the convergence to the north (4-10 mm / year) of the African plate relative to the Eurasian plate along a complex boundary of tectonic plates. Several openings and closures of ocean basins over geological time have made an area extremely rich in seismic hazards with all types of mechanisms. This allows us to divide the territory into two distinct parts: the Eastern Mediterranean (from Italy to Turkey), which is characterized by intense seismicity with earthquakes whose magnitude can rise to 7.5 Richter with more than 350 recorded tsunamis and the Western Mediterranean.

Thus, during the 20th century, 198,548 earthquake victims were recorded. However, the seismic risk is not homogeneous throughout the Mediterranean territory. The Northern shoreline is the most affected, particularly the Italian Peninsula, Greece and Turkey. The Southern shore is much less prone to these risks, despite some violent events (for example, in 1960, the El Asnam earthquake in Algeria killed 2633 people or the Al Hoceima earthquake killed more than 1000 people in Morocco in February 2004).

Volcanism in the Mediterranean is also the result of this intense tectonic activity.

Volcanoes are vents that allow lava, rock fragments and gases to escape from layers beneath the earth's surface. There are several volcanoes in the Mediterranean region including Vesuvius, Etna, and Stromboli. The catastrophic earthquake of Thira is comparable in destruction to the one resulting from the 1883 eruption of Krakatoa, and it is believed to have wiped out the Minoan civilization in 1470 B. C. The Italian Peninsula is especially known for its intense seismic activity as well as its volcanism. Moreover, the presence of magma near the surface has driven some Italian regions to satisfy part of their energy needs by drawing on geothermal sources.

Tsunamis are ripples formed on the ocean surface where the seafloor is abruptly disturbed, displacing the water above it. Sometimes they consist of single waves, but very often a sequence of waves is created due to a seismic event or a landslide. Anything that causes a seafloor disturbance can produce a tsunami[3].

Several devastating tsunami events have been documented for the Mediterranean in the last 2,500 years. Both

3 Earthquakes, volcanic explosions, undersea landslides, and meteor impacts are common causes

earthquakes and volcano eruptions have triggered tsunami in this region in the past.

5. Erosion and sedimentation

Soil erosion and the resulting sedimentation constitute major natural hazards causing social and economic losses. Erosion occurs in all climatic conditions. However, it is discussed as an arid zone hazard because it is a major proximate cause of desertification associated with salinization. Erosion by water or wind occurs on any sloping land regardless of its use.

Soil erosion has three major effects: loss of support and nutrients necessary for plant growth; downstream damage from sediments generated by erosion; and depletion of the water storage capacity, because of soil loss and sedimentation of streams and reservoirs, which results in reduced natural stream flow regulation.

Stream and reservoir sedimentation is often the root of many water management problems. Sediment movement and subsequent deposition in reservoirs and river beds reduce the useful lives of water storage reservoirs, aggravate the flood water damage, impede the navigation, degrade the water quality, damage crops and infrastructures, and result in excessive wear of turbines and pumps.

6. Salinization

Saline water is common in dry regions, and soils derived from chemically weathered marine deposits (such as shale) are often saline. However, saline soils have usually received salts transported by water from other locations. Salinization most often occurs on irrigated land as the result of poor water control. The primary source of salts impacting soils is the surface and/or the ground water. Salts accumulate because of the flooding of low-lying lands, the evaporation from depressions having no outlets, and the rise of ground water close to the soil surfaces. Salinization results in a decline in soil fertility or even a total loss of land for agricultural purposes. In certain instances, farmland abandoned because of salinity problems may be subjected to the water and wind erosion.

Inexpensive water usually results in over-watering. In dry regions, salt-bearing ground water is frequently the major water resource. The failure to properly price water from irrigation projects can create a great demand for such projects and result in misuse of available water, causing waterlogging and salinization.

7. A territory vulnerable to climate change

In 2014, IPCC, which assesses the state of knowledge on climate change, identified the Mediterranean as one of the 25 hotspots of climate change. It is a particularly vulnerable territory due to the fact that:

- Its position between two climatic regimes (arid in North Africa - temperate in Europe);
- Its geographical specificities (semi-enclosed sea surrounded by mountains);
- Its extensive coastline with high concrete content and population concentration.

An increase of 2 to 3°C is expected in the territory by 2050. Temperatures could reach 5°C more by 2100. Currently, the increase is already higher in the Mediterranean Basin than in the rest of the world. There was an increase of 1.4°C over the pre-industrial era compared to 1°C for the whole world.

In addition, the Mediterranean Basin, whose climate is already rather arid, will see its summer rainfall fall by 25% on the Northern shore and 35% on the Southern one. The most pessimistic scenarios predict a decrease of 40% in precipitation by 2100 depending on the country and season. The precipitation reduction is mainly due to the increase of greenhouse gases emissions causing a greater change to climate.

Storm events will intensify, increasing the risk of high floods, which can be destructive to the territory and its biodiversity, and leading to human and economic losses. Similarly, droughts and heat waves will become more frequent, leading to significant water stress in the territory.

Climate change could also lead to the development of new risks, such as sea level rise, ranging from 40cm to 1m by the end of the century, but also, the acidification of water, caused by an excessive absorption of carbon dioxide.

It is therefore important for the whole Mediterranean Basin to act for sustainable development and to establish strategies for resilience and adaptation to climate change.

Position of the topic in the school program:

	11	12	13	14	15	16	17
Mother / Foreign language / Litterature							
History	X	X	X	X	X	X	X
Geography	X	X	X	X	X	X	X
Mathematics							
Biology / Geology	X	X	X	X	X	X	X
Physic / Chemistry							
Social Science / Economy / Law						X	X
Art / Musics							
Technology / Computer science							

Ressources:

- All information about the european agreement (Council of Europe) about natural hazards : https://www.coe.int/en/web/europarisks/about-us
- Resources for young people (in french) about prevention of natural hazards : http://www.jeunes.gouv.fr/spip.php?article7110
- Risks of Tsunami : https://www.eskp.de/en/natural-hazards/tsunami-risk-in-the-mediterranean-sea-935107/
- Coastal risks : https://www.coe.int/t/dg4/majorhazards/activites/2009/Murcia_26-27oct2009/Murcia_26-27oct09_Micallef.pdf
- Tsunamis and coastal risks : https://www.nationalgeographic.com/environment/natural-disasters/tsunamis/
- About earthquakes : https://www.who.int/hac/techguidance/ems/earthquakes/en/ ; https://www.n-d-a.org/earthquake.php
- About floods : https://www.nationalgeographic.com/environment/natural-disasters/floods/
- A geopark is a protected area with geological attractions generally corresponding to geosites Some geoparks in the Mediterranean region are involved in projects to raise awareness of geological phenomena and in particular geological risks. Accéder à la liste des géoparks de l'UNESCO : http://www.unesco.org/new/fr/natural-sciences/environment/earth-sciences/unesco-global-geoparks/list-of-unesco-global-geoparks/
- An overview of natural hazards in european Region : https://www.espon.eu/sites/default/files/attachments/20130704_ESPON_TERRITORAL_07_CS6_CM_Final.pdf