IWMI is advancing use of high-res climate modeling for Middle East and North Africa's small basins

In a region battling worsening climate challenges, this groundbreaking, yet easily replicable climate forecasting model will transform local decision-making processes.

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By Louise Sarant

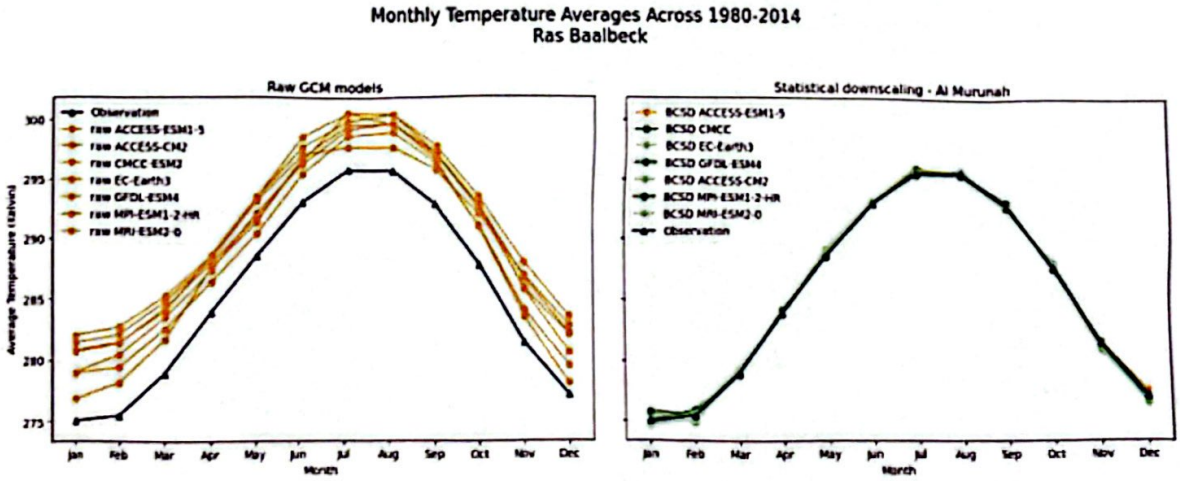
Wadi convergence sign in Ras Baalbek, Lebanon. Photo: Stephen Fragaszy / IWMI

Global climate models are currently the primary tools for predicting future impacts of global climate change. While effective in generating temperature,

precipitation, and evapotranspiration data for large-scale regions, they struggle to display changes for areas of 100 square kilometers or less. At this resolution, the rendered image is too blurry to lend itself to accurate prediction. Through Al Murunah, IWMI is addressing this issue by translating climate projections into finer resolutions, essential for local interpretation, planning and monitoring.

Karim Bergaoui, a meteorology and modeling expert at IWMI, spearheaded the development of this new tool. He designed a four-step methodology to project climate forecasts over four small target basins in MENA. After conducting a baseline assessment of the current climate in each location, he filled historical climate data gaps using climate reanalysis.

"For temperature and rainfall, the reanalysis data we used closely matched ground observations and is highly reliable," Bergaoui notes. The next phase involved selecting the most suitable Global Climate Models for statistical downscaling, culminating in the development of a Bias Correction and Statistical Disaggregation (BCSD) code.



The graph on the left shows that raw global climate models (in yellow) are inconsistent with ground observations (in black) for historical temperature data in Ras Baalbek, Lebanon. Al Murunah's BCSD climate downscaling, represented in green on the graph on the right, closely aligns with ground observations.

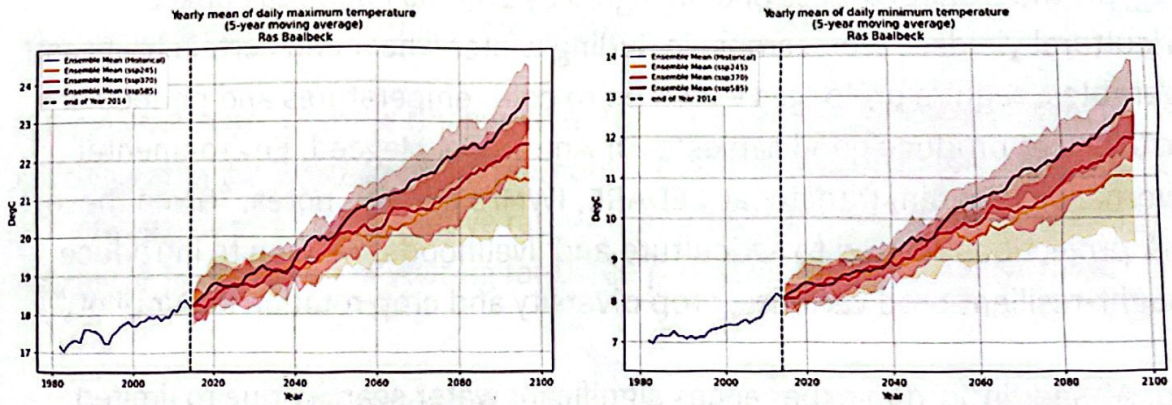
Because it can be replicated and built upon easily, the model will help policymakers, planners, agronomists, extension service agents and water management experts to make informed decisions concerning food and water security, livelihoods and infrastructure in distinct agroecological contexts.

The model is a crucial technical aspect of IWMI's work, which is striving to achieve climate resilience and water security in the MENA region through nature-based solutions, agricultural water management and a gender-transformative approach. Funded by the UK Foreign, Commonwealth and Development Office,

Al Murunah is led by IWMI and implemented with IUCN and local partners in Egypt, Jordan, Lebanon, and the Occupied Palestinian Territories (OPT). The four pilot locations are Wadi Al-Seer in Jordan, Wadi Al-Faria'a in the Occupied Palestinian Territories, Abu Al-Matamir in Egypt, and Ras Baalbek and Qaa in Lebanon.

The pilot site in the OPT, located in Wadi Al Faria'a, is, an area that grapples with wastewater pollution on downstream farms and the periodic drying up of the spring. Photo: Stephen Fragaszy / IWMI

Grim, sweltering hot predictions



By 2090, IWMI's climate downscaling model forecasts a sharp rise in the yearly mean of daily maximum temperature (left), accompanied by a rise in the yearly mean of daily minimum temperature (right) in Ras Baalbek, Lebanon.

Bergaoui and his team applied climate downscaling under various warming scenarios up to 2090, and their findings are stark: "All four basins will witness a surge in the intensity and frequency of droughts, interspersed with sporadic but extreme floods," he stated. The combination of rising temperatures and persistent drought conditions threatens agricultural productivity and water resources, with cold days expected to become rare.

Under the most extreme warming scenario – SSP5-8.5 – the model forecasts a significant rise in extremely hot days in Ras Baalbek and Abu Al-Matamir, with scorching days projected to increase from 14 annually to an alarming 140 by 2090. Cold nights, meanwhile, are predicted to nearly vanish in these two locations.

The project's experts recognize that these climate shifts impact men and women differently, an understanding that guided the intervention design. A comprehensive gender analysis conducted in 2024 across the four basins refined the team's knowledge of local gender-based labor divisions and decision-making dynamics.

Boosting resilience across pilot areas

Fatima Hayek, Technical Assistant at the Society for the Protection of Nature in Lebanon, a local partner of Al Murunah, explains that "Based on this data, we tailored strategies to combat rising temperatures, water scarcity, prolonged dry spells, and occasional floods with flood control structures, groundwater recharge, drought-resistant crops and water-efficient technologies."

In Egypt, the disappearance of cold nights by 2090 is bound to impact agricultural yields. Several crops, including winter wheat and certain fruits and vegetables, require prolonged exposure to cold temperatures and periods of dormancy to produce good harvests. Dr Amr Abdel Megeed, Environmental Governance Program Director at CEDARE, IWMI's partner, notes, "Given these stark projections related to agriculture and livelihoods, we plan to introduce drought-resilient crop varieties, crop diversity and crop rotation in our pilot."

Wadi Al-Seer in Jordan experiences significant water scarcity due to limited rainfall and groundwater depletion, already affecting water supplies for drinking

and irrigation. Under the warmest scenario, the model predicts a distinct warming trend of + 4.8 °C by 2090, a decline in precipitation, and a sharp reduction in cold days.

Due to its proximity to the capital, Amman, Wadi Al-Seer is a sought-after spot during the summer to cool down. Photo: Stephen Fragaszy / IWMI

In Wadi Al-Faria'a, shifting climatic conditions will heighten demand for already scarce water resources. Dr. Ayman Rabi, the Executive Director of Palestinian Hydrology Group and partner of Al Murunah explains that they are formulating strategies to safeguard the sustainability of land and water resources in the pilot design. "The awareness initiatives and training we plan to provide to water users' associations will play a crucial role in this context," he said.

Hakam Mandouri, Climate Change and Resilience Officer at IUCN ROWA, encapsulates the urgency of the moment: "If this data has taught us anything, it is that we need to be proactive rather than reactive—this means building resilience now instead of waiting for these problems to worsen over time."

Looking forward: Expanding impact and integration

The climate downscaling method introduced through Al Murunah represents a profound leap forward in local climate modeling. Dr. Mirja Michalscheck, the project's scaling lead from IWMI, emphasizes that the ambition extends beyond geographical reach: "Scaling the pilots is also about integrating our methods into the fabric of national policies and practices, thereby ensuring widespread and enduring impact."

Stephen Fragaszy, the project lead, adds, "Our goal is not just to apply climate change downscaling in our pilots, but to empower governments and communities to adopt resilient nature-based water solutions widely, ensuring sustainable and equitable benefits for all."

Research
Water, climate change and resilience

Funders & Partners
UK's Foreign, Commonwealth & Development Office (FCDO)

Locations
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climate crisis, hydrological and climate models