Floods in the European Union and the Middle East and North Africa region: Socio-economic impacts, characteristics, and public perception

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Abstract. Floods are the most common natural disaster type worldwide, causing devastating socio-economic impacts. While much research has been conducted on flood impacts in the Global North, less is known about how these impacts vary across regions with different climatic and socio-economic conditions. Moreover, little is known about how measured impacts compare with public perception of flood risk, which is relevant for how populations respond to flood risk management measures. This study has two objectives: 1) to quantify and compare flood impacts within and between the European Union (EU) and the Middle East and North Africa (MENA) using the Emergency Events Database EM-DAT for 2000-2023 and 2) to compare the recorded impacts with public perception of flood risk within the EU based on the SP547 Eurobarometer survey. We find that more floods were recorded in the EU than in the MENA, causing double the economic losses relative to GDP. However, the numbers of fatalities and people affected by flooding were nearly four times larger in the MENA than in the EU. The seasonality of floods and their impacts showed a greater prevalence in central and eastern Europe during summer, in the western Mediterranean during autumn, and in the eastern Mediterranean and Middle East during autumn, winter and spring. Comparing recorded impacts with public risk perception showed that flood risk is overestimated by the population of northern EU countries and underestimated in the southern EU. Our results highlight the need for improved flood impact and perception data to facilitate flood research, especially in the MENA region, where data availability is limited but communities are disproportionately affected by flood disasters.

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1 Introduction

Floods are recognised as the most common natural disaster worldwide (e.g. Delforge et al., 2025; Wilby and Keenan, 2012). They can cause widespread economic losses and societal impacts (Kundzewicz and Kundzewicz, 2005), and are suggested to be the deadliest natural hazard globally (WMO, 2026). However, impacts of flooding vary across regions linked to different societal and geographical conditions. For example, precipitation patterns, topography, soil types, and vegetation cover make some regions more prone to flood disasters and their impacts than others (see e.g. Abdel-Fattah et al., 2017).

Several socio-economic factors play an important role in the variation of flood impacts across regions. These factors include urbanisation, population size, and exposure of housing and assets in flood-prone areas (Barredo, 2007; Wilby and Keenan, 2012; Khodayar et al., 2025), particularly in developing countries, the age distribution of the population in developed countries (Wilby and Keenan, 2012), and land-use (Paprotny et al., 2024). In addition, a larger Gross Domestic Product (GDP) per capita is correlated with greater financial losses due to flooding, but with fewer human impacts, such as deaths or affected people, from this type of natural hazard (Hu et al., 2018). Similarly, economic losses associated with flooding are largest in absolute values in high income countries, but highest in middle-income countries when counted as a proportion of GDP (Wilby and Keenan, 2012). Furthermore, in wealthy countries, better early warning systems and management plans are available, leaving populations from low- and middle-income countries more vulnerable to flood hazards (Yin et al., 2023). Thus, it is important to improve understanding about how these complex socio-economic factors influence flood impacts across different regions.

Flood disasters in the Global North are increasingly well studied. In Europe, floods cause the highest economic losses among all types of natural disasters (Paprotny et al., 2024; Wilby and Keenan, 2012) and are considered as the most significant hazard (Paprotny et al., 2024). For example, the recent flood in central Europe in July 2021 caused around 10.6 billion Euros of insured financial damage and more than 200 fatalities (Koks et al., 2021).

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In contrast, flood impacts in the Global South have received relatively little attention. For example, natural hazard and flood impacts in the Middle East and North Africa (MENA) region are comparatively understudied, leading to calls for more research in this direction (Al Saud, 2022b). Existing natural hazard research in this region tends to focus more on droughts (Kantoush et al., 2022; Loudyi and Kantoush, 2020; Sumi et al., 2022; Yin et al., 2023), which are more prevalent in arid and semi-arid regions like the MENA (Loudyi and Kantoush, 2020). As a result, populations in dry areas are generally less prepared for flooding than communities in wetter climates (Loudyi and Kantoush, 2020; Yin et al., 2023). The relevance of flooding in arid regions is emphasized by devastating events in Derna (Libya) in September 2023, resulting in more than 5,000 fatalities (Armon et al., 2025), and the successive events in Jeddah, Saudi Arabia, in 2009 and 2011, with around 180 fatalities and 570 injured (El-Haddad et al., 2025). In the MENA region, concerns have been raised relating to regional challenges such as insufficient monitoring of floods and their drivers (Loudyi and Kantoush, 2020), a lack of early warning systems (Al Saud, 2022a), and missing flood risk area mapping, especially in urban areas (Abdrabo et al., 2022). Floods and their impacts in this region are also exacerbated by factors such as climate change, uncontrolled urbanisation, and fragile infrastructure (Al Saud, 2022a; Loudyi and Kantoush, 2020). Furthermore, arid conditions can also push populations to live closer to rivers, exposing them to greater flood risk. As a consequence, floods (in particular flash floods) in arid regions of the Global South can be more devastating than those in wetter climates (Yin et al., 2023) but, despite these impacts, these regions remain understudied, including the MENA region (Abbas et al., 2020; Kantoush et al., 2022; Sumi et al., 2022).

Understanding the impacts and characteristics of flood events at a regional level can help guide disaster preparedness. Additionally, it is crucial to take into account public perception of natural hazards, as risk awareness can reduce population vulnerability by increasing the likelihood of adopting protective measures (Becker et al., 2014; Fuchs et al., 2017). Risk perception also plays a role in natural hazard resilience (Becker et al., 2014) as well as in the acceptance of protective measures (Fuchs et al., 2017) and management plans that are put in place (Glaus et al., 2020). For these reasons, studies on flood risk perception are essential for flood risk management and have been called for (Yin et al., 2023), but international comparative studies of risk perception are still relatively rare.

Both of these approaches – assessing flood hazards through recorded impacts and through risk perception surveys – have yielded valuable results in previous research as discussed above. Yet, while previous studies acknowledged the importance of combining social and natural science approaches to study flood consequences (Fuchs et al., 2017), to the best of the authors' knowledge, only a few studies have explicitly combined both methods. For example, Hamidifar and Nones (2025) studied the link between flood impacts recorded in the Emergency Events Database (EM-DAT) and public perception in Europe using *Google Trends.* They found a correlation between peaks in the number of *Google* searches relating to flooding and the number of people who were affected by flood disasters, suggesting that flood impacts and public awareness are interconnected (Hamidifar and Nones, 2025).

The present study addresses the identified research needs by comparing recorded flood impact data across different regions and by combining recorded impacts with public perception data to explore the association between flood impacts and public awareness of flood hazards. Specifically, we quantify flood impacts in the EU and the MENA regions, motivated by the lack of research on the latter region and the different climatic and socio-economic conditions between these two regions. The EU's GDP amounted to nearly 18,000 billion Euros in 2024 (Eurostat, 2024, cited in European Union (2026)), thus making the EU one of the world's biggest economic actors (European Union, 2026). By contrast, countries in the MENA region are predominantly classified as low- to middle-income (Al Saud, 2022a). In terms of climate, most of the EU is dominated by a temperate, humid climate with precipitation year-round (Beck et al., 2018), while most of the MENA region has a semi-arid to arid climate with sparse precipitation (Al Saud, 2022a).

With these considerations in mind, we explore the similarities and differences in flood impacts between the EU and MENA regions and compare these impacts with those stemming from other types of natural hazards. We also investigate the inter- and intra-regional patterns of flood types and seasonality. Finally, we compare observed flood impacts with public perception of flood hazards focused on the EU only due to limited availability of survey data.

Specifically, we aim to address these four research questions:

1. How does the number of flood disasters and their impacts compare to those from other types of natural hazards in the European Union and the Middle East and North Africa?
2. How do flood disasters and their impacts compare between the EU and MENA regions?
3. What are the prevalent types and seasonality of flood disasters and their impacts across both regions?
4. How does the public perception of flood hazards compare with recorded flood impacts within the EU?

2 Data and Methods

2.1 EM-DAT database

To address these research questions, we draw on two main data sources. The impacts of flooding and other natural disasters as well as the flood characteristics are assessed using the EM-DAT database from the Centre for Research on the Epidemiology of Disasters (CRED) at the Catholic University of Louvain (CRED, 2025a). The EM-DAT consists of country-level records of disastrous events – i.e. events overwhelming the local capacity of the impacted area (Delforge et al., 2025) –, which are defined as fulfilling at least one of the following criteria (CRED, 2025a; Delforge et al., 2025):

– causing 10 or more fatalities, including people recorded as missing since the time of the event;

– directly affecting a minimum of 100 people, including injury and becoming homeless;

– resulting in a call for international assistance from the country impacted by the disaster or in a declaration of a state of emergency.

The disasters and their impacts are recorded using different sources, such as newspapers, international organisations, NGOs, as well as reinsurance companies (Delforge et al., 2025).

The EM-DAT database was selected because it is publicly available and includes natural disaster impacts for countries in the EU and the MENA region. Other databases were considered less suitable for the purpose of this study. The Historical Analysis of Natural HaZards in Europe (HANZE) dataset contains only recorded flood events in European countries (Paprotny et al., 2024), the UNDRR Sendai DesInventar database's voluntary structure results in data with limited consistency in time and space (Delforge et al., 2025), and NatCatSERVICE from MunichRe or Sigma from SwissRe are not publicly available (Delforge et al., 2025; Wirtz et al., 2014). EM-DAT is among the most commonly used database for studying impacts from floods and other types of natural hazards at regional and global scales (Delforge et al., 2025) (study examples in e.g. Barredo, 2007, 2009; Donatti et al., 2024; Hu et al., 2018; Tin et al., 2024; Yin et al., 2023).

2.2 Eurobarometer

To assess the public perception of flood events, we draw on aggregate data from the Special Eurobarometer survey *'SP547: Disaster risk awareness and preparedness of the EU population'* (European Commision, 2024), which inventoried public awareness and perceptions of natural disasters. The survey was conducted in all EU member states between 7 February and 3 March 2024 on behalf of the European Commission, and we draw on the results reported at the national level in the final report (European Commision, 2024).

We focus on three questions in the survey to convey different aspects of public perception: 1) exposure to the different types of natural disaster at the national level, 2) exposure at the personal level, and 3) personal experience of the different types of natural disasters. The questions, response options, and received answers are available in Appendix A and Tables A1, A2 and A3.

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To the best of our knowledge, there are no surveys available for the MENA region similar to the Eurobarometer. For instance, the Arab Barometer focuses mainly on the environment and its challenges such as water issues or climate change (Abufalgha, 2022; Green, 2019) whereas the Afrobarometer surveys the perception of the changes in severity of drought and flood events (Afrobarometer, 2022). For this reason, we focus solely on geographical variations within EU countries to address differences in flood risk perception.

2.3 Quantifiable impacts

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The EM-DAT database from CRED is downloaded from their website (CRED, 2025a) for countries in the EU and MENA regions for the period 2000-2023. Annual national population counts and Gross Domestic Product (GDP, in current US$) were downloaded from the World Bank Group website (World Bank Group, 2025) to estimate the flood impacts relative to population size and economic welfare. Geographical information for visualisation of national borders were taken from Natural Earth (Natural Earth, 2025).

To answer RQ1, we compare the impacts of flood disasters against those stemming from other natural disaster types, using the *Disaster Type* variable from the EM-DAT data. To facilitate the comparison with survey data in section 3.4, we sort all disaster types into four main categories (extreme weather events, floods, geological disasters, and fires; see Table 1), corresponding to those in the Eurobarometer. All natural disaster occurrences and their impacts are aggregated per region (EU, MENA, see Fig B1) and per country, including the three impact indicators: 1) the number of fatalities (*Total Deaths*), 2) the number of affected people (*Total Affected*), and 3) the economic losses (*Total Damage ('000 US$)*).

Table 1. Natural hazard categories

Category in this study and in the Eurobarometer	Type (EM-DAT)
Extreme weather event	Drought, Extreme temperature, Storm
Flood	Flood, Glacial lake outburst
Geological disaster	Earthquake, Dry mass movement, Wet mass movement, Volcanic activity
Wildfire, forest fire	Wildfire

To answer the second research question (RQ2), we sum the number of flood disasters and their impacts again regionally and nationally, using the same three impact indicators. These values are normalised using the total national population size for the human impacts, and the national GDP for the financial impacts. Specifically, the normalised values are computed as

$$C_{norm} = \frac{\sum_{i=1}^{n} C_i}{\sum_{i=1}^{n} I_i} \times 100,$$

where C_{norm} is the normalised value, C the consequence under consideration (fatalities, affected people, or economic losses), I the total population count for human impacts, or the GDP for financial damage, n the total number of years in the research period (24 years) and i the index indicating the year.

For the computations, empty fields in the EM-DAT are set to 0 for all impact indicators. A value of zero thus either means that the disaster did not cause any damage, or that its impact is unknown or not registered. This choice introduces a potential bias in the study, since some event types or impacts may be under-reported compared to others. To provide more insight into this aspect, the percentages of zero fields for each disaster category and the corresponding impact indicator are included in Table C2.

To answer RQ3, two main characteristics of flood events are analysed: the flood type (following Barredo (2007); Hu et al. (2018); Paprotny et al. (2018, 2024), for instance) and seasonality (in line with Khodayar et al. (2025); Llasat et al. (2010); Paprotny et al. (2018)). First, the flood occurrences and their three impact indicators are summed by flood type (*Subtype* in the database) and then compared between those categories at the regional and national level. The four considered flood types are: 1) *Coastal floods*, when sea water overflows in coastal regions, for example during a storm or high tide event; 2) *Flash floods*, characterised by a rapid overflow during or following an intense precipitation event; 3) *Riverine floods*, which result from a slower and longer overflow of a river following a rainfall event; and 4) *Flood (General)*, used when more precise information is not available (CRED, 2025b). Second, to evaluate the seasonality of floods, their onset (*Start Month*) was used to classify their occurrence in the traditionally defined meteorological seasons; winter (DJF), spring (MAM), summer (JJA), and autumn (SON). The number of flood events, fatalities, and people affected as well as the economic losses are also summed into these categories, both at an aggregated regional and national level.

2.4 Survey results and comparison between public perception and recorded impacts

To address RQ4, we use aggregated results at the country level for the three questions relating to the national exposure, the personal exposure, and personal experience of the respondent, taken from the *Special Eurobarometer SP547* report (European Commision, 2024). We focus only on results relating to perceived risks from natural hazards, including flooding. We rank the natural disaster type based on the frequency with which they were mentioned in each country for the public perception data, and we rank the type based on the quantity of recorded impacts for all four indicators. If two disaster categories have the same rank, the lowest rank is assigned to both. To assess how well public perception of natural disaster risk agrees with the actual recorded occurrences and impacts of events, we quantify the difference in ranking of each natural disaster category for the number of events and three impact indicators and for the three public perception indicators. The difference (rf) between the measured ($rEM\text{-}DAT$) and the perceived ranking ($rsurvey$) is calculated using the following equation:

$$r_f = r_{EM-DAT} - r_{survey} \, .$$

This difference in ranking indicates whether the public *over*estimates or *under*estimates the risk of a given natural hazard type. A positive difference indicates that the risk of the disaster category is perceived to be lower than its actual occurrence or impacts, as recorded in EM-DAT. On the contrary, a negative difference means that the risk of the disaster category is perceived to be higher than its actual occurrence. If the two data sources align, the calculated difference in rankings is equal to zero. Since this analysis focuses primarily on floods, only the differences in the rankings for that type of natural disaster are presented.

3 Results

3.1 Impacts of floods compared to other natural hazards

In this section, flood impacts are compared with those from the three other types of natural disaster categories using EM-DAT records between 2000 and 2023. Fig. 1 shows the number of natural disaster events and their impacts aggregated over the EU and MENA regions. First, we note that floods represent a high proportion of all events recorded in MENA with around 50%, compared to the EU where floods only account for roughly 35% of all natural disaster events. In the EU, extreme weather events are the most common natural disaster type with extreme temperatures and storms accounting for around 25% and 30% of recorded disaster events, respectively (for more details about these values, see Table C1). Floods affected the most people in the EU (67%), whereas they only affected around 27% of the population from the MENA region. In the MENA region, floods rank as the second most prominent natural disaster category, after extreme weather events, and more specifically droughts (35%). Regarding economic losses, floods caused nearly half of all financial damage resulting from natural disasters in the EU. Conversely, floods only constitute 20% of all recorded economic losses in the MENA region, ranking after geological disasters (earthquakes) and extreme weather events (especially storms). Despite causing many fatalities in both regions, floods in the EU rank only second after extreme weather events (specifically extreme temperatures), and in the MENA region third after geological disasters (earthquakes) and extreme weather events (storms) (Fig. 1). Note that the number of events and their impacts attributed to the different categories should be interpreted with caution. For example, the distinction between flood and extreme weather event categories is not always clear since floods typically result from extreme precipitation events which can also be classified as storms (see the limitations in Section 4.4 for more details).

At the national scale, detailed patterns can be identified (Fig. 2). First, floods represent the natural hazard causing most impacts in many Middle Eastern countries. For instance, in Yemen, floods are responsible for more than half of the recorded disaster events and for more than half of the consequences across all three impact indicators. Moreover, floods account for more than 80% of natural disaster events and their impacts in Saudi Arabia. They are also the cause of more than 80% of recorded events, affected people, and economic losses in Qatar. Finally, they account for more than 50% of events, deaths, and economic losses in Iraq.

A second flood hotspot emerges in central and eastern European countries. Extreme weather events cause more fatalities in these countries, but floods are responsible for the majority of economic losses and the number of affected people (Fig. 2). For example, in Czechia and Poland, extreme weather events caused more than 90% of all fatalities, whilst floods were responsible for more than 80% of recorded economic losses and of people affected by natural disasters. Likewise, in Austria and Germany, extreme weather events accounted for more than 90% of fatalities, whereas floods caused more than half of all economic losses and affected people. It must be noted that the overwhelming majority of deaths in EU countries stems from the *Extreme temperature* type in the extreme weather event category. Among these extreme temperatures, heatwaves were the deadliest in the EU (around 99% of all fatalities). For instance, heatwaves that struck western European countries caused more than 70,000 deaths in the summer of 2003 (Robine et al., 2008) and nearly 40,000 deaths in 2022 (Ballester et al., 2023).

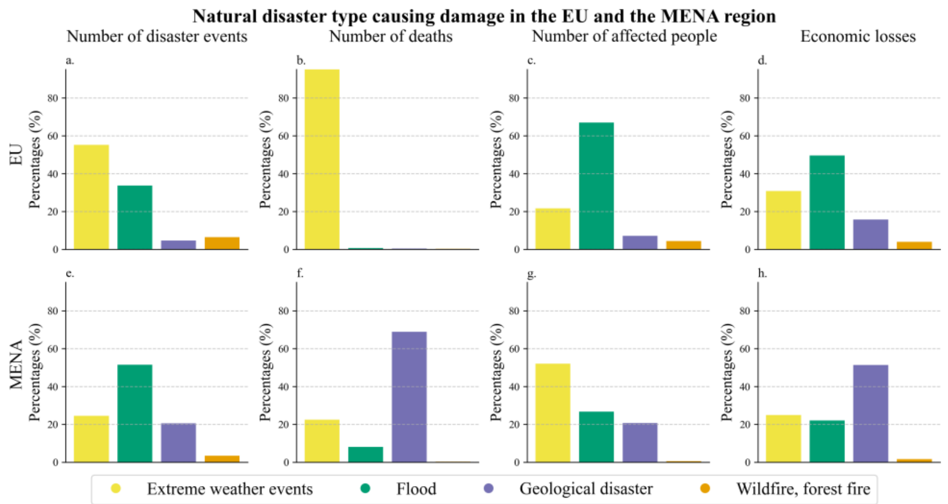

Figure 1. Socio-economic impacts of floods compared to those from three other natural hazard categories in the EU (top) and the MENA region (bottom): Number of natural disaster events (a, e), Number of deaths stemming from these events (b, f), Number of affected people (c, g), Economic losses (d, h). Data source: CRED (2025a).

3.2 Impacts of floods in the EU and MENA regions

To gain more insights into flood disasters and their impacts, we compare the number of events and the attributed deaths, affected people and economic losses between the EU and MENA region (see Table 2). According to the EM-DAT data, approximately, 1.5 times more floods occurred in the EU compared with the MENA region, with 299 and 195 recorded events, respectively. Conversely, human impacts – the number of fatalities and affected people – were nearly 4 times higher in the MENA region than in the EU, both in absolute numbers and normalised to population size. For instance, during the period 2000-2023, approximately 11 out of 10,000 inhabitants of the MENA region were affected by floods, contrasting to around 3 out of 10,000 people in the EU (Table 2). Economic losses are higher in the EU than in MENA, about 11 times in absolute terms and more than twice relative to GDP.

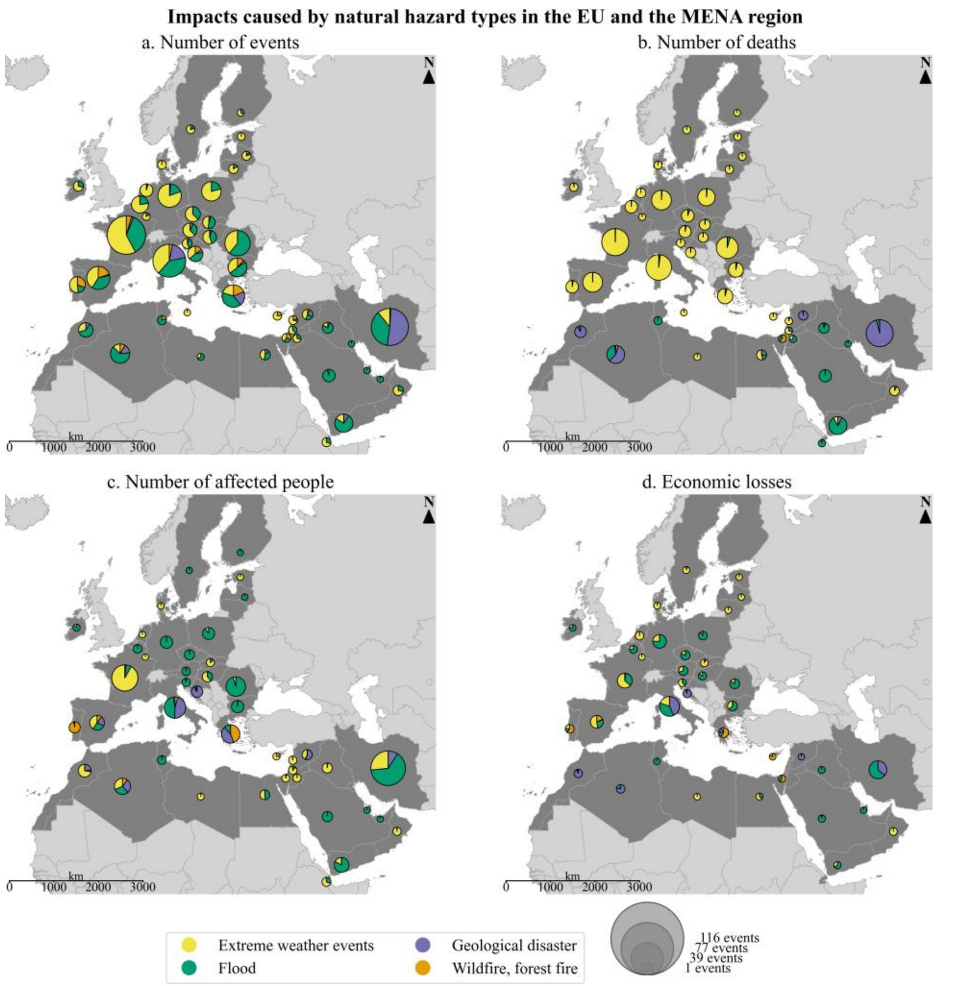

Figure 2. Socio-economic impacts of floods compared to those from the three other natural hazard categories at the national level: a. Number of events, b. Number of fatalities, c. Number of affected people, d. Financial damage. The pie chart size indicates the number of events recorded per country. Data source: CRED (2025a), Country borders: Natural Earth (2025).

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Table 2. Socio-economic impacts of floods in the EU and the MENA region for the period 2000-2023

Region	Events	Deaths	Deaths (% pop)	Affected people	Affected people (% pop)	Economic losses (billion US$)	Economic losses (% GDP)
EU	299	1,368	0.00001	4,370,363	0.03	125.7	0.029
MENA	195	4,830	0.00004	15,036,712	0.11	10.7	0.013

At the national scale (see Fig. B1 in the Appendix), the following six countries record the most flood events: France and Romania (42 events in each country), Iran (41), Italy (37), Yemen (32), followed by Algeria (30). On the contrary, no events were recorded in Bahrain, Cyprus, Estonia, Denmark, and Malta during the 24-year period under consideration.

The human impacts of floods in EU and MENA countries are shown in Fig. 3. Fatalities stemming from flood events show a similar pattern as when aggregated over the two regions. Most of the registered deaths occurred in MENA countries, specifically in Algeria, Iran, and Yemen (Fig. 3a), accounting for nearly three quarters of all flood fatalities in the entire MENA region, with 1,408, 1,126, and 1,080 deaths, respectively. Deaths expressed as a percentage of the population count show a similar geographical pattern with more flood fatalities in MENA than in the EU relative to inhabitants. Three MENA countries measuring the highest mortality numbers relative to the population size are Djibouti (0.0003%), Yemen, and Algeria (both 0.0001%) (Fig. 3b). While floods were the most recorded hazard type in Yemen and Algeria, they only represent 30% of all recorded events in Djibouti, which shows the disproportional mortality caused by this type of hazard in this country, representing around 3 fatalities out of 1M inhabitants. In addition to countries without registered floods, some countries did not record any flood fatalities: Finland, Latvia, Lebanon, Luxembourg, the Netherlands, Qatar, Sweden, and the United Arab Emirates.

The number of affected people at the national level shows some differences to the general pattern of the regional aggregate. Although Iran has the largest number of people affected by flood events (12.3M people), two countries from the EU recorded the second and third largest number of affected people: the Czech Republic and Slovenia, both with 1.5M affected persons (Fig. 3c). Slovenia has the most people affected by floods relative to population size (3.1%), followed by Djibouti (2.0%) the Czech Republic (0.5%), Iran (0.3%), and Yemen (0.1%) (Fig. 3d). Finally, some countries did not register any people affected by floods: Israel, Kuwait, Lithuania, Luxembourg, and the Netherlands.

The economic losses at the national level follow the same pattern as at the regional level, with higher economic damages in EU than in MENA countries (Fig. 4a). The highest recorded national economic losses are reported in Germany (more than 66.7 billion US$), Italy (around 22.4 billion US$), and France (more than 11 billion US$). Similarly to the regional patterns, financial damage resulting from floods proportional to GDP is highest in Germany (0.080%), followed by the Czech Republic (0. 072%) and Yemen (0. 069%). When looking more into details, nearly all the financial damage in Yemen results from one event (95% of the total, out of 3 events). In Czechia, and Germany, one event out of six represents a significant part of the total losses (63% and 61% respectively). Italy registers 23 events with financial damage, but with one especially damaging flood disaster (43% of all recorded damage). On the contrary, 14 events with economic losses were recorded in France, among which the financial damage is rather evenly distributed. Finally, several countries did not indicate any economic losses from reported

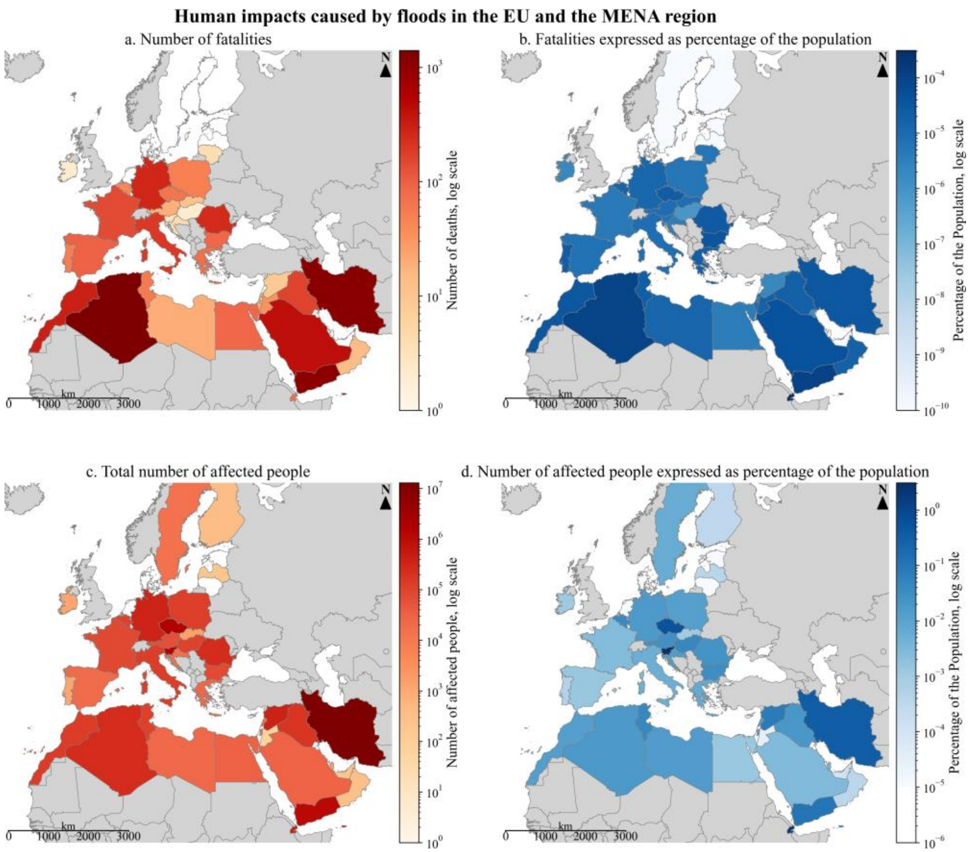

Figure 3. Flood human impacts in the regions of interest. a. Number of deaths, b. Deaths expressed as a proportion of the population, c. Number of affected people and d. Affected people expressed as a proportion of the population. The values are represented using logarithmic scales. Data sources: CRED (2025a) and World Bank Group (2025), Country borders: Natural Earth (2025).

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floods: Djibouti, Finland, Jordan, Kuwait, Latvia, Lebanon, Lithuania, Luxembourg, the Netherlands, Oman, the Palestinian State, Syria, and the United Arab Emirates.

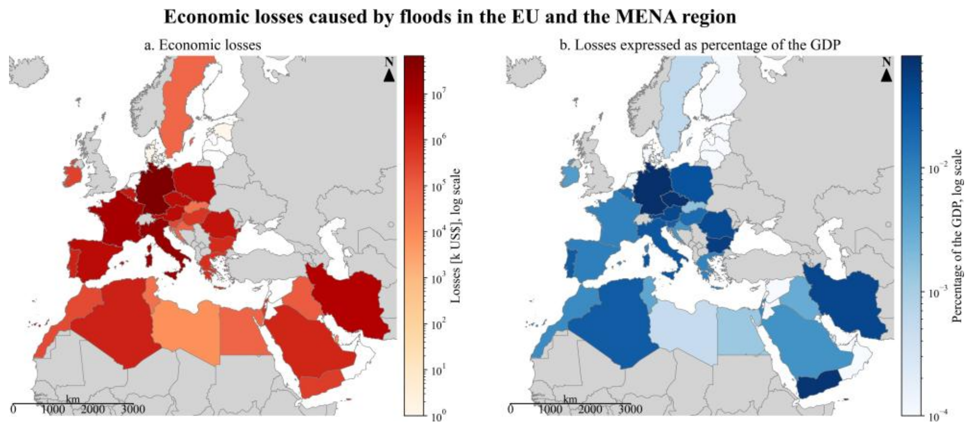

Figure 4. Financial impacts of flooding in the evaluated countries. a. Measured economic losses, b. Economic losses expressed as percentage of the national GDP. The values are represented using logarithmic scales. Data sources: CRED (2025a) and World Bank Group (2025), Country borders: Natural Earth (2025).

3.3 Impacts of flooding by flood characteristics

3.3.1 Flood type

Next, we analyse the spatial patterns of flood disaster types across the EU and the MENA region (Fig. B2), complementing previous work that either focused on Europe solely or on the global scale (Barredo, 2007; Hu et al., 2018; Paprotny et al., 2018, 2024). Regionally aggregated results show a prevalence of riverine floods. This type caused more deaths in both regions in the period 2000-2023 than any other flood type. Moreover, riverine floods are also responsible for most affected people in the EU. However, the highest number of affected people in the MENA and the highest economic losses in both regions are not classified as a particular flood type and are thus allocated to the general flood category. These results, along with the non-negligible number of unclassified flood events, suggest that the results on flood types should be interpreted with caution.

Results at the national level show that floods in central and eastern Europe were mostly classified as riverine for all impact indicators (Fig. 5). For example, this is the case for Austria, Bulgaria, and Hungary, where riverine floods account for more than 75% of the number of events, fatalities, affected people, and economic losses. Moreover, this flood type is also predominant in Romania and Czechia, where they represent more than two thirds of impacts across the three impact indicators. The prevalence of riverine flooding in central and eastern Europe can be linked to multi-day large-scale extreme precipitation events over river catchments (Mudelsee et al., 2003; Ruff and Pfahl, 2023).

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On the other hand, flash floods are prevalent in several MENA countries (Fig. 5). For instance, they accounted for more than 60% of all three flood impact indicators in Tunisia. Flash floods were also responsible for more than two thirds of impacts of the three indicators in Djibouti, Israel, and Qatar. In arid climates, such as in the MENA region, extreme precipitation manifests typically as short-duration precipitation at high intensity, and has therefore a particular relevance for flash floods (Armon et al., 2024). The dominance of flash floods in the MENA region can also be expected given the mountainous character of the region, leading to sudden streams of water funnelling through normally dry wadis. Moreover, the dry ground doesn't easily absorb water, contributing to rapid run-off (Yin et al., 2023).

3.3.2 Seasonality of the flood onset

Next, we assess the spatial distribution of flood seasonality across the EU and MENA regions (Fig. B3), extending existing work that focused on either Europe, or the Mediterranean region (Khodayar et al., 2025; Llasat et al., 2010; Paprotny et al., 2018). At the regional level, a clear distinction emerges between the EU and MENA region. Summer is the prevalent season for flooding in the EU, although many events were also recorded in autumn. Impacts in the MENA region are less concentrated on a specific season but are distributed across autumn, winter, and spring. While many events occurred in autumn and spring, most fatalities and economic losses were recorded during autumn, and the majority of affected people in spring.

Fig. 6 details these patterns at the national level. Summer is the predominant flood season in central and eastern European countries, such as Austria and Lithuania, where the majority of events is recorded and more than 80% of all flood impacts occurred during that season. In addition, in Germany and Czechia, the recorded impacts for all three indicators amount during summer to more than 50% of the annual totals. Similarly, in Romania, floods are prevalent in summer and most of the deaths and economic losses were recorded during this season. Finally, summer floods dominate in Slovakia, where the majority of human impacts occurred during these months. Summer flooding in central and eastern European river catchments typically occur under the influence of well-known weather systems such as slow-moving surface cyclones, tracking counter-clockwise around the south flank of the Alps into central and eastern Europe (so-called Vb cyclones) and cut-off lows (Grams et al., 2014; Hofstätter et al., 2018; Mudelsee et al., 2004; Ruff and Pfahl, 2023). Moreover, the countries in central eastern Europe where summer flood dominate coincide with those recording a prevalence of riverine floods (see Section 3.3.1). Such major riverine floods occurred for example in August 2002, August 2005, May-June 2013, or July 2021 (Blöschl et al., 2013; Grams et al., 2014; Mohr et al., 2023; Ulbrich et al., 2003).

In western Mediterranean countries, most floods occurred in autumn (Fig. 6). For instance, in Spain, Morocco, and Tunisia, floods are most common and more than half of all impacts across the three indicators are recorded during this season. In Italy, floods are more prevalent and cause more human impacts during autumn than in any other season (74% of all deaths and 52% of the affected people), while in Algeria autumn floods account for 83% of the fatalities, 60% of the affected people, and 98% of the economic losses. Also in France, floods dominate in autumn with around 36% of all events, 61% of deaths and 40% of all economic losses. The preference of flooding in the western Mediterranean for autumn has been linked to the relatively high sea surface temperatures during that season, sustaining large amounts of water vapour in the atmosphere (Rico-Bordera et al., 2026). Most of the extreme precipitation in this region and season forms under the influence of cyclones (Flaounas et al., 2022)

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or upper-level troughs and cut-off lows (Argence et al., 2006; Dayan et al., 2015; Funatsu et al., 2008) linked to Rossby wave breaking (De Vries et al., 2024).

Many flood events in the eastern Mediterranean and the Middle East countries occur in autumn, winter, and spring (Fig. 6). For example all flood disasters and their impacts in Lebanon, the State of Palestine, and the United Arab Emirates were recorded in winter, while floods in Jordan, Kuwait, and Qatar were confined to autumn. Moreover, autumn floods in Iraq are the most common (54% of all events) and they cause the majority of the human impacts there (74% of fatalities and 66% of the affected people), whereas spring floods caused the most economic damage (87%). The same two seasons are also predominant in Djibouti, where most of flood disasters were recorded during spring (67%), as well as the majority of fatalities (84%) but autumnal floods affected most people (54%). In Israel, flood disasters and their impacts are distributed between spring and winter: more events (67%) and all economic losses occurred during winter, but more fatalities happened in spring (57%). More spring floods were recorded in Oman (75%), and caused the most fatalities (78%), yet most people were affected in winter (67%). The predominance of flooding in autumn, winter, and spring in eastern Mediterranean and the Middle East, and their near absence in summer, can be linked to the seasonality of precipitation in this region (Tarolli et al., 2012). Due to the influence of the South Asian summer monsoon, the Middle East experiences very dry conditions from June to September (Tyrlis et al., 2013). Most of the annual precipitation falls during the extended cool season (from November to April) (Almazroui et al., 2012), when the southerly positioned jet stream can steer extratropical storms into the region (de Vries et al., 2018). However, floods in Yemen are predominant during summer (56% of events, and 55% of fatalities and 50% of the affected people) related to the monsoon circulation that can support heavy precipitation in this country and season (Alvar-Beltrán et al., 2026).

3.4 Public perception of flood risk and correspondence to recorded flood impacts

This section examines the EU public perception of flood hazards and the three other natural disaster types using the Eurobarometer survey data. This survey shows that the EU population generally considers extreme weather events a bigger threat than floods (European Commision, 2024). Aggregated across the EU (see top rows in Table A1, A2 and A3), respondents perceive the highest national exposure, personal exposure, and personal experience from extreme weather events (50%, 38%, and 12%, respectively). Floods, on the other hand, rank second across all three perception indicators with 44%, 26%, and 9% (European Commision, 2024). The total percentages for each perception indicator are lower than 100% because we only selected the results for natural hazards, among all the possibilities.

This tendency is also visible when looking at the highest ranking natural hazard at the national level (Fig. 7). Extreme weather events are the most prominent hazard across all three perception indicators in most EU countries. Consistent with the regional pattern, floods are the second most frequently selected response (European Commision, 2024). However, floods rank first in terms of national exposure in Ireland, Denmark, Latvia, Czechia, Slovenia, Croatia, and Bulgaria. Also, floods are the most indicated hazard in terms of personal exposure in Ireland and Bulgaria, and in terms of personal experience in Ireland, Denmark, Germany, Czechia, Slovenia, and Bulgaria (European Commision, 2024). It is worth mentioning that, among these countries, floods are responsible for most affected people in Slovenia and Czechia and for the highest recorded economic losses

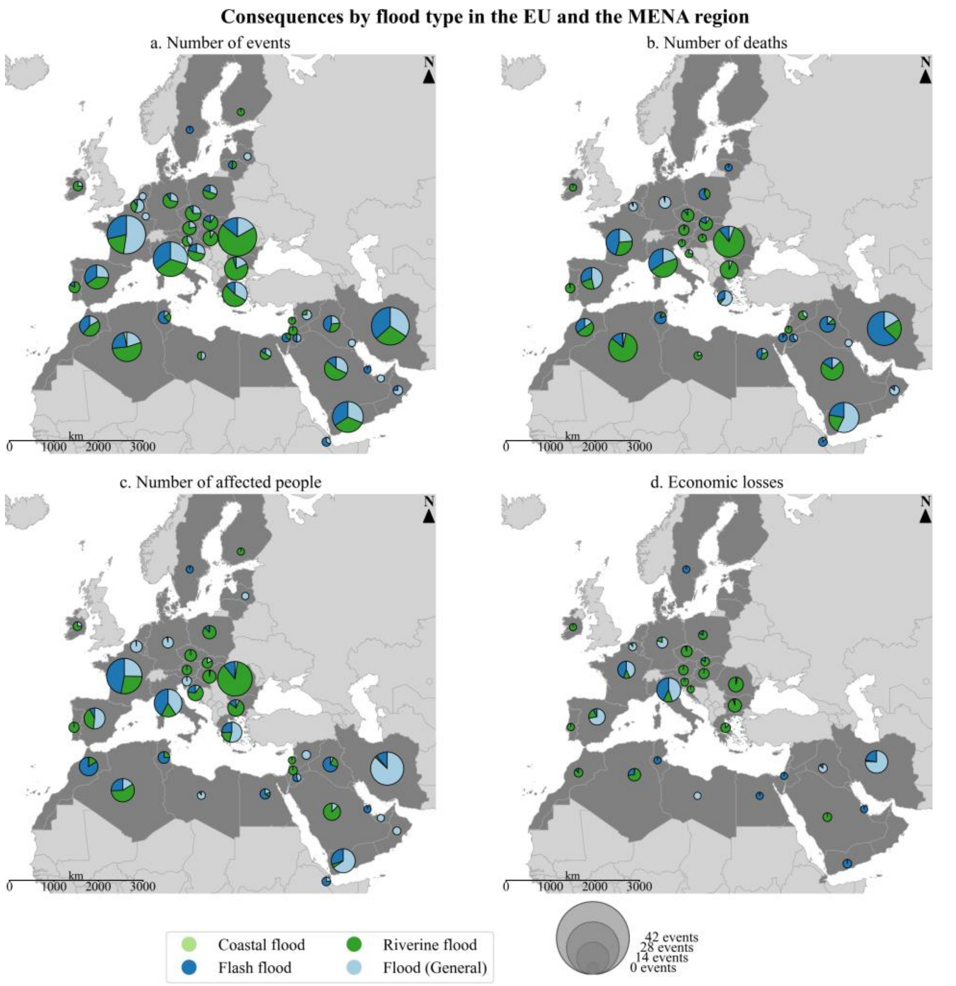

Figure 5. Flood impacts categorised by the type of inundation at the national scale: a. Number of events, b. Number of fatalities, c. Number of people affected, d. Financial damage. The pie chart size is proportional to the number of events recorded in every country. Data source: CRED (2025a), Country borders: Natural Earth (2025).

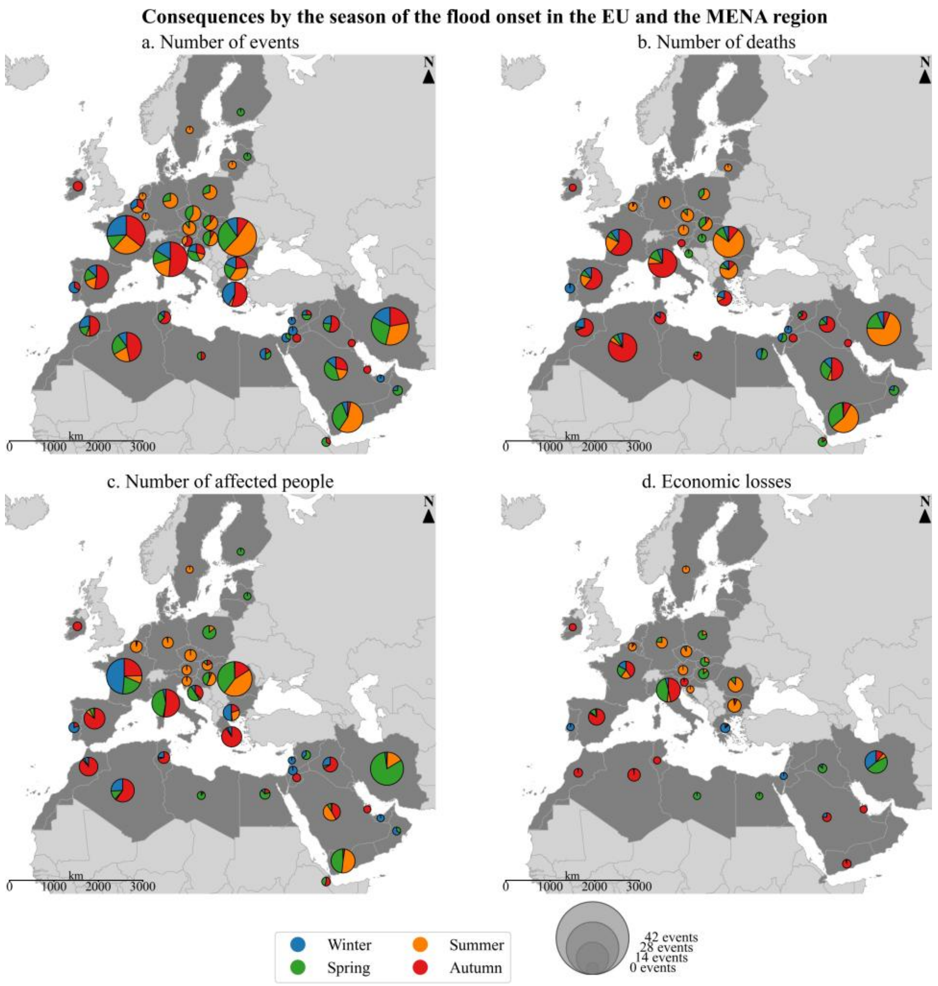

Figure 6. Flood impacts categorised by the season of the event's onset at the national scale: a. Number of events, b. Number of fatalities, c. Number of people affected, d. Financial damage. The pie chart size is proportional to the number of events recorded per country. Data source: CRED (2025a), Country borders: Natural Earth (2025).

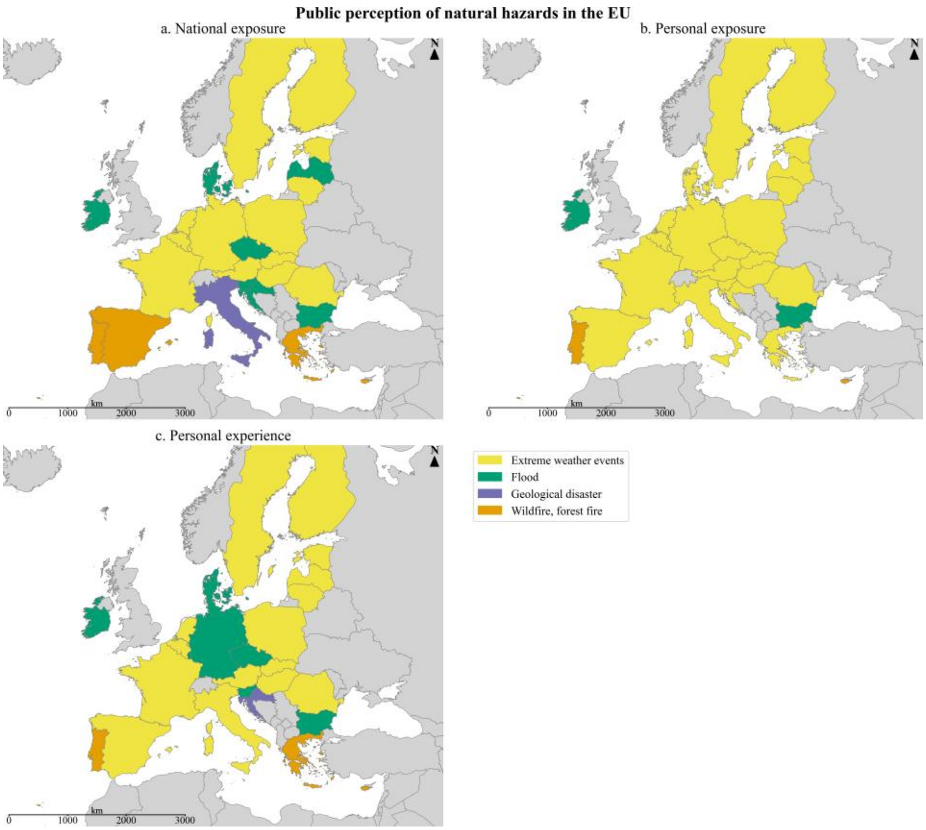

Figure 7. Most mentioned natural hazard type in the Eurobarometer survey, national aggregation following three perception measures: exposure at a national scale (a), at a personal scale (b), and personal experience (c). Data source: European Commision (2024), Country borders: Natural Earth (2025)

in Germany, the Czech Republic and Bulgaria, suggesting a relatively good agreement between perceived risk and observed impacts. All fractions for the four natural hazard categories at the national level are presented in Tables A1, A2 and A3.

Finally, the EU's population perception of hazard risk is compared to the recorded impacts of floods and the other three categories of natural hazard (*Extreme weather events*, *Geological disasters* and *Wildfire and forest fires*). Using the aggregated values for the EU in recorded prevalence of natural hazards and their impacts as well as the regional public perception, we note that flood risk is ranked adequately for all three perception indicators combined with two impact indicators: the number of events and the number of fatalities (see Table 3). On the contrary, flood risk is underestimated by the European population when considering economic losses or the number of affected people.

Table 3. Difference in the relative rankings between the recorded flood impacts and the public perception, aggregated over the 27 EU member states. Only the difference for floods are shown. Data sources: CRED (2025a) and European Commision (2024).

	Number of events	Number of deaths	Number of affected people	Economic losses
Difference in the ranking between the recorded impact and the perceived national exposure	0	0	-1	-1
Difference in the ranking between the recorded impact and the perceived personal exposure	0	0	-1	-1
Difference in the ranking between the recorded impact and the personal experience	0	0	-1	-1

Fig. 8 presents the difference in rankings between the recorded impacts and the public perception of floods among the four natural hazard categories per EU country. This comparison is done across the observed number of events and their impacts with all three perception indicators, resulting in 12 combinations. We observe and discuss four findings. First, consistent with the regional aggregate, flood risk is underestimated in many EU countries when considering the number of affected people and economic losses.

Second, the population in northern EU countries tends to overestimate flood risk. For instance, perceived flood risk ranks higher than recorded flood impacts in Latvia, Luxembourg, and the Netherlands for eight or more combinations of the three public perception measurement with the four recorded impact indicators. In addition, seven of the combinations show an underestimation of flood risk in Sweden. Flood risk is also overestimated by the public for all combinations of public perception and recorded impact in the four EU countries where no flood disaster events were registered (including Denmark and Estonia). However, we cannot exclude that some disaster events are not recorded in the EM-DAT database in these countries during the studied period, which means these values need to be interpreted with caution. For instance, a storm-induced coastal flood occurred in Estonia in January 2005, impacting the Pärnu area (Rosentau et al., 2017), but that event is not present in the EM-DAT database.

Third, populations in southern EU countries tend to underestimate flood risk compared with measured consequences. Italy and Romania show eight or more combinations of public perception with recorded consequences where the latter ranks higher. Moreover, the ranking difference is negative in Spain across all indicator combinations, implying that the population underestimates flood risk regardless of the type of perception measure or impact indicator.

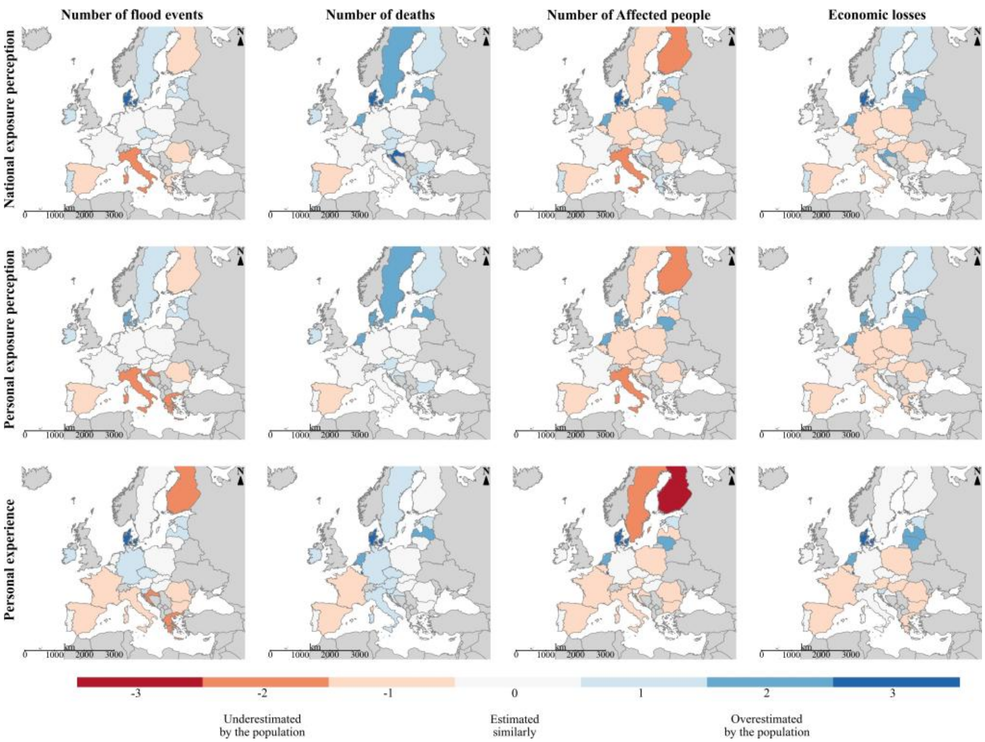

Figure 8. Differences in relative rankings of recorded flood impacts and public perception. Vertically: three perception indicators, horizontally: all recorded impacts. The figure shows only the flood results. Data sources: CRED (2025a) and European Commision (2024), Country borders: (Natural Earth, 2025).

Fourth, the public perception agrees mostly with the recorded impacts in France and Portugal. In these two countries, the ranking of the public perception equals the ranking of the recorded flood impacts for eight combinations. In addition, the ranking of perception and impact are equal in Slovakia for all 12 combinations of indicators.

4 Summary and discussion

4.1 Differences in flood impacts within and between the EU and the MENA region

This study pursued two main objectives. First, we compared flood impacts between and within the EU and the MENA region. Floods were shown to be more prevalent in the EU than in the MENA region. However, we found that the death toll from floods was nearly four times higher in the MENA region compared to the EU, both in absolute numbers and as a proportion of the population. This result is coherent with previous studies indicating a disproportionate death toll in (semi)arid regions worldwide (Yin et al., 2023) and in developing countries (Boutaghane et al., 2022; Hu et al., 2018; Kantoush et al., 2022; Llasat et al., 2010; Schneiderbauer and Ehrlich, 2004). Similarly, more people are affected by floods in the MENA region, which agrees with previous research suggesting that floods affect more people in developing regions compared to developed countries (Kantoush et al., 2022). However, our study also pointed to some exceptions to these general patterns given that the second and third largest number of people affected were recorded in two developed countries within the EU: Slovenia and the Czech Republic. In the Czech Republic, four successive events were recorded in 2002, 2006, 2010, and 2013 (Hamidifar and Nones, 2025) which may explain this large number of affected people. Similarly, Slovenia was hit by a major flood in summer 2023 that prompted a national emergency and affected a large number of people (International Federation of Red Cross and Red Crescent Societies, 2025).

In contrast to human impacts, we noted higher economic losses in the EU than in the MENA region, both in absolute numbers as well as relative to GDP. This finding corresponds to previous research indicating that economic losses caused by floods are higher in developed countries compared with developing countries (Kantoush et al., 2022; Wilby and Keenan, 2012). Wilby and Keenan (2012) found that middle-income countries incurred the highest economic losses expressed as a proportion of the GDP. However, our study also pointed to some exceptions to this general pattern given that the highest economic losses relative to GDP were recorded in Germany and Yemen, a high-income and low-income country, respectively (Al Saud, 2022b; Metreau et al., 2024). In the case of Germany, these high economic losses stem from several major events in the country in 2002, 2013, and 2021 (Alobid et al., 2024).

Our findings on flood disasters and their impacts in Europe align in some aspects with previous studies: France and Italy were previously also identified as countries severely impacted by floods (Barredo, 2007; Paprotny et al., 2018, 2024). Conversely, we found a limited number of floods in Spain (23 events) and Germany (11 events), whereas both countries were considered among the most affected in Europe (for Spain: Barredo (2007); Paprotny et al. (2018, 2024) and for Germany: Barredo (2007)). In terms of flood fatalities in EU countries, our results generally agree with those from Paprotny et al. (2024), which showed that Spain, Italy, France, Germany, and the Netherlands recorded the most flood-related fatalities. In our study, Romania also ranks among the five countries with the most flood fatalities. In contrast, we found no fatalities in the Netherlands, most likely related to the relatively short and recent study period in our work, and thus missing the major coastal flood in 1953 that led to 1836 deaths (Gerritsen, 2005). In the Mediterranean area, more deaths were recorded in Algeria, Italy, and Morocco than in the other countries, which partially agrees with Llasat et al. (2010), who found the same countries recording the highest numbers of deaths, but with a different order: Algeria, Morocco, and then Italy. Economic losses from floods were higher than those from any other natural hazard in the EU, which is consistent with previous findings for Europe (Raška, 2015; Paprotny et al., 2024; Wilby and Keenan, 2012) and for Germany specifically (Hilker et al., 2009).

4.2 Flood characteristics

We also analysed flood characteristics – i.e. their type and seasonality – across Europe and the MENA region, extending previous studies that focused mainly on Europe or the Mediterranean. Our findings agree with previous indications that flash floods cause most economic damage in the MENA region (Kantoush et al., 2022), and that riverine floods are dominant in central Europe (Paprotny et al., 2018, 2024). By contrast, our findings show some discrepancy with previous research that found a majority of flash floods in Europe (Paprotny et al., 2024) and in the MENA region (Boutaghane et al., 2022). Our findings suggest that some countries in both regions recorded more flash floods (e.g. Sweden, Djibouti, Syria, or the State of Palestine), while regionally, riverine floods predominate in the EU and show a slight majority in MENA countries (see Fig. B2). Similarly, most deaths in the EU were caused by riverine floods, whereas previous results indicate that flash floods were the deadliest in Europe (Paprotny et al., 2024). However, our results need to be interpreted with caution given that many flood events were not classified in the EM-DAT database. Unclassified floods, i.e. those that did not have any subtype attributed to them in the database, are listed as a cause for nearly 80% of the affected people in the MENA region (see Fig. B2), showing the limitations of the used dataset.

The seasonality of floods and their impacts shows substantial variations across both study regions. Floods in central and eastern Europe prevail during summer, in the western Mediterranean during autumn, and in much of the eastern Mediterranean and Middle East in autumn, winter, and spring. These results agree with previously reported geographical patterns across the Mediterranean consisting of a greater prevalence in autumn in the western part of this area, and in autumn and winter in the eastern Mediterranean and Middle East (Llasat et al., 2010; Tarolli et al., 2012), as well as the same patterns in flood-induced mortality (Flaounas et al., 2022). The predominance of autumn floods in western Mediterranean countries (Paprotny et al., 2018, 2024; Tarolli et al., 2012; Khodayar et al., 2025) and highest flood mortality during autumn in southern Europe (Khodayar et al., 2025) is also consistent with findings from previous work. The predominance of floods and their impacts during summer in central Europe is also in agreement with existing studies (Paprotny et al., 2018).

4.3 Flood risk perception

Another research objective was to compare public risk perception of natural hazards, using survey data, with recorded disaster impacts to evaluate whether the EU population tends to overestimate or underestimate flood risk. Generally, the EU population recognises floods as a threat, but flood risk is ranked below that of extreme weather events, independent of which indicator is considered - national exposure, personal exposure, or personal experience of a disaster. Overall, the EU population tends to underestimate flood risk given the number of people affected and economic losses incurred by flooding, as recorded in the EM-DAT data. However, this general finding masks some geographical variation in public perception within the EU. The population in northern EU countries, mostly Scandinavia, rather overestimates flood risk, whereas those from southern EU countries, including the Mediterranean, tend to underestimate flood risk.

To be able to compare the recorded impacts from the EM-DAT database and the public perception from the Eurobarometer, we grouped the natural hazards into the same four categories as in the survey (see Table 1). That categorization of natural disaster types can explain some apparent discrepancies with previous studies. For instance, floods were deemed the most prevalent disaster in Europe (Hajat et al., 2005; Paprotny et al., 2024), whereas floods rank second after extreme weather events in our study. However, when we look at the impacts without grouping the natural disaster types in the four categories, we note that flood disasters are the most prevalent disaster subtype in this region (see Table C1). Finally, floods represent an especially impactful natural hazard in both regions compared with other types of hazards, particularly in terms of the number of people affected and economic damages incurred in the EU, and various impact indicators in several Middle Eastern countries.

Furthermore, extreme weather events are the deadliest natural disaster in the EU, but nearly all fatalities result from extreme temperatures (heatwaves and cold waves) only (Table C1), as found by Paprotny et al. (2024). On the contrary, extreme temperatures only accounted for a small part of deaths in the MENA region (0.5% of the recorded fatalities). This result could arise from the relative difficulty in assessing heatwaves as the cause of death, in that region in particular (Delforge et al., 2025; Messori et al., 2025). However, it was also shown that, currently, the MENA region suffers a comparatively smaller effect of heat on the death-rate than for instance western Europe, due to a younger population as well as existing behavioural adaptations in the MENA (Hajat et al., 2023). Nonetheless, even if our categorisation of natural disasters exhibits some inherent restrictions, it enabled us to compare public perception and disaster impacts. Previous studies on that topic used other tools to assess public perception than surveys (e.g. *Google Trends* in Hamidifar and Nones (2025)). Or, when public perception is determined by survey results, disaster impacts were not considered, but the prevalence of disasters alone (Matczak et al., 2015). Thus, we hope that our study approach will inspire future research at the intersection of natural disaster impacts and public perception.

4.4 Limitations of the study

The results from this study are subject to some limitations posed by the data quality and availability. First and foremost, we only used one database, EM-DAT, to assess the recorded impacts. Other datasets such as NatCatSERVICE from MunichRe or Sigma from SwissRe are not publicly available (Delforge et al., 2025; Wirtz et al., 2014), HANZE focuses on European countries only (Paprotny et al., 2024), and FFEM-DB (Papagiannaki et al., 2022) does not include all countries from our research region. Although EM-DAT is widely used in flood research (e.g. Barredo, 2007, 2009; Donatti et al., 2024; Hu et al., 2018; Tin et al., 2024; Yin et al., 2023), this database has several known shortcomings (CRED, 2025c; Delforge et al., 2025).

First, the inclusion criteria (with minimum values of deaths or affected people, or a national emergency state, see Section 2.1 for more details) may cause comparably low-impact events to be under-reported. In addition, some impact indicators can be under-reported in the database compared with the other indicators (CRED, 2025c; Delforge et al., 2025). This is particularly true for economic losses, which are often underestimated compared to human-related impacts. For instance, more than 75% of events in the MENA region do not contain any information about economic losses (see Table C2).

Second, recorded flood types are subject to limitations given that many events were not categorised into any of the flood types available for categorisation in the database (see Section 3.3.1). Additionally, the classification of flood types can be somewhat arbitrary, which can be demonstrated by the fact that most of the floods recorded in Saudi Arabia were reported as riverine, whereas this country is especially prone to flash floods in wadis (valleys or dry river beds) while permanent rivers are virtually absent (El-Haddad et al., 2025). Furthermore, the categorization of natural disasters as floods or storms is somewhat arbitrary given the frequent concurrence of these extreme precipitation related hazards. For instance, the flood in Libya that occurred in September 2023 (for more details about this event, see e.g. El-Haddad et al. (2025)) is categorised as a storm in EM-DAT given its origin from storm Daniel.

Third, since the database uses information from different sources, some inconsistencies can arise between countries, for instance, in the way of reporting the impacts (CRED, 2025c), which may hamper international comparisons (Paprotny et al., 2024). Importantly, there can be a bias in over-representing disasters in developed countries compared to developing countries (Messori et al., 2025), which in our study may manifest bias between the EU and MENA regions. Similarly, there are differences between countries in the way the various hazard types are counted. For instance, heatwaves are under-recorded in African countries (CRED, 2025c; Delforge et al., 2025), which can be explained by this type of hazard being measured by excess mortality, which is more challenging to measure (Delforge et al., 2025; Messori et al., 2025) than deaths arising from sudden events such as floods.

Fourth, using the Eurobarometer data also comes with limitations, such as the fact that it covers the EU only. No similar survey on public perception of natural disasters in MENA countries was available at the time of writing this study. For instance, the Arab Barometer, which covers all countries in the MENA region, does not contain questions related specifically to the perception of disaster risks (Arab Barometer, 2024). Furthermore, the wording of the Eurobarometer questions and answer options makes the somewhat arbitrary distinction between "Extreme weather events" and "Floods". As many flood events result from extreme weather events (for instance storms causing extreme rainfall), and because the "floods" response option of the Eurobarometer contains the words "heavy rain event" in brackets (European Commision, 2024) (see in Appendix A for more details), this may have influenced respondents' answers. Moreover, the results we used were already computed as percentages of the population in the report. However, these percentages were computed using all given answers, but, since some respondents had given more than one answer (as is permitted in the wording of the question), the total percentages can be higher than 100% (European Commision, 2024). This meant we had to assess the differences between the public perceptions and the recorded impacts using differences in relative ranking. Some potential additional insights could have been gained by disaggregating these statistics, and conducting more in-depth analyses of the microdata, which was beyond the scope of the present study. However, we think our work is still a necessary first step for finding new ways to combine disaster impact data from a public perception and recorded impact perspective.

5 Conclusions

To conclude, this study aimed to advance flood research by comparing flood impacts between two regions with very different climatic and socio-economic characteristics and by combining recorded disaster impacts with public perception of natural hazards. This new framework could be adopted in future research covering different parts of the world and different types of natural hazards. However, some data limitations need to be urgently addressed given that existing impact and perception datasets have several shortcomings and that at the same time there is an overall lack of such datasets. Survey data is especially sparse in the MENA region, where human impacts from floods are disproportionately large. This limitation calls for increased efforts to improve the comparability of records of natural disasters and their consequences worldwide, as well as to generate new datasets to improve the understanding of public perceptions of flood (and other natural disaster) risks and the preparedness of the population in different countries. Combining approaches from natural and social science disciplines in such a way can help support risk management strategies and thereby reduce flood and other natural disaster consequences worldwide, as they still cause major impacts today and could continue to have disastrous impacts in the future.

Data availability. For the recorded impacts, we used data from the EM-DAT database, which is publicly available upon registration at https://www.emdat.be/ (CRED, 2025a). We also employed the results published by the Eurobarometer, contained in their report that is downloadable from https://doi.org/10.2795/1333368 (European Commision, 2024)

Appendix A: Eurobarometer results

All the Eurobarometer date presented here comes from their report, available at https://doi.org/10.2795/1333368 (European Commision, 2024).

The three questions and their response options are as follows:

1. Which of the following risks do you think that (OUR COUNTRY) is the most exposed to? Firstly? And then? (%) (European Commision, 2024, QC1ab pp. 12-16)

    - Animal or plant disease outbreak
    - Critical infrastructure disruption (e.g. electricity black-outs, disruption to gas or drinking water, etc.)
    - Cybersecurity threats (e.g. cyberattacks, cybercrimes, etc.)
    - Extreme weather events (violent storms, droughts, heatwaves, cold waves, etc.)
    - Floods (e.g. river or coastal flood, heavy rain event, etc.)
    - Geological disasters (e.g. landslides, earthquakes, volcanic eruptions, etc.)
    - Human health emergency (e.g. a highly contagious disease outbreak)
    - Major accidents (e.g. industrial or chemical accidents, oil spills, major transport accidents)
    - Mass population displacement in emergencies (e.g. sudden influx of refugees due to conflicts in neighbouring countries)
    - Nuclear accidents
    - Political or geo-political tensions (e.g. civil unrest, social divisions, etc.)

- Terrorist attacks
- Wildfire, forest fires
- Other
- Don’t know

2. Which of the following risks, if any, do you feel personally most exposed to? Firstly? And then? (%) (European Commision, 2024, QC2ab pp.19-22)

   - Animal or plant disease outbreak
   - Critical infrastructure disruption (e.g. electricity black-outs, disruption to gas or drinking water, etc.)
   - Cybersecurity threats (e.g. cyberattacks, cybercrimes, etc.)
   - Extreme weather events (violent storms, droughts, heatwaves, cold waves, etc.)
   - Floods (e.g. river or coastal flood, heavy rain event, etc.)
   - Geological disasters (e.g. landslides, earthquakes, volcanic eruptions, etc.)
   - Human health emergency (e.g. a highly contagious disease outbreak)
   - Major accidents (e.g. industrial or chemical accidents, oil spills, major transport accidents)
   - Mass population displacement in emergencies (e.g. sudden influx of refugees due to conflicts in neighbouring countries)
   - Nuclear accidents
   - Political or geo-political tensions (e.g. civil unrest, social divisions, etc.)
   - Terrorist attacks
   - Wildfire, forest fires
   - Other
   - Don’t know

3. With the exception of COVID-19, have you personally experienced - directly or indirectly - a disaster in the past 10 years? This includes disasters experienced in your region and elsewhere in the European Union, for example when travelling (MULTIPLE ANSWERS POSSIBLE) (%) (European Commision, 2024, QC3 pp.26-31)

   - No, you haven’t experienced any disasters in the past ten years
   - Yes, animal or plant disease outbreak
   - Yes, critical infrastructure disruption (e.g. electricity black-outs, disruption to gas or drinking water, etc.)
   - Yes, cybersecurity threats (e.g. cyberattacks, cybercrimes, etc.)

- Yes, extreme weather events (violent storms, droughts, heatwaves, cold waves, etc.)
- Yes, floods (e.g. river or coastal flood, heavy rain event, etc.)
- Yes, geological disasters (e.g. landslides, earthquakes, volcanic eruptions, etc.)
- Yes, human health emergency (e.g. a highly contagious disease outbreak)
- Yes, major accidents (e.g. industrial or chemical accidents, oil spills, major transport accidents)
- Yes, mass population displacement in emergencies (e.g. sudden influx of refugees due to conflicts in neighbouring countries)
- Yes, nuclear accidents
- Yes, political or geo-political tensions (e.g. civil unrest, social divisions, etc.)
- Yes, terrorist attacks
- Yes, wildfire, forest fires
- Yes, other
- Don’t know

Table A1. Eurobarometer results - national exposure, expressed as a percentage and keeping only natural hazards. The national totals may be higher than 100% since the respondents could chose more than one answer. Numbers taken from: European Commision (2024, p.15)

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Country	Extreme Weather Events (violent storms, droughts, heatwaves, cold waves, etc.)	Floods (e.g. river or coastal flood, heavy rain event, ...)	Wildfire, Forest Fires	Geological Events (e.g. landslides, earthquakes, volcanic eruptions, etc.)
EU27	**50**	**44**	**31**	**21**
Austria	51	49	29	28
Belgium	42	39	8	4
Bulgaria	40	51	45	29
Croatia	50	58	44	46
Cyprus	59	26	72	19
Czechia	43	53	34	6
Denmark	54	66	4	4
Estonia	43	20	20	2
Finland	27	6	9	1
France	53	43	38	16
Germany	51	49	22	8
Greece	79	85	88	72
Hungary	60	32	12	13
Ireland	41	54	9	4
Italy	52	48	29	56
Latvia	31	31	13	2
Lithuania	40	21	14	2
Luxembourg	40	39	5	5
Malta	61	24	1	23
Netherlands	57	56	8	2
Poland	38	33	16	13
Portugal	50	51	72	23
Romania	45	36	24	34
Slovakia	49	44	25	31
Slovenia	62	66	40	37
Spain	51	33	55	21
Sweden	37	35	33	21

Table A2. Eurobarometer results - personal exposure, expressed in percentage and keeping only natural hazards. The national totals may be higher than 100% since the respondents could chose more than one answer. Numbers taken from: European Commision (2024, p.22)

Country	Extreme Weather Events (violent storms, droughts, heatwaves, cold waves, etc.)	Floods (e.g. river or coastal flood, heavy rain event, ...)	Wildfire, Forest Fires	Geological Events (e.g. landslides, earthquakes, volcanic eruptions, etc.)
EU27	**38**	**26**	**16**	**13**
Austria	39	26	10	18
Belgium	35	23	6	6
Bulgaria	28	34	24	22
Croatia	43	33	23	39
Cyprus	41	16	47	14
Czechia	31	21	12	2
Denmark	41	33	1	3
Estonia	32	9	9	1
Finland	23	3	5	1
France	40	18	17	10
Germany	37	28	10	4
Greece	61	52	45	56
Hungary	48	22	9	10
Ireland	30	36	5	4
Italy	44	31	14	32
Latvia	28	17	8	3
Lithuania	29	10	5	1
Luxembourg	35	22	5	4
Malta	56	17	1	13
Netherlands	45	33	3	1
Poland	30	24	9	9
Portugal	40	34	49	13
Romania	40	24	17	23
Slovakia	42	24	10	19
Slovenia	48	32	21	22
Spain	35	22	29	12
Sweden	29	26	16	13

Table A3. Eurobarometer results - personal experience, expressed in percentage and keeping only natural hazards. The national totals may be higher than 100% since the respondents could chose more than one answer. Numbers taken from: European Commision (2024, p.30)

Country	Yes, Extreme Weather Events (violent storms, droughts, heatwaves, cold waves, etc.)	Yes, Floods (e.g. river or coastal flood, heavy rain event, ...)	Yes, Wildfire, Forest Fires	Yes, Geological Events (e.g. landslides, earthquakes, volcanic eruptions, etc.)
EU27	**12**	**9**	**6**	**3**
Austria	16	15	6	6
Belgium	11	10	3	2
Bulgaria	10	10	7	5
Croatia	21	18	10	26
Cyprus	6	6	12	3
Czechia	9	11	5	1
Denmark	7	8	2	2
Estonia	13	3	3	1
Finland	4	1	2	1
France	17	8	10	3
Germany	13	17	5	2
Greece	12	12	15	7
Hungary	28	11	7	4
Ireland	5	6	1	2
Italy	10	7	4	6
Latvia	7	6	2	0
Lithuania	5	2	1	0
Luxembourg	11	13	5	2
Malta	28	2	0	3
Netherlands	9	6	3	2
Poland	10	7	4	4
Portugal	6	5	10	1
Romania	17	6	4	4
Slovakia	16	10	5	9
Slovenia	14	17	4	5
Spain	9	6	6	2
Sweden	10	9	9	4

Appendix B: Additional Figures

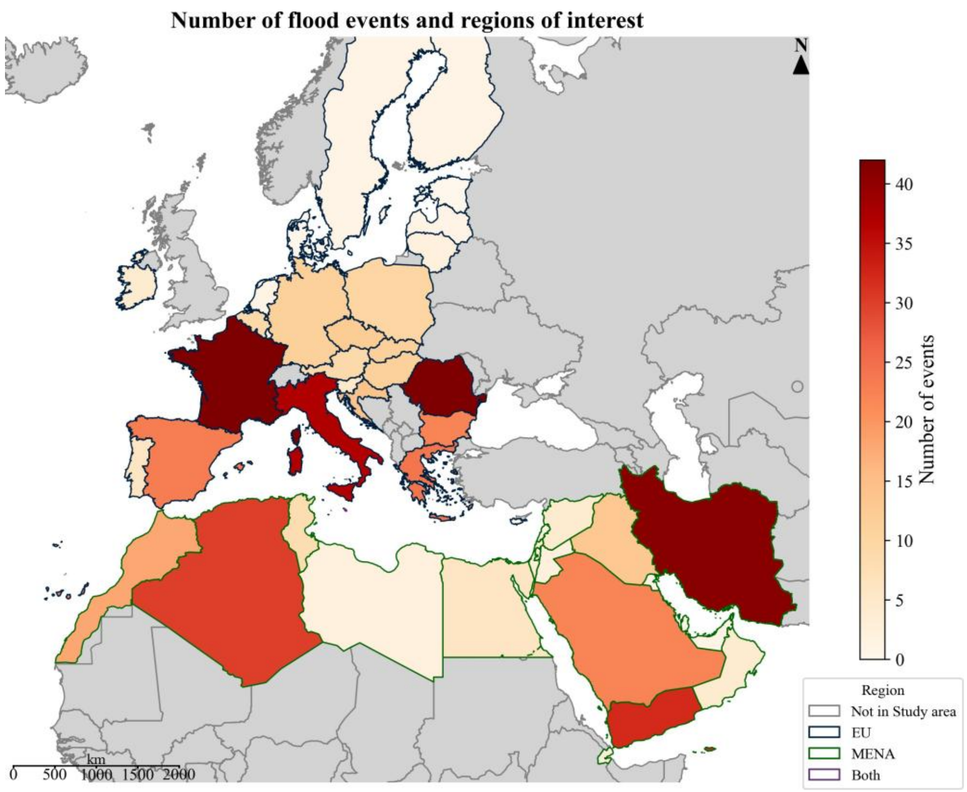

Figure B1. Number of flood events recorded per country, and regions of interest. Data source: CRED (2025a), Country borders: Natural Earth (2025).

Commented [MF13]: As I suggest before, the author move the three figures (B1, B2, and B3) from the appendix to the main body of the paper, following the paragraphs in which they are mentioned

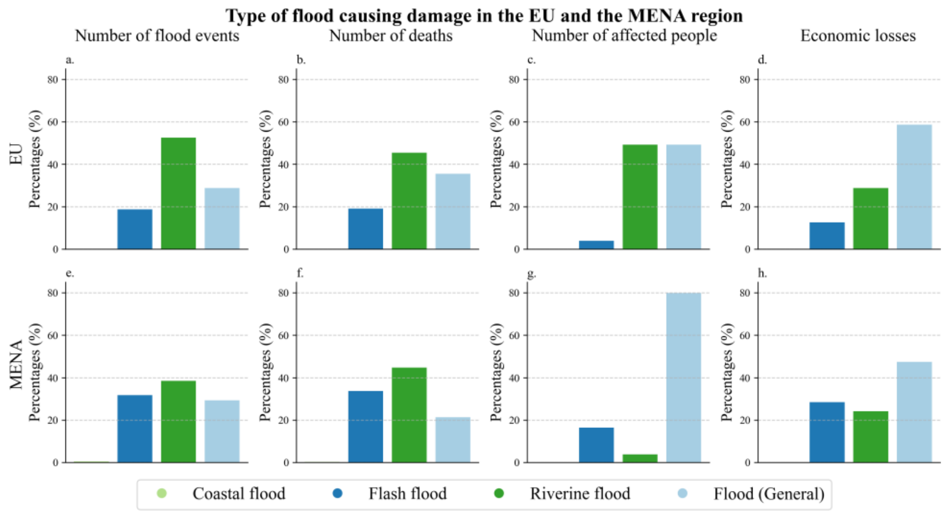

Figure B2. Socio-economic impacts of floods by flood type in the EU (top) and the MENA region (bottom): Number of flood events (a, e), Number of deaths stemming from these events (b, f), Number of affected people (c, g), Economic losses (d, h). Data source: CRED (2025a).

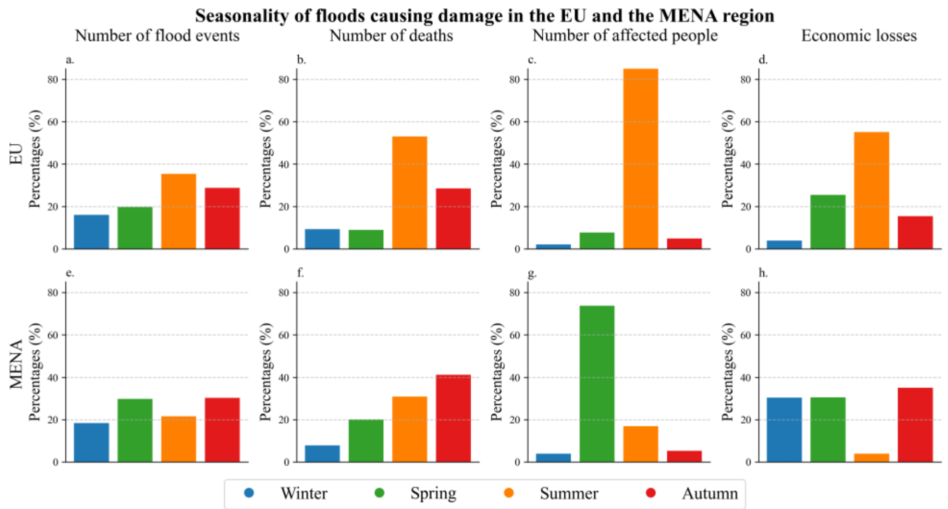

Figure B3. Socio-economic impacts of floods by flood seasonality in the EU (top) and the MENA region (bottom): Number of flood events (a, e), Number of deaths stemming from these events (b, f), Number of affected people (c, g), Economic losses (d, h). Data source: CRED (2025a).

Appendix C: Additional results

C1 Impacts of all natural hazard impacts, without categorisation

Table C1. Impacts caused by the natural hazard types, regionally aggregated. Data source: CRED (2025a)

EU

Type of natural hazard	Number of events	Number of deaths	Number of affected people	Economic losses
Drought	1.9%	0.0%	0.4%	3.3%
Earthquake	3.8%	0.4%	7.1%	15.7%
Extreme temperature	23.8%	98.3%	0.9%	7.2%
Flood	33.6%	0.7%	67.0%	49.6%
Glacial lake outburst flood	0.1%	0.0%	0.0%	0.0%
Mass movement (wet)	0.7%	0.0%	0.0%	0.0%
Storm	29.4%	0.4%	20.3%	20.3%
Volcanic activity	0.2%	0.0%	0.0%	0.0%
Wildfire	6.4%	0.2%	4.4%	3.9%

MENA

Type of Natural Hazard	Number of events	Number of deaths	Number of affected people	Economic losses
Drought	2.9%	0%	35.3%	0%
Earthquake	18.2%	68.4%	20.7%	51.4%
Extreme temperature	5.0%	0.5%	6.7%	0.0%
Flood	51.5%	8.2%	26.7%	22.1%
Mass movement (dry)	0.3%	0.2%	0.0%	0.0%
Mass movement (wet)	1.8%	0.4%	0.0%	0.0%
Storm	16.6%	22.0%	10.1%	24.9%
Volcanic activity	0.3%	0.0%	0.0%	0.0%
Wildfire	3.4%	0.4%	0.5%	1.6%

C2 Proportion of events with missing data

Table C2. Missing indicators from the flood disasters

Region	Events	Events without deaths	Proportion of events without deaths	Events without affected people	Proportion of events without affected people	Events without economic losses	Proportion of events without economic losses
EU	**299**	**117**	**39%**	**72**	**24%**	**190**	**64%**
MENA	**195**	**19**	**10%**	**44**	**23%**	**149**	**76%**
Algeria	30	1	3%	8	28%	22	73%
Austria	9	4	44%	5	56%	5	56%
Belgium	9	6	67%	2	22%	7	78%
Bulgaria	22	7	32%	9	41%	13	59%
Croatia	14	12	86%	2	14%	13	93%
Czechia	12	4	33%	5	42%	6	50%
Djibouti	3	0	0%	0	0%	3	100%
Egypt	6	0	0%	1	17%	5	83%
Finland	1	1	100%	0	0%	1	100%
France	42	16	38%	4	9%	28	67%
Germany	11	4	36%	5	45%	5	45%
Greece	24	13	54%	6	25%	20	83%
Hungary	11	9	81%	2	18%	6	54%
Iran	41	5	12%	6	15%	20	49%
Iraq	13	1	8%	2	15%	10	77%
Ireland	4	3	75%	1	25%	3	75%
Israel	3	0	0%	3	100%	2	67%
Italy	37	8	22%	9	24%	14	38%
Jordan	2	0	0%	0	0%	2	100%
Kuwait	1	1	100%	0	0%	0	0%
Latvia	1	1	100%	0	0%	1	100%
Lebanon	1	1	100%	0	0%	1	100%
Lithuania	2	1	50%	2	100%	2	100%
Libya	2	0	0%	0	0%	1	50%
Luxembourg	1	1	100%	1	100%	1	100%
Morocco	18	3	17%	2	11%	15	83%
Netherlands	1	1	100%	1	100%	1	100%
Oman	4	0	0%	2	50%	4	100%
Poland	10	4	40%	1	10%	7	70%
Portugal	6	2	33%	1	17%	5	83%

Continuing on the next page

Region	Events	Events without deaths	Proportion of events without deaths	Events without affected people	Proportion of events without affected people	Events without economic losses	Proportion of events without economic losses
Qatar	1	1	100%	0	0%	0	0%
Romania	42	10	24%	5	12%	31	74%
Saudi Arabia	22	1	5%	8	36%	19	86%
Slovakia	11	2	18%	6	55%	8	73%
Slovenia	5	4	80%	1	20%	3	60%
Spain	23	3	13%	4	17%	10	43%
State of Palestine	3	2	67%	0	0%	3	100%
Sweden	1	1	100%	0	0%	0	0%
Syria	4	1	25%	1	25%	4	100%
Tunisia	8	1	13%	1	13%	7	87%
United Arab Emirates	1	1	100%	0	0%	1	100%
Yemen	32	1	3%	9	28%	29	91%

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