PART II

CLIMATOLOGICAL CHANGING EFFECTS ON WIND, PRECIPITATION AND EROSION: LARGE, MESO AND SMALL SCALE ANALYSIS

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ABSTRACT: *The Fourier Transformation analysis for monthly average values of meteorological parameters has been considered, and amplitudes, phase angles have been calculated by using ground measurements in Turkey. The first order harmonics of meteorological parameters show large scale effects, while higher order harmonics show the effects of small scale fluctuations. The variations of first - sixth order harmonic amplitudes and phases provide a useful means of understanding the large and local scale effects on meteorological parameters. The phase angle can be used to determine the time of year the maximum or minimum of a given harmonic occurs. The analysis helps us to distinguish different pressure, relative humidity, temperature, precipitation and wind speed regimes and transition regions. Local and large scale phenomenon and some unusual seasonal patterns are also defined near Keban Dam and the irrigation area. Analysis of precipitation based on long term data shows that semi-annual fluctuations are predominant in the study area. Similarly, pressure variations are mostly influenced by semi-annual fluctuations. Temperature and humidity variations are mostly influenced by meso and micro scale fluctuations. Many large and meso-scale climate change simulations for the 21st century are based on concentration of green house gasses. A better understanding of these effects on soil erosion is necessary to determine social, economic and other impacts of erosion. The second part of this study covers the time series analysis of precipitation, rainfall erosivity and wind erosion at the Marmara Region. Rainfall and runoff erositivity factors are defined by considering the results of field measurements at 10 stations. Climatological changing effects on rainfall erosion have been determined by monitoring meteorological variables. In the previous studies, Fournier Index is defined to estimate the rainfall erosivity for the study area, Boodt and Gabriels, (1980). The Fournier Index on the other words a climatic index is defined by Odura-Afriye (1996). New, Hulme and Jones (1999) and (2000) describe the construction of a 0.5 latitude by 0.5 longtitude surface climatology of global land areas, excluding Antartica between 1901 and 1998. The climate surfaces have been constructed from a new data-set of station 1961-1990 climatological normals. The station data were interpolated as a function of latitude, longitude and elevation using thin plate splines. Analysis of Fournier Index values with the additional data between 1901-2002 show that the study area is under the moderate and serve erosion risk especially in winter and spring.*

***Key Words:** Fournier Index, erosivity, climatic index, harmonic analysis, local environmental effects on meteorological parameters.*

1. INTRODUCTION

Harmonic analysis has emerged as a useful tool in studying annual patterns of some meteorological parameters, (Aslan and Topçu, 1994). The spatial distributions of temperature, precipitation and pressure have been examined by Krikyla and Hameed (1989), and Currie and Hameed (1990). The first and higher order harmonics, in other words harmonics of 6,4,3,2.4 and 2 months, show the local and large scale effects on meteorological parameters in this study. The amplitude and phase values are calculated and analysed for each harmonics by using the long and short-term temperature, precipitation, pressure, humidity and wind speed data observed in the vicinity of a dam area over Eastern Anatolia and other geographical regions in Turkey, (Aslan and Okçu, 1997), (Aslan, Okçu and Kartal, 1997).

In order to evaluate climate change impacts, climate information is usually needed at the regional scale (i.e up to 10^7) or the country level. Seasonally and averaged precipitation and surface air temperature for the future period (2070-2099) as compared to the period of 1961-1990 are examined by Giorgi and Francisco (2000). The dominant source of uncertainty in the simulation of average regional climate change is due to inter-model variability with inter –

scenario and internal model variability playing secondary roles. The range of predicted climate changes by different realizations of the same ensemble is small, and simulated changes exhibit a high level o coherency among different forcing scenarios.

2. METHOD

Harmonic analysis is based on the series of trigonometric functions given in the following equation (1), Krikyla and Hameed (1989):

$$X = X_0 + \sum_{i=1}^{N/2} A_i \cos (360\ it/p + \Phi_i) \tag{1}$$

where, X; the value at time t, X_o ;arithmetic mean, A_i; amplitude of harmonics, Φ_i; phase angles, N; number of observation, t; time, p; period of observation, (p= 12 months).

Harmonic analyses of pressure, air temperature, relative humidity, wind speed, pressure and precipitation based on ground measurements over 14 stations have been presented. Environmental effects of Keban Dam and irrigation systems have been analyzed in the Northern part of Elazig. There are large irrigation systems in the near vicinity of Urfa, Mus, Bitlis and Van. Long (between 1940 - 1990) and short term data (between 1990 and 1994) for all Turkey are individually analysed. Time series analysis based on half gridded data between 1900 and 2002 are presented.

3. ANALYSIS

Analysis of Pressure: Annual mean values of pressure based on short term observations decrease in the range of 1.1hPa - 1.8hP in Gümüshane, Erzurum, Erzincan and Elazig. Increasing of pressure observed over other stations are lower than these values. First order harmonics decreased in Bitlis, Diyarbakir, Elazig and Gaziantep between 1990 - 1994. By comparing the long term data with the short term observations, it is concluded that large scale effects on annual pressure variation increases over Diyarbakir, Elazig, Ezurum and Gaziantep in the short period. The role of large scale fluctuations increase in the first half and decrease in the second half of the short term observation period

Analysis of Temperature: Annual mean temperature values showed 2 - 3.6°C increase over all stations between 1990 and 1994. The highest values of temperature increase have been observed in Erzincan (3.6°C), Elazig (3.5 °C), Malatya (3.1°C) and Diyarbakir (3.0°C). Lower values are observed in Erzurum (1.4°C) and in Kars (2.0°C). First order amplitudes of temperature data shows increasing and decreasing trend in short term. Effects of meso scale fluctuation play an important role on temperature fluctuations over Elazig, Gaziantep, Malatya, Tokat, Urfa and Van during short term period. Small scale fluctuations play an important role on temperature variation over the stations (Bayburt, No-1 to Malatya, No-9).

Analysis of Relative Humidity: Annual mean humidity values based on short term data increase in Diyarbakir, Elazig, Gaziantep, Gümüshane, Tokat, Urfa and Van. These values slightly decrease in Erzincan and Erzurum between 1990 and 1995. Minimum relative humidity differences of annual average value were observed in Mardin (2.1%), Gümüshane (39%) and Erzurum (4%) in recent years.

Analysis of Wind Speed: Annual wind speed values decrease in Bayburt, Bitlis, Diyarbakir, Gaziantep and Urfa. They show some increasing and decreasing trends over other stations during the short term period. Meso and small scale fluctuations played an important role over Bitlis and Diyarbakir in recent years. The wind speed fluctuations showed similar behavior over Erzincan and Malatya. The largest dam area is between these two stations.

Analysis of Wind Speed and Precipitation: Annual mean rainfall rate increases over Bayburt, Erzincan, Gümüshane, Kars, Tokat and Van. Large, meso and small scale fluctuations show some decreasing and increasing fluctuations during the short-term observation period. Large and meso scale fluctuations played an important role over Van in recent years. The annual oscillation of rainfall data is observed in the Southwest and Central Anatolia. Oscillations of six months are dominant in the East of Turkey. The first three harmonics play an important role on the rainfall data in the East and West of Turkey. Amplitudes and phase values of six harmonics of precipitation and wind speeds shows that large (1st harmonics) and meso-scale (4th harmonics) phenomena play an important role on wind speed variation in January. These fluctuations have a great importance on wind erosion risk in the pilot area in January.

Time Series Analysis: Descriptive analyses have been presented in this lecture notes (2002) between 1901 and 1998, Aslan, Okçu and Sogut, (2002), Turkes, Sumer and Kılıc, (2002), Turkes, Sumer and Demir, (2002) and Gocer et al., (2002). Analyses of Aridity Index (Fig. 1) and Fournier Index (Fig. 2) values between 1901-2002 show that the study area is under the moderate and serve erosion risk.
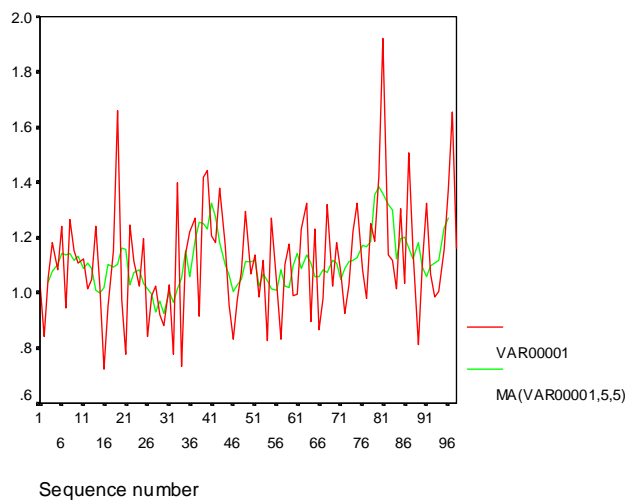

Figure 1- Time Variation of Aridity Index Values in İstanbul (1901-1998), for moving average, l=5
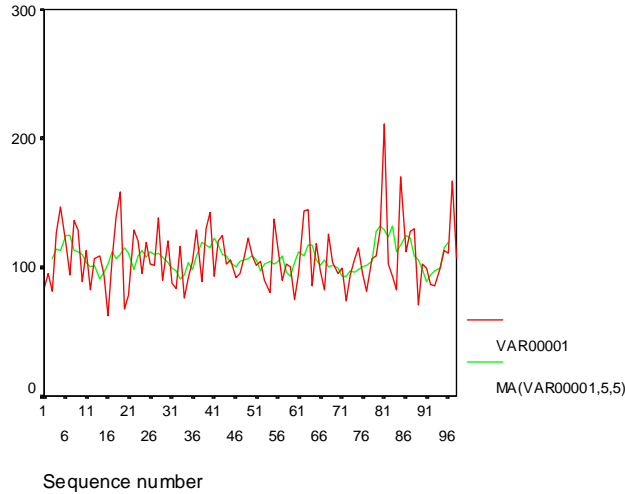
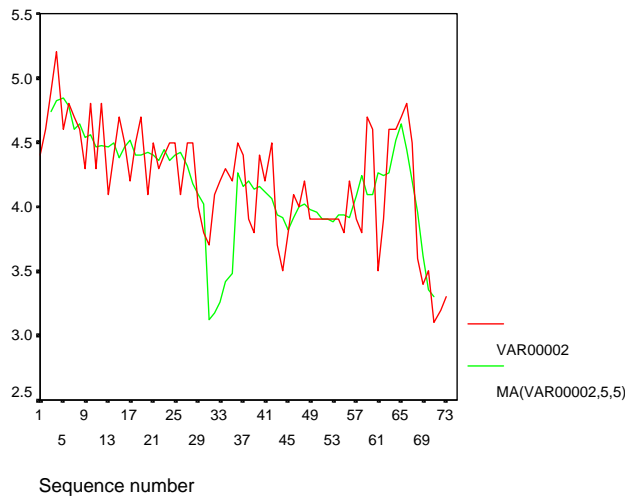Figure 2- Time Variation of FI Values in İstanbul (1901-1998), for moving average, l=5

Figure 3- Time Variation of Wind Speed Values in İstanbul ,for moving average, l=5

Figure 3 shows a decreasing trend of wind speed values in İstanbul.

4. CONCLUSION

Topographic structure, land and sea interactions cause complexity of meteorological parameters such as air temperature, relative humidity, and wind velocity, pressure and precipitation variations. A harmonic analysis of monthly average values of these parameters shows annual, semi-annual, and short term variations. Harmonic analysis determines effects of seasonal variations. This study shows some local effects on meteorological parameters, caused by large dam area and irrigation systems over The Eastern part of Anatolia. Temperature, relative humidity, wind speed, pressure and precipitation variations have mostly been effected by meso scale fluctuations. Large scale phenomenon has also played an important role on the precipitation regime of the study area. Because of water - land temperature differences, wind speeds increase over Elazig and Malatya. The Increase of the relative humidity value over the study area coincides with the increasing evaporating rate from water surface of the dam. Other irrigation systems over The Southern part of the study area contribute to the evaporation rate and relative humidity variations. Because of the

chemical ingredients of Van Lake water, evaporation rate over it's surface is generally less than The Keban Dam. Large scale effects on precipitation, annual average of precipitation increases over Van. Meso scale circulation decreases wind speed. They increase relative humidity values over Van. In conclusion evaporation rate decreased and lake-water level increased in recent years. When the effect of large, meso and small scale fluctuations on meteorological parameters in recent years are compared with the effects observed in previous years, the results present some details on climatological changing effects. The results of harmonic analysis and time series related with precipitation and wind data show the climatological changing effects on water and wind erosion problems.

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