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Statistical analysis and determination of best-fit probability distribution for monthly rainfall in Northern Cyprus

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ABSTRACT

Estimating and analyzing the frequency of rainfall is essential to help in defining the policies regarding water resource management and a source of data for flood hazard mitigation. Additionally, design rainfall is widely utilized in hydraulic structures and urban infrastructure planning. Therefore, finding the suitable probability distribution that fits the actual data is considered as the first step in design rainfall estimation. Therefore, the objective of this study is to determine the best fit probability distribution in the case of average monthly rainfall using 6 years of data (2011–2016) from seven stations. Goodness-of-fit tests including Kolmogorov–Smirnov (K-S) test is used to select the best fit probability, distribution model. The results indicated that Generalized Extreme Value distribution has the lowest value, which is considered as the best distribution function to study the average rainfall characteristics of Girne, Güzelyurt, Lefkoşa, Boğaz, Alevkaya, and Northern Cyprus. Moreover, Gumbel Max is the best overall model according to the K-S test for Gazimağusa and Ercan. A graphic representation of rainfall as a simultaneous function of air temperature and relative humidity in three-dimensional plots was also made. The results demonstrated that a decrease in air temperature and an increase in the relative humidity in the examined period have a great influence on the possibility of increasing the amount of rainfall.

Keywords: Average monthly rainfall; Climate data; Kolmogorov–Smirnov; Distribution functions; Northern Cyprus; Statistical analysis

1. Introduction

The issue of water scarcity has become a global challenge due to the rapid rise in population around the world, and the increasing pressure on the consumption of limited water resources. Additionally, the scarcity and pollution of groundwater are still one of the most important topic nowadays. Several scientific researchers have analyzed the impact of pollution sources on the quality of groundwater [1,2]. Due to the importance of groundwater, it has become the most important source of water supply for domestic, industrial, and agricultural sectors of many places including Northern Cyprus. Rainfall is considered as a vital source of water in Northern Cyprus [3]. According to Song et al. [4] and Kundu et al. [5], the availability of water depends on population growth, energy demand, and climate change.

In general, high temperatures increase the rate of evaporation of the water in the atmosphere, which leads to an increase in the air's ability to carry water [6]. This causes early and short seasons to run and an increase in dry seasons [6]. The further evaporation reduces the levels of

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moisture in the soil, which in turn increases the frequency of droughts in the region, and increases the likelihood of desertification [7]. Besides, a decrease in the percentage of moisture in the soil as well as in infiltration rates leads to reduction in the feeding rate in the groundwater [7]. Moreover, air temperature and rainfall are considered the major factors that affect human activities such as agriculture, which has influenced the economy of the country [8,9].

Cyprus is the third largest island in the Mediterranean Sea with an area of 9,251 km^2. It has a temperate climate (Mediterranean climate) [10]. Two-thirds of the average annual rainfall of 500 mm falls from December to February. The island suffers from drought periodically [11]. The water resources on the island are very limited and the main source of water on the island is rainfall. Generally, in Cyprus, more than two-thirds of the rainfall occurs between October and April.

1.1. Literature review related to water resource in Northern Cyprus

With the increasing world population, it is getting more difficult to utilize the uncontaminated surface water and groundwater resources. In parallel with the technological development, more complex chemical and biological pollutants were released into the environment from the industry without appropriate physical, chemical, and biological treatment. Therefore, these untreated water pollutants contaminated the surface water and groundwater resource to a great extent. As a result, the quantity of water suitable for drinking and irrigation purposes decreased considerably.

The climate of Cyprus is the typical Mediterranean with very hot dry summers and cooler winters [12]. In winter, the mean daytime temperatures vary from 12°C to 15°C, while the mean maximum temperature in summer reaches 40°C [13]. The wet season extends from November to March, with most (approximately 60%) of the rain falling between December and February [13]. Generally, most of the rainfall occurs from October to April in Cyprus.

According to Agboola and Egelioglu [14], and Wright [15], there are no rivers but the area is well watered by gushing perennial springs in Cyprus particularly in Northern Cyprus. There are 38 streams in the northern part of Cyprus, 10 of which originated from the southern part of the island around the Troodos Mountains and relatively rich in water as they flow; however, dam construction by the Southern Administration prevented the flow from the streams to the northern part of Cyprus [16].

The water resources in the country are classified into groundwater, surface water (dam), and Turkey-North Cyprus water pipeline project. The sources of surface water resources in Northern Cyprus are from four main river basins [17]:

- Western Mesarya Plain, including Lefke, with a catchment area of about 640 km^2.
- Central and Eastern Mesarya Plain, including Gazimağusa, with a catchment area of about 1,520 km^2.
- North shore and Girne (Beşparmak) Mountains, with a catchment area of about 460 km^2.
- Karpaz Peninsula, with a catchment area of about 680 km^2.

The streams in Northern Cyprus originate either from the Troodos Mountains in the central part of the island or from the Beşparmak Mountains in the north. According to Türker and Hansen [17], the average annual water carried from the streams is estimated to be about 108 mill m^3 from the Troodos Mountains and 80 mill m^3 from Beşparmak Mountains. Additionally, the total average annual surface runoff is estimated at 188 mill m^3 in the Northern part of Cyprus [17].

According to Türker and Hansen [17], 30 large earth dams are constructed in the North part of Cyprus and the total capacity storage of these dams is around 34.4 million m^3 of which only about 25.6 million m^3 is operational by now due to siltation. The estimated annual volume provided for irrigation and groundwater recharge is approximately 8.4 mill m^3, which means about 33% of the operational storage capacity is used for irrigation purposes. Furthermore, based on theoretical estimation for surface water stored volume for groundwater purposed, it is found that around 14% of the operational storage capacity is used for groundwater recharge. Moreover, it is estimated that about 30%–40% of water stored is lost due to evaporation [17]. Table S1 as supplementary material shows some selected dams in Northern Cyprus with their capacity and year of construction.

The Güzelyurt groundwater basin is located within the western part of Northern Cyprus [18]. Since 1957, increasing rates of pump-age have caused a progressive decline in the groundwater levels, locally reaching 45–50 m below mean sea level [18,19]. Limited natural recharge and excessive withdrawals from approximately 250 active municipal and irrigation wells have not only produced a considerable reduction in the aquifer storage but also degradation of groundwater quality due to saltwater intrusion and bedrock contamination [18]. The aquifer provides the main source of potable water. The total basin area of the aquifer is around 460 km^2 in which 1/3 of this area is under the control of the Greek Cypriot Community and 2/3 is under the control of Turkish Cypriot Community Authorities. Most of the aquifers in the northern part of Cyprus are unconfined (phreatic) made up of the river or coastal alluvial deposits, mainly silts, sands, and gravels. The main aquifers in the north part of Cyprus are Girne mountain aquifer, which is located in Beşparmak Mountains close to the north coast, Güzelyurt aquifer, located in western Mesarya, and Gazimağusa aquifer, located in Southeastern Mesarya. The aquifers are mainly being recharged by rainfall and river flows (in a very limited period of the year) and are more or less all showing trends of depletion due to reduced recharging, frequent droughts, and increased abstraction mainly by farmers in their effort to increase their production level. The aquifers are characterized into 13 groups within eight hydrological regions, which have various capacities of water storage as shown in Table S2 as supplementary material. The Güzelyurt aquifer, which is the largest coastal aquifer in the northwestern of the island, provides water not only for irrigation requirements in the region but also for the municipal needs of Lefkoşa and Gazimağusa cities. According to Gökçekus and Doyuran [19], the capacity of Güzelyurt aquifer is found to be 920 million m^3 and recent studies demonstrate that the aquifer is depleted and the average groundwater level reaches 70 m below the mean sea level in some local areas. It is depleted and the average groundwater level reaches 70 m below the mean sea level in some local areas. The second important aquifer is the Mount Aquifer, which runs across the northern coast of the island with a thin strip of 1.5 km wide. The surface of this underground reservoir is about 40 km^2, with an average annual renewal of 10.5 million m^3. At the watershed of the Güzelyurt groundwater basin various lithological units of the Troodos massif (middle-Upper Cretaceous), Lapathos group (Oligocene-Lower Miocene), Dhali Group (Middle-Upper Miocene) and Mesaoria Group (Upper Miocene-Upper Pliocene) constitute the bedrock. The basin itself comprises flanglomerates (Plestocene) and Holocene deposits.

The Pre-Tertiary Troodos Massif rocks are the oldest units exposed within the watersheds of the Güzelyurt groundwater basin. In general, the Troodos Massif is a huge igneous body, which is exposed in the central part of Cyprus. It is made up to Troodos Plutonic Series, Sheeted dyke complex, and Pillow Lava Series.

According to Türker and Hansen [17], about 100% of water demand provided for public needs in the Island is from groundwater. However, the availability of the groundwater resources is by now rather limited due to over-abstraction of groundwater and due to limited natural recharge from rainfall, which has resulted in the depletion of available freshwater within the aquifers. Due to the over-abstraction, seawater intrusion has occurred in several coastal areas and has in some cases reached an alarming stage (in some areas the chloride concentration has in some cases reached as high as 7,000 ppm) [20–22].

1.2. Literature review related to rainfall distribution analysis

No theoretical distribution can be considered that it can characterize exclusively the annual rainfall profile [23]. Thus, the analysis of rainfall/rainfall data mainly depends on its distribution type. Many researchers have studied the rainfall (rainfall) characteristics using different distribution functions in different parts of the world. Thus, Table 1 summarizes the previous scientific studies that have been conducted around the world on the selection of probability distributions in rainfall/flood frequency analyses.

1.3. Aim of the study

This study aims to analyze the characteristics of the average rainfall of seven selected stations in Northern Cyprus. Additionally, this work aims to determine the best-fit probability distributions in the case of average monthly rainfall using 6 y of data. In this research, 37 distribution function models are utilized. Kolmogorov–Smirnov test is applied to determine the best-fit probability distributions. Moreover, a graphic representation of rainfall as a simultaneous function of air temperature and relative humidity in three-dimensional plots was also made. Fig. 1 illustrates the analysis procedure of this study.

2. Materials and methods

2.1. Data and study area

In the present study, climate data for a period of 2011–2016 (air temperature, rainfall amounts, and relative humidity) were analyzed. The monthly data were collected from the Meteorology Department located in Lefkoşa. The meteorological station's information is listed in Table 2. Additionally, the locations of these meteorological stations are illustrated in Fig. 2.

2.2. Probability distributions

In this work, 37 probability distributions were examined in selecting the best fit probability distribution for average monthly rainfall in Northern Cyprus. Table 3 presents the

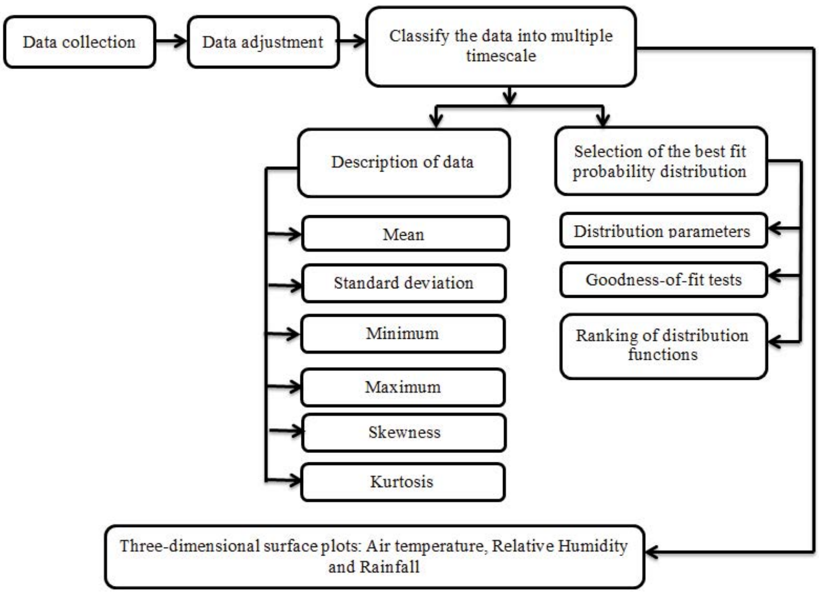

Fig. 1. Flowchart of the analysis procedure of the present study.

Table 1
Summary of previous applications of probability distributions in rainfall/flood analysis

Reference	Data used	Best fit distribution	Country
[23]	Annual rainfall	Gamma	Cyprus
[24]	Annual maximum rainfall data (durations of 1 h to 31 d)	Log-Pearson type 3	Thailand, India, Laos, and the USA
[25]	15, 30, and 60 min and 1, 2, 3, 6, 12, and 24 h and 1, 3, and 7 d of rainfall	Generalized logistic	Oklahoma, USA
[26]	Monthly total rainfall data	Gamma	Libya
[27]	Daily and monthly annual maximum rainfall data	Log-Pearson type 3	Nigeria
[28]	Annual maximum rainfall data (1-h duration)	Generalized Extreme value	Malaysia
[29]	Annual maximum rainfall series (5 min and 1-h duration)	Generalized Extreme value	Southern Quebec, Canada
[30]	Annual maximum rainfall data (24-h duration)	Log-Pearson type 3	Taiwan
[31]	Annual maximum rainfall data (1-h duration)	Mixed-exponential	Malaysia
[32]	Annual maximum rainfall series (1-, 2-, 3-, 4- and 5-day durations)	Log-normal	Ghana
[33]	Daily rainfall	3-parameter Pearson-III distribution and 4-parameter Kappa distribution	The United States
[34]	Annual maximum rainfall series (24-h duration)	Log-normal	Pantnagar, India
[35]	5-min to 72-h durations	Generalized Extreme value	Australia
[36]	1–12 h, 1–7 d rainfall	Generalized Extreme value	Australia
[37]	Annual maximum rainfall	Generalized extreme value and four parameters generalized gamma	Bangladesh
[38]	Annual maximum rainfall 24-h duration	Pearson type 3	Qatar
[39]	Monthly and annual rainfall data	Pearson type 3	Northwest of Iran
[40]	Annual, seasonal and monthly maximum daily rainfall	Normal for annual, post-monsoon, and summer seasons. Lognormal, Weibull, and Pearson 5 for pre-monsoon, monsoon, and winter seasons, respectively.	Sagar Island
[41]	24-h annual maximum rainfall data	Extreme value type 1 and Log-Pearson type 3	Al-Madinah City, Saudi Arabia
[42]	6-h rainfall	Generalized Pareto, Wakeby and Generalized Extreme value	Peninsular Malaysia
[43]	Annual maximum rainfall series (average of 36 y)	Generalized Extreme value	Qatar
[44]	24-h annual maximum rainfall	Log-Pearson type 3	Northern regions of Pakistan
[45]	Annual rainfall	Normal and Gamma distribution	Sudan
[46]	Annual maximum series of daily rainfall data	Generalized Extreme value	Southeastern Nigeria
[47]	Annual maximum hourly rainfall	Log-Pearson type 3	Japan
[48]	Extreme values for rainfall	Gaussian/normal	Bangladesh
[49]	Maximum monthly rainfall	Pearson type 3 and Log-Pearson type 3	Bangladesh
[50]	Daily rainfall	Gamma	Cooch Behar
[51]	Daily maximum rainfall data	Lognormal and Gumbel	Udaipur district
[52]	Extreme rainfall events	Generalized extreme value, generalized Pareto and Frechet	Mumbai, India
[53]	Monthly rainfall	Gumbel Maximum and Logistic	Lebanon

selected distribution model used to analyze the characteristic of the average monthly rainfall. The maximum-likelihood method is utilized to estimate the parameters of distribution models.

2.3. Goodness-of-Fit test; Kolmogorov-Smirnov (K-S) test

In order to check the validity of the specified probability distribution model, Goodness-of-fit test statistics are utilized. Kolmogorov–Smirnov (K-S) test is the most well-known empirical distribution function tests [43,49].

$$D = \max_{1\le i\le n}\left(F\left(x_i\right) - \frac{i-1}{n}, \frac{i}{n} - F\left(x_i\right) \right) \quad (1)$$

where

$$F_n\left(x\right) = \frac{1}{n} \times \left(\text{Number of observation} \le x\right) \quad (2)$$

3. Results and discussions

3.1. Climate data characteristics

3.1.1. Rainfall

Table 4 presents the descriptive statistics of rainfall including mean, standard deviation, variance coefficient, minimum, maximum, and skewness for all selected stations. For all stations, the mean rainfall amount varies from 13.61 to 51.9 mm. Mean rainfall and standard deviation values

Table 2
Details of each location used in this study

Location	Coordinates		Altitude (m)	Characteristics of the location
	Latitude (°N)	Longitude (°E)		
Lefkoşa	35° 10′ 12.9″	33° 21′ 31.32″	146	Surrounded by building
Ercan	35° 10′ 25.86″	33° 32′ 52.08″	105	Airport
Girne	35° 20′ 0.6″	33° 18′ 51.156″	7	Coastal
Güzelyurt	35° 12′ 3.528″	32° 59′ 26.808″	49	Coastal
Gazimağusa	35° 7′ 15.9924″	33° 56′ 15.1116″	7	Coastal
Boğaz	35° 18′ 58.428″	33° 57′ 12.636″	388	Coastal
Alevkaya	35° 16′ 59.52″	33° 32′ 0.6252″	623	Coastal

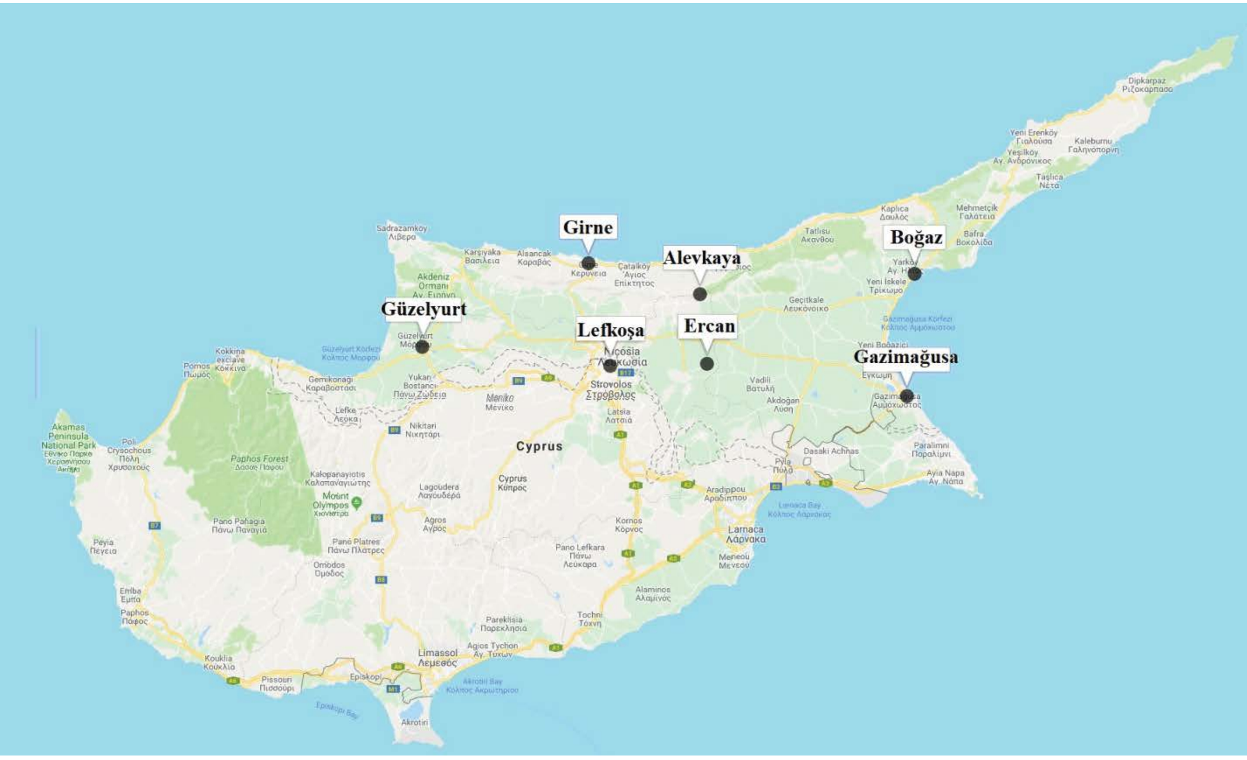

Fig. 2. Representative meteorological stations.

Table 3
Probability density and cumulative distribution of used distribution functions

Distribution function	Probability density function	Cumulative distribution function
Beta	$f(R)=\frac{1}{B(\alpha_1,\alpha_2)}\frac{(R-a)^{\alpha_1-1}(b-R)^{\alpha_2-1}}{(b-a)^{\alpha_1+\alpha_2-1}}$	$F(R)=I_z(\alpha_1,\alpha_2)$
Four-Parameter Burr	$f(R)=\frac{\alpha k\left(\frac{R-\gamma}{\beta}\right)^{\alpha-1}}{\beta\left(1+\left(\frac{R-\gamma}{\beta}\right)^{\alpha}\right)^{k+1}}$	$F(R)=1-\left(1+\left(\frac{R-\gamma}{\beta}\right)^{\alpha}\right)^{-k}$
Three-Parameter Burr	$f(R)=\frac{\alpha k\left(\frac{R}{\beta}\right)^{\alpha-1}}{\beta\left(1+\left(\frac{R}{\beta}\right)^{\alpha}\right)^{k+1}}$	$F(R)=1-\left(1+\left(\frac{R}{\beta}\right)^{\alpha}\right)^{-k}$
Cauchy	$f(R)=\left(\pi\sigma\left(1+\left(\frac{R-\mu}{\sigma}\right)^{2}\right)\right)^{-1}$	$F(R)=\frac{1}{\pi}\arctan\left(\frac{R-\mu}{\sigma}\right)+0.5$
Four-Parameter Dagum	$f(R)=\frac{\alpha k\left(\frac{R-\gamma}{\beta}\right)^{\alpha k-1}}{\beta\left(1+\left(\frac{R-\gamma}{\beta}\right)^{\alpha}\right)^{k+1}}$	$F(R)=1-\left(1+\left(\frac{R-\gamma}{\beta}\right)^{-\alpha}\right)^{-k}$
Three-Parameter Dagum	$f(R)=\frac{\alpha k\left(\frac{R}{\beta}\right)^{\alpha k-1}}{\beta\left(1+\left(\frac{R}{\beta}\right)^{\alpha}\right)^{k+1}}$	$F(R)=1-\left(1+\left(\frac{R}{\beta}\right)^{-\alpha}\right)^{-k}$
Three-Parameter Erlang	$f(R)=\frac{(R-\gamma)^{m-1}}{\beta^{m}\Gamma(m)}\exp\left(-\frac{R-\gamma}{\beta}\right)$	$F(R)=\frac{\Gamma_{(R-\gamma)/\beta}(m)}{\Gamma(m)}$
Two-Parameter Erlang	$f(R)=\frac{(R-\gamma)^{m-1}}{\beta^{m}\Gamma(m)}\exp\left(-\frac{R}{\beta}\right)$	$F(R)=\frac{\Gamma_{(R)/\beta}(m)}{\Gamma(m)}$
Two-Parameter Exponential	$f(R)=\lambda\exp(-\lambda(R-\gamma))$	$F(R)=1-\exp(-\lambda(R-\gamma))$
One-Parameter Exponential	$f(R)=\lambda\exp(-\lambda R)$	$F(R)=1-\exp(-\lambda R)$
Three-Parameter Gamma	$f(R)=\frac{(R-\gamma)^{\alpha-1}}{\beta^{\alpha}\Gamma(\alpha)}\exp\left(-\left(\frac{R-\gamma}{\beta}\right)\right)$	$F(R)=\frac{\Gamma_{(R-\gamma)/\beta}(\alpha)}{\Gamma(\alpha)}$
Two-Parameter Gamma	$f(R)=\frac{R^{\alpha-1}}{\beta^{\alpha}\Gamma(\alpha)}\exp\left(-\left(\frac{R}{\beta}\right)\right)$	$F(R)=\frac{\Gamma_{R/\beta}(\alpha)}{\Gamma(\alpha)}$
One-Parameter Rayleigh	$f(R)=\frac{R}{\sigma^{2}}\exp\left(-\frac{1}{2}\left(\frac{R}{\sigma}\right)^{2}\right)$	$F(R)=1-\exp\left(-\frac{1}{2}\left(\frac{R}{\sigma}\right)^{2}\right)$

Wakeby	$R(F)=\xi+\frac{\alpha}{\beta}\left(1-(1-F)^{\beta}\right)-\frac{\gamma}{\delta}\left(1-(1-F)^{\delta}\right)$	
Three-Parameter Weibull	$f(R)=\left(\frac{\alpha}{\beta}\right)\left(\frac{R-\gamma}{\beta}\right)^{\alpha-1}\exp\left(-\left(\frac{R-\gamma}{\beta}\right)^{\alpha}\right)$	$F(R)=1-\exp\left(-\left(\frac{R-\gamma}{\beta}\right)^{\alpha}\right)$
Two-Parameter Weibull	$f(R)=\left(\frac{\alpha}{\beta}\right)\left(\frac{R}{\beta}\right)^{\alpha-1}\exp\left(-\left(\frac{R}{\beta}\right)^{\alpha}\right)$	$F(R)=1-\exp\left(-\left(\frac{R}{\beta}\right)^{\alpha}\right)$
Generalized Extreme Value	$f(R)=\begin{cases}\frac{1}{\sigma}\exp\left(-\left(1+k\frac{R-\mu}{\sigma}\right)^{-1/k}\right)\left(1+k\frac{R-\mu}{\sigma}\right)^{-1-1/k} & k\neq 0\\ \frac{1}{\sigma}\exp\left(-\frac{R-\mu}{\sigma}-\exp\left(-\frac{R-\mu}{\sigma}\right)\right) & k=0\end{cases}$	$F(R)=\begin{cases}\exp\left(-\left(1+k\frac{R-\mu}{\sigma}\right)^{-1/k}\right) & k\neq 0\\ \exp\left(-\exp\left(-\frac{R-\mu}{\sigma}\right)\right) & k=0\end{cases}$
Four-Parameter Generalized Gamma	$f(R)=\frac{k(R-\gamma)^{k\alpha-1}}{\beta^{k\alpha}\Gamma(\alpha)}\times p\left(-\left(\frac{R-\gamma}{\beta}\right)^{k}\right)$	$F(R)=\frac{\Gamma_{((R-\gamma)/\beta)^{k}}(\alpha)}{\Gamma(\alpha)}$
Three-Parameter Generalized Gamma	$f(R)=\frac{k(R)^{k\alpha-1}}{\beta^{k\alpha}\Gamma(\alpha)}\times p\left(-\left(\frac{R}{\beta}\right)^{k}\right)$	$F(R)=\frac{\Gamma_{((R)/\beta)^{k}}(\alpha)}{\Gamma(\alpha)}$
Generalized Logistic	$f(R)=\begin{cases}\frac{\left(1+k\frac{R-\mu}{\sigma}\right)^{-1-1/k}}{\sigma\left(\left(1+k\frac{R-\mu}{\sigma}\right)^{-1/k}\right)^{2}} k\neq 0\\ \frac{\exp\left(-\frac{R-\mu}{\sigma}\right)}{\sigma\left(1+\exp\left(-\frac{R-\mu}{\sigma}\right)\right)^{2}} k=0\end{cases}$	$F(R)=\begin{cases}\frac{1}{\left(1+k\frac{R-\mu}{\sigma}\right)^{-1/k}} k\neq 0\\ \frac{1}{1+\exp\left(-\frac{R-\mu}{\sigma}\right)} k=0\end{cases}$
Generalized Pareto	$f(R)=\begin{cases}\frac{1}{\sigma}\left(-\left(1+k\frac{R-\mu}{\sigma}\right)^{-1-1/k}\right) & k\neq 0\\ \frac{1}{\sigma}\exp\left(-\frac{R-\mu}{\sigma}\right) & k=0\end{cases}$	$F(R)=\begin{cases}1-\left(1+k\frac{R-\mu}{\sigma}\right)^{-1-1/k} & k\neq 0\\ 1-\exp\left(-\frac{R-\mu}{\sigma}\right) & k=0\end{cases}$
Maximum Extreme Value Type 1	$f(R)=\frac{1}{\sigma}\exp\left(-\frac{R-\mu}{\sigma}-\exp\left(-\frac{R-\mu}{\sigma}\right)\right)$	$F(R)=\exp\left(-\exp\left(-\frac{R-\mu}{\sigma}\right)\right)$
Minimum Extreme Value Type 1	$f(R)=\frac{1}{\sigma}\exp\left(\frac{R-\mu}{\sigma}-\exp\left(-\frac{R-\mu}{\sigma}\right)\right)$	$F(R)=1-\exp\left(-\exp\left(-\frac{R-\mu}{\sigma}\right)\right)$
Three-Parameter Inverse Gaussian	$f(R)=\sqrt{\frac{\lambda}{2\pi(R-\gamma)}}\exp\left(-\frac{\lambda(R-\gamma-\mu)^{2}}{2\mu^{2}(R-\gamma)}\right)$	$F(R)=\Phi\left(\sqrt{\frac{\lambda}{R-\gamma}}\left(\frac{R-\gamma}{\mu}-1\right)\right)+\Phi\left(-\sqrt{\frac{\lambda}{R-\gamma}}\left(\frac{R-\gamma}{\mu}+1\right)\right)\exp\left(\frac{2\lambda}{\mu}\right)$

(Continued)

Table 3 Continued

Distribution function	Probability density function	Cumulative distribution function
Log-Gamma	$f(R)=\frac{(\ln(R))^{\alpha-1}}{R\beta^{\alpha}\Gamma(\alpha)}\exp\left(\frac{-\ln(R)}{\beta}\right)$	$F(R)=\frac{\Gamma_{(\ln(R)/\beta)^{k}}(\alpha)}{\Gamma(\alpha)}$
Logistic	$f(R)=\frac{\exp\left(-\frac{R-\mu}{\sigma}\right)}{\sigma\left\{1+\exp\left(-\frac{R-\mu}{\sigma}\right)\right\}^{2}}$	$F(R)=\frac{1}{1+\exp(-R)}$
Two-Parameter Inverse Gaussian	$f(R)=\sqrt{\frac{\lambda}{2\pi(R-\gamma)}}\exp\left(-\frac{\lambda(R-\mu)^{2}}{2\mu^{2}R}\right)$	$F(R)=\Phi\left(\sqrt{\frac{\lambda}{R-\gamma}}\left(\frac{R}{\mu}-1\right)\right)+\Phi\left(-\sqrt{\frac{\lambda}{R-\gamma}}\left(\frac{R}{\mu}+1\right)\right)\exp\left(\frac{2\lambda}{\mu}\right)$
Log-Logistic	$f(R)=\left(\frac{\left(\frac{\beta}{\alpha}\left(\frac{R}{\alpha}\right)^{\beta-1}\right)}{\left(1+\frac{R}{\alpha}\right)^{\beta}}\right)^{2}$	$F(R)=\frac{1}{\left(1+\frac{R}{\alpha}\right)^{-\beta}}$
Three-Parameter Lognormal	$f(R)=\frac{1}{(R-\gamma)\sigma\sqrt{2\pi}}\exp\left[-\frac{1}{2}\left(\frac{\ln(R-\gamma)-\mu}{\sigma}\right)^{2}\right]$	$F(R)=\Phi\left[\frac{\ln(R-\gamma)-\mu}{\sigma}\right]$
Two-Parameter Lognormal	$f(R)=\frac{1}{R\sigma\sqrt{2\pi}}\exp\left[-\frac{1}{2}\left(\frac{\ln(R)-\mu}{\sigma}\right)^{2}\right]$	$F(R)=\frac{1}{2}+\mathrm{erf}\left[\frac{\ln(R)-\mu}{\sigma\sqrt{2}}\right]$
Log-Pearson 3	$f(R)=\frac{1}{R\lvert\beta\rvert\Gamma(\alpha)}\left(\frac{\ln(R)-\gamma}{\beta}\right)^{\alpha-1}\exp\left(-\frac{\ln(R)-\gamma}{\beta}\right)$	$F(R)=\frac{\Gamma_{(\ln(R)-\gamma)/\beta}(\alpha)}{\Gamma(\alpha)}$
Nakagami	$f(R)=\frac{2m^{m}}{\Gamma(m)\Omega^{m}}R^{2m-1}e^{\left(-\frac{m}{\Omega}G^{2}\right)}$	$F(R)=\frac{\gamma\left(m,\frac{m}{\Omega}R^{2}\right)}{\Gamma(m)}$
Normal	$f(R)=\frac{1}{\sqrt{2\pi\sigma^{2}}}\exp\left(-\frac{R-\mu}{2\sigma^{2}}\right)$	$F(R)=\frac{1}{2}\left[1+\mathrm{erf}\left(\frac{R-\mu}{\sigma\sqrt{2}}\right)\right]$
Two-Parameter Rayleigh	$f(R)=\frac{R-\gamma}{\sigma^{2}}\exp\left(-\frac{1}{2}\left(\frac{R-\gamma}{\sigma}\right)^{2}\right)$	$F(R)=1-\exp\left(-\frac{1}{2}\left(\frac{R-\gamma}{\sigma}\right)^{2}\right)$

suggest that there is good consistency in the wind behavior. The coefficients of variation are moderately high, ranging from 88.29 to 212.05. During the investigation period, the Skewness values of all stations are positive indicating that all distributions are right-skewed expected the year of 2011 in Güzelyurt, that is, the negative value of skewness indicates that all distributions are left-skewed.

Fig. 3 illustrates the variations of monthly rainfall for each station during the investigation period of 2011–2016. It is observed that the monthly rainfall is varied from 369.6 to 0 mm and the general trend is that rainfall decreases from May to September and then starts to increase afterward for the rest of the year. Furthermore, it is noticed that the maximum and minimum values of monthly rainfall are recorded in winter and summer seasons at all studied stations, respectively. In comparison, it is found that Boğaz and Lefkoşa have the highest and lowest annual mean rainfall amount with a value of 50.38 and 23.95 mm, respectively.

Table 4
Statistical parameters of monthly rainfall

Station	Variable	Mean (mm)	Standard deviation (mm)	Variance coefficient	Minimum (mm)	Maximum (mm)	Skewness
Girne	2011	50	63.9	127.78	0	177.8	1.46
	2012	48.1	56.2	116.86	0	162.8	1.03
	2013	24.32	30.86	126.9	0	91.4	1.34
	2014	31.87	30.23	94.85	0	92	0.76
	2015	37.8	52	137.63	0	181.1	2.16
	2016	44.6	94.7	212.05	0	334.2	3.05
	Average	39.5	41.8	105.91	0	118.8	0.95
Gazimağusa	2011	37	40	108.25	0	109.1	0.82
	2012	51.9	61.9	119.24	0	171.6	1.08
	2013	13.62	17.75	130.38	0	59.3	1.75
	2014	23.79	22.66	95.23	0	66.4	1.02
	2015	28.98	31.3	107.99	0	92.9	0.84
	2016	21.07	28.47	135.13	0	102.4	2.39
	Average	29.39	26.96	91.71	0	82.47	0.94
Güzelyurt	2011	26.03	23	88.36	0	51.9	−0.08
	2012	38.7	42.8	110.59	0	135	1.17
	2013	14.28	16.97	118.9	0	53.1	1.27
	2014	32.75	29.28	89.4	3.3	102.1	1.41
	2015	26.32	24.92	94.69	0	67.5	0.65
	2016	22.24	30.19	135.75	0	96.6	1.62
	Average	26.72	20.84	78	1.5	64.57	0.61
Ercan	2011	32.27	29.55	91.59	0	91.7	0.8
	2012	30.93	33.14	107.15	0	102.8	1.38
	2013	24.91	31.44	126.21	0	98.8	1.31
	2014	27.15	27.31	100.58	0	89	1.15
	2015	21.55	21.14	98.11	0.1	56	0.67
	2016	19.57	30.57	156.22	0	111.4	2.84
	Average	26.06	21.85	83.83	0.05	74.4	0.96
Lefkoşa	2011	23.75	22.52	94.8	0	66.2	0.36
	2012	33.99	32.87	96.7	0	86	0.35
	2013	21.85	29.08	133.1	0	90.6	1.54
	2014	21.85	29.08	133.1	0	90.6	1.54
	2015	19.98	19.6	98.06	0	48.8	0.44
	2016	22.28	31.48	141.29	0	110.6	2.29
	Average	23.95	21.57	90.04	0.1	58.6	0.52
Boğaz	2011	70.2	92.5	131.73	0	263.3	1.56
	2012	64.2	84.7	131.96	0	235	1.46
	2013	55.2	82.8	149.95	0	202.9	1.29
	2014	32.62	34.05	104.4	0	115.2	1.31
	2015	45.2	59.5	131.69	0	196.8	1.7
	2016	55.3	105.7	191.33	0	369.6	2.78
	Average	53.8	53.7	99.9	0	152.4	0.8
Alevkaya	2011	52.9	46.7	88.29	0.2	130.8	0.45
	2012	54.2	54.2	99.96	0	137.4	0.3
	2013	55.2	82.8	149.95	0	202.9	1.29
	2014	42.1	47	111.76	0	163.4	1.69
	2015	35.97	33.79	93.95	0.1	103.4	0.77
	2016	43.9	76.8	175.03	0	270.9	2.75
	Average	47.4	42.9	90.58	0.1	143.1	0.92
All Northern Cyprus	2011	39.7	35.4	89.09	0	103.6	0.84
	2012	48.4	51.9	107.04	0	164.7	1.07
	2013	23.63	25.56	108.19	0	68.1	0.69
	2014	26.71	24.19	90.58	0.4	80.9	1.1
	2015	31.22	27.74	88.86	0.5	77	0.57
	2016	30.5	47.9	156.88	0	174.3	2.84
	Average	33.37	28.85	86.45	0.45	90.25	0.78

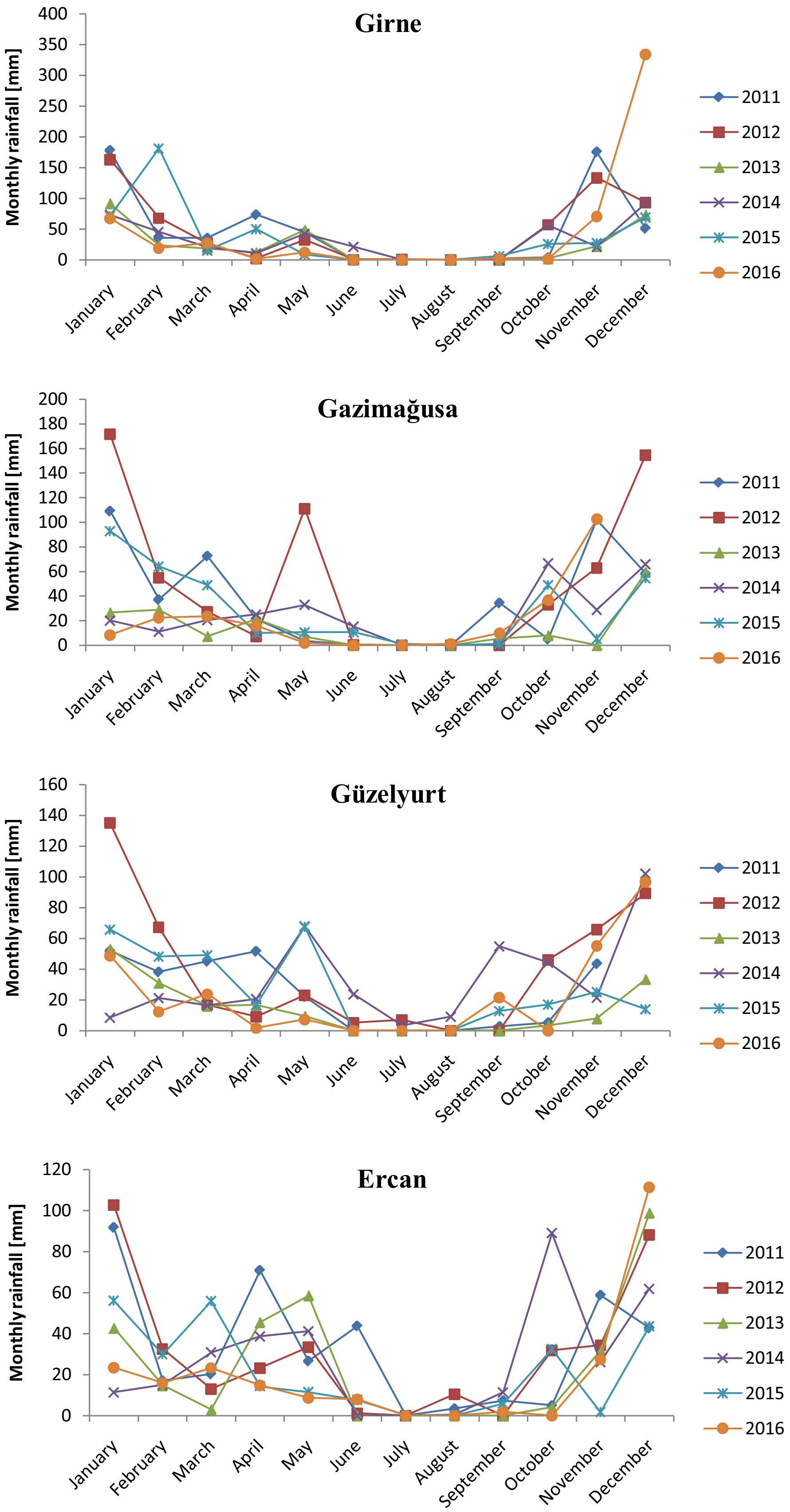

Fig. 3. Continued

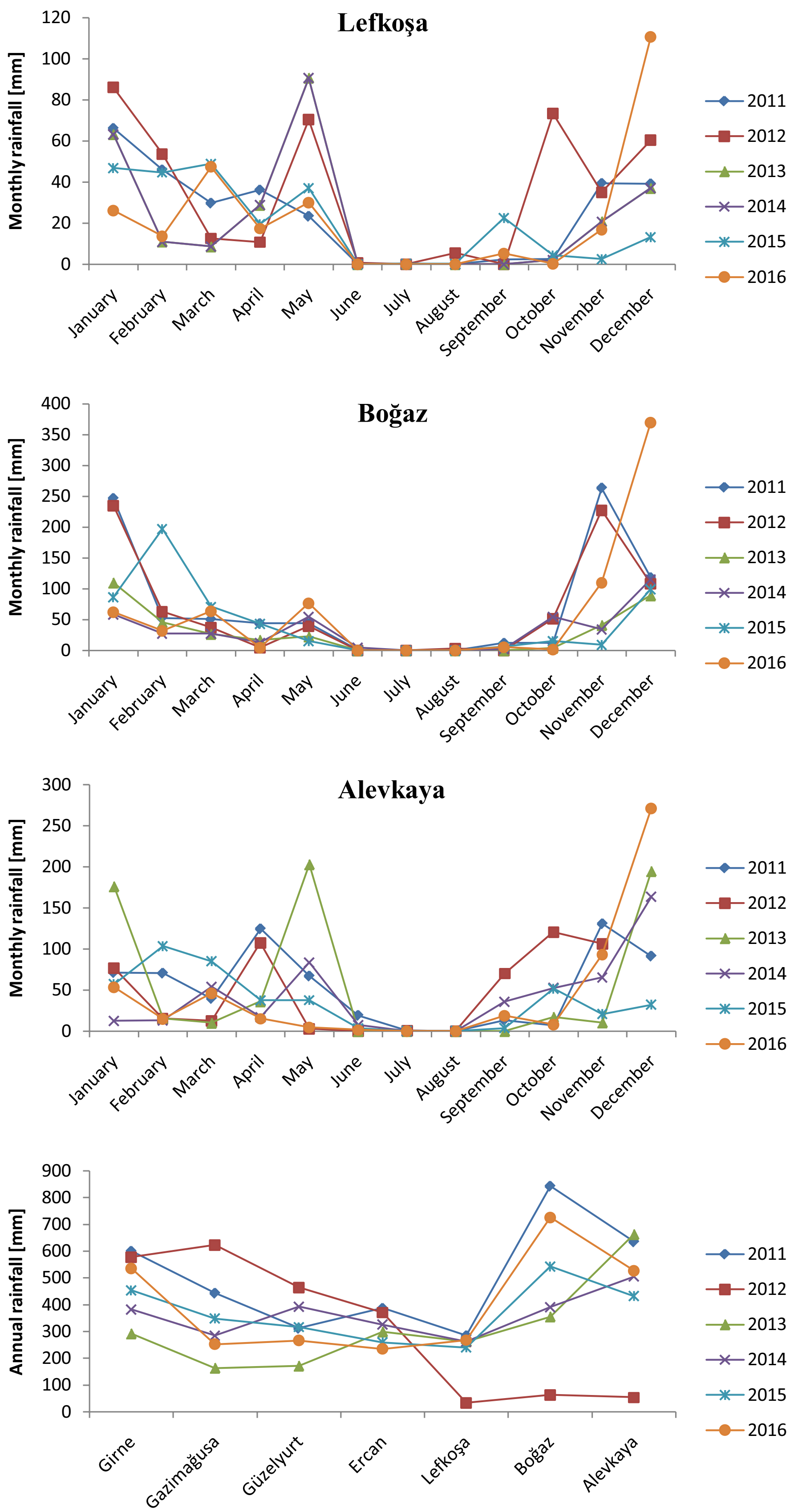

Fig. 3. Monthly rainfall during the investigation period for all selected meteorological stations.

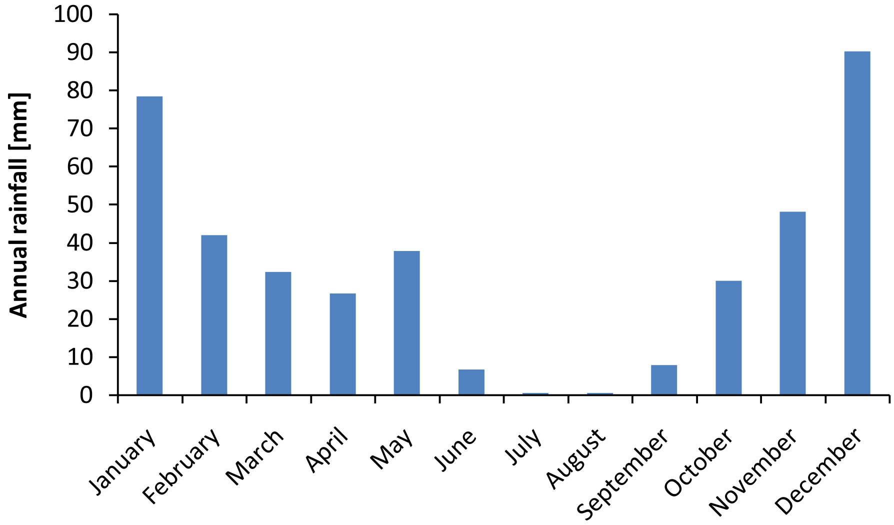

Fig. 4. Monthly rainfall for Northern Cyprus during the investigation period (2011–2016).

Moreover, Fig. 4 shows the mean monthly rainfall amount during investigation periods (2011–2016). It is found that the highest monthly mean rainfall amount is recorded in December and January, while the lowest one is obtained in July and August.

3.1.2. Air temperature

The maximum and minimum monthly air temperatures for all stations are listed in Table S3 as supplementary material. It is observed that the monthly maximum temperature was occurred in August 2011 at Lefkoşa with a value of 46.6°C and August 2015 at Güzelyurt with a value of 43.8°C. In addition, it is noticed that Lefkoşa has the lowest monthly minimum air temperature of –3.8°C compared with other stations, which was recorded in January 2008.

Moreover, Table S4 as supplementary material presents the descriptive statistics of each station including mean averaged temperature, standard deviation, variance coefficient, minimum averaged temperature, maximum averaged temperature, and skewness. For all stations, the mean averaged temperature vary from 16.22°C to 21.18°C. Mean averaged temperature and standard deviation values suggest that there is good consistency in the wind behavior. The coefficients of variation are moderately high, ranging from 25.33 to 45.15. During the investigation period, the skewness values of all stations are varying, which depends on the year and station, that is, positive value indicates that all distributions are right-skewed, while the negative value of skewness indicates that all distributions are left-skewed.

In addition, the monthly air temperature of the selected stations is shown in Fig. S1 as supplementary material. During the winter season (December, January, and February); the average monthly air temperature ranged from 16.5°C to 7°C at all studied stations. The maximum and minimum monthly air temperatures were recorded at Girne during December 2011 with 16.5°C and Alevkaya during January 2016 with 7°C, respectively. In the spring season (March, April, and May), the maximum and minimum value of air temperature was recorded in Ercan with 23.4°C during May 2013 and Alevkaya with 9.2°C during March 2012. In the summer season, the air temperature level was reached 30.2 and 20.6 m/s at Lefkoşa and Alevkaya during July 2016 and June 2015, respectively. During the autumn season, the air temperatures ranged from 27.7°C to 11.4°C. The maximum and minimum mean monthly air temperatures were recorded at Girne in November 2015 and Alevkaya in November 2011, respectively. Besides, Fig. 5 and Table 5 show the annual average temperature of all meteorological stations. It is noticed that during the investigation periods, the maximum and the minimum averaged temperatures were obtained in Girne and Boğaz.

3.1.3. Relative humidity

Fig. S2 as supplementary material highlights the monthly variation of mean relative humidity at seven stations and shows the annual relative humidity of each station. For Girne, the monthly averaged relative humidity varied from 68.50% to 44.30%, which the minimum value was recorded in October 2013. For Ercan, the monthly relative humidity falls gradually from January to June and begins to increase afterward. A similar trend is also observed at Güzelyurt, Lefkoşa, Boğaz, and Alevkaya. The minimum mean monthly relative humidity is occurred in October 2013 for all stations expect Lefkoşa and Alevkaya. It can be seen that the lowest monthly relative humidity at Lefkoşa and Alevkaya is obtained in September 2014 and August 2013, respectively. In general, the annual relative humidity values are ranged between 58.828% and 67.90% with an average value of 63.20%.

3.2. Selecting the best-fit distribution for rainfall

This study was designed to find the best-fit probability distribution of average monthly rainfall and total rainfall in Northern Cyprus using 37 probability distributions. The maximum likelihood method was used to determine

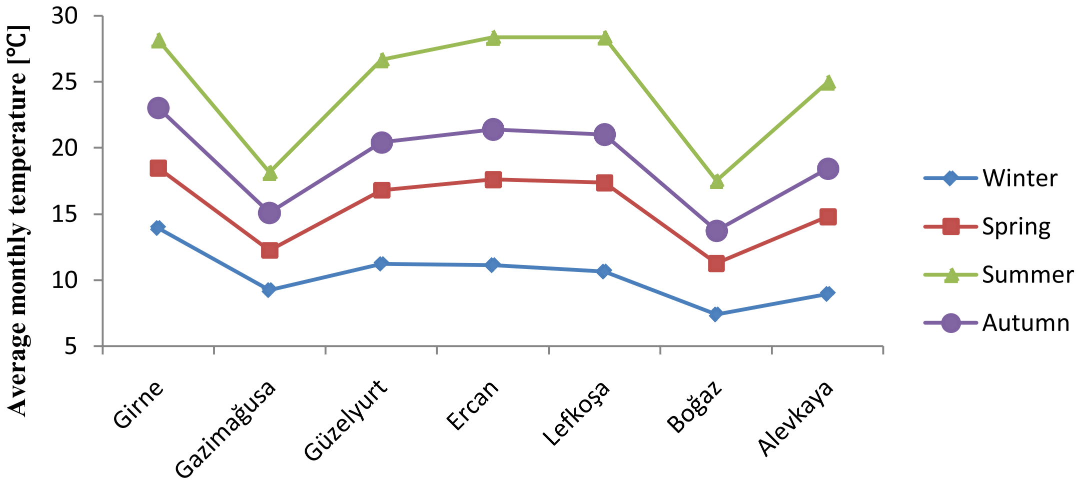

Fig. 5. Mean seasonally fair temperature at different seasons for the seven stations (2011–2016).

Table 5
Annual average monthly temperature in °C at selected stations

Year	Girne	Gazimağusa	Güzelyurt	Ercan	Lefkoşa	Boğaz	Alevkaya
2011	20.558	–	18.233	18.783	18.883	–	16.217
2012	20.892	–	18.592	19.533	19.208	–	16.725
2013	21.000	20.425	18.717	19.708	19.358	18.725	17.017
2014	21.067	20.575	19.183	19.825	19.483	18.550	16.758
2015	20.750	20.383	18.617	19.542	19.125	18.717	16.692
2016	21.175	20.717	19.383	20.325	19.975	18.933	17.392
Whole years	20.907	20.525	18.788	19.619	19.339	18.731	16.800

Whole years: average monthly temperature of the investigation period.

the distribution parameters. Also, the performances of the distributions are evaluated using the K-S test. Table S5 as supplementary material lists the distribution parameters for all selected stations. Fig. 6 illustrates the frequency histograms and probability plots of rainfall of selected locations.

Generally, the distribution with the lowest K-S value will be selected to be the best model for the rainfall distribution in the studied location. Table 6 presents the goodness-of-fit statistics for each distribution for the selected regions along with the ranking of the distribution models. Based on the K-S tests, Generalized Extreme Value distribution has the lowest value, which is considered as the best distribution function to study the average rainfall characteristics of Girne, Güzelyurt, Lefkoşa, Boğaz, Alevkaya, and Northern Cyprus. Moreover, Gumbel Max is the best overall model according to the K-S test for Gazimağusa and Ercan.

3.3. Relationship between air temperature, relative humidity and rainfall

The influences of interactions of the air temperature and relative humidity on the rainfall amount at different stations were graphically investigated using three-dimensional surface plots as shown in Fig. 7. It was observed that there was a relatively significant interaction between every two independent variables. There is a relationship between the two independent variables (air temperature and relative humidity) and their effects on the response variable (rainfall amount). For example, it was found that decreasing the air temperature leads to an increase in the rainfall amount at the selected station. In addition, it can be observed that the increase in the relative humidity leads to increase rainfall amount. The curvature's nature of the surfaces suggested significant interactions of rainfall amount with air temperature and relative humidity at the studied stations.

4. Conclusions

Freshwater is a finite and vulnerable resource that is essential for sustaining life, the environment, and future development. Consequently, the importance of water continues to grow around the world. Rainfall is considered as the main water sources in Northern Cyprus. In this study, climate data in terms of monthly rainfall amount, air temperature, and relative humidity of seven selected stations were analyzed statistically to experience different climatic environments in Northern Cyprus. The results showed that the average air temperature, relative humidity, and

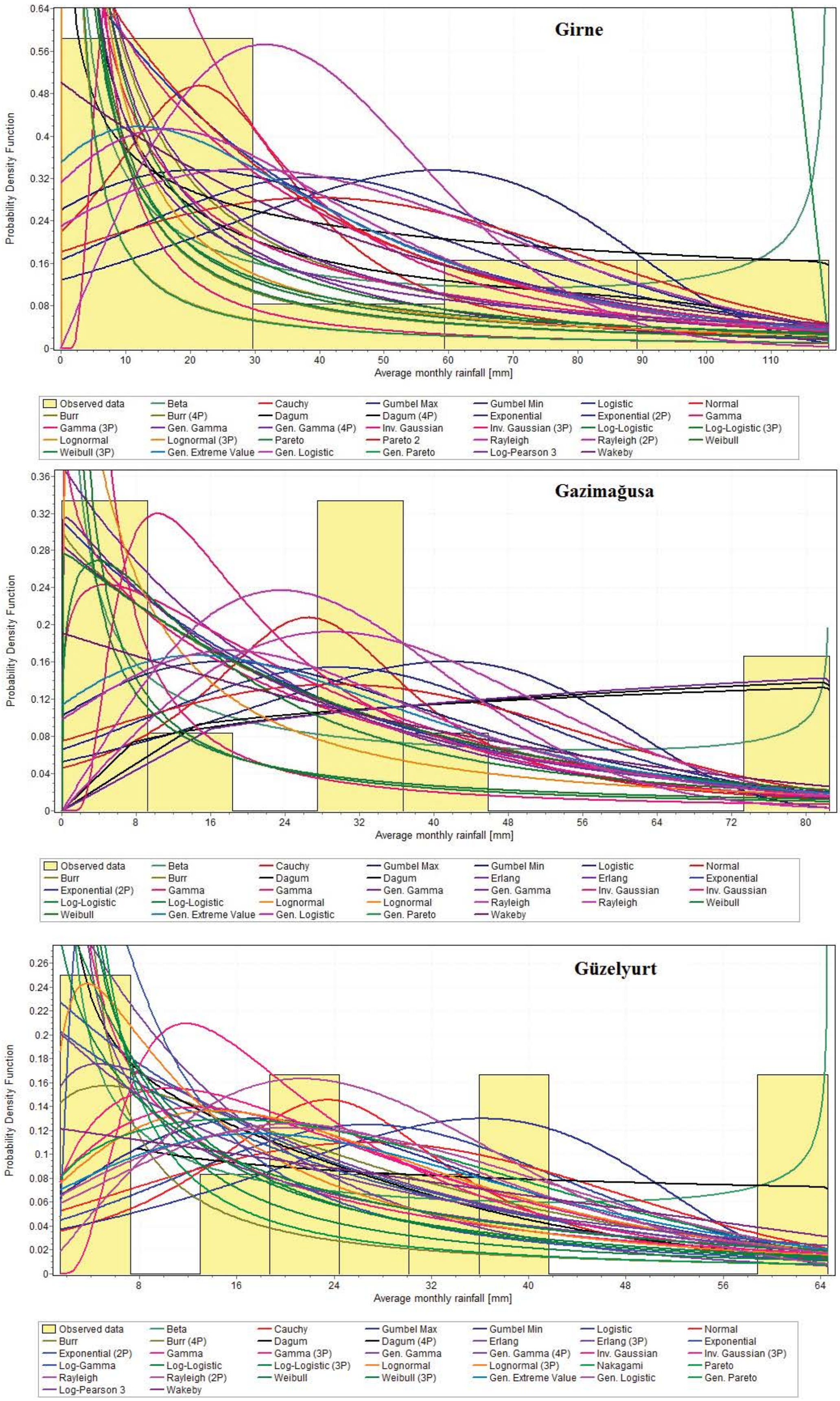

Fig. 6. Continued

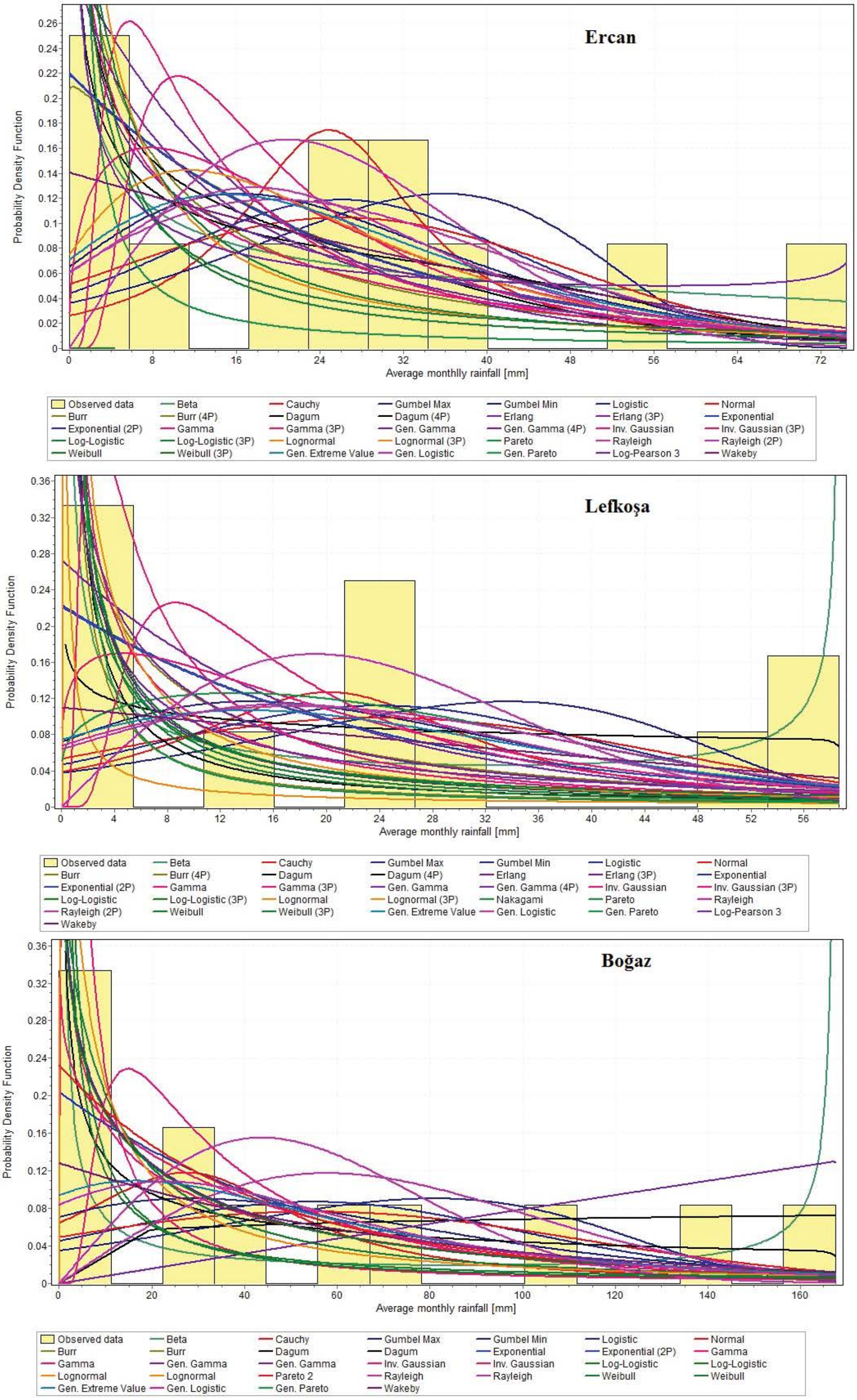

Fig. 6. Continued

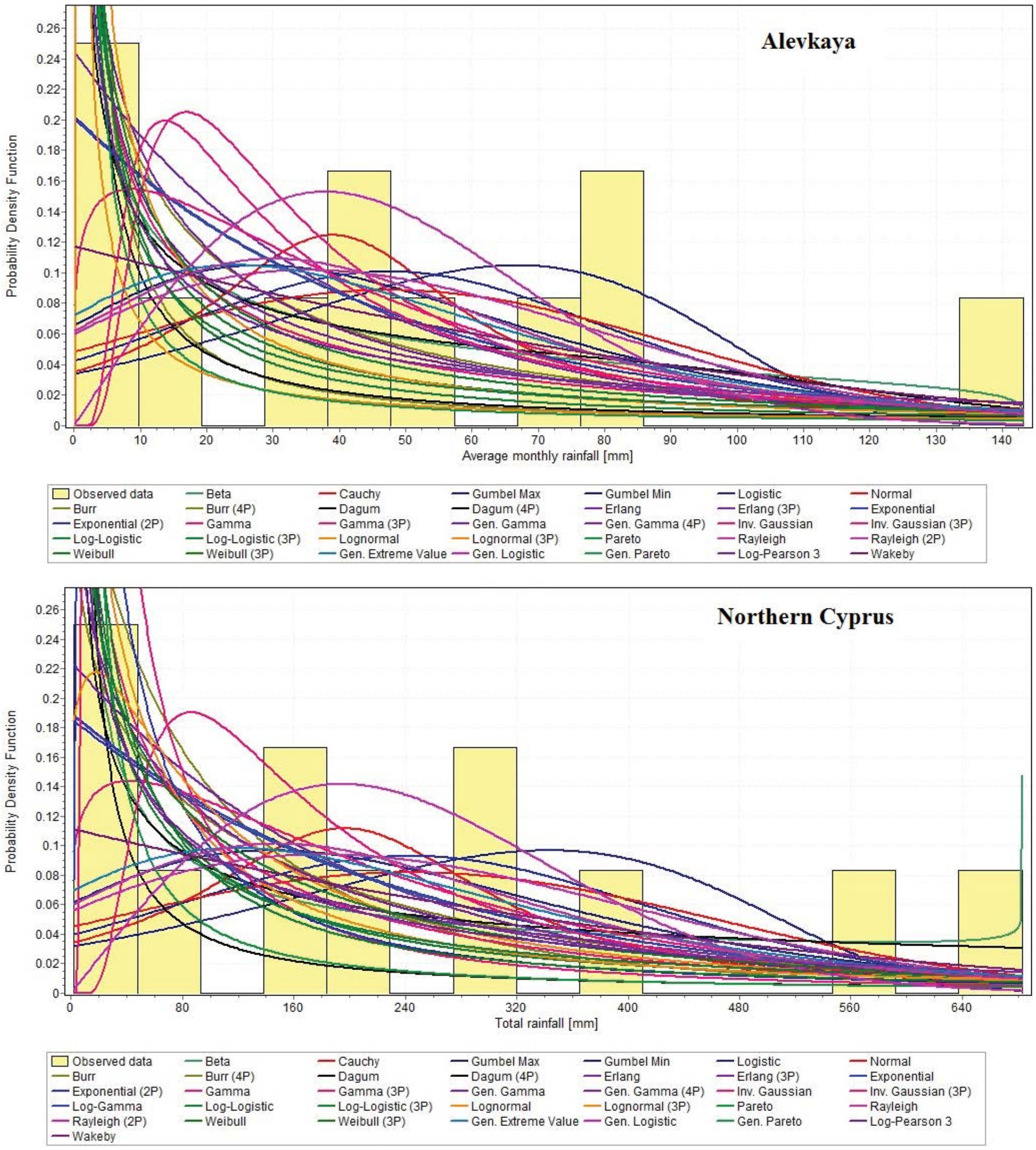

Fig. 6. Frequency histograms and probability density function plots of average monthly rainfall.

rainfall amount is within a range of 16.22°C–21.18°C, 44.30%–68.50%, and 13.61–51.9 mm, respectively, during the investigation period. Besides, mean monthly rainfall data were modeled using 37 distribution functions to forecast the behavior of rainfall in Northern Cyprus. The maximum likelihood method was used to estimate the parameters. Based on the K-S tests, Generalized Extreme Value distribution has the lowest value, which is considered as the best distribution function to study the average rainfall characteristics of Girne, Güzelyurt, Lefkoşa, Boğaz, Alevkaya, and Northern Cyprus. Moreover, Gumbel Max is the best overall model according to the K-S test for Gazimağusa and Ercan. Furthermore, the influences of interactions of the air temperature and relative humidity on the rainfall amount at different stations were graphically investigated using three-dimensional surface plots. It was found that decreasing the air temperature leads to an increase in the rainfall amount at the selected station. Also, it can be observed that the increase in relative humidity leads to an increase in the amount of rainfall.

Acknowledgments

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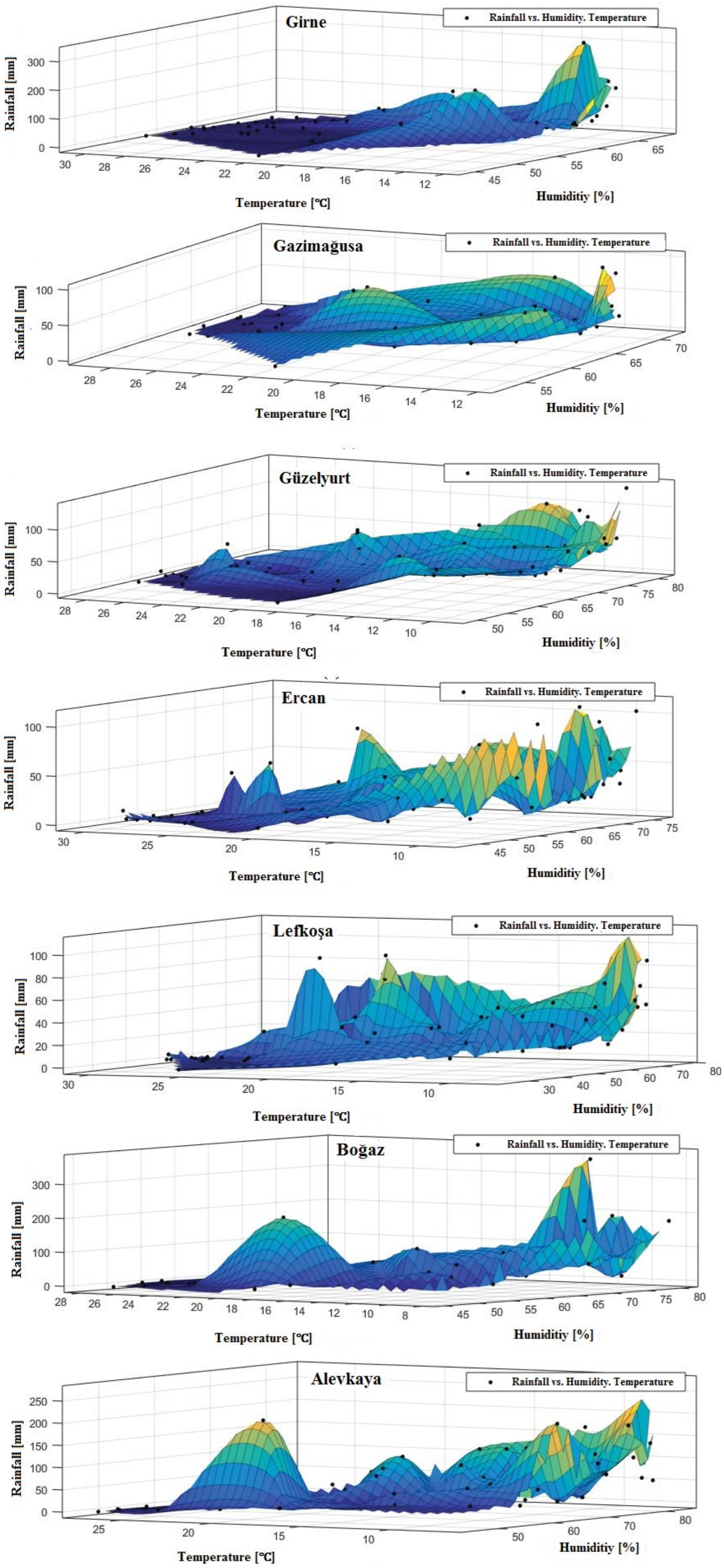

Fig. 7. Surface plots of rainfall amount of the selected stations using curve fitting.

Table 6
Results of goodness-of-fit and ranking of distribution functions based on goodness-of-fit for average monthly rainfall for whole years

Girne			Gazimağusa			Güzelyurt		
Distribution	Statistic	Rank	Distribution	Statistic	Rank	Distribution	Statistic	Rank
Beta	0.18542	6	Beta	0.17894	13	Beta	0.17602	18
Burr	0.25238	17	Burr	0.17307	9	Burr	0.14348	6
Burr (4P)	0.26613	21	Burr	0.17377	12	Burr (4P)	0.34346	35
Cauchy	0.23269	9	Cauchy	0.15542	2	Cauchy	0.16527	13
Dagum	0.25856	19	Dagum	0.44821	31	Dagum	0.21511	23
Dagum (4P)	0.26844	22	Dagum	0.42955	30	Dagum (4P)	0.21982	24
Exponential	0.24682	13	Erlang	0.26859	25	Erlang	0.36122	36
Exponential (2P)	0.24745	14	Erlang	0.17323	10	Erlang (3P)	0.17255	14
Gamma	0.22688	8	Exponential	0.20515	18	Exponential	0.18531	21
Gamma (3P)	0.24872	15	Exponential (2P)	0.20515	19	Exponential (2P)	0.17256	15
Gen. Extreme Value	**0.1517**	**1**	Gamma	0.19343	16	Gamma	0.17395	17
Gen. Gamma	0.27484	23	Gamma	0.18397	14	Gamma (3P)	0.27762	30
Gen. Gamma (4P)	0.4141	31	Gen. Extreme Value	0.1632	6	**Gen. Extreme Value**	**0.11453**	**1**
Gen. Logistic	0.15794	2	Gen. Gamma	0.20304	17	Gen. Gamma	0.17308	16
Gen. Pareto	0.15799	4	Gen. Gamma	0.45441	32	Gen. Gamma (4P)	0.29465	32
Gumbel Max	0.17937	5	Gen. Logistic	0.16205	5	Gen. Logistic	0.11549	2
Gumbel Min	0.31167	26	Gen. Pareto	0.16042	4	Gen. Pareto	0.14386	7
Inv. Gaussian	0.32934	28	**Gumbel Max**	**0.14124**	1	Gumbel Max	0.13507	3
Inv. Gaussian (3P)	0.5219	33	Gumbel Min	0.24703	23	Gumbel Min	0.19888	22
Log-Logistic	0.30063	24	Inv. Gaussian	0.45476	33	Inv. Gaussian	0.23865	28
Log-Logistic (3P)	0.25214	16	Inv. Gaussian	0.25751	24	Inv. Gaussian (3P)	0.13701	4
Log-Pearson 3	0.22333	7	Log-Logistic	0.28323	27	Log-Gamma	0.29136	31
Logistic	0.25318	18	Log-Logistic	0.16421	7	Log-Logistic	0.26639	29
Lognormal	0.30388	25	Logistic	0.17333	11	Log-Logistic (3P)	0.30974	33
Lognormal (3P)	0.46617	32	Lognormal	0.21281	21	Log-Pearson 3	0.16127	12
Normal	0.24308	11	Lognormal	0.2128	20	Logistic	0.15369	11
Pareto	0.352	30	Normal	0.19062	15	Lognormal	0.22948	27
Pareto 2	0.24109	10	Pareto 2	0.22017	22	Lognormal (3P)	0.13861	5
Rayleigh	0.32692	27	Rayleigh	0.30416	29	Nakagami	0.17845	19
Rayleigh (2P)	0.24372	12	Rayleigh	0.2894	28	Normal	0.15278	10
Wakeby	0.15799	3	Wakeby	0.16042	3	Pareto	0.37228	37
Weibull	0.26554	20	Weibull	0.27323	26	Pareto 2	0.18489	20
Weibull (3P)	0.3401	29	Weibull	0.17222	8	Rayleigh	0.22497	26
Erlang		No fit	Log-Gamma		No fit	Rayleigh (2P)	0.14967	9
Erlang (3P)		No fit	Log-Pearson 3		No fit	Wakeby	0.14386	8
Log-Gamma		No fit	Nakagami		No fit	Weibull	0.22103	25
Nakagami		No fit	Pareto		No fit	Weibull (3P)	0.31043	34

Ercan			Lefkoşa			Boğaz		
Distribution	Statistic	Rank	Distribution	Statistic	Rank	Distribution	Statistic	Rank
Beta	0.20461	13	Beta	0.16666	8	Beta	0.22647	17
Burr	0.21786	17	Burr	0.24326	20	Burr	0.20282	13
Burr (4P)	0.27127	29	Burr (4P)	0.33955	31	Burr	0.20302	14
Cauchy	0.13769	2	Cauchy	0.1871	10	Cauchy	0.26535	24
Dagum	0.18854	12	Dagum	0.21823	17	Dagum	0.37999	28
Dagum (4P)	0.29022	32	Dagum (4P)	0.31554	30	Dagum	0.18472	6
Erlang	0.34682	33	Erlang	0.27059	23	Exponential	0.25903	22
Erlang (3P)	0.21772	16	Erlang (3P)	0.21547	15	Exponential (2P)	0.25903	21
Exponential	0.21789	18	Exponential	0.21192	14	Gamma	0.23812	18
Exponential (2P)	0.21772	15	Exponential (2P)	0.2158	16	Gamma	0.18732	7
Gamma	0.17945	10	Gamma	0.22956	18	**Gen. Extreme Value**	**0.14853**	**1**
Gamma (3P)	0.26056	25	Gamma (3P)	0.37117	34	Gen. Gamma	0.19695	9
Gen. Extreme Value	0.14886	4	**Gen. Extreme Value**	**0.13123**	**1**	Gen. Gamma	0.56162	31
Gen. Gamma	0.27039	28	Gen. Gamma	0.27158	24	Gen. Logistic	0.15539	2
Gen. Gamma (4P)	0.26982	27	Gen. Gamma (4P)	0.34763	33	Gen. Pareto	0.17275	5
Gen. Logistic	0.13935	3	Gen. Logistic	0.14563	3	Gumbel Max	0.1561	3
Gen. Pareto	0.16331	7	Gen. Pareto	0.14785	5	Gumbel Min	0.24428	19
Gumbel Max	**0.13387**	**1**	Gumbel Max	0.15714	6	Inv. Gaussian	0.41995	30
Gumbel Min	0.24284	23	Gumbel Min	0.19797	11	Inv. Gaussian	0.33161	26
Inv. Gaussian	0.23613	21	Inv. Gaussian	0.28759	27	Log-Logistic	0.28654	25
Inv. Gaussian (3P)	0.26127	26	Inv. Gaussian (3P)	0.28953	28	Log-Logistic	0.20913	15
Log-Logistic	0.2729	30	Log-Logistic	0.27212	25	Logistic	0.2127	16
Log-Logistic (3P)	0.2506	24	Log-Logistic (3P)	0.26917	22	Lognormal	0.20032	10
Log-Pearson 3	0.21261	14	Log-Pearson 3	0.20119	12	Lognormal	0.20032	11
Logistic	0.16895	8	Logistic	0.16486	7	Normal	0.19178	8
Lognormal	0.28057	31	Lognormal	0.27247	26	Pareto 2	0.24968	20
Lognormal (3P)	0.1733	9	Lognormal (3P)	0.72824	36	Rayleigh	0.34322	27
Normal	0.18246	11	Nakagami	0.24529	21	Rayleigh	0.40713	29
Pareto	0.42233	34	Normal	0.14396	2	Wakeby	0.17275	4
Pareto 2	0.22637	19	Pareto	0.34627	32	Weibull	0.26005	23
Rayleigh	0.22786	20	Pareto 2	0.21071	13	Weibull	0.20253	12
Rayleigh (2P)	0.15341	5	Rayleigh	0.30008	29	Erlang	No fit	
Wakeby	0.16331	6	Rayleigh (2P)	0.18398	9	Erlang (3P)	No fit	
Weibull	0.23626	22	Wakeby	0.14785	4	Log-Gamma	No fit	
Weibull (3P)	N/A		Weibull	0.23258	19	Log-Pearson 3	No fit	
Log-Gamma	No fit		Weibull (3P)	0.43761	35	Nakagami	No fit	
Nakagami	No fit		Log-Gamma	No fit		Pareto	No fit	

(Continued)

Table 6 Continued

Alevkaya			Northern Cyprus		
Distribution	Statistic	Rank	Distribution	Statistic	Rank
Beta	0.2111	17	Beta	0.20365	18
Burr	0.24828	20	Burr	0.21205	19
Burr (4P)	0.40266	35	Burr (4P)	0.34838	35
Cauchy	0.17843	10	Cauchy	0.18736	12
Dagum	0.19518	15	Dagum	0.18271	11
Dagum (4P)	0.28129	25	Dagum (4P)	0.3164	31
Erlang	0.2547	23	Erlang	0.23954	24
Erlang (3P)	0.18355	12	Erlang (3P)	0.17031	8
Exponential	0.18363	13	Exponential	0.17176	10
Exponential (2P)	0.18321	11	Exponential (2P)	0.17032	9
Gamma	0.17089	8	Gamma	0.18778	13
Gamma (3P)	0.28291	27	Gamma (3P)	0.32737	33
Gen. Extreme Value	**0.12499**	**1**	**Gen. Extreme Value**	**0.13636**	**1**
Gen. Gamma	0.28176	26	Gen. Gamma	0.23566	22
Gen. Gamma (4P)	0.3078	32	Gen. Gamma (4P)	0.29374	29
Gen. Logistic	0.13164	2	Gen. Logistic	0.14779	5
Gen. Pareto	0.14429	5	Gen. Pareto	0.14085	3
Gumbel Max	0.13536	3	Gumbel Max	0.15523	6
Gumbel Min	0.22113	18	Gumbel Min	0.19335	16
Inv. Gaussian	0.2498	21	Inv. Gaussian	0.28807	28
Inv. Gaussian (3P)	0.23925	19	Inv. Gaussian (3P)	0.4339	36
Log-Logistic	0.2892	30	Log-Gamma	0.31698	32
Log-Logistic (3P)	0.26422	24	Log-Logistic	0.28326	27
Log-Pearson 3	0.20365	16	Log-Logistic (3P)	0.2349	21
Logistic	0.15064	6	Log-Pearson 3	0.19793	17
Lognormal	0.29719	31	Logistic	0.16363	7
Lognormal (3P)	0.35332	33	Lognormal	0.27559	26
Normal	0.15138	7	Lognormal (3P)	0.23888	23
Pareto	0.37157	34	Normal	0.14264	4
Pareto 2	0.18876	14	Pareto	0.34279	34
Rayleigh	0.28477	28	Pareto 2	0.18824	14
Rayleigh (2P)	0.17237	9	Rayleigh	0.30117	30
Wakeby	0.14429	4	Rayleigh (2P)	0.19134	15
Weibull	0.2538	22	Wakeby	0.14085	2
Weibull (3P)	0.28587	29	Weibull	0.245	25
Log-Gamma	No fit		Weibull (3P)	0.22942	20
Nakagami	No fit		Nakagami	No fit	

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Supplementary information

Table S1
Dams in Northern Cyprus constructed after 1987 [12]

District	Dams	Year of construction	Capacity (10^3) (m^3)	Irrigation area (ha)
Gazimağusa	Gönendere	1987	940	150
	Geçitkale	1989	1,360	240
	Mersinlik	1989	1,140	170
	Tatlisu	1989	156	50
	Ergazi	1989	400	84
Güzelyurt	Akdeniz	1988	1,470	–
	Gemikonağı	1988	4,120	–
Girne	Geçitköy	1989	1,800	161
	Zeytinlik	1989	50	–
	Karsiyaka	1989	25	–
	Arapköy 1	1990	440	40
	Arapköy 2	1990	600	65
	Beşparmak	1992	775	67
	Dağyolu	1994	392	82
Lefkoşa	Değirmenlik	1990	297	30
	Hamitköy	1992	529	95
	Serdarli	1992	391	56
	Lefkoşa	1994	517	40

Table S2
Aquifers' capacities in Northern Cyprus

Aquifers	Recharge (10^6) (m^3)	Sustainable yield (10^6) (m^3)	Withdrawals (10^6) (m^3)
Güzelyurt	37	37	57
Akdeniz	15	15	1.5
Lefke–G. Kona ği Y. dalga	15.5	6	6
Yesilirmak	7	1.5	1.5
Girne	11.5	11.5	11.5
Mountains Gazimağusa	2	2	8.5
Beyarmudu	0.5	0.5	0.5
Çayön–Güvercinlik–Türkmenköy	2	2	2
Lefkoşa–Serdarli	0.5	0.5	0.5
Yesilköy	1.6	1.6	3
Girne Coast	5	5	5
Yedikonuk–Büyükkonuk	0.3	0.3	0.3
Dipkarpaz	1.5	1.5	1.5
Korucam	1.5	1.2	1.2
Others	2	2	2
Total	89.1	74.1	103

Table S3
Monthly maximum and minimum air temperature in °C at selected stations (2007–2016)

Year	Period	Girne		Gazimağusa		Güzelyurt		Ercan		Lefkoşa		Boğaz		Alevkaya	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
2007	January	16.8	9.6	–	–	17	3.8	16.2	3.2	16.5	4	–	–	11	4.5
	August	33.2	25.4	–	–	33.8	21.1	37	22.1	38	23	–	–	31.5	20.5
2008	January	19.3	5.6	–	–	18.4	–2	19	–2.1	18.9	–3.8	–	–	13.7	–1
	August	36.5	24.2	–	–	40.3	17.6	40.8	20.6	41.2	20.3	–	–	35.4	18.2
2009	January	19.7	5.1	–	–	21	0.5	19.6	0.5	19.9	–1.4	–	–	16.6	–1.3
	August	37.8	23.4	–	–	40	16	39.9	18.2	40.1	17	–	–	35.3	17.4
2010	January	23.5	6	–	–	25	1	22.5	–1.6	24.3	–1.6	–	–	22.1	4.6
	August	38.8	25.1	–	–	42.7	19.1	45	20.1	46.6	19.1	–	–	40.5	18.2
2011	January	19.2	9.8	–	–	19.4	2.5	18.2	3.4	18.5	2.3	–	–	15.2	0.6
	August	37	23.9	–	–	40.3	17.1	41.2	18.8	40.9	18.1	–	–	36.5	17.5
2012	January	19.6	4.1	–	–	19	–2.1	17.7	–2.9	17.5	–2.8	–	–	14.1	–2.1
	August	38.3	23.1	–	–	40.5	15.3	39.6	17.4	39.6	16.7	–	–	35.9	18.4
2013	January	19.9	2.3	18.9	1.9	19.9	–1.4	19.6	–1.1	19	–2.5	17.5	–0.7	16.4	–1.8
	August	39	2.4	34.3	22.9	40.6	17.2	39.8	19.3	41	18.2	36.9	20.2	36.3	17.9
2014	January	21	10.8	19.5	7.4	21.3	2.2	19.8	3.5	20.3	2.3	17.9	7.3	15.7	4.9
	August	35.3	24.1	34.2	23.9	41.8	19.4	39.8	20.7	41.9	20.2	37	20.6	36.6	17.3
2015	January	20.1	3.9	18.2	2	21.2	–2.3	18.6	–1.8	19.8	–3.4	16.9	0	16.4	–2.3
	August	36.5	25.1	36.6	23.4	43.8	18.5	42.3	21.2	43.1	20.1	39	21	38.6	18.8
2016	January	20.1	4.9	19.8	2.4	21.3	–2.6	21.5	–1.9	22	–3.7	18.6	–1	17.8	–1.5
	August	34.6	23.9	35.3	23.6	37.4	17.7	39.9	20.7	41	18.6	36.5	20.1	36.5	16.8

The highest and lowest temperatures are recorded in August and January during the investigation period.

Table S4
Statistical parameters of mean air temperature

Station	Variable	Mean (°C)	Standard deviation (°C)	Variance coefficient	Minimum (°C)	Maximum (°C)	Skewness
Girne	2011	20.56	6.09	29.64	13.8	29.4	0.32
	2012	20.89	6.65	31.84	12.2	30.4	0.11
	2013	21	5.9	28.12	13.3	29.6	0.12
	2014	21.07	5.42	25.71	14.5	29.3	0.3
	2015	20.75	6.1	29.38	12.9	29.8	0.12
	2016	21.18	6.21	29.31	12.5	29.5	0.01
	Average	20.91	6.02	28.77	13.28	29.65	0.18
Gazimağusa	2013	20.42	5.66	27.72	13	28.6	0.07
	2014	20.57	5.21	25.33	13.7	28.2	0.25
	2015	20.38	5.95	29.19	12.6	29	0.11
	2016	20.72	5.93	28.61	12.2	28.7	–0.03
	Average	13.68	3.76	27.48	8.73	19.08	0.12
Güzelyurt	2011	18.23	6.58	36.08	10.8	27.3	0.26
	2012	18.59	7.03	37.81	9.3	28.5	0.07
	2013	18.72	6.28	33.53	10.4	27.6	0.08
	2014	19.18	5.89	30.69	12	28.1	0.25
	2015	18.62	6.57	35.27	10.3	28.2	0.1
	2016	19.38	6.46	33.33	10.4	28.2	–0.03
	Average	18.79	6.41	34.12	10.68	27.87	0.14
Ercan	2011	18.78	7.01	37.35	11	29.2	0.24
	2012	19.53	7.86	40.26	8.9	30.6	0.04
	2013	19.71	7.12	36.13	10.1	29.7	0.01
	2014	19.82	6.46	32.59	11.9	29.3	0.25
	2015	19.54	7.35	37.61	9.9	30	0.07
	2016	20.32	7.3	35.92	9.7	30.2	–0.09
	Average	19.62	7.12	36.29	10.38	29.65	0.1
Lefkoşa	2011	18.88	7.45	39.43	10.7	29.4	0.29
	2012	19.21	8	41.64	8.4	30.4	0.05
	2013	19.36	7.21	37.27	9.6	29.5	–0.01
	2014	19.48	6.6	33.85	11.6	29.2	0.25
	2015	19.13	7.5	39.21	9.2	29.7	0.05
	2016	19.98	7.47	37.39	9.3	30.2	–0.05
	Average	19.34	7.31	37.8	9.9	29.53	0.12
Boğaz	2013	17.02	6.51	38.24	8.3	26.8	0.03
	2014	18.55	5.67	30.54	11.7	26.9	0.29
	2015	18.72	6.85	36.57	9.7	27.9	–0.04
	2016	18.17	8.21	45.15	0	28	–0.88
	Average	12.08	4.24	35.09	5.65	17.63	–0.06
Alevkaya	2011	16.22	6.86	42.31	8.6	26.1	0.34
	2012	16.72	7.38	44.1	7	27.2	0.07
	2013	17.02	6.51	38.24	8.3	26.8	0.03
	2014	16.76	5.76	34.38	9.7	25.6	0.34
	2015	16.69	6.75	40.42	7.8	26.2	0.08
	2016	17.39	6.84	39.34	7	26.8	–0.16
	Average	16.8	6.6	39.27	8.18	26.15	0.14
All Northern Cyprus	2011	19.21	6.41	33.38	12.1	28.5	0.31
	2012	19.52	7.03	36	10.2	29.3	0.07
	2013	19.78	6.24	31.55	11.5	28.8	0.04
	2014	19.77	5.68	28.72	12.7	28.2	0.27
	2015	20.05	6.2	30.92	10.9	29	–0.09
	2016	20.07	6.52	32.5	10.5	28.8	–0.09
	Average	19.73	6.25	31.66	11.45	28.7	0.15

Table S5
Parameter values of different distribution function over the investigated period

Distribution	Girne	Distribution	Gazimağusa
Beta	$\alpha_1 = 0.26277$ $\alpha_2 = 0.52889$ $a = 0.03$ $b = 118.8$	Beta	$\alpha_1 = 0.40875$ $\alpha_2 = 0.73814$ $a = -1.0000E-14$ $b = 82.47$
Burr	$k = 886.86$ $\alpha = 0.59683$ $\beta = 2.5691E+6$	Burr	$k = 4.1953E+8$ $\alpha = 0.99996$ $\beta = 1.3467E+10$
Burr (4P)	$k = 0.47911$ $\alpha = 0.65586$ $\beta = 1.9423$ $\gamma = 0.03$	Burr	$k = 3.3965E+10$ $\alpha = 0.98772$ $\beta = 1.4723E+12$
Cauchy	$\sigma = 19.109$ $\mu = 21.339$	Cauchy	$\sigma = 14.042$ $\mu = 26.438$
Dagum	$k = 0.00488$ $\alpha = 135.37$ $\beta = 121.82$	Dagum	$k = 0.0043$ $\alpha = 294.09$ $\beta = 83.431$
Dagum (4P)	$k = 0.02473$ $\alpha = 12.832$ $\beta = 118.41$ $\gamma = 0.03$	Dagum	$k = 0.00299$ $\alpha = 402.92$ $\beta = 83.279$
Exponential	$\lambda = 0.02535$	Erlang	$m = 1$ $\beta = 24.723$
Exponential (2P)	$\lambda = 0.02537$ $\gamma = 0.03$	Erlang	$m = 1$ $\beta = 32.064$
Gamma	$\alpha = 0.89151$ $\beta = 44.253$	Exponential	$\lambda = 0.03402$
Gamma (3P)	$\alpha = 0.40126$ $\beta = 106.23$ $\gamma = 0.03$	Exponential (2P)	$\lambda = 0.03402$ $\gamma = -1.0000E-14$
Gen. Extreme Value	$k = 0.2108$ $\sigma = 26.723$ $\mu = 17.066$	Gamma	$\alpha = 1.1888$ $\beta = 24.723$
Gen. Gamma	$k = 0.74364$ $\alpha = 0.73347$ $\beta = 44.253$	Gamma	$\alpha = 0.88644$ $\beta = 36.171$
Gen. Gamma (4P)	$k = 1.1778$ $\alpha = 0.26985$ $\beta = 68.632$ $\gamma = 0.03$	Gen. Extreme Value	$k = 0.07941$ $\sigma = 20.248$ $\mu = 15.987$
Gen. Logistic	$k = 0.31278$ $\sigma = 19.869$ $\mu = 27.948$	Gen. Gamma	$k = 0.88907$ $\alpha = 1.1485$ $\beta = 24.723$
Gen. Pareto	$k = -0.04696$ $\sigma = 50.292$ $\mu = -8.5833$	Gen. Gamma	$k = 427.88$ $\alpha = 0.00303$ $\beta = 83.123$
Gumbel Max	$\sigma = 32.579$ $\mu = 20.647$	Gen. Logistic	$k = 0.22198$ $\sigma = 13.985$ $\mu = 23.98$
Gumbel Min	$\sigma = 32.579$ $\mu = 58.258$	Gen. Pareto	$k = -0.27337$ $\sigma = 43.963$ $\mu = -5.1336$
Inv. Gaussian	$\lambda = 35.172$ $\mu = 39.453$	Gumbel Max	$\sigma = 21.018$ $\mu = 17.26$
Inv. Gaussian (3P)	$\lambda = 1.0291$ $\mu = 42.48$ $\gamma = 0.02927$	Gumbel Min	$\sigma = 21.018$ $\mu = 41.524$
Log–Logistic	$\alpha = 0.48578$ $\beta = 7.7252$	Inv. Gaussian	$\lambda = 1.897$ $\mu = 32.064$
Log–Logistic (3P)	$\alpha = 0.52441$ $\beta = 14.939$ $\gamma = 0.03$	Inv. Gaussian	$\lambda = 34.942$ $\mu = 29.392$
Log–Pearson 3	$\alpha = 2.3832$ $\beta = -1.7403$ $\gamma = 6.4197$	Log–Logistic	$\alpha = 0.49682$ $\beta = 7.1497$
Logistic	$\sigma = 23.037$ $\mu = 39.453$	Log–Logistic	$\alpha = 1.246$ $\beta = 22.297$
Lognormal	$\sigma = 2.5722$ $\mu = 2.2722$	Logistic	$\sigma = 14.862$ $\mu = 29.392$
Lognormal (3P)	$\sigma = 5.0258$ $\mu = -1.0471$ $\gamma = 0.03$	Lognormal	$\sigma = 1.6515$ $\mu = 2.807$
Normal	$\sigma = 41.784$ $\mu = 39.453$	Lognormal	$\sigma = 1.6515$ $\mu = 2.807$
Pareto	$\alpha = 0.17305$ $\beta = 0.03$	Normal	$\sigma = 26.957$ $\mu = 29.392$
Pareto 2	$\alpha = 14.27$ $\beta = 524.62$	Pareto 2	$\alpha = 115.79$ $\beta = 3252.9$
Rayleigh	$\sigma = 31.479$	Rayleigh	$\sigma = 28.888$
Rayleigh (2P)	$\sigma = 53.396$ $\gamma = -24.594$	Rayleigh	$\sigma = 23.451$
Wakeby	$\alpha = 50.292$ $\beta = 0.04696$ $\gamma = 0$ $\delta = 0$ $\xi = -8.5833$	Wakeby	$\alpha = 43.963$ $\beta = 0.27337$ $\gamma = 0$ $\delta = 0$ $\xi = -5.1336$
Weibull	$\alpha = 0.36184$ $\beta = 30.73$	Weibull	$\alpha = 0.31739$ $\beta = 26.592$
Weibull (3P)	$\alpha = 0.4745$ $\beta = 18.853$ $\gamma = 0.03$	Weibull	$\alpha = 1.0062$ $\beta = 32.129$
Erlang	No fit	Log–Gamma	No fit
Erlang (3P)	No fit	Log–Pearson 3	No fit
Log–Gamma	No fit	Nakagami	No fit
Nakagami	No fit	Pareto	No fit

Table S5 Continued

Distribution	Güzelyurt	Distribution	Ercan
Beta	α_1 = 0.47889 α_2 = 0.71871 a = 1.5 b = 64.57	Beta	α_1 = 0.57163 α_2 = 1.0624 a = 0.05 b = 81.856
Burr	k = 6152.6 α = 1.1643 β = 50271.0	Burr	k = 5.6394E+11 α = 1.0115 β = 1.0792E+13
Burr (4P)	k = 0.55898 α = 0.65781 β = 1.6714 γ = 1.5	Burr (4P)	k = 10.024 α = 0.75757 β = 453.14 γ = 0.05
Cauchy	σ = 12.545 μ = 23.45	Cauchy	σ = 10.44 μ = 24.87
Dagum	k = 0.00249 α = 331.24 β = 65.372	Dagum	k = 0.10998 α = 5.4834 β = 61.355
Dagum (4P)	k = 0.25205 α = 2.6868 β = 41.22 γ = 1.5	Dagum (4P)	k = 0.15792 α = 3.6834 β = 46.265 γ = 0.05
Erlang	m = 1 β = 16.257	Erlang	m = 1 β = 18.317
Erlang (3P)	m = 1 β = 25.22 γ = 1.5	Erlang (3P)	m = 1 β = 26.016 γ = 0.04496
Exponential	λ = 0.03743	Exponential	λ = 0.03837
Exponential (2P)	λ = 0.03965 γ = 1.5	Exponential (2P)	λ = 0.03845 γ = 0.05
Gamma	α = 1.6437 β = 16.257	Gamma	α = 1.4227 β = 18.317
Gamma (3P)	α = 0.53474 β = 47.381 γ = 1.5	Gamma (3P)	α = 0.59081 β = 46.794 γ = 0.05
Gen. Extreme Value	k = –0.03399 σ = 18.013 μ = 16.91	Gen. Extreme Value	k = 0.04214 σ = 17.098 μ = 15.449
Gen. Gamma	k = 0.88137 α = 1.4619 β = 16.257	Gen. Gamma	k = 0.79772 α = 1.164 β = 18.317
Gen. Gamma (4P)	k = 2.092 α = 0.2025 β = 69.88 γ = 1.5	Gen. Gamma (4P)	k = 2.5877 α = 0.20362 β = 62.91 γ = 0.05
Gen. Logistic	k = 0.14827 σ = 11.678 μ = 23.798	Gen. Logistic	k = 0.19729 σ = 11.566 μ = 22.131
Gen. Pareto	k = –0.48351 σ = 44.622 μ = –3.3587	Gen. Pareto	k = –0.34087 σ = 38.735 μ = –2.8282
Gumbel Max	σ = 16.25 μ = 17.34	Gumbel Max	σ = 17.035 μ = 16.227
Gumbel Min	σ = 16.25 μ = 36.1	Gumbel Min	σ = 17.035 μ = 35.893
Inv. Gaussian	λ = 43.918 μ = 26.72	Inv. Gaussian	λ = 37.076 μ = 26.06
Inv. Gaussian (3P)	λ = 154.87 μ = 42.521 γ = –15.801	Inv. Gaussian (3P)	λ = 17.712 μ = 28.387 γ = 0.03751
Log–Gamma	α = 4.7753 β = 0.584	Log–Logistic	α = 0.6015 β = 10.19
Log–Logistic	α = 1.05 β = 14.345	Log–Logistic (3P)	α = 0.87345 β = 14.131 γ = 0.05
Log–Logistic (3P)	α = 0.7393 β = 9.9517 γ = 1.5	Log–Pearson 3	α = 0.8499 β = –2.1591 γ = 4.3221
Log–Pearson 3	α = 3.6374 β = –0.66915 γ = 5.2227	Logistic	σ = 12.046 μ = 26.06
Logistic	σ = 11.491 μ = 26.72	Lognormal	σ = 1.9057 μ = 2.4871
Lognormal	σ = 1.2219 μ = 2.7888	Lognormal (3P)	σ = 0.57172 μ = 3.4962 γ = –12.425
Lognormal (3P)	σ = 0.47902 μ = 3.6707 γ = –17.104	Normal	σ = 21.848 μ = 26.06
Nakagami	m = 0.63209 Ω = 1,112.1	Pareto	α = 0.18239 β = 0.05
Normal	σ = 20.842 μ = 26.72	Pareto 2	α = 93.307 β = 2364.6
Pareto	α = 0.41958 β = 1.5	Rayleigh	σ = 20.793
Pareto 2	α = 174.03 β = 4,648.6	Rayleigh (2P)	σ = 29.204 γ = –9.551
Rayleigh	σ = 21.319	Wakeby	α = 38.735 β = 0.34087 γ = 0 δ = 0 ξ = –2.8282
Rayleigh (2P)	σ = 28.506 γ = –8.3081	Weibull	α = 0.45842 β = 30.304
Wakeby	α = 44.622 β = 0.48351 γ = 0 δ = 0 ξ = 3.3587	Weibull (3P)	α = 0.54876 β = 2.8257E–5 γ = 0.04533
Weibull	α = 0.77366 β = 27.363	Log–Gamma	No fit
Weibull (3P)	α = 0.6184 β = 18.907 γ = 1.5	Nakagami	No fit

Table S5 Continued

Distribution	Lefkoşa	Distribution	Boğaz
Beta	α_1 = 0.31677 α_2 = 0.46013 a = 0.1 b = 58.6	Beta	α_1 = 0.15809 α_2 = 0.20509 a = 2.3553E–15 b = 167.47
Burr	k = 1,994.5 α = 0.69587 β = 1.1173E+6	Burr	k = 3,885.3 α = 0.75143 β = 3.1025E+6
Burr (4P)	k = 0.9567 α = 0.36241 β = 1.5555 γ = 0.1	Burr	k = 1956.2 α = 0.75256 β = 1.2255E+6
Cauchy	σ = 13.372 μ = 20.168	Cauchy	σ = 30.124 μ = 27.351
Dagum	k = 0.00632 α = 131.1 β = 59.632	Dagum	k = 0.00343 α = 324.35 β = 171.4
Dagum (4P)	k = 1.4857 α = 0.37613 β = 2.1911 γ = 0.1	Dagum	k = 0.00371 α = 139.23 β = 169.53
Erlang	m = 1 β = 19.417	Exponential	λ = 0.01829
Erlang (3P)	m = 1 β = 23.889 γ = 0.09059	Exponential (2P)	λ = 0.01829 γ = –1.0000E–14
Exponential	λ = 0.04175	Gamma	α = 0.87977 β = 62.131
Exponential (2P)	λ = 0.04192 γ = 0.1	Gamma	α = 0.6182 β = 96.458
Gamma	α = 1.2336 β = 19.417	Gen. Extreme Value	k = 0.19938 σ = 38.282 μ = 23.261
Gamma (3P)	α = 0.35766 β = 42.191 γ = 0.1	Gen. Gamma	k = 0.83941 α = 0.84312 β = 62.131
Gen. Extreme Value	k = –0.01375 σ = 18.346 μ = 13.609	Gen. Gamma	k = 787.62 α = 0.0025 β = 168.42
Gen. Gamma	k = 0.70361 α = 0.95759 β = 19.417	Gen. Logistic	k = 0.30465 σ = 28.281 μ = 38.812
Gen. Gamma (4P)	k = 0.49005 α = 0.69363 β = 25.031 γ = 0.1	Gen. Pareto	k = –0.06595 σ = 72.914 μ = –13.742
Gen. Logistic	k = 0.16112 σ = 12.029 μ = 20.667	Gumbel Max	σ = 45.438 μ = 28.433
Gen. Pareto	k = –0.44496 σ = 44.366 μ = –6.7516	Gumbel Min	σ = 45.438 μ = 80.888
Gumbel Max	σ = 16.815 μ = 14.247	Inv. Gaussian	λ = 3.2143 μ = 59.63
Gumbel Min	σ = 16.815 μ = 33.658	Inv. Gaussian	λ = 48.089 μ = 54.661
Inv. Gaussian	λ = 29.547 μ = 23.953	Log–Logistic	α = 0.48391 β = 8.8202
Inv. Gaussian (3P)	λ = 7.4918 μ = 28.603 γ = 0.09471	Log–Logistic	α = 0.91197 β = 29.278
Log–Logistic	α = 0.54562 β = 6.4183	Logistic	σ = 32.129 μ = 54.661
Log–Logistic (3P)	α = 0.59706 β = 10.98 γ = 0.1	Lognormal	σ = 1.9275 μ = 3.0931
Log–Pearson 3	α = 2.6478 β = –1.4363 γ = 5.8466	Lognormal	σ = 1.9275 μ = 3.0931
Logistic	σ = 11.89 μ = 23.953	Normal	σ = 58.276 μ = 54.661
Lognormal	σ = 2.2377 μ = 2.0435	Pareto 2	α = 7.8155 β = 375.41
Lognormal (3P)	σ = 7.7386 μ = 8.7703 γ = 0.1	Rayleigh	σ = 43.613
Nakagami	m = 0.60295 Ω = 1,000.1	Rayleigh	σ = 57.687
Normal	σ = 21.566 μ = 23.953	Wakeby	α = 72.914 β = 0.06595 γ = 0 δ = 0 ξ = –13.742
Pareto	α = 0.23009 β = 0.1	Weibull	α = 0.30738 β = 34.15
Pareto 2	α = 235.13 β = 5454.6	Weibull	α = 0.74946 β = 51.982
Rayleigh	σ = 19.111	Erlang	No fit
Rayleigh (2P)	σ = 29.039 γ = –11.547	Erlang (3P)	No fit
Wakeby	α = 44.366 β = 0.44496 γ = 0 δ = 0 ξ = –6.7516	Log–Gamma	No fit
Weibull	α = 0.40604 β = 21.968	Log–Pearson 3	No fit
Weibull (3P)	α = 0.33551 β = 4.3973 γ = 0.1	Nakagami	No fit
Log–Gamma	No fit	Pareto	No fit

Table S5 Continued

Distribution	Alevkaya	Distribution	Northern Cyprus
Beta	$\alpha_1 = 0.48043$ $\alpha_2 = 1.1682$ $a = 0.15$ $b = 143.1$	Beta	$\alpha_1 = 0.41173$ $\alpha_2 = 0.90089$ $a = 2.37$ $b = 682.75$
Burr	$k = 2714.6$ $\alpha = 0.737$ $\beta = 1.8950E+6$	Burr	$k = 1687.0$ $\alpha = 0.84853$ $\beta = 1.4396E+6$
Burr (4P)	$k = 0.77953$ $\alpha = 0.53578$ $\beta = 2.0551$ $\gamma = 0.15$	Burr (4P)	$k = 5.2942$ $\alpha = 0.91028$ $\beta = 804.43$ $\gamma = 2.37$
Cauchy	$\sigma = 24.357$ $\mu = 38.953$	Cauchy	$\sigma = 129.28$ $\mu = 196.04$
Dagum	$k = 0.06836$ $\alpha = 7.0169$ $\beta = 130.28$	Dagum	$k = 0.00321$ $\alpha = 145.41$ $\beta = 705.46$
Dagum (4P)	$k = 1.4698$ $\alpha = 0.36768$ $\beta = 2.6996$ $\gamma = 0.15$	Dagum (4P)	$k = 2.5292$ $\alpha = 0.28185$ $\beta = 0.55799$ $\gamma = 2.37$
Erlang	$m = 1$ $\beta = 38.881$	Erlang	$m = 1$ $\beta = 201.22$
Erlang (3P)	$m = 1$ $\beta = 47.19$ $\gamma = 0.14983$	Erlang (3P)	$m = 1$ $\beta = 241.33$ $\gamma = 2.132$
Exponential	$\lambda = 0.0211$	Exponential	$\lambda = 0.00411$
Exponential (2P)	$\lambda = 0.02117$ $\gamma = 0.15$	Exponential (2P)	$\lambda = 0.00415$ $\gamma = 2.37$
Gamma	$\alpha = 1.2187$ $\beta = 38.881$	Gamma	$\alpha = 1.2094$ $\beta = 201.22$
Gamma (3P)	$\alpha = 0.41955$ $\beta = 119.49$ $\gamma = 0.15$	Gamma (3P)	$\alpha = 0.53032$ $\beta = 340.9$ $\gamma = 2.37$
Gen. Extreme Value	$k = 0.0561$ $\sigma = 33.451$ $\mu = 26.119$	Gen. Extreme Value	$k = 0.07804$ $\sigma = 170.41$ $\mu = 130.8$
Gen. Gamma	$k = 0.73771$ $\alpha = 0.96551$ $\beta = 38.881$	Gen. Gamma	$k = 0.81283$ $\alpha = 1.0328$ $\beta = 201.22$
Gen. Gamma (4P)	$k = 1.4279$ $\alpha = 0.28528$ $\beta = 121.41$ $\gamma = 0.15$	Gen. Gamma (4P)	$k = 3.6261$ $\alpha = 0.1086$ $\beta = 631.1$ $\gamma = 2.37$
Gen. Logistic	$k = 0.20649$ $\sigma = 22.805$ $\mu = 39.241$	Gen. Logistic	$k = 0.22107$ $\sigma = 117.61$ $\mu = 198.04$
Gen. Pareto	$k = -0.3154$ $\sigma = 74.578$ $\mu = -9.3114$	Gen. Pareto	$k = -0.27581$ $\sigma = 370.57$ $\mu = -47.108$
Gumbel Max	$\sigma = 33.467$ $\mu = 28.067$	Gumbel Max	$\sigma = 172.53$ $\mu = 143.76$
Gumbel Min	$\sigma = 33.467$ $\mu = 66.703$	Gumbel Min	$\sigma = 172.53$ $\mu = 342.94$
Inv. Gaussian	$\lambda = 57.749$ $\mu = 47.385$	Inv. Gaussian	$\lambda = 294.3$ $\mu = 243.35$
Inv. Gaussian (3P)	$\lambda = 42.954$ $\mu = 56.679$ $\gamma = 0.14971$	Inv. Gaussian (3P)	$\lambda = 37.57$ $\mu = 172.09$ $\gamma = 2.37$
Log–Logistic	$\alpha = 0.5334$ $\beta = 13.496$	Log–Gamma	$\alpha = 6.5053$ $\beta = 0.71619$
Log–Logistic (3P)	$\alpha = 0.64882$ $\beta = 29.49$ $\gamma = 0.15$	Log–Logistic	$\alpha = 0.72719$ $\beta = 89.06$
Log–Pearson 3	$\alpha = 1.8004$ $\beta = -1.7314$ $\gamma = 5.9163$	Log–Logistic (3P)	$\alpha = 0.76894$ $\beta = 146.49$ $\gamma = 2.37$
Logistic	$\sigma = 23.665$ $\mu = 47.385$	Log–Pearson 3	$\alpha = 2.8454$ $\beta = -1.0829$ $\gamma = 7.7403$
Lognormal	$\sigma = 2.2243$ $\mu = 2.7992$	Logistic	$\sigma = 122.0$ $\mu = 243.35$
Lognormal (3P)	$\sigma = 5.6959$ $\mu = 2.8187$ $\gamma = 0.15$	Lognormal	$\sigma = 1.7489$ $\mu = 4.659$
Normal	$\sigma = 42.923$ $\mu = 47.385$	Lognormal (3P)	$\sigma = 1.2589$ $\mu = 4.9823$ $\gamma = -12.182$
Pareto	$\alpha = 0.21293$ $\beta = 0.15$	Normal	$\sigma = 221.28$ $\mu = 243.35$
Pareto 2	$\alpha = 258.01$ $\beta = 12032.0$	Pareto	$\alpha = 0.26342$ $\beta = 2.37$
Rayleigh	$\sigma = 37.808$	Pareto 2	$\alpha = 137.68$ $\beta = 31880.0$
Rayleigh (2P)	$\sigma = 56.883$ $\gamma = -21.771$	Rayleigh	$\sigma = 194.16$
Wakeby	$\alpha = 74.578$ $\beta = 0.3154$ $\gamma = 0$ $\delta = 0$ $\xi = -9.3114$	Rayleigh (2P)	$\sigma = 292.77$ $\gamma = -112.38$
Weibull	$\alpha = 0.40196$ $\beta = 46.775$	Wakeby	$\alpha = 370.57$ $\beta = 0.27581$ $\gamma = 0$ $\delta = 0$ $\xi = -47.108$
Weibull (3P)	$\alpha = 0.54127$ $\beta = 36.632$ $\gamma = 0.15$	Weibull	$\alpha = 0.54015$ $\beta = 224.59$
Log–Gamma	No fit	Weibull (3P)	$\alpha = 0.74535$ $\beta = 217.7$ $\gamma = 2.37$
Nakagami	No fit	Nakagami	No fit

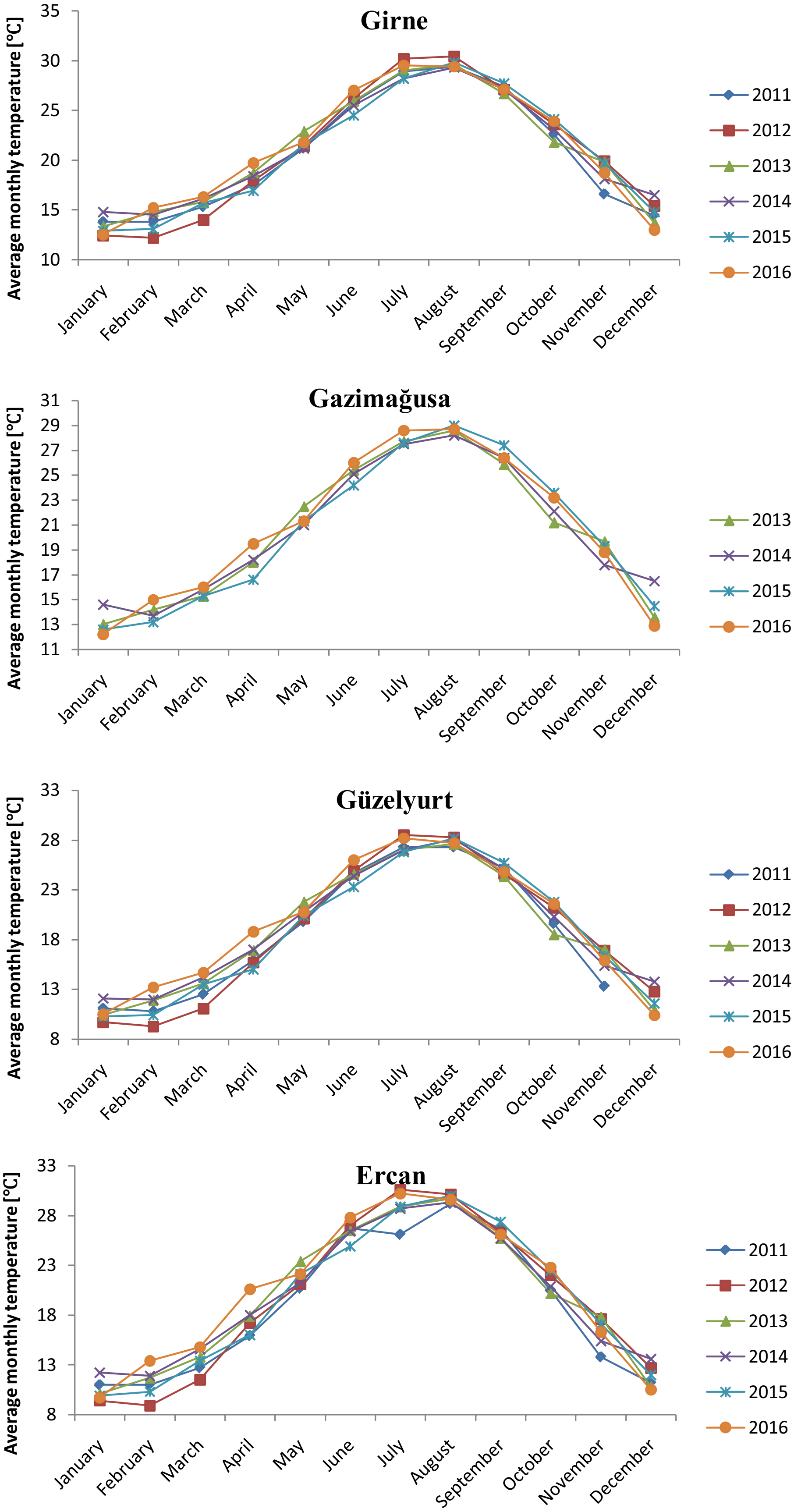


Fig. S1. Continued

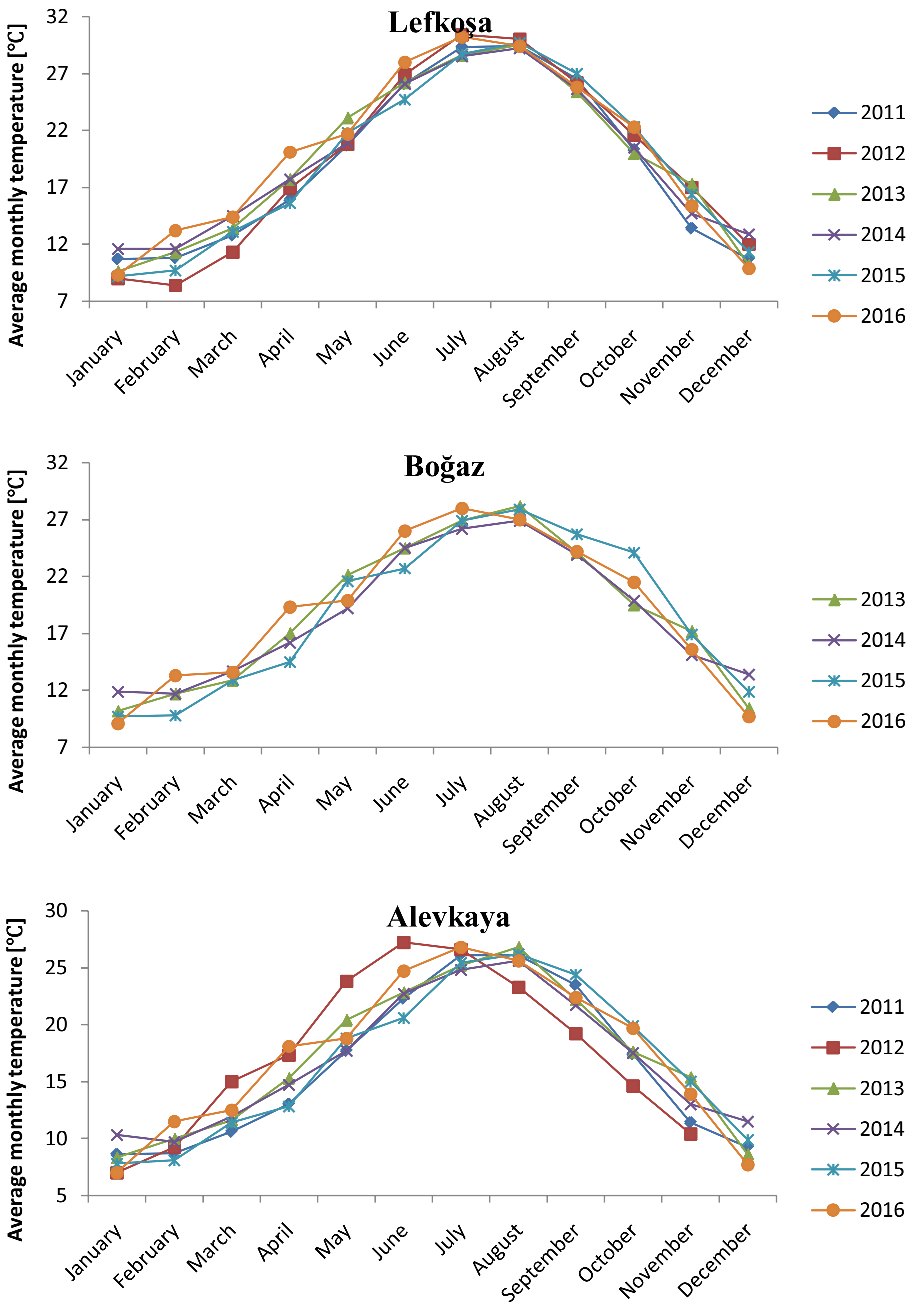


Fig. S1. Average monthly temperatures at selected meteorological stations during the investigation periods.

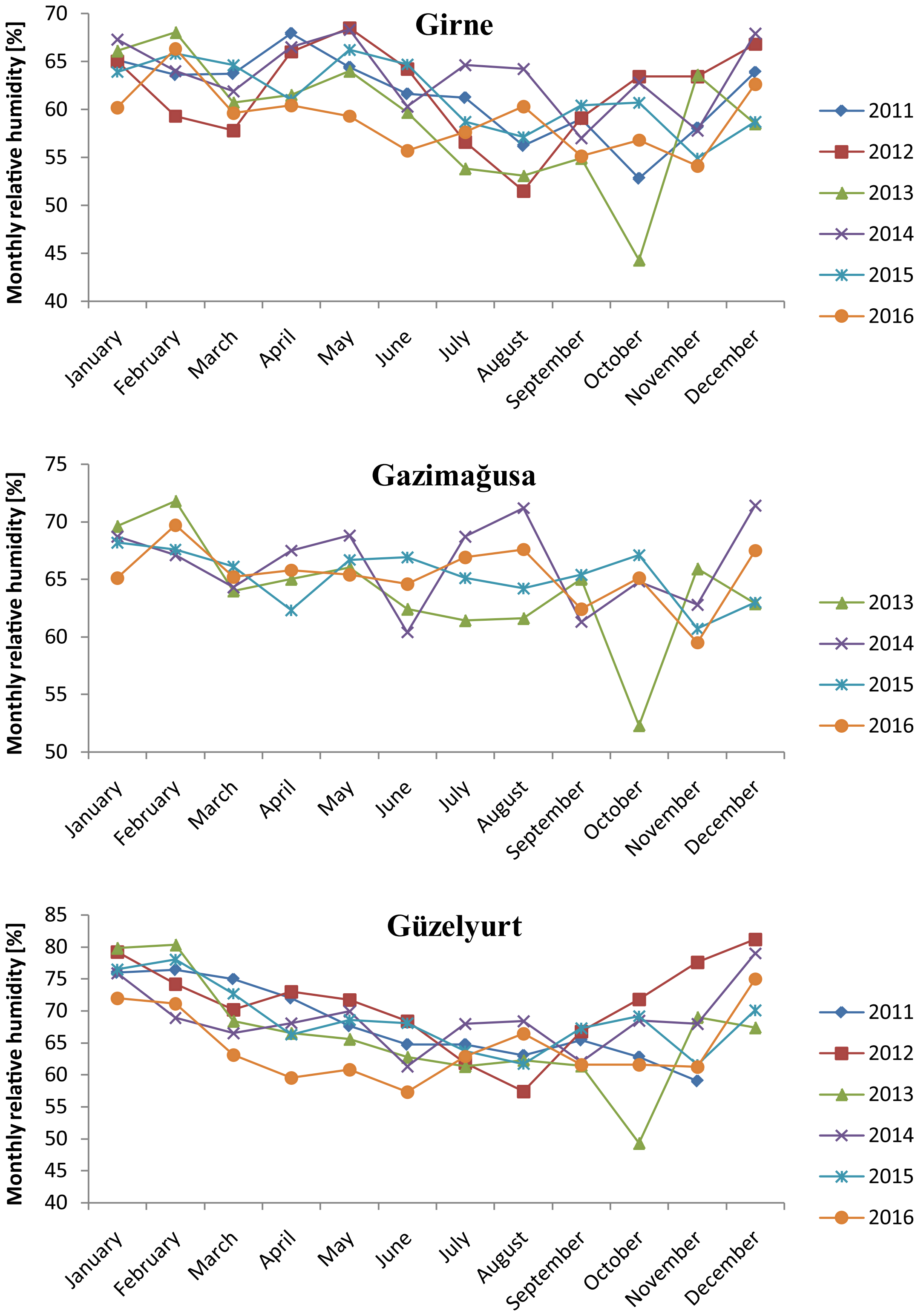


Fig. S2. Average monthly relative humidity for all selected stations during the investigation periods.

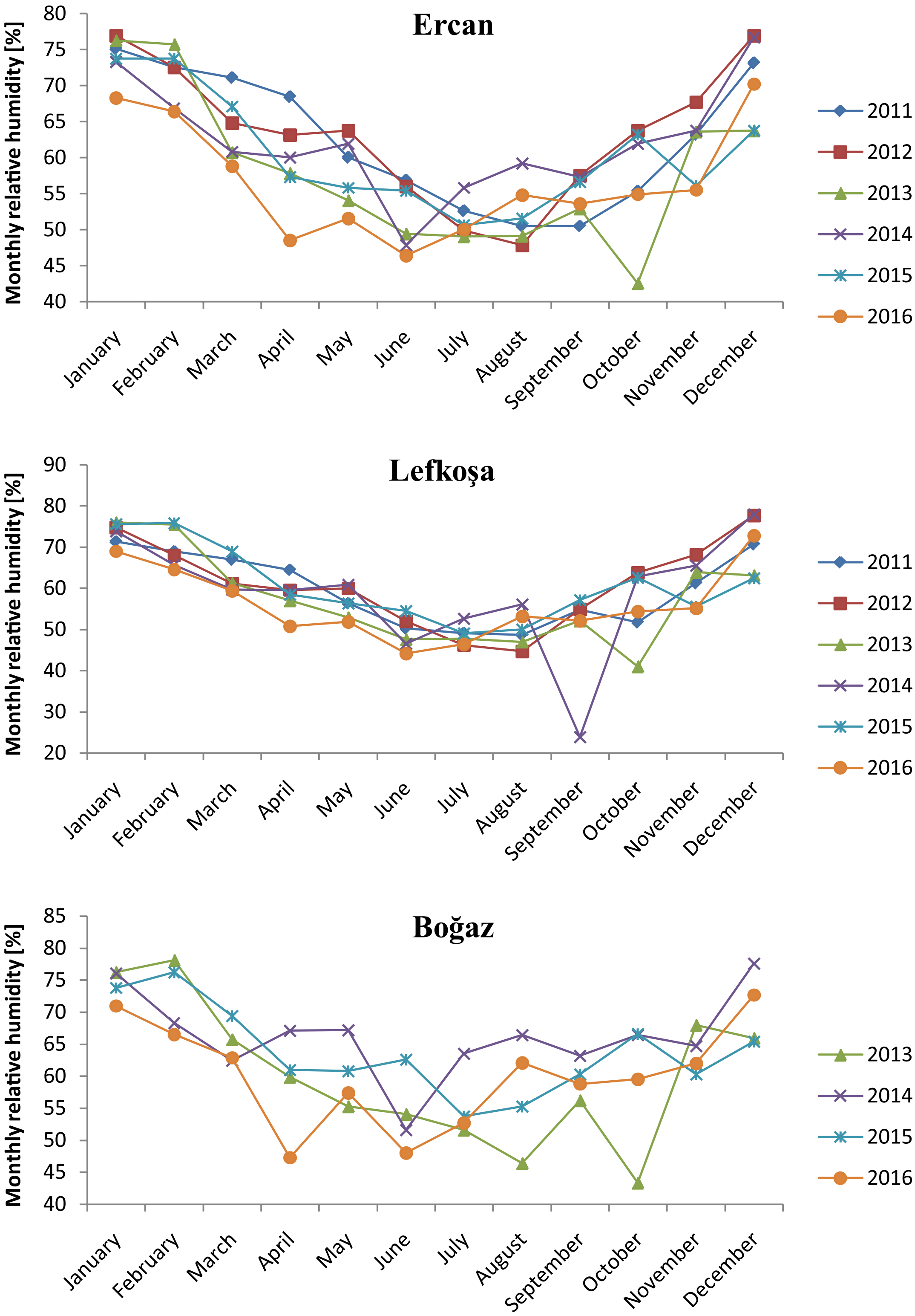
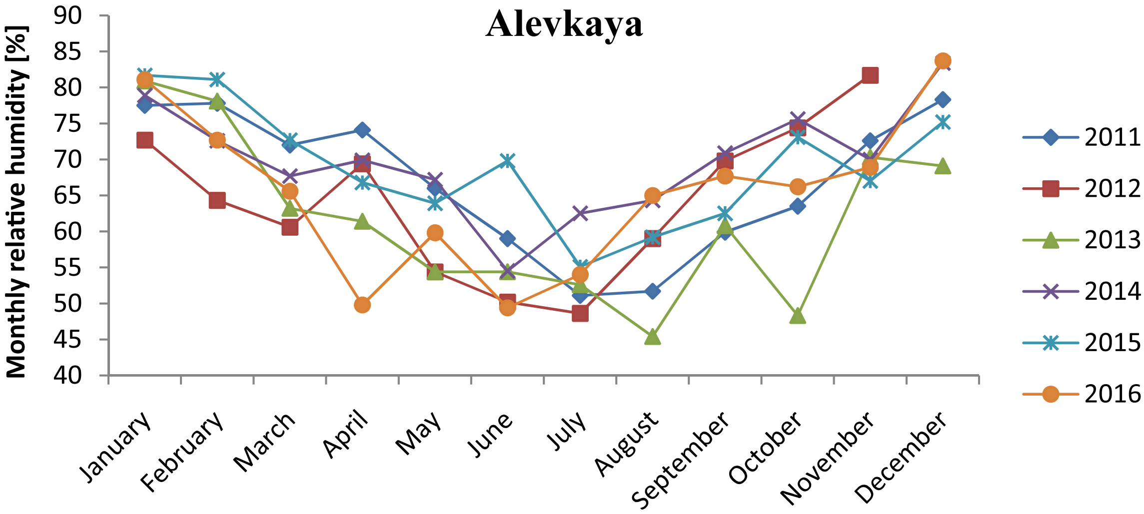


Fig. S2. Continued



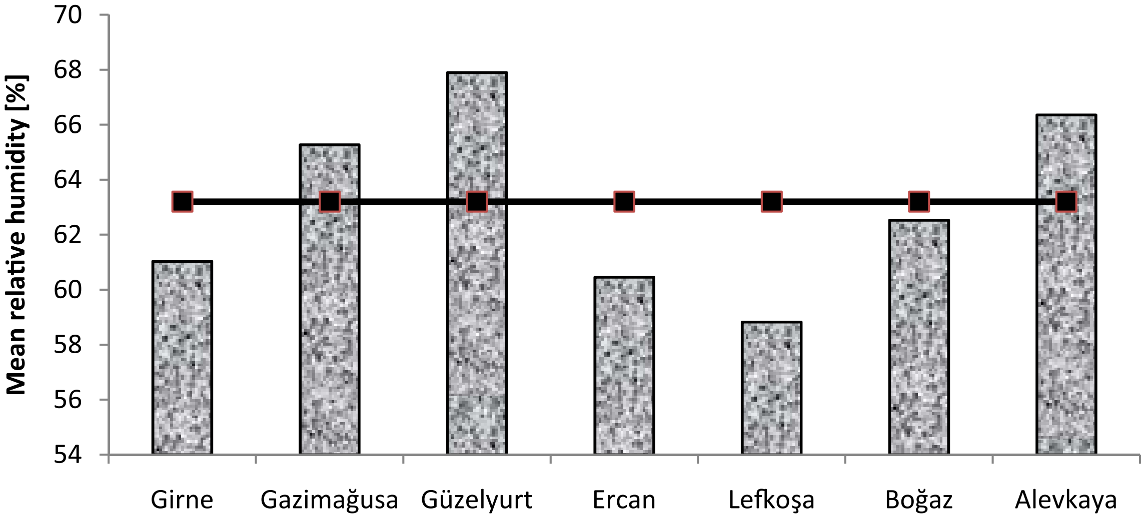


Fig. S2. Average monthly relative humidity for all selected stations during the investigation periods.