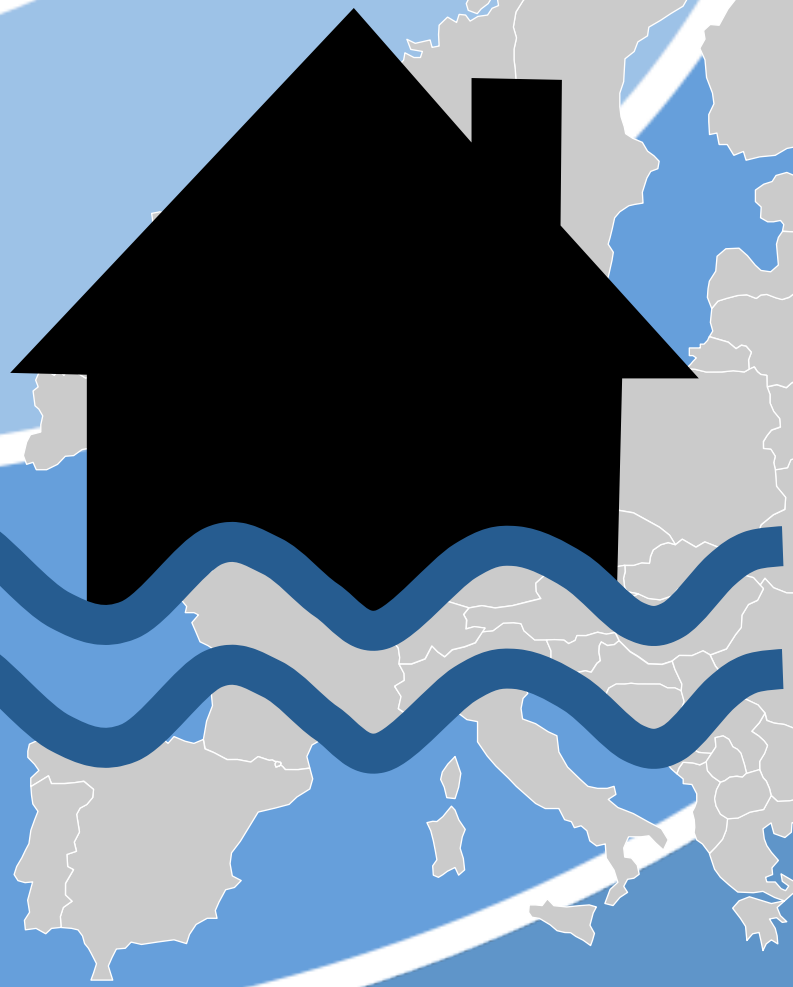
Europe's river floods in a changing climate



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Latest update: 12 February 2019

River floods

Past

River flood risk

There is no evidence from flood observations over the last 80-150 years for recent upward trends in the occurrence rate of extreme floods (return periods of 100 years and more) like the ones that occurred in Europe in the last two decades.

Flood risk = probability X consequences

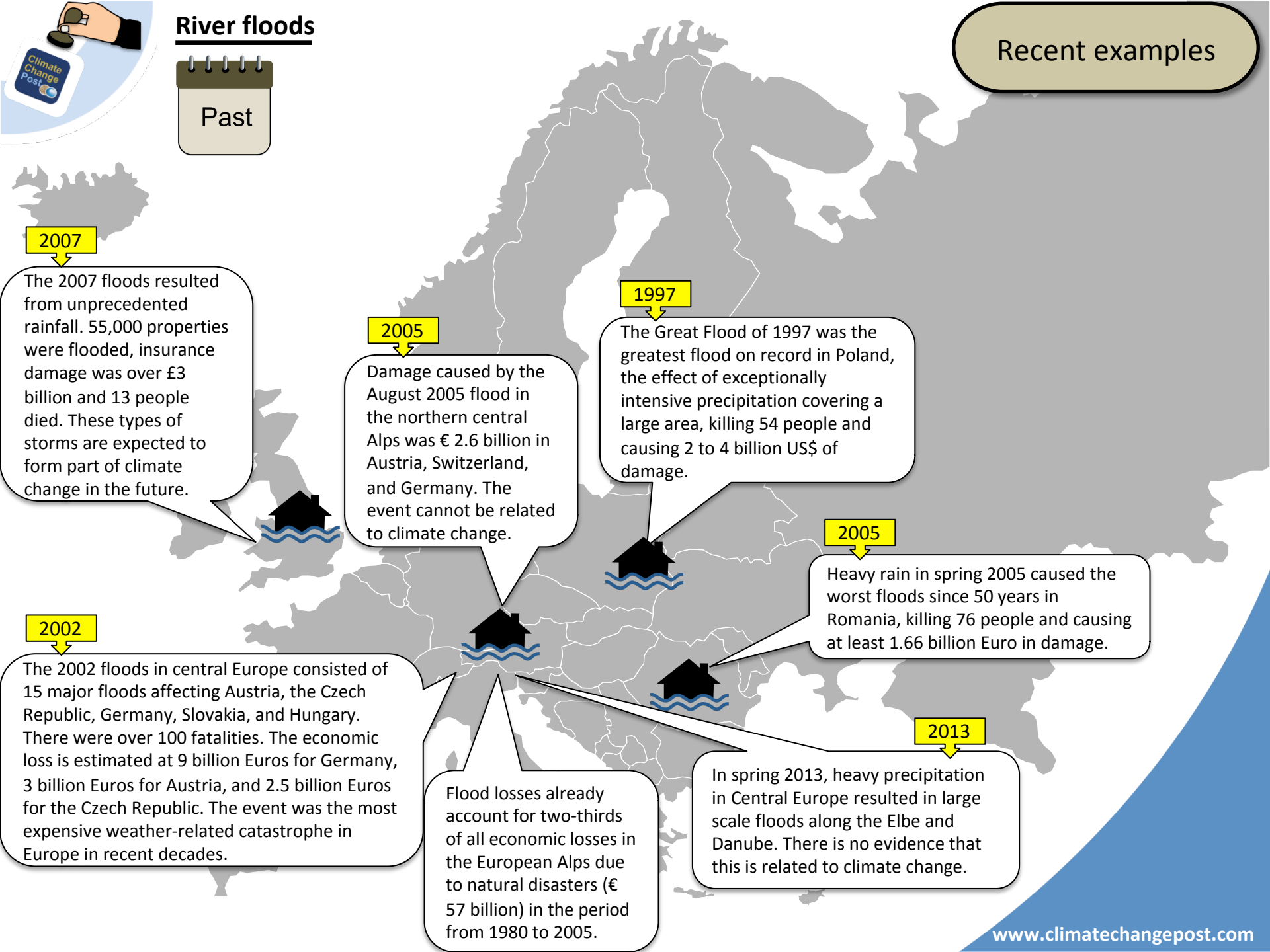
Developments on floodplains, river channel straightening, and a general under-investment in flood defences have all contributed to the increasing flood risk.

Economic river flood damages in Europe have increased over recent decades but this increase is due to economic development in flood zones and not due to observed climate change.

River floods

Past

Recent examples



2007

The 2007 floods resulted from unprecedented rainfall. 55,000 properties were flooded, insurance damage was over £3 billion and 13 people died. These types of storms are expected to form part of climate change in the future.

2005

Damage caused by the August 2005 flood in the northern central Alps was € 2.6 billion in Austria, Switzerland, and Germany. The event cannot be related to climate change.

1997

The Great Flood of 1997 was the greatest flood on record in Poland, the effect of exceptionally intensive precipitation covering a large area, killing 54 people and causing 2 to 4 billion US$ of damage.

2005

Heavy rain in spring 2005 caused the worst floods since 50 years in Romania, killing 76 people and causing at least 1.66 billion Euro in damage.

2002

The 2002 floods in central Europe consisted of 15 major floods affecting Austria, the Czech Republic, Germany, Slovakia, and Hungary. There were over 100 fatalities. The economic loss is estimated at 9 billion Euros for Germany, 3 billion Euros for Austria, and 2.5 billion Euros for the Czech Republic. The event was the most expensive weather-related catastrophe in Europe in recent decades.

Flood losses already account for two-thirds of all economic losses in the European Alps due to natural disasters (€ 57 billion) in the period from 1980 to 2005.

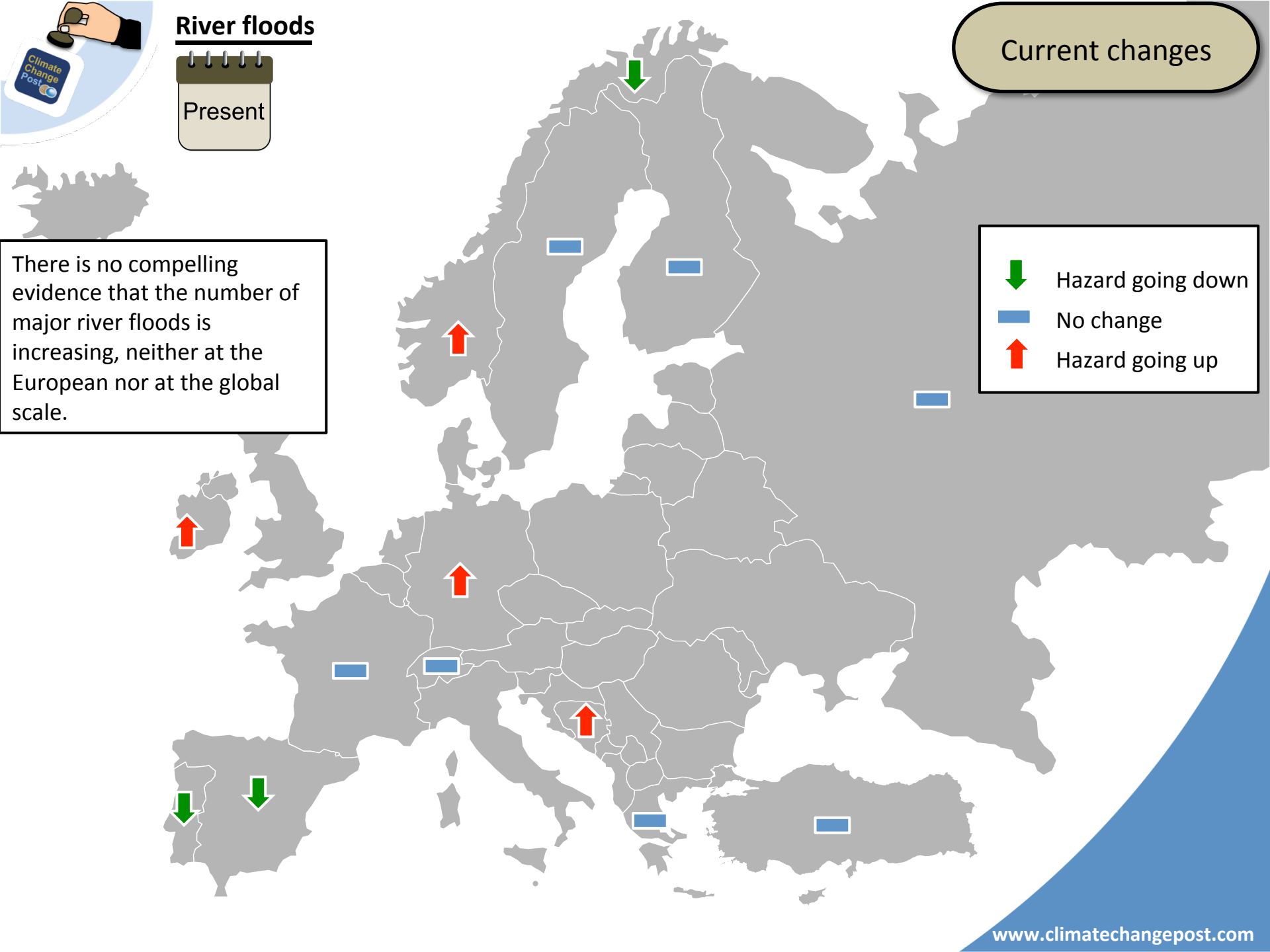
2013

In spring 2013, heavy precipitation in Central Europe resulted in large scale floods along the Elbe and Danube. There is no evidence that this is related to climate change.

River floods

Present

Current changes



There is no compelling evidence that the number of major river floods is increasing, neither at the European nor at the global scale.

River floods

Present

The story behind these changes

Flood frequencies have been increasing in the last decades in southern and western Norway, mainly due to increase in the frequency of rainfall dominated events.

In the same time flood frequencies have been decreasing in northern Norway, mainly due to decrease in the frequency of snowmelt dominated floods.

However, overview studies covering many Scandinavian rivers show no statistically significant trend in river peak discharge over the last century.

Hazard going down

No change

Hazard going up

A general upward trend in flood magnitude was detected in the south and west of Ireland over the last decades.

Flood hazard in Germany increased during the last five decades, particularly due to an increased flood frequency. Most changes were detected for the west, south and centre of Germany.

For Russia there is no clear consensus on observed changes in number of flood events and the seasonality of flood risk (and onset of ice break-up and ice damming).

At a national scale no clear trend of changing flood magnitudes have been found for France so far.

In Bosnia, floods that previously occurred once in a lifetime may now occur every 5 or 10 years.

Deforestation, a major problem in Greece, and urbanization significantly contribute to the genesis of floods. Greater Athens, the most urbanized part of Greece, suffered most flood damages in Greece. This is due to streams being converted into streets, buildings constructed over old stream beds, little flood protection and insufficient storm drainage.

A trend of decreasing flood magnitudes has been found for Spain and Portugal for the period 1956-1995.

Although natural catastrophes are observed to occur more frequently in Switzerland, long-term changes in the frequency of extreme events may not be positively identified until their extent has become very considerable and extensive damage has been caused.

So far, no significant trends in the magnitude of observed river floods in Turkey have been found.

River floods

2050

The main impacts for 2050

Floods driven by snowmelt decrease, because less snow accumulates in winter and snowmelt starts earlier. This will be the case for spring floods in large parts of Northern Europe. There is strong evidence that rainfall will replace snowmelt as the dominant driver of floods in most Scandinavian catchments where snowmelt is the most important driver under current conditions.

An exception are high northerly mountain catchments in which snowmelt is expected to continue to be important in the future, whilst increases in extreme precipitation during and following the snowmelt season will contribute to an increase in the flood hazard.

Floods driven by rainfall and snowmelt (mixed) increase. In catchments with mixed flood regimes the increase in extreme precipitation dominates over the reduction of snowmelt.

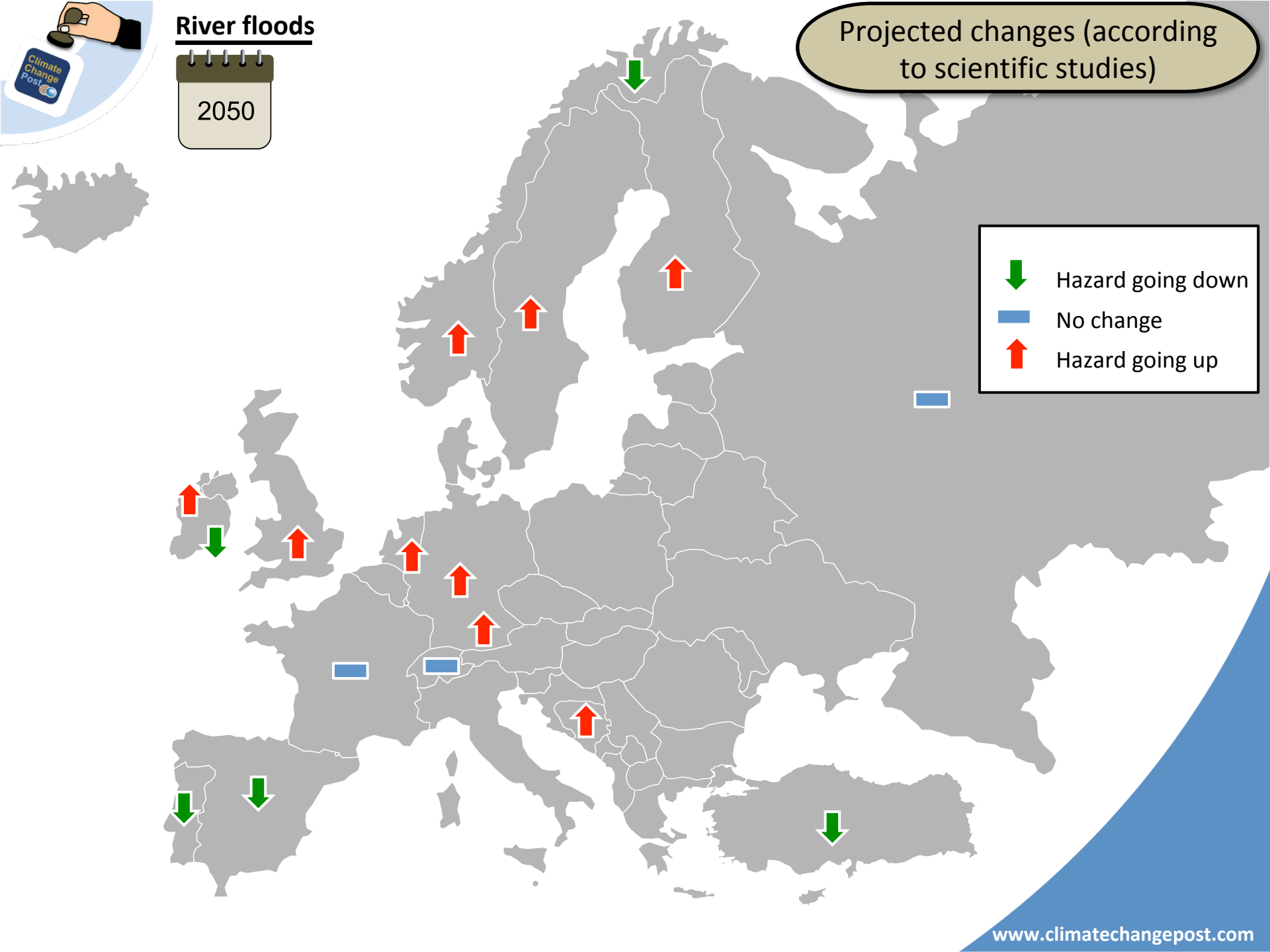
Floods driven by rainfall increase.

In the Mediterranean region flood peaks decrease due to strong decreases in annual precipitation.

River floods

2050

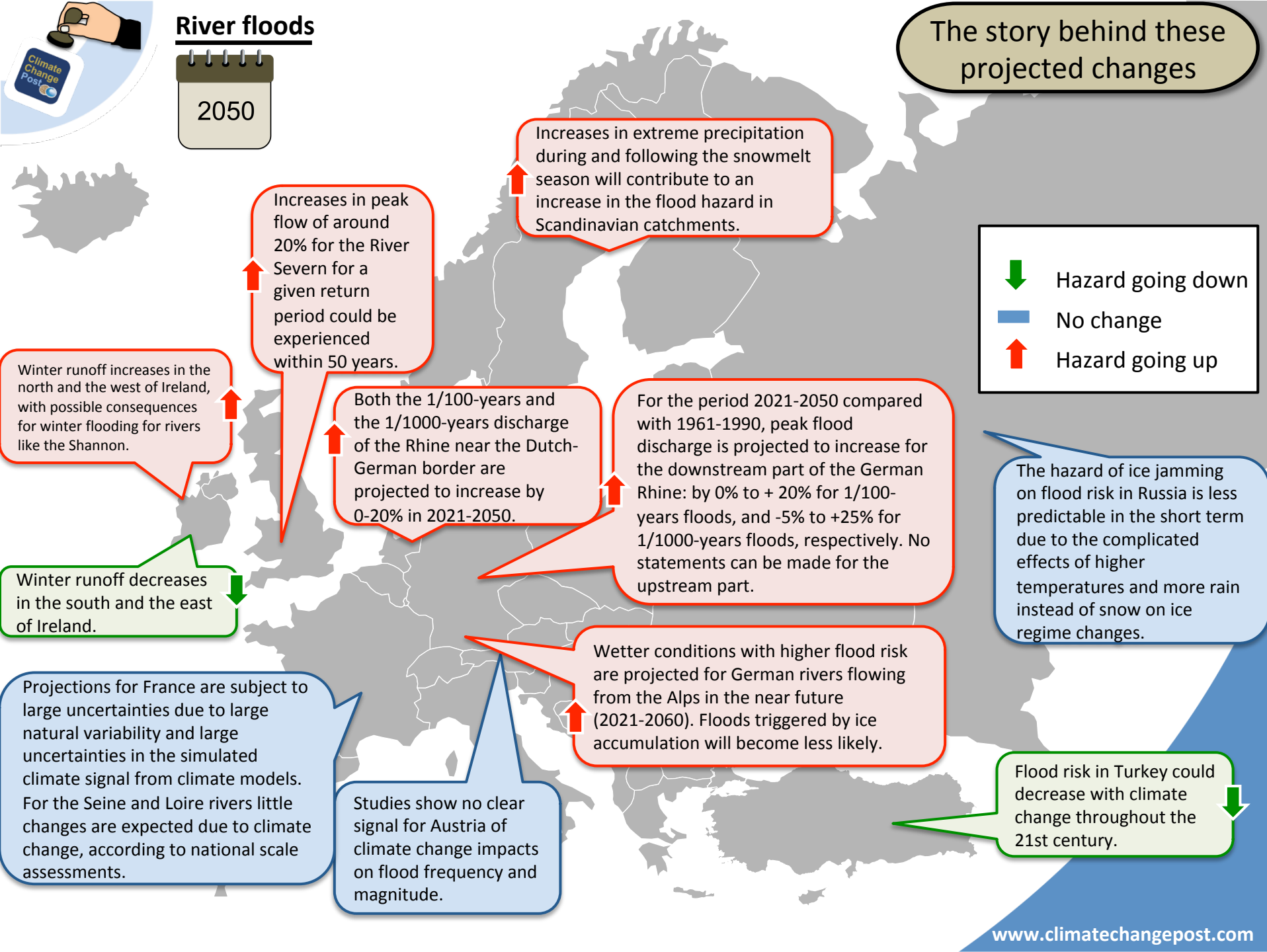
Projected changes (according to scientific studies)



River floods

2050

The story behind these projected changes



River floods

2100

The main impacts for 2100

Between now and the end of this century the frequency of a current 100-year flood event increases in West and Northwest Europe, including the UK, Ireland, the Low Countries and most of France. In Western Europe current 100-year events could manifest every ~30 years in 2080s.

Increase flood magnitude
Increase flood frequency

Atlantic and Continental Europe can be considered as a transition zone between **flood magnitude** decreases in Southern and increases in Northern Europe. Projected changes in these regions are generally less than 10% in magnitude.

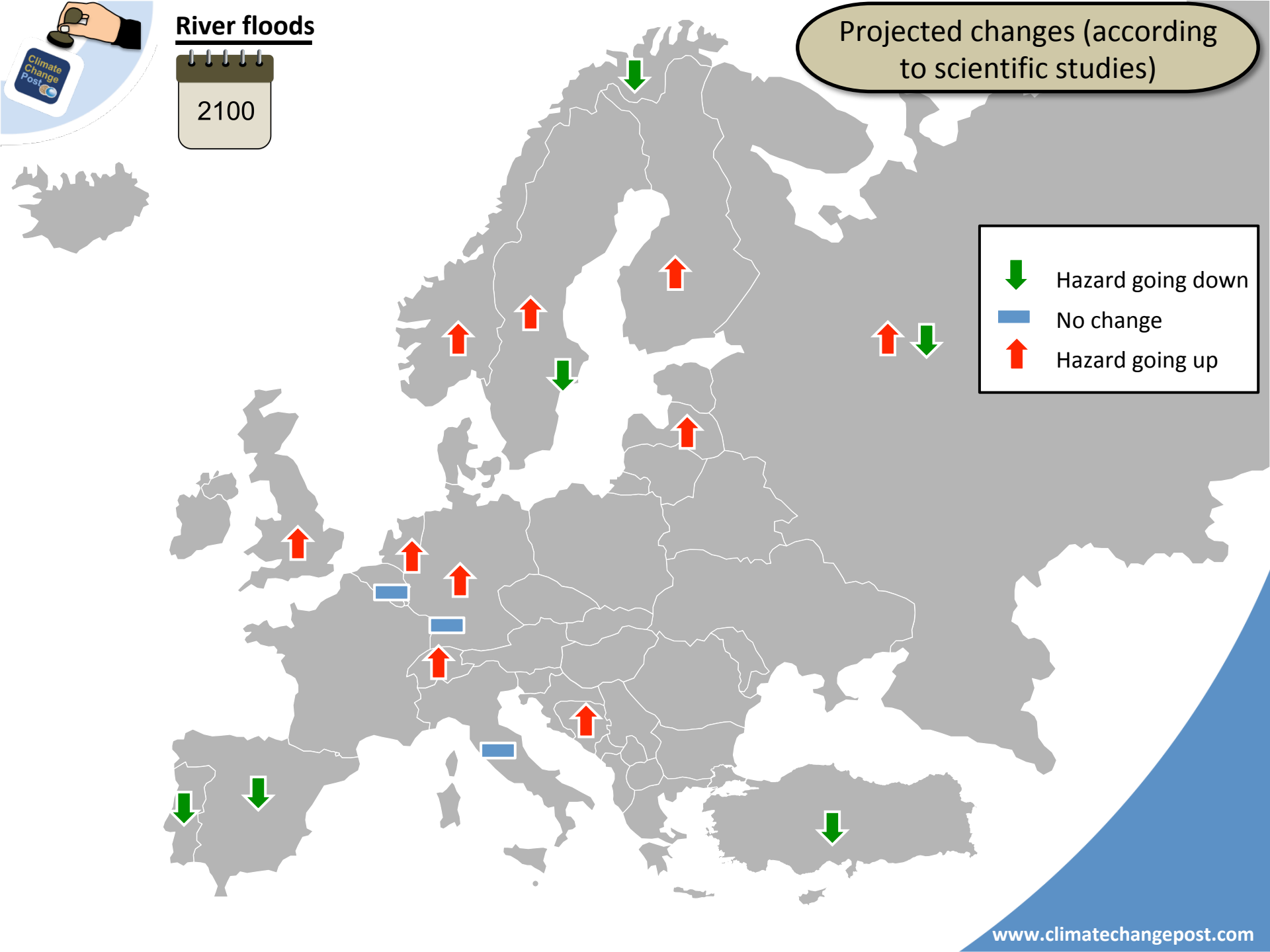
A modest but significant decrease in river **flood frequency** is projected in Southern, Central and Eastern regions, in the latter because of the strong reduction in snowmelt induced river floods, which offsets the increase in average and extreme precipitation.

Decrease flood magnitude
Decrease flood frequency

River floods

2100

Projected changes (according to scientific studies)



River floods

2100

The story behind these projected changes

The heaviest floods in Northern Finland will still be caused by melting snow. Their magnitude will remain unchanged or decline slightly.

Smaller increases or even large decreases are projected for inland regions and the northernmost region of Norway.

High flows with a return period of 100 years will increase sharply in western Sweden.

Winter floods are expected to become more common in Southern and Central Finland, while spring floods will decline. The heaviest floods in Southern Finland will be caused by heavy rain in the summer or autumn and may significantly increase in line with the increase in major rainfall.

In Norway, increases in the magnitude of floods will be largest in the western regions. This holds for both mean annual flood, the 200-year flood and the 1000-year flood. Flood magnitude may increase to > 30%.

High flows with a return period of 100 years will decrease in eastern Sweden where warmer winters will result in less remaining snow cover, which will to a smaller spring flood.

In the long term, climate change leads to a significant reduction of the duration of the ice regime periods in Russia, and a lower risk of ice jamming. For large rivers flood probability will strongly decrease. For Northern European Russia, a general decrease in the 100-year flood level with climate change was found of 20-40% towards the end of the 21st century.

With no change in policy, economic flood risk may increase up to 20-fold by the 2080s for England and Wales, due to climate change and increasing economic vulnerability.

Both the 1/100-years and the 1/1000-years discharge of the Rhine near the Dutch-German border are projected to increase by 0-25% in 2071-2100.

Flood risk in Lithuania will probably increase due to more frequent intensive precipitation.

At the end of the 21st century compared with 1961-1990, peak flood discharge is generally projected to increase for the downstream part of the German Rhine (up to + 30 %); no statements could be made for the upstream part.

For small and medium rivers of the European part of Russia the probability of flooding caused by rainfall will increase.

Changes in future flood probabilities of Belgian rivers are highly uncertain.

The uncertainty of extreme flood event projections for the large German rivers is too large to identify robust change signals.

In Switzerland, winter floods will become more frequent. Under a 2°C temperature increase and 10% increase in precipitation intensity, the 100-year flood discharge will reduce its return period to about 20 years.

Projections of changes in flood risk for Italian rivers range from a 100% increase to a 75% decrease.

Extreme flood events could become smaller in magnitude and occur less frequently than present under climate change.
Turkey's future river flood risk increases due to socioeconomic development (more assets and people exposed to floods) and hardly due to climate change.

Hazard going down

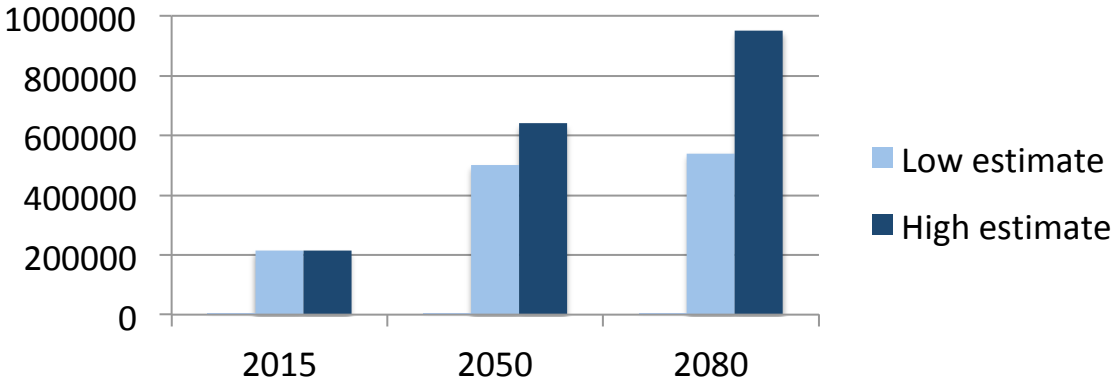
No change

Hazard going up

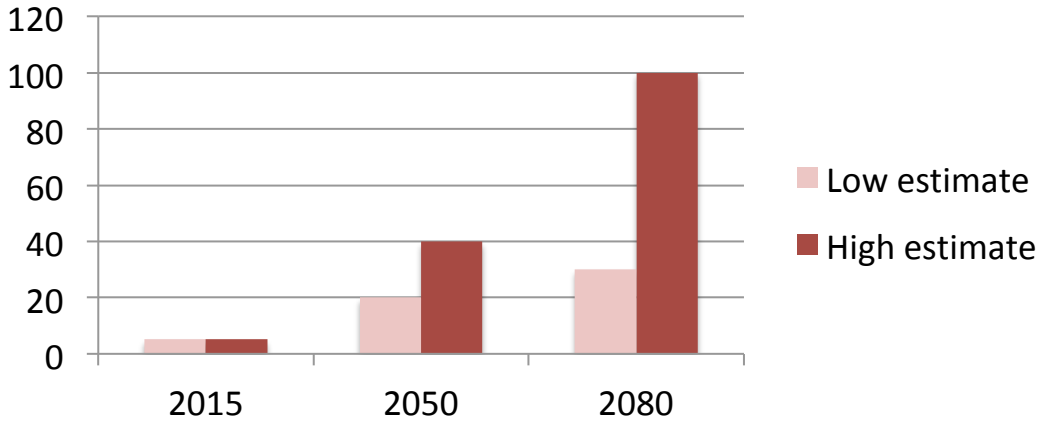
River floods

Future projections for Europe

Number of people affected by river floods in Europe annually



Economic damage by river floods in Europe annually (billion Euros)



In the current situation, large river floods in Europe affect some 216,000 people and lead to €5.3 billion damage annually.

Central estimates of population annually affected by these floods, both due to climate change and socio-economic developments, are within 500,000 and 640,000 in 2050 and within 540,000 and 950,000 in 2080.

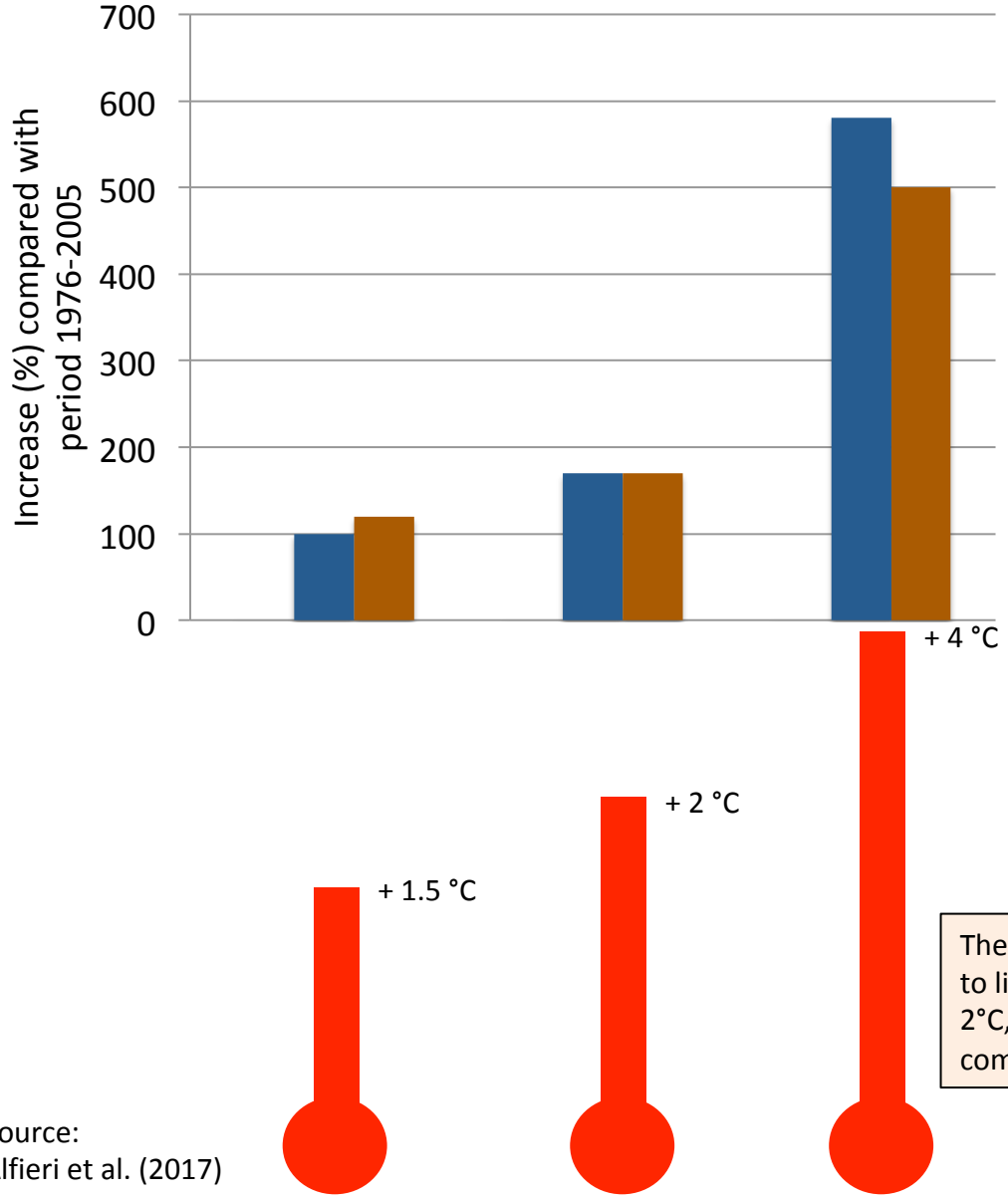
Larger variability is foreseen in the future economic growth and consequently in the expected damage of flooding, with central estimates at €20-40 billion in 2050 and €30-100 billion per year in 2080. The bulk of these increases (about two-thirds) is due to socio-economic development rather than climate change itself. These results are based on realistic flood protection levels in European countries.

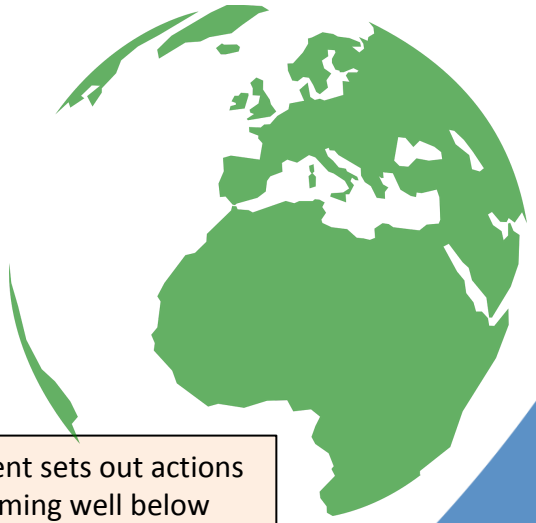
Source:
Alfieri et al. (2015)

River floods

Future projections globally

Increase expected annual damage and number of people affected by river floods globally under 1.5, 2 and 4 degrees of global warming



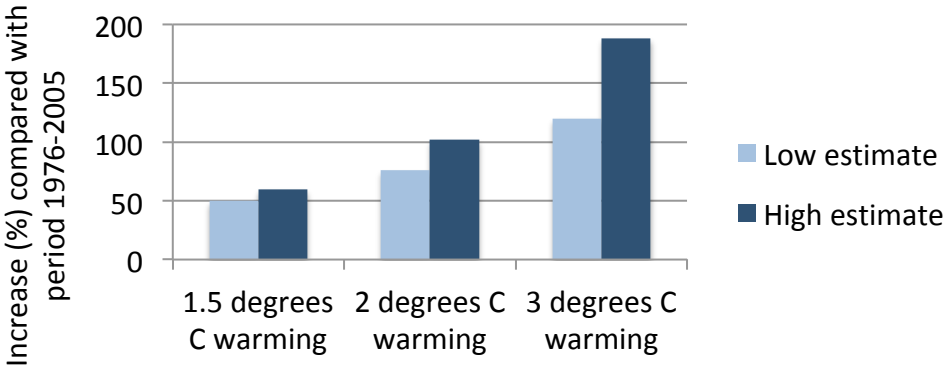


The Paris Agreement sets out actions to limit global warming well below 2°C, and preferably below 1.5°C compared to preindustrial levels.

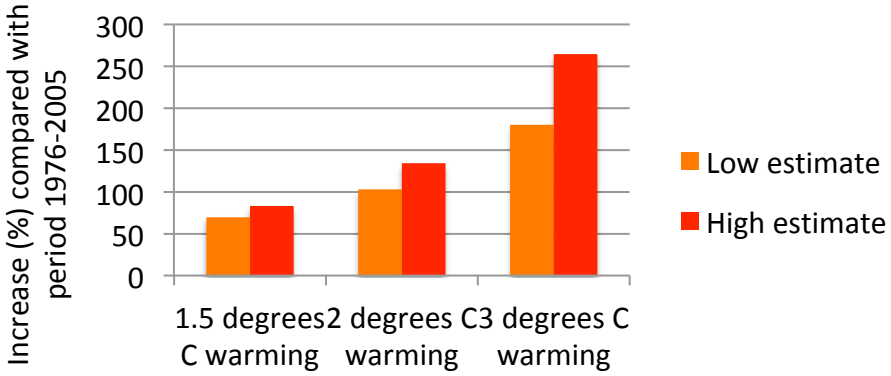
Source:
Alfieri et al. (2017)

Future projections globally

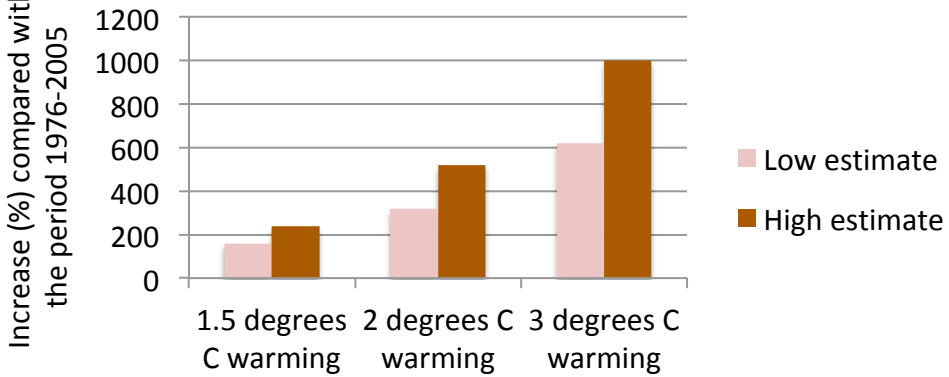
Increase global number of people affected by river floods annually



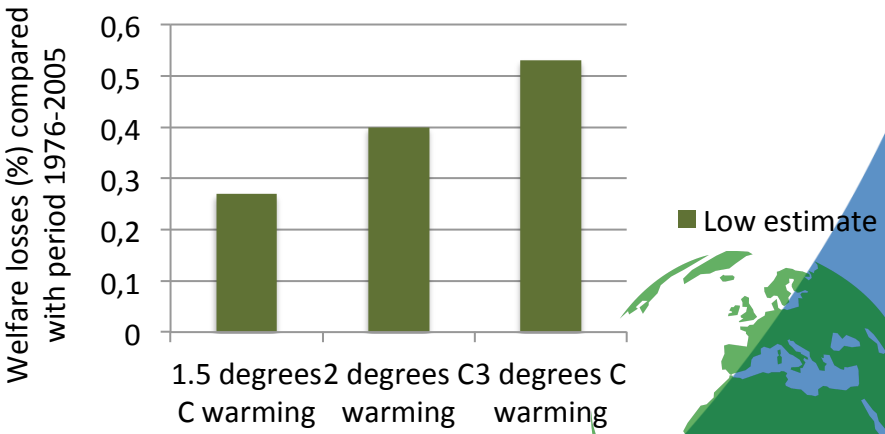
Increase global number of fatalities by river floods annually



Increase global expected annual (direct) damage by river floods



Global welfare losses



Source:
Dottori et al. (2018)

River floods

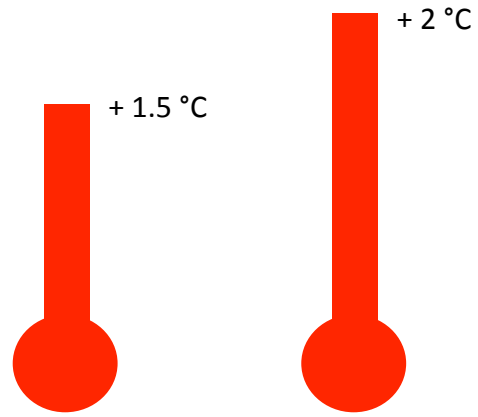
Future projections globally

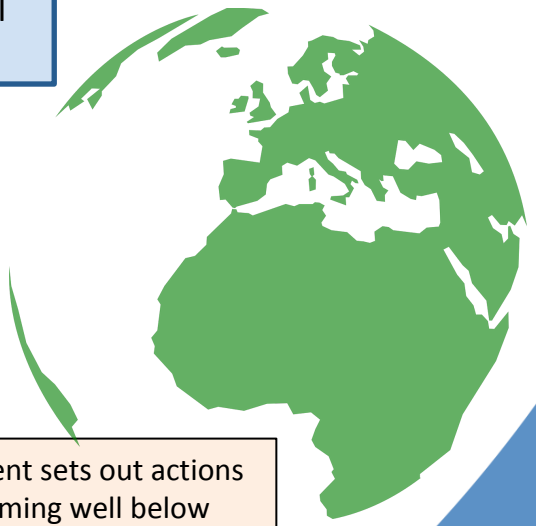
If we succeed in stabilizing global warming at 1.5 °C or 2.0 °C:

- the frequency of the current 1-in-100 year flow shifts to once in 70-90 years or once in 50 years, respectively, in most of the world. This includes central-western Europe.

- some world regions see a decrease in the frequency of high flows. In most of these regions, the current 1-in-100 year flow decreases in frequency to approximately 1-in-150 years, with little further decrease at 2.0 °C. This includes Scandinavia.

- frequency changes of the current 1-in-100 year flow are small for North America and eastern Europe.





The Paris Agreement sets out actions to limit global warming well below 2°C, and preferably below 1.5°C compared to preindustrial levels.

Source:
Paltan et al. (2018)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