ISSUE BRIEF

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IMPACT AND LESSONS FROM THE 2024 EUROPEAN FLOODS: CLIMATE CHANGE, INFRASTRUCTURE DAMAGE, AND RECOVERY

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November 4, 2024

(Views expressed in the brief are those of the author, and do not represent those of ISSI)

Introduction

In mid-September 2024, record rainfall from Storm Boris triggered catastrophic flooding across Central and Eastern Europe, displacing over 25,000 people and causing widespread damage. The floods affected Austria, Czech Republic, Slovakia, Poland, Romania, Italy and Hungary, with Austria and Czech Republic being the hardest hit. The disaster resulted in over 20 deaths across several countries, while infrastructure, homes, and essential services were severely impacted. The storm, caused by a confluence of Arctic and Mediterranean air masses, brought unprecedented rainfall, overwhelming river systems and causing dam breaches, power outages, and evacuations.[1] Furthermore, in late October 2024, Spain experienced one of its most devastating flash flood events in decades. An extraordinary volume of rain, over 500 millimeters within just eight hours, hit the Valencia region, wreaking havoc on infrastructure and claiming over 200 lives.[2] Climate change has been linked to the increasing frequency and intensity of such

1 "Rivers in Europe Burst Their Banks," Earth Observatory, September 20, 2024, https://earthobservatory.nasa.gov/images/153358/rivers-in-europe-burst-their-banks

2 "Devastating rainfall hits Spain in yet another flood-related disaster," WMO, October 31, 2024, https://wmo.int/media/news/devastating-rainfall-hits-spain-yet-another-flood-related-disaster

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extreme weather events. The floods highlighted the region's vulnerability to climate-induced disasters and the need for stronger resilience measures.

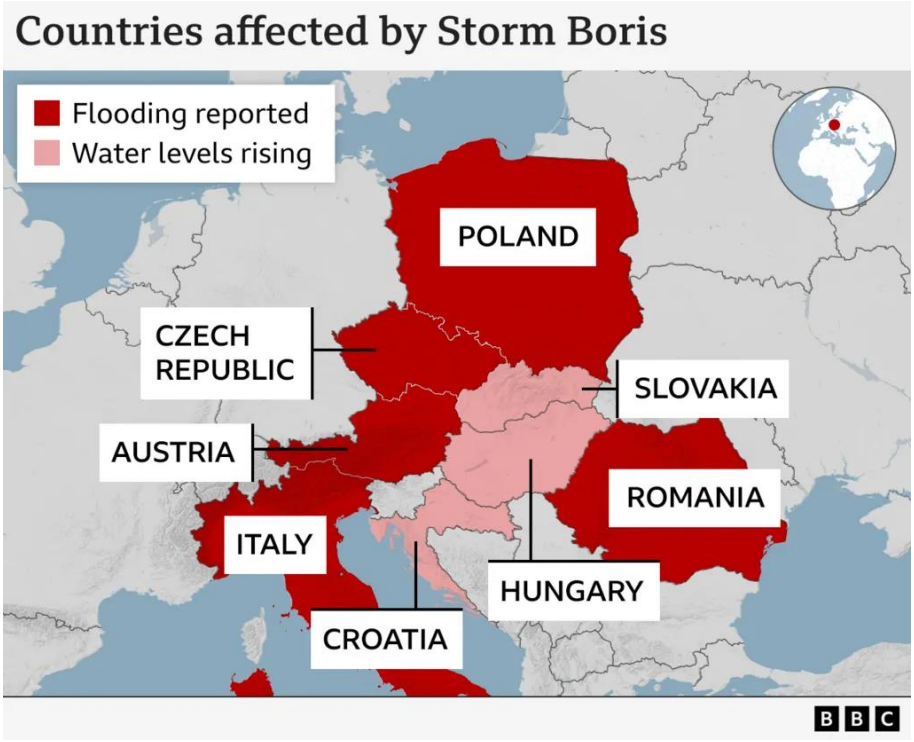

Figure1: Countries Effected by Storm Boris[3]

Meteorological Causes

Storm Boris developed due to a Genoa low-pressure system wherein cold Arctic air mixed with warm Mediterranean air. This created a slow-moving weather pattern between September 14 and 21, 2024, which led to record rainfall. The system became cut off from the jet stream, resulting in continuous downpours across Central and Eastern Europe. The Vb depression—a meteorological pattern where cold polar air interacts with warm southern air—exacerbated the precipitation, particularly affecting urban areas along major rivers.[4]

3 Adam Durbin, "Italy next to face storm after 21 killed in Europe floods," BBC, September 18, 2024, https://www.bbc.com/news/articles/ckgmrnwgm7zo

4 "Climate change and high exposure increased costs and disruption to lives and livelihoods from flooding associated with exceptionally heavy rainfall in Central Europe," World Weather Attribution, September 25, 2024, https://www.worldweatherattribution.org/climate-change-and-high-exposure-increased-costs-and-disruption-to-lives-and-livelihoods-from-flooding-associated-with-exceptionally-heavy-rainfall-in-central-europe/

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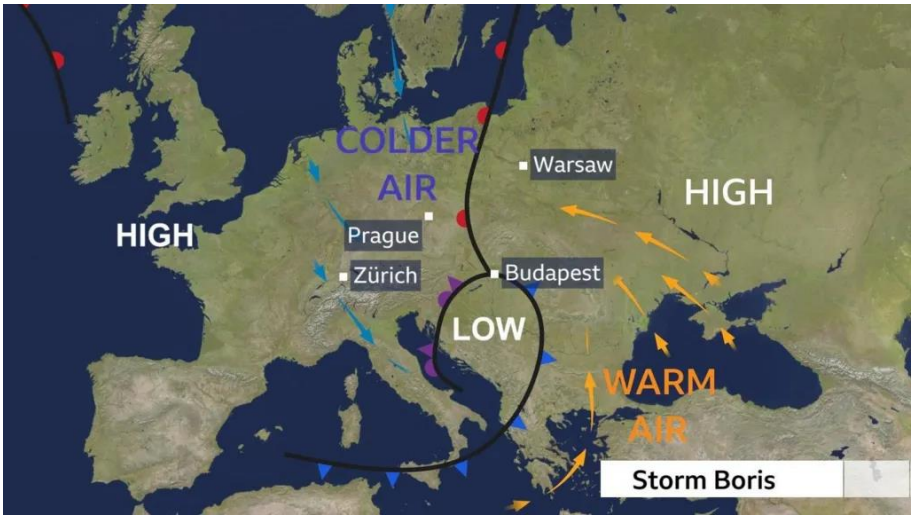

Figure2: Storm Boris[5]

Spain's weather pattern, known as "gota fría" or "cold drop," is a natural meteorological event that typically affects the country during autumn. Cold air from the polar regions descends upon the warm Mediterranean Sea, creating conditions for intense storms. The hot surface of the sea allows moist air to rise rapidly, forming towering clouds capable of unleashing vast amounts of rainfall when they move over land. The Mediterranean is warming faster than other parts of the world, with recent summers pushing sea surface temperatures to record highs. In mid-August, the Mediterranean reached an unprecedented 28.47°C, fueling storms like the recent DANA (Depresión Aislada en Niveles Altos), a type of isolated low-pressure system that moves slowly, allowing rain to accumulate over a concentrated area, which is what happened on October 29, 2024.[6]

5 Adam Easton, "Catastrophe' as deadly floods hit Central and Eastern Europe," BBC, September 16, 2024, https://www.bbc.com/news/articles/c0jwp3ppp6xo

6 "What to know about flash floods that killed over 200 people in Spain," Al Jazeera, November 3, 2024, https://www.aljazeera.com/news/2024/11/3/what-to-know-about-flash-floods-that-killed-over-200-people-in-spain

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Figure3: Deadly flash floods devastate Spain's eastern Valencia region[7]

Geographic and Hydrological Impact

The floodwaters overflowed major rivers, such as the Oder and Danube, leading to severe damage across the region. Poland, Austria, and Czech Republic were among the hardest-hit countries. Southeastern Poland saw the Oder River breach its banks, flooding farmland and towns, with the dam in Stronie Slaskie bursting, destroying homes and infrastructure. In Austria, the province surrounding Vienna recorded rainfall up to 215 mm, leading to widespread flooding, damaged dams, and disruption to rail and road transport. In Italy, the country's National Civil Protection Service has issued yellow alerts for nearly 50 regions.[8]

The Danube River posed a significant threat as it surged across Austria, Slovakia, and Hungary, while the Oder reached critical levels in Poland. The town of Klodzko in Poland and Jesenik in the Czech Republic faced severe damage, with transport services halted and widespread evacuations initiated.

7 Teresa Medrano and Joseph Wilson, "What to know about the unprecedented floods that killed more than 200 in Spain," AP, November 4, 2024, https://apnews.com/article/flash-floods-spain-valencia-climate-change-what-to-know-f942142b82de24f5b4a18867bc32ae00

8 Emily Cassidy, "Water World: Europe's Epic Flood Disaster Explained," SciTechDaily, September 28, 2024, https://scitechdaily.com/water-world-europes-epic-flood-disaster-explained/

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Additionally, the Austrian Alps experienced an unusual event—recorded snowfall in September—exacerbating the flood situation.[9]

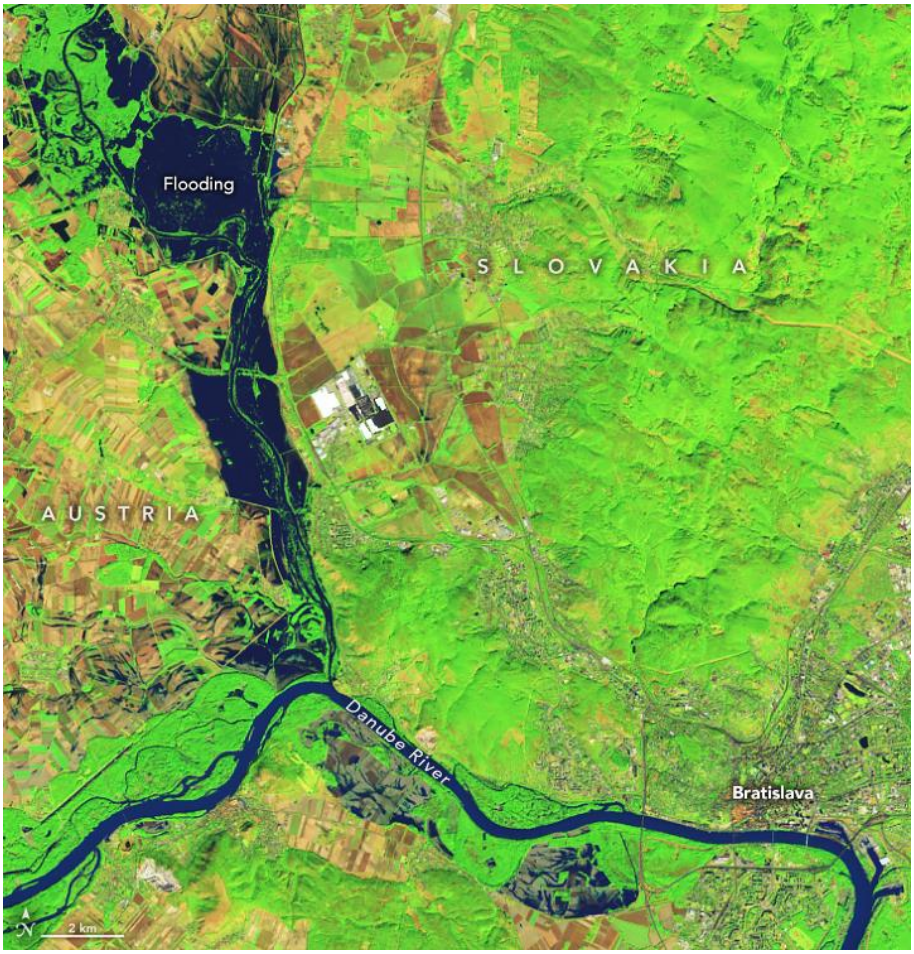

Figure4: Danube River on September 21[10]

In Spain the Valencian towns were among the worst affected. Entire communities were submerged, with images showing people stranded on rooftops and trapped in vehicles. Despite warnings issued by AEMET, Spain's meteorological agency, the sheer speed and intensity of the floods left many residents with little time to react, with several bridges washed away and entire streets flooded, stranding vehicles and endangering lives.[11]

9 "EU pledges billions in aid for flood-stricken areas as northern Italy hit," Aljazeera, September 19, 2024, https://www.aljazeera.com/news/2024/9/19/storm-boris-floods-northern-italy-as-leaders-to-discuss-eu-aid-in-poland

10 "Rivers in Europe Burst Their Banks," Earth Observatory, September 20, 2024, https://earthobservatory.nasa.gov/images/153358/rivers-in-europe-burst-their-banks

11 "Valencia Floods," Earth Observatory, October 30, 2024, https://earthobservatory.nasa.gov/images/153533/valencia-floods

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Figure5: Valencia, Spain on October 30[12]

Humanitarian Crisis

By September 20, the floods had displaced more than 25,000 people, with more than 20 deaths. Casualties included seven people each in Poland and Romania, five in Czech Republic, and three in Austria. Critical infrastructure, including power and water supplies, was severely disrupted, particularly in regions like Klodzko, Poland, where thousands were left without power.[13]

Rescue operations were hampered by the scale of the disaster. In Slovakia and Austria, military and emergency services were deployed to manage evacuations and protect vital infrastructure.

12 ibid

13 Adam Easton, "'Catastrophe' as deadly floods hit Central and Eastern Europe," BBC, September 16, 2024, https://www.bbc.com/news/articles/c0jwp3ppp6xo

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Volunteers and emergency workers constructed sandbag barriers to prevent further flooding, though some areas remained cut off from rescue efforts.[14]

The Spanish government declared three days of national mourning, and a massive rescue operation was launched, with over 10,000 military personnel mobilized to assist in rescue and recovery efforts. As relief efforts continue, thousands of volunteers are helping to clear mud and debris while facing shortages of clean drinking water and other essentials.[15]

Economic Impact

The economic toll from the 2024 floods is significant. Initial estimate placed the damage between $2.2 billion and $3.3 billion. Poland's Prime Minister Donald Tusk declared a state of emergency, and emergency funds were released to support recovery efforts. The floods also impacted industrial operations, with factories, including chemical plants in the Czech Republic, suspending production. This economic disruption further complicated the response and recovery process, with many countries relying on emergency aid and donations.[16] In Valencia, Spain with roads, railroads, infrastructure and business areas buried by the disaster the total cost is expected to be staggering. Meanwhile, the Ford plant also halted its operations in the wake of the flooding.

Role of Climate Change

Researchers attribute the severity of the 2024 floods to climate change. Studies showed that heavy rainfall events, like those caused by Storm Boris, have become more frequent and intense due to global warming. Since the pre-industrial era, such rainfall events have doubled in likelihood, with 10% higher intensity. This trend is expected to worsen as global temperatures continue to rise, emphasizing the need for adaptive measures to mitigate the effects of future climate disasters.[17]

The floods in Spain echo similar disasters around the world this year, with climate change widely recognized as a catalyst. Warming temperatures have intensified the hydrological cycle, resulting in

14 Monika Scislowska, "Floods threaten new areas in Central Europe and Italy," LA Times, September 19, 2024, https://www.latimes.com/world-nation/story/2024-09-19/floods-in-central-europe-threaten-new-areas-heavy-rains-also-inundate-parts-of-italy

15 Sam Jones, "Spain floods: 10,000 troops and police drafted in to deal with disaster," Guardian, November 2, 2024, https://www.theguardian.com/world/2024/nov/02/spain-floods-disaster-5000-more-troops-drafted-in-to-deal-with-aftermath

16 Kuba Stezycki, Janis Laizans and Radovan Stoklasa, "Central European floods leave trail of devastation; new areas to evacuate," Reuters, September 18, 2024, https://www.reuters.com/world/europe/poland-fortifies-towns-deadly-floods-afflict-central-europe-2024-09-17/

17 Austyn Gaffney, "Flooding in Europe Is a 'Clear Reminder' of the Threat of Extreme Weather," NewYork Times, September 18, 2024, https://www.nytimes.com/2024/09/18/climate/central-europe-floods-global-warming.html

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an erratic pattern of droughts and floods. Dr. Friederike Otto of Imperial College London asserts that climate change has amplified this phenomenon. Rising temperatures, driven by greenhouse gas emissions, enable the atmosphere to hold more moisture, resulting in heavier bursts of rain during these storms. For every degree Celsius of warming, atmospheric moisture increases by approximately 7%, contributing to record-breaking downpours.[18]

Governments across Europe have begun implementing climate adaptation strategies, but the 2024 floods underscore the inadequacy of current measures. Emergency management systems, flood defences, and early warning systems are in place, but further investments in green infrastructure and sustainable urban planning are essential to cope with the increasing threat of extreme weather events.[19]

Regional Responses and Recovery Efforts

In response to the floods, affected countries mobilized military and emergency services to manage rescue and recovery operations. In Poland, 17,000 people were without power, and towns such as Nysa faced evacuations as military helicopters dropped sandbags to protect embankments. The Czech Republic declared a state of emergency in the northeast, with thousands evacuated from towns like Ostrava and Litovel. Austria faced similar challenges, with officials preparing for further rainfall as the Danube River threatened more regions.[20]

Governments also set aside funds for relief efforts, with Poland's government allocating $260 million to aid victims. The European Union (EU) pledged support of $11 billion from the cohesion fund for recovery efforts, while local communities organized food donations for those affected by the floods.[21] On November 1, the Spanish Ministry of Transport allocated €24.8 million for initial emergency repairs to roads and rail infrastructure affected by severe flooding in the Valencia

18 Matt McGrath, "Scientists say climate change made Spanish floods worse," BBC, October 31, 2024, https://www.bbc.com/news/articles/c98eylqeg06o

19 "MOTION FOR A RESOLUTION on the devastating floods in central and eastern Europe, the loss of lives and the EU's preparedness to act on such disasters exacerbated by climate change," European Parliament, September 17, 2024, https://www.europarl.europa.eu/doceo/document/B-10-2024-0057_EN.html

20 Karel Janicek and Monika Scislowska, "Central Europe flooding leaves 16 dead in Romania, Poland, Czech Republic and Austria," AP, September 17, 2024, https://apnews.com/article/central-europe-floods-poland-czech-e9501517da041fda946454f875dc890c

21 "Flooding in Central Europe blamed for 24 deaths as EU promises $11 billion in emergency repair funding," CBS, September 20, 2024, https://www.cbsnews.com/news/flooding-europe-blamed-for-24-deaths-as-eu-promises-11-billion-in-emergency-repair-funding/

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region.[22] Recovery efforts have been slow, with some regions still bracing for additional rainfall and potential flooding.

Lessons and Future Preparedness

The 2024 floods in Europe highlight the urgent need for stronger flood defences and climate adaptation strategies. The severity of the event underscores the role of climate change in exacerbating natural disasters. As global temperatures rise, the likelihood of extreme weather events will continue to increase, threatening both human lives and economic stability.[23]

EU leaders and climate experts have called for accelerated investment in green infrastructure and sustainable urban planning to better protect against future floods. Efforts to improve early warning systems and strengthen embankments are underway, but more comprehensive policies are required to mitigate future risks. International cooperation, particularly within the EU, will be essential to ensure that all member states are adequately prepared for the challenges posed by climate change.[24]

Upcoming international forums, such as the COP29 climate summit in Azerbaijan, provide critical opportunities for global leaders to agree on concerted actions to mitigate climate risks. Investment in technologies that predict and monitor extreme weather patterns, coupled with policies aimed at enhancing community resilience, are essential steps to managing climate-related hazards. Spain's flash floods offer a stark reminder of the urgent need for climate action. Climate scientists stress that time is running out. Without significant reductions in emissions, the frequency and intensity of events like Spain's recent floods will likely continue to rise.[25]

Conclusion

The 2024 European floods highlight the escalating threat of climate change, with unprecedented rainfall from Storm Boris inflicting catastrophic damage across Central and Eastern Europe.

22 Sandrine Morel, "'Incalculable' economic losses in the wake of Spain's floods," Le Monde, November 2, 2024, https://www.lemonde.fr/en/economy/article/2024/11/02/incalculable-economic-losses-in-the-wake-of-spain-s-floods_6731369_19.html

23 "2024 Central and Eastern Europe Floods," CDP, September 19, 2024, https://disasterphilanthropy.org/disasters/2024-central-and-eastern-europe-floods/

24 Ajit Niranjan, "Climate scientists troubled by damage from floods ravaging central Europe," Guardian, September 16, 2024, https://www.theguardian.com/world/2024/sep/16/climate-scientists-troubled-by-damage-from-floods-ravaging-central-europe

25 Ajit Niranjan, "Spain's deadly floods and droughts are two faces of the climate crisis coin," Guardian, October 30, 2024, https://www.theguardian.com/world/2024/oct/30/spain-deadly-floods-and-severe-droughts-are-two-faces-of-the-climate-change-coin

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Thousands were displaced, and economic losses reached billions, underscoring the urgent need for stronger flood defenses, advanced early warning systems, and climate-resilient infrastructure.

The devastating floods in Spain particularly illustrate the complex link between rising temperatures, natural weather patterns, and human vulnerability. As Europe faces increasingly severe storms, floods, and droughts, coordinated action from governments, scientists, and communities becomes essential to address the challenges of a warming world.

Although the journey ahead is challenging, proactive measures can reduce the impacts of climate change. Building resilience in vulnerable communities, adapting infrastructure, and committing globally to emission reductions are critical steps in mitigating future climate-induced disasters.

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