Aggregated climate change scenarios for the Netherlands: their construction and stakeholder uptake

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Why develop climate scenarios?

- translation of IPCC findings to national context
- potential indicators of climate change and their uncertainties
- plausible and consistent images of the future
- potential impacts and key vulnerabilities
Cascade of scenario assumptions

- Socio-economic scenarios
- Emission scenarios
- Concentration scenarios
- Climate change scenarios
- Climate impact scenarios

Source: After IPCC, AR4, WGI (2007), Chapter 13, Fig. 13.2
Downscaling and bias correction methods

- statistical and dynamical downscaling methods
- often dynamical downscaling with the help of RCMs used
## Large collection of European national climate scenarios

<table>
<thead>
<tr>
<th>Country</th>
<th>Reference period</th>
<th>Time horizons</th>
<th>RCPs or emissions scenarios</th>
<th>Year publication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>1971-2000</td>
<td>2021-2050, 2071-2100</td>
<td>4.5, 8.5</td>
<td>2015</td>
</tr>
<tr>
<td>Belgium</td>
<td>Not defined explicitly</td>
<td>30, 50 and 100 years ahead</td>
<td>Low, medium, high (4.5 + 8.5)</td>
<td>2015</td>
</tr>
<tr>
<td>Denmark</td>
<td>1986-2005</td>
<td>2046-2065, 2081-2100</td>
<td>2.6, 4.5, 6.0, 8.5</td>
<td>2014</td>
</tr>
<tr>
<td>France</td>
<td>1976-2005</td>
<td>2021-2050, 2041-2070, 2071-2100</td>
<td>2.6, 4.5, 8.5</td>
<td>2014?</td>
</tr>
<tr>
<td>Germany (Kliwas)</td>
<td>1961-1990</td>
<td>2021-2050, 2071-2100</td>
<td>Range of models (A1B)</td>
<td>2015</td>
</tr>
<tr>
<td>Ireland</td>
<td>1971-2000</td>
<td>2021-2050, 2071-2100</td>
<td>2.6, 8.5 (4.5)</td>
<td>2018</td>
</tr>
<tr>
<td>Netherlands</td>
<td>1981-2010</td>
<td>2016-2045, 2036-2065, 2071-2100</td>
<td>4.5-8.5</td>
<td>2014</td>
</tr>
<tr>
<td>Norway</td>
<td>1971-2000</td>
<td>2031-2060, 2071-2100</td>
<td>4.5, 8.5</td>
<td>2017</td>
</tr>
<tr>
<td>Switzerland</td>
<td>1981-2010</td>
<td>2020-2049, 2045-2074, 2070-2099</td>
<td>2.6, 4.5, 8.5</td>
<td>2018</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>1981-2010, 1961-1990</td>
<td>2020-2039 to 2080-2099 (20-year periods)</td>
<td>2.6, 4.5, 6.0, 8.5</td>
<td>2018</td>
</tr>
</tbody>
</table>
Dutch approach a bit different

Switzerland: downscaling chain

Netherlands: decomposition of ensemble between **global** response and **local** feedback
What are (KNMI’14) climate scenarios?

› (1) A comprehensive summary of large ensemble of climate projections
What are (KNMI’14) climate scenarios?

› (1) A comprehensive summary of large ensemble of climate projections

Separated two important drivers:
- Global temperature change
- Anomalies related to variations in
  - regional atm. circulation (precipitation, extremes)
  - ice cap dynamics (sea level rise)

› Aggregation of 245 GCM projections into 4 locally relevant scenarios

Local feedback may be different for different regions/climate zones

(monsoon, snow or land surface feedback, local SST patterns, ...)

[Diagram showing climate scenarios with axes for global temperature rise and change in air circulation pattern, with GH, GL, WH, WL]

[For reference, KNMI is the Royal Netherlands Meteorological Institute, and GCM stands for General Circulation Model.]
What are (KNMI’14) climate scenarios?

- (2) A local interpretation of this summary

- Long table of relevant climatological indicators and their change
- Table is based on stakeholder consultations
- Well embedded in Dutch water management design
Downscaling and bias correction methods

Potential range of change

More detailed info for the Netherlands

Time series for the future
Transformation of time series for rainfall

Add/subtract change from climate model projections to observed climate time series

**Advantage:**
- Local observations (also used for current-day system analyses) act as baseline
- Relatively simple procedure

**Disadvantage:**
- Operation can become complex (change in mean $\neq$ change in extreme)
- Historical sequence of events is inherited from baseline record (not all changes can be applied)
Transformation time series for 2050 rainfall

Scenario $W_H$

Average rainfall

Scenario $W_L$

Wet day frequency
Climate Impact Atlas

Days per year with $\geq 15$ mm

Current climate (1981-2010)

Future: 2050 - WH
1/10 yr rainfall in 24 hours (mm) (for a specific region)

Current: 59
2050: 68
2085: 76

Max: 60
Min: 59
Short duration rainfall extremes

In observations:
- At higher temperatures faster increase of hourly rainfall extremes than Clausius Clapeyron
Short duration rainfall extremes

- Most current climate models do not simulate convective rainfall well
- High resolution models perform better
Protocol extreme precipitation information

1. What rainfall information needed?
   - Point or area statistics?
   - For which "current" climate?
   - Which (range of) rainfall durations and return times?
   - Format

2. Check rainfall statistics currently used/available
   - Point/area statistics?
   - Reference period?
   - Method used?
   - Correction for trends?
   - Available rainfall durations and return times?
   - Format

3. If required rainfall data not available:
   - Process existing data
     - Transform point data into area data with ARFs or on the basis of gridded point statistics
     - Adapt format
   - Generate required data
     - Generate statistics for the needed reference period and/or correct for trends
     - Generate statistics for the required rainfall durations and/or return times
     - Use a different method for generating the rainfall statistics
     - Generate area statistics

Required rainfall statistics available: use data

If relevant, generate derived variables

Systematic survey of required and currently available information and methods to close gaps
Climate scenarios need to
• Aggregate uncertain information
• Relate to impacts

Multiple (downscaling) steps are required

Local uptake of scenario information requires
• A good physical narrative
• A simple procedure to ingest scenario information to local applications
• Long-term interaction with users