

Report: provision of climate model data to hydrological models for the Eastern Mediterranean and Middle East

MedClivar / GLOWA, 3-4 March 2008, Reading, UK

Summary

The workshop brought together approximately thirty scientists from several institutions and projects. The topic of the workshop was the use of climate and hydrological models to predict climate and water availability in the eastern Mediterranean and Middle East. Presentations and discussions focused on the following themes:

- Climate modelling of present and future climate in the Mediterranean and the Middle East.
- Development of hydrological models for the region
- Downscaling climate model data to appropriate temporal and spatial scales for use in hydrological models

Projects represented (see also participants' list)

- MedClivar aims to coordinate and promote the study of the Mediterranean climate.
- Water, Life and Civilisation (WLC) aims to assess the impact of changes in the hydrological climate on past, present and future societies in the semi-arid regions of the Middle East and North Africa, with a case study of the Jordan Valley
- GLOWA Jordan River (Global Change and the Hydrological Cycle) aims to assess how the benefits from the Jordan River region's water resources can be maximized for humans and ecosystems under global change
- CIRCE (Climate Change and Impact Research in the Mediterranean Environment) aims to predict and to quantify physical impacts of climate change for the Mediterranean; to evaluate the consequences of climate change for society and the economy; to develop an integrated approach to understand combined effects of climate change and to identify adaptation and mitigation strategies, jointly with regional stakeholders
- SUSMAQ (Sustainable Management of the West Bank and Gaza Aquifers Project) aimed to support the sustainable management and use of scarce water resources of the West Bank and Gaza Strip
- SWAP (South West Asia Project) aims to quantify and monitor the processes shaping the landscapes of Southwest Asia.
- PreciS (PRoviding Regional Climates for Impact Studies) was developed in order to help generate high-resolution climate change information for as many regions of the world as possible. The intention is to make PRECIS freely available to groups of developing countries in order that they may develop climate change scenarios at national centres of excellence, simultaneously building capacity and drawing on local climatological expertise.

Description of the scientific content of and discussion at the event and assessment of the results and impact of the event on the future direction of the field

Summary of the presentations and discussion

1. Climate modelling

Present day and future scenarios from standard resolution global climate models, a 20km resolution global climate model and regional climate models (with resolution ranging from 50km to 6km) were presented. For all emissions scenarios and for all GCMs and RCMs discussed, the Middle East and North Africa was predicted to be drier in winter and spring (less rainfall - in particular in the rainy season - and higher temperatures) in the period 2070-2100 than in pre-industrial times or the present day. Results for the Middle East in summer and autumn are controversial and the whole region is crossed by a sharp gradient of precipitation. However, in the northern part of the Mediterranean, the climate is predicted by most models to get wetter, particularly in the Alps.. For the immediate future (2020-2040), the results were more ambiguous, with some models predicting wetter conditions and others predicting drier conditions. However, it was pointed out that for this period, when the greenhouse gas concentrations are less perturbed relative to present day or pre-industrial conditions, it is difficult to distinguish between interdecadal variability and true anthropogenic climate change.

The importance of adequate resolution was emphasised by several participants. The high-resolution global model was shown to represent the spatial variability in the climate better than standard resolution global climate models or coarser regional climate models. Nested regional climate models (down to 6km resolution) were shown to capture the spatial variability due orographic features better than coarser (50km resolution) regional climate models.

Despite an acceptable level of consensus between models, questions over the reliability of their predictions remain. In particular, some models were shown not to capture present day climate variability (including the seasonal cycle) or observed trends in rainfall. Regional models were shown to be sensitive to the domain chosen, while standard resolution global models could not capture aspects of climate variability that were strongly affected by topography – a particular problem in the Middle East. Very high-resolution global climate models might overcome some of these problems, but are expensive to run.

Although differences between GCMs and RCMs was discussed, it was not possible to draw conclusions about which model was “best” because all the modelling groups were using different domains, different validation datasets and examining different diagnostics. This suggests that a more formal regional climate model intercomparison would be of value.

2. Changing water availability: Hydrological and socio-economic modelling

Results from hydrological models ranging from large-scale models applied globally to fine-scale, process-based models developed for particular catchments were presented.

Although climate models calculate hydrological parameters, such as run-off and actual evaporation, the usefulness of these estimates is limited by coarse spatial resolution, model systematic error and poor representation of hydrological processes. Running off-line models with inputs from the climate models gives the opportunity to adjust climate model bias and include improved representations of hydrological processes. For these reasons, all the projects represented at the meeting have chosen to use off-line hydrological models.

Several participants pointed out the difficulties of applying hydrological models developed for temperate regions to semi-arid regions like the Middle East. The hydrological modelling groups were tackling these problems by adapting existing models such as INCA, PITMAN and WASIM, carrying out field studies of hydrological processes, and developing or adapting truly process-based models (such as the TRAIN-ZIN model).

The hydrological models presented all performed well when forced with observed data. Preliminary indications are that the projected drying of the Middle East in 2070-2100 would have a highly detrimental effect on water availability – due to reduced runoff and groundwater recharge and increasing evaporative demands - for local populations. However, these results remain uncertain because of model errors and the difficulties of downscaling climate model data to appropriate spatial and temporal resolutions.

All the participants agreed that while most focus had been on climate inputs into hydrological models, other parameters such as the land-surface conditions and abstractions were crucial also. Furthermore, assessment of changing water availability requires estimates of population change and assumptions about water management policy. The projects represented were addressing these problems in various ways. GLOWA is currently developing future land-use and other socio-economic scenarios for inputting into their hydrological and water management models. The WLC hydrology sub-project is using a sensitivity study approach to land-use and population change, and will interpret the hydrological model outputs in the light of the conclusions from the development and archaeology sub-projects. SUSMAQ developed socio-economic models and a decision-making tool, and then ran their hydrological models as part of an integrative framework.

3. Integrating climate and hydrological models

Using climate model input into hydrological models has proved a major challenge for all the projects represented. Rainfall data from climate models have serious errors, to the extent that SUSMAQ was unable to use regional climate model future scenarios directly. Furthermore, climate models generally do not provide sufficient space and time resolution to be used directly. In order to overcome these limitations, the other projects have used a combination of statistical techniques and regional modelling to downscale climate model data and correct biases. It was emphasised that statistical methods must be capable of simulating extremes and variability in future climates, if they are to be useful. Both WLC and GLOWA plan further focus on statistical techniques - although through adaptation of existing research and tools rather than as new research efforts.

On a practical level, getting sufficient high quality daily and sub-daily data had proved a challenge to both WLC and GLOWA. A high-resolution gridded daily data set for the whole Mediterranean would be an asset to all the projects represented at the meeting. A meta-data archive of daily and sub-daily station and radar data would also be of great value, although it was recognised that gaining permissions from the local meteorological services to utilise this data would remain a challenge.

Workshop participants agreed that existing experience with both statistical and regional modelling approaches to downscaling (eg from GLOWA-JR, WLC, STARDEX and PRUDENCE) had not been synthesized in a form useful to other groups. MedClivar will be holding a round table at the EGU assembly in April and will discuss ways of addressing this, perhaps including setting up a working group.

Recommendations and outputs

- Inter-comparison of regional climate models for a large domain encompassing the whole Mediterranean and Middle East would be of value both to impacts modellers and climate modellers. This will be discussed in more detail at the MedClivar workshop “Climate Change Modeling for the Mediterranean region” to be held at the International Center for Theoretical Physics, Trieste, Italy 13-15/10/2008, A specific MedCLIVAR initiative will be discussed at the next MedCLIVAR SG meeting
- Collation of daily climate data, both as meta-data (in the case of proprietary station and radar data) and as a gridded daily dataset would be a great asset to the projects represented at the workshop. As a first step, workshop participants should consider contributing to the MedClivar meta-data archive. Guidelines on data specification and a common format should be discussed. This issue will be reported at the next MedCLIVAR SG.
- Guidelines on best practice for downscaling climate model data for input into hydrological models would be valuable for the projects represented. Ways to take this forward, perhaps by forming a working group, will be discussed at the EGU MedClivar roundtable session in April 2008.

A web page including the presentations from this meeting, this report and a Wiki of the modelling being carried out by the workshop participants will be set up

Final programme of the meeting

Monday 3rd March: Geosciences Building, Sorby Room 9-5.30pm

9.00	Workshop starts: Coffee	
9.30	Introduction and workshop goals	Black
Session 1: The Global Picture		
9.40	Intro, IPCC 4AR, the eastern Mediterranean in the global climate system, WLC survey of IPCC monthly data	Hoff, Black
10.00	Initial results from JMA 20km resolution GCM and GRiveT Global River flow model	Alpert
10.20	The hydrological cycle in global climate models	Arnell
10.40-11.10	Coffee	
Session 2: Regional modeling results for the Eastern Mediterranean		
11.10	Mediterranean regional climate modeling 1	Lionello
11.30	Regional climate modelling of the Middle East	Evans
11.50	Hadley Centre Precis regional modeling	Hassell
12.10	WLC climate modeling (HadRM3/PRECIS/statistical methods)	Black/Brayshaw
12.30 - 2.00	Lunch	
2.00	GLOWA 1: RegCM	Krichak/Alpert
2.20	GLOWA 2: MM5	Kunstmann
Session 3: Hydrological Impact Modelling		
2.40	WLC hydrological modeling (INCA/HySimm)	Wade
3.00	GLOWA 1: Climate change: Hydrological effects in the semi-arid and arid parts of the Jordan region	Menzel/Lange
3.30	Tea	
4.10	GLOWA 2: WASIM	Kunstmann
4.30	SUSMAQ	O'Connell
4.50	CIRCE	Hemming (climate) Lionello (extremes) Alpert (water) Hoff (ecosystems)
5.30	End of day	

Tuesday 4th March: Carrington Building, Room 201 9-3pm

Discussions on topics arising from the first day and on planned activities. Some of these discussions may take place in working groups. Areas for discussion will include:

Research gaps, bridging the gap between models and applications

The topics will be determined by issues arising during the first day, but may include:

- 1) What is the state-of-the-art for simulating present day and future Eastern Mediterranean climate using global models/regional models/statistical techniques? What impact models are being used and how well can they simulate the hydrology of the region?
- 2) What methods are currently being used to drive hydrological models with climate model data? How can information from climate/hydrological models be provided to policy makers?
- 3) What are the main research and knowledge gaps?

New Activities and Products

- 1) Review paper on hydrological impacts of climate change in the eastern Mediterranean, e.g.
 - currently used RCMs and hydrological impact models
 - model diagnostics (outputs), including information on extremes / drought and water stress
 - key results and uncertainties
- 2) New model intercomparison with standardized input data for deriving some estimate of uncertainty and range of plausible scenarios, also probabilistic forecasts?
- 3) Guidelines / report for water managers and policy makers, e.g. from ministries, authorities, ODA on the use of climate and hydrology products

Summary and Next Steps

Tasks, timeline, partners, additional funding for research activities/new product