EUCP Policy Brief No 1

EUCP

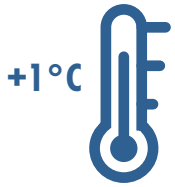
European Climate Prediction system

PREPARING FOR CLIMATE DISRUPTION IN EUROPE

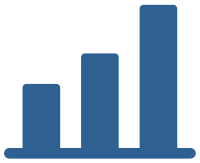
Predictions and projections of climate can help governments, businesses and other stakeholders better plan how to deal with the challenges and opportunities that a changing climate brings. EUCP (European Climate Prediction System) is a research project that has supported scientists and other climate information providers to produce better climate information for these users.

In this brief, we describe some of the changes in the climate across Europe already happening and the impacts this has produced in recent years. Through findings from EUCP research, we outline how the future climate of Europe is likely to change and what impacts this could have on key industries and communities. This information is intended to communicate key findings from EUCP research on future climate projections in Europe to support climate change policy. The results can be used alongside other information, such as the IPCC 6th assessment of climate change.

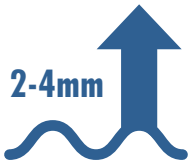
WHAT CHANGES HAVE WE SEEN SO FAR?



'Natural catastrophes caused estimated global insured losses of $123 billion (USD) in 2021, the fourth highest since 1970', according to the Swiss Re Group[1]. Atmospheric concentrations of greenhouse gases continue to increase and are at the highest levels in the instrumental record. Despite the year 2021 being just outside of the top 10 warmest years overall in Europe, it was the warmest European summer on record at 1˚C warmer than average for the season, relative to 1991-2020[2].



2021 saw a number of record-breaking extreme events across Europe[2]. During July, record levels of rainfall contributed to severe flooding in Western Europe, affecting parts of the Netherlands, Belgium, France and Germany, resulting in 184 fatalities in Germany, 38 in Belgium and considerable damage to infrastructure, including houses, motorways, railway lines, bridges and businesses. The Swiss Re Group estimates insured losses of over $13 billion (USD)[1]. During the July and August Mediterranean heatwave, a provisional temperature record for Europe of 48.8 ˚C was set in Sicily and the most intense fire season since 1991 occurred with 800,000 ha burnt across the Mediterranean.



Between 1993 and 2021, sea level has risen between 2 and 4 mm per year across Europe, depending on the location. Glaciers across Europe continue to see substantial and prolonged loss of ice mass, having lost between 9 and 30 metres of ice thickness since 1997[2].

HOW MIGHT EUROPE'S CLIMATE CHANGE IN THE FUTURE?

The amount of future climate change will depend on the global emissions of greenhouse gases. Here we consider a high emission scenario that is often used for adaptation risk assessments. Successful mitigation of emissions will lead to slightly less climate change to 2050 and could result in significantly less warming by 2100.

The IPCC 6th Assessment Report tells us that warming in continental Europe will be greater than the global average changes that we often hear about. A typical summer of 2050 in **Europe will be around 2 degrees hotter** than the present day, and inhabitants of the Mediterranean basin will experience the largest temperature increases. Both winter and summer are projected to become warmer throughout Europe, with the warming being strongest in winter over northern Europe and in summer over the Mediterranean and northern Scandinavia. EUCP shows that for southern Spain and low-lying areas of Italy and the Balkans, the number of days with a daily maximum temperature over 35˚C is projected to increase by more than 50 days a year by the end of the century under a high emission scenario[3]. All of Europe will be subject to **longer and more exceptional heatwave episodes**. In winter northern Europe will experience **fewer days of frost** and the **snow cover period will become shorter**. The expected changes in rainfall will depend on where in Europe you are with much more rain in the winter over the north of Europe and less rainfall in the summer, particularly over southern and central Europe.

[1] All results in this section are based on Representative Concentration Pathway 8.5 (RCP8.5), which is generally associated with a future that has limited or no greenhouse gas mitigation measures. It is commonly used in research to provide a strong, but still plausible, climate change signal for studying future impacts.

While average rainfall in winter will increase over the north of Europe, the amount of **snow will decrease**. These projections imply fundamental changes to future winter weather and climate risks - such as a reduction of snow traffic disruptions and spring snow-melt flooding but the need for additional management for increased winter water[4].

EUCP research has also revealed **a change in the seasonality of future rainfall extremes**. Extreme rainfall in summer undergoes a relatively small increase. However, this contrasts with large increases in extreme rainfall during autumn and winter.

The slow movement of **convective storms** that produce intense rainfall can lead to long periods of **extreme rainfall**, leading to very high rainfall accumulations in a local area. Latest science from the EUCP project has found that slow-moving storms that have high precipitation potential could be 14x more frequent across Europe by 2100 under a high emission scenario – potentially having serious consequences for **future flood risk**. Almost stationary storms are currently uncommon across Europe but are expected to occur in the future across the continent[5].

New EUCP results also tell us that the **frequency of extreme windstorms could increase** in the future across Europe.

Some specific types of cyclones can develop a particularly damaging phenomenon known as a **sting jet**, a small area of very intense winds. EUCP research has found that weather systems that develop sting-jets account for a large proportion of increases in the most damaging windstorms in the future[6].

Renewable energy, including **wind power**, will be key to future efforts to mitigate climate change, however a warmer world could alter wind patterns. Research from EUCP has shown that periods of low wind speed during European winters (**'wind droughts'**) have already become more frequent and are set to become more frequent still as the climate continues to warm. This is particularly pronounced in northern Europe, affecting the wind power industries in the North and Baltic Seas. Understanding these impact projections will be useful for planning wind power development and how this can fit into a wider renewable strategy.

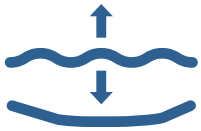
The IPCC 6th Assessment Report tells us that alongside these changes we can also expect future increases in global **sea level** of up to 0.74 metres. The increases around Europe will tend to be slightly lower in the northern regions and larger to the south.

WHAT IMPACTS COULD THIS HAVE?

Projections of the impacts of climate change are a key part of informing effective adaptation measures and policies aimed at reducing these impacts. EUCP has done a number of studies looking at climate impacts in specific regions or industries, taking a detailed look at what we might expect.

Temperature extremes can have wide-ranging impacts on health, infrastructure, agriculture and more. Europe is expected to warm faster than the global average, while heatwaves are also set to become more frequent and more intense. Events like the devastating heatwave of 2003 could become commonplace by the 2040s[7]. EUCP has also helped reveal local impacts: Andalusia may well experience more than 20 days above 40˚C every summer, while even northerly regions such as Germany could experience several days a year above 35˚C.

Extreme rainfall can have severe impacts on local communities, including flooding and landslides. The extension of the extreme rainfall season could see more impact events such as floods, potentially with less time available to recover from them, further taxing affected communities[4]. The new high-resolution future climate information generated in the EUCP project has been applied to river flow models to offer new insights in future water resources and flood regimes. EUCP's work has revealed that flash floods in the Alps are set to increase during autumn, whilst decreasing in frequency in summer. Both seasons, though, see more of the most severe extreme flooding events in these studies. These impacts studies increase our understanding of the potential changes in the risk of these dangerous events.



In southern Europe, decreased summer rainfall and higher evaporation lead to a marked reduction in minimum river flow under a high emission scenario. In northern Europe however, earlier snow melt leads to increased minimum river flow. Results for changes in average and maximum flows are more mixed, but still significant for certain rivers. Changes like this can have major impacts for natural communities, as well as human communities that live nearby or otherwise rely on rivers. Predicting departure from historical norms is the first step in effectively adapting to them[8].

The agricultural sector also faces significant impacts linked to climate change. Drought can be a serious threat to crops, and an ability to plan for such events is a key part of agricultural policy and adaptation measures. EUCP has supported these efforts, demonstrating that climate modelling can predict drought indicators better than the existing approach using past data only. Full operationalisation of this new method could help farmers avoid or mitigate costly crop losses and enhance food security[9].

EUCP has also explored the impact of future climate change on the skiing industry in the Alps and Pyrenees, applying a model at individual ski resort-scale for the first time. By the middle of the century the predictions show a reduction in snow reliability across the Alps and Pyrenees. This could be countered by increased snowmaking if there is enough water available, but it would require significant investment by the skiing industry. By the end of the century, however, the picture could be very different. 3˚C of warming by 2100 would see more than 80% of seasons being snow scarce without artificial snowmaking, which would require unrealistic quantities of water for widespread use. For over 4˚C of warming by 2100, no ski resorts would remain naturally reliable in the Pyrenees or the French Alps, with only 24 of the 175 ski resorts in these areas able to remain open with artificial snowmaking, all of them in the Alps[10][11].

One of the most dramatic signals of a changing climate is coastal erosion as a result of sea level rise. Sandy shores are particularly vulnerable, potentially exposing local communities to storm impacts and damaging local ecosystems. Using a new method to assess sandy shorelines based on their individual characteristics, EUCP researchers have projected retreats of sandy shores by 54 metres on average by 2100, even under only a moderate future emissions scenario. The team also highlighted erosion hotspots, such as the Italian Adriatic coast and the eastern Baltic. Results like these are a key part of helping local communities adapt to these hazards and limit their impact[12].

Through mitigation these impacts can be significantly reduced but not eliminated, and this will require global effort. Adaptation can help to deal with the residual committed impacts in many sectors, drawing on approaches and data from EUCP to inform the decision making.

EUROPE'S CLIMATE IN 2050

This film provides the keys to understand how climate will reshape our landscapes and lifestyles over the coming decades, and to enable us to better anticipate the need for human societies to adapt to this partly inevitable climate change.

You can view the film here: **tinyurl.com/EUin2050**.
It is also available in other languages: Deutsch, Español, Français, Hrvatski, Italiano, Svenska

REFERENCES

1. Swiss Re Institute sigma estimates 2021: swissre.com/media/press-release/nr-20211214-sigma-full-year-2021-preliminary-natcat-loss-estimates.html
2. European State of the Climate 2021, Copernicus Climate Change Service, Full report: climate.copernicus.eu/ESOTC/2021
3. Coppola et al. (2020) J. Geophys. Res. Atmos., **126**, e2019JD032356, doi: 10.1029/2019JD032356
4. Chan et al. (2020) Clim. Dyn., **55**, 409-428, doi: 10.1007/s00382-020-05192-8
5. Kahraman et al (2021) Geophys. Res. Lett., **48**, e2020GL092361, doi: 10.1029/2020GL092361
6. Manning et al. (2022) Clim. Dyn., **58**, 2387-2404, doi: 10.1007/s00382-021-06011-4
7. Stott et al. (2004) Nature, **432**, 610-614, doi: 10.1038/nature03089
8. Sperna Weiland et al. (2021) Front. Water, **3**, 713537, doi: 10.3389/frwa.2021.713537
9. Solaraju-Murali et al. (2021) npj Clim. Atmos. Sci., **4**, 34, doi: 10.1038/s41612-021-00189-4
10. Spandre et al. (2019) Sci. Rep., **9**, 8043, doi: 10.1038/s41598-019-44068-8
11. Spandre et al. (2019) Crysophere, **13**, 1325-1347, doi: 10.5194/tc-13-1325-2019
12. Athanasiou et al. (2020) Sci. Rep., 10, 11895, doi: 10.1038/s41598-020-68576-0

EUCP has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 776613