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COMPARISONS OF ANNUAL MEANPRECIPITATION GRIDDED AND STATION DATA: AN EXAMPLE FROM ISTANBUL, TURKEY

Yıllık Ortalama Gridlenmiş Yağış Verisi ve İstasyon Yağış Verisinin Karşılaştırılması, İstanbul Örneği [1]

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ABSTRACT

Gridded precipitation data is valuable for applied climatological research. Gridded dataset are useful because they provide more spatial representation. In comparison to gridded data, station (point) dataset are irregularly distributed throughout space and frequently have periods of missing data. In this study, annual mean precipitation gridded and station dataset are compared using meteorological stations in Istanbul; Florya, Bahçeköy, Kumköy, Kireçburnu, Göztepe, Kandilli, Kartal and Şile between the 1970 – 2007 period. We obtained annual precipitation gridded data from station data with linear interpolation method using Matlab programme tools. The main objective of this study is to demonstrate the differences between the two dataset and to clarify the significance of their different aspects for research in applied climatology.

Keywords: *Annual mean precipitation, Gridded data, Station data, Istanbul, Turkey*

ÖZET

Gridlenmiş yağış verisi uygulamalı iklim çalışmaları için oldukça önemlidir.

Gridlenmiş veri setleri mekansal dağılımı gösterdiği için kullanışlıdır. İstasyon verileri gridlenmiş verilerle karşılaştırdığımızda, mekanda düzensiz bir dağılış göstermektedirler ve eksik, kayıp veri içermektedirler. Bu çalışmada 1970 – 2007döneminde İistanbul'da bulunan meteoroloji istasyonlarından Florya, Bahçeköy, Kumköy, Kireçburnu, Göztepe, Kandilli, Kartal and Şile

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meteoroloji istasyonlarının yıllık ortalama gridlenmiş ve istasyon yağış verileri karşılaştırılmıştır. İstasyon verisinden grid veri elde etmek amacıyla Matlab programında griddata fonksiyonu kullanılarak istasyon yağış verisine lineer interpolasyon yöntemi uygulanmıştır. Bu çalışmanın temel amacı uygulamalı iklim çalışmaları için iki veri seti arasındaki farkları göstermek ve bu farkların önemini açıklamaktır.

Anahtar Kelimeler: *Yıllık ortalama yağış, gridlenmiş veri, istasyon verisi, İstanbul, Türkiye.*

1. INTRODUCTION

Gridded data are obtained by interpolated of station data (Hewitson ve Crane, 2005). Gridded data form consist of regular three-dimensional matrices as value of latitude, longitude and data. Gridded precipitation dataset are useful for many types of climate research, including the analysis of climatic change and variability. Gridded dataset are developed and used because they provide a more spatial representation of precipitation and also provide important information on the dynamics of land surface processes (Ustaoğlu, 2012a; Hong et al. 2007; Zhang et al. 2004). In comparison, meteorological station dataset typically are irregularly distributed throughout space and frequently have periods of missing data. In addition, high elevations, oceans and areas with low population are generally not well represented in precipitation dataset composed of station networks (Ensor and Robeson, 2008). The demand for spatial data set in digital form has risen dramatically in recent years according to development of computer technologies (Daly et al., 2002, İkiel and Ustaoğlu, 2011; Ustaoğlu 2012b; İkiel et al., 2012; Kılıç and İkiel, 2012). Methods for mapping climate from point data fall into two main categories: human- expert and statistical. Human-expert methods use human experience, expertise, and knowledge acquisition capabilities. They involve the manual preparation of climate often based on topographic analyses such as topographic position, slope, exposure, elevation. These maps were widely accepted as reflecting the best understanding of spatial climate distribution at the time (Daly et al., 2002). There are a lot of studies about daily, monthly and annual analysis of spatial distribution of precipitation applying a variety of statistical methods and using station data in Turkey (Türkeş, 1996; Çiçek, 2001; Kadıoğlu, 2000; Türkeş and Erlat, 2003; Tatlı et al., 2004; Ünal et al.,

2003; Koç and İrdem, 2005; Türkeş et al., 2009; Ünal et al., 2012). In recent years, spatial distribution of precipitation has examined using the gridded data specifically (Önol and Semazzi, 2009; Bozkurt and Şen, 2011; Ustaoğlu, 2012). Studies using data grid is extremely widespread in the world (Silva et al. 2007; Ensor and Robeson, 2008; Serbin and Kucharik, 2009, Jurkovi´c and Pasari´c, 2012).

The study area, city of Istanbul, is located at 41.01°N, 28.58°E. The Bosporus, a 30-km strait that connects the Black Sea with the Sea of Marmara, is considered to be the boundary between Europe and Asia. The distribution of the settlement is in southern direction. The North of the city toward the Black Sea is mostly covered by forests. The most populated parts of the city are located in the south, along the Sea of Marmara. The climate of Istanbul is the Marmara Type between the Mediterranean climate and Black Sea Climate (Koçman, 1993). According to Rainfall Regime Regions of Turkey (İkiel, 2005), Black Sea Rainfall Regime is seen in İstanbul. Istanbul, based on station averages, has average air temperatures of 28°C in summer and 8°C in winter. Average annual total precipitation is around 800 mm. Most of the precipitation falls in winter. Summer months have the lowest rainfall amounts (Ezber et al., 2007).

This paper aims to give new methodology on "geospatial climatology". Our objective is to demonstrate the differences between the precipitation of station data and precipitation of gridded data. To understand the characteristics and limitations of annual gridded and station dataset, a comparison of a gridded with station (point) observations is performed.

2. DATA

2.1. Station precipitation data

We used data of eight meteorological stations, named as Florya, Bahçeköy, Kumköy, Kireçburnu, Göztepe, Kandilli, Kartal and Şile, in this study (Figure 1). Meteorological data used in the statistical analysis of this study have been obtained from the Turkish State Meteorological Service. The dataset contains time series of 'annual precipitation' for the stations located in Istanbul. The elevations of the stations are within 150 m from the mean sea level. We used 1970–2007 as the period for the

analysis. The term 'annual precipitation' refers to the average of annual precipitation in the period of record (38 years) in this study.

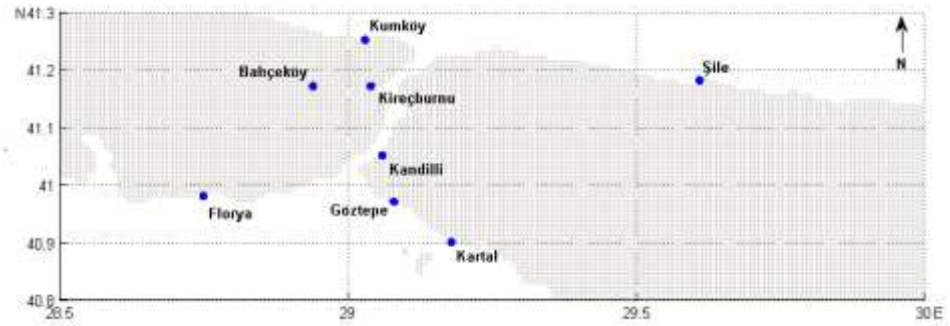

Figure 1. *The location map of the meteorological stations of Istanbul*

2.2 Gridded precipitation data

Annual precipitation station data is used to determine gridded dataset of precipitation in the selected area. Linear interpolation method implemented on the station data via *griddata* function of MATLAB to get expanded dataset. 120 x 120 resolution applied per 1 x 1 latitude longitude areas. 60 x 180 data grids constructed for the selected study area.

2.3. DEM data

Gtopo 30 was used as digital elevation model (DEM) in this study. Gtopo 30 data is digital elevation model which is sampled the earth 30sec intervals (~ 1 km resolution) (USGS, 2012) (Figure 2).

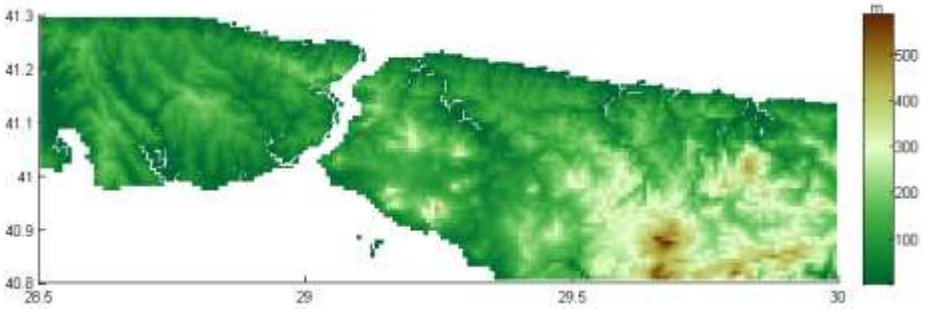

Figure 2. *The elevation map of Istanbul*

3. METHODOLOGY

We used linear interpolation method which is inside the MATLAB program griddata function in this study. After preparation of two dataset, we analyzed the data as described below (Figure 3):

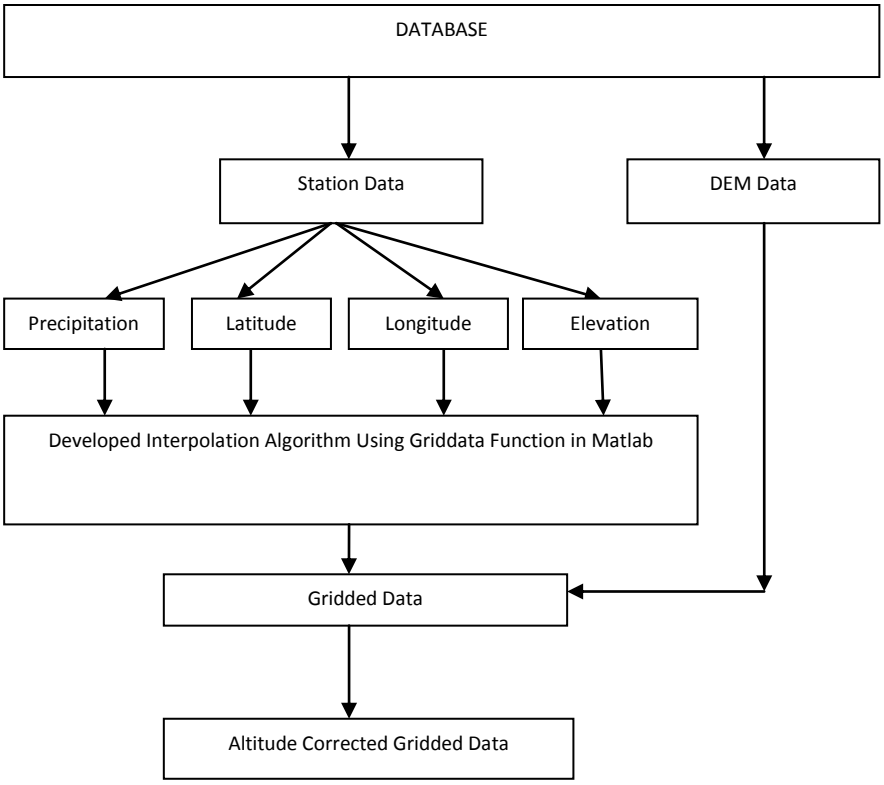

Figure 3: *Work flow chart of the study.*

a.) For station data; we obtained long term annual mean precipitation for each station using arithmetic mean.

b.) For gridded data; we established grid coordinates of target locations for interpolation.

c.) We have obtained values corresponding to grids using linear interpolation method, after that, we obtained average value for grids representing stations' coordinates.

d.) Data comparisons were done based on data differences (station- gridded).

e.) The distributions of both dataset over the terrain were depicted.

Altitude factor correction has been applied to the obtained precipitation values of meteorological stations of which resolution has been increased. To do this, Gtopo30 altitude has been determined from the station altitude data of which resolution has been increased and the precipitation data has been multiplied with -54 and they have been added to the station precipitation data.

$Y_h = Y_{o+} 54\ h$

In this equation, Yo means the annual rainfall of the reference station; Yh means the annual rainfall of the searched station; h means the altitude difference between the two stations in hectometer (Erinç, 1996).

4. RESULTS AND DISCUSSION

When we looked at the station data analysis results, total precipitations amounts of station on the European side are greater than Asia side (Maximum, Bahçeköy 1166.6 mm; Minimum Florya 635.0 mm). However, precipitation in the north is higher than the south of Bosporus (Kumköy, 817.7 mm; Kartal 642.3 mm) (Figure 4). This direction is coherent to the distribution of the density of settlement. We have also obtained the same results from gridded data (Figure 5). The significant result of this study is long-term totals (averages) are shown to be similar and little difference (max. ±20 mm) in both station and gridded dataset (Figures 6-7). Topography is an important factor on the result. Because, the elevation of the study area is not so high and the topography is not so complex. When we analysed the spatial distribution of mean annual precipitation of North – eastern Anatolia, we obtained some significant differences between gridded and station data in a number of stations (Ustaoğlu, 2012a). If daily or monthly data are analysed, it will be possible to obtain more detailed results.

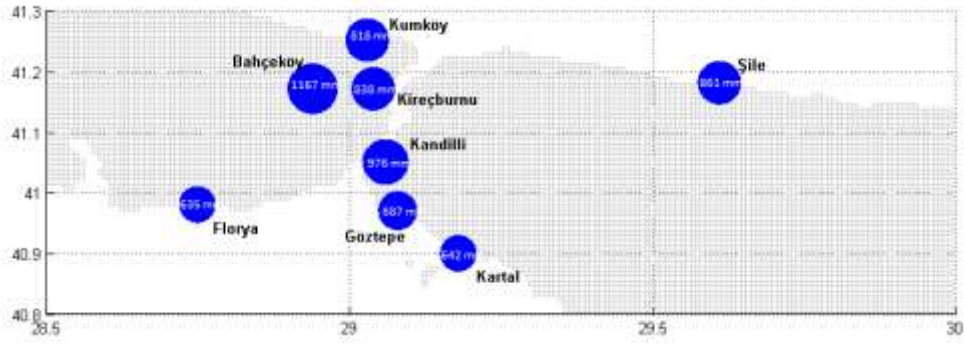

Figure 4. *Distribution of the station precipitation data of Istanbul*

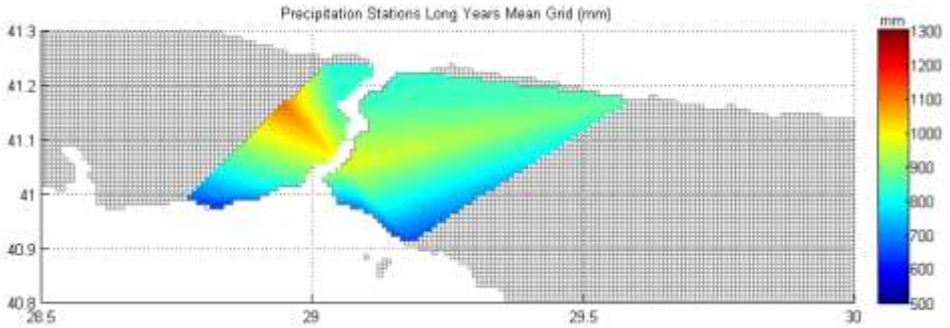

Figure 5. *Distribution of the gridded precipitation data of Istanbul*

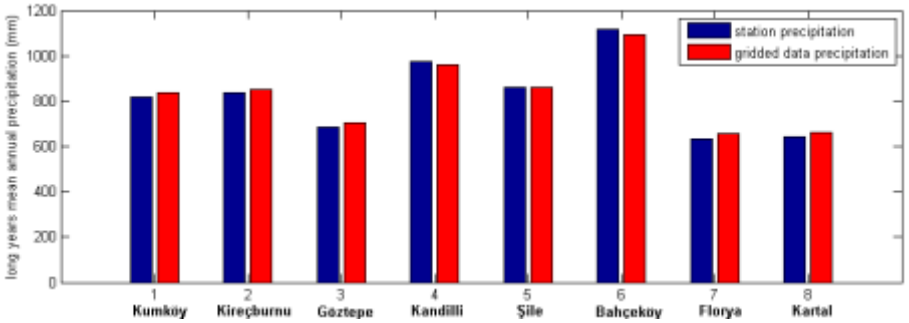

Figure 6. *Long years mean annual precipitation of Istanbul*

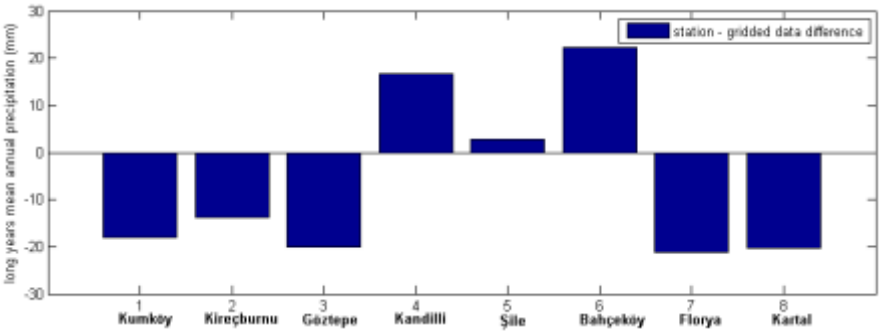

Figure 7. *Difference between gridded and station data of Istanbul*

5. CONCLUSIONS

We have made the comparison of station and gridded data of Istanbul (1970-2007) in this study. Interpolated gridded annual precipitation dataset show a close relationship with station annual precipitation dataset according to the gridded precipitation map and statistical results of station data. Topography is an important factor on the result. Because, the elevation of the study area is not so high and the topography is not so complex. There is a little difference between two dataset (max. 20 mm). But gridded data has some advantages with comparison to station data. Spatial distribution map of gridded data gives a better illustration of precipitation than station data map prepared by using experimental methods. This gridded dataset provides a high-resolution alternative to coarser-scale data for regional-scale analyses such as risk assessment and input to ecological process models and these dataset can be useful tools for a wide range of studies in applied climatology.

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