European Commission

Impacts of climate change on windstorms

Windstorms are amongst the most damaging natural hazards in Europe. Annual loses are approximately 5 €billion in the EU+UK. Although windstorm intensity and frequency is not projected to increase significantly in the EU+UK with climate change, the absolute damages caused by windstorms will increase in the future due to rising asset values as the economy grows.

KEY MESSAGES

No increase in future windstorm intensity or frequency

Climate model projections of extreme winds show no increase in the intensity or frequency of windstorms with global warming over most of the European land surface.

However, without adaptation, the economic loses from extreme winds will rise due to increasing asset values.

Measures to lessen the impact

Impacts of wind extremes could be reduced by a range of measures, such as the development and implementation of enhanced windstorm-resilient standards and building codes.

About PESETA IV

The JRC PESETA IV project aims to better understand the biophysical and economic consequences of climate change. It does this by using projections of climate change for Europe from several climate models along with a set of climate change impact models. The project covers several sectors that are relevant to society and the natural environment, such as freshwater, agriculture, and coasts.

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Current effects of windstorms

Over the last few decades a number of damaging windstorms have had considerable human and economic impacts in Europe, ranging from human fatalities and injuries to damage to roads, power plants, the agriculture sector, forests, infrastructure, and private properties. The estimated annual losses for the EU+UK amount to 5 €billion/year (in 2015 values), or approximately 0.04% of total GDP (of 2015). The highest absolute losses are in Germany (850 €million/year), France (680 €million/year), Italy (540 €million/year) and the UK (530 €million/year).

Each year approximately 16 million EU citizens are exposed to windstorms with an intensity that happens only once every 30 years in the present climate, resulting in nearly 80 deaths every year on average. While in tropical regions an increase in the frequency and intensity of cyclones has been observed in recent decades, in Europe there is no robust trend.

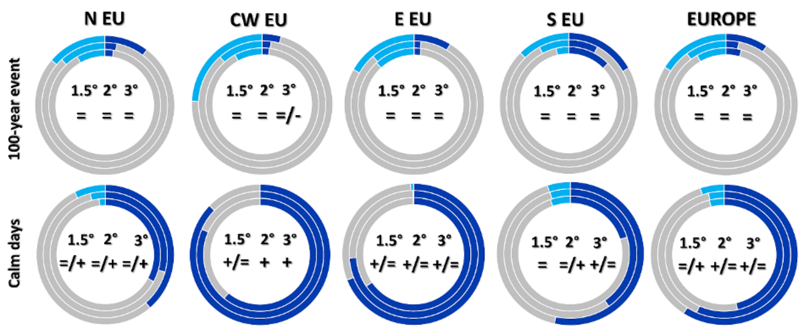

Figure 1. The area (%) of each European region (northern, central-western, eastern, and southern), and Europe, with a significant increase (dark blue), decrease (light blue) and no change (grey), in 100-year wind speed, and the number of calm days. Inner circles represent 1.5°C warming, the middle circle 2°C, and the outer circle 3°C.

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Wind hazard across Europe in a warmer climate

Climate model projections suggest little change in wind hazard with global warming in Europe (Figure 1). With 3°C warming, maximum wind speeds will reduce over 16% of the land area, increase over nearly 10%, and remain relatively stable over the rest of Europe. Regionally, Southern Europe is the region with the largest area share that will see an increase in wind extremes (17% of the area with 3°C warming). The number of windy or stormy days is not projected to change significantly across Europe.

For most of Europe there is a robust tendency towards more calm days with global warming, defined as when the daily maximum wind speed is below 3.5 m/s, particularly for central, western and eastern Europe (Figure 1).

Economic losses from windstorms assuming no future socioeconomic change

The lack of a significant trend in wind hazard with global warming across Europe implies that human and economic impacts in the EU will remain stable, when assuming current socioeconomic conditions continue into the future (Figure 2). For most countries, impacts remain stable, although losses could grow to 0.08% of national GDP (of 2015) in Hungary, Romania and Slovakia with 3°C global warming, compared to 0.06% in the present climate.

Economic losses from windstorms with future socioeconomic change

The projected losses in absolute terms are larger when future socioeconomic change is accounted for, compared to when current socioeconomic conditions are assumed to continue into the future. This is because the size of the economy grows in the future, and as a result, exposed assets have higher values. The absolute annual damages due to windstorms in the EU+UK could grow from 4.6B€ in 2015 to 11.3B€ (1.5 ºC) and 11.4B€ (2 ºC and 3 ºC) in 2100 without adaptation (Figure 2).

	No change in socioeconomic conditions from present				Socioeconomic conditions in 2100			
	base	1.5°C	2.0°C	3.0°C	base	1.5°C	2.0°C	3.0°C
Wind losses (€ billion)	4.6	4.5	4.6	4.6	4.6	11.3	11.4	11.4
Wind losses (% GDP)	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03

Figure 2. Annual wind losses for the EU+UK, assuming that current socioeconomic conditions continue into the future, and assuming socioeconomic conditions in 2100 according to the ECFIN Ageing Report.

Resilience to wind extremes

Although it is expected that the hazard from windstorms in the EU+UK will not rise significantly due to climate change, increasing society's resilience to wind extremes could reduce the magnitude of impacts on future societies. There are a wide range of measures that could be taken, such as increasing windstorm forecast accuracy and warning time, improving storm readiness, emergency communications and response, as well as structural measures for wind-proofing infrastructures, which in the EU could be stimulated by amendments of Eurocodes.

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Approach

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Projections of daily wind speed under a high emissions scenario (RCP8.5) and moderate mitigation scenario (RCP4.5) were used to estimate changes in wind hazard between the present (1981-2010) climate and at global warming levels of 1.5, 2 and 3°C above preindustrial levels. Wind damage functions, which relate the total construction stock with wind speed and economic losses, as well as reported fatalities, were derived from past wind events and their reported impacts. In the absence of information on future vulnerability, these impact relations were kept constant in the future.

The damage and mortality relations were then applied in a static socioeconomic scenario, in which the wind hazard at the three warming levels was applied to the present population and construction stock. The wind hazard was also applied separately to the warming levels with projections of exposed construction assets and population for 2050 and 2100 according to the ECFIN Ageing Report.

The spatial resolution of the wind data is too coarse to capture severe local windstorms. Also, physical representation of wind dynamics is limited in the current generation of climate models. In the absence of wind gust data at a sub-daily time scale, daily maximum wind speed was used as a proxy for windstorms.

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