Geophysical Research Abstracts,
Vol. 10, EGU2008-A-12004, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-12004
EGU General Assembly 2008

Assessment of global warming at basin scale

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The effects of climate change on various environmental variables have been widely observed in many regions around the world. Among these variables, precipitation and temperature are the two meteorological processes that are most likely to be impacted by a possible climate change. Changes in precipitation and/or temperature, in turn, cause a relative variation in runoff as they affect the rainfall-runoff transformation process in a hydrologic basin.

Dokuz Eylul University Water Resources Management Research Center (DEU SUMER) has been assigned the task of carrying out studies on "Modeling for Climate Change Effects in the Gediz and Buyuk Menderes River Basins under the UNDP-GEF Project: Enabling Activities for the Preparation of Turkey's Initial National Communication to the UNFCCC". The purpose of the project was defined as "provision of preliminary assessments regarding the possible impacts of global climate change on water resources", as hydrologic systems and water resources are seriously prone to the possible effects of global climate change. Gediz and Buyuk Menderes River Basins are used in the project as test cases to investigate the likely consequences of a possible global climate change at watershed scale. Each basin is analyzed by dividing it into sub-basins for more accurate watershed modeling results.

The project is designed to focus on prediction of changes in hydrologic processes, i.e., evapotranspiration and runoff, which result from estimated changes in precipitation and temperature. The steps of this analysis cover: (a) generation of climate change scenarios to estimate changes in precipitation and temperature for every case study basin; (b) application of these changes to every basin through a downscaling procedure and

a basin water balance model to estimate changes in output variables of evapotranspiration and runoff; (c) testing the sensitivity of runoff to changes in precipitation and temperature.

To analyze the effects of climate change on precipitation and temperature, future projections of climate change are evaluated by GCMs, considering different emission scenarios over the test basins. According to the results obtained through the two basic scenarios (B2-MESSAGE and A2-ASF), it can be concluded that an increase of 1.2 0C in mean annual temperature and a decrease of 5% in mean annual precipitation may be expected for the year 2030. In the year 2050, the mean annual temperature increases around 20C, and the mean annual precipitation decreases around 10%. On the other hand, due to the assumptions underlying the applied GCMs, the range of estimations for 2100 has a steeper deviation in comparison with those of 2030 and 2050; thus, any interpretation on the estimated values for this year is not preferable. In the second part of the study, model estimations via GCMs are downscaled to the scale of test basins. The results have shown increases in monthly temperatures, which indicate that warmer winters and hotter summers are expected. Although model outcomes indicate decreases in precipitation in all months, the sharp decreases in spring and autumn months are significantly important, because the summers in the region are already dry.

The impact of climate change on water resources in the test basins are further evaluated, using a parametric water budget model. Parameters of the model are calibrated, using observed monthly runoff time series at selected streamgaging stations in the region. Simulation results have shown that nearly 20% of the surface waters in the studied basins will be reduced by the year 2030. By the years 2050 and 2100, this percentage will increase up to 35% and more than 50%, respectively. The decreasing surface water potential of the basins will cause serious water stress problems among water users, mainly being agricultural, domestic and industrial water users. Furthermore, the increasing potential crop evapotranspiration (up to 10% and 54% for the years 2030 and 2100, respectively) will increase the irrigation water demand enormously. It may be stated that the effects of an expected climate change at regional scale in each basin would be to enhance the already existing water scarcity and water allocation problems. This, in turn, will worsen the current conflicts among water users, which have already started due to the high anthropogenic activities in both basins.