KLIWAS: organisational aspects and current work of BfG on climate change

1st Rhine-Mekong Symposium
“Climate change and its influence on water and related sectors”
8-9 May 2014, Koblenz, Germany

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Drought

Low flow Rhine river 2003
Figure 1: Number of models projecting an increased annual mean precipitation (comparison of the periods 1980–1999 and 2080–2099, Multi-Model Data (MMD), A1B Scenario)
Reliable supply?
Policy Questions

- How will climate change influence inland and coastal waterways in Germany?
- When will changes occur?
- What is the range of regional potential changes?
- What adaptation measures can help?
30 Projects

national and international cooperation
Coast & Estuaries

- Research task 2: Hydrology coast (4 projects)
- Research task 3: Water condition coast (9 projects)

Inland

- Research task 4: Hydrology Inland (5 projects)
- Research task 5: Water condition Inland (8 projects)

30 Projects

Climate scenarios, projection (3 projects)

national and international cooperation
Multi model approach

Model chain - schematic

Model chain - data
## Selection of relevant indicators

<table>
<thead>
<tr>
<th>Diagnostics</th>
<th>Notation</th>
<th>Unit</th>
<th>Description and definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average discharge</strong></td>
<td>MQ</td>
<td>m³/s</td>
<td>Mean discharge; arithmetic mean of daily mean discharge per time-span (annual and seasonal, with reference to the hydrological year or hydrological season); averaged to 30-year long-term annual seasonal means; hydrological yearbook primary statistic</td>
</tr>
<tr>
<td><strong>Low flow</strong></td>
<td>NM7Q</td>
<td>m³/s</td>
<td>Lowest arithmetic mean of discharge during 7 consecutive days; calculated per hydrological season; averaged to 30-year long-term annual or seasonal means</td>
</tr>
<tr>
<td></td>
<td>FDC_Q90</td>
<td>m³/s</td>
<td>Discharge undershot on 10% of all days of a 30-year period (i.e. the 90th percentile of the flow duration curve representing 10950 days, no leapyears taken into account)</td>
</tr>
<tr>
<td><strong>High flow</strong></td>
<td>MHQ</td>
<td>m³/s</td>
<td>Mean maximum discharge; arithmetic mean of all annual maximum discharges (per hydrological year) per timespan (here: 30-year, 3000-year); hydrological yearbook primary statistic</td>
</tr>
<tr>
<td></td>
<td>HQ10</td>
<td>m³/s</td>
<td>Discharge corresponding to a 10-year return period, i.e. discharge which occurs once every 10 years; calculated from a fitted distribution to the annual (hydrological year) maximum discharge values per timespan in a return level plot; for HQ10 a 30-year time-span is used</td>
</tr>
<tr>
<td></td>
<td>HQ100</td>
<td>m³/s</td>
<td>Discharge corresponding to a 100-year return period; a 3000-year time-span from the rainfall generator is used</td>
</tr>
</tbody>
</table>
vulnerability

Step 1: CHG emissions → Climate change

Step 2: Exposure, Sensitivity → Potential impacts

Socio-economic and institutional capacity → Willingness to adapt

Adaptive capacity

Vulnerability

Human systems and the natural environment

Mitigation

Adaptation

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gauge Kaub, Rhine Change in low flow*

-5/+10% -15/0%

* NM7Q, water year (Apr-Mar), 31 years, moving average
Morphodynamics

River Rhine

Bed level variation near future (2021 – 2050)
Bed level variation distant future (2071 – 2100)

Morphologic homogenous sections

Hillebrand et al. 2013
Water temperature

Model chains:
1 = C20-A1B_ECHAM5r3_REMO-ENS_QSIM
2 = C20-A1B_BCM_RCA3_QSIM
3 = C20-A1B_HADCMQ0_HADRMQ0_QSIM
4 = C20-A1B_ECHAM5r3_RACMO_QSIM
5 = C20-A1B_ECHAM5r1_CLM24_QSIM

Rhine, ~ km 360 - 865

Hardenbicker et al. 2013
Impacts of climate change on annual total transport costs [€ /a]

→ Optimistic and pessimistic discharge scenario

**Distant future**

Quelle: Nilson et al. (2013)
vulnerability

Step 1: GHG emissions

Step 2: Exposure, Sensitivity

Step 3: Potential impacts, Socio-economic and institutional capacity, Willingness to adapt

Vulnerability

Adaptation

### Science + responsibility

**Uses/functions depending on** | **Parameters** | **Need for action with view to** | **Assessment of information**
--- | --- | --- | ---
Water supply (e.g. water abstractions) | **MQ** (mean river discharge), hydrological year (Nov.-Oct.) | Rhine | **0** | +
 |  | Elbe | Since 2050 | ++ | +
 |  | Danube | Since 2050 | ++ | +
Summer flow (e.g. water resources management) | **MQ** (mean river discharge), hydrological summer (May-Oct.) | Rhine\(^\circ\) | Since 2050 | ++ | ++
 |  | Elbe | At once | + | ++
 |  | Danube\(^\circ\) | At once | + | ++
Minimum water volume (e.g. fish migration, navigability) | **NM\(_7\)Q** (lowest mean discharge in a period of 7 days) or **NM\(_{MoMQ}\)** (lowest mean monthly discharge), water year (Apr.-March) | Rhine\(^\circ\) | Since 2050 | + | ++
 |  | Elbe | Since 2050 | ++ | +
 |  | Danube\(^\circ\) | At once | + | ++
Technical and operational adaptation options

- Multiple propellers
- Dynamic tunnel apron
- Diesel-electric engine
- Hydraulic engineering
- High strength steal
- Reduction of safety depth
- Small vessels as tug-barge systems
- Reduction of max. draught
- Fleet composition
- Hydraulic engineering
Currently ….

- Project reports & publications on the dimension of climate signals & when, dimension and relevance of impacts for running the waterways, adaptation options

- Synthesis for decision makers

- Synthesis on methodology

→ contributions for the GFCS
Currently + outlook

Step 1: GHG emissions

Step 2: Climate change

Step 3: Exposure

Step 4: Socio-economic and institutional capacity

Ministry & Water and Shipping Authorities & research

Human systems and the natural environment

Vulnerability

Adaptation

European Environment Agency. 2008. Impacts of Europe’s changing climate: 2008 indicator based assessment (Ch.6. Adaptation to climate change; figure from Isoard, Grothmann and Zebisch (2008)).
Currently …

Seasonal prognosis/ decadal projections

2021-2050

2071-2100

Short-term

2021-2050

2071-2100

Currently …

planning horizon

investments in infrastructure
outlook: new projections

Source: Sperna Weiland & Bouaziz (2014)
outlook: consistent scenarios for all transport modes

Source: dpa (2013)
Thanks

To the KLIWASians
Thank you!

www.kliwas.de

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