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The creation of future daily gridded datasets of precipitation and temperature with a spatial weather generator, Cyprus 2020-2050

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High-resolution gridded daily datasets are essential for natural resource management and the analysis of climate changes and their effects. This study aimed to create gridded datasets of daily precipitation and daily minimum and maximum temperature, for the future (2020-2050). The horizontal resolution of the developed datasets is 1 x 1 km^2, covering the area under control of the Republic of Cyprus (5.760 km^2).

The study is divided into two parts. The first consists of the evaluation of the performance of different interpolation techniques for daily rainfall and temperature data (1980-2010) for the creation of the gridded datasets. Rainfall data recorded at 145 stations and temperature data from 34 stations were used. For precipitation, inverse distance weighting (IDW) performs best for local events, while a combination of step-wise geographically weighted regression and IDW proves to be the best method for large scale events. For minimum and maximum temperature, a combination of step-wise linear multiple regression and thin plate splines is recognized as the best method.

Six Regional Climate Models (RCMs) for the A1B SRES emission scenario from the EU ENSEMBLE project database were selected as sources for future climate projections. The RCMs were evaluated for their capacity to simulate Cyprus climatology for the period 1980-2010. Data for the period 2020-2050 from the three best performing RCMs were downscaled, using the change factors approach, at the location of observational stations. Daily time series were created with a stochastic rainfall and temperature generator. The RainSim V3 software (Burton et al., 2008) was used to generate spatial-temporal coherent rainfall fields. The temperature generator was developed in R and modeled temperature as a weakly stationary process with the daily mean and standard deviation conditioned on the wet and dry state of the day (Richardson, 1981). Finally gridded datasets depicting projected future climate conditions were created with the identified best interpolation methods.

The difference between the input and simulated mean daily rainfall, averaged over all the stations, was 0.03 mm (2.2%), while the error related to the number of dry days was 2 (0.6%). For mean daily minimum temperature the error was 0.005 ºC (0.04%), while for maximum temperature it was 0.01 ºC (0.04%). Overall, the weather generators were found to be reliable instruments for the downscaling of precipitation and temperature.

The resulting datasets indicate a decrease of the mean annual rainfall over the study area between 5 and 70 mm (1-15%) for 2020-2050, relative to 1980-2010. Average annual minimum and maximum temperature over the Republic of Cyprus are projected to increase between 1.2 and 1.5 ºC. The dataset is currently used to compute agricultural production and water use indicators, as part of the AGWATER project (AEIFORIA/GEORGO/0311(BIE)/06), co-financed by the European Regional Development Fund and the Republic of Cyprus through the Research Promotion Foundation.

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