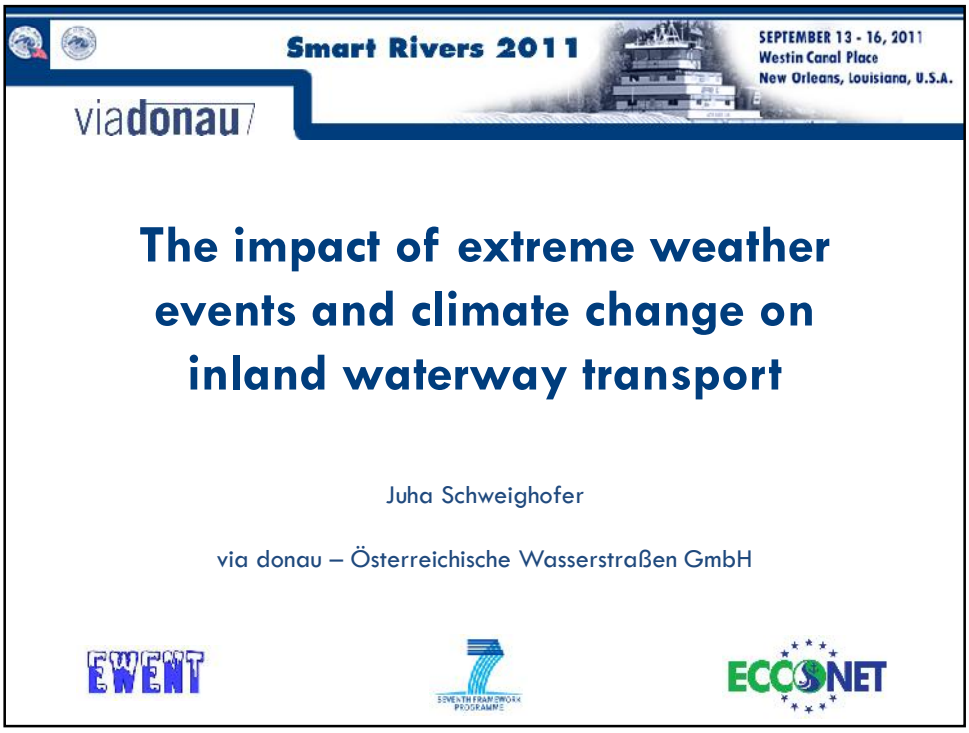
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The impact of extreme weather events and climate change on inland waterway transport
Juha Schweighofer
via donau – Österreichische Wasserstraßen GmbH
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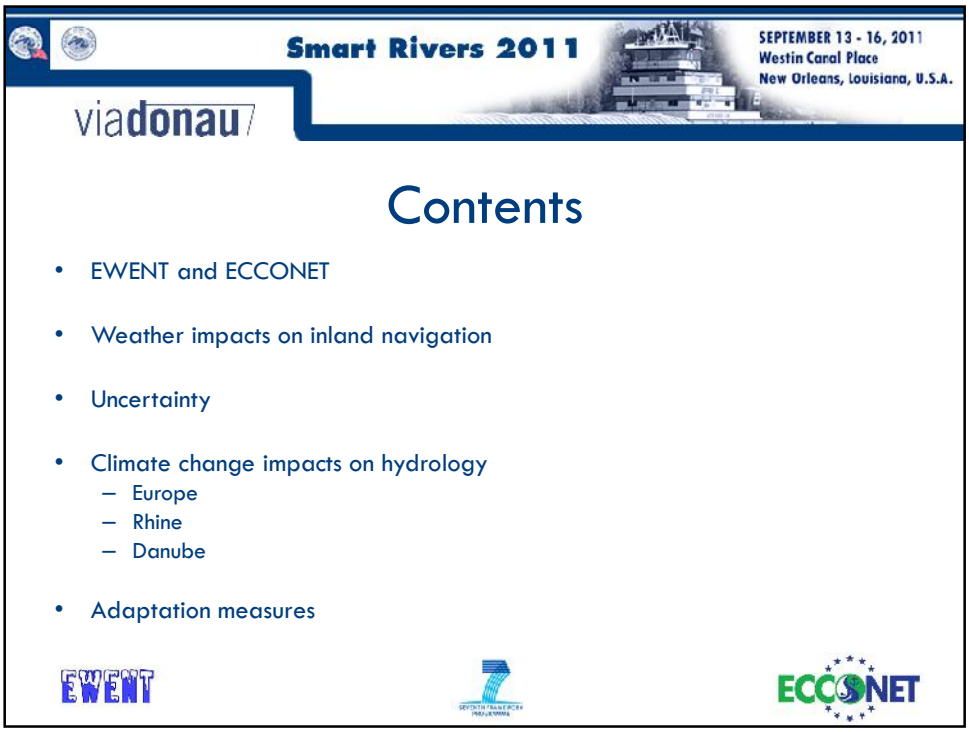
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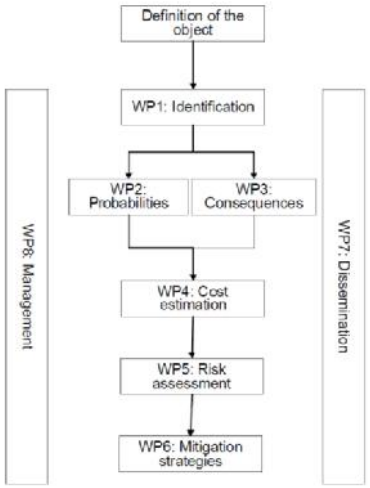
- Extreme weather impacts on European networks of transport (all modes)
- Funded within FP7 by the European Commission
- Duration: 2009 – 2012
- Website: www.ewent.vtt.fi



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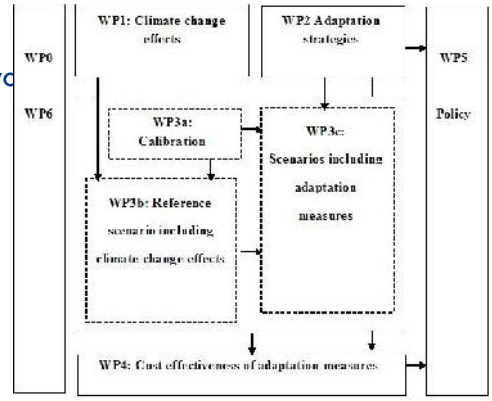
ECCONET

- Effects of climate change on the inland waterway netwo
- Funded within FP7 by the European Commission
- Duration: 2010 – 2012
- Website: www.ecconet.eu



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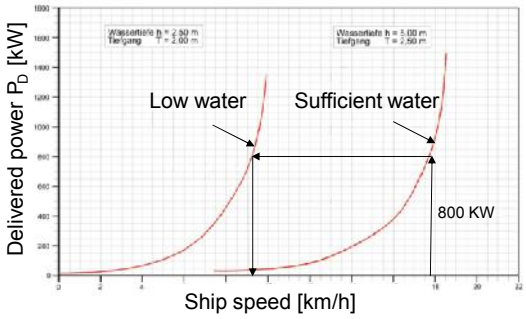
Weather impacts on navigation (1)

- Reduced water levels:
  - Reduced capacity utilisation of vessels
  - Increase:
    - sailing times
    - fuel consumption
    - transportation costs per ton



Source: DST, Kliwas 2009. Modified figure.

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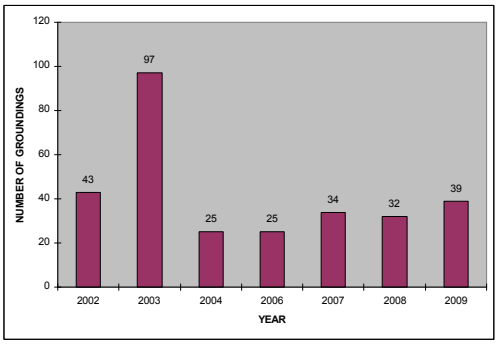
Weather impacts on navigation (2)

- Reduced water levels:
  - Accidents: grounding
  - Associated with longer periods



Development of grounding events on the Upper and Central Rhine within 2002 and 2009. Based on WSD Südwest.

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Weather impacts on navigation (3)

- High water levels:
  - Suspension of navigation
  - Usually limited only to a few days
- Ice
  - Suspension of navigation
  - Once it occurs it might take several days or weeks, depending on region
- Wind, storms:
  - Increased requirements on maneuverability and course stability
  - Main cause for accidents due to environmental reasons
- Reduced visibility
  - Reduced speed or interruption of navigation

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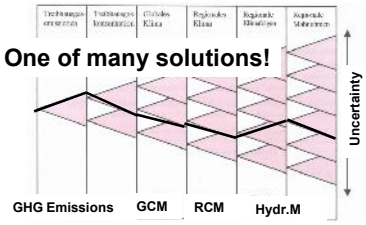
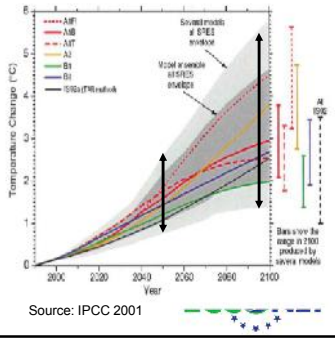
Uncertainty

- Model: simplification of reality
- Usage of multiple climate models => bandwidth of possible projections rather than single results
- Ensembles and KLIWAS
- Single model chain: uncertainty difficult to assess objectively
- Reproduction of future from past events not necessarily correct
- Climate change signals weaker till 2050 than 2100 due to continuously increasing temperatures till 2100





Source: IPCC 2001

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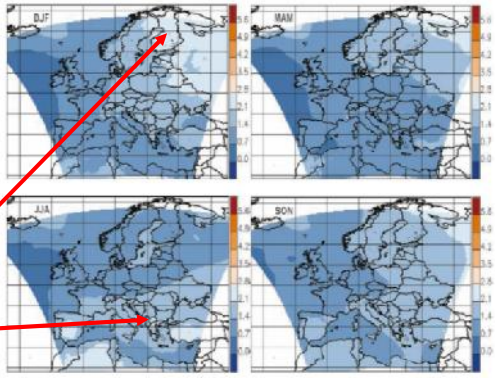
Climate change in Europe (1)

- Temperature
  - Temperature increase for all areas and seasons (2021 -2050)
  - Strength of T increase dependent on region
  - N-Europe: greatest warming in winter, spring and autumn, less in summer (JJA)
  - S-Europe: greatest warming in summer



Source: Ensembles

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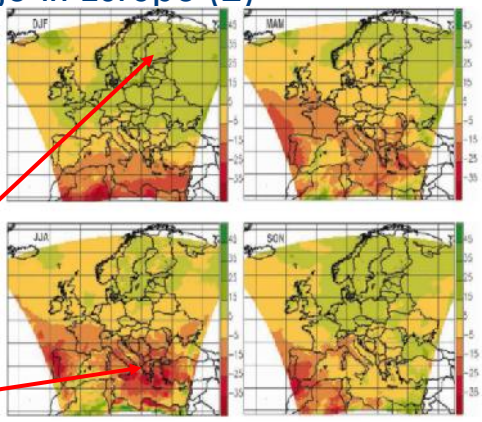
Climate change in Europe (2)

- Precipitation (2021 – 2050)
  - Annual precipitation:
    - N-Europe: increase
    - S-Europe: decrease
    - Rhine-Main-Danube: almost no change
  - Seasonal precipitation:
    - North: All seasons: increasing trend greatest in winter
    - South: All seasons: decreasing trend greatest in summer



Source: Ensembles

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Climate change in Europe (3)

- Hydrology (end 21st century)
- Finland, Russia, South Spain:
  - 100-year return levels of river discharge (floods): decrease
- Rest of Europe:
  - almost no changes or increase of floods
  - ⇒ Consideration of floods will gain importance

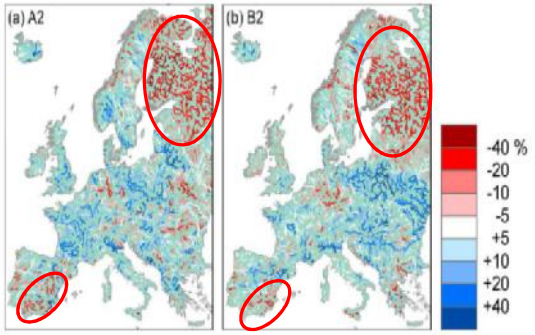

Figure 1-41: The relative change in 100-year return level of river discharge between the future period 2071–2100 and the control period 1961–1990 for the 3.9°C, A2 emissions scenario (left) and the 2.1°C, B2 emissions scenario (right).

Source: Peseta

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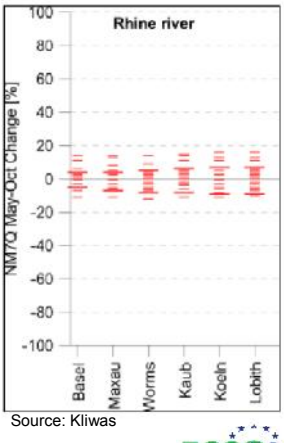
Changes in hydrology in Rhine region

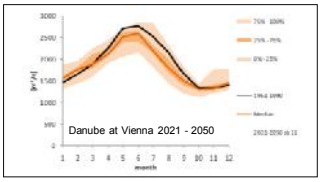
- Low water NM7Q
  - Summer:
    - almost no change till 2050 by KLIWAS for all relevant gauges
    - Significant decrease by 42% by KNMI06 W+ at Lobith
  - Winter: moderate increase in discharge
- Mean discharges: no clear tendency
- 100-year return levels of discharge:
  - No changes till 2100 by Peseta
- No suspension of navigation due to ice on the Upper and Central Rhine since 1970!



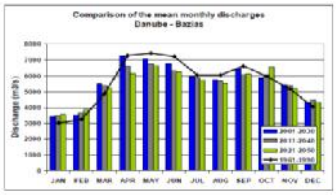
Source: Kliwas

Changes in hydrology in Danube region (1)

- Upper and Central Danube (till 2050)
- Annual discharge: slightly decreasing
- Maximum discharge: slightly decreasing
- Minimum discharge: almost no change
- Till 2100 changes become significant
- 100-year return levels (floods):
  - Upper and Central Danube:
    No change (A2) or moderate increase (B2)
  - Lower Danube:
    No change (A2) or significant increase (B2)



Source: Pöyry Energy GmbH, 2011, Auswirkungen verschiedener Szenarien der Klimaänderung auf den österreichischen Abschnitt der Donau



Source: CLAVIER

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Changes in hydrology in Danube region (2)

- Glaciers – influence of melting ice on discharge:
  - Currently most significant in August 10 % (Achleiten, Glowa Danube)
  - Vienna most significant in August 2% (Pöyry Energy GmbH)
  - Vanishing glaciers only little or negligible influence on discharge of Danube
- Ice occurrence decreasing

	1901 - 1960	1964 -1986	1994 - 2010
Ice flow	80%	60%	40%
Ice cover	60%	40%	0%

Table 29: Ice phenomena on the Hungarian Danube reach (Balint, 2011).

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Changes in visibility and wind gusts

- Reduced visibility clearly decreasing for most airports in Europe
- Indication for better visibility conditions in IWT
- Wind gusts till 2050: almost no change in the Rhine-Main-Danube corridor

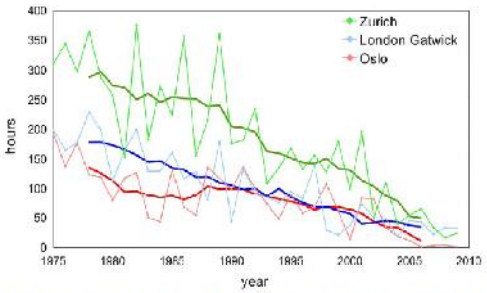

Figure 2.19. Annual numbers of hours with visibility less than 200 m at the airports of Zurich (green), London Gatwick (blue) and Oslo (red). The thin lines are the actual observed values, the thick lines are 7 year moving averages.

Source: ESSL- European Severe Storms Laboratory (Pieter Groenemeijer), EWENT Deliverable 2.1

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Adaptation relevant to IWT (1)

- Floods and high water often excluded as short lasting event
- Focus: Low water occurrence
- Measures:
  - Transport systems (fleet, operations, logistic chains)
  - Infrastructure
  - Prediction methods seasonal forecast
  - Production processes and store keeping

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Adaptation relevant to IWT (2)

- Infrastructure
  - Provision of navigation conditions according to international agreements
  - Improved waterway management and ICT offers large potential
  - Economical safety: current and future fleet
  - Benefits already today!
- Shallow water vessels
  - Under current conditions not economical
  - More economical than current vessels only if navigation conditions not sufficient over a long period
  - Economical and ecological performance decreases
  - Uncertainty related to dimensions and time of profitable operation

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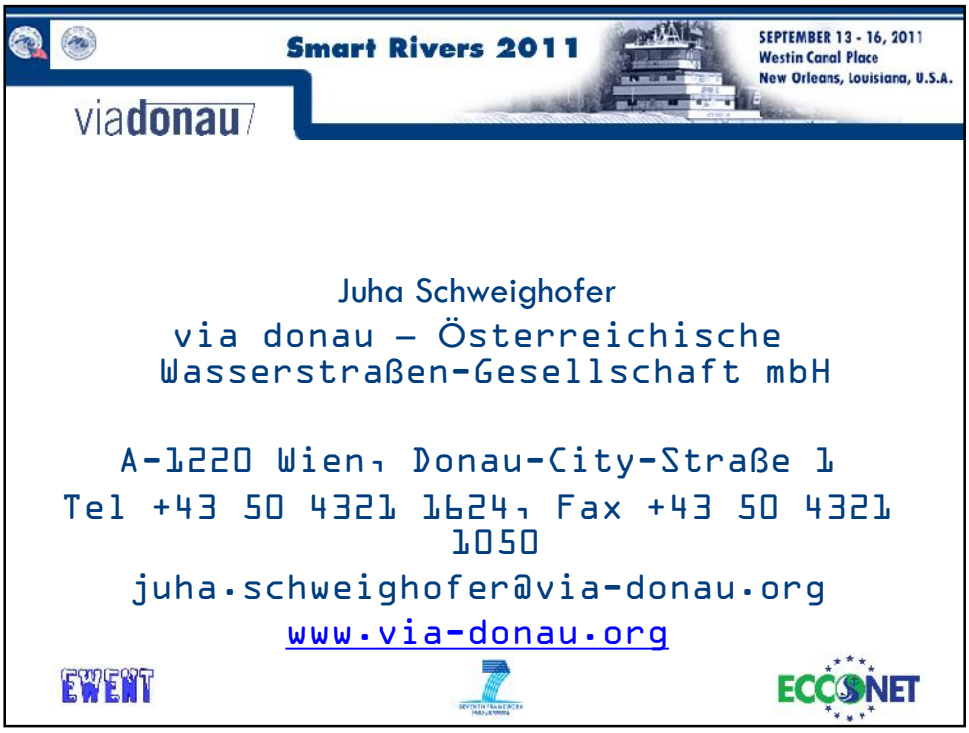
Summary

- **Uncertainties** are still high
- **Floods** are not projected to decrease for European waterways (except Finnland, Russia and South Spain)
- **Low water:** No convincing evidence for increase in severity till 2050
- **Ice** occurrence is decreasing
- **Visibilty** is impoving
- **Wind activity** in the Rhine-Main Danube corridor: almost no change
- **Rhine-Main-Danube corridor:**
  - No decrease in the **performance of inland waterway transport** due to climate change till 2050
  - **Research need:** Central and Lower Danube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