D3.1 CRITERIA FOR SELECTION OF SAMPLE FOR SURVEYING THE DISADVANTAGED PEOPLE'S HAZARD VULNERABILITY

Project acronym: BuildERS

Project title: Building European Communities' Resilience and Social Capital

Call: H2020-SU-SEC-2018-2019-2020/H2020-SU-SEC-2018

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Executive Summary

Deliverable 3.1 links findings from a multitude of disciplinary scientific studies with technology-aided maps of hazard impacts and populations endangered retrieved from Copernicus emergency services and ArcGIS environments which visualized hazard discharge, physical damages and emergency propagation over time for more explicit identification of highly fragile human cohorts whose hazard encounters will be assessed by T3.2 and T3.3 survey studies.

D3.1 has critically reviewed an array of scientific literature to create a knowledge base for understanding of how natural hazards did alleviate the risks of morbidity and mortality for the entire European population. Based on observatory, scientific and satellite images evidencing natural and other hazards that affected Europe over the last decade D3.1 have created a cross-disciplinary framework which revealed that the most fragile human sub-populations in Europe are composed of heterogeneous cohorts suffering from a multitude of social deprivation and several morbidities (psycho-pathologies, cardiovascular, respiratory and addiction diseases). In addition to obvious perils of severe hydrological and/or geophysical hazards, these cohorts are also highly fragile to atmospheric conditions, which by themselves do not cause large-scale material destructions and until quite recently were not considered as life-threatening stressors. Reason lies in interaction between meteorological-risks and pre-existing health conditions which affect vulnerable persons' thermoregulatory functions and collectively precipitate early deaths. Juxtaposition of data on severe fires and floods against geospatial concentration of people living below national poverty lines has disclosed that the most affected regions in Portugal, Spain, Italy, Southern France and Greece were also the ones with the highest shares of poor sub-populations.

The knowledge produced might help in categorizing the different fragile people cohorts whose representatives will be invited to participate in BuildERS international surveys, where the immediate and long-term consequences of hazard impacts on these people's life conditions will be explored to provide witness testimony collected by the Salvation Army personnel.

Based on cross-disciplinary framework and technology-aided evidence, the following social groups have been designated as socially, economically and medically highly fragile towards hazard impacts and their representatives should be polled by BuildERS international surveys

1) Elderly individuals 65 + who live at alone home or with families but depend on social help for life-supporting resources (food, clothing, social network, transportation, medical care and medicines)
2) Middle-aged individuals such as working poor who depend on social help for life-supporting resources – shelter, food, clothing, medical, money transfers and who reside in private dwellings particularly in Oslo and London where private accommodations are very expensive
3) Homeless individuals (of both genders) in all age cohorts between 18 and 75+
4) Homeless families with young children
5) Young adults with families but sleeping roughly
6) Young adults sleeping at intermittent locations (owned by friends, acquittances, and occasionally with family or relatives)
7) People with disabilities (also members of their families) with or without disability pensions
8) Refugees and registered /unregistered migrants in large urban centres
9) Long-term unemployed seeking help from SAL and/or other NGOs
10) Combinations of people from different fragility clusters – homeless migrants vs. homeless people in their own country
11) People who work predominantly outdoor and whose health conditions bear the negative marks of elongated exposure to different types of weather and who also witnessed severe hazards (e.g., floods, fires and /or combinations thereof) with high death toll and material destructions.

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Using the earth images retrieved from Copernicus satellite emergency service, and ArcGIS applications D3.1 has recorded spatial impacts of floods, fires, storms and earthquakes during 2015-2019. This period was selected instead of years 2013-2018 of the DoW to better fit the timing of the interviews, which are to be carried out since year 2020. Based on partners' reports of local extreme events, the cases for survey pilots in Oslo, Brussels and Tallinn have also been selected. For the full-blown survey the hazard tables and the integrated maps help in selection of areas where disadvantaged groups are located. Representatives of different sub-groups might be invited by the Salvation Army to personnel participate in BuildERS international survey.

Identification of territory affected by a given hazard through satellite imaging is quite helpful for operative rescue work. By taking images of territory exposed during the pre-crisis phase and during the first phases of emergency, the hazard discharge area could be geo-spatially marked for orientation of relief and rescue agencies. The Copernicus platform basically provides two services: one for planning (at pre-crisis stage) and one for emergency management. The service functions activities are quite up to date, as the occurrences of severe hazards are observed and registered in almost real-time. The problem is that every request for Copernicus satellite services must be carried by a national civil protection authority (national focal point) and that this delays exploitation of hazard mapping for on-the-ground evacuation. The point in times for the requests and the costs of image provision are also critical for utilizing this precious information when the time is scarce for preventing more fatalities. These hindrances will be reported to the European Commission for help in management of future emergences.

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List of Acronyms and Terms Used in D3.1

AB	Advisory Board
BuildERS	Building European Communities Resilience and Social Capital project
D	Deliverable
DoA	Description of Action
FG and FGI	Fragmentation Geometry and Fragmentation Geometry Index (FGI) are defined as presence of artificial surfaces and traffic infrastructure including mediums sized roads in given area. The more FG fragments the landscape, the higher the effective mesh density, hence the higher fragmentation. The higher the fragmentation, the higher is the size of land covered by impenetrable structures which obstruct or delay water absorption to the ground thus contributing to water retention, overflows, flooding and inundation.
UTC	Universal Thermal Climate Index is a measure reflecting the scale of human physiological reactions to the multi-dimensionality of actual outdoor thermal environment. The index is constructed from the data providing minimum, average and maximum values of air temperature, wind speed, radiation and humidity. UTC is used in medical biology for defining level of precautionary thermal planning for different cohorts of population
MMT	Minimum Mortality Temperature is biometric measure of daily temperature (average, maximum and minimum) with the fewest number of temperature-related mortality in given city/region. The minimum mortality temperature is particularly relevant in locations that display the characteristic "J-curve" which shows that mortality rate usually decreases as temperature increases (in Northern hemisphere) up to a certain point (the MMT). When temperature increases above the MMT, mortality rates begin to increase again.
CI	Confidence Interval in statistics is a type of estimate computed from the statistics of the observed data. This proposes a range of plausible values for an unknown parameter (for example mean). The interval has an associated interval level that the true parameter is in the proposed range. The level of confidence could be chosen by investigator. In general terms a confidence interval to an unknown parameter is based on sampling the distribution of the corresponding estimator
T3.2	Task 3.2 in WP3
WP	Work Package
NGO	Non-governmental Organisation

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1. Introduction and purpose statement for D3.1

Deliverable 3.1 presents results from WP3 preparatory work proving scientific and geo-spatial substance for the pan-European survey which will explore how the recent natural and man-made hazards affected life conditions of severely vulnerable segments of EU population. This mandate is directly connected to the BuidERS project's overall objective which seeks to increase social security and safety for the most disadvantaged social groups by creating new knowledge informing the current social protection policies on how to strengthen social capital and hazard resilience of all EU communities exposed to climate change.

To this end, D3.1 has four specific aims

1) Create a knowledge base for assessment of criteria delineating the most vulnerable EU subpopulations who because of their relative social disadvantage might have been disproportionally exposed to harms of natural and man-made hazards. Rereview the latest records of hazard types, human costs and discharge areas, and economic losses which over the recent decades afflicted Europe and identify the most health-and life-threatening perils with severe physical damages

2) Review the latest studies on socio-economic and medical characteristics of vulnerable human cohorts whose representatives will participate in BuildERS international surveys exploring the scale of consequences these perils have invoked on the respondents' life conditions, and their morbidity and mortality

3) Identify hazard discharge areas and the socio-economic and demographic features of populations settled in locations /regions affected to inform the geo-spatial sample composition of the T3.2 and T3.3 surveys

4) Assess the medical and social mechanisms that enhance the risk of death for vulnerable humans magnified by natural hazards, including atmospheric variability which does not cause immediate physical damage, but still inflicts mortal consequences

Deliverable 3.1 is structured by seven chapters.

Chapter 1 – presents background and D3.1 study objective.

Chapter 2 – describes the methodology guiding collection of knowledge, data and information sources providing empirical manifestations of constructs and research themes used in the DOW and discussed by the BuildERS project partners as content inputs to T3.2 and T3.3.

Chapter 3 - reviews the most severe geophysical, hydrological, meteorological and climatological hazards which over the recent decades inflicted human fatalities and economic losses and stratifies them by death tolls, geo-spatial locations and values of physical destruction.

Chapter 4 – presents images of geophysical and hydrological hazards and territories affected during 2015-2019 retrieved from Copernicus satellite emergency service and integrated maps displaying time-coincided multiple hazard geo-spatial coverage to pinpoint which populations strata in the BuildERS-study countries were severely affected by these calamities

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Chapter 5 - reviews medical studies that broaden our understanding of links between mortality and morbidity and atmospheric conditions, which by themselves do not impose immediate a catastrophic damage butt whose deadly impacts are seldom accounted for in socio-economic, political and engineering studies and whose mortal harms are not yet adequately recognised by climate resilience improving policies.

Chapter 6 - reviews data and statistics documenting the latest occurrences of fire and flood disasters, damages scope and population segments gravely affected.

Chapter 7- summarises findings from literature and statistics studies and defines several categories of severely vulnerable populations whose health and lives are grievously imperilled by the current climate changes and who qualify to be interviewed by survey studies.

Before proceeding, we define several terms and concepts used in BuildERS Deliverable 3.1 which relate to impacts that natural and other hazards have imposed on human wellbeing and relationship between natural environment and human vulnerability seen from the social system perspective.

Hazard: A process, a natural phenomenon or human activity that may cause loss of life, injury or other health damage, physical damage, social and economic disruption or environmental degradation. Hazards may also encompass interpersonal violence, the trauma of war or death of a loved one, serious industrial and/or technologic disasters and terrorism.

Hazards may be natural, anthropogenic or socio-natural in origin. Natural hazards are predominantly associated with natural processes and phenomena. Anthropogenic hazards, or human-induced hazards, are induced entirely or predominantly by human activities and choices. This term does not include the occurrence or risk of armed conflicts and other situations of social instability or tension which are subject to international humanitarian law and national legislation. Several hazards are socio-natural, in that they are associated with a combination of natural and anthropogenic factors, including environmental degradation and climate change (UN-UNISDR, 2019a).

Resilience - might take on different meanings depending on which analytical approach is applied in given study and what is the level of analysis. In Deliverable 3.1 *resilience* concept pertains to personal skills and abilities that might allow a given individual to bent but not break, bounce back and even grow in the face of adverse life experiences such as strain imposed by natural hazards. However, as resilience might be considered as a trait whose deficiency makes a person vulnerable, then we are talking about a host of biological, psychological, social, demographic and cultural factors which determine whether a given person is capable or not to withstand a set of hazardous stressors. This binary approach is considering resilience as a condition that either is present or not, which however does not fit the context of BuildERS study. Here, resilience might be perceived as a continuum that might vary together with other aspects of individual's life meaning that people suffering from social marginalization might have lower resilience and tolerance for potentially traumatic events such as natural hazards, increasing their chances of earlier death compared to the rest of society. For review of multi-faceted content of individual resilience construct see Southwick et al., 2014.

A disaster stands for “A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and preventive capacity, leading to one or more of the following: human, material, economic and environmental losses and other harmful impacts” (UN-UNISDR, 2019a).

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2. Methodology and Data Sources

The methodology for D3.1 was motivated by an effort to find empirical manifestations for concepts, research themes, and analytical procedures mentioned in the DOW and in inter-partner discussions which revealed several different understandings were attributed to basic scientific notions by members of the BuildERS project team with different disciplinary backgrounds and scientific traditions. This confirmed needs for knowledge base, composed of unobtrusive evidence and data sources produced by integration of different perspectives and technical methods as rationale for survey studies and selection of respondents. Another function of knowledge base was to supplement and/or broaden the survey findings with inherent conditions of sub-populations impacted by different hazards' calamities.

So, the first purpose was to establish semantical connections between the different meanings and characteristics of e.g., "vulnerable or relatively disadvantages people" concepts and find empirical examples of these notions in observational reports, statistics, data bases, and research studies that linked vulnerable human collectives (individuals, families, groups, communities and networks) with different geospatial locations and hazard impacts. This required delving into several scientific disciplines which dealt with fragile human clusters and their sub-sets in different socio-technical contexts and assessed a broad array of physical, mental and/or bodily harms attributed to natural hazards in conjunction with pre-existing on-the-ground complexities.

The second purpose was to collate the multifaceted concepts such as "hazard impacts" and "social vulnerability" and to bond them into cross-disciplinary approaches, explored by various literature fields and data sets thus allowing convergence between different perspectives and produce a comprehensive knowledge support for T3.2 and T3.3 survey studies and the forthcoming WPs. Since natural hazards induce shocks which kill and traumatize individuals, disrupt social equilibria, immobilize governments and harms communities, it was important to unravel several causal factors which severely harmed the EU social populations by imposing high death tolls, increasing mortality and morbidity among some population clusters and damage natural, technical and built environments. In this pursuit we did not favour any conceptual perspective over another, because each of them delivered valuable contributions which together enlightened the complexity of phenomena studied.

Thus, considering the above and the intricacy of causal links affecting hazards' human impacts, the D3.1 applied cross-disciplinary methodology which used findings from international economic, social, medical, meteorological, and geo-spatial and engineering studies, the NGO-sponsored analyses and contract research, hazard statistics, satellite retrieved hazard maps and other observations for understanding how the different features of populations at risk might interact with the scale and severity of natural adversities and affect the scale of social, economic and human losses. For more explicit presentation of themes and research reviewed, the findings from a multitude of disciplinary scientific studies are reported in chapters 3, 5,6 and 7 while chapter 4 present results from technology-aided maps of hazard impact retrieved from Copernicus emergency services, ArcGIS environments and other observation equipment which visualized hazard discharge, physical and eco-social damages and emergency propagation over time. All seven chapters complement and support each other for broadening the D3.1 analytical and empirical outcomes.

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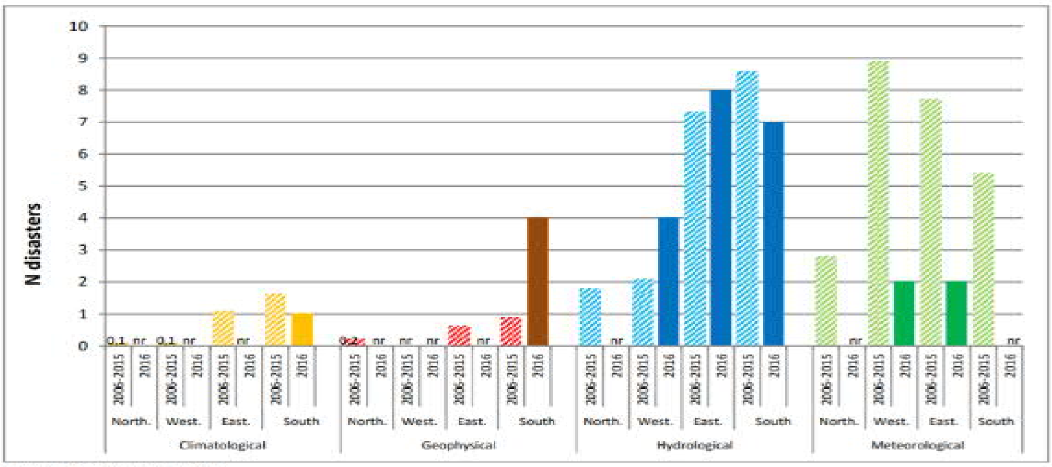
3. Hazards in Europe – an Overview

Below, the different categories of hazards are reviewed with special focus on events who over the last decades became more preponderant in Europe and whose impacts imposed severe harms to human populations and their natural and or build environments

Figure 1: Natural Hazard Subgroup Classification.
Source: Guha-Sapir, D., Hoyois, P., Wallamacq, P., and Below, R. (2017) "Annual Disaster Statistical Review 2016. The Numbers and Trends" Centre for Research on the Epidemiology of Disasters (CRED) Institute of Health and Society (IRSS), Universite catholique de Louvain- Brussels, Belgium, p.14.

This figure developed by the Centre for Research on Epidemiology (CRED) at University of Louvain in Brussels shows different categories of hazards. Hazards are divided into geophysical (earthquakes, landslides, tsunamis and volcanic activity), hydrological (avalanches and floods), meteorological (extreme temperatures, cyclones and storms/wave surges), climatological (wild fires and droughts).
Based on the above classification, CRED has registered the occurrence of these different types of in Europe. The table below covers the period 2006 – 2016 and shows the occurrence in 2016 as well. This table considers four out of six types of hazards.



nr: no disaster reported

Figure 2: Different types of hazards in Europe 2006-2016 vs. 2018.
Source: Guha-Sapir, D., Hoyois, P., Wallamacq, P., and Below, R. (2017) "Annual Disaster Statistical Review 2016. The Numbers and Trends" Centre for Research on the Epidemiology of Disasters (CRED) Institute of Health and Society (IRSS), Universite catholique de Louvain- Brussels, Belgium.

The geographical areas are divided into Northern, Western, Eastern and Southern European regions.

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Climatological disasters occurred most frequently in many European countries. In 2016, only one wildfire in Portugal was reported and one in Sweden. However, in 2017 and 2018 severe wildfires affected Spain, Portugal, Greece and Sweden. In the years 2006-2015, two climatological disasters were reported in Northern and Western Europe: one calamitous **drought** in Lithuania in 2006 and a disastrous **wildfire** in France in 2009. Climatological disasters were more frequently reported in Eastern and Southern Europe during the last decade. In Eastern Europe, five droughts occurred in the Russian Federation or neighbouring countries, in 2007, 2010 and 2012, while four wildfires were reported in the Russian federation in 2010, 2012 and 2015 and two in Bulgaria in 2007. In Southern Europe, only one drought was reported in Italy in 2012, while 15 wildfires were reported during the years 2006 to 2015, eight occurring in 2007 and four in 2009.

Geophysical disasters are infrequent in Northern and Central Europe. The regions that most frequently and severely were hit are in Southern and South-eastern Europe where nine **earthquakes** were reported during the years 2006-2015 (two in Italy, two in Greece, one in Albania, one in Serbia and one in Spain), and four in 2016 alone (three in Italy and one in Macedonia). No geophysical disasters occurred in the three other European regions in 2016. Yet, during the years 2006-2015, six earthquakes were reported in Eastern Europe (three in the Russian Federation, two in Bulgaria and one in Hungary), two in Northern Europe (one earthquake in the UK and one **volcanic event** on an island), but none in Western Europe. In December 2018, Mount Etna started volcanic eruption and triggered a 4.8 magnitude earthquake which damaged neighbouring cities and villages in Sicilian Catania province and caused one death.

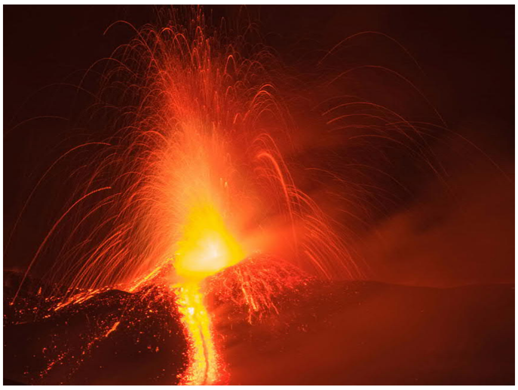

Figure 3: Mount Etna activity 2019.
Source: https://www.theatlantic.com/17e0b1cf-4259-4cb8-93d6-35ee4961d4ec

Figure 4: Environmental Emergency in Albania, August 2019.*
Source: https://www.google.no/search?q=Caritas-+earthquake+in+Albania&hl=en&tbm=isch&source=iu&ictx=1&fir=gEVk3jetdc2n-M%253A%252CT3KC5y29xv8n1M%252C_&vet=1&usg=AI4_-kRqEVEK1AZZbVfdE471T6ULo5n9lw&sa=X&ved=2ahUKEwiB6MrZpbLlAhXIepoKHRIRBeMQ9QEwB3oECAcQDA#imgrc=72Qhww3lUQCTQM:&spf=1571830754580&vet=1

*In summer 2019, Albania was hit by three earthquakes of magnitude 5.3 which were followed by torrential rains and flash floods and caused severe material damage and human casualties

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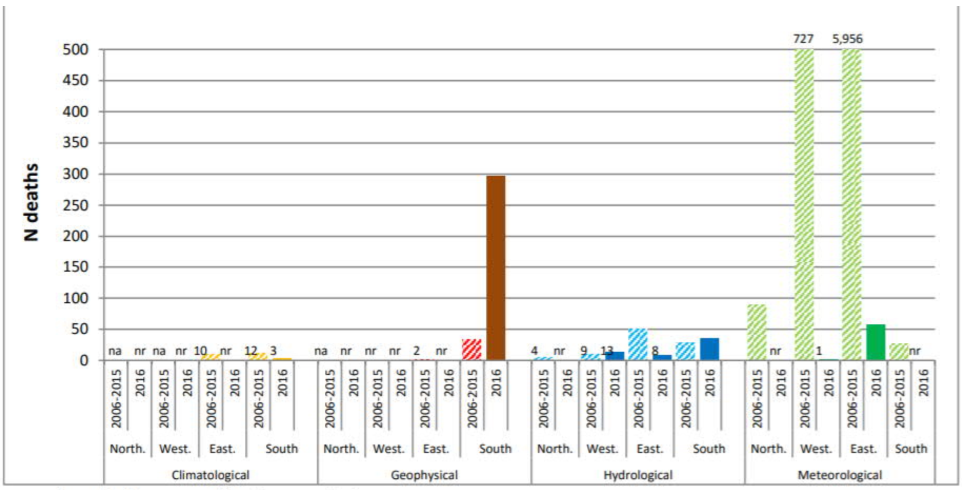
However, in 2016, **floods** were the most reported disaster in Europe with some significant differences between regions. The number of floods in Northern and Western Europe have a similar 2006-2015 annual average (1.8 and 2.1, respectively). However, in 2016, four calamitous floods occurred in Western Europe while none occurred in Northern Europe. In Eastern and Southern Europe, floods are much more common, their annual averages similar (7.3 and 8.6, respectively), as well as the number of floods suffered in 2016 (8 and 7, respectively). However, these numbers are low compared to the 19 reported in Eastern Europe in 2006 and the 16 that occurred in 2010 and 2014 in Southern Europe.

Since 2006, **meteorological** disasters were the second most frequently reported in Europe. Yet as compared to hydrological disasters, have a different distribution between regions. In Northern Europe, meteorological disasters are slightly more frequent than hydrological ones. In Western Europe, the annual average of meteorological disasters is more than four times that of hydrological disasters. In Eastern Europe, the two averages are comparable, while in Southern Europe, meteorological disasters appear less frequent than hydrological ones. Neither Northern nor Southern Europe experienced meteorological disasters in 2016, while Western and Eastern Europe suffered two disasters, each. However, these very different in type, with storms in Western Europe but extreme temperatures in Eastern Europe. When examining this further, the annual averages for storms are similar in Northern (1.8), Eastern (1.9) and Southern Europe (1.8) but are three times higher in Western Europe (6.1).

Extreme temperature periods have a different distribution, with an annual average of one in Northern Europe, 2.8 in Western Europe, 3.6 in Southern Europe and 5.8 in Eastern Europe. Heat waves accounted for 10% of all extreme temperature episodes in Northern and Eastern Europe, while in Western and Southern Europe for 25%. A large numbers of heat waves were reported in 2006 in Western Europe and in 2007 in Eastern and Southern Europe, while cold waves or extreme winter conditions affected 39 European countries in 2012. As for the **geophysical** disasters, the annual average of 34 deaths in Southern Europe comes from the L'Aquila earthquake, in Italy, in 2009 in which 295 people died. A similar number, 297 people, was reported in 2016 for the Amatrice earthquake, in the same region of Italy.



na: not available; nr: no disaster reported

Figure 5: Number of deaths by disaster type. Mean 2006-2015 vs. 2016.

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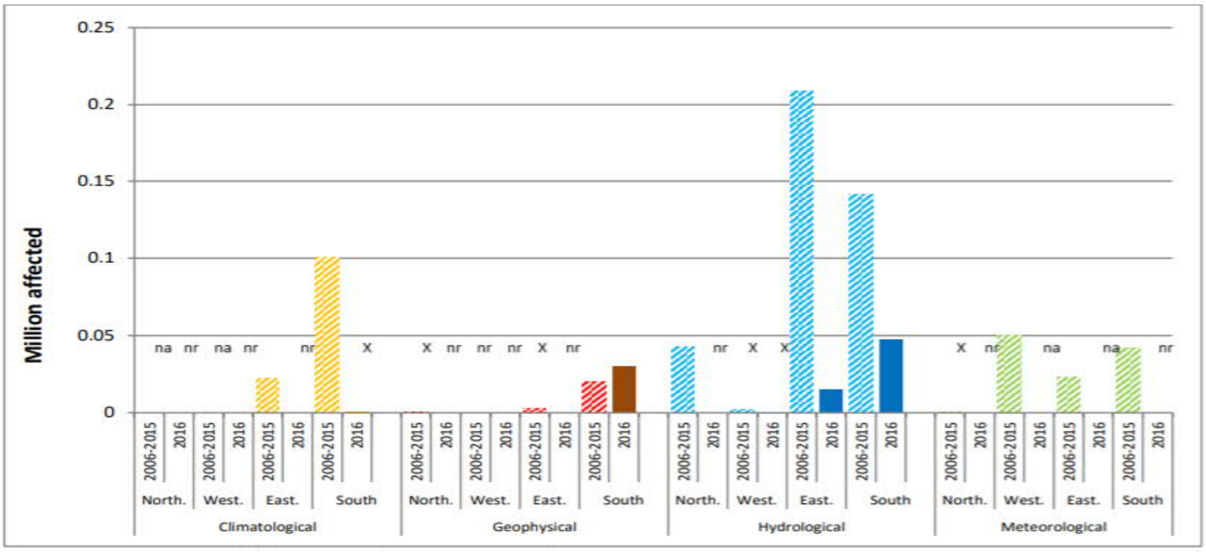

X:< 0,005; na: not available; nr: no disaster reported

Figure 6: Number of people reported affected by disaster type in Northern, Western, Eastern and Southern.
Source: Guha-Sapir, D., Hoyois, P., Wallamacq, P., and Below, R. (2017) "Annual Disaster Statistical Review 2016. The Numbers and Trends" Centre for Research on the Epidemiology of Disasters (CRED) Institute of Health and Society (IRSS), Universite catholique de Louvain- Brussels, Belgium.

A **heat wave** killing 760 people in the United Kingdom in 2013, accounted for 86 % of the total number of deaths reported for Northern Europe for the years 2006 to 2015. The annual average of 727 deaths from **meteorological** disasters in Western Europe is explained by two heat waves in 2006 and 2015 which resulted in 3,340 and 3,685 deaths, respectively. The annual 5,956 deaths, on average, in Eastern Europe, follows the 55, 736 people killed by a heat wave in the Russian Federation in 2010.

Between 2006 and 2015, **meteorological** disasters cost an annual average of 281 million US$ in damages in Northern Europe. Most costs resulted from **storms** Kyrill and Desmond in 2007 and 2015, which cost 1.4 and 1.2 billion US$, respectively. In Western Europe, the storm Kyrill in Germany in 2007 cost 6.3 billion US$, Klaus and Xynthia in France in 2009 and 2010 cost 3.6 and 4.6 billion US$, respectively, and one convective storm in Germany in 2013 cost 4.9 billion US$ in damages. In 2016, one convective storm cost 844 million US$ in the Netherlands. In Eastern Europe, the 2006-2015 annual average includes damages from **extreme temperature periods** and from storms. In Russia, one extreme winter episode cost 1.2 billion US$ in 2006, and one heat wave around 440 million US$ in 2010.

Disasters affecting at least one million people are infrequent in Europe. Between 2006 and 2015, only three such large disasters occurred: one wildfire in Macedonia in 2007, one flood in the Czech Republic in 2013, and another flood in Bosnia-Herzegovina in 2014. Only six disasters affected more than 100,000 people.

Climatological disasters were rare in Northern and Western Europe and data on the numbers of people affected are not always reported exactly. In Eastern Europe, the annual average is strongly biased by the more than 200,000 people affected by a **drought** in Moldova in 2007. Otherwise, in this region, severe climatological disasters affected between 6,000-7,000 people, most often. In Southern Europe, the 1 million people affected by a **wildfire** in Macedonia in 2007 is much higher compared to the 1,161 who suffered from a wildfire in Portugal in 2016.

Damages from **earthquakes** were reported in two out of three cases. In Northern Europe, damages from the only earthquake reported since 2006 cost 70 million US$ in 2007. In Eastern Europe, damages were reported for two earthquakes in the Russian Federation in 2006 and 2007 with costs of 70 and 480 million

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US$, respectively. In Southern Europe, the 2006-2015 annual average (2 billion US$) can be mostly attributed to two earthquakes in Italy, which in 2009 and 2012 made 2.8 and 16.4 billion US$ damages, respectively.

In Northern Europe, five **floods** in the UK increased the annual average. Two floods in 2007 cost, both, 4.6 billion US$, while three in 2012, 2014 and 2015 caused 4.7, 1.5 and 1.2 billion US$ in damages, respectively. In Western Europe, the 1.87 billion US$ annual average in costs comes mostly from four floods in France in 2010 (1.6 bn. US$) and 2015 (0.9 bn. US$), and in Germany (13.2 bn. US$) and Austria (1 bn. US$) in 2013. In 2016, one flood cost 2.4 billion US$ in Germany, meanwhile another cost 2 billion US$ in damages in France. In Eastern Europe the annual average of 1.01 billion US$ damages from floods is mostly attributed to four events: one in Ukraine in 2008 (1.1 billion US$), two in Poland and Romania in 2010 (3.4 and 1.2 billion US$, respectively) and one in the Russian Federation in 2013 (1 billion US$). In 2016, one flood cost 10 million US$ in the Russian Federation. In Southern Europe, the annual average of 823 million US$, is mainly due to two major floods in Portugal in 2010 and Serbia in 2014, costing 1.5 and 2.1 billion US$, respectively. However, it is also due to five floods in 2014: one in Bosnia-Herzegovina with 440 million US$ in damages and four in Italy, two costing around 300 million US$ each, and two 120 million US$ each. In 2016, two floods in Italy and Serbia cost 100 million US$ each, one in Greece 56 million US$ and two flash floods. In Macedonia and Spain 50 million US$, each.

Four storms strongly influenced the annual average for damages: 550 million US$ from a hailstorm in Bulgaria in 2014, the 2007 extra-tropical storm Kyrill cost 170 million US$ damages in the Czech Republic, and 115 million US$ in Poland and Ukraine. In Southern Europe, also, meteorological disaster damages annual average combines extreme temperature episodes and storms. In Italy, a cold wave cost 140 million US$ in 2012, while storm Klaus cost 2.12 billion in damages in Spain in 2009, and two storms in Italy, in 2010 and 2015, caused 950 and 880 million US$ in damages, respectively.

3.1 Economic Damages and Life Losses Attributed to Natural Hazards in EU and EEA Member States 1980-2017

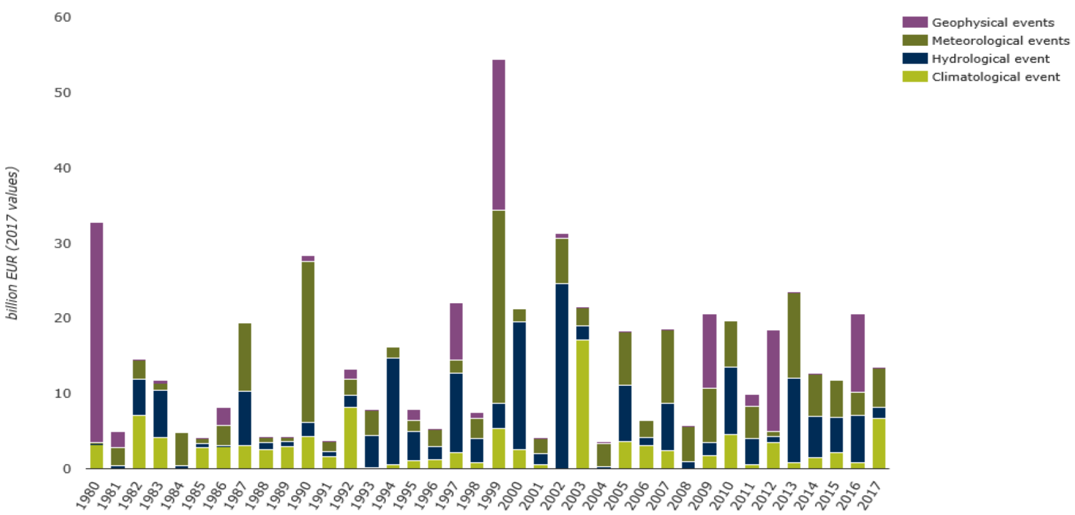

Figure 7: EEA 33 - Economic Damage Caused by Weather and Climate-induced Events in Europe 1980-2017.
Source: https://www.eea.europa.eu/data-and-maps/indicators/direct-losses-from-weather-disasters-3/assessment-2
Notes: Geophysical events -earthquakes, tsunamis, volcanic eruptions
Meteorological events: storms
Hydrological evens – floods, mass movements
Climatological events: cold waves, heat waves drought, forest fires.

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For the period 1980-2017, fatalities, total values of losses and insured losses in EUR million (in 2017 prices) based on records from NatCatService of Munich Re and the EUROSTAT structural indicators are shown below.

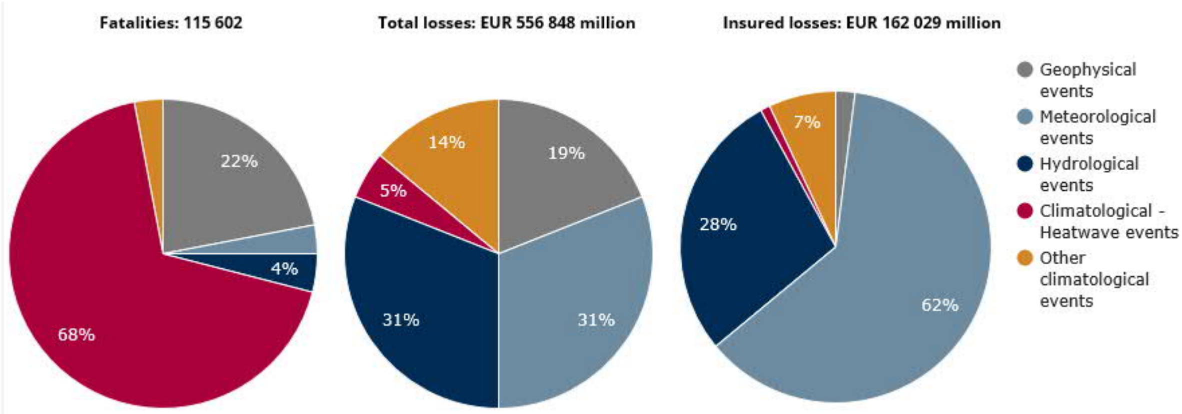

Figure 8: Fatalities, Total Losses and Insured Losses in EU and EEA Member States 1980-2017
Source: NatCatService provided by Munich Re https://www.eea.europa.eu/data-and-maps/indicators/direct-losses-from-weather-disasters-3/assessment-2

For the period 1980-2017, the economic losses from all-natural disasters in the EU and EEA member countries amounted to EUR 557 billion and the insured losses were approximately EUR 162 billion (in 2017 values). Around 63 % of all economic losses were a result of meteorological and hydrological events, while most fatalities were caused by **heatwaves**. The large portion of fatalities was highly influenced by the heat waves of 2003, with around 13,000 fatalities reported as excess deaths during the hot summer period.

Recorded economic losses from weather and climate-related extremes have varied substantially over time. The average annual economic loss (inflation-corrected) was around EUR 7.4 billion per year in the 1980, EUR 13.4 billion in the 1990s, and EUR 14.0 billion per year in the 2000s (2000-2009) In the period 2010-2017 the average annual economic loss amounted to around EUR13.0 billion. While the heat and cold waves were responsible for 68% of 115, 602 fatalities during 1980-2017, the second most dangerous hazard were geophysical events (e.g., earthquakes and other ground movement calamities). However, meteorological and hydrological hazards were responsible for 62% of the recorded € 556,848 million total losses and for 80% €162, 029 million of insured losses. Yet, it needs to be noted that increases in the economic wealth over the period analysed, had major effect on amount of annual losses.

As shown in table below, the distribution of weather and climate-related loss categories among the EU and EEA 33-member countries is uneven. The biggest overall economic losses in absolute terms (in order of rank) were suffered by Germany, Italy and France. Yet, France has registered the highest number of fatalities - 23,415 – attributable to climatic hazards, Italy – 20,557, Spain 14,611 and Germany 9,856.

Table 1:Economic Losses and Fatalities Attributed to Extreme Weather and Climate-related Events on the EU and EEA Countries. 1980-2017

Country	Losses (million Euro)	Loss per capita (Euro)	Loss per sq.km (Euro)	Insured losses (million Euro)	Insured losses (%)	Fatalities
Austria	13 489	1 681	160 818	4 156	31	595
Belgium	4 308	415	141 125	2 531	59	2 168
Bulgaria	2 452	302	22 217	129	5	205
Croatia	3 014	674	53 256	74	2	722
Cyprus	386	565	41 760	8	2	77
Czechia	10 533	1 018	133 551	3 554	34	220
Denmark	10 336	1 936	240 838	6 307	61	42
Estonia	108	76	2 387	33	31	9
Finland	1 959	380	5 789	397	20	4
France	62 059	1 026	98 011	30 961	50	23 415
Germany	96 494	1 271	270 008	45 188	47	9 856
Greece	7 319	693	55 424	113	2	2 431
Hungary	6 035	588	64 881	137	2	703
Iceland	88	312	850	43	50	52
Ireland	4 014	1 017	57 515	2 059	51	69
Italy	64 673	1 120	214 099	2 918	5	20 657
Latvia	412	175	6 380	49	12	103
Liechtenstein	6	182	36 212	3	58	0
Lithuania	976	288	14 943	7	1	69
Luxembourg	718	1 627	277 817	424	59	130
Malta	63	163	197 984	26	41	7
Netherlands	8 111	517	195 240	3 771	46	1 729
Norway	3 597	794	11 110	1 977	55	40
Poland	15 057	397	48 155	1 027	7	1 217
Portugal	6 869	672	74 475	584	9	3 108
Romania	11 065	508	46 414	60	1	1 310
Slovakia	1 669	314	34 045	106	6	112
Slovenia	1 690	846	83 368	203	12	241
Spain	37 106	889	73 341	4 508	12	14 611
Sweden	4 272	479	9 741	1 165	27	46
Switzerland	18 805	2 609	455 431	9 621	51	1 160
Turkey	4 405	70	5 622	635	14	1 682
United Kingdom	50 504	848	203 208	35 106	70	3 535

Source: NetCatSERVICE provided by Munich Re at https://www.eea.europa.eu/data-and-maps/indicators/direct-losses-from-weather-disasters-3/assessment-2
Note: For the period 1980-2017, figures are in EUR prices based on damage records from the NatCatSERVICE and EUROSTAT structural indicators.

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4. Mapping of hazard discharge areas for connection with survey respondents

Hereunder several maps and satellite images of hazard outbreaks with discharge areas are presented for geospatial delimitation of territories and populations affected to support further the WP3 work and empirical foundation for the subsequent WPs.

The interviews will be carried out in areas where severe hazards have occurred in recent years. The area must be among the selected BuildERS-study countries and cities where SAL operates and thus has number of disadvantaged people groups. Consent forms must be accepted by the country's ethical committee, and information sheets and privacy documents should be available to be presented to prospective informants in their language to obtain voluntary participation consent. We discuss further these points in the following chapters.

4.1 Survey Respondent Selection

As mentioned, members of marginalized subpopulations whose experiences from hazard encounters will be registered and documented by WP3 survey will be invited as survey respondents. Predominantly, recruitment sites will be cities and urban areas with population over 50,000 inhabitants in the BuildERS project consortium countries with Salvation Army's, Caritas and/or Red Cross welfare providing apparatus. Also, some other countries and cities which host the above and/or other NGOs will be considered (see Table 2 for all candidate countries and cities). The selection of the groups will be based on 1) local knowledge of Salvation Army, Caritas or Red Cross personnel providing rescue and relief to hazard-affected people and generally socially deprived groups, and 2) integrated maps showing where and how severe hazards hit during 2015-2019. This timespan was selected instead of 2013-2018 in DoW, to fit better to the timing of the interviews, since 2020.

Table 2. Cities with Salvation Army's Service Stations and Shelter Facilities

Country	Cities
Norway	Oslo, Bergen, Bodø, Haugesund, Trondheim, Stavanger, Fetsund, Mandal, Tønsberg,
Sweden	Gothenburg, Stockholm, Uppsala, Sundsvall
Germany	Frankfurt, Cologne, Dresden, Göttingen, Wiesbaden, Neuenburg, Freiburg, Kassel, Lübeck, Stuttgart, Munich, Berlin
Finland	Helsinki, Espoo, Tampere, Turku
Estonia	Tallinn
Italy	Rome
Greece	Athens
Hungary	Budapest
Romania	Lasi, Ploiesti
Lithuania	Lietuwoje, Klaipeda
Austria	Vienna
Czech Republic	Prague, Brno, Jirkov, Krnov, Sumperk, Opava, Ostrava, Havirov, Jirkov, Prerov, Karlových, Varech
Slovakia	Bratislava, Plavecky Svrtok
UK	London, Leeds
Belgium	Brussels, Liege

Source: www. salvationarmy.org

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Since WP3 survey will pole the people from multiple countries, the consent forms must be approved by each nations Local Ethics Board before the interviews, and the information sheet, privacy document and study questionnaire translated into target respondents' languages (see status in. Participation in the survey will be voluntary. These prerequisites that respondent consent for part taking in the study will be obtained before each polling session and that participant's understanding of her /his freedom to terminate interview any time is also ascertained. In addition, protection of informants' private data will be assured by survey organizers to each prospective informant.

Table 3. Status of Preparatory Documents and Respondent Consent Forms at Time of D3.1 Completion

Country	Language	Consent form approved by Local Ethics Board	Information sheet translated	Privacy document translated
Belgium	Dutch		X	x
UK	English		X	x
Czech rep.	Czech		X	x
Belgium	French		X	x
Estonia	Estonian	X	X	x
Finland	Finnish	X	X	x
Germany	German		X	x
Greece	Greek		X	x
Hungary	Hungarian	x	X	x
Norway	Norwegian	x	X	x
Sweden	Swedish		X	x
Romania	Romanian		X	x
Italy	Italian	x	X	x
Austria	German		X	x
Lithuania	Lithuanian	in process	in process	in process
Slovakia	Slovak	in process	in process	in process

Source: D3.1 elaboration

Respondents from at least two fragile people clusters (e.g., homeless – elderly, young, and families with children, individuals with limitations and/or registered/unregistered migrants) in two countries hit by given hazard type will be contacted for survey participation. This will allow to compare the hazards human impacts across two social groups in two countries with different techno-social resilience.
In the following, different hazard categories and discharge areas are delineated as indicators for affected social groups.

4.2 Selection of Hazards Categories

4.2.1 Criteria

Definition of criteria for selection of hazard cases for BuildERS analyses was challenging. In Italy and Greece geophysical hazards imposing high death tolls among general population could be identified. However, in Nordic countries' mortality among socially marginalized people might be attributed to different hazard stressors and not associated with highly dramatic events although the large-scale forest fire catastrophes in Sweden have been quite devastating. Against this backdrop, the following criteria were proposed which however might be amended by empirical evidence collected during the projects.

1. The hazard can be natural or man-made
2. The hazard has occurred between 2015-2019

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3. Based on hazards statistics in the target countries the following natural hazard were selected earthquakes, flooding, wildfires and/or, vehicle and structure fires, heat waves, cold waves. Man-made hazards can be linked to natural conditions such as structural fires lit by long-lasting drought or heat period.

4. Hazards which temporarily overwhelmed on the-ground-coping capacities such as earthquakes and which turned into disasters with high death tolls.

Consequently, the following criteria are proposed

- Hazards that caused human deaths, injuries and/or large-scale displacement
- Hazards that affected large number of people (N x 1 000's),
- Hazard that Inflicted extensive immediate damages to buildings, roads, telecommunication, health-care providing facilities or water supply
- Hazards which did not cause immediate physical damages but acted as catalyst between the inherent human frailties' and atmospheric conditions causing immediate and/or delayed mortality
- Hazard which have been registered by Copernicus emergency service and instigated the national governments' requests for international help, either for purpose of monitoring or mapping the discharge areas and/or for assessing the magnitude of physical damages.

It is noteworthy that mortality rates attributed to heatwaves and cold ambient conditions are difficult to verify because they might vary across different climatic zones and/or oftentimes could be diagnosed as death tolls caused by cardiovascular, pulmonary and/or addiction-related diseases. The epidemiology studies reviewed in the following chapters have estimated excess mortality associated with ambient variability by comparing the deaths stock during the timeline with MMT (minimum mortality temperature) against deaths befalling during higher or colder periods. The World Meteorological Organization defines a heat wave as 5 or more consecutive days of prolonged heat in which the daily maximum temperature is higher than the average maximum temperature by 5 °C (9 °F) or more but might vary across the countries studied (https://www.britannica.com/science/heat-wave-meteorology). It is however unknown whether this definition did consider the geo-spatial changes in MMT induced by the last decade climate variability.

4.2.2 Information Sources on Hazard Cases

Hazard cases were inventoried by inspection of reports, media stories and web pages associated with natural and manmade disasters. Important sources of data included

1. Reports like the Annual Disaster Statistical Review 2016 - The numbers and trends.

2. Copernicus emergency service https://emergency.copernicus.eu/mapping/list-of-activations-rapid. These pages provide information on hazards globally since 2012, the year of European Space Agency's Sentinel series satellites have been operating. It contains hazards for which a satellite imaging request has been provided by the national official authority, to help in monitoring the impact areas and hazard damages. Appendix 1. shows the locations of these hazards for years 2015-2019. The hazard types and damages best represented by satellite image monitoring are wildfires and floods, large areas of fallen trees from storms, whose extents can be accurately mapped from optical satellite images like Sentinel-2. Earthquakes and landslides ordered by the imaging requests are monitored with radar imagery like Sentinel-1. In optimal cases, the pages provide detailed maps and statistics on damaged buildings, see Appendix 2. These pages are active and show very recent global hazards occurring in a time space of the last 1 to 2 days.

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3. European severe weather database (https://www.eswd.eu/, https://www.essl.org/cms/european-severe-weather-database)

4. Estonian Weather Service, https://www.ilmateenistus.ee/?lang=en

5. Emergency database CRED (https://www.emdat.be)

6. Local partners and authorities provided detailed information on hazard e from national databases, emergency management services and newspapers.

7. Swedish forest service https://www.skogssverige.se/skog/stormfallning/kanda-stormar

8. Finnish Meteorological Institute https://ilmatieteenlaitos.fi/tiedote

9. NASA earth observatory https://earthobservatory.nasa.gov/images/

10. USGS earthquake events https://earthquake.usgs.gov, https://www.usgs.gov/natural-hazards/earthquake-hazards/lists-maps-and-statistics, https://earthquake.usgs.gov/earthquakes/search/

4.2.3 Records of Hazard Events and Categories

From the found hazards, fulfilling the criteria in chapter 4.2.1, the following attributes were recorded:

1. Type of hazard
2. Country affected
3. Date of start
4. Date of end (if known)
5. Link to Copernicus emergency system depicting hazard discharge area OR the name of the city/cities or region/s of discharge area, from the source in field 11 or 12.
6. Free text for description of hazard, regions, areas affected, name of the hazard
7. Mortality (if known)
8. Number of injured individuals (if known)
9. Number of other individuals to whose life the hazard were affected immediately
10. Monetary values or extent of immediate damages, like ha of burned forest, or number of households without electricity (if known)
11. Primary source of information
12. Additional source of information
13. Copernicus emergency service ID

Appendix 3 shows the table with selected hazards and attributes. It contains 119 hazards that have occurred in BuildERS-study countries between 2015-2019.

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4.2.4 Integrated Maps of Hazard Cases

The hazards and their impact areas were collected by the ArcGIS map environment. It contains the same selection attributes as in the hazard table. One example is the date of occurrence, so that compound events can be identified. Figure 9 and Figure 10 show extracts from the integrated maps with hazards impact areas and the Salvation Army's operations cities (in green) and the gross domestic product layer. The GDP layers indicated which socio-economic strata of people have been affected by hazard impacts. It indicates that some low-income population strata were prevalent in large parts of hazard affected territories.

Figure 9 shows hazards whose impact area covers the city of Brussels. Heat extremes, heat waves and storms are the events that affected Brussels inhabitants, particularly homeless groups, elderly or disabled living in lightly built households or without efficient air conditioning, and people who worked outdoors.

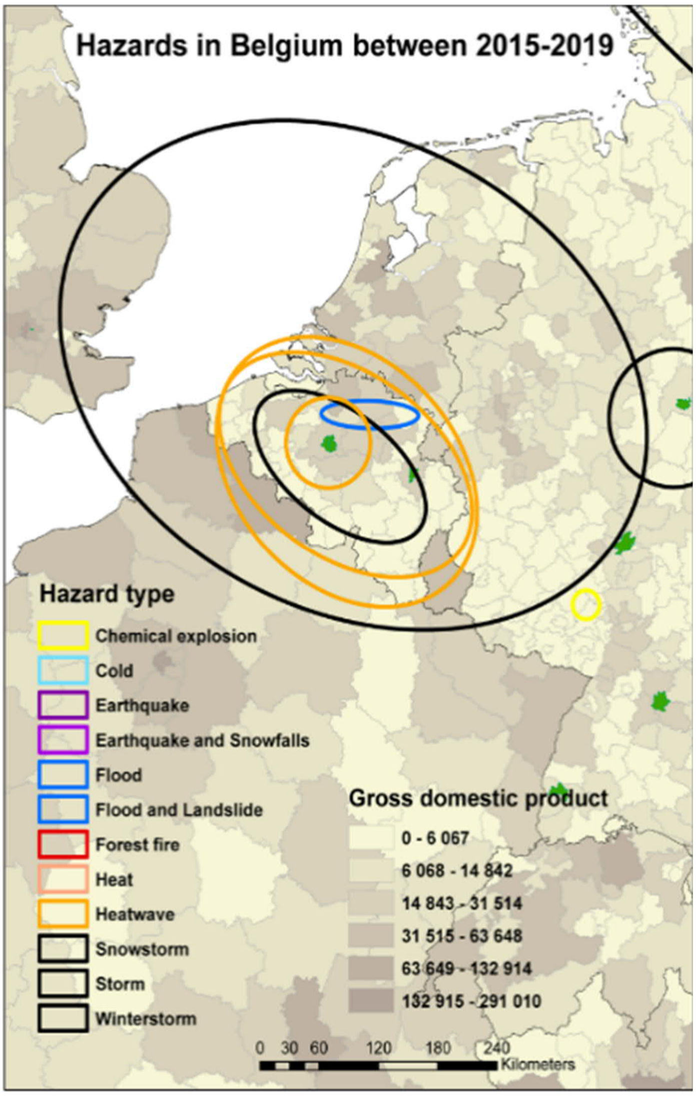

Figure 9. Hazards in Belgium between 2015 and 2019 with SAL Cities in Green*

Source: ArcGIS Online Dataset

** GDP Layer is from ArcGIS online datasets, the GDP unit is €/Year, and presented by NUTS level 3. We can see, for instance a chemical explosion in Western Germany marked yellow, in a large homogenous area of very low economic production)*

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In Figure 10 we see hazards which have stricken Italy and Greece. In Italy no severe hazards were found which affected Rome, but Verona and several floods hit vast areas in Sicily. In Central Italy, north-east from Rome several earthquakes occurred in 2016-2017, causing several hundreds of deaths and physical damages which harmed several tens of thousands of individuals. In Greece, earthquakes and wildfires are the most dominant categories of severe hazards. Floods, wildfires and earthquakes affect most to homeless, disabled and elderly population groups more than other social segments. Study performed by Hemingway and Priestley (2005) indicates that these groups can be disadvantages in the delivery and design of immediate relief and evacuation services due to physical and social barriers.

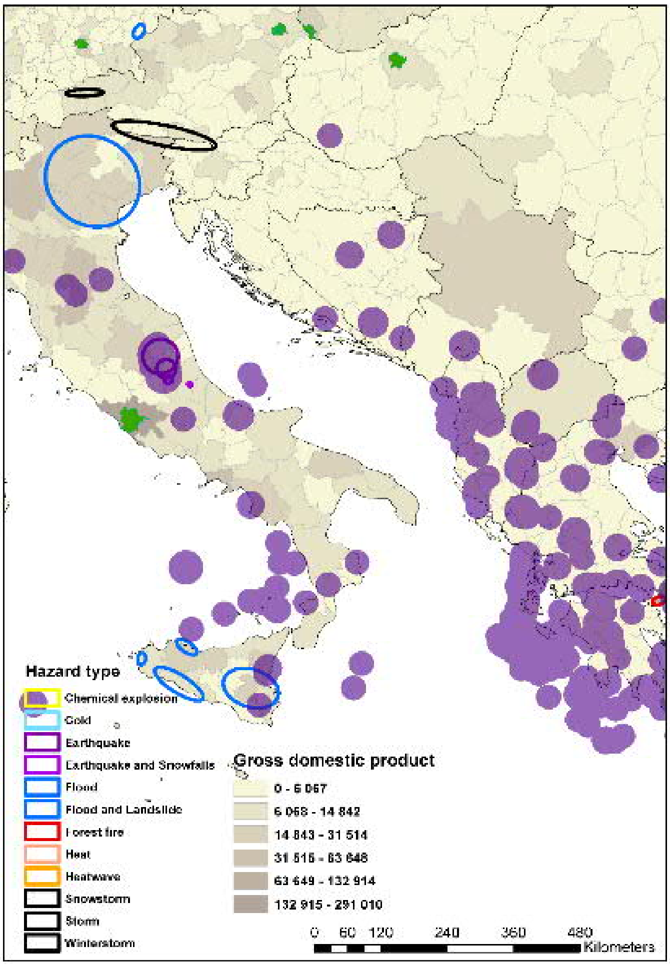

Figure 10. Hazards in Italy and Greece between 2015 and 2019 with SAL Cities in Green.

Source: GDP Layer is from ArcGIS Online Datasets, the GDP unit is €/Year and presented by NUTS Level 3.

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5. Hazard Categories and Survey Pilots

Brussels, Tallinn and Oslo are cities selected for survey pilots which will probe into impacts of hazards that occurred during 2015-2019. Among the most preponderant hazards during this timeline were heat or cold waves, and some storms. This information might help the informants to recall what has happened in the city of their stay during the period explored by the survey.

In Oslo, no other hazards have occurred during the period mentioned except for extreme heat wave which hit the country and Oslo city during summer 2018 (https://www.lifeinnorway.net/norways-summer-heatwave) The list of hazards occurred in Belgium and Brussels during 2015- 2019 are shown Table 4.

Table 4. Meteorological Hazards in Belgium During 2015 -2019

Hazard type	Country	Area	Date	Mortality Injured	Source 1
Storm	Belgium	Belgium	4-5.6.2019	5 injured	https://www.vrt.be/vrtnws/nl/2019/06/04/code-oranje-deze-middag-zwoel-en-onweer/
Storm	Belgium	Belgium	18.1.2019	1 death	https://www.theguardian.com/world/2018/jan/18/amsterdam-schiphol-flights-storm-chaos-europe
Heatwave	Belgium	Belgium	19.7.2019	1 death	https://www.brusselstimes.com/all-news/belgium-all-news/61488/belgium-sees-first-death-as-a-result-of-record-heat-wave/
Heatwave	Belgium	Brussels 39 degrees	28.10.2019		The Sun, July 26th 2019, 22:40
Heatwave	Belgium	Belgium	19-25.6.2017	235 (estimated based on normal condition statistics)	http://www.flanderstoday.eu/current-affairs/more-deaths-during-heatwave-june

Sources in table

Table 5 shows the cold and heat waves and weather extremes in Estonia during 2015 - 2019. It is not sure whether severe weather area covers the entire Tallinn agglomeration, as the extreme heat or cold were referenced to the entire country, and only the locations or cities with extreme heat and cold have been named.

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Table 5. Weather Hazards in Estonia, Including Tallinn, During 2015 - 2019

Hazard type	Country	Area	Date	Mortality/ Injured	Source
Heat wave	Estonia	Estonia,including Tallinn >30 degrees	5-8.7.2019		Estonian Weather Service, https://www.ilmateenistus.ee/?lang=en
Cold	Estonia	Estonia, Tiirikoja -26.5 degrees	23.2.2018		Estonian Weather Service, https://www.ilmateenistus.ee/?lang=en
Heat	Estonia	Estonia, including Tallinn 34.2 degrees	29.7.2018		Estonian Weather Service, https://www.ilmateenistus.ee/?lang=en
Cold	Estonia	Estonia, Võru -25 degrees	7.1.2017		Estonian Weather Service, https://www.ilmateenistus.ee/?lang=en
Heat	Estonia	Estonia, Viljandi 30.8 degrees	12.8.2017		Estonian Weather Service, https://www.ilmateenistus.ee/?lang=en
Flooding	Estonia	Tallinn, from thunderstorm	17.8.2017		Estonian Weather Service, https://www.ilmateenistus.ee/?lang=en
Cold	Estonia	Estonia, Tõravere -30	8.1.2016		Estonian Weather Service, https://www.ilmateenistus.ee/?lang=en
Heat	Estonia	Estonia, Võru 32.4	26.6.2016		Estonian Weather Service, https://www.ilmateenistus.ee/?lang=en
Flooding	Estonia	Tallinn,from heavy rain	10.7.2016		Estonian Weather Service, https://www.ilmateenistus.ee/?lang=en
Cold	Estonia	Estonia, Vaike-Maarja -20.7	7.1.2015		Estonian Weather Service, https://www.ilmateenistus.ee/?lang=en
Heat	Estonia	Estonia, Voru 31.6	6.8.2015		Estonian Weather Service, https://www.ilmateenistus.ee/?lang=en
Cold	Estonia	Estonia, Jöhvi -25.9	23.1.2014		Estonian Weather Service, https://www.ilmateenistus.ee/?lang=en
Heat	Estonia	Kunda 33.1, Tallinn 31.4	19.5.2014		Estonian Weather Service, https://www.ilmateenistus.ee/?lang=en
Heat wave	Estonia	>30 degrees in several places	23.7.2014		Estonian Weather Service, https://www.ilmateenistus.ee/?lang=en
Heat	Estonia	Estonia, Lääne-Nigula 33.5	4.8.2014		Estonian Weather Service, https://www.ilmateenistus.ee/?lang=en

In the following, D3.1 delves deeper into meteorological impacts which by itself is not considered as a deadly calamity, but which despite being perceived as relatively innocuous have considerably elevated the risk of mortality, particularly among the most fragile population cohorts. We do so because these climate-related changes in ambient conditions, in addition to well-recognized hazards, are serious killers of relatively young and deprived social minorities. The results from the studies reviewed below might be used as evidence-based decision support for deriving informant sample for T3.2. and T3.3 surveys and for public policy interventions proposed in WP5 for improving access to medical services, poverty relief, and public housing to highly hazard-and-climate change susceptible cohorts whose social isolation is a testimony of considerable social capital shortcomings and the lack of human justice[1].

[1] Wikipedia 2020 defines the concept of *social justice* as fair and just relationships between the individual and society as measured by the distribution of wealth, opportunities for personal activity, and social privileges. In the current global grassroot movement for social justice, the emphasis has been on the breaking of barriers for social mobility, the creation of safety net and economic rightfulness (https://en.wikipedia.org/wiki/Social_justice)

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6. Links between atmospheric variability and mortality of vulnerable people in the EU

6.1 Human Vulnerability and Environmental Risks

To better comprehend vulnerability of people affected by hazard impacts whose experiences will be studied in WP3 T3.2 and T3.3, it is important to understand the reciprocal relationship between human populations and natural environments. The environment itself might be then understood as "a combination and interaction of natural and human systems which both produce and are affected by global change" (Klein, 2006). Within this context, the increasing vulnerability of human habitats and livelihoods to climatic hazards could also be seen as socially produced (Hemingway and Priestley, 2015). The idea that vulnerability is socially affected is by no means new, and evident in analyses of human geography and political economy (Blaikie, Cannon, Davis and Wisner, 1994; Cutter, Boruff and Shirley, 2003; Dow, 1992; Liverman, 1990; Timmermann, 1981) Such approaches have motivated research into interactions between social and/or individual life factors and climate-variability and their collective impacts of human life risk (Füssel and Klein, 2002). To this end, the International Disaster Reduction Strategy defines vulnerability as "The conditions determined by physical, social, economic, and environmental factors or processes which increase the susceptibility of a community or an individual to the impacts of hazards" (United Nations and International Strategy for Disaster Resolution, 2004). The same definition is incorporated in the Hyogo and Sendai Frameworks on reduction of human vulnerability to climate impacts. From this perspective, human vulnerability to natural hazards might be dependent on techno-social organisation and by "every pattern of social interaction with surrounding ecosystems" (Yamin, Rahman Haq, 2005).

If human vulnerability to natural hazard can be moulded or even amplified by socio-economic factors, then socially disadvantaged groups are likely to be disproportionately affected (Hemingway and Priestley, 2015). Recent Climate Change Agreements Hyogo, Kyoto and Paris) highlight the specific vulnerability of disadvantaged populations and suggest a link between economic welfare, civil protection and reduction of climate change vulnerabilities. Yet the concept of human vulnerability is a complex one and cannot be considered as simply a proxy for poverty removal and social inclusion. It is also a function of coping, techno-social resilience, adaptability and intra-and-inter communal cohesion. "Communities are not homogenous. Sharing climate impacts or threats does not imply that each member of the community is affected in the same way as all others. Whether small or large communities, all are highly differentiated in terms of access to resources and factors such as age, gender, class and ethnicity, and these differences might be highly significant to their vulnerability and capacity for hazard resilience (Yamin, Rahmnam and Haq, 2005)

Incorporating these perspectives into vulnerability assessment, the connections between social welfare, social marginalisation, demographics, weather climate and severity of hazard impacts on specific human cohorts are explored below.

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6.2 Links between Temperature and Population Mortality

Although relationship between non-catastrophic changes in **ambient** conditions **imposed by climate change** and human mortality is hard to pinpoint causally owing to complexity of human reactions to **atmospheric** environment and the potential confounding effects of other factors (e.g., other **atmospheric** characteristics - wind strength, humidity and radiation, organisation of public hazard preparedness, socio-demographic conditions of people exposed to hazard impacts and individual resilience level), still, research in epidemiology, social marginalization and climatology show that heat and cold waves are associated with lower well-being among general population and increases in mortality and morbidity among particular social groups whose death toll exceeds the death numbers among general population.

Mortality-temperature association is often schematically described as U-shaped (or V-, J- shaped) exposure-response curve with a trough at the so-called minimum mortality temperature (MMT) and an increase in mortality towards hot and cold tails of temperature distribution (Armstrong, 2006). These methods have been used to document that more frequent heat waves within the different climatic zones in Europe were related to thousands of premature deaths in Europe since 2 000 (Gasparrini et al., 2015), some of which attributed to just few deadly extreme events.

The largest effect of heat waves has been observed among the elderly (75+), but in some places, also among people of all-ages, including younger adults. Although elderly people might be more vulnerable to the effect of heat or cold, owing, in part to poorer physical health and cognitive impairment of the perceptions of temperature-related health risks, many other population segments also face a heightened risk of mortality attributed to temperature stressors. People with disabilities[2] who often suffer from lower socio-economic status and attitudinal negativity or simply those with poor health living in poverty or other forms of relative deprivation and/or social exclusion, the *permanently* homeless, rough sleepers, substance abusers, and migrant workers, in addition to homeless families (especially with young children and elderly members), all those are more prone to psychological stress and physical ailments induced by severe ambient conditions (Caritas International, 2011; Ramin and Svoboda, 2007, Kumari-Cambell, 2008)[3].

Also, people exposed to long hours in sun, hot, cold and humid weather (such as manual labourers), or migrants or refugees who move between different climatic zones and who might be deprived of access to shelters with cooling/heating facilities and/or other needy protection measures, are also exposed to higher risk of life loss compared to other segments of population (Cahn and Guild, 2010; European Asylum Support Office, 2016). Research indicates that mortality and morbidity among people who rapidly move between hot and cold climatic zones with different range of seasonal temperatures, winds strengths, precipitation and radiation intensity are more exposed to death hazard. Combinations of these ambient stressors strongly affect the human energy balance and the *individual biothermal resilience* whose impact might induce traumatic condition and overpower the influence of air temperature alone (Jendritzki, 2009; Ruuhela et al.,2017).

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[2] People with disabilities are defined by the Centre for European Social and Economic Policy as persons with limitations reducing their activities because of health problems lasting for at least six months, Greammenos, S (2019) Social Scoreboard and Persons with Disabilities, Working Paper, March,2019

[3] The definition of homeless people commonly used in *health* research includes individuals and families who sleep in shelters or other intermittent lodgings as well as “absolute” “core” or “sustained“ homeless, such as individuals and families who sleep outdoor or at places not intended for human habitation with low external protection (Hvang, Tolomiczenko, Kouyoumodijian and Garner (2005) “Interventions to Improve the Health of the Homeless: A Systematic Review” American Journal of Preventive Medicine, 29 (4) .311e1-311-9 and European Observatory on Homelessness , 2017.

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Therefore, the *minimum mortality temperature* (MMT) degrees vary across the regional climatic and atmospheric conditions. Lower MMT levels prevail in cooler lands while higher in warmer regions. The differences in MMT could indicate the differences in levels of acclimatization of population exposed to given climatic conditions (Guo et al., 2014). Guo at al., (2014) established, based on data from 12 countries in different climatic zones, that MMT is found at approximately the 75th percentile of the temperature distribution, varying between the 66th and the 88th percentile. However, Tobias et al. (2017) detected a much wider range of the MMT among cities in Spain. Some studies in Finland indicated that MMT temperature ranges between 12-17^{0}C while in Mediterranean climatic zone, the lowest morality was observed at 22 -25 ^{0}C (Keatinge et al.,2000; Häyhä, 2005, 2007; Tobias et al, 2017). As observed, mortality risk induced by temperature and/or other atmospheric conditions varies with *biothermal resilience* of the population. However, the differences in population fragility and exposure to mortality-related atmospheric hazards depend also on socio-economic, demographic and non-climatic factors. Hondula et al., (2015); (Shi & Stevens,2010) have found that urban environments with high percentage of children, elderly, disabled individuals and residents with minority background living on low income and with low educational attainments are highly exposed to life-threatening atmospheric dangers, although the key explanatory variables varied from one city to another.

Outside their biothermal temperature comfort, people could be highly fragile to hot-or-cold-ambient impacts, thus elevating the relative risk (RR) of life loss (Lucas et al., 2014). The multi-country study by Lucas et al. (2014) has estimated the overall cumulative exposure-response curves (figure below) for mortality in four European cities with the corresponding minimum mortality temperatures and cut-offs used to define mortality- temperature thresholds.

Risk increases slowly and linearly for cold temperature below the MMT, although in London and Madrid it showed a higher increase in extreme cold than in Stockholm and Rome in 2016. Risk generally escalated quickly and non-linearly at high temperatures. Death attributable to extreme heat is roughly as frequent as death attributable to moderate heat, while death attributable to extreme cold are negligible compared to death caused by moderate cold in cities analysed (Baccini et el. (2011).

Exposure-response associations between high temperature and mortality in four European cities together with related temperatures distribution shown below are adopted from the European Environmental Agency elaboration on temperature-induced death vulnerability in four large European cities (December 2016) (https://www.eea.europa.eu/data-and-maps/figures/associations-between-temperature-and-mortality).
The shaded grey area delineates the 95% of empirical confidence interval (C I) for death occurrence. Solid grey vertical lines delineate the 2.5 and the 97.5th temperature percentile.

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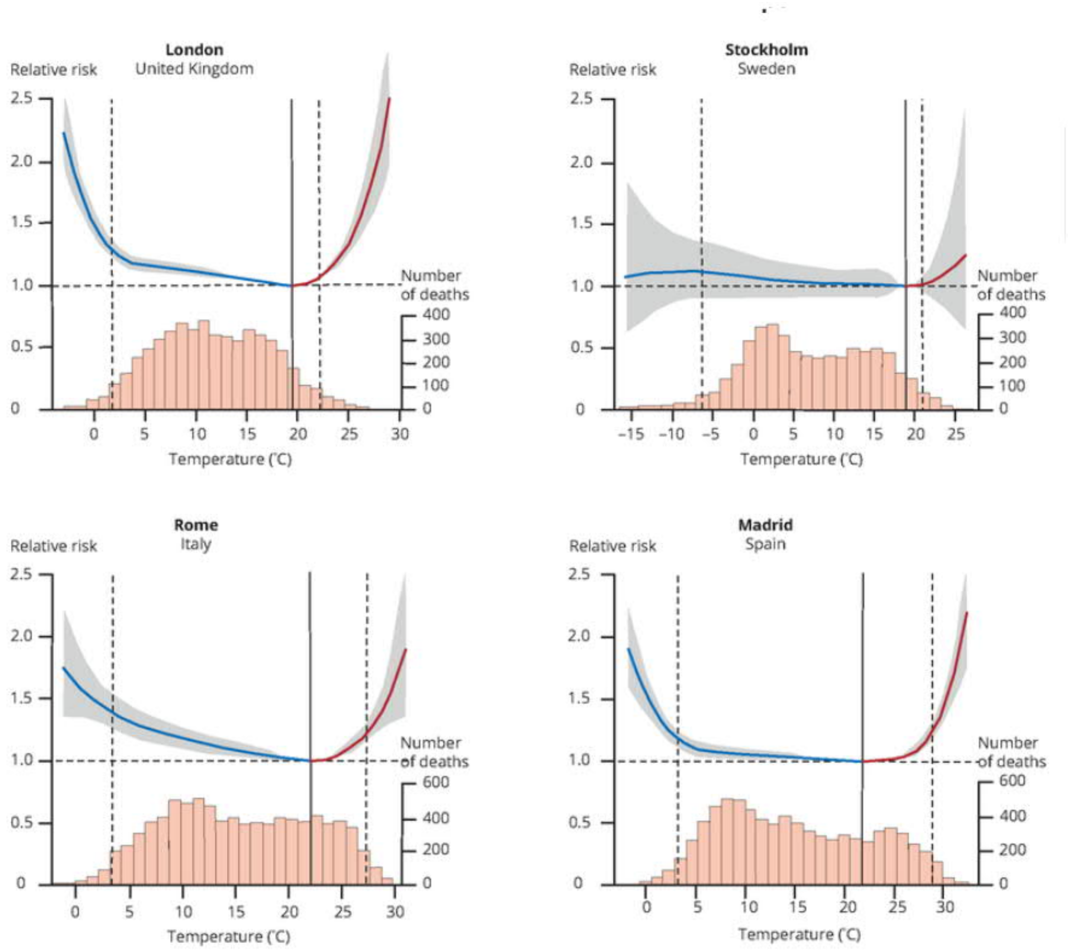

Figure 11: Association between Temperature and Mortality in Four European Cities (2016)
Source: London School of Hygiene and Tropical Medicine, reproduced by The European Environmental Agency,2016 Maps and Publications (https://www.eea.europa.eu/data-and-maps/indicators/heat-and-health-2/assessment

Other studies (Josseran et al.,2011; Wolf et al., 2015) have estimated that about 1.6 - 2.0% of total mortality in the warm season could be attributed to heat. These results differ from research on heat and cold-related mortality in 18 French cities which revealed that between 2000 - 2010, 3.9 % of the total deaths was attributed to cold weather while 1.2 % to hot temperatures. That indicated that cold represented a bigger challenge to public health in France because it generates higher life risk even at moderately low temperatures. The study has concluded that French population better adapted to warm temperatures, albeit up to certain threshold, which, when slightly surpassed became an acute public health emergency problem (Pascal, Wagner, Corso, Laaidi, Ung, and Beaudeau; 2018). However, authors admit, relationship between temperature-mortality can vary broadly between different regional, and administrative settings because it is also affected by the techno-social standards of given location, i.e., the availability of heating at the dwellings and access to green areas which function as natural coolers and/or to mechanically cooled facilities when temperature exceeds caution level. In addition, the population's economic welfare and the quality of health-sector service do moderate the negative impacts of temperatures. These parameters might also determine the effectiveness of prevention measures in the place, i.e., how effectively the medical help and other social relief provisions protect the population exposed against health and life-threatening hazards. The quality of public health is important to all population sub-groups, but foremost to highly fragile groups because it is virtually certain that the length, frequency and intensity of heat waves will increase in the future as the climate change accelerates (Peseta II and Climate Cost in EU studies, 2018).

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An indication of what may become more frequent in the future, the figure below reviews the extreme summer temperatures registered in 2019 in countries located in the Northern part of European continent such as The Netherlands, Belgium and the UK which until recently seldom experienced heat emergencies.

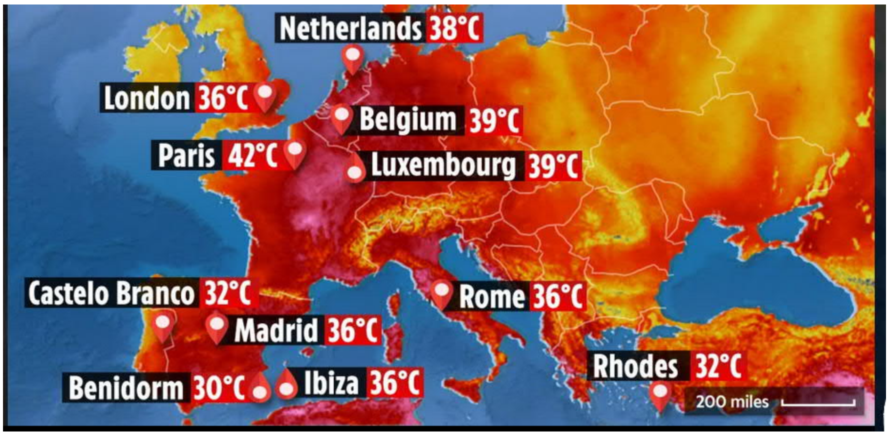

Figure 12:European Heat Waves 2019. 10. 28.
Source: The SUN Newspaper, July 26th, 22:40 hrs.

Several studies confirm that the homeless people are particularly vulnerable to variability in meteorological conditions, such as hot/cold weather and heat waves because the risk factors for mortality and morbidity arising from these factors correlate closely with the characteristics of homeless individuals (see Ramin and Svoboda, 2009 for literature review). Pre-existing psychiatric illness has been shown to triple the risk of death from extreme heat. Other risk factors for death during heat waves include cardiovascular disease, pulmonary disease, advanced age, living alone, substance abuse and cognitive impairments. In addition, homeless are often forced to live in hazard-prone areas and often lack appropriate resources to protect themselves against potentially harmful events (Winchester, 1992; Wisner, 1993). These characteristics make them extremely fragile and susceptible to hazard strains. Furthermore, majority of homeless in the EU live in urban and sub-urban areas where they are at increased risk from heat waves due to "heat island effect" (Bouchama, Dehbi, Mohamed, Matthies, Shoukri, and Menne; 2007). The effect occurs because the built structures such as concrete, asphalt and metal preferentially absorb heat that is then re-radiated thereby causing urban areas to be 5-11^{O} C warmer than surrounding rural regions.

Also, several climate change studies do project that increasingly higher numbers of urban population will be exposed to heat-related atmospheric adversities and thus also the homeless persons because the numbers of city inhabitants in some metropolitan areas are expected to increase substantially toward 2050 (Confalonieri et al., 2007).

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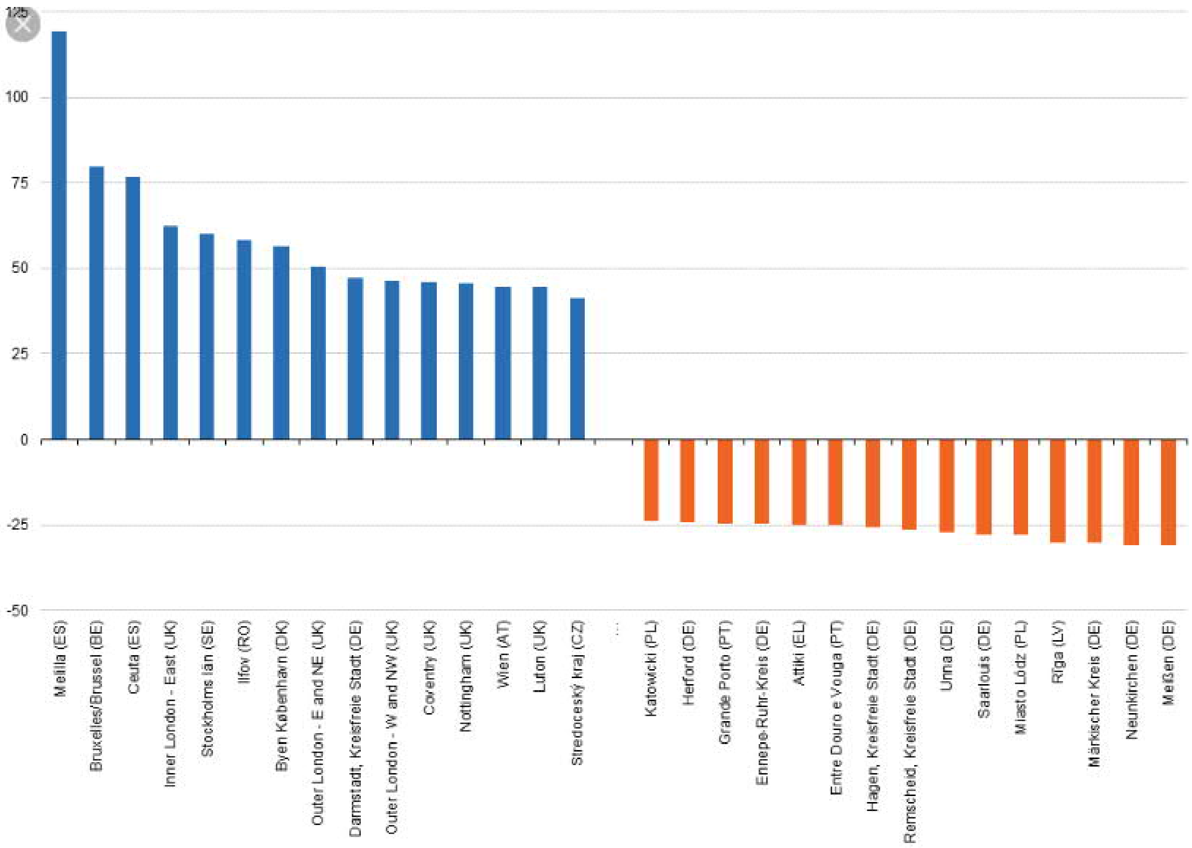

Figure 13: Projected Rates of Change of Number of Inhabitants of 15 Predominantly Urban Regions in the EU-28 during the Period 2015-2050
Source: Eurostat (2016) "Urban Europe – Statistics on Cities, Towns and Suburbs- Pattern of Urban and City Developments"

Because it is not unlikely that the frequency and duration of heat extremes such as the numbers of monthly heat records will increase, the consequence will be a marked increase in inhabitants' thermal discomfort levels in many EU cities. This might lead to higher numbers of excess heat-related deaths, unless effective adaptation policy measures are deployed. People in highly urbanized areas are projected to be at higher risk of heat stressors as compared to those living in rural surroundings because of lesser greenery in city landscape capable to absorb the heat and counteract higher heat accumulation in build structures producing urban heat islands that amplify ambient excess warming. (Peseta II and Climate Cost in EU studies, 2018).

A study exploring changes in heat/cold ambient temperature impacts on human wellbeing and death risk shows a doubling or tripling in frequency of "great discomfort" in some EU southern cities like Athens and Palma among general publics. Also, observational evidence (1959-2018) and short term-forecast until 2025 of ambient temperature changes in the northernmost European cities (Helsinki Vantaa, and Oulu) show that the heat-induced discomfort is becoming increasingly more frequent because high temperature spells have nearly quadruplicated there during the last decade (Found, 2019). The graphics below illustrate changes in hot/cold days per decade in Athens (a) Sophia (c), Palma (e), Paris (g) Rotterdam (i), and Helsinki Vantaa (k).

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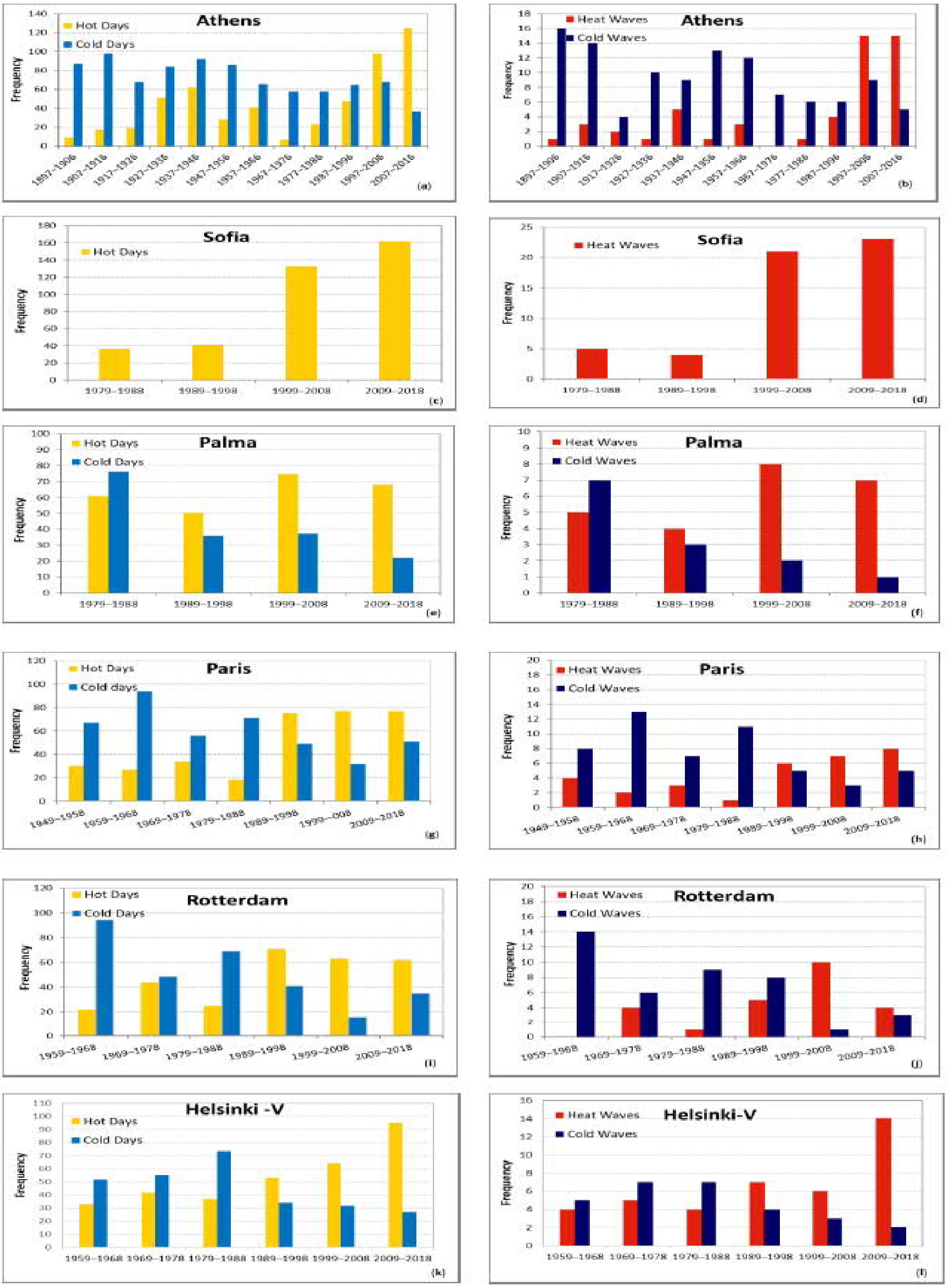

Figure 14: Frequency of (total number of hot/cold days per decade in Athens,Palma,Paris, Rotterdam, Helsinki (Vantaa)
Source:Founda d., Pierros F., Katavoutas, G., and Keramitsoglou „Observed Trends in Thermal Stress at European Cities with Different Background Climates", Atmosphere, 0,436. p.9

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It is interesting to observe that in all cities studied warming trends are associated with simultaneous decreasing trends in occurrence of cold extremes, namely cold days, even in Helsinki where the decrease become more abrupt since 1980s. The readings of ambient temperature at Helsinki Vantaa has shown the frequency of hot days has been increasingly progressive since 1980s and that a very prominent increase in occurrence of hot days is observed during the last decade (2008-2018). As result of these temperature changes, the frequency of cold-induced discomfort conditions for population exposed dropped by more than 20% in Helsinki Vantaa and Oulu during the last decade as compared to decade 1976-1985 (Founda, 2019). The frequency of cold-related discomfort conditions has also lessened in Rotterdam and Paris during the last decade as compared to the 1970s, while in Athens and Palma, these changes were negligible. On the other hand, however, as the levels and the duration of heat waves have increased in latter cities, so did also the risks of thermal discomfort for the focal population. Because the impacts of heat spells enhance the health and life threats to all population segments, below we present the ranks in heat discomfort conditions for different locations as expressed by heat index (HI) levels.

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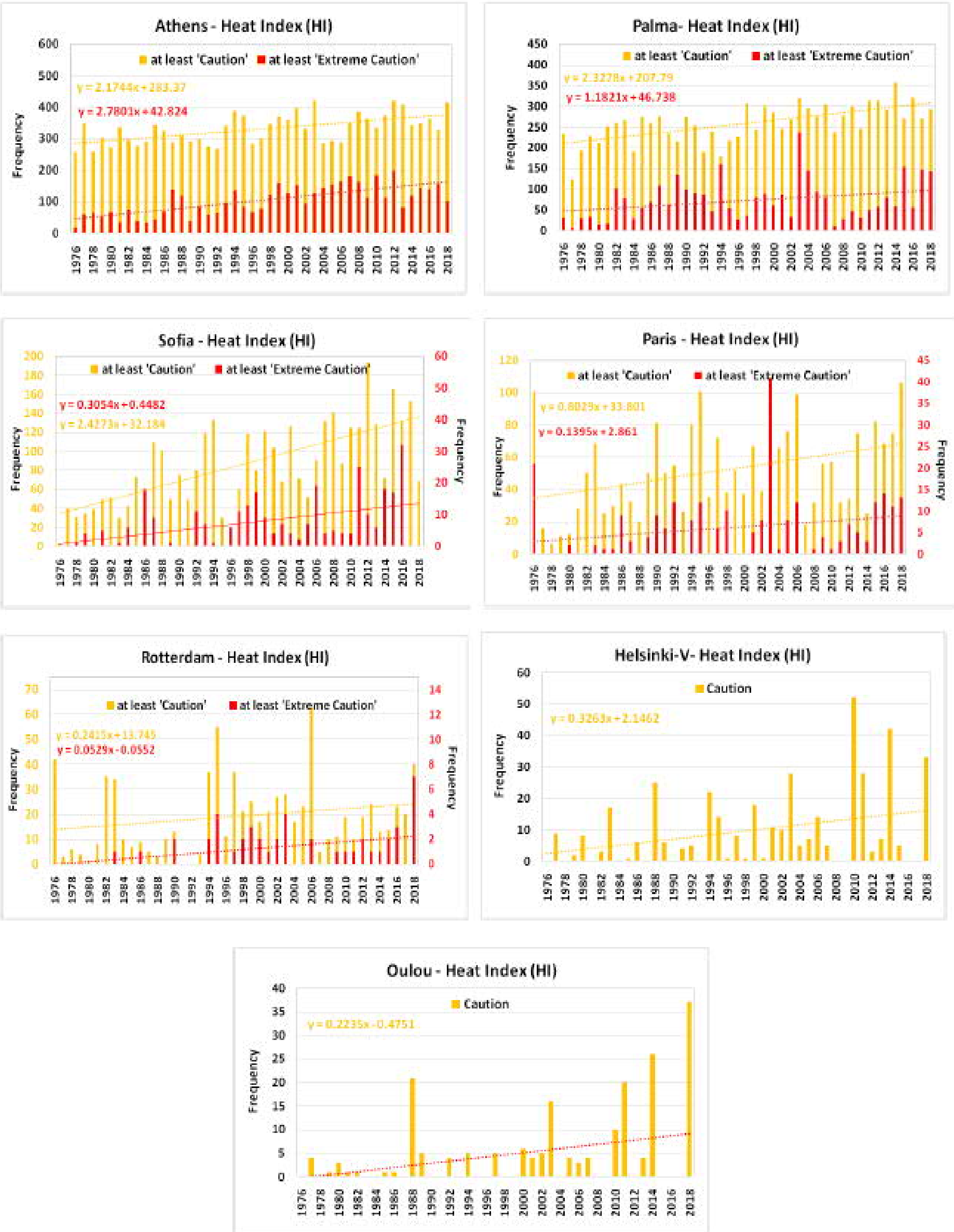

Figure 15: Frequencies (Number of Cases from the Three-hour Resolution Observations) of at Least "Caution" (HI >270C) and at Least "Extreme Caution" (H I> 32 0C) Condition Based on the Heat Index (HI) Classification at European Cities over the Period 1979-2018.

Source: Founda D., Pierros, F., Katavoutas, G., and Keramitsoglou "Observed Trends in Thermal Stress at European Cities with Different Background Climates", Atmosphere, 10,436. p.13.

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Based on the HI classification, all cities were found to experience statistically significant ($p< 0.05$) upward trend in frequency of at least "caution" and at least "extreme caution" condition over the years 2010-2018, except Rotterdam, where the occurrence of warm temperatures justifying "caution" and at least "extreme caution" conditions were significant at $p < 0.10$ (Found et al., 2019). As expected, noticeably higher frequencies are observed in cities with hotter background climate in summers such as Athens, Palma and Sofia and across other locations in Greece, Spain and Bulgaria. In 2015 heat waves in France caused more than 3,000 deaths alone. Even cities in the northernmost latitudes such as Helsinki Vantaa and Oulu, the recommendation of "caution" because of ambient temperature became increasingly more frequent during the last decade. Such conditions were almost never observed in the 1970s, while the "extreme caution" condition did not occur at all.

Since the latter finding might have quite large bearings on vulnerable social groups in Finland, below we explore in-depth the temperature-mortality relationship for this country. For this purpose, two studies are reviewed. The first is the Simo Näyhö's (2007) work which established causal link between the variability in ambient temperatures and mortality rates in Finland. Using observational data, the study has shown that between 2000 and 2005 the fewest deaths (126 per day) occurred at a mean daily temperature of 12 ^{0}C, and that the deaths increased to 138 per day (by 10%) on the warmest days (+24 ^{0}C), and to 151 per day (20%) on the coldest days (-31^{0}C). An estimated 160 deaths per day (0.3% of all deaths) were attributed to higher than optimal temperatures and 2,400 deaths per year (5%) were ascribed to low temperatures. In individual years, the fraction of deaths attributable to heat varied from 0 to 0.5% with little consistency across the summer temperatures. While the relative risk of an individual dying from heat increased consistently with rising temperatures, most heat-related deaths occurred at temperatures less than +20 ^{0}C. During the warm spell in summer 2 000, deaths increased by an estimated 360 cases (0.7% of annual deaths) but decreased to 250 (0.5%) once the Midsummer Festival was excluded. Näyhö concluded that as the high temperature spells might become more frequent and more haphazard in future, heat might become a severe threat to public health in Finland, which was not the case until the last decade. Figure below shows excess mortality rates related to low and high temperature levels in Finland.

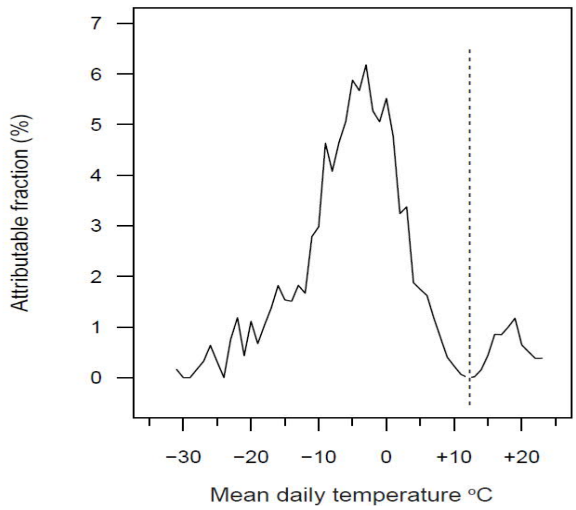

Figure 16: Fraction of Excess Mortality, 2000-2005, Attributable to Temperature Changes Relative to Temperature with the Lowest Mortality. The Temperature of Lowest Mortality (12 0C) is Shown by Vertical Line.
Source: Adopted from Näyhä, S., (2007) "Heat Mortality in Finland in the 2000s", International Journal of Circumpolar Health, 66:5, 418-424.

Another study, performed by Ruuheal, Hyvärinen and Jylhä (2018) from the Finnish Meteorological Institute is quite important because it has explored the numbers of deaths registered across 24 hospital districts in Finland during 2000– 2014 and assessed the regional differences in temperature-mortality relationships at NUTS 5 level. The work by Ruuheal and colleagues has thus elongated the study period covered by the Naynä's research, also the methodology was much more sophisticated. The daily numbers

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of all-cause all-aged deaths were studied in each hospital district by using daily mean temperatures spatially averaged across each hospital district to assess exposure to heat stress and cold stress. The relationships were modelled using distributed lag non-linear model (DLNM). The study incorporated findings from clinical observations indicating that the effects of hot temperature on mortality appear on the same day and usually last few days, while the effects of cold stressors appear after a couple of days and might last about 10 days or even week (Anderson et al., 2009). Taking heed of the above, the authors adopted a 25-day-lag on cold-induced mortality. In a simple model version, no delayed impacts of heat and cold on mortality were considered, whereas a more complex version included delayed impacts to 25 days. Subsequently, a meta-analysis with selected climatic and sociodemographic covariates was conducted to study the differences in the temperature-death relationships between the hospital districts. A pooled mortality-temperature relationship was produced to unearth the average relationship in Finland. The simple DLNM model version gave U-shaped dependencies between mortality and temperatures without exception. The outputs of the model version with a 25-day- lag were also U-shaped almost in all hospital districts. After the meta-analysis was performed, it has shown that the differences in the temperature-mortality relationships between hospital districts were not statistically significant on the absolute temperature scale, meaning that the pooled mortality-relationship can be applied to the whole country. However, on the relative temperature scale heterogeneity was found and the meta-regression suggested that morbidity index in combination with population demographics in the hospital district might explain some of this heterogeneity. The pooled estimate for the relative risk (RR) of mortality at daily mean temperature of 24 ^{0}C was 1.16 (95% CI 1.12-1.20) with reference at 14^{0}C which is the minimum mortality temperature (MMT) of the pooled relationship. On the cold side, the RR at daily mean temperature – 20^{0}C was 1.14 (95% CI 1.12-1.16). On a relative scale, of daily mean temperature, the MMT was at the 79th percentile. Excerpts from the various hospital districts studied with annual temperature distribution over 1981-2010 and mortality rates in 2014 are shown below.

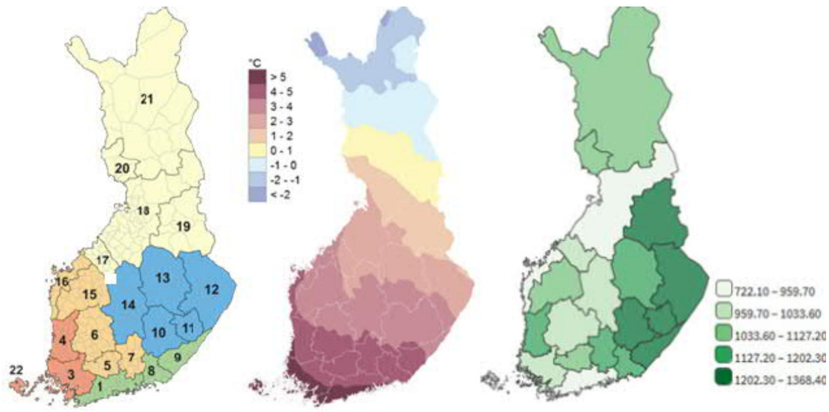

Figure 17: Hospital Districts (Left 2011) Annual Mean Temperature in Finland during 1981-2010 (Middle) and Mortality Rates (1/100,000) by Hospital District in 2014 (Right)
Source: Ruuhela, R., Hyvärinen, O., and Jylhä, K. (2018) "Regional Assessment of Temperature-Related Mortality in Finland", International Journal of Environmental Research and Public Health" 15, 406, 21-13.

Further, mortality-related to cold temperatures in two capitals of the Baltics: Tallinn and Riga were analysed by Åströ and al., (2019) to test the association between *cold* ambient conditions and all-cause mortality as well as the cause-specific mortality in these two Northern European cities. The study collected daily information on deaths from the state death registries and data on minimum temperatures from November to March over the period 1997-2015 in Tallinn and 2009-2015 in Riga. In total, there were 36.646 deaths in Tallinn and 27.495 deaths in Riga during the study period. The relationship between the daily minimum temperature and mortality was assessed using the Poisson regression, combined with distributed lag non-linear model (DLNM) with mortality lag time up to 21 days. The results showed significantly higher all-cause mortality occurring during periods with cold-temperature both in Tallinn (Relative Risk (RR)= 1.28, 95% Confidence interval (CI) 1.01-1.62) and Riga (RR=1.41, 95% CI:1.11-1.79). The minimum mortality temperature (MMT) was similar in Tallinn and in Riga at 4.0 ^{0}C and 4.4 ^{0}C, respectively. The MMT was found at the 94.2 and 89.6 percentiles of the cold season temperature distribution in Tallinn and Riga, respectively. Results are presented for the cumulative relative risk (RR) over lags of 0 to 21 days, at the 5th percentile of the city-specific temperature distribution, using the city-specific MMT as a reference. The study has shown that cold temperatures significantly increased all-cause mortality in Tallinn and in Riga. In Tallinn, all-cause mortality has increased by 28% (95 % CI) and, in Riga mortality has increased by 41% 95% (CI:11-79%). All-cause mortality increased slowly below the seasonal MMT in both cities. Due to the choice of the function used to describe mortality, the increase is not entirely linear with similar effects between 0 ^{0}C and - 5 ^{0}C.

In addition, significantly increased mortality was observed in the 75+ cohort (RR= 1.64, 95%, CI 1.17 -2.31 and among people suffering from cardiovascular condition (RR=1.83, 95%, CI 1.31 - 2,55) in Tallinn (but not significant in Riga), and in the *under 75 age* group in Riga (RR = 1.58, 95%, CI 1.12 - 2.22). The study did not find statistically significant relationship between mortality due to respiratory diseases and low temperature periods or external causes and cold days. The cold-related attributable (death) fraction (SF) was 7.4% (95% CI: 3.7-17.5) in Tallinn and 8.3% (95% CI: - 0.5 -16.3) in Riga. These results indicate that relatively large proportion of all-age deaths in these two Northern European cities could be attributed to low winter temperatures.

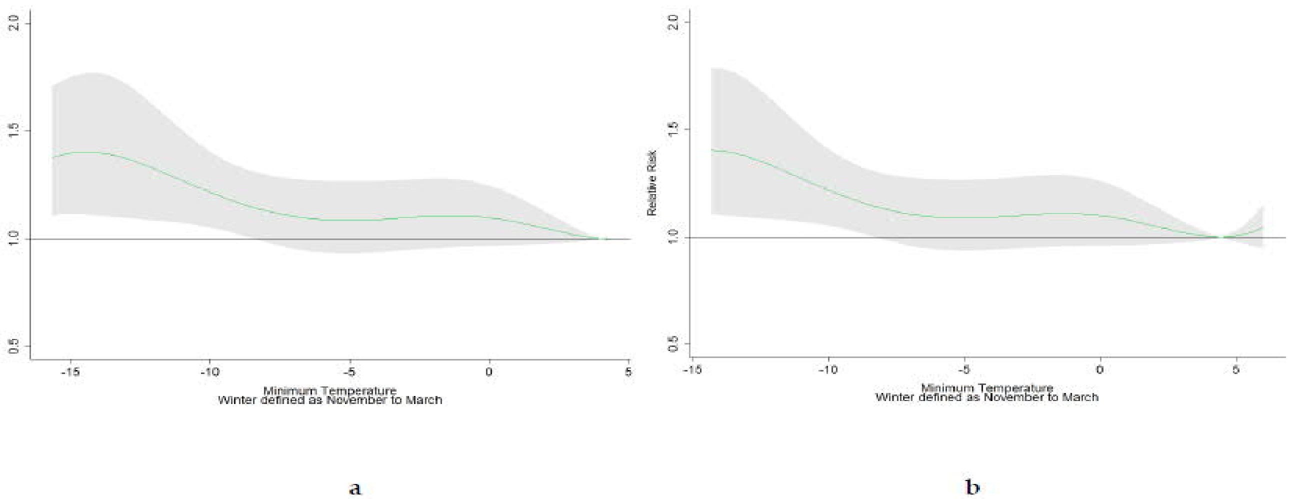

Figure 18: Cumulative Effect on Mortality over Lags between 0-21 Days for the Winter Months (November to March in Tallinn (a) and Riga (b). Shading 95% CI.
Source: Åström, D, A., Veber, T., Martisone, Z., Kaluznaja, D., Indermitte, E., Oudin, A., and Orru, H., (2019) "Mortality Related to Cold Temperatures in Two Capitals of the Baltics: Tallinn and Riga", Medicina, 55, 429, 1-11, p.4

The amplification of future occurrence of extreme temperatures on urban population was studied by Martinez et al. (2018) in Vilnius, Lithuania and mortality projections for the near and more distant future periods elaborated. The temperatures in Vilnius during summer and winter seasons for 2009-2015 were assessed and used as baseline for projecting summertime and wintertime daily temperature for two prospective periods, one for the near future (2030 -2045) and another for the far future (2085 -2100), both under the Representative Concentration Pathway (RCP) 8.5 global warming indicators (IPCC, 2016).

Then, the historical relationship between temperature and mortality during the 2009-2015 was estimated and projected for two future periods, 2030 - 2045 and 2085 - 2100 considering changing climatic conditions and population numbers while also assuming alternatively no acclimatization and acclimatization scenarios to the heat and cold, based on a constant percentile threshold temperature. Results showed that during the baseline period 2009-2015 an increase in daily mortality was detected when the maximum daily temperature reached 30 ^{0}C (the 96 the percentile of temperature series) amounting to average 7 deaths

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per year. Regarding wintertime cold-related mortality during the baseline years 2009-2015, an increase in mortality on days when the minimum daily temperature fell below – 12 ^{0}C was also observed (the 7th percentile of the temperature series) with an average around 10 deaths/year.

During the near future timeline (2030-2045) the annual average heat-related mortality was forecast to reach 24 deaths/year (95% CI: 84- 38.4), and 46 deaths/year (95% CI:16.4 -7.4) during 2085-2100 if no acclimatisation or adaptation measures were deployed during these two periods for shielding population against hot temperatures. When such heat acclimatisation scenario was assumed, mortality would not increase significantly neither during 2030-2045 nor during 2085-2100. Keeping the threshold temperature constant, annual average cold-related mortality might decrease markedly during 2030-2045 to 5 deaths/year (95% CI:0.8 -7.9) and even more during 2085-2100, down to 0.44 deaths/year (95% CI: 0.1 - 0.8). However, when assuming a “middle ground” between the acclimatisation and non-acclimatisation scenarios, the decrease in cold-related mortality would not counterbalance the increase in heat-associated mortality. The study concludes that the increased risk of heat-related mortality will exceed the reduction in risk of cold-related deaths during the both future periods. Hence, there is a growing need for public health authorities to put in place measures protecting population of Vilnius against deaths from thermal stress.

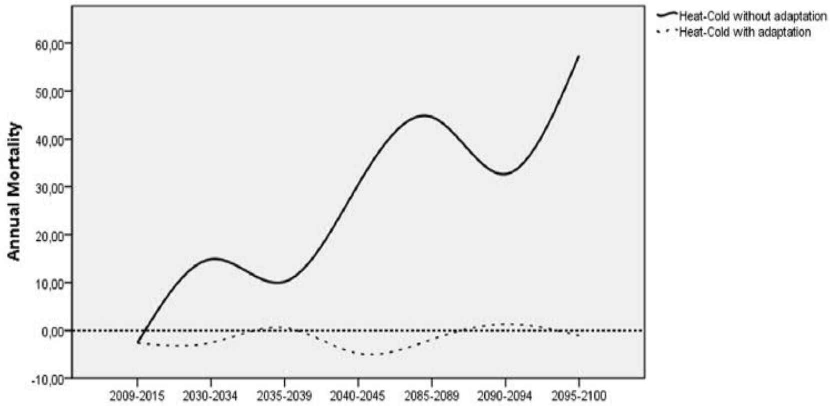

Figure 19: Time Trend of the Annual Mortality in Vilnius, Lithuania, Attributable to Heat and Cold during Different Periods of Time and Depending on Deployment and Non-Deployment of Public Health Adaptation Policy Measures.
Source: Adopted from Martinez, G.S., Diaz, J, Hooyberghs, H., Lauwaet, D., De Ridder, K, Linares, C., Carmona, R., Ortiz, C., Kendrovski, V., Adamonyte, D. (2018),"Cold-related vs Heat-related Mortality in a Changing Climate: A Case study in Vilnius (Lithuania)" Environmental Research, October, 166, 384-393, p.390

The association between temperature and daily mortality was also explored among the citizens of Oslo during 1990-1995 by a study performed by Nafstad, Skrondal, Bjertness (2001). Data on daily mortality were linked to daily temperature, relative humidity, wind, velocity and air pollution. At temperature below 10 ^{0}C a 1 ^{0}C fall in the last 7 days average temperature has increased the daily mortality from all diseases by 1,4%, respiratory disease by 2.1% and cardiovascular diseases by 1.7%. Above 10 ^{0}C there was no statistically significant increase in daily mortality, except for respiratory mortality, which increased by 4.7% per 1^{0}C increase in the last 7 days average temperature. The increase starts at lower temperatures than that observed in the warmer regions of the world, but at higher temperatures than in regions with ever colder climates.

A more recent study which investigated the evolution in minimum mortality temperature in Stockholm, Sweden (Åström,Tornevi, Ebi, Rocklöv, Forsberg (2016) used the variations in daily mean temperatures to investigate whether minimum mortality temperature (MMT) did change in Stockholm from the beginning of 20th century to 2009. Findings indicate that that throughout the 20th century, MMT ranged from 10.3^{0}C to 20^{0}C (median 17.4 ^{0}C). Relative MMT ranged from the 64th percentile to the 95th percentile of lag 0 ^{0}C distribution (median = 90th percentile). Similar results were found from sensitivity analyses, which used 10 degrees of freedom for the time trends. The mean temperature in Stockholm increased from 6.0 0 C during

1900 -1929 to 7.4 0C during 1980-2009. The increase in both absolute and relative MMT over the entire period analysed was also observed. However, the absolute MMT during for decade 2000-2009 reached 16 ^{0}C which indicates that the Stockholm population might have acclimatized to gradual increases in thermal averages over this time.

6.3 Links between Temperature and Mortality among Vulnerable People in BuildERS-study Countries

In the following, D3.1 reviews several studies which connect the risk of death with ambient temperatures that the particularly fragile human groups in the EU, **the homeless people** are exposed to. Homeless people constitute an EU-wide subpopulation who live under conditions of perpetual disaster often leading to trauma-related disorders, which sometimes, but for limited time only, might contribute to the so called “stress-induced resilience” (Southwick et al., 2014). However, as individual resilience is primarily related to personal strength deriving from healthy life conditions which allow return to sound baseline functioning after a highly adverse event, *the stress-induced resilience* might not protect homeless and/or rough sleepers against negative impacts of more frequent natural events nor against life risks produced by long-term atmospheric changes imposing not catastrophic but still deadly risks (Bonanno, 2004; Bonanno, Westphal and Mancini (2011)[45].

Also, impacts of natural disasters and atmospheric variability disproportionally place persons with disabilities and their families in life threatening situations. Persons with disabilities who might live with their families, could be helped during evacuation and during post-disaster recovery. However, empirical evidence from several natural disasters examined by the Center for International Rehabilitation (2005), World Health Organisation (2005) and other studies reviewed by Hemingway and Priestley (2015) reveal that disabled people are at greater risk of injury, mortality, disease, destitution and displacement when compared with general population, even in highly developed countries. More, the reviewers conclude that “the disabled people’s lives were put adversely at risk, not simply by individual limitations but by social and environmental factors. These included the vulnerability of buildings and facilities used by disabled people, an absence of specific evacuation plans, inaccessible warning information, lack of accessible evacuation transport, and sometimes, the actions of neighbours, staff and rescue workers” Hemingway and Priestley, (2015). Further in the face of climate change, and in the times of environmental and/or humanitarian disasters, the relative poverty of persons with disabilities, combines with the problems listed and may precipitate greater illness and even death (UN Department of Economic and Social Affairs (2011; www.disability-europe.net).

Most of the homeless live in cities and towns, majority of them are men (The Abbé Pierre Foundation FESNTSA, 2018; Baptista et al., 2017). However, growing numbers of women with young children and even single young children or young adults have joined the homeless cohorts over the last decade.
Family homelessness is revealed to be highly gendered i.e., it was experienced by lone women parents and their children at very disproportionate rates. Unlike lone adults experiencing sustained or recurrent homelessness, homeless families were not reported as often characterised by severe mental illness, addiction or limiting illness or disability. A broad association between family homelessness and existence

[4] For comprehensive review of definitions and content of “individual resilience construct” see Southwick et al; 2014.
[5] This definition of resilience is not promoting “*ableis*t” which according to Amundsen and Taira (2004) is a doctrinal posture that “falsely treats people with impairments as inherently and naturally horrible and blame the impairments themselves for the problems experienced”. For a comprehensive review of issue of ableism as “ideas, practices, institutions and social relations that presume “able-bodiedness” and by so doing construct people with disabilities as marginalized and largely invisible “Others”, see Kumari-Campbell, F., (2008) “Refusing Able(ness): A Preliminary Conversation about Ableism”, M/C Journal, 11, 3, pp.1-5

of poverty was reported as were associations with inadequacies of supply of affordable housing and well paid jobs (Busch-Geertsema, Edgar, O'Sullivan and Pleace (2010); Baptista et al., 2017).

The latest update on housing exclusion in Europe published by The Abbé Pierre Foundation FESNTSA in 2018 provides highly disturbing statistics on the scale and human costs of homelessness in Europe. According to data presented there, 13,371 was the enumeration of estimated deaths among homeless people in France between 2002 and 2016. Average age of death of homeless person was 49.6 years, and 47 years in Great Britain. In Amsterdam, mortality among homeless people was 3.5 times higher than in population as whole and shortened by 30 years life expectancy of this very cohort as compared to general population. Rough sleepers' standardized mortality ratios could be 10-13 times higher compared to general population in the EU. The average amount of person's life spent as homeless could be as high as 10.3 years. The FEANTSA foundation has also revealed that children under the age of 18 are severely affected by homelessness in Europe. In Ireland, 3,333 children were homeless in November 2017, up 276 % since November 2014. In Sweden, between 10,000 and 15,000 children were homeless in April 2017 which displayed 60% increase in emergency accommodation between 2011 and 2017. In 2015 4,000 children were registered as homeless in the Netherlands, 60% up on 2013.

The longer a person stays homeless the more likely he/she would suffer from cancer, cardiovascular and respiratory diseases, accidents, intoxication and/or danger of suicide. Homeless people also experience severe poverty and oftentimes come from disadvantaged minorities, the factor that independently is associated with poor health. For more comprehensive review of literature supporting the above factual data please refer to Ivers, Zgaga, O'Donoghue-Hynes, Heary, Hallway and Barry (2018).

As homeless people belong to a segment of the EU population which is highly susceptible to excess mortality caused not only by distinctive natural perils by also by seemingly not dangerous ambient variability, we collected some statistics to approximate the scale of these people's plight in different BuildERS countries and to substantiate the need for more in-depth exploration of these people life threatening hazards by the BuildERS survey investigations.

Although homelessness statistics in the EU are quite sketchy, they indicate that the numbers of people sleeping rough have risen during 2013-2017 and so did their mortality attributable to atmospheric and hydrological severities, at least in the locations reviewed. The table below provides some estimates of the scale of homelessness problem in selected EU countries. The homeless stock of population is divided into three categories – the individuals who are natives of the home country, households with several members (could vary between two and more) residing in home country but also with people from foreign countries, and refugees/migrants registered by the national authorities or by the care and shelter providing NGOs. The counts were done at different points in time during 2014-2016-2017. Data were retrieved from the "Global Homelessness Statistics" Europe chapter, available at https://homlessnessworldcup.org./homelessness statistics. In this context it is essential to stress that enumeration of homeless migrants might not be reliable because it requires "counting the uncountable" (Triandafyllidou, 2010). Thus, to the degree these figures include irregular migrants who remain unregistered, they are probably severely underestimated because such people seek to be invisible.

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Table 6: Estimated Numbers of Homeless People in Some EU Countries/Cities Broken Down by Status and Year of Enumeration (2013, 2016,2017)

Country	Native Individuals	Native Households	Refugees/ Migrants	2013	2016	2017
Austria	x		X		35,900	
Belgium/Brussels	x	X			3,386	
Finland	X		X			7,112
France	X	X	X	103,000		
Germany	X	X	X			860,000
Greece	X	X				21,216
Netherlands	X	X			31,000	
Norway	X		X		3,909	
Poland	X					30,408
Portugal	X			4,420		
Romania/Bucharest	X			6,000		
Spain	X	X				31,000
Sweden	X	X				33,250
Switzerland/Zurich	X		X			4,801

Source: Global Homelessness Statistics, Europe, htttps://homelessworldcupt.org/homelessness-statistics/

Records in the table above are not consistent. Some refer to entire countries while others to cities with large concentration of homeless stock. Two large EU countries, France and Germany with large subpopulations of those who live on streets, do not inform how these groups are distributed across large cities or towns. In the pursuit of more detailed knowledge, a longitudinal study investigating the scale, causes and the dynamics within the homeless populations which took place during 2013-2018 in London and across the UK regions "The Homelessness Monitor: England 2019" was consulted. Figure below shows divided homeless stock into several different categories and how the numbers and structure of this subpopulation have enfolded from 2010 to 2017.

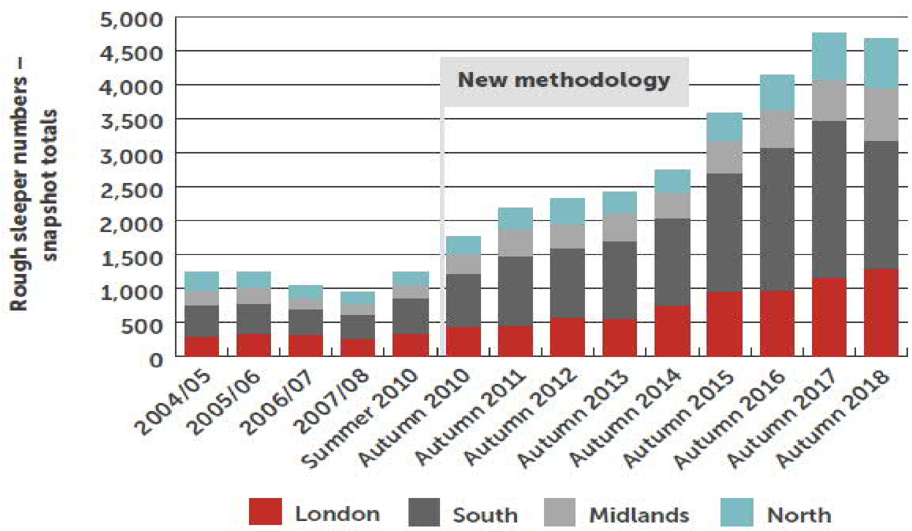

Figure 20: Trends in Local Authorities Rough Sleepers Estimates by Regions 2004-2018

Source: Fitzpatrick, S., Pawson, H., Bramley, G., Wood, J., Watts, B., Stephens M., and Blankinsopp, J. (2019) „The Homelessness Monitor: England 2019" Technical Report by Institute of Social Policy, Housing and Equalities Research (I-SPHERE), and The Urban Institute of Heriot-Wats University; City Futures Research Centre, University of New South Wales, May 2019, p.58.

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Figure above displays the trends and profile in evolution of homeless numbers in different England regions from 2004 -2018 showing seasonal variation between summer and autumn counts. Note that in Autum 2018 the rough sleeper enumeration marked the first reversal in the England's total for a decade. Notwithstanding that the England-wide total remained 165 p.c. higher than in 2010, it fell back by 2 p.c. on 2017. At the same time, however, a drop was recorded in only one of England's four broad regions, the largely non-metropolitan South. Here the numbers of recorded rough sleepers were 19 p.c. fewer than the numbers in Autumn 2018 compared to a previous year. In the other broad regions, population of rough sleeping persons continued to increase in 2018 – by 13 p.c. in London, by 28 p.c. in Midlands and by 7 p.c. in the North. Numbers rose substantially in the core cities of both Manchester (by 31 p.c.) and Birmingham (by 60 p.c.). Further, the homeless counts in great London area show a continuous rise during summer and autumn seasons from 2004 to 2018 because they have evolved from under 500 in 2004 to almost 1,250 in 2018, an increase exceeding 400 p.c.

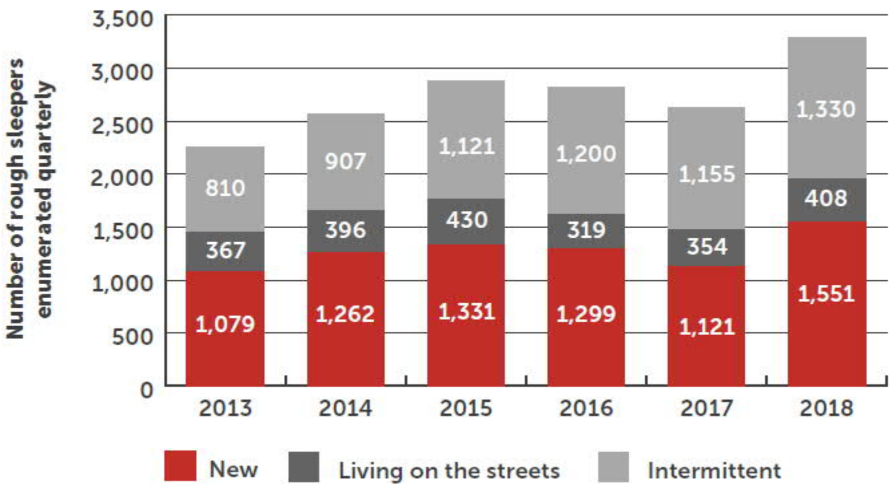

Figure 21 : London Rough Sleepers Enumerated Q4 2013-2018: Breakdown by Assessed Status (2013-2018)
Source: Fitzpatrick, S., Pawson, H., Bramley, G., Wood, J., Watts, B., Stephens M., a nd J. Blankinsopp (2019) „The Homelessness Monitor: England 2019" Technical Report by Institute of Social Policy, Housing and Equalities Research(I-SPHERE), and The Urban Institute of Heriot-Wats University; City Futures Research Centre, University of New South Wales, May 2019, p.61.

Figure above indicates that along with "new" homeless category, (i.e., people who recently were evicted from their homes, or those who suffered from mortgage repossession or lost dwelling due to natural or man-made hazards), and the "intermittent" rough sleepers (people who occasionally sleep at family home), and people "living on the street" did increase in number in Q4 2013 as compared with Q4 2018. However, the greater part of the increase was related to new rough sleepers, with numbers in this category growing by 38 p.c. in 12 months.

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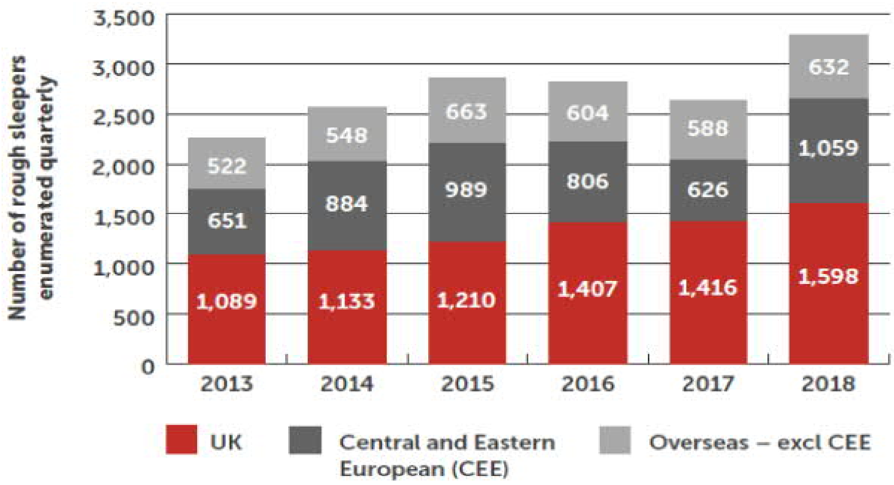

Figure 22: London Rough Sleepers Enumerated Q4 2013-2018. Breakdown by Home Regions of Rough Sleeper Sub-population.
Source: Fitzpatrick, S., Pawson, H., Bramley, G., Wood, J., Watts, B., Stephens M., and J. Blankinsopp (2019) "The Homelessness Monitor: England 2019", Technical Report by Institute of Social Policy, Housing and Equalities Research(I-SPHERE), and The Urban Institute of Heriot-Wats University; City Futures Research Centre, University of New South Wales, May 2019, p.60.

Data in figure above show the rising numbers of persons sleeping roughly who originated from three regions inside and outside the UK from Q4 2013 to Q4 2018, despite a slight reversal in 2017. This happened mainly owing to rise in a cohort of rough sleepers of Polish and Romanian origins, whose numbers increased by 69 p.c. compared with Q4 2017. Figure below shows the categories of people who compose the "Core Homelessness" sub-population, i.e., those who are not eligible to receive social help and support from local authorities.

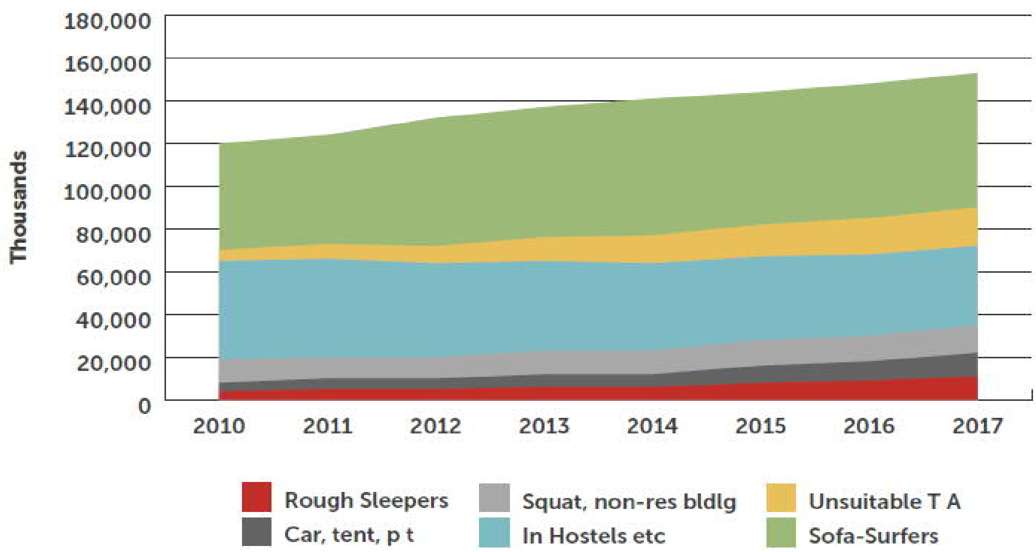

Figure 23: Core Homelessness by Category in England, 2010-2017
Source: Source: Fitzpatrick, S., Pawson, H., Bramley, G., Wood, J., Watts, B., Stephens M. and Blankinsopp, J. (2019) „The Homelessness Monitor: England 2019" Technical Report by Institute of Social Policy, Housing and Equalities Research(I-SPHERE), and The Urban Institute of Heriot-Wats University; City Futures Research Centre, University of New South Wales, May 2019, p.62.

As shown in figure above the core homelessness in England has risen from 120,000 in 2010 to 163,000 in 2017, an increase of 28 p.c. over the period. The rate of the overall increase has been fairly steady in this period. However, different components have shown contrasting trends. As the number of beds available at hostels and the likes has declined by nearly 20% during this period, the cases of rough sleeping and the related categories have increased quite strongly (as reflected in official statistics since 2010). The fastest growing component over the most of this period was Unsuitable TA (260 p.c. increase), reflecting

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the growing pressure on LAs as increased demand has faced static or falling supply of social lettings and increasing difficulty using private renting. The largest category of core homelessness is "sofa surfers", (encompassing people sleeping haphazardly at different places) which has risen by 26 p.c.

The publication by NGO FEANTSA Country Fiche 2018, "Homelessness in Italy" fio.PSD, 50,724 persons were registered as rough sleepers without roof over head in 2017 in Italy (htpps://www.fiopsd.org/country-fiche-2018/). What characteristics and conditions contributed to become a "homeless person" was explored by Italy's National Survey (2014) which revealed social profile of people falling under this category and mechanisms contributing to homelessness. A typical homeless person was a man (87.5% of the sample polled), a migrant (58.2% of sample pooled), living in Northern Region of Italy (56.0%) and a single (76.5%). He was 44-year-old on average (although migrants were younger than Italians). He worked few hours during a week earning an average 300 € per month. He lived on a street for a long time (2.5 years). He suffered from 1) lack of stable relationship with family and/or friends, 2) personal trauma, 3) inability to work causing long-term unemployment, and 4) some social and/or behavioural disorders.

Divorce and/or separation from the primary family caused by migration of younger males were among the most important triggers of homelessness and mental strain. The FEANTSA homeless data from 2017 show that only 14% of 50,724 homeless people were affected by severe physical condition, or mental and/or communication disorders. Women constituted 14.3% of homeless subpopulation in 2017. They had similar socio-demographic characteristics as men (divorced, separated, personal trauma related to forced separation from children). The highest concentration of homeless persons was in Milano (12 004), Rome (7, 709) and Palermo (2,887). These findings were confirmed by dataset collected by CARITAS Italy in 2017 which polled the users of its homeless counselling services. According to CARITAS records, 28 697 persons used counselling services in 2017 and demographics of this cohort are presented in table below.

Table 7: Homeless People Encountered into the CARITAS Counselling Services in Italy, 2017

Homeless People Demographics	Percentage Share	Homeless People Demographics	Percentage Share
Regional Macro Areas		***Marital Status***	
Northern	64	Married	34
Centre	24	Unmarried	43
Southern	12	Separated	9
Gender		Widowed	7
Men	70	Other	3
Women	30	***Educational Level***	
Age		No Title or Primary Education	30
Under 18	0.2	Lower Secondary Education	40
19-34	33	Upper Secondary Education	25
35-44	23	Bachelor	5
45-54	24	***Occupational Status***	
55-65	15	Employed	8
Over 65	5	Unable to Work or Retired	4
Average Age	42	Unemployed	80
Nationality		Irregular Jobs	2
Italian	33	Other	6
Foreign	67		

Source: Adopted from SPSD Elaboration by Italian Caritas Dataset (2018)" published by "Homelessness in Italy" at https/www.fiopsd.org/country-fiche-2018/)

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Considering that temperature impacts on human well-being, health condition and mortality might vary within the temperate climate zone where the UK, Baltic countries, Ireland, Italy, Germany and Poland are located, even small increases in cold and heat stressors might be fatal for homeless people. Research shows that, environmental conditions became a significant independent mortality risk factor for homeless cohorts, in addition to, or in combination with circulatory, respiratory and infectious diseases and addiction-related sickness. As mentioned, homeless people are particularly prone to some addictions, and have significantly shorter life-span as compared to general population. Further, rough sleepers often die of different causes than do members of general population. The below reviewed studies of relationship between ambient conditions and mortality among homeless people in Poland, Ireland, France, UK and Canada confirm these subgroups' extreme fragility and needs for stronger protection.

A study by Romaszko et al., (2017) has analysed mortality causes of 176 homeless people who died during 2010-2016 in the city of Olsztyn in north-east Poland with temperate climate of transitional type. The average life span of a homeless person was shorter by about 17.5 years than that of general population. The most frequent cause of death were circulatory system diseases, conditions related to smoking, and infectious diseases like tuberculosis. To characterize the association between the weather and the deaths analysed, meteorological data on minimum and maximum ambient temperatures and the Universal Thermal Climate Index (UTCI) were applied. The largest number of deaths occurred under conditions of cold stress (of different intensity). Deaths caused by hypothermia were thirteen-fold more frequently recorded among the homeless cohort than among general population. A relative risk of death for a homeless person even under moderate cold stress condition was higher (RR = 1.84) than that under *thermoneutral* conditions, i.e., when the UTCI values remained within the range of 9.1^{0}C and 26^{0}C.
Higher Relative risk (RR) of death among homeless people when temperature went down was also corroborated by the French study performed by Vuillermoz, C., Aouba, A., Grout, L., Vandentorren, S., Tassin, F., Moreno-Betancur, M., Jougla, E. and G. Rey (2016). Out of 1145 homeless registered death during 2008-2010, 693 cases were matched with database repositioning causes of death. Log-binominal regression was used to compare mortality among homeless to that of the general population. The homeless people who died were 49 years old on average compared to 77 in the general population during 2008 -2010. Overall, homeless death rates were slightly higher during winter. Among homeless cohort the risk of dying from hypothermia was the highest (RR = 6.4). Deaths associated with alcohol intoxication (RR= 1.7) were less likely, while RR of deaths attributed to mental disorder, diseases of digestive and circulatory systems and undetermined causes varied between 1.5 to 3.7. The authors postulate needs for more research to establish the interaction between cold temperature, alcohol abuse and low temperature impacts on risk of dying by members of rough-sleeping sub-populations.

Data on deaths of people who experience homelessness in Dublin Region in Ireland were analysed by Ivers, Zgaga, O'Donoghue-Hynes, Heary, Gallwey and Barry (2018). Two hundred and nine deaths were recorded during 2011-2015 among homeless people with 156 deaths verified as males (77.6%). Drug and alcohol-related poisoning were among the leading causes of death and accounted for 38.4% of deaths. Although the authors did not explicitly analyse the association between mortality and temperature, they have however observed that at least 20% of deaths registered occurred when temperature dropped to – 3 ^{0}C and that all these deaths could have been avoided had the emergency accommodation was provided by the Dublin City Council. In addition, the Irish Examiner newspaper from December 14th, 2019 also observed that the Dublin city councillor could not offer enough temporary lodgings to shelter all homeless citizens during period of 2018-2019 winter frost.

Also, mortality causes among homeless individuals were assessed by the Office for National Statistics for England and Wales in 2017 which detected that the impacts of extreme weather such as cold and/or heat waves and hydrological and fire hazards, plus some other pathologies were quite preponderant death causes among this subpopulation.

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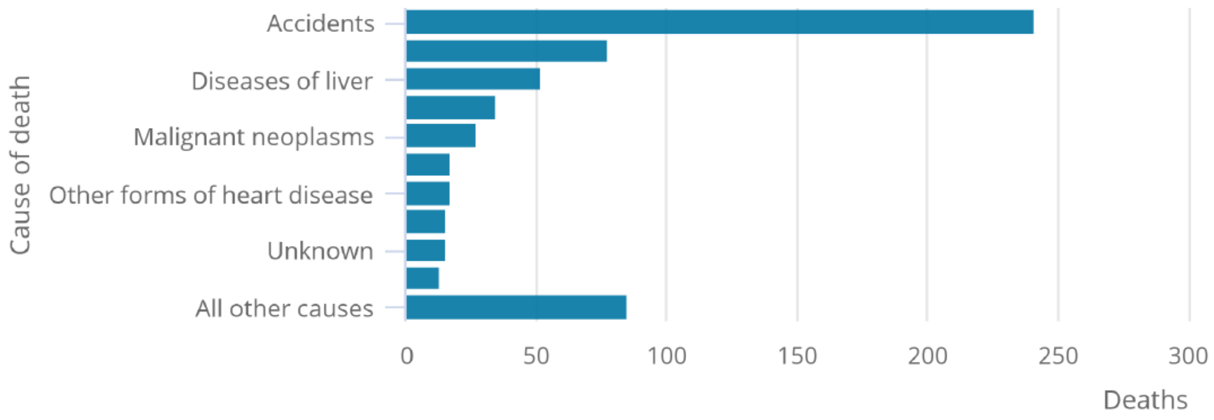

Figure24: Deaths of Homeless People in England and Wales by Underlaying Cause of Death (Persons), 2017.
Source: Office for National Statistics "Deaths of Homeless People in England and Wales (2013-2017)," Statistical Bulletin of 20 December 2018.

As shown in figure above, the most important cause of death of homeless people in 2017 in regions investigated were accidents which killed 80% of rough sleepers. Accidents involved a broad array of death causes such as freezing (cold temperature), heat strokes causing hyperpyrexia (heat waves), drowning (riverine and flash foods), burnings (wild, vehicle and other fires), drug and/or alcohol overdoses (intoxication), and compound hazards such as death in car accidents associated with alcohol and/or drug overdose. An article at The Guardian newspaper on 1st of October 2019 reproduced the numbers of homeless people published by the Office of National Statistics which indicate much higher homeless death numbers in the England and Wales during 2017 and 2018 (figure below).

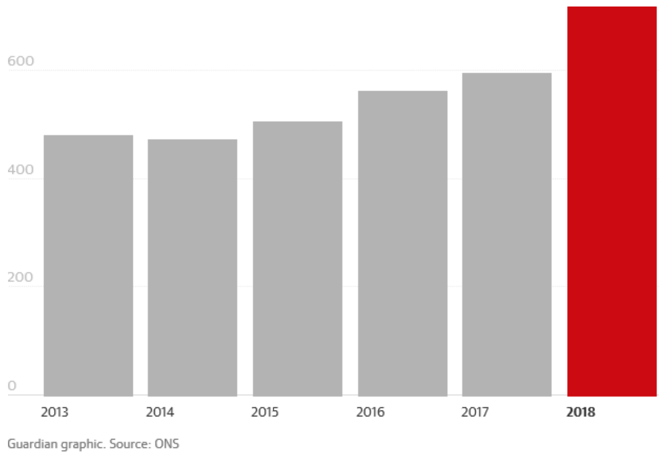

Figure 25:Estimationd of Homeless People Who Died in Wales and England in 2018 compared to 2003
Source: Guardian Newspaper edition from 1st October 2019.

Citing the Office for National Statistics as data source, The Guardian newspaper from October 1st, 2019 published the numbers of homeless people who died in 2018 in England and Wales. The number reached 726 persons and represented 22 p.c. rise on 2017. However, those who perished in 2017 were estimated at 580 persons. The biggest rise in dead number was linked to drug-related deaths, 55 p.c. up since 2017. However, most of these deaths could also be attributed to cold stress, which especially hardly hit "new comers", i.e., people who were newly released from prisons and hospitals without having opportunity to relocate to their own or emergency dwellings or immigrants without recourse to public support or help. It is also noteworthy, that as observed, enumeration of rough sleepers who died in 2017 in the same two

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regions seems to be much higher than in figure derived from ONS Bulletin of 20th December 2018 (shown above).

Finally, in a search to better understand the risk of cold-weather injuries among vulnerable sub-populations, we reviewed a study performed by Zhang and colleagues (2018) titled "Cold-related Injuries in a Cohort of Homeless Adults" in Toronto, Canada. This work has also confirmed that people experiencing homelessness face an increased risk of cold-related injuries like frostbites or hypothermia that can lead to severe morbidity or even death. The results revealed that the rates of cold-induced injuries among homeless men were much higher than among homeless women in Toronto during winter season 2013. Also, the rate of cold-related injuries among homeless men were significantly higher in comparison to their housed low-income peers (Zhang et al.; 2018). After demonstrating highly elevated level of risk for cold-related injuries or even mortality among homeless and low-income cohorts in Toronto the study proposed several public health interventions such as relaxed shelter restrictions to decrease the number of individuals staying outdoor during high frost days, an increased deployment of street outreach teams, distribution of transit tokens to help people travel to shelters at city outskirts, and addition of shelter beds during cold weather emergency.

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7. Impacts of fire and flood hazards on population in some BuildERS-study countries

In the following the impacts and consequences of different fire disasters and flood calamities are reviewed with a purpose to pinpoint the populations groups which have suffered from these perils.

7.1 Fire Hazards

As fire hazards became more preponderant over the last decade, their damage and severity have increased as well. Below we review the scale and the scope of these calamities and the harms they have imposed on general population in several EU nations and the most vulnerable social groups.

Table 8: Number of Fires and Burnt Areas Reported by EFIS countries in 2017.

Country	Number of fires			Burnt area (ha)			Notes
	2017	2007-16 average	2017 as % of average	2017	2007-16 average	2017 as % of average	
Austria	265	357	74	30	142	21	Change in method of recording fires
Bulgaria	513	568	90	4569	9158	50	
Switzerland	110	93	118	118	132	89	
Cyprus	92	102	90	428	2125	20	
Czech Rep.	966	958	101	170	287	59	
Germany	424	735	58	395	319	124	
Algeria	2992	3367	89	53975	33426	161	Average 2011-16
Estonia	61	50	122	33	204	16	
Spain	13793	12501	110	178234	91432	195	
Finland	881	1174	75	460	496	93	
France	4403	3687	119	26378	10143	260	
FYROM	301	282	107	5619	7407	76	
Greece	1083	1145	95	13393	49442	27	
Croatia	329	229	144	48543	9064	536	
Hungary	1454	982	148	4933	4853	102	
Italy	7855	6132	128	161987	78898	205	Provisional data in 2017
Lebanon	92	184	50	264	1312	20	Only 2 previous years to compare
Lithuania	80	197	41	53	106	50	
Latvia	423	525	81	265	347	76	
Morocco	433	455	95	2414	2859	84	
Norway	264	103	257	525	842	62	Change in method of recording fires 2016
Poland	3592	7634	47	1023	3325	31	
Portugal	21002	18257	115	540630	85189	635	
Romania	447	270	165	2459	1588	155	
Russian Fed.	10051	17404	58	1459099	2326529	63	Average 2010-2016
Sweden	5276	3961	133	1433	2876	50	
Slovenia	108	94	115	441	247	179	
Slovakia	162	270	60	295	457	64	
Turkey	2411	2426	99	11993	9042	133	

Source: JRC Technical Report: "Forrest Fires in Europe, Middle East and North Africa" (2018), EU 29318 EN, p U 29318EN, p. 10

Data in table above reveal that Portugal was the EU country which in 2017 has suffered most from large numbers of forest fires invoked by the staggering 21,002 blaze cases. Portugal's negative fire record were followed by Spain and Italy which in 2017 registered 13,793 and 7,855 fire hazards, respectively. Other countries which also experienced unusually high numbers of forest fires were Sweden (5,276) and France (4,403). As the size of burnt forest areas in Portugal accounted for 540,639 hectares, its citizens have also suffered from the largest scale, severity and intensity of blaze perils in the EU. However, the scale of fire damage as measured by the number of forest hectares burnt was also high Spain (178 234), Italy (161,987) and Greece (13, 393). Poland was affected by 3,953 blaze disasters, Hungary by 1,454 and Greece by 1,083.

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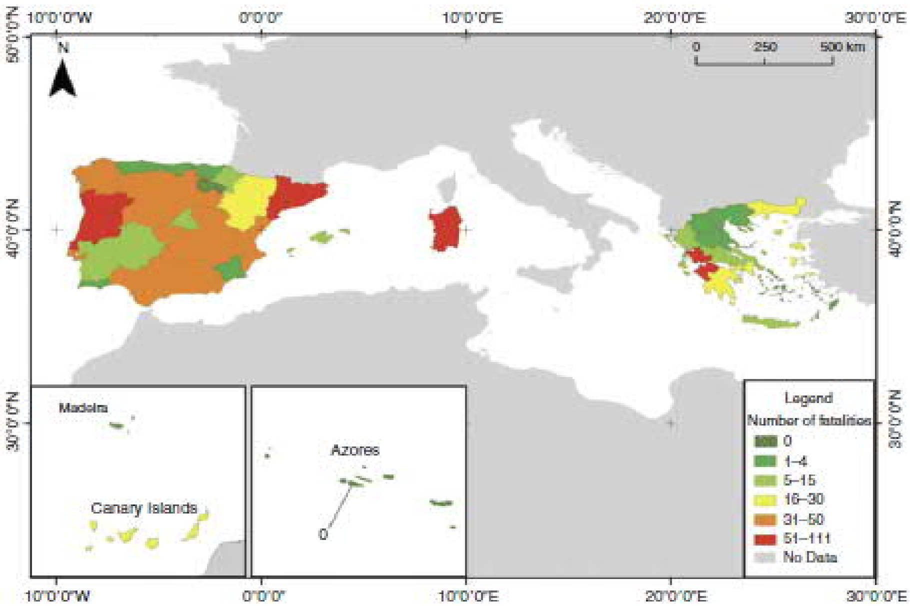

Figure 26:Spatial Distribution of Wildfire Fatalities in Each NUTS2 Region in Spain, Portugal, Greece, Sardinia (Italy) 1979-2016.
Source: Molina-Terrén at al., (2019) "Analysis of Forest Fire Fatalities in Southern Europe; Spain, Portugal, Greece and Sardinia (Italy)",International Journal of Wildland Fire 28, pp 85-98.

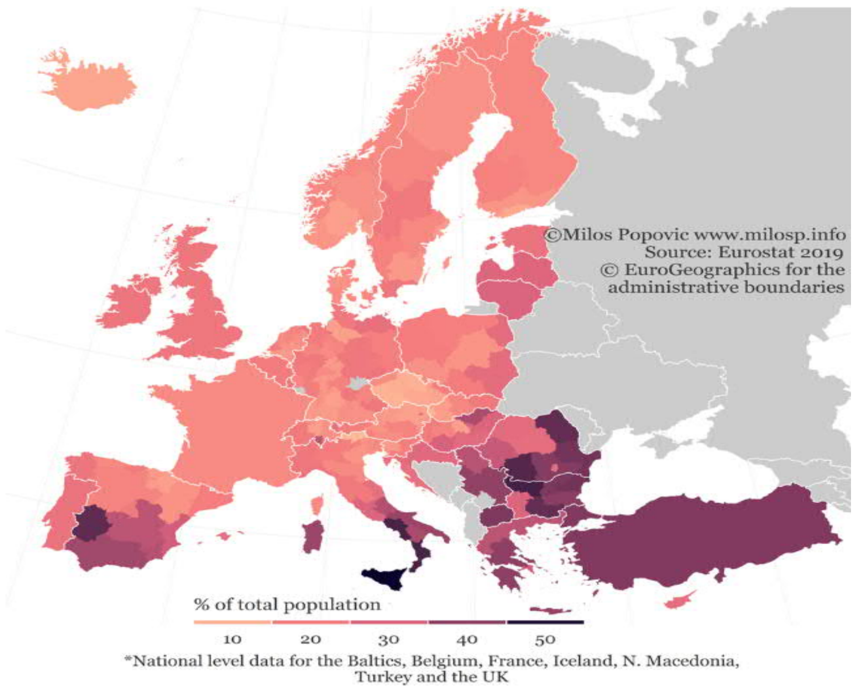

Figure 27: People at Risk of Poverty or Social Exclusion in EU Member Nations NUTS 2 Regions, 2017
Source: Eurostat 2019 at https://external-preview.redd.it/9AxDwmqRatdJO36WEwcFoxMUURuPsOXTWssNJcv1A_E.png?auto=webp&s=75d5d5525b124bbe48b34b7a09e30fcd60cc0d41

Comparison of data in figures 24 and 25 indicates that the highest numbers of fatalities attributed to wild fires in Spain, Portugal, Greece and Italy's during 1976 - 2016 occurred in regions where thirty percent or

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higher share of population were at the risk of poverty and social exclusion in 2017[6]. In the pursuit of more knowledge on how the scorching disasters affected the EU most vulnerable sub-populations, we turned to a paper by The Centre for European Social and Economic Policy (CESEP-ASBL) prepared by Stefanos Grammenos in March 2019 and titled "Social Scoreboard and Persons with Disabilities" (Grammenos, 2019). The paper has established that in 2016, at the European levels 30.1p.c. of people with disabilities aged over 16 and over lived in households which were at risk of poverty and social exclusion compared to 20.9 p.c. of persons without disability of the same age group. The percentage for all persons aged 16 and over is 23.1 p.c. At the EU level, the poverty gaps between persons with and without disabilities amounted in 2016 to 9.2 percentage points. High poverty gaps were found in Bulgaria, Estonia, Ireland and Latvia (see chart below). On the contrary, small poverty gaps affecting people with limitations were found in Romania, Greece and Italy, the last two nations severely affected by fires in 2017, 2018 and 2019. It might be outright wrong to assume that in countries where disabled people suffer most from social exclusion (manifested by among others high risk of unemployment) they might also be disproportionally more severely affected by scorching disasters. Still, such working proposition might be worthy verification by inclusion of disabled people into the T3.2 survey respondents. The chart below adopted from the "Social Scoreboard and Persons with Disabilities" by the Centre for European Social and Economic Policy shows the percent of people who either are at risk of poverty or severely materially deprived or living in households with very low work intensity. Disability was defined by limitation in activities people usually do because of health problems for at least 6 months. At EU level the gaps are high.

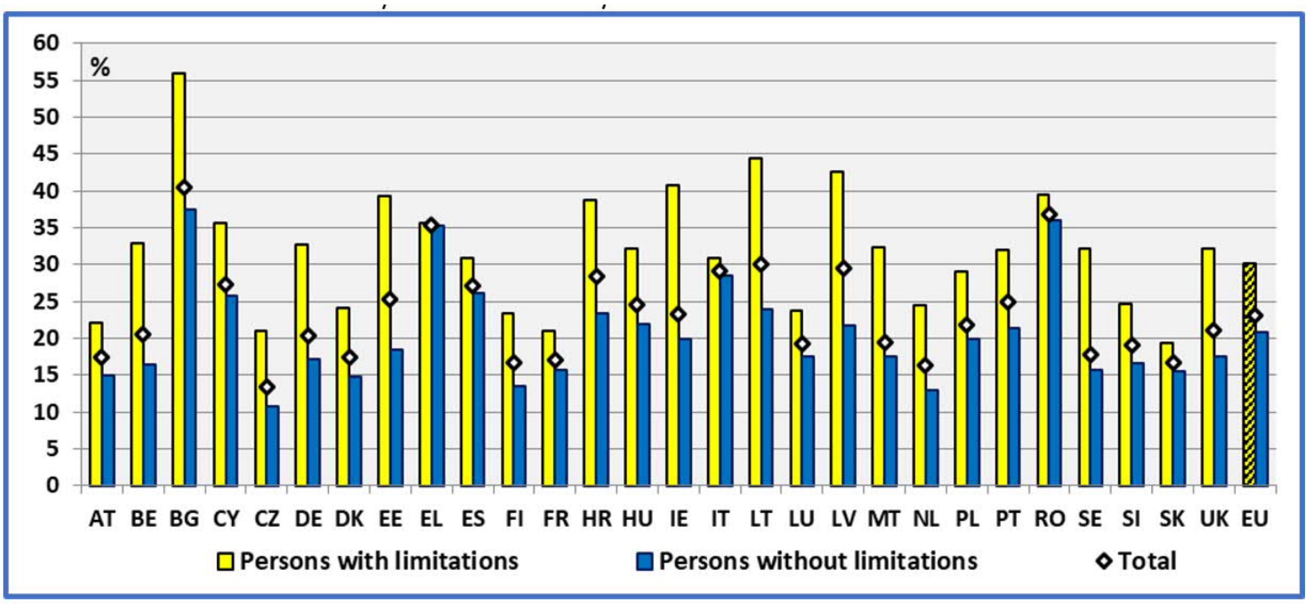

Figure 28: Percent of People Living in Households at-Risk-of-Poverty and Social Exclusion, 2016. Age:16+
Source: Data from EU-SILC UDB2016 reprinted from Grammenos,S. (2019)"European Pilar of Social Rights- Social Scoreboard and Persons with Disabilities, Headline Indicators" , The Centre for European Social and Economic Policy on behalf of the Academic Network of European Disability Experts (ANED), March 2019. p.20.

To gain more insights into the scale of fire disasters measured by the number of civilian deaths and injuries in several EU countries, data from the World Fire Statistics were collected and analysed.

6 It is assumed that the level of poverty and degree of social exclusions assessed in 2017 might had regressive validity in 2016, when fire-induced fatalities were recorded.

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Table 9: Fire Statistics: Population size, Number of Firefighter Calls (Including False Calls), Number of Fire Incidents (Structural, Forest, Vehicle, Rubbish and Other), Deaths and Injuries Attributed to Fires in Selected EU Countries in 2017.

No	EU country	*Population thousand inhabitants*	Number of			
			firefighter calls	**fires**	**fire deaths (civilians)**	**fire injuries (civilians)**
1	France	66 628	4 658 600	306 600	277	1 226
2	Great Britain	63 786	687 413	199 894	325	8 897
3	Italy	61 000	1 00 071	325 941	288	-
4	Spain	46 570	335 317	130 915	212	-
5	Poland	38 416	519 002	125892	475	4 328
6	Romania	20 121	421 015	33 352	241	702
7	Netherlands	17 022	115 340	72 980	40	-
8	Czech Republic	10 610	2 678 732	16 757	92	1 392
9	Sweden	10 120	127 750	27 783	110	414
10	Hungary	9 798	77 969	25 303	121	897
11	Austria	8 773	302 154	47 951	-	-
12	Bulgaria	7 365	60 536	9 119	146	301
13	Denmark	5 756	41 040	13 107	61	-
14	Finland	5 474	104 392	11 851	61	696
15	Croatia	4 290		14 507	32	117
16	Lithuania	2 848	26 954	9 394	103	181
17	Latvia	1 950	18 638	9 137	79	381
18	Estonia	1 314	26 120	4 733	28	102

Source: CTIF (International Association of Fire and Rescue Services), 2019, "World Fire Statistics", No. 24, Centre for Fire Statistics. Data compiled from Table 2.

In-depth inspection of data compiled by the Centre for Fire Statistics and published in the World Fire Statistics on fire accidents that took place in 40 countries in 2017 provided basis for the following conclusions[7]:

1. EU countries with the highest number of injuries inflicted by fires on civil populations in 2017 (calculated per 1 million inhabitants) were - Latvia (19.5), Great Britain (13.9), the Czech Republic (13.1), Finland (12.7), Poland (11.3) and Hungary (9.2).

2. EU countries with the highest number of (built) structure fires in 2017 were - France (84 694), Poland (32 388), Austria (19 447), Sweden (10 638), Hungary (9 493), Denmark (7 160), Finland (5 288), and Croatia (3 581).

3. EU countries with the highest number of forest fires were – Croatia (6 981), Poland (3 316), and Sweden (2 784).

4. EU countries with highest number of vehicle fires in 2017 were – France (108 597), Poland (9 408), Sweden (5 364), Bulgaria (2 364), Finland (2 080), the Czech Republic (2,035), and Denmark

[7] Not all EU countries are included in the CTI's 2017 Fire Statistics. Portugal and Greece were missing despite being severely affected.

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(1 988)

5. EU countries with the highest numbers of grass and bushfires in 2017 were – France (61 648), Poland (17 035), Bulgaria (14 307), Romania (10 040), Lithuania (2 683), Sweden (2 671) and Austria (2605).

6. EU countries with the highest number of rubbish fires in 2017 were – Poland (19 598), Bulgaria (6 894), Romania (4 384), Sweden (2 290), and Lithuania (2 074).

It needs to be observed that the structure and vehicle fires showed to be more lethal in some EU countries as compared to wildfires. Table below presents number of structure and vehicle fires and fatalities attributed to these disasters in 2017. France, Romania, Hungary and Sweden suffered most from the highest number of fatalities in 2017.

Table 10 : Selected EU countries by Number of Structure and Vehicle Fires and Deaths Attributed to These Fires in 2017.

No	Country	Number of structure and vehicle fires	Number of deaths
1	France	193 291	239
2	Austria	20 987	-
3	Sweden	16 002	105
4	Hungary	10 265	115
5	Denmark	9 148	58
6	Finland	7 368	58
7	Croatia	4 360	25
8	Romania	4 272	229
9	Bulgaria	2 572	139
10	Lithuania	2 350	98
11	Estonia	1 660	36
12	Latvia	1 613	75

Source: Data have been compiled from Brushlinsky, N.N., Ahrens, M., Sokolov, S.V., and P. Wagner (2019) "World Fire Statistics" No.24, published by International Association of Fire and Rescue Services, Table 6.

Table 11: Total and Mean Annual (in Parentheses) Number of Fatalities Related to Forest Fires in Span, Portugal, Greece, Sardinia (Italy).1979-2016.

Period	Spain	Portugal	Greece	Sardinia (Italy)	Total
1979-2016	346 (9.1)	203(5.3)	308 (5.5)	63 (1.9)	820 (21.6)

Source: Source: Molina-Terrén at al. (2019)" Analysis of forest fire fatalities in Southern Europe; Spain, Portugal, Greece and Sardinia (Italy)", International Journal of Wildland Fire 28, pp 85-98

With 700,000 hectares of land burnt in 2017, this year was one of the most devastating for the EU countries. Data from the European Forest Fire Information (FFFI) **data centre** indicate that nearly all wildfires were man-made, with very few resulting from natural lightnings. However, the hot and dry conditions induced by climate change resulted in more severe fires and higher frequency of small fires to become uncontrollable, thus creating severe danger to human lives and livelihood. Toxic smoke from these fires left many people severely harmed and even dead. The map below shows the distribution of severe wildfire damages in Spain and Portugal in 2016.

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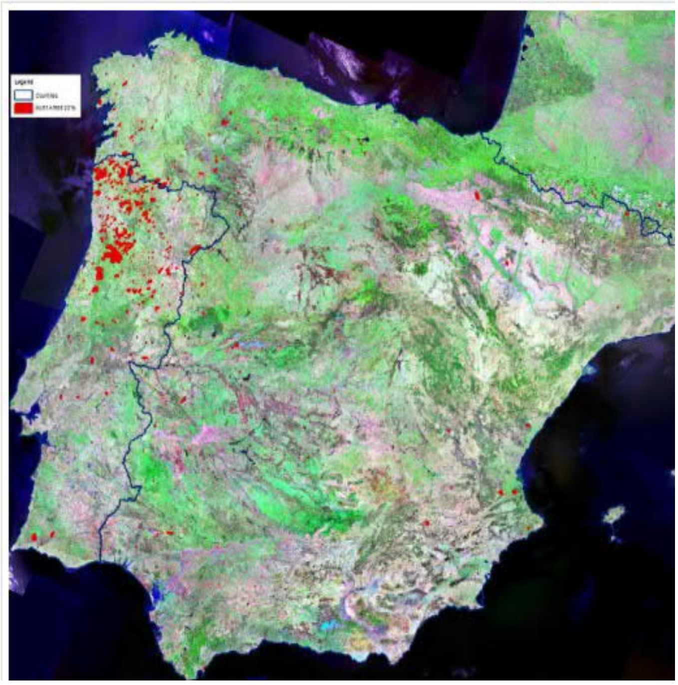

Figure 29: Extent of Severe Fire Damage in Spain and Portugal in 2016 by EFFIS Assessment Module.
Source: eu/jrc/sites/files/forest

Below, an evolution in trends of burnt areas (ha) in Europe per week from 2008 to 2018 is shown along the growth in number of hectares burnt until 14 May 2019.

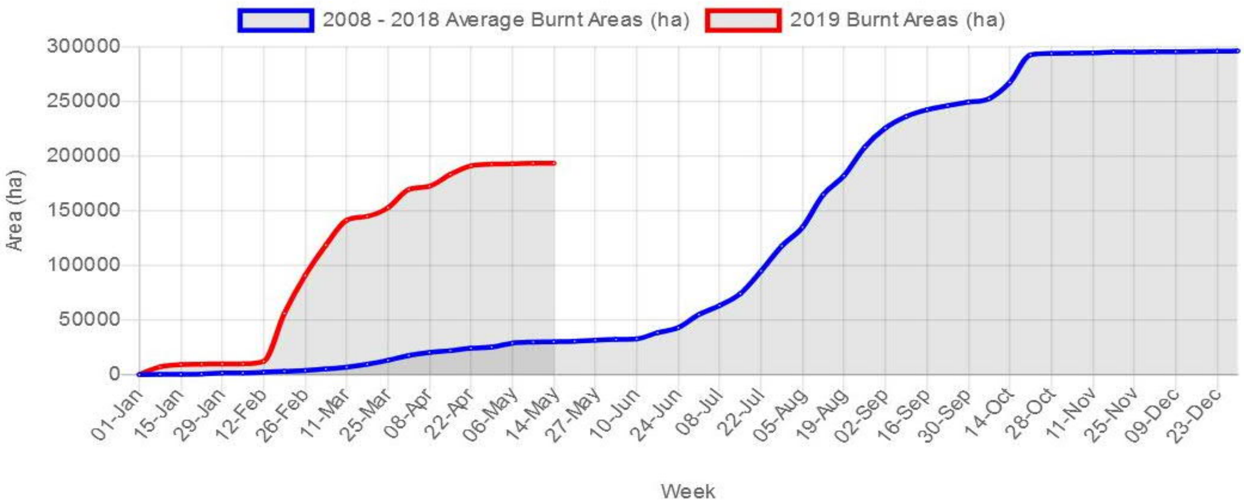

Figure 30: The Visualization of EFFIS Data Show the Spread of Fire Damage across the EU during 2019 and over 2008-2018.
Source: http://effis.jrc.ec.europa.eu

Map below shows that the northern regions of Spain and Greece suffered considerably from wild and forest fires. In In 2017 110 people have perished in Portugal alone from wildfires while 100 people have been killed in Greece in 2018 (Climate Change Post (2019) "Damage and Fatalities by Extreme Weather Events in Europe on the Rise", August 26th,2019.

During the 2018 fire season, 181 000 hectares were burnt by 1,192 cases of blaze registered in the EU. These observations come from the EFFIS 2018 reports which reveal a much more intense wildfire trend during 2018 as compared to both 2016 and 2017. Unfortunately, fire numbers and the size of areas burnt

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have increased even more in 2019. According to FFIs, already in April 2019, i.e., within the first half of 2019, 1,233 cases of fires have been recorded leaving behind 300,000 hectares burnt, with devastation including many human dwellings.

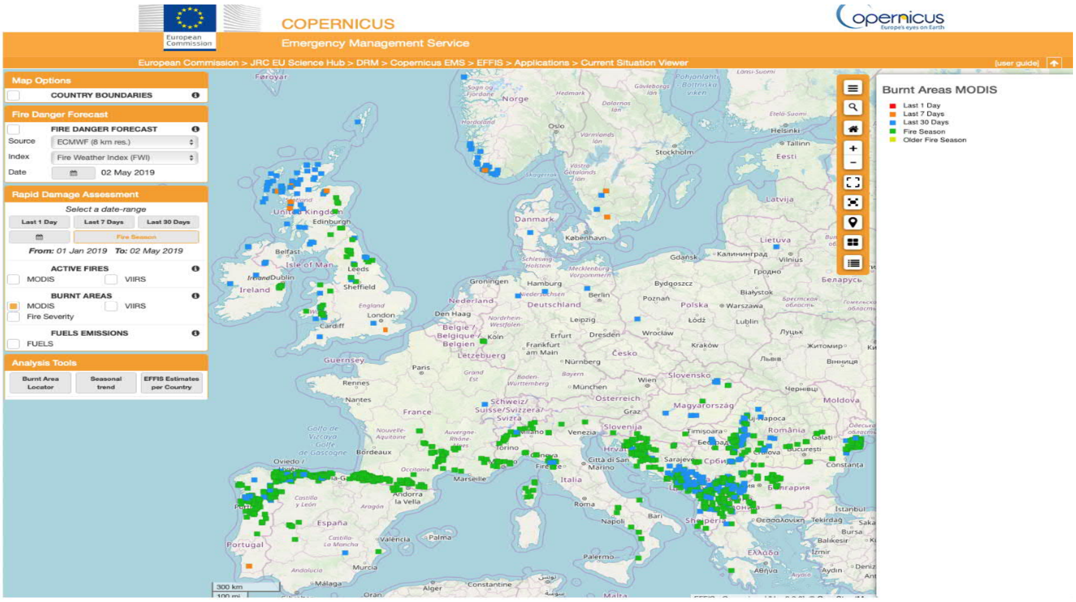

Figure 31: Burnt Areas in EFFIS Countries from January 01, 2019 until May 02,2019
Source: https//ec.Europe.eu/jrc/stes/files/effis current situation 02.05,2019.png

It is important to notice that in 2019 vast explosion of hazard areas hit countries where the long-lasting wildfires were not so common in the past, such as Sweden, Latvia, Germany and UK. As result, populations in these countries have suffered from severe wildfires both in 2018 and 2019. Figure 31 also shows that northern regions of Spain, southern France, West Balkan, and Greece suffered considerably from long-lasting wild and forest fires. In 2017, 110 people perished in Portugal alone from wildfires, while 100 people have been killed in Greece in 2018 (Climate Change Post (2019) "Damage and Fatalities of Extreme Weather Events in Europe on the Rise", August 26th,2019. Map in figure below indicates during the autumn 2019 fire disasters lasted longer in Southern, Central and Eastern Europe. They have been quelled in the Northern European territories, but not in the UK.

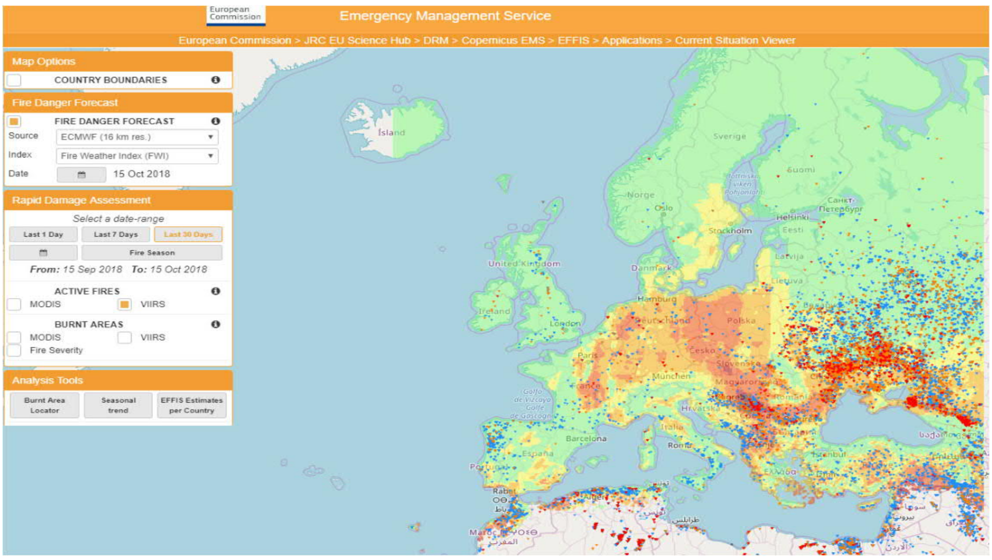

Figure 32: Map of Fires that Lasted from 1 to 30 Days between 15 September and 15 October 2019.
Source: Copernicus Images at https://emergency.copernicus.eu/

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Figure 33: A Firefighting Helicopter Drops Water over Fire in Ljusdal, in Lapland, Sweden
Source: The Guardian Newspaper of July 30th, 2018

An interesting finding could be revealed by juxtaposing the data on fire types and the size of fire harms (measured in hectares of burnt areas in EU countries) in Figure no. 30 and the graphics in Figure no. 29 against the data from Figure no. 32 revealing who might have suffered most from 2018 and 2019 fire disasters.

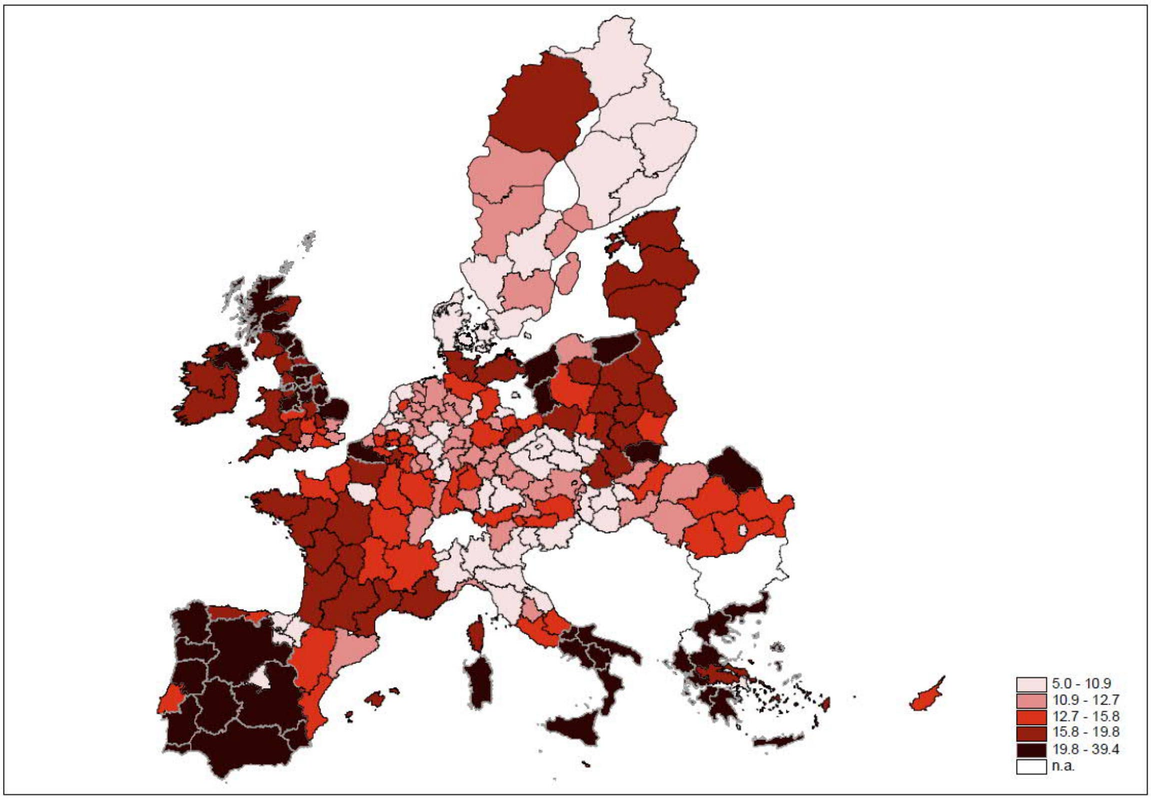

Figure 34 :Head Counts Ratio at NUTS2 Regions below County's Poverty Line
Source: Verma, V., Betti, G., Natilli, M., Lemmi A. (2016) "Indicators of Social Exclusion and Poverty in Europe's Regions" @ https://www.researchgate.net/publication/265190118_Indicators_of_Social_Exclusion_and_Poverty_in_Europe%27s_Regions

Figure no. 33 shows percentages of people domiciled in the EU country regions who lived below the national poverty lines in 2016. Comparison of data on fires geospatial distribution with map of poverty concentration in EU regions indicates that the regions with highest share of poor people have also been affected in 2018 by highly destructive blaze disasters. Inspection of figure 32 above reveals the concentration of areas with the highest poverty rates could be found in Portugal, Spain, Greece and

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Southern Italy. The highest estimated poverty rate in the EU using country poverty lines was in Sicily (39.4%), and the next highest in Calabria (39.2%) after excluding the "new" EU member states[8]. Next in this line comes Greece (39%). In UK, the proportion of poverty is quite high outside the South-East, which are the regions that have also suffered badly from fire disasters. It might be interesting to explore how the persons with different types of disabilities and homeless sub-groups might have been further affected by fire disasters.
Another hypothesis posing that the homeless people in regions affected by fires might have suffered more fatalities than the population at large due to impaired perceptions of hazard dangers and/ or inability to access proper shelter is also worth to be verified empirically by the T3.2 and T3.3
survey studies.

7.2 Floods and Flooding Hazards

In publication "Urban Areas at Risk of River Flooding", The European Environmental Agency (EEA) forecasts that in many parts of Europe, the risk of river and flash flooding is expected to increase substantially except the North-Eastern Europe where the probability of floods is expected to fall. As consequence of increase in urban population, the placement of many new urban areas and the accumulation of built assets in low-lying locations close to rivers and other large water reservoirs the exposure to river and /or flash floods has intensified. The map in Figure 35shows the low-lying urban areas potentially threatened by river flooding in a one-in-a country flood event both during the less distant past (2008-2015), and for the projected future (2071-2100) (https://www.eea.europa.eu/data-and-maps/figures/projected-change-in-damage-of-rive..). It reveals that large urban areas in UK, the Netherlands, Belgium Germany, Austria and Poland are dangerously exposed to the forthcoming flood disasters. Yet it needs to be observed, the map does not consider eventual future changes in urban land-take (fragmentation geometry- FG), nor any adaptation measures like building of flood defences and water retention facilities that may lower the future flood risk (Tavares da Costa et al., 2018).

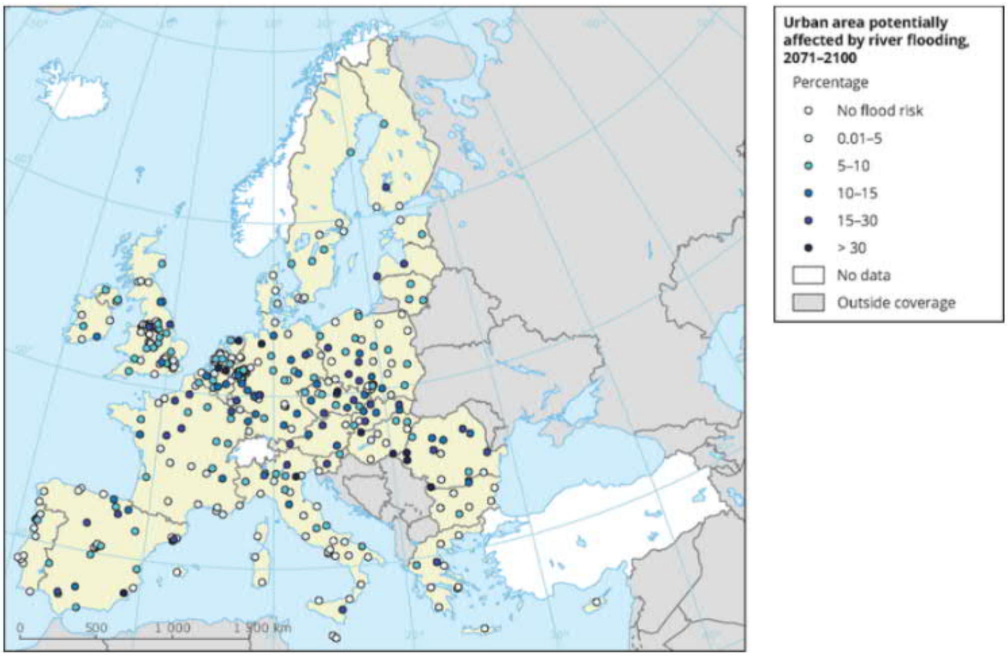

Figure 35: Urban Areas at Risk of River Flooding, Trend 2008-2015.
Source: https://www.eea.europa.eu/data-and-maps/figures/projected-change-in-damage-of-rive.).

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[8] "New Member States" include countries who joined the European Community in 200 and 2007.

Map in Figure no. 35 presents data on Pan-European fragmentation as defined by Fragmentation Geometry Index (https://www.eea.europa.eu/about-us/countries-and-eionet/intro). The relevance of increases in high concentration of the European landscapes being interrupted by high-level interventional fragmentation consist in investments in overland infrastructure which alter the geomorphic characteristics of the territory covered by decreasing the speed of water absorption into underlying earth layers and increasing the risk of water spillage and area overflows.

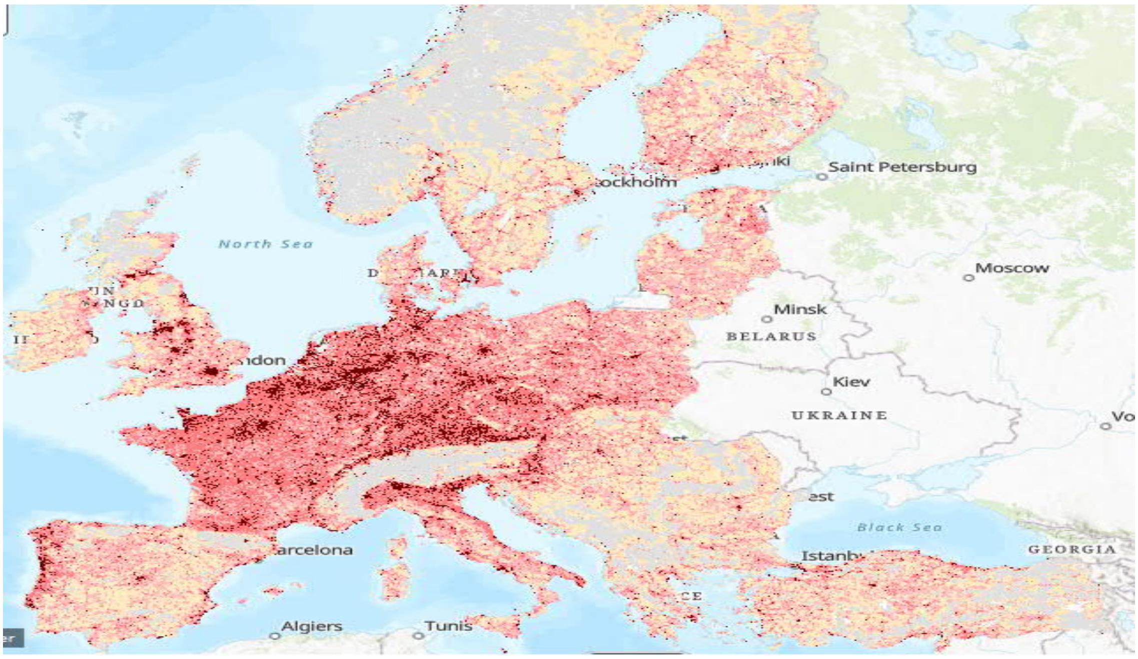

Figure 36: The Fragmentation of European Landscape Interrupted by Fragmentation Geometry (FG), 2016[9].
Source: https://www.eea.europa.eu/about-us/countries-and-eionet/intro

The maps in Figure 37 and Figure 38 present two interesting data sets which when combined might indicate that several high-age cohorts in some European cities might be more susceptible to high risk of urban flooding than the other age-groups. Figure 37 shows the European cities with large senior sub-populations with high-level old-age dependency ratio stratified by the size of sub-populations of elderly inhabitants. Inspection of map in Figure 37 indicates that Germany, France, UK, Spain, Portugal and Italy possess large sub-groups of elderly citizens settled in the southern parts of Europe and/or along coastal territories (UK) with low elevation, which increase exposure to risk of riverine and flash flood disasters and sea storm inundation.

[9] FG is defined as presence of surfaces and traffic infrastructure including mediums sized roads. The more FG fragments the landscape, the higher the effective mesh density, hence the higher fragmentation. The higher the fragmentation, the higher the land areas covered by impenetrable structures which obstruct or delay water absorption thus contributing to water retention, overflows, flooding and inundation.

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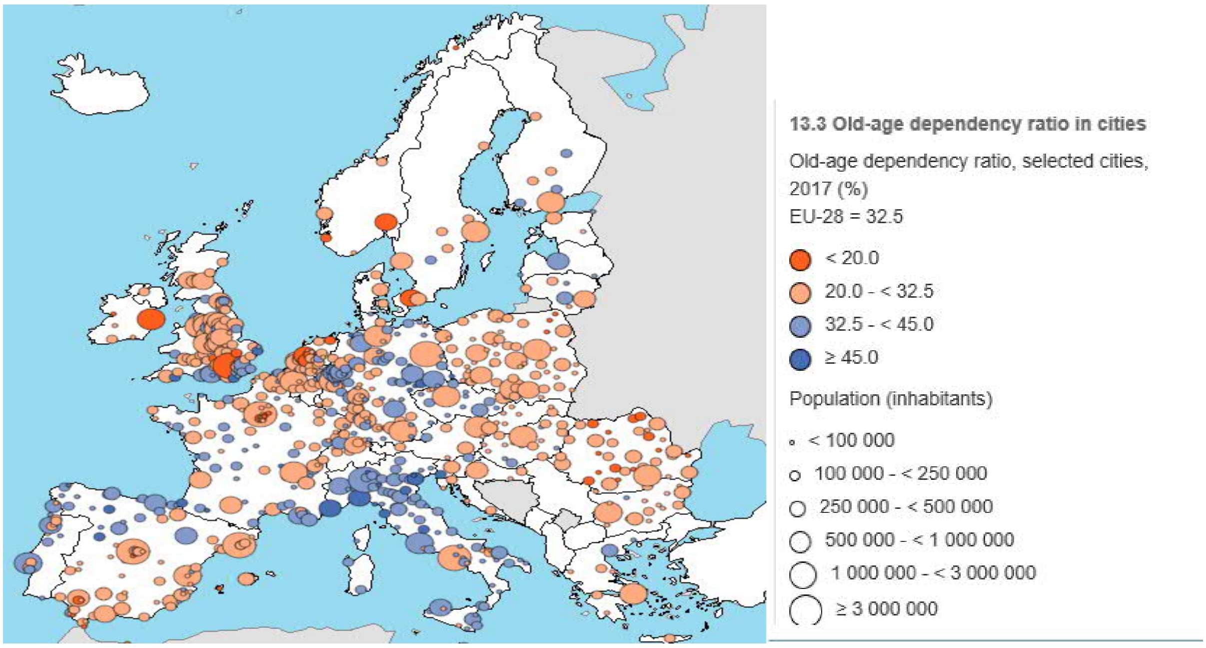

Figure 37:Old-Age Dependency Ratio in Selected Cities, 2017 (%) by Population Numbers.
Source: Eurostat, Statistical Atlas, Eurostat Regional Yearbook, 2019 athttp://ec.europa.eu/eurostat/statistical-atlas/gis/viewer/?year=&chapter=13&lcis=BKGNT02016&mids=BKGCNT,BKGNT02016,C13M03&o=1,1,1&ch=GRP,C13&center=50.00754,19.98211,3&

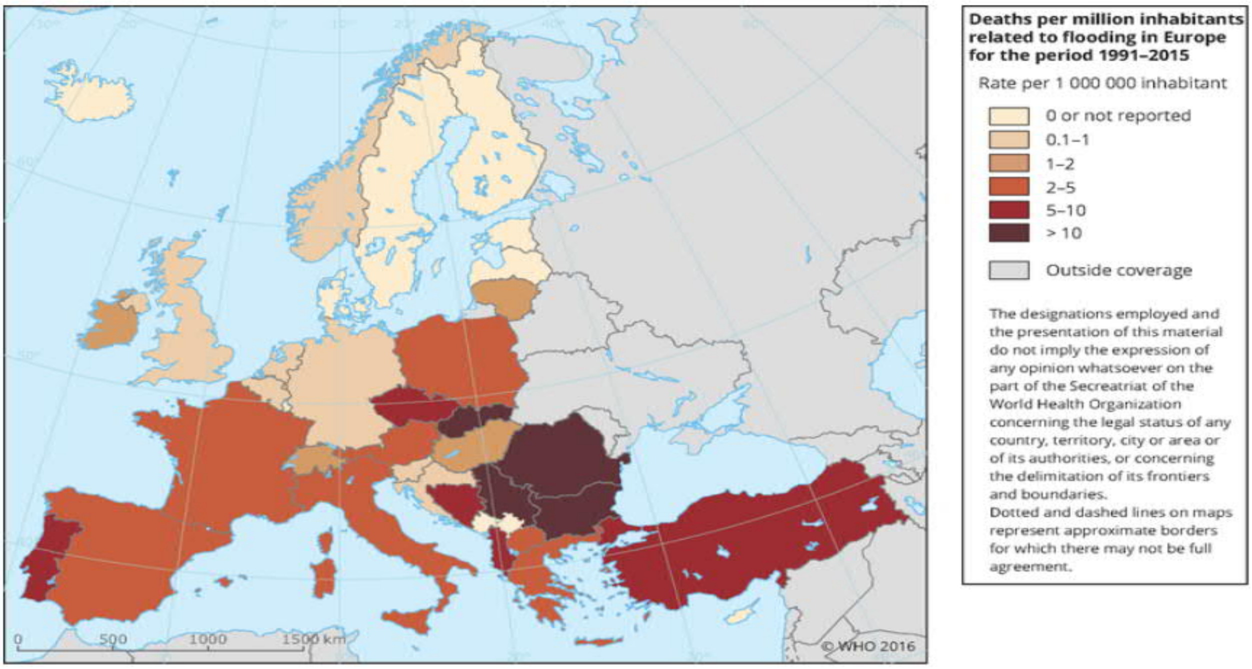

Figure 38: Number of Deaths Related to Flooding per Million Inhabitants (Cumulative over Period 1991-2015, with Respect to 2015 Population).
Source European Environmental Agency (https://www.eea.europa.eu/data-and-maps/figures/people-per-million-population-affected-1)

The map in Figure 38 indicates that the highest numbers of flood attributed mortality during 1991-2015 were recorded in Romania, Bulgaria, Slovakia and Serbia. The second highest number of people whose mortality was associated with riverine and flash floods were in the Czech Republic and Portugal in the EU, and in Albania, Turkey and Bosnia outside EU. At the third place in statistics on flood fatalities were the four Mediterranean basin countries, Spain, France, Italy and Greece. Further, based on data from the Mediterranean Flood Fatality Database (MEFF DB), 24 deaths were recorded in November 2017 in Western Attica in Greece, 13 deaths in Balearic Islands in October 2018 in Spain and in southern France where 15 people also died during October flood in 2018 (Vinet et al., 2019). This shows that flood-related mortality remains a major concern within the EU, not least in countries around the Mediterranean basin.

Studies of data repositioned in a 39-year-old European Flood Fatalities Database covering period 1980-2018, indicate a stable trend in flood mortalities influenced by increasing individual fatality numbers in Greece, Italy, and Southern France and decreasing fatality counts in Turkey and Catalonia in Spain. A study by Petrucci et al., (2019) which in addition to southern Spain, France, Italy, Greece also included Portugal, The Czech Republic, Turkey, and Israel during 1980-2018 has recorded 2466 fatalities during the 39-period for which data were collected and analysed. It revealed that persons killed were mainly men, aged between 30-49 years and majority of deaths happened outdoor, on the roads. Most often people were dragged by water and/or mud when travelling by motor vehicles. Female mortality was more numerous than males in the following age cohorts < 15 years (children), 16-29 years (young adults), 65-84 (elderly) and elder than 85 years. Some cases of hazardous behaviours such as fording rivers, were also detected (Petrucci et al., 2019). The primary clinical cause of death was drowning followed by heart attacks; with the latter might being exacerbated by the pre-existing chronic medical condition of cardiovascular disease.

Majority of flood-related mortality cases in the Mediterranean region found place in 6 national regions: Catania (Spain), Balearic Islands (Spain), Languedoc-Roussillon, and Provence-Alpes-Cote d´Azure (Southern France), Calabria (Italy) and Western Attica (Greece). Map in Figure 39 displays fatality rates, F, by NUTS 3 regions in Spain, France, Italy, Greece and Turkey (Vinet et al., 2019).

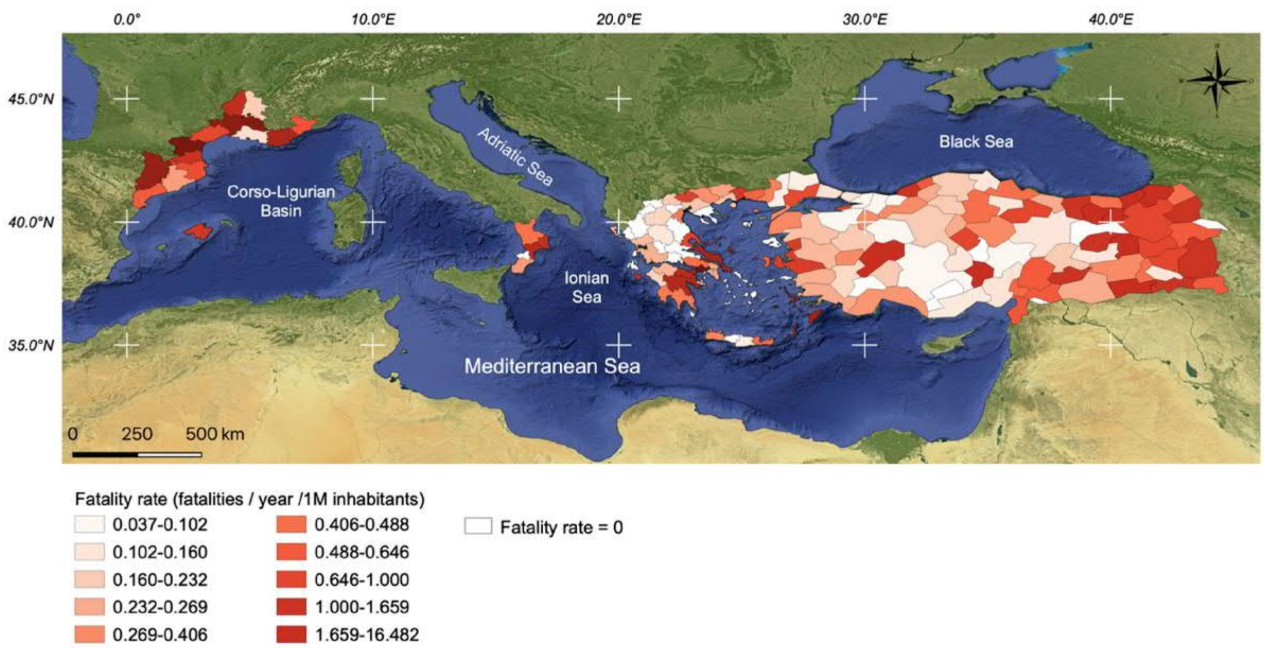

Figure 39: Fatality Rate (F) Attributed to Floods (Pluvial and Fluvial) by NUTS3 Regions in Spain,Italy, France Greece and Turkey.
Source:Adopted from Vinet et al., (2019) "Mapping Flood-Related Mortality in the Mediterrabean Basin. Results from the MEFF v.2.0 DB" Water, 11, 2196.

In this context it is interesting to compare the flood afflicted regions of Southern Europe with travel routes for crossing of Mediterranean Sea by refugees and migrants approaching EU from Asia and Africa. The chart below shows the number of migrant and refugee arrivals to Spain, Italy, Greece, Malta, Bulgaria and Cyprus in 2018 and the sea-crossings-routes chosen by the travellers to reach mainland destinations. High

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number of drownings among these social groups during the sea-crossing journeys indicate these people took very high risks to escape that made them highly fragile to death, traumatization, malnourishment and integration challenges. While they seek new lives in the EU, they are put into refugee/migrant camps and oftentimes turn homeless. Lacking the geo-spatial knowledge of new settlement locations, language and cultural understandings plus social network and families, they become very susceptible to weather changes, and natural and other hazards such as pluvial and fluvial floods and fire disasters. Comparison of content in Figure 39 and Figure 40 indicate clearly that migrant landing destinations in 2017 and 2018 were located within the flood-affected-regions of Spain, Greece and Italy. Although no valid data could be found for linking mortality recorded in the flooded (and/or burnt) inland areas with migrant and refugee cohorts, still information provided by Migration Policy Institute indicates that in 2018 and 2019 people from Africa (sub-Saharan), Asia and Pacific, Central America and Caribbean, Middle East and North Africa and South America illegally entered EU borders. This allows to posit that the innate fragility of these people could have also made them highly susceptible to flood and fire dangers.

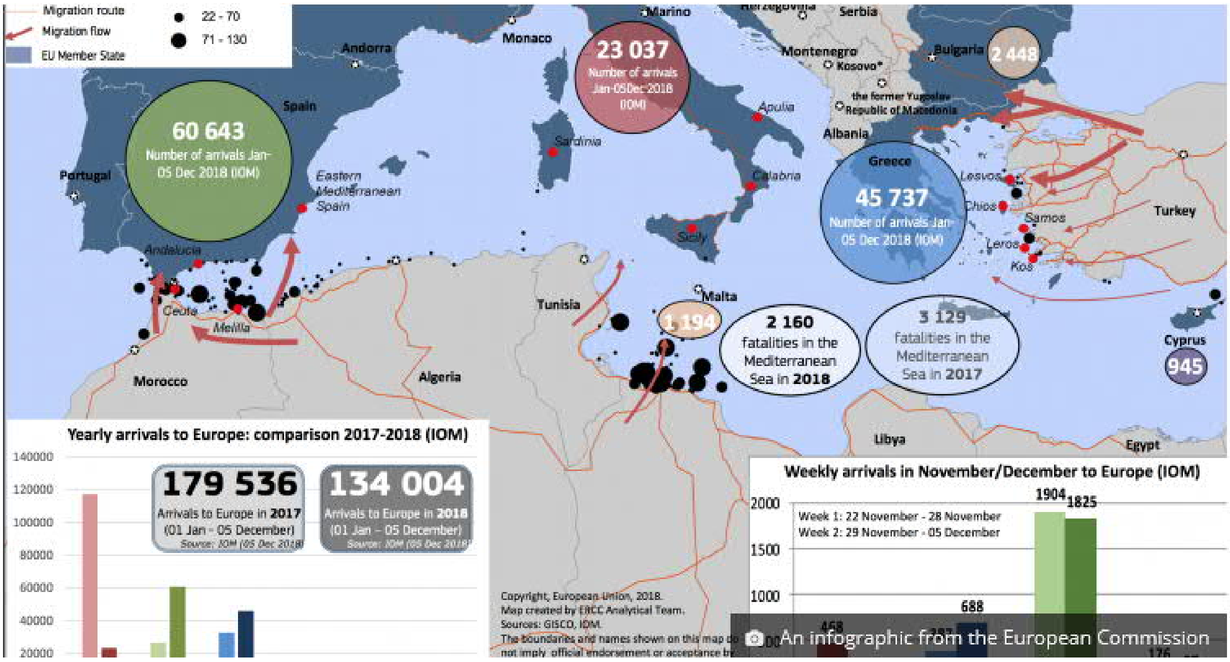

Figure 40: Fact and Figures for Migrant and Refugee Arrivals to the EU in 2018
Source:ERCC and European Commission.

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8. Summary and conclusions

Deliverable 3.1 has critically reviewed international economic, social, medical, meteorological and geo-spatial scientific literature, the NGO-sponsored analyses and contract studies, hazard statistics, fatality data, press articles, satellite calamity maps reporting on natural and other hazards that affected Europe over the last decade and even longer before to create a knowledge base for understanding how these adversities have alleviated the risk of morbidity and mortality for the European population and the scale of material losses suffered.

However, the primary goal of D3.1 was to assess how the natural and man-made adversities strained life conditions of severely vulnerable people in EU countries and based on this knowledge, help in locating informants to BuildERS project's survey where these impacts will be more in-depth studied. Outcomes from the international-survey-study with provide evidence-based inputs to civil protection policy and climate proofing instruments tasked with reducing mortality and morbidity among all groups of EU population but foremost among its weakest clusters.

The cross-disciplinary approach applied in D3.1 work was substantiated by the complexity of interactions between hazards and the variety of hazard harms imposed on different social segments. As consequence, the technology-aided satellite images combined with cross-disciplinary approach helped to establish discharge and impact areas of major hazards, and the populations endangered. They constituted several heterogeneous cohorts living in relative poverty and suffering from multiple morbidities (psychopathologies, cardiovascular and respiratory diseases) in addition to social marginalization. Because of their inherent frailty, when exposed to natural or other stressors (even those which do not cause immediate physical damage), marginalized people are ten-folds more susceptible to climatic and ambient impacts and become easy prey to premature mortality as compared to general population. Testimony from these people's past hazard encounters will provide evidence to social policy rendering stronger civil, social, medical and technical protection against climate change dangers and more effective multi-agency collaboration.

In this context it was important to re-confirm that atmospheric variability which by itself does not cause instant physical damages (as compared to floods, fires earthquakes or compound cataclysms), had considerably increased the risk of mortality and morbidity of Europe's general population, but foremost of its highly vulnerable people. This derives from interaction between meteorological-risks and pre-existing health frailty which affects vulnerable persons' thermoregulatory functions and precipitates early deaths (International Health Statistics Reports, 2014, UN).

To attain the above objectives, Deliverable 3.1 has been composed of seven chapters, as follows.

1) Chapter 1 contains introduction and goals for the D3.1 study
2) Chapter 2 describes research methodology, and data and information sources for creation of knowledge base
3) Chapter 3 reviews the most preponderant natural hazards, human fatalities and economic losses attributed to geophysical, hydrological, meteorological and climatological adversities which have afflicted Europe over the last decades. This reveals the enormous scale of damage that these cataclysms inflicted on welfare of European society as measured by fatality numbers, and monetized values of total and insured physical losses (Figure 9).

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4) Chapter 4 collected images from Copernicus satellite emergency service to make an inventory of severe hazard cases between 2015-2019 which affected the BuildERS-study countries and their populations. These maps provided information of hazard discharge areas and on-the-ground-damages but not on human fatalities and/or injuries. Besides, they recorded calamities which imposed immediate damage and not atmospheric disasters. Therefore, the BuildERS partners collected geospatially coordinated hazard entries which were listed in excel table to help in selection of areas where many people were affected. These inputs were used in construction of integrated maps produced through ArcGIS environment showing compound hazard categories which coincided over time and territorial downloads stratified by GDP distribution layers to identify economically most fragile social strata among settlements affected. Subsequently the locations of Salvations Army service apparatus available in BuildERS-study countries were overlaid over integrated hazard maps to discern service stations whose users might be polled. This knowledge will provide circumstantial evidence for hazard-triggered traumas that survey informants might have reported to Salvation Army personnel and might be willing to share through questionnaire answers.

5) Chapter 5 sheds light on how ambient temperatures in combination with other climatological, hydrological, geo-spatial events have affected the wellbeing of general population and mortality risks, with special focus on life risks of fragile human cohorts. The rationale for this analytical approach derives from Chapters 3 and 4 which established that the largest numbers of lives lost were attributed to heat and cold waves and that the highest mortality rates were registered among people in urban environments suffering from social marginalization, medical conditions and economic poverty. In search for criteria to select survey respondents T3.2 and T3.3 studies, the chapter discusses how interactions between meteorological, social and health conditions enhanced the risk of earlier deaths of fragile individuals in the BuildERS-study countries and cities, and in Toronto (Canada).

6) Chapter 6 focuses on devastations that fire and floods exerted on populations and their habitats in some BuildERS-study countries. This work has detected overlaps between severity of hazards impact on European regions and concentration of fragile people. In effort to pinpoint how hazard disasters might have affected fragile cohorts, statistics on social and economic hardships experienced by people with disabilities, and homeless groups were compared with regions hit by fires and floods. The juxtaposition confirmed that in Portugal, Spain, Italy, Southern France and Greece, the most affected regions were also the ones with the highest share of poor subpopulations. In addition, the it has been revealed that several large European cities with sizable numbers of senior inhabitants might be under growing danger of floods whose social harms might be exacerbated by high-levels of old-age social dependency and high-level urban landscape fragmentation. It is also noteworthy, that the above countries became destinations for large flows of migrants and refugees from Africa, and Asia who entered the EU in 2017 and 2018. The inherent vulnerability of these people could have also made them susceptible to life loss risk triggered by fire and flood catastrophes.

Based on evidence reviewed, the following social groups have been designated as socially, economically and medically fragile and therefore their representatives should participate as informants in BuildERS-survey studies

1) Elderly individuals 65 + who live at alone home or with families but depend on social help for life-supporting resources (food, clothing, social network, transportation, medical care and medicines**)** Middle-aged individuals such as working poor who depend on social help for life-supporting resources – shelter, food, clothing, medical, money transfers and who reside in private dwellings particularly in Oslo and London where private accommodations are very expensive
2) Homeless individuals (of both genders) in all age cohorts between 18 and 75+
3) Homeless families with young children

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4) Young adults with families but sleeping roughly
5) Young adults sleeping at intermittent locations (owned by friends, acquittances, and occasionally with family or relatives)
6) People with disabilities (also members of their families) with or without disability pensions
7) Refugees and registered /unregistered migrants in large urban centres
8) Long-term unemployed seeking help from the Salvation Army and/or other NGOs for life-essential resources like food, shelter and medical aid
9) Combinations of people from different fragility clusters – homeless migrants vs. homeless people in their own country
10) People who work predominantly outdoor and whose health conditions bear the negative marks of elongated exposure to harsh weather and who might also have witnessed severe hazards (e.g., floods, fires and /or combinations thereof) causing death toll and material destructions.

The above designation provides a framework for convenience sampling which is not representative of all national vulnerable populations in the EU. However, this procedure is substantiated by the national composition of BuildERS consortium and access to informant cohorts using the Salvation Army's welfare service stations and shelters, and/or other personal support amenities.

Chapter 4 has confirmed that images of territories hit by hazards which were retrieved from satellite applications are quite helpful for operative rescue work. Taking images of territory exposed both during the pre-crisis phase and during the first phases of emergency helps the rescue teams in assessing the scale of an event impact, the structure of damage, and the pace of danger proliferation. The Copernicus platform basically provides two services; one for planning (at pre-crisis stage) and one for emergency management. Transfers of satellite beaming images are quite up to date, as the occurrences of severe hazards are observed and registered in almost real-time. However, the problem is that every request for access to Copernicus services must be carried by a national civil protection authority (national focal point) and that this delays receipt of hazard mapping for more efficient on-the-ground rescue and evacuation operations. Times for placing requests and getting access to service and the costs are also critical for reducing the possibility of utilizing this precious information when the time is scarce, and rescue must prevent more fatalities. These issues will be forwarded to the European Commission with suggestions for removal of the hindrances mentioned.

Appendices

Appendix 1 shows hazard cases year by year in Europe during 2015-2019, from Copernicus emergency service.
Appendix 2 lists examples showing how the detailed damage maps and statistics can be found from Copernicus emergency service for some hazard cases.

Appendix 3 presents the table on the selected hazards in BuildERS-study countries between 2015-2019

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Appendix 1. Hazard Cases in Europe During 2015 - 2019

The following figures shows the location of all-natural hazards in Europe between 2015 and 2019 for which the satellite imaging has been ordered from the Copernicus emergency service. This does not contain all the hazards occurred, like heat waves and cold periods but instead floods, fires, earthquakes, landslides, storms and others with visible damages.

Figure A1.1 Legend for the Copernicus Emergency Service Maps

Figure A1.2 Hazards with Satellite Imaging Requested by National Contact Points in 2015.
Source: Copernicus Emergency Management Service (© 2019 European Union).

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Figure A1. 3 Hazards with Satellite Imaging Request in 2016.
Source: Copernicus Emergency Management Service (© 2019 European Union).

Figure A1.4 Hazards with Satellite Imaging Request in 2017.
Source: Copernicus Emergency Management Service (© 2019 European Union).

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Figure A1.5 Hazards with Satellite Imaging Request in 2018.
Source: Copernicus Emergency Management Service (© 2019 European Union).

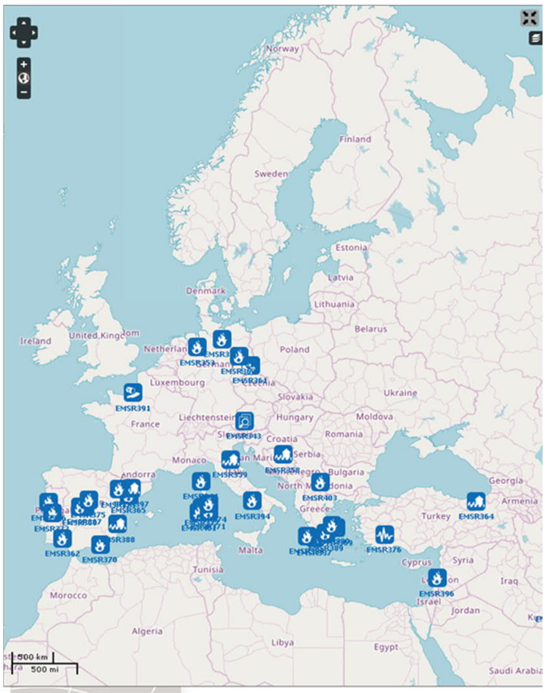

Figure A1.6 Hazards with Satellite Imaging Request in 2019.
Source: Copernicus Emergency Management Service (© 2019 European Union).

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Appendix 2. Examples of Information from Copernicus Emergency Service

The example below refers to Amatrice earthquake in Italy in 2016. Figure below shows the locations of the earthquake discharge areas as imaged by Copernicus emergency service which hit Central Italy on August 26th 2016. The image was requested by Italian authorities to assess the geo-squares corresponding to earthquake discharge. The next figure shows a detailed assessment of damaged buildings and roads network, and Table 1 shows statistics on the hazard damages and persons affected.

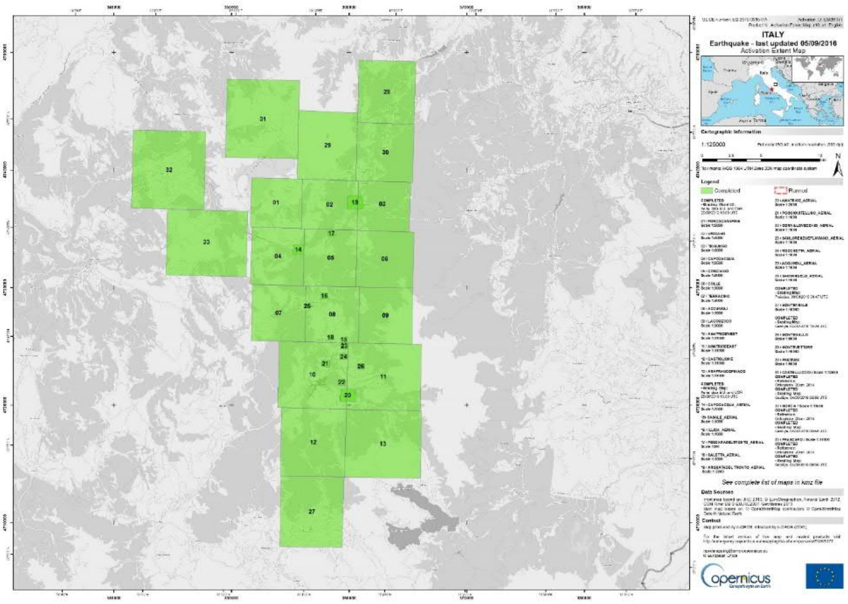

Figure A2.1 Impact areas of Amatrice Earthquake in 2016 in Italy.
Source: Copernicus Emergency Management Service (© 2019 European Union), [EMSR177]

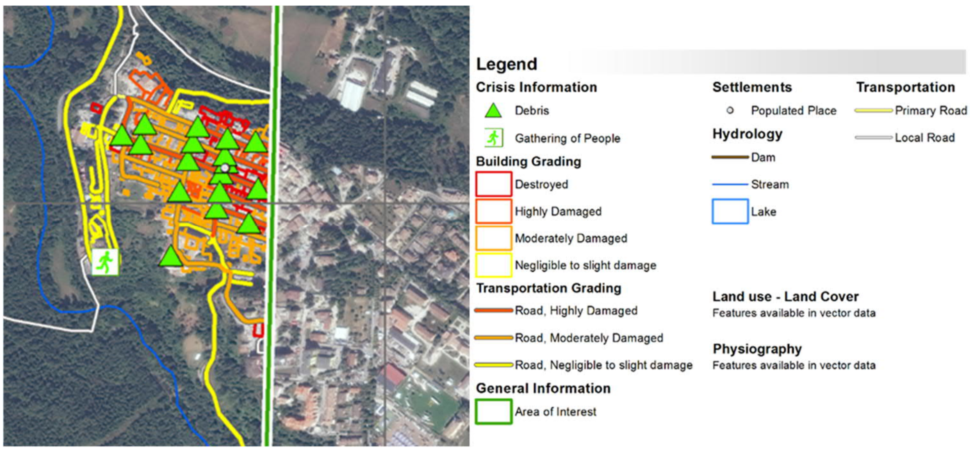

Figure A2.2 Extract of Layer Showing Part of Damaged Buildings and Roads during Amatrice Earthquake in August 2016 with Legend to the Right.
Source: Copernicus Emergency Management Service (© 2019 European Union), [EMSR177]

Table A2.1 Impact Statistics Extracted from Satellite Image.

Consequences within the AOI									
	Unit of measurement		Destroyed	Highly damaged	Moderately damaged	Negligible to slight damage	Total affected	Total in AOI
Gathering of people		No.						1
Estimated population		No. of inhabitants					290	1038
Settlements	Residential	No.	50	50	142	20	262	1645
	Agriculture	No.	0	0	0	0	0	16
	Cemetery	No.	0	0	0	0	0	68
	Commercial	No.	0	0	0	0	0	1
	Industrial	No.	0	0	0	0	0	21
	Medical	No.	0	5	0	2	7	7
	Multi-functional	No.	0	0	0	0	0	31
	Religious	No.	3	0	4	0	7	7
Transportation	Primary roads	km	0.0	0.3	0.0	0.9	1.2	22
	Local roads	km	0.0	0.7	1.1	1.2	3.0	90.5
Land use	Cropland	ha	0	0	0	0	0	1615.3
	Grassland	ha	0	0	0	0	0	14.5
	Woodland	ha	0	0	0	0	0	1586.3

Source: Copernicus Emergency Management Service (© 2019 European Union), [EMSR177]

It is noteworthy that satellite observations retrieval has accessed the GIS database to calculate the number of people located in area of interest (AOI) which were enumerated to be 1,038 persons out of which 290 were affected by the earthquake at the time the picture of this event was taken.

Appendix 3. Table of selected hazards in BuildERS-study countries between 2015-2019

Table A3.1 Hazard case table in BuildERS target countries between 2015-2019

Hazard type	Country	Discharge area or link to discharge area delineation	Date	Mortality, Injured and Affected, or Satellite imaging request	Source 1
Storm, Snow	Austria	Heavy snowfall in Austria	7.1.2019	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR343
Storm	Austria	Wind Storm in the South of Austria	28.10.2018	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR340
Flood	Belgium	Floods in Limburg Province, Belgium	2.6.2016	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR166
Storm	Belgium	Storm in Belgium	4-5.6.2019	5 injured	https://www.vrt.be/vrtnws/nl/2019/06/04/code-oranje-deze-middag-zwoel-en-onweer/
Storm	Belgium, Germany	Storm in Belgium	18.1.2018	9 deaths	https://www.theguardian.com/world/2018/jan/18/amsterdam-schiphol-flights-storm-chaos-europe
Heatwave	Belgium		19.7.2019	1 death	https://www.brusselstimes.com/all-news/belgium-all-news/61488/belgium-sees-first-death-as-a-result-of-record-heat-wave/
Heatwave	Belgium	Brussels 39 degrees	28.10.2019	na	The Sun, July 26th 2019, 22:40
Heatwave	Belgium	Belgium	19-25.06.2017	235 deaths (estimate based on normal condition statistics)	http://www.flanderstoday.eu/current-affairs/more-deaths-during-heatwave-june
Heat wave	Belgium	Brussels	2015	na	https://www.emdat.be/sites/default/files/maps_created_2017/Heatwave_occurrence_BEL_georef.jpg
Heat wave	Estonia	Estonia, including Tallinn >30 degrees	5-8.7.2019	na	Estonian Weather Service, https://www.ilmateenistus.ee/?lang=en
Flooding, Thunderstorm	Estonia	Tallinn	17.8.2017	na	Estonian Weather Service, https://www.ilmateenistus.ee/?lang=en
Flooding Heavy rain	Estonia	Tallinn	10.7.2016	na	Estonian Weather Service, https://www.ilmateenistus.ee/?lang=en
Winter storm	Finland	Southern Finland	19.12.2019	32 000 electricity cut-off	https://www.iltalehti.fi/kotimaa/a/fcb5c1e4-78ae-44a6-9693-a9f11f96df47
Forest fires	Finland	Pyhäranta, Varsinais-Suomi	July 2018	100 ha forest	https://yle.fi/uutiset/3-10314168

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				burnt, evacuations	
Storms	Finland		January 2019	1 death	
Storm	Finland	Kainuu power shortages	August 2017	Thousands of electricity cut-off	
Storm	Finland	Kainuu power shortages	August 2018		
Attack	Finland	Turku	2017		
Drinking water	Finland	Nousiainen	2017		
Heatwave	Finland		July. August 2018	380 deaths (estimate based on normal conditions statistics)	https://thl.fi/en/web/thlfi-en/-/last-summer-s-heat-wave-increased-the-mortality-of-older-people-prepare-for-hot-weather-in-time
Storm	Finland	Kiira	August 2017		https://ilmatieteenlaitos.fi/tiedote/400025196 and https://fi.wikipedia.org/wiki/Kiira-rajuilma
Winter storm	Finland	Juupajoki	21.11.2015		
Flood	Finland, Sweden	Floods in Finland	17.5.2018	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR284
Explosion	Germany	Ludwigshafen	8.7.1905	5 deaths, about 10 injured	https://www.dw.com/en/fourth-person-dies-after-basf-chemical-plant-blast-in-ludwigshafen/a-3619888
Flood	Germany	Floods in Lower Saxony, Germany	14.12.2017	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR261
Flood	Germany	Flood in Braunschweig "Julihochwasser"	27.7.2017	Imaging request	https://www.braunschweig.de/leben/umwelt_naturschutz/wasser/hochwasserschutz.php
Flood	Germany	Floods in Bavaria, Rottal-Inn, Passau, Triftern, Germany	1.6.2016	10 000 houses without electricity	https://www.pnp.de/themen/2016/hochwasser_2016/?em_index_page=18 https://www.focus.de/panorama/videos/triftern-ueberschwemmung-in-niederbayern-familie-fuerchtet-um-existenz_id_5590110.html https://www.sueddeutsche.de/bayern/hochwasser-unwetter-mit-ueberschwemmungen-bayern-steht-unter-wasser-1.3020149

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Landslide	Germany	Landslides in Saxony, Germany	9.4.2019	Imaging request	
Storm	Germany	Wind Storm Friederike in Central West...	18.1.2018	8 death, affected millions of people	https://www.n-tv.de/panorama/So-wuetete-Friederike-durch-Deutschland-article20239933.html
Storm	Germany	Wind Storm Friederike in Central West...	18.1.2018	Imaging request	https://www.n-tv.de/panorama/So-wuetete-Friederike-durch-Deutschland-article20239933.html
Storm	Germany	Wind Storm in Saxony, Germany	29.10.2017	4 deaths, affected millions of people	https://www.sueddeutsche.de/panorama/naturkatastrophen-die-bilanz-von-sturm-herwart-1.3730440
Storm	Germany	Storm Xavier	October 2017	7 deaths in Germany	https://www.merkur.de/welt/sturm-xavier-erschlaegt-sieben-menschen-news-ticker-zum-orkan-ueber-deutschland-zr-8745224.html https://www.zeit.de/gesellschaft/zeitgeschehen/2017-10/sturmtief-xavier-deutsche-bahn-hannover-hamburg-berlin https://www.bz-berlin.de/berlin/so-wuetete-sturm-xavier-in-berlin
Wildfire	Germany	Forest fire in Mecklenburg-Western...	July 2019	650 people directly affected, thousands of others indirectly affected by fine-dust	https://www.spiegel.de/panorama/luebtheen-waldbrand-in-mecklenburg-vorpommern-der-ueberblick-a-1275251.html
Wildfire	Germany	Forest Fire in Brandenburg, Germany	3.6.2019	Imaging request	
Wildfire	Germany	Wildfire in Lower Saxony, Germany	July 2019	No casualties	https://www.nwzonline.de/region/vechta/blaulicht/damme-einsatz-im-landkreis-vechta-feuerwehr-loescht-waldbrand-bei-damme_a_50,5,1538262276.html
Wildfire	Germany	Fire in Brandenburg, Germany	June 2019	No causalities	https://www.faz.net/aktuell/gesellschaft/feuer-in-brandenburg-weitet-sich-aus-16253426.html
Wildfire	Germany	Forest Fire in Jüterborg, Germany	3.6.2018	Imaging request	https://www.rbb24.de/panorama/beitrag/2019/06/wetter-hitze-waldbraende-jueterbog-hitzewarnung-.html
Wildfire	Germany	Forest fire in Saxony-Anhalt, Germany	4.7.2018	Imaging request	https://www.volksstimme.de/sachsen-anhalt/waldbrand-80-hektar-brennen-bei-wittenberg
Flood	Greece	Flood in Western Greece	12.1.2019	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR337
Flood	Greece	Flood in North Eastern Greece	28.6.2018	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR292
Flood	Greece	Floods west of Athens, Greece	27.6.2018	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR294

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Flood	Greece	Flood in Thrace, Greece	27.3.2018	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR277
Flood	Greece	Floods in Central Greece	24.2.2018	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR271
Flood	Greece	Flood in Attika, Greece	15.11.2017	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR257
Flood	Greece	Flood in Greece	30.3.2015	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR117
Flood	Greece	Flood in Greece	1.2.2015	Imaging request	
Forest fire, wildfire	Greece	Fires on Thasos Island	10.9.2016	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR177
Wildfire	Greece	Forest fire in Zakynthos Island, Greece	15.9.2019	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR390
Wildfire	Greece	Forest fire in Loutraki area, Greece	14.9.2019	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR389
Wildfire	Greece	Forest fire in Evia Island, Greece	13.8.2019	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR380
Wildfire	Greece	Forest Fire in Evia Island, Greece	4.7.2019	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR369
Wildfire	Greece	Forest Fire in Sithonia, Greece	25.10.2018	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR331
Wildfire	Greece	Forest Fire in Evia Island, Greece	12.8.2018	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR306
Wildfire	Greece	Forest Fire in Western Achaia, Greece	11.9.2017	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR242
Wildfire	Greece	Forest fire in Zakynthos Island and Kalamos	11.8.2017	State of Emergency	https://emergency.copernicus.eu/mapping/list-of-components/EMSR224
Wildfire Heat wave Forest fire	Greece	Forest Fires in Attika, Greece	23.7.2018	91	Concurrent 2018 hot extremes across Northern1hemisphere due to human-induced climate change.pdf
Forest fire, wildfire	Hungary	Fire in Hungary, Kiskunsag National Park, a Natura 2000 protected area	24.7.2015	0	https://www.researchgate.net/publication/326175866_A_2015-OS_BOCSAI-KASKANTYUI_ERDOTUZ_TERINFORMATIKAI_ALAPU_FELMERESE_ES_TOVABBI_TERMESZETVEDELMI_KEZELESE
Wildfire	Hungary	Forest Fire in Nagyivan, Hungary, Hortobágy National Park	3.8.2017	0 people, 400 animals	https://www.dehir.hu/hajdu-bihar/hortobagyi-tuz-honvedsegi-helikopterek-is-reszt-vesznek-az-oltasban/2017/08/04/

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Flood	Ireland	Flood in North Western Ireland	22.8.2017	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR231
Flood	Ireland	Floods in Roscommon II	4.3.2016	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR154
Flood	Ireland	Floods in Roscommon	5.2.2016	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR151
Flood	Ireland	Flood in Ireland	4.12.2015	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR148
Storm	Ireland	Hurricane Ophelia in Ireland	16.10.2017	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR249
Flood	Italy	Venice	November 2018	Imaging request	
Earthquake	Italy	Earthquake in Central Italy Umbria and Marche	26.10.2016	Affected > 22 000	Annual Disaster Statistical Review 2016 - The numbers and trends. Pdf
Earthquake	Italy	Earthquake in Central Italy Amatrice Lazio Abruzza Umbrio	24.8.2016	296 deaths, affected around 5000	Annual Disaster Statistical Review 2016 - The numbers and trends. Pdf
Earthquake with heavy snowfalls	Italy	Earthquake in Central Italy Abruzzo	18.1.2017	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR194
Flood	Italy	Flood in the North of Italy	11.5.2019	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR359
Flood	Italy	Flood in Veneto, Italy	30.10.2018	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR332
Flood	Italy	Flood in southern Sardinia, Italy	10.10.2018	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR329
Flood	Italy	Flood in Northern Italy	12.12.2017	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR260
Flood	Italy	Flood in Tuscany, Italy	10.9.2017	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR238
Flood	Italy	Floods in Northern Italy	24.11.2016	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR190
Flood	Italy	Flooding and landslides in Campania, Italy	14.10.2015	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR138
Flood	Italy	Flooding and landslides in Emilia Romagna...	14.9.2015	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR136
Flood and landslide	Italy	Flood in Sicily, Italy	2.11.2018	12 deaths	https://emergency.copernicus.eu/mapping/list-of-components/EMSR333

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Flood Landslide	Italy	Flood in Sicily, Italy	18.10.2018	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR330
Flooding and landslide	Italy	Torino	November 2018		
Flooding and landslide	Italy	Palermo	November 2018	Nx10 deaths	
Forest fire, wildfire	Italy	Forest Fires in Sardinia	4.7.2016	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR169
Forest fire, wildfire	Italy	Fires in Sicily	16.6.2016	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR167
Other	Italy	Volcanic eruption Mount Etna, Italy	3.12.2015	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR141
Other	Italy	Flooding and landslides in Emilia Romagna...	14.9.2015	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR136
Other	Italy	Phytosanitary emergency in Italy	10.4.2015	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR124
Storm	Italy	Wind Storm in north-east of Italy	26.10.2018	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR334
Storm	Italy	Storm in Friuli, Italy	10.8.2017	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR225
Wildfire	Italy	Forest fire in Sardinia, Italy	22.10.2019	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR401
Wildfire	Italy	Forest fire in Campania, Italy	20.9.2019	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR394
Wildfire	Italy	Wildfire in Sardinia, Italy	6.8.2019	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR377
Wildfire	Italy	Fire in Sardinia, Italy	28.7.2019	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR374
Wildfire	Italy	Fire in Sardinia, Italy	13.7.2019	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR371
Wildfire	Italy	Forest Fire in Tuscany, Italy	24.9.2018	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR316
Wildfire	Italy	Forest fire in Piemonte, Italy	27.10.2017	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR253
Wildfire	Italy	Forest Fire in Southern Italy	11.7.2017	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR213

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Volcanic activity	Italy	Etna Volcano eruption in Sicily, Italy	24.12.2018	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR336
Storm and rains	Italy		November 2018	29 deaths	
Explosion	Italy	Sicily firework factory explosion	November 2018	5 deaths, about 10 injured	
Flood	Norway	Floods in Norway	10.5.2018	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR283
Flood	Norway	Floods in Norway	21.10.2017	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR251
Heat wave	Norway		10.7.1905		
Flood	Romania	Flood in Romania	30.6.2018	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR293
Flood	Romania	Floods in Romania	12.10.2016	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR182
Floods	Romania		2019		https://www.romania-insider.com/floods-romania-early-june-2019, http://floodlist.com/tag/romania
Nightclub fire	Romania		2015	27 deaths, 184 injured	https://www.reuters.com/article/us-romania-blast/romanian-nightclub-fire-leaves-27-dead-184-injured-idUSKCN0SO2UG20151031
Storm	Romania	Timisoara	September 2017	Several deaths	https://www.bbc.com/news/world-europe-41302569, https://www.euronews.com/2017/09/18/romania-battered-by-deadly-storm
Heat wave	Sweden		July 2018	700 deaths (estimate from normal conditions statistics)	https://www.folkhalsomyndigheten.se/nyheter-och-press/nyhetsarkiv/2018/december/okad-dodlighet-under-sommarens-varmebolja/
Wildfire	Sweden	Forest Fire in Central Sweden	16.7.2018	Evacuations of people (~100) and livestock	https://www.regeringen.se/4906d2/contentassets/8a43cbc3286c4eb39be8b347ce78da16/skogsbranderna-sommaren-2018-sou-2019-7.pdf
Wildfire	Sweden	Forest fire in Sweden	3.6.2018	Evacuations of people and livestock	https://emergency.copernicus.eu/mapping/list-of-components/EMSR290
Storm	Sweden	Alfrida	01-02.01.2019	100 000 households without electricity	https://www.skogssverige.se/skog/stormfallning/kanda-stormar http://www.smhi.se/kunskapsbanken/meteorologi/alfrida-och-jan-januari-2019-1.143353
Storm	Sweden	Gorm	29-30.11.2015		https://www.skogssverige.se/skog/stormfallning/kanda-stormar

Storm	Sweden	Egon	10-11.01.2015	70 000 households without electricity	https://www.skogssverige.se/skog/stormfallning/kanda-stormar
Refugee crisis	Sweden		2015	156 110 first time applicants (16 016 applicants/ million inhabitants)	https://ec.europa.eu/eurostat/documents/2995521/7203832/3-04032016-AP-EN.pdf/790eba01-381c-4163-bcd2-a54959b99ed6 https://www.imf.org/external/pubs/ft/sdn/2016/sdn1602.pdf
Heatwave	UK	London	28.10.2019		The Sun, July 26th 2019, 22:40
Flood	UK	Flooding in Northern Ireland, United...	23.8.2017	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR228
Flood	UK	Flood in Northern Ireland	11.1.2016	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR151
Flood	UK	Flood in England	27.12.2015	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR147
Flood	UK	Flood in Cumbria	5.12.2015	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR149
Wildfire	UK	Wildfire in England	24.6.2018	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR291
Wildfire	UK	Wildfires in Northern Scotland	15.4.2018	Imaging request	https://emergency.copernicus.eu/mapping/list-of-components/EMSR281

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