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EU PARTNERSHIP FOR LOCAL CLIMATE ACTION IN TÜRKİYE PROJECT

PERFORMANCES OF THE MODELS PREVIOUSLY USED FOR CLIMATE PROJECTIONS FOR TÜRKİYE

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EXECUTIVE SUMMARY

Understanding the Earth's climate system and its future projections requires the use of complex general circulation models known as Global Climate Models (GCMs). Based on physical principles, these models analyze the complex interactions between the atmosphere, ocean, land surface, and ice surface, providing valuable information about climate variability and change. However, the reliability of GCMs mostly depends on validation and evaluation against reference data.

Regional Climate Models (RCMs) provide improvements in representing regional climate processes compared to Global Climate Models (GCMs) by offering higher spatial resolutions. RCMs act as a bridge to fill the gap between large-scale and micro-scale processes in the modeling of climate processes, thereby enhancing the temporal and spatial characteristics of energy, water, and mass fluxes between the surface and the atmosphere. This allows for better resolution of medium-scale weather events and enables detailed representation of extreme events such as heavy precipitation, heatwaves, and storms.

This report aims to assess the performance of the models used in climate projections for Türkiye (HadGEM2-ES, MPI-ESM-MR, GFDL-ESM2M, and CNRM-CM5.1) and to examine the outputs of regional climate models generated with these models. In the report, the performance of GCMs is investigated in regional and global studies in the literature, while the outputs over Türkiye are evaluated using the “New Scenarios for Türkiye Climate Projections and Climate Change Report” (MGM, 2015), “The Impact of Climate Change on Water Resources Project - Final Report” (SYGM 2016), “The Strengthening Climate Change Adaptation Action in Turkey Project - Climate Projections Analysis and Evaluation Report” (UNDP Climate Adaptation Project, 2022), and Demircan et al. (2017).

When evaluating the performance of GCMs used in regional climate models over Türkiye, it is observed that the models show highly variable results for different study areas and different climate variables. However, the studies evaluated in this report show that the HadGEM2-ES model is more successful globally for key climate variables such as temperature and precipitation compared to other models. The study conducted by Bagcaci et al. (2021) over Türkiye is also consistent with these results.

When evaluating the outputs of regional climate models, it is observed that the HadGEM2-ES and MPI-ESM-MR models stand out with their reference period performances in the reports. According to the analyses conducted within the scope of projected climate changes in Türkiye, significant increases in average temperatures are expected according to the RCP 4.5 and RCP 8.5 scenarios. For instance, annual average temperature increases are expected to be in the range of 1°C to 2°C in the period 2016-2040, 1.5°C to 4°C in the period 2041-2070, and 1.5°C to 5°C in the period 2071-2099. Particularly in the summer months, this increase is projected to reach 6°C by the end of the century. The examinations reveal that temperature increases show low variability across Türkiye and occur at similar levels in different regions.

When evaluating precipitation outputs, it is observed that there is high variability both among models and regions for the RCP8.5 scenario. While regional climate models project seasonal and annual increases in precipitation in the Black Sea and Eastern Anatolia regions, a decreasing trend in



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precipitation is observed across the country. The highest decreases are expected in the Mediterranean Region. When evaluating regional averages projected by the end of the century under the RCP8.5 scenario, it is expected that precipitation changes in the Marmara Region will range from 3.80% to -22.50%, in the Black Sea Region from 7.60% to -14.60%. In the Central Anatolia Region, all models point to decreases ranging from -6.40% to -24.30%. In the Aegean Region, precipitation is expected to decrease between -5.80% and -31.90%, and in the Mediterranean Region between -10.80% and -37.20%. In the Eastern Anatolia Region, changes are expected to range from 0.30% to -16.40%, and in the Southeastern Anatolia Region from -7.90% to -23.20%.

The Weather Research and Forecasting (WRF) model, also utilized in the Coordinated Regional Climate Downscaling Experiment (CORDEX) by global partnerships, was run over Türkiye at a 4 km resolution using an ensemble approach with CMIP6 climate models. The model was driven by the SSP58.5 emission scenario for the period 2080-2100 using the pseudo-global warming (PGW) method. Additionally, ECMWF ERA5 reanalysis data was downscaled to 4 km resolution to create reference period data for 1995-2014, against which future climate changes under SSP58.5 were calculated. The high-resolution reference and future climate simulations obtained with WRF provided more detailed spatiotemporal distributions of climate change and variability over the region, contributing to a better understanding of extreme weather events triggered by topographic features.

According to the projected climate changes in Türkiye, temperatures are expected to increase, and precipitation is generally expected to decrease, indicating a warmer and drier climate across Türkiye.