Downscaling of climate model projections

Challenge: Unknown climate risks **Adaptation response:** Hazard and risk assessment

Description

Downscaling of climate change models is the procedure of using large-scale climate models to make climate predictions at finer temporal and spatial scales to fit the purpose of local level analysis and planning. This typically involves use of Global Climate Models (GCMs) representing physical processes in the atmosphere, ocean, cryosphere and land surface, simulating the response of the global climate system to increasing greenhouse gas concentrations, using different emissions scenarios. Downscaling tools such as high resolution regional climate models (RCMs) can then be used to simulate the scenarios on a finer spatial scale, using finer level local conditions.

There are two general approaches of downscaling:
Dynamical – were outputs from GCM's are used to drive higher resolution regional climate models with a better representation of local terrain and other conditions
*Statistica*l – where statistical links are established between large-scale climate phenomena and observed local-scale climate. (These are always needed to correct for biases even in RCM's).

Implementation

Downscaling methodologies can take many forms, but usually starts with selecting the appropriate downscaling approach (statistical or dynamical). This is followed by preparation of input datasets - local and global, and further a simulation of large scale variables (GCMs) to local circumstances. The results of these can then be coupled with hydrological modelling tools as appropriate to determine local impacts on water resources – e.g. for vulnerability assessments of water resources. They can also be fed into various adaptation scenario development.

Environmental Benefits

- Scenario outputs quantifying climate impacts assists in planning for adaptation responses that are sustainable and appropriate for future climate conditions in the given location
- Helps to identify most vulnerable ecosystems for intervention

Socioeconomic Benefits

- Improved preparedness for future climate conditions, including extreme events such as floods and droughts helps to minimize losses and damages resulting from improper adaptation

Opportunities and Barriers

Opportunities:

- Improved understanding of local future climate conditions and their impacts on water resources
- Continuously improving technologies and methods

Barriers:

- High levels of uncertainty and numerous scenarios with various, often highly different outcomes can make it difficult to derive conclusive results
- Computationally and resource demanding
- The uncertainty of results increases as the projections are downscaled for local applications (higher resolution).

Implementation considerations*

Technological maturity:	3-4
Initial investment:	2-3
Operational costs:	2
Implementation timeframe:	1-3

* This adaptation technology brief includes a general assessment of four dimensions relating to implementation of the technology. It represents an indicative assessment scale of 1-5 as follows:
Technological maturity: 1 - in early stages of research and development, to 5 – fully mature and widely used
Initial investment: 1 – very low cost, to 5 – very high cost investment needed to implement technology
Operational costs: 1 – very low/no cost, to 5 – very high costs of operation and maintenance
Implementation timeframe: 1 – very quick to implement and reach desired capacity, to 5 – significant time investments needed to establish and/or reach full capacity
This assessment is to be used as an indication only and is to be seen as relative to the other technologies included in this guide. More specific costs and timelines are to be identified as relevant for the specific technology and geography.

Sources and further information

Mearns O.L. (2009). Methods of Downscaling Future Climate Information and Applications. National Center for Atmospheric Research, NARCCAP Users' Meeting, Boulder, CO, September 10-11, 2009. Available at: https://www.narccap.ucar.edu/users/user-meeting-09/talks/Downscaling_summary_for_NARCCAP_Users_Meet09.pdf.

NCAR (2017). What is downscaling? The National Center for Atmospheric Research. Available at: https://gisclimatechange.ucar.edu/question/63

UN CC:Learn (2013). Predicting and Projecting Climate Change, United Nations Institute for Training and Research (UNITAR). Available at: https://unfccc.int/files/cc_inet/application/x-httpd-php/ccinet_getfile.php?file=271.

USAID (2014). A review of downscaling methods for climate change projections, September 2014. Available at: http://www.ciesin.org/documents/Downscaling_CLEARED_000.pdf.