

AN ASSESSMENT OF 2023 EXTREME CLIMATE MANIFESTATIONS IN SOUTHERN EUROPE

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According to numerous reports, the year 2023 is considered the hottest year on record, as a series of natural disasters have struck especially in countries bordering the Mediterranean Sea.

These calamities, such as vegetation fires and floods like the recent ones in Greece, are not just a localised threat, but one that goes beyond the perimeter of countries bordering the Mediterranean Sea, as these uncommon occurrences of nature are also being observed in other parts of the world.

Considering that this sort of threat is highly unpredictable and requires specific measures, this paper aims to assess the effects of the recent natural disasters in Southern Europe and to identify measures taken by Greece to counter and mitigate the effects of the mentioned calamities.

Keywords: natural disasters; Mediterranean Sea area; disaster management; climate change; threats to society;

INTRODUCTION

As a subunit of climate, the weather has a significant role in daily life and has an impact on a person's activity as well as mood. When waking up in the morning, the first thing one normally does is to have a look out of the window to check the weather, to plan activities for the day and the outfit. From human to human, the weather also has a psychological impact, which can affect productivity, fatigue or even the level of serotonin our bodies produce. Thermal discomfort is usually associated with the temperature-humidity index exceeding a certain threshold specific to hot summer days, with air temperatures above 35°C and low relative humidity. Due to climate change, such days when heat wave orange codes persist will become increasingly frequent, with a significant impact on one's energy and working capacity.

The debate on climate change is no longer new. There are initiatives to promote awareness on these topics, but large-scale action is yet to become mainstream. Responding appropriately at the right time requires on one hand comprehensive and transparent reporting and on the other hand allocation of necessary resources. Global warming is not a recent phenomenon since reporting on this development can be dated back to the 1960s when industries began to expand and the concentration of greenhouse gases began to increase beyond control. Experts in the field have developed several climate models and have estimated that the average annual temperature will rise by between 1.1°C and 6.4°C during the 21st century (Meteo.ro, 2023).

But what is global warming and how does it affect daily lives? According to Meteo Romania, "*global warming is the phenomenon of an increase in the average recorded temperatures of the atmosphere in the vicinity of the land as well as the oceans*" (Ib.). Rising temperatures are determined by climate change depending on the area affects several domains of activity such as tourism, agriculture, other parts of the economy and therefore national security. Tourists plan holidays according to the time of the year and the destination, and relatively recent global warming makes this almost impossible due to temperature changes and the disasters that come with them. Agriculture is a very sensitive area and it is affected

by this development as global warming leads to seasonal average temperatures exceeding the threshold and decreasing water sources, hence crops are affected and food trade is potentially at risk. Agriculture and tourism are the main industries that support the economy of a developed country that is well placed on the map in terms of terrain and accessibility to water sources, so the impact of climate change can be felt in almost all areas of work.

In the first three quarters of 2023, recorded events have demonstrated that climate change can cause significantly more unpredictable damage and that countries are not prepared enough to cope with the effects of disasters such as wildfires in Greece and Spain, floods in Türkiye, Bulgaria and Libya.

Amid voices in the public space claiming that some outbreaks were caused by humans, on purpose, and not by climate change, this paper aims to highlight as much as possible that global warming is real and contributes to the natural disasters that are occurring increasingly often in Southern Europe, as well as in countries bordering the Mediterranean Sea.

GEOGRAPHICAL LOCATION AND SPECIFIC CLIMATE

General characteristics

To understand better why Southern Europe and the countries bordering the Mediterranean Sea are more vulnerable to natural disasters, one needs to look at the terrain and climate.

Europe is located between 36° and 71° latitude North, which situates it largely in a temperate climate, and the northern area beyond the Arctic Circle in a cold climate. Air masses play an important role in the temperature distribution on synoptic maps, so the southern part of Europe is dominated by Mediterranean or North African air masses with warm and humid characteristics. This results in higher temperatures and increased atmospheric instability. The air temperature decreases from S-W to N-E, resulting in higher temperatures in this area. Atmospheric precipitation decreases from west to east, making the area around the Mediterranean more prone to drought (Matei, 2023). While these general characteristics should explain the vegetation fires in this area, flooding also takes place where rainfall is normally completely absent.

Our planet is deviating from the well-known rules, hence there is a need to see where it all starts. The atmosphere is divided into five layers: troposphere (where all living beings exist), stratosphere, mesosphere, thermosphere, and exosphere. It is

important to know these layers because this is where weather phenomena originate. The ozone layer is about 20-30 kilometres above sea level and plays an important role in sustaining life on our planet. It is naturally formed in the atmosphere. If this ozone layer did not exist, the Earth's temperature would be much higher because UV rays would come into direct contact with the ground, thus increasing ground temperature and eventually air temperature. Despite speculation and assumptions, the main source of heat on Planet Earth is not the Sun, but the ground, so the ozone layer can be seen as a barrier against solar radiation preventing additional heating. Reports indicate in recent decades that the ozone layer is thinning faster than it would naturally. Additionally, a high level of CO₂ is present in the atmosphere and plays an important role in the greenhouse effect, exceeding normal limits (Piticar, 2023, p. 15).

The greenhouse effect is a natural process that keeps heat in the lower troposphere. It is favoured by certain greenhouse gases such as water vapour, CO₂, methane and other gases. Without it, the heat would evaporate faster into the atmosphere and the earth's surface temperature would be 33°C lower. As a natural process, the gases that form it are found in the atmosphere as follows: water vapour comes from evaporation at the surface of seas and oceans, methane comes from the decomposition of organic matter and CO₂ from human and animal respiration. The amount of CO₂ is multiplied due to excessive pollution in the atmosphere, and greenhouse gases lose balance (Piticar, 2023, pp. 30-34).

Thus, the thinning of the ozone layer which causes much stronger radiation from the Sun, together with the high concentration of greenhouse gases and a large amount of CO₂ present in the lower atmosphere, increases ground temperature significantly.

Permanently influencing phenomena

Annual temperatures are rising, the ozone layer is reportedly thinning, and natural disasters surprise us at every step. The general characteristics that explain higher temperatures in southern Europe are not a good enough argument to support calamities in 2023. It is also worth looking at the *Jet Currents*, permanent currents that influence the weather, but also on the *El Nino* phenomenon.

Jet streams are bands of very strong winds, which are found in the upper levels of the atmosphere around 30,000 feet or 9,000-10,000 meters. The winds blow from west to east, and due to the properties of warm and cold air; the band

of currents moves north and south. Depending on the latitude at which they are located, they vary in height as well as speed, with some reaching speeds of over 442 km/h (NOAA, 2023).

El Nino is a climate model that describes the unusual warming of the surface waters of the eastern Pacific Ocean. *El Nino* represents the warm phase of this phenomenon and *El Nina* the cold phase. This phenomenon not only influences ocean temperatures but also the speed and strength of ocean currents, along with weather from Australia to South America (Society, National Geographic, 2023).

Although the *El Nino* weather pattern does not seem to affect Europe, in recent years with an influence from the *Jet Stream*, it has warmed Europe in summer and cooled it in winter according to the sources cited above.

Mediterranean climate

After a brief analysis, it can be stated that there are factors countries affected by natural disasters have in common, such as their proximity to the Mediterranean Sea and the Mediterranean climate. By name, the Mediterranean climate is predominant in countries bordering the Mediterranean Sea. It is characterised by a temperate climate, very hot and dry summers and rainy winters. It can be associated with four types of climates, but only three of them represent an area of interest for this study.

The typical Mediterranean climate is found throughout much of Spain and the average temperature is over 18°C, often reaching the heat wave threshold. The continental Mediterranean climate is predominant in areas further from the coast, where humidity decreases. It can be found in Italy, Türkiye, Lebanon, and inland Spain. The dry Mediterranean climate occurs when there is a transition between the Mediterranean climate and the desert, thus very arid areas. This is where Greece and Libya fall as areas of interest, as well as most North African countries (Sanchez, 2023).

EXTREME PHENOMENA IN COUNTRIES BORDERING MEDITERRANEAN SEA IN 2023

At the time of the study, i.e., mid-September 2023, it can be mentioned that during the nine months of this year, numerous allegedly natural disasters have occurred. Among the most known are floods in Greece, Türkiye, Bulgaria, and Libya, earthquakes in Turkey and Syria, and vegetation fires in Spain and Greece.

The disasters that occurred are many more in number, but they were given much attention so they have not been publicised. The dangers are much greater, and after every disaster, it seems a lesson was learned, but are these countries really prepared? In the following, the study will mention all major natural disasters that occurred this year to date, then conclude with the measures that were taken, and conclude with the question: “*What to do if it hits again/other regions too?*”.

Türkiye

On 6 February, an earthquake measuring 7.8 on the Richter scale struck in southern Türkiye, on the border with Syria. Just nine hours later, another earthquake struck the country, this time measuring 7.5 in magnitude. This was the strongest earthquake recorded in Türkiye in the last 20 years, matching another one from 1939. According to several sources, the death toll exceeded 57,000, with more than 121,000 injured (CDP, 2023).

There are still no studies to confirm that climate change plays a role in earthquakes, although along with other natural disasters such as floods and wildfires, we can see that tectonic plate movements have also increased this year. However, one can observe that this event kicked off the calamities in 2023. Therefore, further work may be required to determine any potential connection between climate change and other potential natural disasters.

Wildfires season in the Mediterranean

Major fires hit Spain ahead of the season, along with other countries such as Greece, Italy, Portugal and the islands of Rhodes and Corfu due to a lightning strike in July. August was a critical month for the European Union (EU) as the fires caused significant material damage and casualties. The most severe fires were recorded in Greece, in the Alexandropoulos area on the border with Türkiye. They started on 19 August and continued for several days, fuelled by the dry vegetation specific to Greek terrain, but also by strong winds and high temperatures. They razed over 45,000 hectares of forest and over 62,000 hectares of nature reserves. A study underlined that in some countries bordering the Mediterranean Sea, more than 135,000 hectares of forest burned in 12 days and more than 120,000 people were affected (Joint Research Center, 2023).

August is the month when numerous tourists choose to travel, especially to warm-weather destinations. Those who had chosen Tenerife as their destination suffered from vegetation fires that razed over 15,000 hectares of forest in just a few

days. According to the authorities, the flames were more than 40-50 meters high and more than 13,000 people were evacuated. The islands' climate in the Atlantic Ocean, along with dry timber scattered across the island, high temperatures and winds typical to coastal terrain, made it almost impossible for firefighters to put out the fire in a short time and stop it from spreading to people's homes (Brelie, 2023).

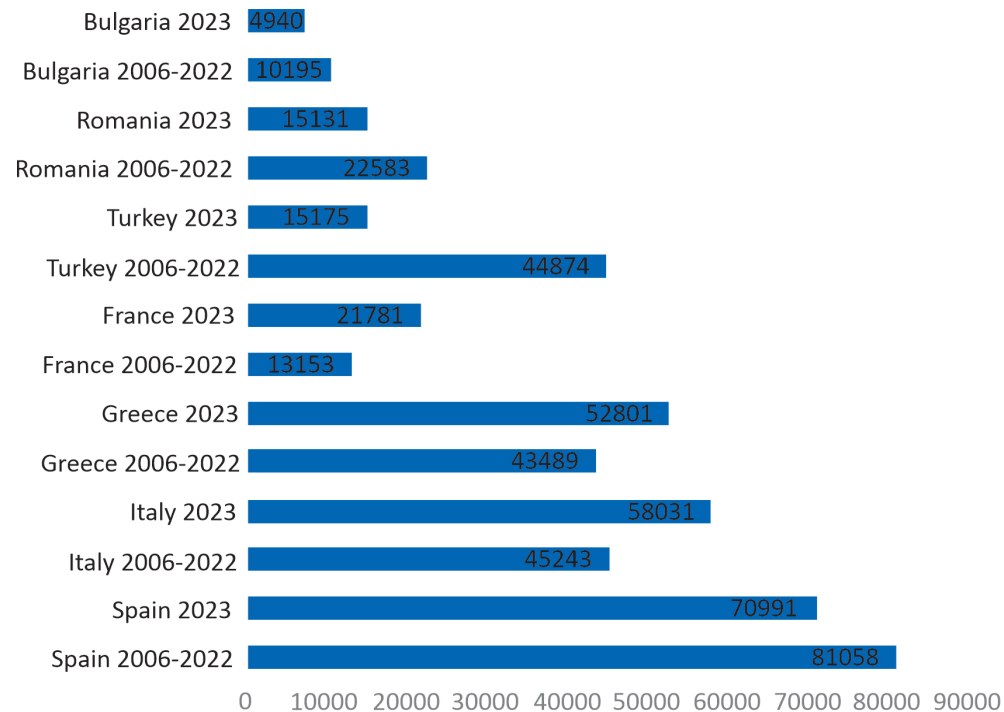


Figure 1: Area burnt by vegetation fires (in hectares) (Salas, 2023).

According to *Figure 1*, we can see that the number of hectares burned in 2023 in most countries is close to the number of hectares burned during the previous 16 years of measurements. France, Greece, and Italy exceeded the previous 16-year total of fires in 2023 to date. What does this mean? In the countries bordering the Mediterranean Sea, more hectares burned in 2023 than in 16 previous years combined, which is a worrying record. The amount of carbon dioxide and other harmful gases released in the atmosphere is immense, leading to the waste of long efforts towards preventing climate change in days due to uncontrolled fires caused by climatic factors and, why not, the population. There is no official data that can confirm the total number of fatalities from the wildfires, but in Greece, at least 20 people lost their lives due to fires.

Floods beyond the Mediterranean Sea

If questions about guilt could be asked, man or nature, when it comes to floods, the answer is clear. Although there are many ways for countries to prevent flooding, including canals, drains, and dams, it is practically impossible to control the amount of rain that will fall, and even with the best prevention systems, to avoid flooding if the amount of water that reaches the ground in one day equals the amount that would fall in 5 months has not been planned for. This happened in mid-September in southern France, a country bordering the Mediterranean Sea. The event is still ongoing and the damage cannot yet, be estimated. Major floods from southern Europe are further analysed in chronological order.

Outside the Mediterranean region, there were floods in the UK, Germany, and Serbia earlier this year, where dozens of people lost their lives. Returning to the countries adjacent to the Mediterranean Sea, in March a series of floods occurred in Türkiye in a southeastern region, with 14 people losing their lives. April got off to a strong start in the Calabria area of Italy, where one person lost their life after a vehicle was swept away. May was a critical month for several areas of Italy after dozens of people died and hundreds more were evacuated from flooded regions. Fortunately, the floods in Bosnia and Herzegovina did not cause any casualties but left hundreds of people homeless. Towards the end of the month, deadly floods hit Italy again, this time in other areas. June focuses on Türkiye, Kosovo, and Romania, where dozens of people lost their lives in heavy rains. July does not surprise Türkiye with anything new, with the same area again suffering casualties as more than 250 mm of water per square metre fell in less than 24 hours. September started with a series of floods in Spain, where rainfall exceeded 240 mm in 24 hours. Greece, Türkiye and Bulgaria were hit by rainfall exceeding in some regions 600 mm per square meter, which killed dozens of people. Although these amounts of water were reported in advance, inadequate infrastructure in the cities led to extensive material damage (Floodlist, 2023).

The World Meteorological Organization (WMO) named storm "Daniel" as the cause of flooding in Greece and Libya. It moved from southern Europe to northern Africa along the Mediterranean Sea. According to the water cycle in nature, water vapour is formed at the surface of the seas and oceans, the humidity is higher in the neighbouring areas, so cloud formations above water surfaces can be more water-laden. This has caused massive flooding in Libya, with the Derna dams collapsing,

approximately several thousand casualties and more than 10,000¹ people missing at the time of this study (WMO, 2023).

Although there is speculation that the Derna dams have been partially damaged since the 1990s, this does not explain the flooding level that occurred given the topography of Libya, which is considered the most desert country in the world with over 98% of its territory desert and rocky. With such a dry Mediterranean climate and terrain, it is almost impossible to prepare such a country against such deadly flooding.

Table 1²: Analysis of the 2023 floods in countries bordering the Mediterranean Sea

Where?	When?	Why?	Damage (nr. of victims, evacuated families)	Amount of precipitation
Türkiye	15 March	Heavy rain, floods	14 deaths	104-151 mm in 24 hours
Italy	3 April	Heavy rain, floods	One dead	118 mm in 24 hours
Italy	3 May	Heavy rain, floods, rising rivers	15 deaths, 36.000 evacuated	190 mm in 24 hours
Italy	26 May	Heavy rain, floods	One dead	No data
Türkiye	5 June	Heavy rain, floods	2 deaths	127-147 mm in 24 hours
Spain	7 July	Heavy rain, floods	No data	27.6 mm in 10 minutes 46 mm in a few hours
Türkiye	9 July	Heavy rain, floods	One dead, over 700 evacuated	250 mm in 24 hours
Spain	2 September	Heavy rain, floods	No data	243 mm in 24 hours

¹ Please note that for the moment the number of casualties is modified every day by the Libyan authorities.

² It should be noted that posts/articles from the floodlist.com website have been consulted to fill in the table below. To avoid cluttering the page with footnotes, I have referred only to the general site, respectively, Floodlist, 2023.

Where?	When?	Why?	Damage (nr. of victims, evacuated families)	Amount of precipitation
Greece Turkey Bulgaria	5 September	Heavy rain, floods, Storm "Daniel" in Greece	11 deaths	754 mm in 24 hours in Greece (Davies, 2023)
Libya	9-10 September	Heavy rain, floods, storm "Daniel", broken dams	Different figures are mentioned, including 11.300 deaths	414 mm in 24 hours (Davies, Breaking News, 2023)

According to the analysis of countries mentioned above, we can see that among the most affected countries are Italy and Türkiye if the number of floods that occurred this year was considered. If the number of victims is considered, unfortunately, Libya is at the top of the list, followed by Türkiye and Italy. As mentioned in the previous chapter, the climate of these countries is predominantly Mediterranean with a maritime influence. The phenomenon of showers is not known in the countries of Europe, but the amount of rainfall in a few hours can be compared to the amount of rain that has fallen in recent years in these countries. This is a very special phenomenon and raises alarm bells for climatologists because of climate change

MEASURES TAKEN AGAINST CLIMATE DISASTERS

With the year 2023 considered to be the hottest in history, with millions of property damage and hundreds of victims of wildfires and floods, the European Union is under increasing pressure to find long-term solutions. This year has brought hundreds of fires, temperatures exceeding 40 degrees Celsius, hence thousands of tourists have been evacuated and dozens of locals have lost their homes and businesses. There are now several projects underway, experimenting with ways to reduce fires and their impact (European Commission, 2023).

One example would be "GreenChainSAW4LIFE", an ongoing project in Northern Italy that aims to address climate and environmental risks, including fires, in certain areas of the country. This project is worth around €5.5 million and will run until 2024. It hopes to save up to 200 tons of CO₂ per year by reducing forest fires.

How will it achieve this? The project aims to manage local forests innovatively, making them resilient to climate change and using wood to produce green energy and biomaterials to benefit the local economy and nature. The project also promises to assess the possibility of switching to renewable energy by mapping the territory's energy consumption (Greenchainsaw4life, 2023).

Spain and Portugal, two of the countries most affected by wildfires, are running a project called *"LIFE LANDSCAPE FIRE"* which aims to prevent fires by allowing goats to walk free and eat all the dry grass and shrubs. The project coordinator in Portugal mentioned that dry grass and shrubs are like fuel for fires, and this should reduce the risk of fires (European Commission, 2023).

Another project run by the European Commission is *"LIFE REFOREST"*, a project using a state-of-the-art biotechnology also called *mycotechnosol*. With this, soil and burnt vegetation will quickly recover to produce soil erosion. Worth €1.6 million, it has already been tested in three of the worst affected areas in north-west Spain and Portugal, with considerable results: soil erosion has been reduced by 70% and water pollution by up to 90% so that soil has recovered in half the typical time (European Commission, 2023).

In fact, an organisation was created specifically to provide information on emergency situations arising from natural disasters. *"The Copernicus Emergency Management Service"* has continuously monitored the impact of fires on areas adjacent to the Mediterranean Sea. The CEMS fire system has recorded more than 1,273 fires in the European Union by the end of August 2023. Through its components, CEMS provides essential information to civil authorities to prepare for and monitor critical events. In addition, the mapping service produces detailed geographical maps of the events that help to estimate the population, buildings and infrastructure affected (Joint Research Center, 2023).

Following Greece's request for help on 20 August, the European Union's Emergency Centre responded with the largest ever aerial fire-fighting operation, mobilizing 11 aircraft and 1 helicopter in addition to 5 from Greece. Through the European Union Civil Protection Mechanism, more than 62 vehicles and 407 people jumped in to help. This followed the Union's swift response a month earlier, when fires were raging across the country and it took 9 planes, 510 firefighters and more than 117 vehicles to douse the blaze (Joint Research Center, 2023).

CONCLUSIONS

As noted in this research, the effects of climate change can be both unpredictable and disastrous, as seen in southern Europe this year, which has not yet ended. Climate change is an issue of international concern and a topic of increasing discussion at various UN, EU and WMO conferences. Measures to combat climate change to conserve the planet have been in place for several years and are well known to the population: increasingly electric cars on the market and encouragement to buy them, recycling, replacing plastic products with cardboard ones, and the list goes on. Although the population is made aware of these measures, not everyone complies with them as the rules remain at a recommendation level as of now. The year 2023 exhibited what the planet is capable of if significant action is not taken, and the effects are worrying. There is an acute need to properly identify, report and tackle climate change-related disasters. Every week major wildfires and floods occur in neighbouring countries and aid has been sent, but preventive measures are still to be properly developed. *"What to do if it hits again/other regions too?"*

If an extreme weather event has only happened once, it cannot be attributed to climate change. What can be attributed is the likelihood of new extreme events occurring in a short period of time (Mistry, 2023).

On another note, Romania as a country, has not implemented extensive measures against climate change, probably on the premise of low occurrence rate and resources constraints. These assumptions may have become wrong because climate disasters do not take into account country, terrain or climate. A good argument for this statement would be what is happening right now in Libya, a country with predominantly desert terrain, where it rained in a year as much as in ten, or rather, the increase in floods and vegetation fires in Romania. Romania's hydrological network is extensive, which increases the risk of flooding. Temperatures this summer in the south often exceeded 40 degrees Celsius and the asphalt went to higher temperatures, hence the risk of fires is also increasing. Countries like Spain and Greece, which have invested millions of Euros in global warming projects made some steps in this direction. These countries have a terrain and climate prone to wildfires, but they have taken measures for all types of climate disasters.

Potential future impacts of climate change include more wildfires, longer periods of drought and increased wind and rainfall from tropical cyclones as stated by NASA. These effects will increase the mortality rate in the affected areas

and cause property damage that is difficult to estimate. Given this, and the fact that climate change is irreversible and getting worse every day, this represents an issue of international concern that needs to be taken seriously and deserves more attention because the future can still be positively impacted.

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