Application of a weather type classification to assess the impact of climate change on flood occurrence in Austria

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Floods

Large floods in Austria 2002, 2005
(picture: Steyr 2009)

- “more floods due to climate change”
Large floods in Austria 2002, 2005  
(picture: Steyr 2009)

- “more floods due to climate change”

- no general trends observed

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**Flood trends in Austria, Nobilis & Lorenz 1997**

<table>
<thead>
<tr>
<th>Period</th>
<th>Stations</th>
<th>Number of floods per year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Trend (p = 0.05)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>positive</td>
</tr>
<tr>
<td>1952–1961</td>
<td>177</td>
<td>15</td>
</tr>
<tr>
<td>1962–1971</td>
<td>232</td>
<td>2</td>
</tr>
<tr>
<td>1972–1981</td>
<td>336</td>
<td>96</td>
</tr>
<tr>
<td>1982–1991</td>
<td>441</td>
<td>16</td>
</tr>
<tr>
<td>1952–1971</td>
<td>162</td>
<td>5</td>
</tr>
<tr>
<td>1972–1991</td>
<td>321</td>
<td>38</td>
</tr>
<tr>
<td>1952–1991</td>
<td>142</td>
<td>29</td>
</tr>
</tbody>
</table>

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**Flood trends in Germany, Petrow & Merz 2009**
Method

– **Aim:**
  Investigate possible changes in occurrence of flood events due to climate change in Austria
  
  • Using climate model data
  • Focusing on meteorological impacts

– **Approach:**

- Periods of flood occurrence 20C (runoff observations)
- Catalogue of weather types 20C (ERA40)
- Flood generating weather types
- Catalogue of weather types 20C (GCM control runs)
- Catalogue of weather types 21C (GCM scenario)
- Flood occurrence 21C
Aim:
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- Catalogue of weather types 21C (GCM scenario)
- Flood occurrence 21C
Weather type classification

- Simplified version of the WLKC733 classification scheme developed in the framework of COST733

- Input variables:
  - geopotential height at 500 hPa and 925 hPa
  - true wind at 700 hPa

- Result: 36 weather types
  described by
  - flow direction class
  - cyclonic or anticyclonic vorticity at the two levels

Weather type example: 7 A C
7: wind dominantly from west
A: anticyclonal at 500hPa
C: cyclonal at 925hPa

- wind sectors (0 = undefined)
- domain of analysis and weights
Flood periods

- Runoff data:
  - 554 gauges
  - 1971 - 2000

- Seven climate regions in Austria

- Peak over threshold approach (4 events/year)

- Seasonal analysis
Flood generating weather types

- Flood generating period: day of peak + 2 days before
- Weather type catalogue for 1971-2000 from ERA40
- Relative frequency of occurrence of weather types in flood generating periods (relative to overall occurrence)

\[ \text{rel.freq. during flood periods} \]
\[ hh_{WL} = \frac{\sum_{i=d}^{d+HW} WL}{\sum_{i=d}^{d+HW} WL} \]

weather type: 1AA
Weather types with high relative frequencies in flood periods identified

10 flood generating weather types selected for CC analysis

for each climate region and season
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− **Approach:**

![Diagram showing the method]

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Climate model data and WLK733

- Climate model data:
  - ECHAM5: A1B, B1
  - HADCM3C: A1B
- WLK733: ERA40 vs. GCM control runs
  - good agreement for flow directions
  - large discrepancies for specific weather types
- WLK733: scenarios
  - shifts from control runs to scenarios (2\textsuperscript{nd} half of 21\textsuperscript{st} century) smaller than deviations
Method

– Aim:
Investigate possible changes in occurrence of flood events due to climate change in Austria
  • Using climate model data
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– Approach:
– Change in occurrence of flood generating weather type: Indicator for change in flood occurrence

– Qualitative analysis

- For most climate regions and seasons projected changes varied for different climate models and scenarios

- Consistent findings only for winter and spring and western and northern regions: increase in frequencies of flood generating weather types
Flood generating weather types can be identified with WLKC733

Large uncertainties in climate change application:
- Discrepancies in weather type frequencies from reanalyses and GCM control runs
- Different projections in different scenarios and different models

No drastic changes in circulation patterns over central Europe expected

Consistent trends:
- Increase in north-western and western flows in winter and spring
- Indicator for more frequent flood occurrences in northern and western regions of Austria, where these circulation patterns prevalently cause flood events.
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Thank you for your attention!

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