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The August 2002 Flood in Central and Eastern Europe and Results from the EU "STARDEX" Project

Introduction

During the last decades parts of Europe suffered several severe hydro-meteorological extremes (e.g. floods, severe storms, droughts and heatwaves) and there is a concern, that the occurrence of such events could increase in the 21st century as a result of anthropogenic climate change. One of the most recent severe events in central and eastern Europe was the **August 2002 flood**, which caused huge economic losses. Heavy long-lasting rainfall induced flooding on several major rivers, including the Elbe, Vltava (Moldau), Danube, Inn and Salzach. Besides Germany, Austria and the Czech Republic, also Italy, Spain, Russia, Slovakia and Hungary were affected.

The August 2002 flood demonstrates the vulnerability of society, economy and the natural environment to extreme events and their possible changes in the coming decades. For many socio-economic and environmental sectors of Europe there is a clear need for more reliable, high resolution scenarios of extremes. This problem is addressed by the EU research project **"STAtistical and Regional dynamical Downscaling of EXtremes for European regions (STARDEX)"**- see: **http://www.cru.uea.ac.uk/projects/STARDEX.**

Meteorological Situation

The meteorological situation leading to the August 2002 flood was marked by a rain-bearing, low-pressure system (Ilse) tracking across Europe (Fig. 1) and a depression occurring slightly earlier south of the Alps. The low pressure system (Ilse) came from south Greenland, crossed England and became a cold cell over Europe. Initially it passed along the southern part of the Alps and then headed for Saxony from the Gulf of Genoa along the southern rim of the Alps [MunichRe, 2002]. This is the so-called **circulation type Vb**. By passing over the Mediterranean Sea, low pressure systems take up a huge amount of moisture.

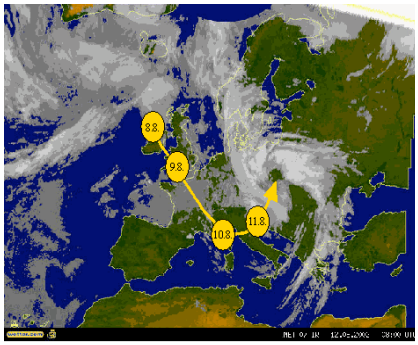

Fig. 1: Track of the low-pressure system "Ilse" over Europe. [MET 7 IR satellite image from 12.08.02, 08:00 UTC].

Many historical sites such as the "Zwinger" in Dresden were flooded by the August 2002 flood.

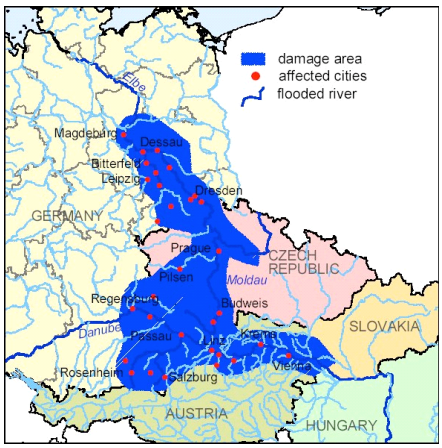

Fig. 2: Main regions and cities affected by the August 2002 flood [Munich Re, 2002].

Losses:

- **Fatalities: > 100**
- **Economic losses:**
  - **Austria: € 3 bn**
  - **Czech Republic: € 3 bn**
  - **Germany: € 11.7 bn**
  - **Europe: > € 21.1 bn**
- **Insured losses:**
  - **Austria: approx. € 400 m**
  - **Czech Rep.: approx. € 1.2 bn**
  - **Germany: approx. € 1.8 bn**
  - **Europe: approx. € 3.4 bn**

*All estimates are provisional!

Losses estimated at Oct. 2003 for the August 2002 flood by Munich Re [2003].

Circulation type Vb often produces long lasting heavy precipitation when it meets with cold air from the north. Precipitation activity began in Bavaria on 10th August 2002, whilst Austria, the Czech Republic and eastern Germany were affected from 12th August. [Munich Re, 2002].

Fig. 2 shows the main regions affected by the August 2002 flood. For more detailed information about the synoptic weather conditions causing the August 2002 flood see Rudolf & Rapp (2003).

House in Weesenstein near Dresden, damaged by the Müglitz river flood.

Passau/Bavaria flooded by the Danube on 15.08.2002

Aerial view of flooding in Saxony on 19.08.2002

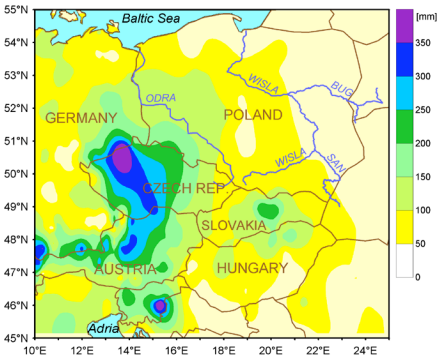

Fig. 3: Precipitation totals [mm] in August 2002 [Rudolf & Rapp, 2003].

Circulation type Vb caused 3 major floods within 5 years in the region

Generally, river flooding of large areas is caused by long-lasting, intensive rainfall. Furthermore, intensive precipitation can be highly significantly correlated with critical atmospheric circulation patterns (CPs). Therefore, it is reasonable to analyze observed extremes conditioned on these "critical" CPs.

The Elbe flood in August 2002, the Odra flood in July 1997 and the Wisla flood in July 2001 were all caused by circulation type Vb. Therefore Vb is a "critical" CP with respect to flooding in the central and eastern European region causing 3 major floods within 5 years.

Fig. 3 shows the August 2002 precipitation totals calculated from more than 600 European stations [Rudolf & Rapp, 2003]. Precipitation totals causing the Odra and Wisla floods are shown in Fig. 4 and Fig. 5 based on more than 400 European stations [Fuchs & Rudolf, 2001].

One of the major differences between the events was the region where the centre of the stationary low pressure system stayed for a longer time. Due to this, the area with the highest precipitation amounts was shifted more to the east or west.

The Odra flood of 1997 mainly affected southern Poland, the eastern Czech Republic and eastern Germany and caused **economic losses of US $ 5.9 billion and 110 fatalities**. **The Wisla flood of July 2001** mainly affected many regions in southern Poland, northern Czech Republic and northern Slovakia and caused **economic losses of US $ 700 million**.

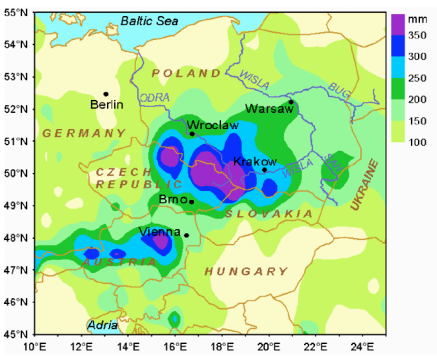

Fig. 4: Precipitation totals [mm] in July 1997 causing the Odra flood [Fuchs & Rudolf, 2001].

Major STARDEX Objectives

- To evaluate and systematically intercompare statistical, dynamical and statistical-dynamical downscaling methods for the reconstruction of observed European hydro-meteorological extremes.
- To provide reliable future scenarios of temperature and precipitation based extremes for selected European regions.

STARDEX objectives related to "critical" CPs:

- Identify "critical "CPs for different European regions which are associated with observed severe hydro-meteorological extremes.
- Analyze whether these "critical" CPs are showing significant changes in frequency and duration.
- Investigate whether current GCMs/RCMs are able to simulate the "critical" CPs with realistic seasonal frequencies and durations.
- Investigate whether the "critical" CPs and the associated extremes will occur more frequently in the future
- Develop, calibrate and validate models for downscaling precipitation and temperature based extremes for different European regions by using observed "critical" CPs.

The methodology has been successfully applied to western and central Europe. By using subjectively and objectively classified CPs it is found that most of the severe European winter storms and river floods in Southwest Germany over the last 25 years have occured during long-lasting periods of CP type "West cyclonic (Wz)" in winter (Dec.-Feb.) [Caspary, 1996].

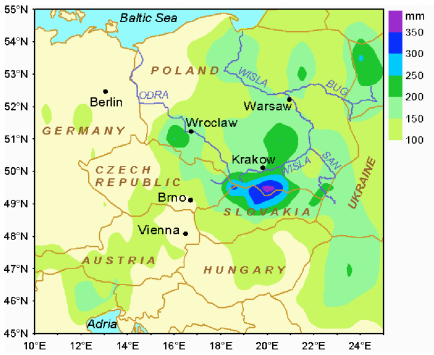

Fig. 5: Precipitation totals [mm] in July 2001 causing the Wisla flood [Fuchs & Rudolf, 2001].

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www.cru.uea.ac.uk/projects/stardex/

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