Interaction of Spatial and Temporal Integration of Climate Characteristics by GIS

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Key words: GIS, Climate, Meteorology, Statistics, Temperature

SUMMARY

Climate is the average weather conditions experienced in a particular place over a long period on the earth. Various parameters are composed of the climate. The basic climatic parameters are temperature, pressure, wind rainfall and humidity. These elements display seasonal and annual variation somewhat different from normally expected climatic conditions. In order to generate the climate maps, meteorological regime, geographical location and its characteristics are significant parameters as well as statistical approaches are adopted in recent years. Geographic Information Systems (GIS) provide integration between meteorological data and spatial data, as well as analysis and visualisation environment. This study aims to import meteorological data, coming from 8 stations (Bahcekoy, Florya, Goztepe, Kandilli, Kartal, Kirecburnu, Kumkoy, Sile) located in Istanbul, Turkey, into GIS environment, to create distribution maps using interpolation techniques, and to examine relationship to each other and between spatial information. The meteorological data were obtained from both General Directorate of Meteorology and Meteorology Laboratory of Kandilli Observatory and Earthquake Research Institute at Bogazici University. In this study, the meteorological parameters in Istanbul such as relative humidity, cumulative precipitation, monthly mean temperature, monthly maximum temperature, and monthly minimum temperature for the period of 1976-2016 are investigated. The obtained data are analyzed for that period in order to determine the spatial distribution of climatic data. In this process, inverse distance weighted interpolation algorithm is used. Furthermore, total annual precipitation changes are represented in the long run.

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1. INTRODUCTION

Climate is the average weather conditions experienced in a particular place over a long period on the earth. The weather condition is the atmospheric condition in a short period of time. The climate and weather play a huge role among the people's lives and activities. Many elements such as; vegetations, rivers, agriculture, sheltering, economy are under the climate control. Various parameters are composed of the climate. The basic climatic parameters are temperature, pressure, wind rainfall and humidity. Climatic elements can be affected each others and also they can be affected the atmosphere lonely and together. Climatic elements provide weather events in the short run and wide variety of climate types throughout the world in the long run. Climatology analyzes these meteorological parameters that constitute the climate. In climatic studies, a minimum 30 year data series is needed. A 30 year data series is called "normal" since normal climate is usually defined for three decades. Global climate change refers to changes in the mean surface temperature of the Earth as well as changes in the climate as a result of the rapid increase in greenhouse gas emissions released by the atmosphere through human activities such as the use of fossil fuels, land use changes, industrial processes etc. as a result of strengthening the natural greenhouse effect. Some of those are the scarce water resources, floods, droughts, hurricanes, heat waves and changes in food production.

Geographic Information Systems (GIS) provide integration between meteorological data and spatial data, as well as analysis and visualisation environment. By means of GIS, it is possible to determine the spatial distribution of the meteorological parameters. Creating distribution maps of climatic parameters by using interpolation techniques contributes to many fields such as agriculture, ecology, hydrology, erosion and transportation. These maps can be created by deterministic and stochastic interpolation techniques. Since stochastic methods involve both mathematical and statistical functions, they are used in many similar studies today. Since stochastic methods involve both mathematical and statistical functions, they are used in many similar studies today. Statistical analysis gives information whether or not there is a certain order in teh data set, relation between data and they are statistically significant. In spatial statistics, case study area's location, width and detail numbers can alter the results.

2. METHODOGLY & DATASET

In this study, Bahceköy, Florya, Göztepe, Kandilli, Kartal, Kirecburnu, Kumkoy, Sile meteorology stations data were used. These stations were situated in the border of Istanbul (Figure 1). Meteorological parameters for the seven stations were obtained from General Directorate of

Meteorology (GDM). The other station was located at Bogazici University Kandilli Observatory Earthquake Research Institute. Parameters, periods and station information are given in Table 1.

Figure 1: Location of meteorologic stations (SRTM-DEM)

Table 1: Station Information, Meteorological Parameters and periods.

Station no	GDM Station No	Station Name	Latitude (N)	Longitude (E)	Height (m)	Meteorological parameters period	Meteorological parameters
1	17619	Bahçeköy	41º 10'	28º 59'	130	(1976-2016)	Monthly Avr. Temperature Total Precipitation Relative Humidity
2	17636	Florya	40º 59'	28º 45'	36		
3	17062	Göztepe	40º 58'	29º 03'	33		
4	B.U.	Kandilli	41º 04'	29º 04'	114		
5	17638	Kartal	40º 54'	29º 09'	18		
6	17061	Kirecburnu	41º 08'	29º 03'	58		
7	17059	Kumkoy	41º 15'	29º 02'	30		
8	17610	Sile	40º 47'	30º 25'	83		

The changes of meteorological parameters (air temperature, total rainfall and relative humidity) of ground observation stations used in the study were statistically analyzed by using EXCEL, SPSS and MATLAB software. All data were transferred GIS environment via ArcGIS software and generated distrubution maps by using enterpolation methods. Creating climate maps, meteorological regime, geographical location and characteristics are significant parameters as well as statistical approaches are adopted in recent years (Chai vd., 2001; Daly, 2006; Dobesch vd., 2007; Dodson ve Marks, 1997; Muhammad vd., 2010; Sen ve Sahin, 2001; Sensoy vd., 2008; Willmott ve Matsuura,

1995; Zimmerman vd., 1999). In this study, an inverse weighted distance (idW) interpolation technique was used to determine the spatial distribution of climate data. In this method, generated values were the results of the function for the distance and the size of neighboring points. This technique is used oftenly in order to examine the meteorological parameters. The distribution maps were created by using ArcGIS.

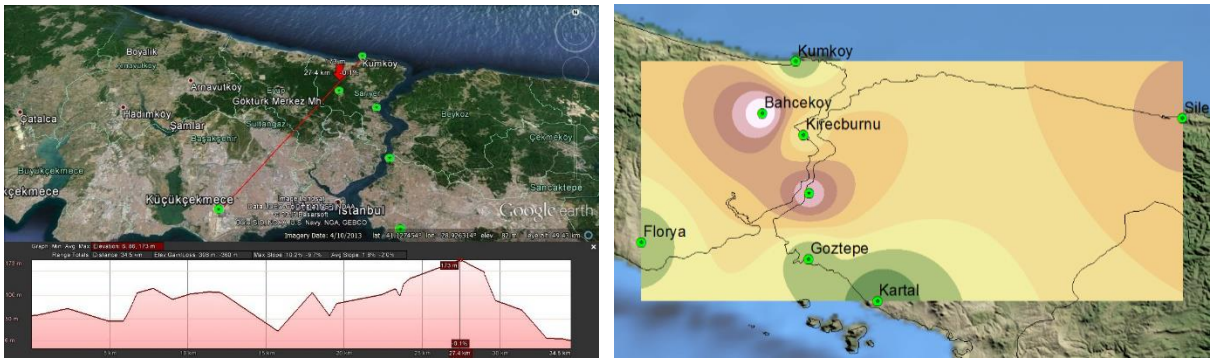

Figure 2: Case study profile and height difference

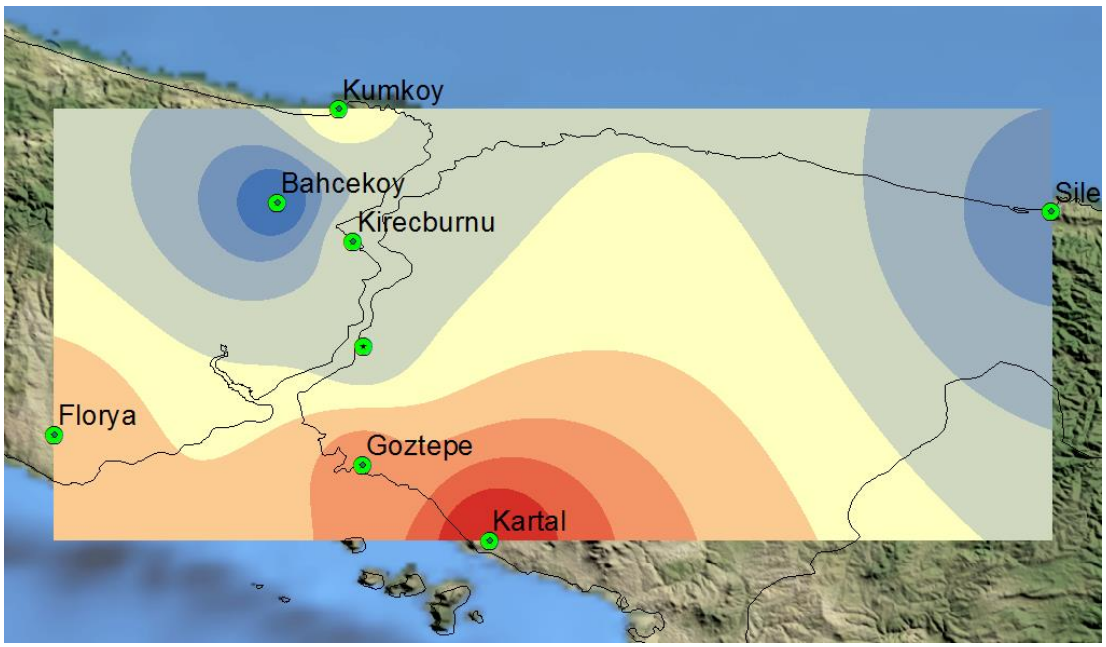

Figure 3: Distribution of mean annual temperature for Istanbul

3. RESULTS & CONCLUSION

For Bahcekoy station, the total annual precipitation had a linear increase trend in general however, between 1979-1995 there was a drop of and then again after 1995 there was a dramatic increased was observed. The total annual precipitation of Florya station, there was an increase till 1981, then considerable fall was observed. From the 1960's for Goztepe station, the total annual precipitation had a slightly increase in general as well as the highest precipitation was observed at 1981. For Kandilli station, from the 1950s, there was a significant increase for the total annual precipitation and the highest precipitation, 1289.4 mm., was observed at 1981. Besides, between 1976-2016 period, for Kartal station, the highest total annual precipitation was observed at 1981 too. In the review period, Kirecburnu and Kumkoy stations had same increase trend until 1981 then their precipitation decreased. From the 1960s for Sile station, total annual precipitation had slightly increased and the highest precipitation, 1696.8 mm., was observed at 1981.

Variations in annual mean relative humidity (%) based on long-term (1976-2016) observations of all meteorology stations were displayed in Figure 4.

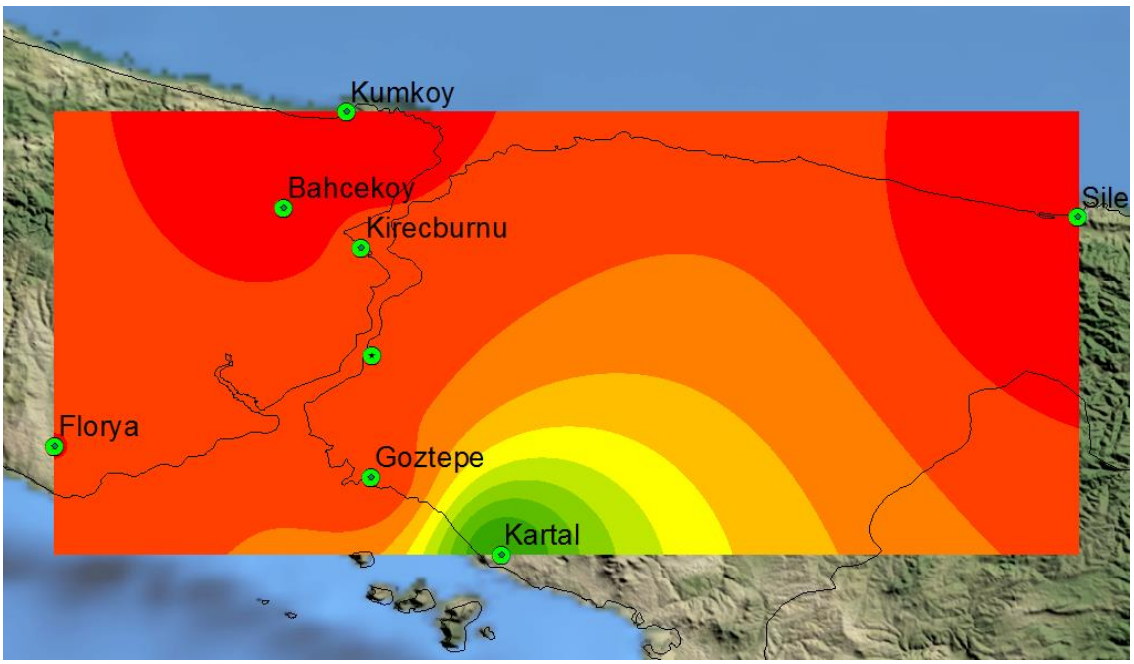

Figure 4. Annual humidity distribution

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BIOGRAPHICAL NOTES

Assoc. Prof. Dr. **Asli DOGRU** was born in 1976. She received the B.S. degree (1999), and the M.Sc. (2002) in Geodesy and Photogrammetry Engineering both from Istanbul Technical University and Ph.D. (2008) degree in Geomatic Engineering from the same university. She is currently working at the Geodesy Department of Kandilli Observatory and Earthquake Research Institute, University of Bogazici. She has more than ten years experience in earthquake studies on North Anatolian Fault Zone and carried out more than 15 scientific research as a researcher. Her main interests are application of information technologies to the solution of problems in geoscience, geodesy, InSAR applications in geoscience research, GPS and crustal deformation using precise geodetic techniques. She has authored or co-authored over 70 scientific papers. She is a member of the Turkish Chamber of Surveying Engineers and the American Geophysical Society.

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