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# Estimation of Rainfall Distribution Map of Turkey By IDW and Kriging Interpolation Method

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***ABSTRACT:*** *In this study Inverse Distance Weighting (IDW) and Kriging Interpolation Method were modeling in order to estimate the long term rainfall of study area. ArcGIS software components which were used to generate sets of digital maps for selected study area, the Turkey, were spatial analysis–Hydrology tools Arc-Map, Arc-Catalog, and Arc Hydro extension tools. The precipitation data used in the study is taken from Hydro meteorological office that branch of the Turkey General Directorate of Meteorology (MGM). The data consist of mean monthly precipitation values measured at 260 meteorological stations between 1970 and 2006. The results showed that the best model to generate rain properties map was Ordinary Kriging with spherical and models. The reason for this is the weight difference in the Kriging method. Mainly in this study; it is aimed to estimate the lack of data belonging to station points and to obtain the most correct data belonging to that station. By comparing two methods, it is tried to determine the method that gives more accurate result when missing data is encountered.*

***KEYWORDS:****Water need, inverse distance weighting (IDW), ordinary kriging (OK)*

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## I. INTRODUCTION

Water, the common symbol for humanity, valued and respected in all religions and cultures, 9 billion by 2050. Consequently, as increasing in world population, also demands for water (fresh water) have alsoincreasedrapidly [1]. It is a vital source for the continuation of the nations. Day by day, declining water resources are unable to meet the needs of the growing world population. Many studies are currently being conducted to protect water resources. These studies can be advanced approaches as well as on-site applications (simulation). Geographic Information Systems (GIS) is one of the common means of approach. Geographical Information Systems have been traditionally used to accomplish the management functionalities in hydrologicapplications [2;3]. ArcGIS software components which were used in this study to generate sets of digital maps for selected study area, the Turkey, were spatial analysis–Hydrology tools Arc-Map, Arc-Catalog, and Arc Hydro extension tools. Environmental System Research Institute is one of the institute using GIS. ArcGIS, Arc Map, IDRISI are some of the software that using and developing from ESRI. The reason of using GIS technology in hydrological models is because it allows the spatial information to be displaced in integrative ways that are readily comprehensible and visual. Nowadays the applicability of GIS can be found in many fields of study mainly the town planners, engineers, architects and scientists use GIS for measuring, mapping, monitoring and modeling environmental features and process such as studies on environmental impact or protection, emergency management, transportation planning, physical planning, land use planning or zoning, non-point source pollutants, monitoring hazardous waste sites etc. Thus, GIS is continuous process of data acquisition, pre-processing, data management, manipulation and analysis and productgeneration [4;5;6]. Arc-Map is the central application in ArcGIS Desktop. It is the GIS application used for all map-based tasks, including cartography, map analysis, and editing. In this application, you work with maps. Maps have a page layout containing a geographic window, or a data frame, with a series of layers, legends, scale bars, North arrows, and other elements. Arc Map offers different ways to view a map's geographic data and layout views in which you can perform a broad range of advanced GIS tasks (ESRI, 2009). In this study Inverse Distance Weighting (IDW) and Kriging Interpolation Method were modeling in order to estimate the long term rainfall of

study area and its close region. The aim of this study is to compare Inverse Distance Weighted (IDW) and Ordinary Kriging (OK) methods based on error estimation in rainfall distribution of Turkey map.

## II. STUDY AREA & DATA

The geographical coordinates of Turkey located at 36 42 North latitude and 26 45 East longitude. The area of the country is 783,562 km. The Republic of Turkey is located in an area very close to each other with Asia and Europe. On the other hand, East Georgia, Armenia and Iran, Bulgaria and Greece, Syria and Iraq are some of the countries have their own border with Turkey. The country is surrounded by three seas, the Black Sea in the North, the Mediterranean in the South and the Aegean in the West. According to the report (TUIK) Turkey's total population in 2017 was 80,810,525 people increased by 995.654 people compared to the previous year. Turkey is located on sub-tropical (hot middle generation) region. For this reason, the country generally has a mild climate. At the same time, various types of climates can be seen in different regions of the country with the influence of the seas and the forms of the earth. Depending on the type of Turkey's rainfall and climate, Black Sea, Mediterranean and Terrestrial climates are seen different regions of the country. The precipitation data used in the study is taken from Hydro meteorological office that branch of the Turkey General Directorate of Meteorology (MGM). The data consist of mean monthly precipitation values measured at 260 meteorological stations between 1970 and 2015. Figure 1 shows the locations of the stations and the long-term average annual precipitation.

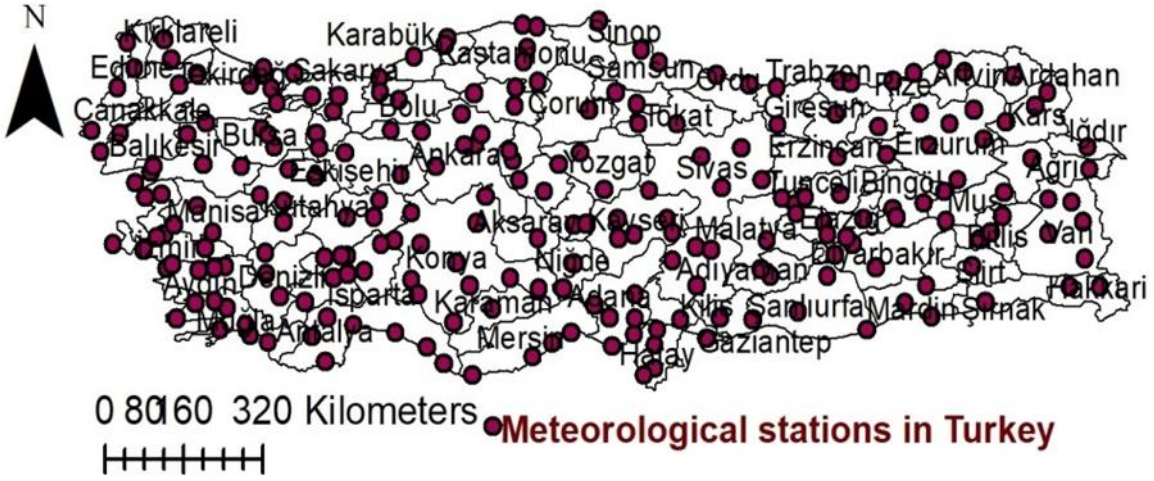


**Figure 1Meteorologicalstationsforwhich precipitationdata areavailablefortheperiodfrom 2010-2015**

## III. SPATIALPREDICTIONMETHODS

Inverse Distance Weighting (IDW) and Kriging Interpolation Method were modeling in this study in order to estimate the long term rainfall of study area and its close region. The aim of this step is to compare Inverse Distance Weighted (IDW) and Ordinary Kriging (OK) methods based on error estimation in rainfall distribution. ArcGIS software components which were used in this study to generate sets of digital maps for selected study area.

### 3.1 Inverse Distance Weighting

IDW is one of the most common techniques for interpolation of scatter points. IDW has a fundamental assumption that the interpolating surface should be influenced most by the nearby points and less by the more distant points. The interpolating surface is a weighted average of the scatter points, and the weight assigned to each scatter point diminishes as the distance from the interpolation point to the scatter point increases. The values to unknown points are calculated with a weighted average of the values available at theknownpoints [7].

### 3.2 Kriging Interpolation Method

The Kriging method has been used for Geostatistical interpolation and has been proved to be sufficiently huge for estimating values at unsampled locations based on thesampleddata [8]. Kriging is a group of geostatistical methods for interpolation of the different regional variables' values at an unobserved location from observations of its value at nearby locations, which consist of OK, universal kriging, indicator kriging, co-kriging, andothers [9]. The ordinary Kriging method is one of the Kriging methods, which plays an important role in interpolation and mapping precipitation data in any region. OK plays a special role because it is

compatible with a stationary model, only involves the variogram, and is in fact the form of kriging that is most often used. The most popular and efficiency method types in Kriging is Ordinary Kriging. Ordinary Kriging was utilized in this study.

## IV. COMPARISON OF INVERSEDISTANCEWEIGHTING (IDW) ANDKRIGINGINTERPOLATION

Figure 2 relates to the distribution of annual precipitation by Inverse Distance Weighted (IDW). Figure 3 illustrates the distribution of annual precipitation by Ordinary Kriging Interpolation (OK). The map generated by ArcGIS program for whole meteorological stations located in Turkey. All stations data is for five years (2010-2015) annually. The pixel value counted from the map for study area region and according to IDW, estimated rainfall by ArcGIS is about 526mm. On the other hand Ordinary Kriging showed that estimated rainfall is approximately 542mm. The real parameter is 537 mm annually. Also standard deviation is 142,670 at Ordinary Kriging and 213,180 at IDW method.

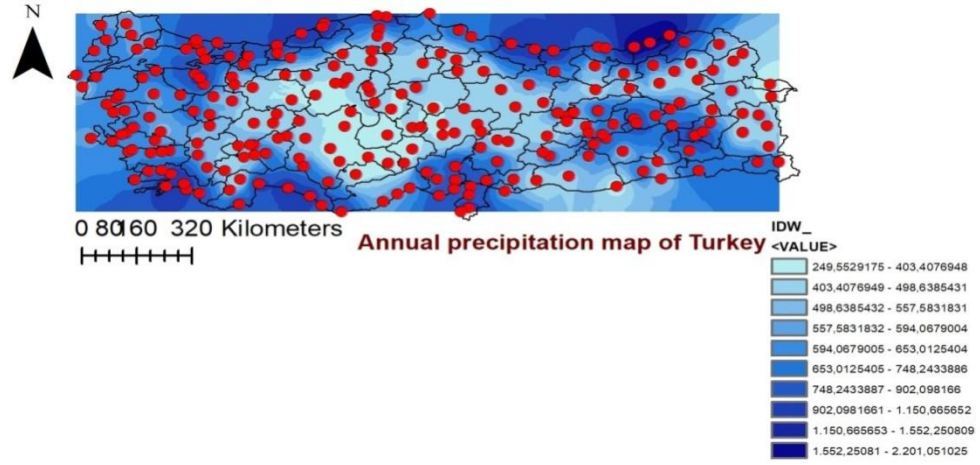


**Figure 2 Annual Precipitation Map of Turkey According to IDW Method**

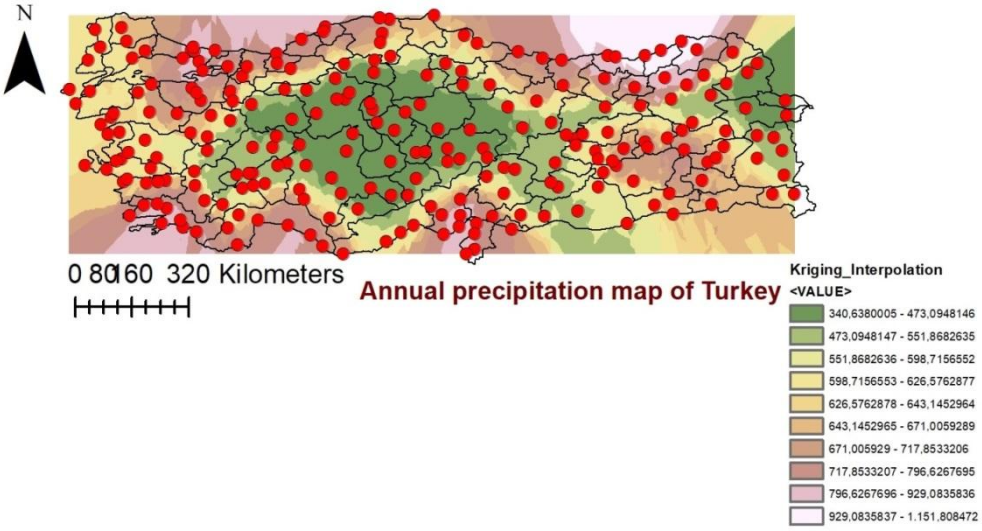


**Figure 3 Annual Distribution of Precipitation by OK (Ordinary Kriging)**

## V. CONCLUSION

In this study a comparison of the prediction performances of OK (Ordinary Kriging) and IDW was performed. The spatial distribution of average annual precipitation over Turkey was used as a test case. Mean monthly precipitation values from 2010 to 2015 were measured from 260 meteorological stations distributed regularly over Turkey. Long term averages were computed from these monthly values by averaging over the five years. In Turkey, need for drinking and household water increases day by day in parallel with the increasing population, civic improvement and development in the area of industry. In addition to the available household and drinking water resources, more water reserves are needed. The rainfall map was generated by ArcGIS program for whole meteorological stations located in Turkey. The results showed that the best model to generate

rain properties map was Ordinary Kriging with spherical and models. The reason for this is the weight difference in the Kriging method. It is not only in the distance. Furthermore like real parameters, estimated values show the driest month as August and the wettest one is December. The Kriging method has been shown to make the best possible estimate in the field interpolation. It is emphasized that after the Kriging method, the second best estimate is obtained from the IDW method results. Mainly in this study; it is aimed to estimate the lack of data belonging to station points and to obtain the most correct data belonging to that station. By comparing two methods, it is tried to determine the method that gives more accurate result when missing data is encountered.

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