Flood damage potential in Europe

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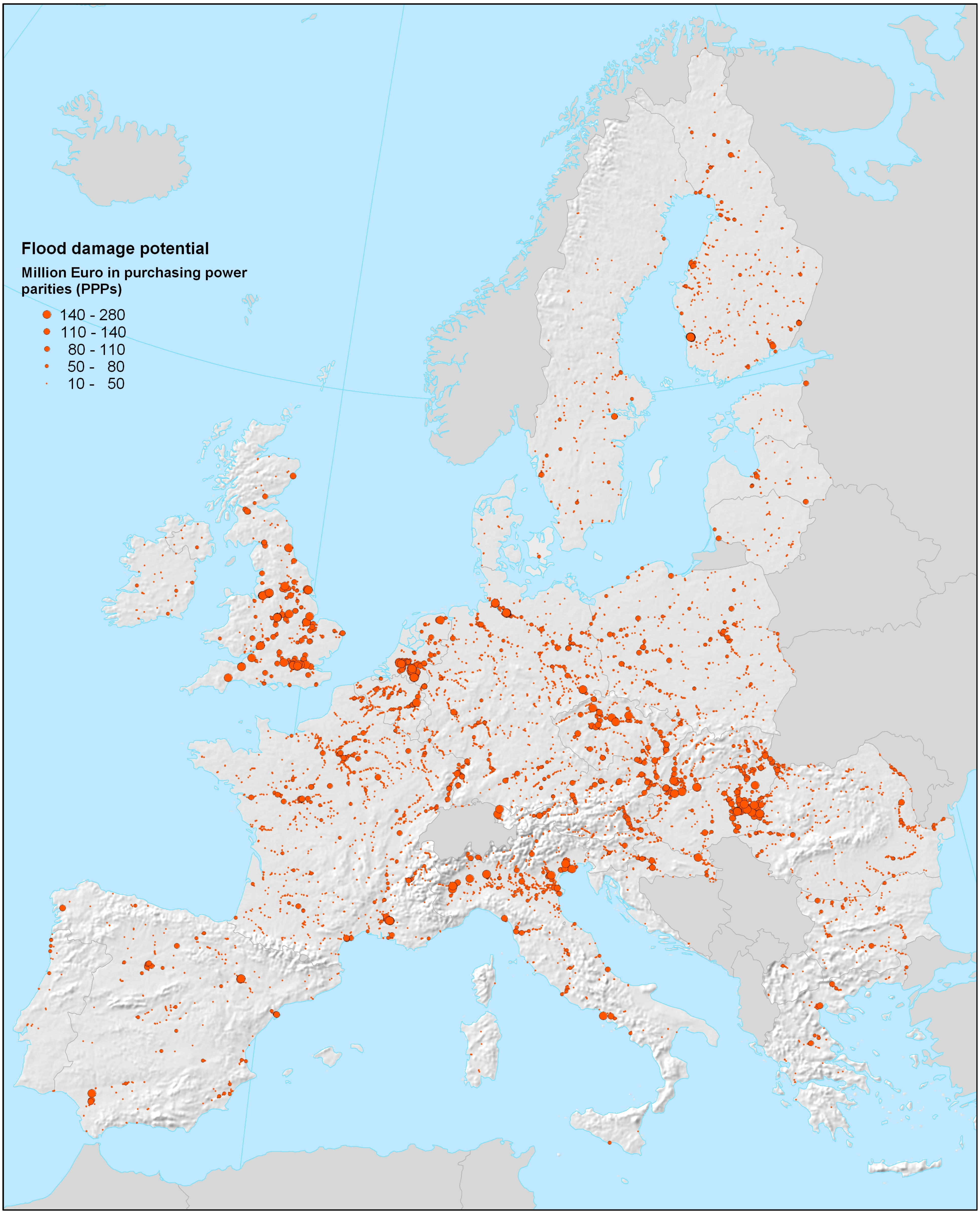

Map of flood damage potential in Europe. Note that the EU's areas not included in the map are currently being processed.

This document is designed to be printed in A3 size.

The map can be obtained at: http://natural-hazads.jrc.it/activities_flood_riskmapping.html

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There is good reason to be concerned about the growth of flood losses in Europe. Economic losses as a consequence of extreme flood events have been dramatic in recent years. The 1997 floods in Poland and Czech Republic were responsible for losses of about EUR 5.2 billion. In 2000, Italy, France and Switzerland experienced losses of EUR 9.2 billion. In 2002 the material flood damage recorded in Germany, Czech Republic and Austria of EUR 17.4 billion has been higher than in any single year before. And the cost of floods in the UK in summer 2007 has been estimated at around EUR 4.3 billion. The annual average flood damage in Europe in the last few decades is about EUR 4 billion per year (Barredo, 2007).
We present a map that makes a first estimate of the exposure to flooding at continental scale. The aim of this study is to calculate the damage potential with a probability of 1 into 100 years for riverine flood events, and to show the spatial distribution of potential damage across Europe. This map shows early results of this study.
Baseline data is a fundamental aspect of decision making. The effectiveness of public policies designed to reduce losses from natural hazards must rely on geographical information (Cutter, 2005; Messner et al., 2007), such as records of disaster losses (e.g. Barredo, 2007), flood damage potential (e.g. Büchele et al., 2006) and flood risk maps (e.g. Hall et al., 2005).

1. Defining flood damage potential
This study estimates exposure to a 1 in 100 year riverine flood event assuming no defences. We study ex-ante direct flood damage with an economic perspective, impacts such as human health or environmental damage are not considered in this work. Flood damage potential is the maximum possible damage in a flood prone area. Damage potential does not necessarily translate into impact. For more comprehensive figures, such as risk, information of flood defences must be assessed. Nevertheless exposed assets and people rely on protection measures that can fail.
We assessed damage potential on the basis of the calculated flood water depth for a 100 year return period flood event. It is worth noting that flood damage potential is different from “expected flood damage”, which is defined as the flood damage figures estimated before a flood event in the context of flood risk management (Messner et al., 2007). Flood damage potential is considered in this study on the basis of exposure and hazard.

2. Factors of flood damage potential
The map shows a financial evaluation of the flood damage potential. It is widely agreed that natural risks are the product of the hazard and its consequences. Within this approach damage potential is a function of hazard, exposure and vulnerability. If any one of the factors increases, the amount of damage also increases. Conversely, if any one of the factors reduces, so the damage reduces. In this framework hazard is defined as the occurrence of a hydrologic flood event with a given probability. The metric represented in the map is the potential damage associated with such an event expressed as monetary losses.
The **hazard** factor is represented in the form of extreme river discharge and flood water depth. An extreme natural event is the driver of the hazard component. Here, a flood event with a probability of 1 into 100 years was assessed. Flood water depths for such an event were calculated by driving a hydrological model with the output of a regional climate scenario (reference period) and extrapolating the resulting flood water levels onto a digital elevation model.
Exposure is among the anthropogenic factors that contribute to flood damage potential. Exposure is represented by the assets that are present on each location. This is typically expressed by statistics on population, socio-economic data on sectorial activities and infrastructure. In this study exposure was assessed on the basis of land use information from CORINE Land Cover datasets (EEA, 1993).
Vulnerability is defined as the susceptibility of the exposed structures at contact with water. This factor measures the extent to which the subject matter could be affected by the hazard. One of the advantages of the method used is that the damage-determining factors are given both on the hazard side (water depth) as well as on the side of vulnerability (stage-damage functions for individual land-use classes) (Büchele et al., 2006). Flood damage functions show the susceptibility of assets to certain inundation characteristics, in this study specifically against inundation depth.

2.1. Mapping flood hazard
As a first step to obtain the hazard factor, the flood water depths in the river channels for a 100 year return period event were calculated. For this purpose we used the control run from the HIRHAM regional climate model (Christensen et al., 1996) to drive the distributed hydrological model LISFLOOD (De Roo et al., 2000; van der Knijff et al., 2008), developed for operational flood forecasting at the European scale (Thielen et al., 2008). The control run of the climate model consists of a 30 year time slice with a greenhouse gas forcing corresponding to the period from 1961 – 1990 with a horizontal resolution of ~ 12km, which was resampled to the 5km grid size of the hydrological model.
The LISFLOOD input parameters on soil and land use were derived from European databases and the remaining hydrological model parameters were estimated by calibrating against historical records of river discharge in 231 catchments and subcatchments. A Gumbel distribution was fitted to the annual maximum values in every grid cell to estimate the probability of discharge levels with a 100 year return period, which were then transformed into water depths (assuming no defences). For more detailed information on the assessment of extreme discharges using the HIRHAM and LISFLOOD models see Dankers and Feyen (2008).
In a second step, flood water depths were resampled to 100m grid size and selected on the basis of the river network obtained from the pan-European River and Catchment Database CCM2 at 100m grid size (Vogt et al., 2007). Finally, the flood water levels were extrapolated onto the digital elevation model of the CCM2 database to obtain the flood depth of the areas affected by the simulated 100 year return period event.

3. Flood damage potential mapping
The map was derived by overlapping the maps of water-depth and land use to evaluate which elements or assets would be affected by the given water depth and how much they are affected in terms of inundation depth.
Flood-damage functions provide information about the susceptibility of the exposed elements to flooding. The set of damage functions implemented are absolute damage functions in current Euros. GIS spatial analysis techniques and scripting tools were used for the integration of the datasets. The flood-damage functions show the absolute amount of damage, for each country, for each land use class as a function of the magnitude of a given inundation depth. This method is considered an standard approach for assessing large regions (Messner et al., 2007).
The calculation of the flood damage potential was performed at 100m grid size. This is the nominal grid size of the layers representing hazard and exposure. The graduated symbol map presented shows the flood damage potential for areas of 1 by 1 km for a better readability of the map. Thus each circle in the map represents one area of 1 by 1 km.

4. Using Purchasing Power Parities as unit of measure for damage potential
Purchasing Power Parities (PPP) are indicators of price level differences across countries. PPP are price relatives, which show how many currency units a given quantity of goods and services will cost in different countries (Eurostat, 2008). The effect of differences in prices between countries with different socio-economic conditions is best captured by using PPP (Fisher et al., 2007; Van Vuuren and Alfsen, 2006).
This approach allows between-country comparisons of damaging events. This study denominates flood losses in current EUR based on conversions using PPP. Data on PPP were obtained from Eurostat.

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