Lessons learnt from recent flood disasters in Europe: Indicative cases.

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ABSTRACT

Europe suffers from flood disasters, which have increased in intensity and frequency in recent years and are likely to be exacerbated by the effects of increased urbanization, climate change and inadequate drainage infrastructure and storage areas. The question facing hydro-environmental researchers is: “What lessons have we learnt from recent flood disasters in Europe?”. The IAHR Leadership Team Europe is organizing the preparation of a detailed paper to answer this question. The present abstract provides a brief description of the main parts of this paper, together with an indicative list of flood disasters in the last ten years with their basic characteristics.

1. Recent catastrophic floods in Europe

Flood risk management in Europe has steadily improved, but catastrophic floods with high human losses and damages continue to occur. Relatively recent flood disasters, such as the floods of July 2021 in Western and Central Europe, have shown that European countries continue to experience catastrophic high magnitude floods with significant loss of life and damage, even in some countries with sophisticated risk mitigation measures.

Italy experienced 43 events between 2020 and 2023, causing 43 deaths and affecting 80,000 people. In particular, unrecorded major events in Marche (2022) and Emilia Romagna (2023) caused 26 additional deaths, over 35,000 evacuations and significant financial losses. Recent floods in Tuscany (November 2023) caused 8 deaths and affected 23,000 people, with estimated losses of €2 billion. Unprecedented floods in several European countries, including Belgium, Poland, Greece, Germany, Norway, Spain, France and Portugal, have highlighted the urgent need for improved flood-resilient urban planning and crisis management. In Belgium, the Meuse River Basin experienced record-breaking flows in July 2021, resulting in deaths, severe property damage and infrastructure disruption. Similar catastrophic floods occurred in Poland in 2010, causing significant economic losses and casualties. Greece faced more than 380 floods with

132 deaths between 2000 and 2020, with the deadliest event in Mandra in November 2017. Germany suffered extensive losses of over €30 billion and 180 deaths in July 2021, highlighting deficiencies in communication and flood risk management. In Norway, heavy rainfall led to flooding and landslides, highlighting the need to adapt infrastructure to climate change. Spain, facing both floods and droughts, implemented flood risk assessment measures and identified more than 1,300 areas at risk. France, with a high annual cost of flood-related damage, experiences frequent flash floods in the south-east, resulting in significant economic losses and casualties. In northern France, heavy rainfall in November 2023 caused local rivers to overflow, causing €1.3 billion in damage and affecting 517,000 people. Portugal has a history of devastating floods, with the tragic "Ponte Entre-os-Rios" event in 2000/2001 and coastal flooding affecting 75% of the population. The case of Furadouro beach in Aveiro illustrates the persistent challenges of coastal flooding that Portugal has faced since 1857.

These collective experiences highlight the critical importance of comprehensive flood risk management and adaptation strategies in the face of increasing climate-related challenges. On the basis of the above brief descriptions, hydro-environmental researchers are faced with the question “What lessons have we learnt from the recent flood disasters in Europe?” The IAHR Leadership Team Europe is organizing the preparation of a detailed paper to answer this question. This paper will consist of the following four parts: (1) the formulation of a catalogue of the most important flood disasters that have occurred in different European countries, (2) the collection of detailed characteristics of these floods, (3) the processing and inter-comparison of these characteristics, and (4) the presentation of the answer to the question posed. Table 1 summarizes the main characteristics of recent floods in Europe, highlighting their severity over the last fifteen years. The records provide a valuable database for thorough cross-analysis, revealing common features and site-specific conditions that influence mitigation and prevention plans across regions. Despite centuries of exposure to extreme floods in Europe, a comprehensive literature benchmark is lacking. Our study aims to collect detailed data on meteorological, hydrological and hydrodynamic aspects, as well as existing flood management systems during disasters, such as early warning systems. The results will be presented in tables and figures, providing insights into lessons learned and addressing the research question.

Table 1. Main characteristics of indicative recent catastrophic floods in Europe.

Country, Region	Period	Brief description
France, South-East, French Riviera	2-3.10.2015	Cause: rainfall = 110 mm in Cannes/Mandelieu in 1 h – 160 mm in the Brague in 3h, exceeds 100-year return period; Combination of factors: low-pressure system born in the Mediterranean Sea and precipitation lasted all day; 20 casualties; damage= €1 billion. The 2015 event becomes the reference flood for the catchment, the plan for Flood Risk Prevention is therefore revised for ten municipalities.
Greece, West Attica	15.11.2017	Cause: barometric low Eurydice & Cyclone Numa; rainfall = 150 mm in 7 hours; deaths = 24; damaged buildings: ≈ 1000.
Greece, Northern Greece, Halkidiki	11.07.2019	Cause: overnight storm in 20 mins; deaths = 7; wounded: 100.
Greece, Central Greece, Evia	09.08.2020	Cause: severe thunderstorms and heavy precipitation due to storm Thalia; rainfall=300 mm in 8 h; water depths = 1.5 m, deaths=8; homes destroyed = 2000, road network: extensive damages; cost of damage = millions.
France, South-Est, upstream catchments of Alpes-Maritimes	02.10.2020	Cause: powerful early-season extratropical cyclone; particularly devastating floods and resulting landslides, especially in three catchments (Roya, Vésubie and Tinée); rainfall of 500 mm in less than 24h; Damages: around 60 km of roads destroyed, 20 bridges collapsed, around 100 houses at Saint-Martin-Vésubie; deaths = 11, and 8 missing; damage= €1 billion.
Belgium, Eastern part, Meuse basin;	14-15.07.2021	Extreme riverine floods in tributaries of the Meuse River, following two days of rainfall with an accumulated volume of up to 300 mm. About €5 billion of flood losses.
Germany, Ahr and Erft Rivers	14-15.07.2021	Extreme flash floods and river floods in the tributaries and main channel of the rivers Ahr and Erft following two days of rainfall with an accumulated volume of more than 150 mm. Losses in excess of €30 billion and more than 180 fatalities.
Italy, Central Italy, Marche, and Umbria Region	15.09.2022	Cause: self-regenerating storm; rainfall = 400 mm in 6 hours with peaks of 90 mm in 1 hour; deaths: 12; damage to houses, economic activities, infrastructures.
Italy, North Italy, Emilia Romagna Region	1-15. 05.2023	Cause; cyclone; rainfall 250 mm in 48 hours; more than 24 rivers flooded, deaths 14; billions of damages to houses, economic activities, infrastructures, environmental goods.
Greece, Central Greece, Thessaly	07.09.2023	Cause: very heavy rainfall due to storm Daniel; deaths = 23; killed livestock: tens of thousands; area flooded: 8500 km^2 mostly prime farmland; crops: destroyed; swamped buildings: hundreds; main railway, roads, and bridges: savaged; cost of damage = billions.
Italy, Central Italy, Tuscany	2-3.11.2023	Cause: cyclone; rainfall 200 mm in 2 h; several rivers flooded, deaths: 8; 2 billion of damage to houses, economic activities, infrastructures, environmental goods.