Statistical downscaling: Status and open issues
Rob Wilby, Loughborough University, UK
Flooding of Djibouti by the Oued Ambouli in April 1994
The downscaling mantra

What the climate model centres provide...

...what (we think) the climate impacts community needs.
Downscaling is at the heart of the uncertainty cascade
What have we learnt so far?

- GCM boundary conditions are the main source of uncertainty affecting all downscaling methods
- Statistical and dynamical downscaling have similar skill
- Different downscaling methods yield different scenarios
- There are no universally “optimum” predictor(s)/domains
- Downscaling extreme events is highly problematic (for example summer rainfall predictability is very low)
- Traditional skill measures for current climate may not be the best guide to future scenarios of change
“Pulse check” for the downscaling industry...

Number of ISBN research publications listed on the Web of Science.
Accessed 10 February 2009
A few practical considerations

Photo: Bull (1930)
Decaying observing networks

The global network of the World Weather Watch (WWW) stations colour coded to indicate silence (red dot) or reporting rates in 2008. Source: WMO (2009)
Concerns about data quality in vulnerable regions

Distribution of daily precipitation amounts recorded at Ibb (including 14.6 and 15.8 mm on 30 and 31 February 1995!)
Djibouti’s met station
“Shed-loads” of uncertainty

Djibouti annual PRCP2050s

Djibouti annual TMAX 2050s

Data source: Climate Systems Analysis Group, University of Cape Town
<table>
<thead>
<tr>
<th>Tool/source</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>clim.pact</td>
<td>R functions for downscaling monthly and daily mean climate scenarios <a href="http://cran.r-project.org/src/contrib/Descriptions/clim.pact.html">http://cran.r-project.org/src/contrib/Descriptions/clim.pact.html</a></td>
</tr>
<tr>
<td>CSAG</td>
<td>Data portal for downscaled African precipitation scenarios for the 2080s <a href="http://data.csag.uct.ac.za/">http://data.csag.uct.ac.za/</a></td>
</tr>
<tr>
<td>ENSEMBLES</td>
<td>Experimental portal for downscaling tools applied to Europe <a href="http://grupos.unican.es/ai/meteo/ensembles/index.html">http://grupos.unican.es/ai/meteo/ensembles/index.html</a></td>
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<tr>
<td>FINESSI</td>
<td>Multi-sector/ multi-variable climate change scenarios for Finland <a href="http://www.finessi.info/finessi/?page=explore">http://www.finessi.info/finessi/?page=explore</a></td>
</tr>
<tr>
<td>LARS-WG</td>
<td>Tool for producing time series of a suite of climate variables at single sites <a href="http://www.rothamsted.bbsrc.ac.uk/mas-models/larswg.php">http://www.rothamsted.bbsrc.ac.uk/mas-models/larswg.php</a></td>
</tr>
<tr>
<td>MAGICC/ SCENGEN</td>
<td>Interactive software for investigations of global/regional climate change <a href="http://www.cgd.ucar.edu/cas/wigley/magicc/">http://www.cgd.ucar.edu/cas/wigley/magicc/</a></td>
</tr>
<tr>
<td>RClimex</td>
<td>Graphical interface to compute 27 core indices of climate extremes <a href="http://ccma.seos.uvic.ca/ETCCDMI/software.shtml">http://ccma.seos.uvic.ca/ETCCDMI/software.shtml</a></td>
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<td>SDSM</td>
<td>Downscaling tool for scenario production at single sites <a href="http://www-staff.lboro.ac.uk/~cocwd/SDSM/">http://www-staff.lboro.ac.uk/~cocwd/SDSM/</a></td>
</tr>
<tr>
<td>Tearfund</td>
<td>Mainstreaming disaster risk reduction: a tool for development organisations <a href="http://www.tearfund.org/webdocs/Website/Campaigning/Policy%20and%20research/Mainstreaming%20disaster%20risk%20reduction.pdf">http://www.tearfund.org/webdocs/Website/Campaigning/Policy%20and%20research/Mainstreaming%20disaster%20risk%20reduction.pdf</a></td>
</tr>
<tr>
<td>UNFCCC</td>
<td>Database on local coping strategies <a href="http://maindb.unfccc.int/public/adaptation/">http://maindb.unfccc.int/public/ adaptation/</a></td>
</tr>
<tr>
<td>WRI</td>
<td>Climate Analysis Indicators Tool (CAIT) <a href="http://cait.wri.org/">http://cait.wri.org/</a></td>
</tr>
</tbody>
</table>

Too many tools?

More worked examples needed

GENERAL GUIDELINES ON THE USE OF SCENARIO DATA FOR CLIMATE IMPACT AND ADAPTATION ASSESSMENT

Version 2
June 2007

Prepared by
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with comments or contributions from:

Task Group on Data and Scenario Support for Impact and Climate Assessment (TGICA)

Intergovernmental Panel on Climate Change

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Water crises NOW!...not 2080s...or even 2020s

<table>
<thead>
<tr>
<th></th>
<th>Djibouti</th>
<th>Morocco</th>
<th>Yemen</th>
<th>Spain</th>
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<tbody>
<tr>
<td>Population (1000)</td>
<td>793</td>
<td>31,478</td>
<td>20,975</td>
<td>43,064</td>
</tr>
<tr>
<td>Growth rate (%)</td>
<td>2.1</td>
<td>1.5</td>
<td>3.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Water per capita (m³/yr)</td>
<td>378</td>
<td>921</td>
<td>195</td>
<td>2578</td>
</tr>
<tr>
<td>GDP agriculture (%)</td>
<td>4</td>
<td>16</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>Rural water access (%)</td>
<td>59</td>
<td>56</td>
<td>65</td>
<td>100</td>
</tr>
</tbody>
</table>

Now the good news
There are regions where “top down” / scenario-led approaches make sense.

Projected Patterns of Precipitation Changes

Source: IPCC AR4 (2007)
Downscaling to stations across Morocco
Downscaling daily weather in Morocco

Casablanca TAVG 1993 (r=0.88)

Casablanca TAVG 1999 (r=0.89)

Casablanca PRCP Dec 1995 to May 1996

Casablanca PRCP 1991-2000

Loughborough University
Decisions must still be robust to uncertainty

Projected changes in spring and annual precipitation totals for the 2080s for two downscaling methods (UCT, SDSM) and three climate models (CSIRO, ECHAM4, HadCM3) under A2 emissions

Where do we go from here?
1) Number of participating models and partners. Of course the more the better, however it should be realized that at the moment there is no funding specifically available for this, so that the participation needs to be necessarily on a voluntary basis. On the other hand, we feel that a well conceived and designed plan might elicit opportunities for funding.

2) Experiments to be completed. In the next round of IPCC there is a wide range of experiments planned, from decadal prediction to standard scenario runs (using specified GHG Reference Concentration Pathways), stabilization runs and a number of sensitivity experiments to isolate the effects of different forcings and processes. We cannot obviously do them all, so we need to prioritize the key ones to be carried out.

3) Choice of domains, resolution and time slices. WCRP is keen that as many regions of the globe as possible be treated. This may increase the number of domains by quite a lot. The model resolution should be state-of-the-art, and a value that has been floating around is 25 km grid point spacing. Should we do full 150 year simulations or time slices? We need to find an optimal compromise among these issues.

4) Choice of GCMs for providing lateral boundary conditions or, more generally, forcing fields. This is a key issue. In order to produce RCD runs, we need to have GCM data to downscale, and we need them in a timely fashion. At the last WGCM meeting, GCM groups generally expressed their support for this notion, as long as it does not add to much work for them. So we need to design an approach workable for them as well as for us.

5) Databases and data accessibility. Another key issue. There will be a lot of data, both the GCM data to drive the RCDs and the output produced by the RCDs. CMIP3 has been incredibly successful because of the role of the PCMDI databank. How should we approach this? The idea has been floating around of regional databases, since nobody might afford a comprehensive central one. And then, how to produce comprehensive but workable sets of model fields?

6) We need to involve the end-user community, represented in Toulouse by a number of impact experts, from the very beginning of the discussion, because they are the recipient of the RCD-information. How to optimize this process?

7) A final issue that WCRP is very keen on is to increase the involvement of scientists from developing countries, so we do need to discuss this issue as well.

These are some of the basic issues we will discuss in Toulouse. Hopefully, if we all come prepared we will have a straw-man plan that can be presented at the following JSC/WCRP meeting at the beginning of April in Maryland. The plan is then to eventually finalize the framework at the RCM workshop of May 4-8 in Lund, so that participating groups can gear up to start their simulations not too far thereafter. It is expected that the GCM groups will start their simulations sometimes in the second half of 2009, and we should plan to start ours not much later than that. We may even decide to use AR4 global simulations if it turns out that using the new AR5 ones is not feasible. In other words have a plan B. All this needs to be discussed in Toulouse.

We stress that if this enterprise is successful it will represent one of the newest aspects of the AR5 and will likely have an extremely high visibility, so that we hope you appreciate the importance of our task. Hoping that this letter is of some help for your participation in the Toulouse workshop, looking forward to see you there and to work with you in the next year.

With our best regards,

Filippo Giorgi
A science agenda driven by adaptation needs

Flooding of Djibouti by the Oued Ambouli in April 1994
“Second generation downscaling”: Improved access and support
Admitting that “Bottom up” approaches make more sense where the map is blank

Projected Patterns of Precipitation Changes

Source: IPCC AR4 (2007)
Know your end user!