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Increasing Resolution of Temperature Maps by Using Geographic Information Systems and Topography Information

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Meteorological measurements cannot be done in every part of country both due to lack of appropriate topographical condition and high costs of measurement. In countries, with a large and mountainous geography, observation stations often cannot be covered all country. For this reason, different models can be used to detection of changes in temperatures depending on the topography and to derive temperature data. Geographical Information Systems (GIS) used to increase the resolution of the climate model output and meteorological measurements maps, particularly has been a tool since the 2000's. There are some model studies which are made by Geo-statistical and Geographical Weighted Regression (GWR) tools of GIS programs, and using temperature, height, slope and aspect data and the maps were produced. However, these models, although statistically correct, does not reflect the distribution of the temperature depending on topography as climatological perspective.

In this study, it is intended to predict temperature data for the areas which has not got temperature measurement and for this purpose relationship between temperature and elevation data are used. Lapse Rate is defined as the change of temperature with height. Lapse Rate has been changed according to the amount of moisture in air with a rate between 0.5 ° C to 1.0 ° C. It is expected to this predicted data can be meet demands of sectors for their analysis and planning.

In this study, mean annual temperature values measured at 228 meteorological stations of Turkish State Meteorological Service over Turkey are used for visualization and interpolation to reveal spatial distribution of mean annual temperature values. Mean annual temperatures have been obtained from period of 1971-2000 long term temperature data sets. Elevation data have been obtained from digital elevation models (DEM) with the help of GIS. There have been studied with temperature data of in and around Uludağ stations to determine value of lapse rate. Lapse rate have been found average 5°CKm-1 with regression coefficient (R2) 0.97. Grid points with dimension of 1x1Km, have been formed by HAWHTS TOOL in GIS which are covered Turkey. Temperature data from 78 stations for first group and 103 stations for second group have been selected from 228 meteorological stations and used during the study. 150 stations for first group and 125 stations for second group were retained for validation. In the study, temperature data sets, the heights of the stations and rate of 0.5°C Lapse Rate were used to reduce station's temperature to sea level. Then reduced temperatures were distributed to sea level plane by using the Inverse Distance Weighted Interpolation Technique "ArcGIS / Spatial Analyst Tool IDW". Temperatures were taken to the grid points and then height of grid points and Lapse Rate value were used to reduce these temperature values to grid point's height. Grid's temperatures were distributed by Inverse Distance Interpolation Weighted technique, after that the temperatures values were extracted to control stations, the temperatures of observation and extracted temperatures of these stations were compared.

For observations and predicted temperature values of first group (150 stations); maximum, minimum and mean errors are respectively, 2.89, -3.20 and -0.14°C and root-mean-square-error (RMSE) is 1,025 and regression coefficient (R2) is 0.93. For observations and predicted temperature values of second group (125 stations); maximum, minimum and mean errors are respectively, 2.64, -3.17 and -0.18°C and root-mean-square-error (RMSE) is 0,868 and regression coefficient (R2) is 0.94.

In addition, the method was applied to ERA40 re-analysis data set of the European Center for Medium-

Term Weather Forecasts (ECMWF) for method validation. The temperature values of ERA40 were prepared for same data time interval with 1971-2000 stations temperature data set. ERA40's temperature and height values were reduced to sea level. Then reduced temperatures were distributed to sea level plane by using the IDW. ERA40's temperatures were distributed by IDW, after that the temperatures values were extracted to stations and reduced to their height, the temperatures of observation and extracted temperatures of these stations were compared. For observations and extracted temperature values of stations; maximum, minimum and mean errors are respectively, 3.1, -3.8 and -0.3°C and root-mean-square-error (RMSE) is 1.114 and regression coefficient (R2) is 0.94.

Predicted temperature values in study, were compared with mean temperature data from the World Climate Data (WorldClim) which were produced by ANUSPLIN model for data verification. For predicted and WorldClim temperature values; maximum, minimum and mean errors are respectively, 2.5, -1.9 and 0.5°C and root-mean-square-error (RMSE) is 0.793 and regression coefficient (R2) is 0.97.

KEY WORDS: Temperature, Climate, Lapse Rate, Height, Geographical Information Systems (GIS)