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JAPAN INTERNATIONAL COOPERATION AGENCY

THE [illegible] REPUBLIC OF MACEDONIA
MINISTRY OF DEVELOPMENT

THE STUDY
ON
INTEGRATED WATER RESOURCES DEVELOPMENT AND
MANAGEMENT MASTER PLAN
IN
THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA

FINAL REPORT

VOLUME III
SUPPORTING REPORT I

SECTOR STUDY ON CURRENT CONDITIONS

MAY 1999

NIPPON KOEI CO., LTD.
KOKUSAI KOGYO CO., LTD.

JAPAN INTERNATIONAL COOPERATION AGENCY

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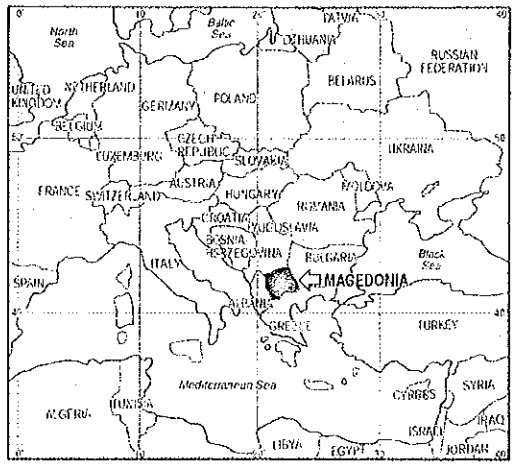
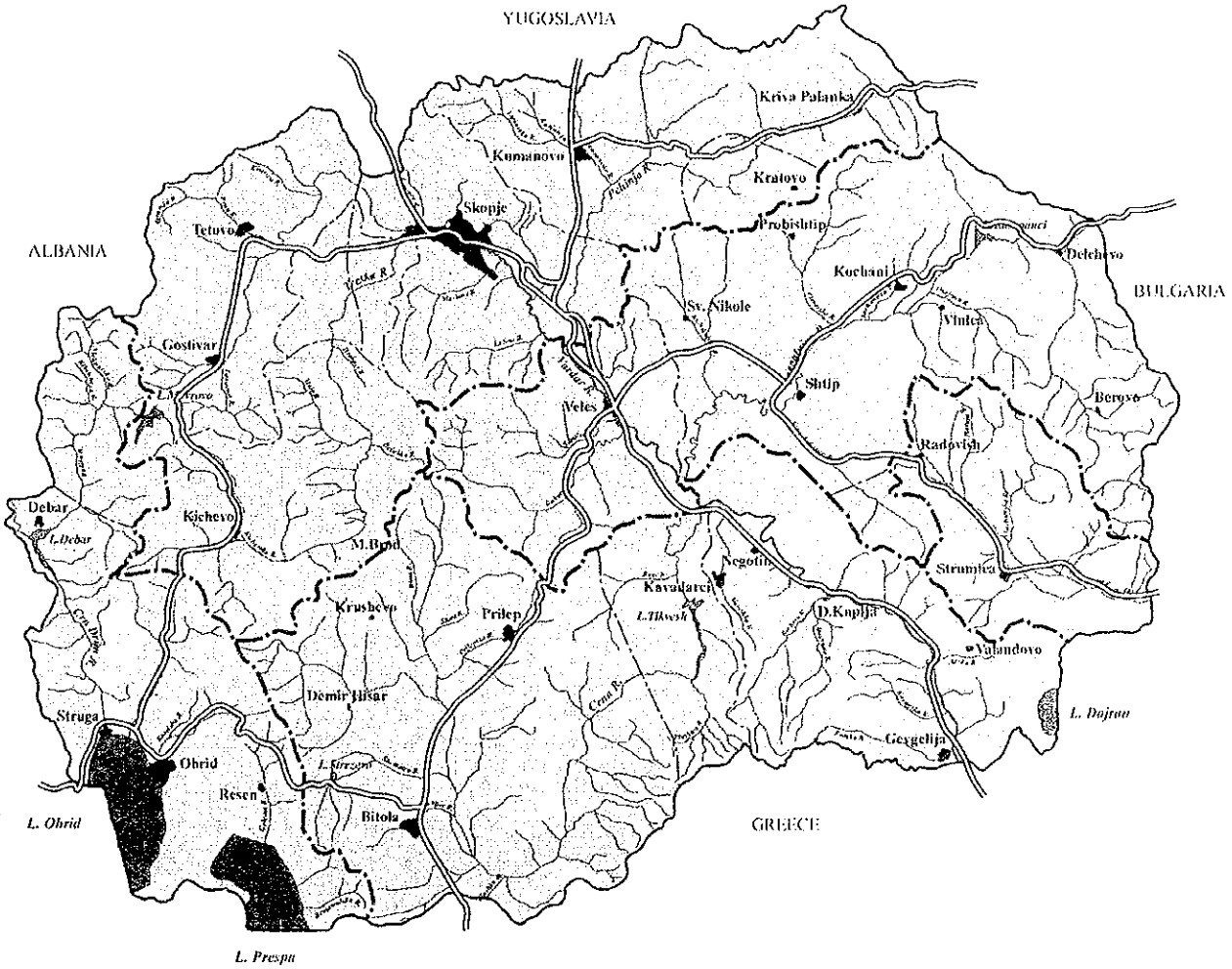
COMPOSITION OF FINAL REPORT

EXCHANGE RATES

The exchange rates used in this Study are:
US Dollar (US$)1.00 = Macedonian Denar (MKD) 52.00
Deutsche Mark (DM) 1.00 = Macedonian Denar (MKD) 30.98
as of Jan.1999





Location Map

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ABBREVIATIONS AND ACRONYMS

ACU	-	Aid Coordination Unit
a.s.l	-	above sea level
BOD	-	Biological Oxygen Demand
CE(s)	-	Communal Enterprise(s)
DO	-	Dissolved Oxygen
EBRD	-	European Bank for Reconstruction and Development
ECM	-	Electric Power Company of Macedonia
EC	-	European Community
EL	-	Elevation
EU	-	European Union
FRY	-	Federal Republic of Yugoslavia
FYROM	-	The Former Yugoslav Republic of Macedonia
GDP	-	Gross Domestic Product
GEF	-	Global Environment Facility
GNP	-	Gross National Product
GOJ	-	Government of Japan
GOM	-	Government of Macedonia
GTZ	-	Deutsche Gesellschaft für Technische Zusammenarbeit
HMI	-	Republic Hydrometeorological Institute
I/R	-	Interim Report
IEE	-	Initial Environmental Examination
IBRD	-	International Bank for Reconstruction and Development
IDA	-	International Development Association
IMR	-	Infant Mortality Rate
JICA	-	Japan International Cooperation Agency
JUS	-	Jugoslavian Standards
MAFWE	-	Ministry of Agriculture, Forestry and Water Economy
MCIC	-	Macedonian Center for International Cooperation
MKS	-	Macedonian Standards
MOD	-	Ministry of Development
MOE	-	Ministry of Economy
MOH	-	Ministry of Health
MUPC	-	Ministry of Urban Planning and Construction
MOEn	-	Ministry of Environment
MOS	-	Ministry of Science
MOFA	-	Ministry of Foreign Affaires
NDS	-	National Development Strategy 1997
NEAP	-	National Environmental Action Plan 1997
NEHAP	-	National Environmental Health Action Plan
NGO(s)	-	Non Governmental Organization(s)

ABBREVIATIONS AND ACRONYMS (Continued)

ODA	-	Official Development Assistance
O&M	-	Operation and Maintenance
PCM	-	Project Cycle Management
PDM	-	Project Design Matrix
PHARE	-	Pologne et Hongri Aide a Reconstruction Economique (Poland and Hungary Aid for Economic Reconstruction)
PIP	-	Program for Public Sector Investment in the Republic of Macedonia 1998-2000
P/R	-	Progress Report
PWME	-	Public Water Management Enterprise
RIHP	-	Republic Institute for Health Protection
S/W	-	Scope of Work
SS	-	Suspended Substances
SFRY	-	Socialist Federal Republic Yugoslavia
UNDP	-	United Nations Development Program
UNESCO	-	United Nations Educational, Scientific and Cultural Organization
UNICEF	-	United Nations Children's Fund
WHO	-	World Health Organization
WDI	-	Water Development Institute
WMO(s)	-	Water Management Organization(s)
WUA(s)	-	Water Users' Association(s)

WEIGHTS AND MEASURES

Metric System

mm	-	Millimeter(s)	ha	-	Hectare (100m x 100m)
m	-	Meter(s)	l	-	Liter(s)
m^2	-	Square meter(s)	lit/sec (l/sec)	-	Liter per second
km^2	-	Square kilometer(s)	m^3	-	Cubic meter(s)
lpcd	-	litre/capita/day	m^3/sec (m^3/s)	-	Cubic meter(s) per second
			p.e.	-	population equivalent

CURRENCY

MKD	-	Macedonian Denar	DM	-	Deutsche Mark
USD	-	United States Dollar	JPY	-	Japanese Yen

Appendix A

Meteorology and Hydrology

Appendix A METEOROLOGY AND HYDROLOGY

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Appendix A METEOROLOGY AND HYDROLOGY

A.1. Meteorological Analysis

A.1.1 Source of Data

Meteorological data were collected from the Republic Hydrometeorological Institute (HMI) - Meteorological Department. The institute is organized as republic organization with duties of performing collection and analysis of the meteorological, hydrological, and water quality data. In accordance with the constitutional structure and regulations of the Hydrometeorological Service Law, the Institute operates as national telecommunication center for data processing and collection in Macedonia. The main operation takes place in the main center (headquarter) located in Skopje.

A.1.2 Meteorological Network Stations

Registered meteorological network stations on the territory of Macedonia consist of 35 meteorological stations (14 main and 21 secondary stations), and 295 rainfall stations. In General, main meteorological stations are equipped by instruments to measure sunshine duration, rainfall, and soil temperature that are not available in the secondary stations. The Study Team and Meteorological Department of HMI applied a new identification names to the meteorological network stations that give them a clear and unique definition as follows: meteorological stations as MST00_Name (e.g. MST03_Tetovo), and rainfall stations as RST000_Name (e.g. RST025_Bitola). Table A.1 lists the information of the main and secondary meteorological network stations (name, elevation, latitude, and longitude), while Table A.2 lists the information of the rainfall network stations. Location maps of the meteorological network stations and rainfall stations are shown in Figure A.1 and Figure A.2 respectively.

A.1.3 Data Collection

During the Study, monthly mean climatic records for the period 1961- 1990 and daily rainfall records for the period 1961 – 1996 were collected and encoded by the Study Team. Out of 11 (eleven) meteorological parameters that are recorded in meteorological stations (Table A.3), five monthly climatological parameters were collected as follows: (1) air temperature (maximum, minimum, and mean), (2) wind speed and direction, (3) sunshine duration, (4) cloud cover, and (5) relative humidity.

The collected rainfall data was subjected to intensive analysis by the Study Team. After a detailed analysis of the data records within the 295 rainfall network stations, interruptions (missing data) in the records of some of the stations were

found. Table A.4 presents the inventory of the rainfall network stations and shows the details of the missing years. From the table it can be seen that for the period 1961-1965, rainfall records were available for only 43 stations among the total of 295 stations.

A.1.4 Results of Analysis

A.1.4.1 General Climatological Characteristics of Macedonia

In general, Macedonia is under climatic influence of so-called modified type of Mediterranean climate that includes influence from Continental climate of Middle-European and East-European regions. The influence of Mediterranean and Continental climate characteristics can be used to divide Macedonia into 7 climatic regions as shown in the table below based on altitude range (minimum of 59 m at Gevgelija and maximum of 2,764 m on Mt. Korab).

Climatic Regions in the Republic of Macedonia

No	Classification	Altitude Range m	Average Surface Area, ha	Area % to Total area
1	Continental to Sub-Mediterranean	50 to 600	897,000	34.9
2	Warm Continental	600 to 900	704, 000	27.4
3	Cold Continental	900 to 1100	342, 000	13.3
4	Sub-Hilly Continental Mountain	1100 to 1300	250, 000	9.7
5	Hilly Continental Mountain	1300 to 1650	269,000	10.4
6	Sub-Alpine Mountain	1650 to 2250	97, 000	3.8
7	Alpine Mountain	over 2250	13, 000	0.5
	Total		2,572,000	100

Source: Characteristics of the Climatological-Vegetation-Soil Regions in Republic of Macedonia, Pece Ristevski et. al, 1996.

The geographic location of Macedonia lies between 20° 21' 31" and 23° 02' 12" of east longitude and 40° 51' 16" and 42° 22' 21" of north latitude. With this geographic location, great African and Eurasian dry land masses affect the climate characteristics of Macedonia. On the other hand, the Adriatic, Aegean and the Mediterranean Seas, which are close to Macedonia (80-140 km), represent sources of humidity during summer season. At the same time, with the characteristics of the Adriatic Sea that is warmer than the Atlantic Ocean (6°-7°), cyclones (barometer depression) influence the thermal behavior of the country.

A.1.4.2 Rainfall Analysis

As the territory of Macedonia is under influence of Mediterranean and Continental climate characteristics, the variations in the rainfall records, as well as other climatic parameters, are quite significant between the east, middle, and west regions. Generally, rain falls within two seasons in spring / autumn and winters. Winter rainfall is classified as cyclonic rain from the Mediterranean Sea,

however the effect of the Mediterranean anticyclones during the summer is typical for the region of the Balkan Peninsula, as well as for Macedonia. As a result of this phenomenon, Macedonia has high rainfall amounts in May and June followed by long, dry and rainless summers, especially in the north-east region of the country which is typically forms the so-called continental rainfall regime.

(1) Annual Rainfall

Annual rainfall (mm) was estimated for the 295 rainfall stations. The rainfall regime in the western part of the country has greater amount of rainfall with an average annual of more than 1000 mm (RST013_Lazaropole = 1029.2 mm). The eastern part has an average of less than 700 mm (RST009_Kriva Palanka = 606.5 mm). The central part of the country, including Vardar Valley, has the lowest amount of precipitation with an average of 500 mm (RST027_Skopje = 493.8 mm).

Based on the collected rainfall data from all the 295 registered rainfall stations for the period of 1961-1996, an isohyetal map of average annual rainfall was constructed as shown in Figure A.3.

For the purpose of the water balance study, 26 rainfall stations were selected from the rainfall network stations, to represent the annual rainfall characteristics for each of the 26 sub-basins considered in the Study. Average annual rainfall variations of these stations for the period of 1961 – 1996 are presented in Figure A.4. In the figure, the stations were grouped in the basis of the major 7 basins classification. Rainfall stations in the Pchinja river basin have the lowest annual rainfall amounts (< 800 mm as an average) among the other stations.

(2) Drought

The annual rainfall data for 38 stations that has the minimum missing data set within the period 1961-1996 were examined to estimate the magnitude and order of the historical drought. Mean rainfall depth for each year was calculated and ranked in ascending order as shown in Table A.5. Based on average calculations, the worst drought occurred in 1993 and the second worst occurred in 1973. The years of the last decade, since 1990, are within the worst 10 drought ranks as follows: 1990 (6), 1992 (8), 1993 (1), and 1994 (5). In the other hand, the decade of 1961 – 1970 was the most wet decade as most of the rank numbers during these period are higher than 20 (out of 36-years). The following table lists the rank of the most 10 wet and dry years.

Most 10 Wet and Dry Years

Dry Years		Wet Years	
Rank	Year	Rank	Year
1	1993	1	1962
2	1973	2	1963
3	1986	3	1981
4	1977	4	1995
5	1994	5	1979
6	1990	6	1964
7	1988	7	1980
8	1992	8	1972
9	1961	9	1966
10	1984	10	1983

(3) Basin Rainfall

In order to estimate the rainfall characteristics for each of the major 7 basins, a Thiessen polygon network was constructed using 197 rainfall gauging stations. These stations were selected to represent homogenous spatial and temporal conditions for each of the basin based on the following criteria:

1. Continuous record for the 36 years period of 1961-1996, allowing short interruptions as minimum as possible.
2. Approximate density of 1 gauge per 125 km^2.

The following table shows the total numbers of the available and selected rainfall gauging stations for Thiessen polygon network, in each of the major 7 basins:

Number of Station Selected for Basin Rainfall Analysis

Basin	Total No. of Stations	Selected No. of stations
B1: Vardar	79	47
B2: Treska	20	18
B3: Pchinja	31	24
B4: Bregalnica	51	32
B5: Crna	56	37
B6: Strumica	23	16
B7: Crn Drim	35	23
Total	295	197

The estimated areas for each station using Thiessen polygon network are shown in Table A.6. As a single rainfall station polygon may be located among several basins, each station in the table has 7 divisions that represent the area of the station polygon in each basin. Table A.7 shows the average annual basin rainfall for each of the 7 basins.

Based on annual basin rainfall results using Thiessen polygon network, drought frequency of annual rainfall occurrences for 2, 5, 10, 20, 50, and 100 are

estimated using Log Normal distribution. Results for each basin are listed in the following table:

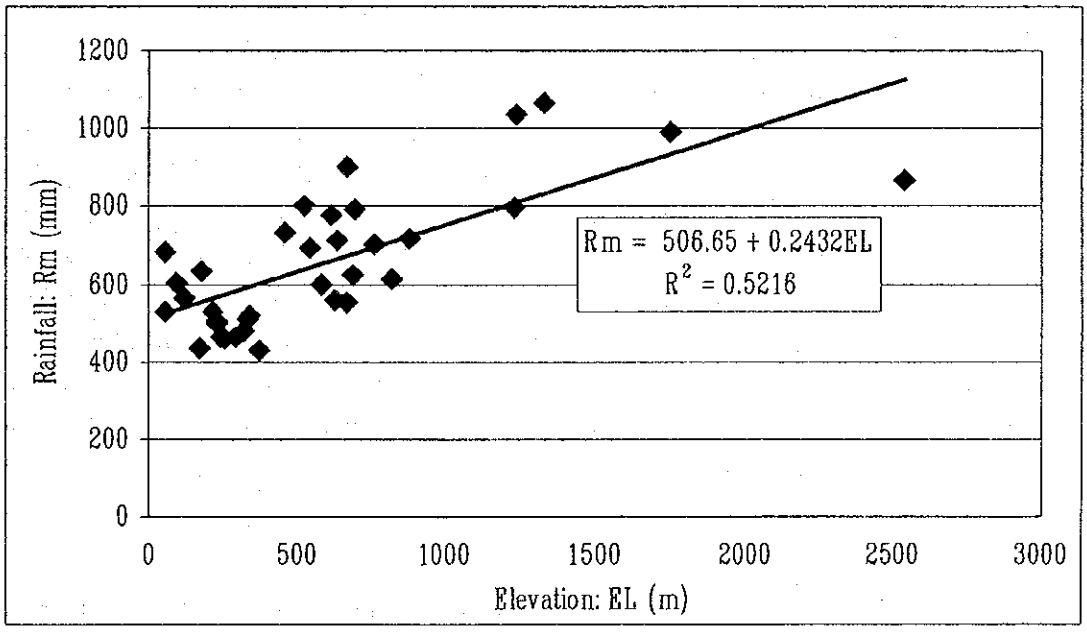
Drought Frequency for Different Return Periods

(units: mm)

Return Period (years) / Basin	2	5	10	20	50	100
Vardar	569.42	474.16	425.25	385.32	340.86	311.50
Treska	628.38	521.05	481.30	454.78	430.44	416.90
Pchinja	491.82	409.17	371.43	342.82	313.37	295.40
Bregalnica	526.58	435.04	392.62	360.12	326.10	304.81
Crn	536.59	436.34	389.17	352.69	314.14	289.84
Strumica	551.72	437.28	380.00	333.98	283.51	250.64
Crn Drim	753.58	604.44	538.23	488.93	439.02	409.01
Average	588.48	487.76	438.45	399.37	357.10	329.88

(4) Annual Rainfall – Elevation Correlation

Analysis of the relation between annual rainfall and station elevation is carried out for the 34 meteorological network stations. The annual rainfall is by station highly correlated to its elevation as shown in following figure.



The relation between them can be described as the following equation:

$$Rm = 506.65 + 0.2432 \times EL \qquad \text{(Eq. 1.1)}$$

$$R = 0.723 \qquad \text{(Eq. 1.2)}$$

Where:

Rm is the annual rainfall (mm)
EL is the station elevation (m)
R is correlation coefficient

(5) Monthly Rainfall

In Macedonia, the month of May has the highest magnitude of rainfalls, while August has the lowest rainfalls through the year. To represent monthly variations in rainfall regimes, 34 rainfall stations were selected to represent the main and secondary meteorological network stations, for the period 1961-1996. Table A.8 presents the mean monthly and annual rainfall for the selected 34 rainfall stations. Figure A.5 illustrates the mean monthly rainfall for the 14 main meteorological station. Based on these data, it can be seen that the minimum average monthly rainfall of 21.14 mm is recorded in RST044_Radovish in August, and the maximum average monthly rainfall of 145.60 mm is recorded in RST013_Lazaropole in November.

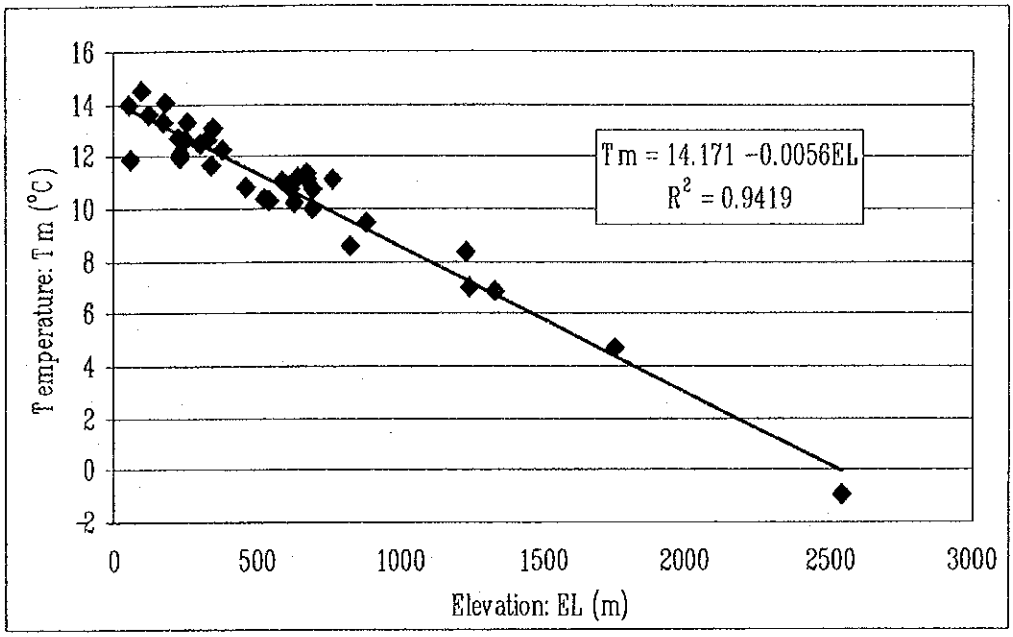
Details of rainfall characteristics for the period 1961 – 1996 (average monthly, total annual, total number of wet days in the year, maximum 1-day, maximum 2-days, ...etc.) were prepared for all the 295 registered stations (e.g. Table A.9 represents RST027_Skopje). The accompanying chart is based on the average monthly rainfall for the same period.

A.1.4.3 Temperature

Maximum, minimum, and mean daily temperature are observed in all the meteorological network stations using automatic thermometers. According to the collected data, mean monthly temperature ranges between -8.88 and 25.30 °C. Mean annual temperature recorded for the period 1961 – 1990 ranges between -0.92 °C in MST06_Solunska Glava and 14.51 °C in MST02_Valandovo with an average of 10.8 °C for the entire country. Table A.10 shows the mean monthly and mean annual temperatures for the main and secondary meteorological stations and Figure A.6 presents the mean monthly temperature for the main meteorological stations. Figure A.7 represents the isohyetal map of the mean annual temperature based on the temperature records for the 35 main and secondary meteorological stations for the period 1961 –1990.

Annual Mean Temperature – Elevation Correlation

Analysis of the relation between annual mean temperature and station elevation is carried out for the 34 meteorological network stations. The annual mean temperature is by station highly correlated to its elevation as shown in following figure.



The relation between them can be described as the following equation:

$$Tm = 14.171 - 0.0056 \times EL \qquad \text{(Eq. 1.3)}$$

$$R = 0.9705 \qquad \text{(Eq. 1.4)}$$

Where:

Tm is the annual mean temperature (°C)
EL is the station elevation (m)
R is correlation coefficient

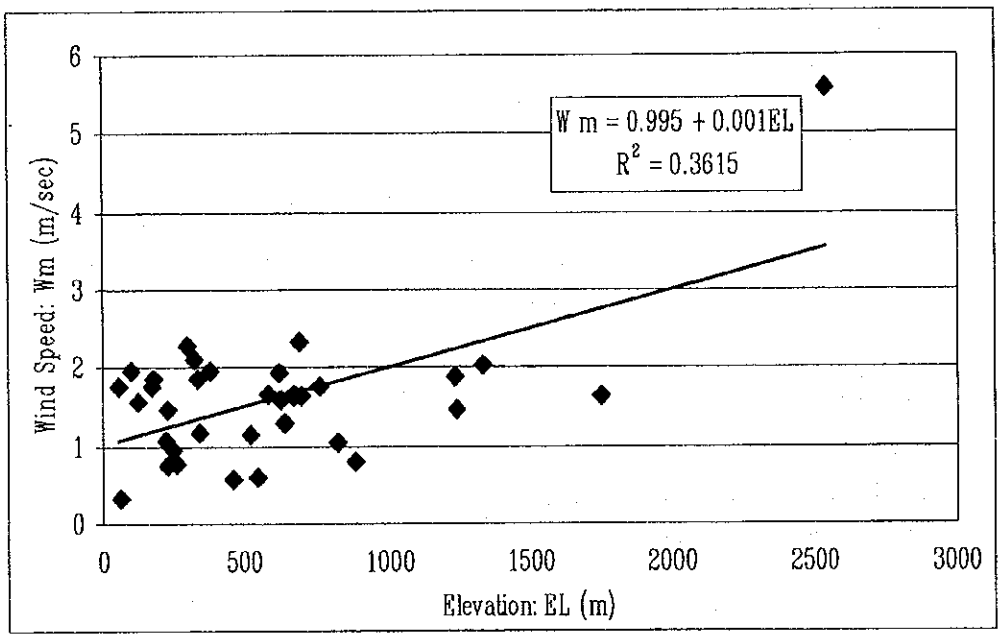
A.1.4.4 Wind Speed and Direction

The wind speed and direction are observed in all the main and secondary meteorological network stations as shown in Table A.3. Wind speed is observed by two automatic methods (anemograph and anemometer) and wind direction is obtained visually using Vildoff instruments. North wind direction in Macedonia is called Vardarec which has a significant influence. North wind in the Ohrid region is called Belichnik. During summer season, constant air depression over the Asia Continent is affecting Macedonia and it blows from the Atlantic Oceans towards Middle Asia. In the Aegean region, these winds blow towards southwest direction and provide constant sunny, warm and dry summers. Passat winds also influence Macedonian climate bringing drought periods. According to the collected data, stations MST06_Solunska Glava and MST25_Kriva Palanka have the maximum average annual of 5.57 and 2.33 m/sec respectively. Station MST24_Katlanovo has the minimum mean annual value of 0.32 m/sec. Mean monthly wind ranges between 0.26 to 2.74 m/sec with an average of 1.43 m/sec for all the stations except in station MST06_Solunska Glava that has high range of 3.89 to 7.29 due to its high altitude (El. 2540 m). Table A.11 presents the

mean monthly and annual wind speed values in the meteorological network stations for the period 1961 – 1990. Maximum wind speed and direction measured using automatic anemograph are listed in Table A.12 for some main stations. As can be seen in the table, the wind direction in station ST08_Skopje has tendency to blow towards North direction while station ST13_Ohrid has tendency to blow towards South direction.

- Annual Mean Wind Speed – Elevation Correlation

Analysis of the relation between annual mean wind speed and station elevation is carried out for the 34 meteorological network stations. The annual mean wind speed is by station highly correlated to its elevation as shown in following figure.



The relation between them can be described as the following equation:

$$Wm = 0.995 + 0.001 \times EL \qquad \text{(Eq. 1.5)}$$

$$R = 0.6012 \qquad \text{(Eq. 1.6)}$$

Where:

Wm is the annual mean wind speed (m/sec)
EL is the station elevation (m)
R is correlation coefficient

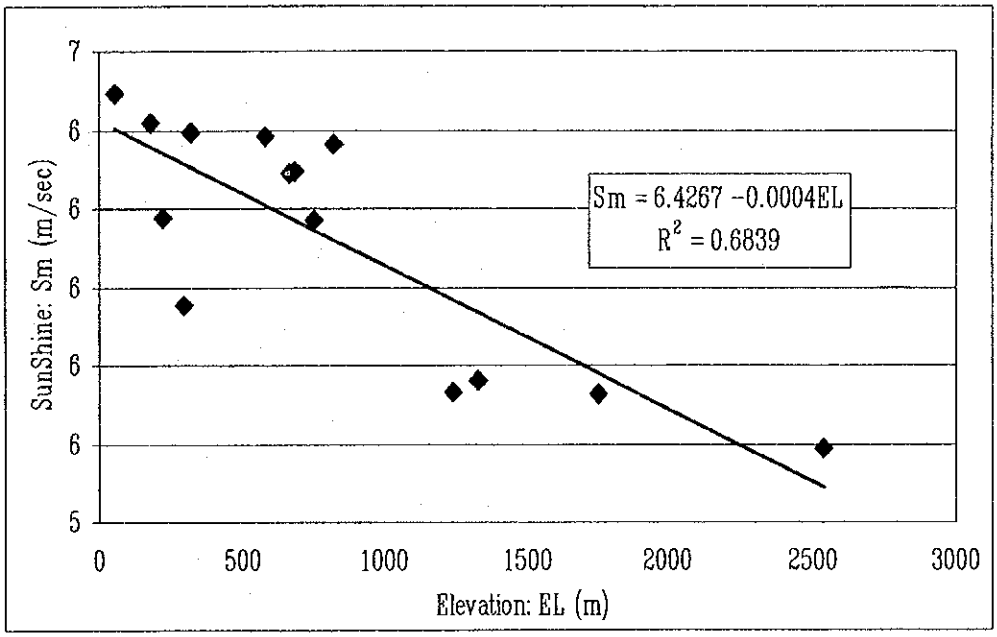
A.1.4.5 Sunshine Duration

Sunshine duration (hours) is observed in the 14 main meteorological network stations using automatic heliograph instruments. According to the collected data, station MST27_Gevgelija has the maximum mean annual sunshine duration value of 6.49 hours/day while station MST06_Solunska Glava has the minimum mean annual value of 5.59 hours/day. Mean monthly sunshine duration among

all the stations ranges between 1.95 to 10.78 hours/day with an average of 6.12 hours/day. Table A.13 presents the mean monthly and annual sunshine duration values observed in the 14 main meteorological network stations for the period 1961 – 1990.

- Annual Mean Sunshine – Elevation Correlation

Analysis of the relation between annual mean sunshine and station elevation is carried out for the 34 meteorological network stations. The annual mean sunshine is by station highly correlated to its elevation as shown in following figure.



The relation between them can be described as the following equation:

$$Sm = 6.4267 - 0.0004 \times EL \qquad \text{(Eq. 1.7)}$$

$$R = 0.8269 \qquad \text{(Eq. 1.8)}$$

Where:

Sm is the annual mean sunshine duration (hours/day)
EL is the station elevation (m)
R is correlation coefficient

A.1.4.6 Cloud Cover

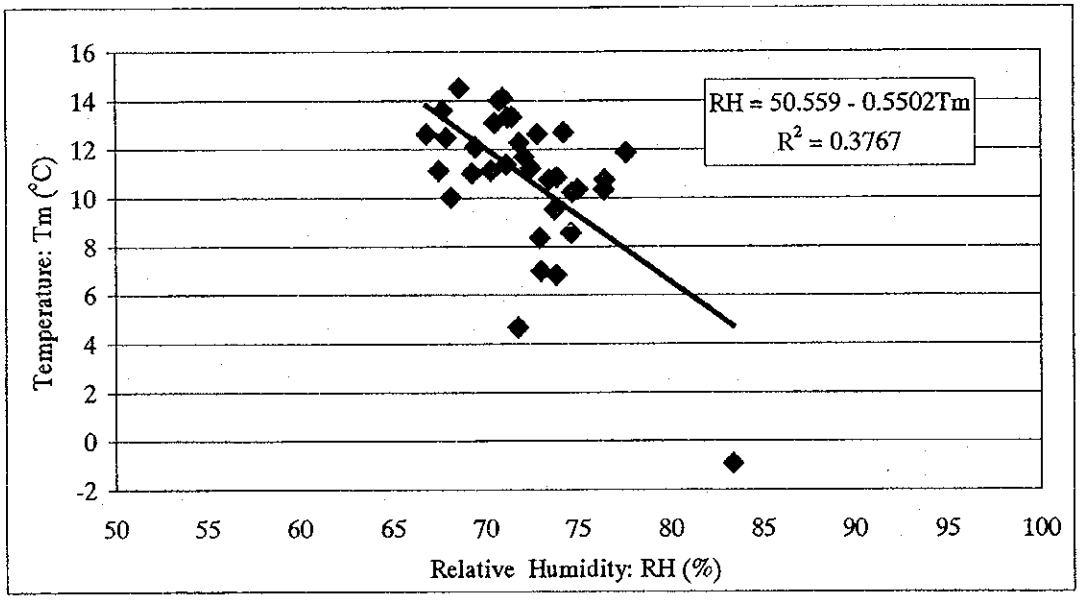
Cloud cover is visually observed within all the meteorological network stations and its values is recorded between 0 (clear sky) and 10 (100% cloudy). According to the collected data, mean monthly cloud cover ranges between 2.02 to 7.97 (dimensionless). Table A.14 presents the mean monthly and annual cloud cover values observed in the meteorological network stations for the period 1961 – 1990.

A.1.4.7 Relative Humidity

Relative humidity is observed within all the meteorological network stations using automatic hygrometer and hygrograph. According to the collected data for all the meteorological stations (except station MST35_Trubarevo that has no available data) mean monthly relative humidity ranges between 53.4 to 87.9 %. Table A.15 presents the mean monthly and annual relative humidity values observed in the meteorological network stations for the period 1961 – 1990.

- Annual Mean Relative Humidity – Elevation Correlation

The annual mean relative humidity is by station highly correlated to its annual mean air temperature as shown in the following figure:



The relation between them can be described as the following equation:

$$RH = 50.559 - 0.5502 \times Tm \quad \text{(Eq. 1.9)}$$

$$R = 0.6138 \quad \text{(Eq. 1.10)}$$

Where:

RH is the annual mean relative humidity (%)
Tm is the annual mean temperature (°C)
R is correlation coefficient

A.2 Hydrological Analysis

A.2.1 Source of Data

A fairly large amount of data related to hydrological events of Macedonia is available from the Hydrological Department of the Republic Hydrometeorological Institute (HMI). The Hydrological Department is responsible for collecting and evaluating hydrologic data at the rivers and lakes

in Macedonia, in which their database systems in the headquarter in Skopje dated since 1923. The Department's database is organized into two main divisions: (i) Surface water database, and (ii) Groundwater database. The surface water database is further organized into the following three data systems:

1) Basic information of water level gauging stations.
2) Daily water level for the rivers network as well as for the three major lakes (Ohrid, Prespa, and Dojran Lakes).
3) Rating curves of the flow-stage relationship for the rivers network.

The hydrological network stations include 110 stations for surface water and 115 stations for ground water. The Study Team and Hydrological Department of HMI applied new identification names to the surface hydrological network stations that give them a clear and unique definition as MST00_Name (e.g. ST008_Skopje). A list of gauge discharge stations information (ID number, station registry No., name of the station, etc.) is shown in Table A.16 and the location of these stations are indicated in Figure A.8.

Before using parts of this data, its reliability, which might affect the results of the Study, has been examined. In the first and second stage of the Study, intensive investigation and field survey were conducted for the hydrological network stations to study their condition and data availability. Table A.17 lists the historical background of the hydrological data within the network stations. The following are general overview of the data conditions:

1) 9 stations were constructed to monitor the water levels in the three natural lakes of Ohrid (4), Prespa (3), and Dojran (2).
2) 80 stations are located in the Vardar river and its tributaries (Main – 37, Treska –8, Pchinja – 9, Bregalnica – 12, and Crna – 14)
3) 14 stations are located in the Crn Drim river and 7 stations are located in the Strumica river.
4) 65 stations were constructed before 1960 with the oldest construction date of the station network started since 1923 (e.g. ST008_Skopje, ST010_Veles, and ST016_Gevgelija) while recent construction of stations is dated to the early 90's such as ST011_Nogaevci that was constructed in 1990.
5) 41 stations are equipped with limnographs for automatic water level monitoring.
6) 16 stations are monitoring sediment loading.
7) 20 stations have flood monitoring systems. Daily data from these stations are used for water forecasting as well as for international exchange programs.
8) Some of the stations, that are not operating now, were destroyed because of flood (e.g. ST031_Markov Manastir) or shortage of facilities and employees (e.g. ST074_Vatasha).
9) Some of the stations were closed (e.g. ST051_Istibanja) due to dam construction (Kalimanci Dam). In the other hand, some new stations are

planned for future construction (e.g. ST029_Belica) to incorporate with future dam construction (Kozjak Dam).

10) Water level and water temperatures are monitored once or twice per day for all the surface hydrological stations.
11) Almost all-existing water level gauges have been installed at the river-bank of perennial rivers and at lake shores.
12) Rating curves at most of the stations were stored in the database in which, discharge measurements are carried out periodically with a range of 5 to 8 times per year.
13) None of the flow reported in the database was estimated based on Rainfall-Runoff relationship, hence, flow abstractions for ground water, base flow, and evapotranspiration were not available.

A.2.2 Data Collection

Of all the registered surface hydrological stations, daily flow and water levels data of 37 stations were collected in the first stage of the Study and additional daily flow records of 3 stations were collected in the second stage. The selection of the stations was conducted based on the data availability during the period 1951 – 1996, as well as the location of the station from the basin distribution viewpoint. The distribution of these stations among the major 7 river basins and the 3 natural lakes were as follows:

1) 3 stations in the three natural lakes of Ohrid (1), Prespa (1), and Dojran (1).
2) 31 stations in the Vardar river basin and its 4 major tributaries as follows: Main (10), Treska (4), Pchinja (6), Bregalnica (7), and Crna (4)
3) 3 stations in the Crn Drim river basin and 3 stations in the Strumica river basin.

The daily flow records were prepared in a standard format sheets (files) established between the Study Team and the staff of HMI. Inspection of the flow records in these collected stations showed that their duration and continuity were not uniform throughout the whole record period of 46 years (1951 – 1996). According to the collected data, 6 stations have full data record set for 46 years (1951 – 1996) and 9 stations have data records available from 1961 – 1996. For the period 1961 – 1990, 28 stations have continuous flow records. Table A.18 shows the missing period in the flow records within the 40 collected stations in which, ST066_Vozarci has the longest missing period (40-years). Out of the collected 40 stations, 24 stations with minimum missing records during the period of 1961 – 1996 were selected for the purposes of hydrological analysis These stations are marked as (*) as shown in Table A.18.

A.2.3 Correlation Analysis

The purpose of the statistical correlation analysis is to obtain the missing daily flow for the collected flow records and to obtain a corrected flow regime. The missing flow data within the selected 24 stations for the period 1961 – 1996 was determined by utilizing correlation analysis using flow records from 14 stations defined as characteristic stations. The following table lists the characteristic stations according to their river locations and their corresponding stations for correlation analysis.

List of the Characteristic Stations Used for the Correlation Analysis

River Basin	No.	Characteristic Stations	Corresponding Stations For Analysis	Type of Analysis
Vardar	1	ST006_Radusha	ST003_Balin Dol	MD & C
			ST004_Sarakinci	MD & C
			ST005_Jegunovec	MD & C
			ST016_Gevgelija	MD
	2	ST008_Skpoje	ST016_Gevgelija	MD & C
	3	ST010_Veles		
	4	ST014_Demir Kapija		
Treska	5	ST025_Zdunje	ST023_M. Brod	C
			ST026_Sv. Bogorodica	C
			ST028_Kichevo	MD & C
Pchinja	6	ST038_Trnovec	ST036_Zidlovo	MD & C
			ST037_Kriva Planka	C
	7	ST035_Katlanonvska Banja	ST034_Pelince	C
			ST041_Kumanovo	MD & C
Bregalnica	8	ST057_Zletovo	ST052_Shtip	MD
	9	ST048_Berovo		
	10	ST055_Laki		
	11	ST052_Shtip	ST050_Ochi Pale	MD
			ST054_Kamenica	MD
Crna	12	ST064_Skochivir	ST066_Vozarci	MD & C
	13	ST065_Rasimbegov Most		
Strumica	14	ST103_Sushevo	ST104_Novo Selo	C
			ST106_Smiljanci	C

Notes: C = Correction of the Data MD = Missing Data Filling

The characteristic stations selected in this study have continuous records within the period of 1961 – 1996 with no missing period. Station ST052_Shtip was first correlated with stations ST057_Zletovo, ST048_Berovo, and ST055_Laki to fill 2-years (1961 –1962) missing data before considering as a characteristic station. It should be noted that considered characteristic stations were subjected to continuous check and analysis from RHI -Hydrological Department- as key stations that has a significant role in the assessment of the potential of surface water availability in Macedonia. These stations were considered in the recent report published by RHI (Climate and Hydrology in the Republic of Macedonia, Part II Hydrology in the Republic of Macedonia, February 1998).

A.2.3.1 Missing Data

For missing data, mathematical relationship was determined to filling in gaps in the flow record when data exists at one or more nearby characteristic stations. The mathematical method employed multiple cross correlation among the characteristic stations and the stations under analysis (target) within the same river basin (e.g. in the Vardar river basin station ST016_Gevgelija was correlated with stations ST006_Radusha, ST008_Skpoje, ST010_Veles, and ST014_Demir Kapija). However, simple cross correlation between dependent (target) and independent (characteristic) stations was also employed (e.g. in Treska river basin station ST028_Kichevo was correlated with station ST025_Zdunje).

It should be noted that, only the missing period in the stations was provided to fill the missing gaps keeping the original recorded data unchanged.

To carry out these analysis, a statistical software was used (SPSS V8.0) in which all the necessary statistical information and analysis can be obtained. One of the main reasons for choosing this software is its capability for analyzing long period of record with multiple stations, which is the case in this Study (13,149 series of daily record within 36-years of 1961 – 1996).

(1) Example of Correlation Analysis in the Vardar River

The daily flow records collected in the Study were subjected to series of arrangement and formatting. As of the agreement with the Hydrological Department, flow data of each station was stored in one file contains 3 worksheets each of which includes 10 years of daily flow data (m^3/sec). To define the period of missing data and to perform check analysis among the stations, the data was re-arranged in a basin file format that includes flow records in all stations within the basin and reads the data in one column per station starting from January 1, 1961 to December 31, 1996. This file was transported to the statistical software (SPSS V8.0) in order to perform the statistical correlation analysis. The following steps presents the analysis procedure performed to fill missing data in station ST016_Gevgelija at the downstream of Vardar river basin:

(2) Descriptive Statistics for Hydrological Stations on the Vardar River:

Descriptive statistics (diagnose) for the flow records within all stations in the river basin were performed. Comparisons of descriptive statistical parameters for the number of available daily records (minimum, maximum, mean, and standard deviation) were obtained for all stations in the river basin as shown in the table below:

Descriptive Statistics of Flow Records for Hydrological Stations Along Vardar River

	N	Minimum	Maximum	Mean	Std. Dev.
ST003	3519	.85	164.00	11.3132	6.2535
ST004	6117	1.30	296.00	21.4913	12.2364
ST005	5110	3.40	259.00	23.0001	12.6269
ST006	13149	.10	270.00	23.7429	14.7805
ST008	13149	5.20	738.72	58.9497	44.1090
ST010	13149	1.00	1300.00	74.6965	61.1785
ST014	13149	10.00	1970.00	129.5612	125.1548
ST016	6481	7.30	2254.00	144.1460	130.9001
ST030	5473	.11	118.81	3.7191	4.6632
ST033	10956	.08	118.00	2.7348	3.5622

Based on the above table, ST006, ST008, ST010, and ST014 have full period of data records (13,149 days) and their descriptive statistics shows no-errors in the discharge sequence towards downstream station (ST016).

(3) Statistical Correlation among Hydrological Stations on the Vardar River

To predict the best correlation among the stations, the correlation-matrix was formed using Pearson product-moment correlation coefficients. The results of the correlation matrix are presented as shown in the table below. As shown in the table, the two-tailed tests (non-directional) displays a high correlation (> 0.6) between station ST016 with stations ST006, ST008, ST010, and ST014. Therefore, it was decided to perform a multiple correlation between ST016 and the above-mentioned stations.

Bivarite Matrix Correlations Among the Hydrological Stations

	ST003	ST004	ST005	ST006	ST008	ST010	ST014	ST016	ST030	ST033
ST003	1.000	.213**	.407**	.307**	.272**	.226**	.277**	.227**	.073**	.098**
ST004	.213**	1.000	.964**	.852**	.835**	.781**	.609**	.546**	.345**	.706**
ST004	.407**	.964**	1.000	.895**	.819**	.775**	.680**	.660**	.438**	.623**
ST006	.307**	.852**	.895**	1.000	.839**	.787**	.692**	.682**	.443**	.563**
ST008	.272**	.835**	.819**	.839**	1.000	.962**	.849**	.758**	.576**	.685**
ST010	.226**	.781**	.775**	.787**	.962**	1.000	.891**	.792**	.634**	.691**
ST014	.277**	.609**	.680**	.692**	.849**	.891**	1.000	.891**	.792**	.634**
ST016	.227**	.546**	.660**	.682**	.758**	.792**	.912**	1.000	.607**	.576**
ST030	.073**	.345**	.438**	.443**	.576**	.634**	.584**	.607**	1.000	.508**
ST033	.098**	.706**	.623**	.563**	.685**	.691**	.574**	.576**	.508**	1.000

**.Correlation is significant at the 0.01 level (2-tailed).

(4) Multiple Cross Correlation between ST016 with ST006, ST008, ST010, and ST014

The multiple cross correlation among the characteristic stations (independents) ST006, ST008, ST010, and ST014 with the station (dependent) ST016 was used

in the form of the following linear equation:

$$Q_{ST016} = a + b_1 Q_{ST006} + b_2 Q_{ST008} + b_3 Q_{ST010} + b_4 Q_{ST014} + e_t$$

Where:

Q_{ST016} = Dependent variable of daily flow at station ST016_Gevgelija
Q_{ST006} = Independent variable of daily flow at station ST006_Radusha
Q_{ST008} = Independent variable of daily flow at station ST008_Skopje
Q_{ST010} = Independent variable of daily flow at station ST010_Veles
Q_{ST014} = Independent variable of daily flow at station ST014_Demir Kapija
a, b_i = Intersect and correlation coefficients
e_t = Standard random residual that can be modeled stochastically assuming a normal distribution and by applying conventional Monte Carlo method.

The process of obtaining the model parameters (a, b_i) was obtained from the statistical software, however the process for calculation of the random residual (ℓt) was carried separately by means of simple linear modeling.

(5) Obtaining the model parameters (a, b_i)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.913a	.834	.833	53.4185

a. Predictors: (Constant), ST014, ST006, ST010, ST008
b. Dependent Variable: ST016

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	92554349	4	23138587	8108.756	.000[a]
	Residual	18479467	6476	2853.531		
	Total	1.11E+08	6480			

a. Predictors: (Constant), ST014, ST006, ST010, ST008
b. Dependent Variable: ST016

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-2.569	1.294		-1.985	.047
	ST006	.486	.084	.055	5.803	.000
	ST008	-.129	.063	-.043	-2.053	.040
	ST010	.146	.046	.065	3.173	.002
	ST014	1.001	.012	.852	86.610	.000

a. Dependent Variable: ST016

The above three tables present the coefficients estimate results as well test of goodness. As shown in the table, Beta coefficients, sometimes called

standardized regression coefficients, are the regression coefficients when all variables are expressed in standardized (z-score) form. Transforming the independent variables to standardized form makes the coefficients more comparable since they are all in the same units of measure.

Test of null hypothesis is presented by t-values and conditional probability is presented by Sig-values. According to the above tables, using the estimated coefficients, the selected equation can be written as:

ST016=-2.569 + 0.486 * ST006 – 0.129 *ST008 + 0.146 * ST010 + 1.001 * ST014

Analysis of the diagnose parameters (minimum, maximum, mean, standard deviation) was carried out for the estimated flow values in station ST016 as shown in the table below. Analysis of the residuals of estimated values were also presented.

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	8.6479	1485.5813	144.1460	119.5118	6481
Std. Predicted Value	-1.134	11.224	.000	1.000	6481
Standard Error of Predicted Value	.6667	12.0229	1.2535	.7938	6481
Adjusted Predicted Value	8.6485	1487.7587	144.1560	119.5794	6481
Residual	-999.4476	1990.1807	1.233E-12	53.4020	6481
Std. Residual	-18.710	37.256	.000	1.000	6481
Stud. Redisual	-19.143	37.274	.000	1.002	6481
Deleted Residual	-1046.24	1992.0518	-1.00E-02	53.6572	6481
Stud. Deleted Residual	-19.707	42.054	.001	1.046	6481
Mahal. Distance	.009	327.256	3.999	13.043	6481
Cook's Distance	.000	3.431	.001	.043	6481
Centered Leverage Value	.000	.051	.001	.002	6481

a. Dependent Variable: ST016

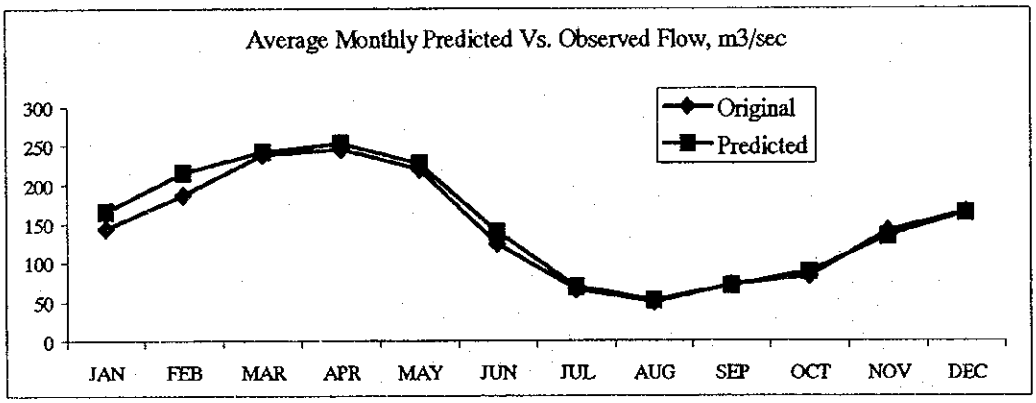
(6) Analysis of the Predicted Flow for ST016_Gevgelija

The original flow records in station ST016_Gevgelija has a daily missing record for 16 years as shown in Table A.18. The predicted daily flow, using the multiple cross correlation models, was tested by several means of statistical methods as shown in the table above. However, it was important to establish the order of magnitude of the difference between average flow for the long-term period of original available data set (20-years) against the predicted data set (36-years). The following table and figure present comparisons of average monthly flow for long-term data set.

Average Monthly flow of Predicted vs. Original

Units: m^3/sec

Month	Original (18-years)	Predicted (36-years)
January	143.53	151.33
February	186.78	192.38
March	237.42	213.81
April	244.51	236.53
May	219.21	212.72
June	124.33	126.88
July	66.150	61.00
August	49.67	44.79
September	71.24	59.41
October	82.68	73.67
November	140.40	116.03
December	164.95	143.00
Average	144.24	135.96



Results show no significant differences between the original and predicted values. Therefore, it may be concluded that the predicted flow series within the missing records can be added to the original records to represent the long-term period of 1961 – 1996 since the estimated averages are quite close to the values of the original records. The methodology of correlation analysis explained above was applied to the other stations that has missing data and predicted missing periods were then considered to represent the long-term of the hydrological analysis during the period 1961- 1996.

A.2.3.2 Flow Corrections

For the purpose of flow corrections, all the stations were tested to identify the range of mismatch data (from the viewpoint of flow accumulations towards the downstream). Comparison of daily flow corrections was applied to the records that were adopted from filling the missing data gaps. It should be noted that, only the mismatched data in the stations was provided to replace the mismatched period keeping the original corrected data unchanged as much as possible. For every basin, one key station (independent) was selected to adjust the mismatch

flow records assuming the record within this station has no errors. For Vardar river basin, three key stations were considered. Except station ST052_Shtip, all other selected key stations were not subjected to missing data analysis. The methodology of simple linear correlation was employed to establish a mathematical relation among stations that has flow errors (dependents) and the key stations (independents). These relations were used to produce corrected flow values that were replaced in the mismatch data records. The following table shows the flow correction criteria that were applied in each river basin. The selected key stations (independents) for flow corrections using correlation process are also shown in the table:

List of Key Stations Selected for the Flow Corrections

River Basin	Corrections Criteria	Key Station	Station Condition
Vardar	ST004 > ST003	ST014	Missing Data applied
	ST005 > ST004	ST008	Missing Data applied
	ST006 > ST005	ST010	
	ST008* > ST006 + ST026		
	ST010* > ST008 + ST033 + ST035		
	ST014* > ST010 + ST052 + ST066		
	ST016 > ST014		Missing Data applied
Treska	ST028 < ST023	ST025	Missing Data applied
	ST025 > ST023		
	ST026 > ST025		Missing Data applied
Pchinja	ST036 < ST037	ST035	Missing Data applied
	ST038 > ST037		
	ST035* > ST041 + ST038 + ST034		Missing Data applied
Bregalnica	ST050 > ST048	ST052	Missing Data applied
	ST052* > ST050 + ST054 + ST055 + ST057		Missing Data applied Missing Data applied
Crna	ST064 > ST060	ST064	
	ST066 > ST064		Missing Data applied
Strumica	ST103 > ST106	ST103	
	ST104 > ST103		

* Stations subjected to individual check as well as summation check

A.2.4 Hydrological Characteristics of Macedonia

Hydrological analysis for the potential of surface water in Macedonia was carried out based on the flow data collected and adopted (missing data and flow corrections) in the Study. Water from the surface area of Macedonia flows along the 7 major river basins that covers more than 98 % of the total area of Macedonia. The Vardar river has the largest river basin in the country in terms of total catchment area (22,612 km^2) and average annual flow (135.96 m^3/sec or 4,287 million m^3 based on 36 years period 1961 – 1996). The flow from the Vardar river basin is accumulated through the four main basins of Treska, Pchinja, Bregalnica, and Crna as well as the main river stem that flows from the most in the north–west (New Yugoslavia border) to the most south–east (Greece border).

For the Vardar river basin, the records of average monthly flow at the river most downstream location (ST016_Gevgelija) for the period 1925 – 1993 were collected as shown in Table 1.19. Based on the monthly flow records shown in the table, the maximum and minimum mean annual flow were recorded in 1962 and 1993 with values of 396.4 m^3/sec and 57.2 m^3/sec respectively. The maximum and minimum mean monthly flows for the period 1925 – 1993 are recorded in April and August with values of 264.7 m^3/sec and 40.3 m^3/sec respectively. The absolute maximum mean monthly flow was recorded in February 1962 (989 m^3/sec) and the absolute mean minimum monthly flow was recorded in August 1989 (8.9 m^3/sec). Figure A.9 shows the average annual flow for the period of 1925 – 1993 in which the trend of the moving average 2-years intervals shows a reduction of flow values during the last 15 years (1980 – 1993). Mean monthly flow distribution is presented in Figure A.10 in which the peak flow records are illustrated.

For the other river basins, flow records at stations located at the most downstream of the basin (e.g. ST035_Katlanonvska Banja at downstream of Pchinja river basin) were used to compare flow condition among the 7 basins. Figure A.11 shows the comparison of the average annual flow records for the period 1961 – 1996 for the 7-basins. All the basins had maximum flow records during the year 1963 while minimum records occurred during the year 1990. According to the collected data for the period 1961 - 1996, maximum mean monthly flow occurred in Vardar river basin (ST016_Gevgelija) with 236.53 m^3/sec on April and minimum mean monthly flow occurred in Pchinja river basin (ST041_Kumanovo) with 0.17 m^3/sec on August. Table A.20 presents the mean monthly flow recorded at 24 selected hydrological stations for the period 1961 – 1996 and Figure A.12 shows the average mean monthly flow records at some selected main stations. Figure A.13 represents isohyetal map of mean annual runoff depth (mm).

The following general findings were estimated based on careful analysis of the flow records within the selected 40 stations:

1) An extremely dry period can be noticed during the last 7-years (1990 – 1996).
2) In general, years 1962, and 1979 where the most wet years, and the driest year was 1990.
3) The most wet year is considered the fiscal year 1962/63 because the extreme values were recorded in November 1962 (in western and southwestern parts) and in February-March 1963 (in eastern and northern parts). In this fiscal year, most of the river flows in the country have over-spilled from the riverbeds, flooding large areas and causing great damages.
4) Another wet year in this period is 1979. In November 1979, high water levels were also recorded (a bit lower than in November 1962), and again, many river flows flooded wide areas, causing damages.

5) Most of the rivers have maximum flow records in spring season (due to snow melting), and in autumn season (due to heavy rainfalls). In the summer season, most of the rivers have minimum flow records.
6) The first decade 1961-1970 is the richest decade with water in all river flows in the country, while the last decade 1981-1990 is the poorest decade with water amounts.

A.2.5 Runoff Coefficient

In general, the annual runoff balance in the Republic of Macedonia of 25,713 km^2 is estimated at station ST016_Gevgelija as 192.3 mm of runoff depth, 590.90 mm of rainfall depth, and 398.60 mm of loss based on average 36 years data (1961 – 1996). The annual losses include losses due to evapotranspiration, groundwater recharge as well as artificial intakes by water users. The annual runoff balance for the major 7 basins are summarized in following table

Runoff Coefficients for the Major 7 Basins

		(1)	(2)	(3) = (1) – (2)	(2)/(1)
		Rainfall	Runoff	Loss	Runoff
No.	Basin	mm	mm	mm	Coefficient
1	Vardar	590.90	192.30	398.60	32.54
2	Treska	696.44	391.50	304.94	56.21
3	Pchinja	520.93	134.20	386.73	25.76
4	Bregalnica	538.05	122.60	415.45	22.79
5	Crna	554.42	156.10	398.32	28.16
6	Strumica	564.57	86.27	478.30	15.28
7	Crn Drim	800.74	228.80	571.94	28.57
	Average	609.43	187.40	422.04	29.90

A.2.6 Flow Duration Analysis

The purpose of performing flow duration analysis is to estimate the values of maintenance flow for biological demands. In this Study, it was decided to define the maintenance flow based on 10 % of the average river flow, 95 % flow duration, and 97 % flow duration.

To establish flow duration analysis, flow records for the period of 1961 – 1996 at the selected 24 stations were used to produce two sets of outputs:

1) Flow duration using daily flow records.
2) Flow duration using mean monthly flow records.

Table A.21 shows the percentages of flow duration for the 24 stations based on mean monthly flow records. Table A.22 shows details of the flow duration (ratio of flow/mean average) for station ST008_Skopje based on daily flow records.

Figure A.14 shows non-dimensional flow duration curves for the 24 stations based on daily flow records for the period 1961 –1996.

A.2.7 Low Flow Analysis

Low flow characteristics are commonly used to describe the capability of river system to supply requirements for river navigation, municipal and/or industrial supplies, liquid waste disposal, irrigation, and maintenance of suitable conditions for aquatic life. Low flow characteristics of a river vary considerably in space and time. At a location with a significant amount of discharge data available, low flow characteristics may be described by frequency curves of annual or daily minimum flows or by duration curves. If the amount of available discharge data for a given site is not sufficient, the estimates of low flow characteristics are frequently quite inaccurate.

Since the flow records in the selected 24 hydrological stations have long daily record period (36-years from 1961 ~ 1996), probability analysis and low flow frequency can be performed. The low flow frequency analysis can be made by using the annual minimum records of daily flow of each calendar year and probable daily low flow can be estimated for pre-selected recurrence intervals of 5, 10,20, 50 and 100 years. The analysis of the annual minimum flow was conducted by using 3 frequency distributions of Gumbel extreme minimum, Log-normal, and Log-Pearson type III. The estimated values using the three methods showed a good correlation with the observed using the three distributions, however, Log-Pearson type III has the best-predicted values. Table A.23 presents the probable low flow outputs using the three methods for the 24 selected stations.

A.2.8 Flood Analysis

A.2.8.1 Objective of Analysis

The purpose of flood analysis is to predict the magnitude of the design flood flows which the current and future hydraulic structures (spillways, weir,... etc.) are expected to handle. There are various methods by which the estimate of design flood can be carried out. Some of these methods are purely empirical and other are based on statistical analysis of the previous flow records. More detailed methods are based on storm records and rely on the construction of flood hydrograph using the principle of unit hydrograph. Through data collection and verification in the first phase of the Study, it has been revealed that availability of flood hydrographs was limited even at main stations along Vardar mainstream. Therefore, in this stage of the Study, a statistical methods based on frequency analysis of the instantaneous peak flows were applied to estimate the design flood values based on different recurrence intervals. A

regional frequency analysis with then applied to predict flood-area relationship by estimation of Creager's coefficient values for major hydrological stations. Further, envelope curves were plotted to represent the trends of estimated flood for each river basin.

A.2.8.2 Flood Frequency Analysis

Statistical study of floods refers to the frequency of extreme values that may be calculated for different return periods. Extreme values were considered in the Study as the instantaneous peak discharge records that were available at total of 22 stations as shown in Table A.24. Total 6 (six)-distribution functions were applied to estimate frequency of peak flow for different return periods. The six distribution functions were namely Normal, Log-Normal type II, Log-Normal type III, Pearson type III, Log-Pearson type III, and Gumbel Extreme type I. The analysis was made for 10 cases of return periods of 2, 5, 10, 20, 50, 80, 100, 200, 500, 1,000 years.

The probable discharges estimated through the frequency analysis are tabulated in Table A.25. Among the results of the six functions, Pearson type III was found to have the best fitted estimates compared to the recorded data, hence it was selected to estimate the probable flood discharge. It should be noted that the Pearson type III method is commonly utilized by HMI with minor modification of parameters.

Figure A.15 compares the estimated flood using Pearson type III for the different return periods indicated by the major 7-basins. Vardar and Crna river basins have the highest flood values among the other basins (e.g. 500-years return period 3,104 and 1,705 m^3/sec respectively). The estimated floods for the 7 major basins using corresponding to different return periods can be summarized as the following table:

Unit : m^3/sec

Basin	Return Period, years								
	2	5	10	20	50	100	200	500	1,000
B1: Vardar	660	1,070	1,372	1,674	2,075	2,381	2,690	3,104	3,422
B2: Treska	114	234	352	485	680	840	1,009	1,245	1,433
B3: Pchinja	153	259	310	355	409	446	481	526	558
B4: Bregalnica	129	217	273	325	391	438	485	546	592
B5: Crna	148	243	376	547	822	1,062	1,325	1,705	2,016
B6: Strumica	36	80	116	155	209	252	296	356	403
B7: Crn Drim	118	177	214	248	290	321	351	390	419

A.2.8.3 Regional Analysis

In general, flow is highly correlated to the catchment area, and so do the flood values. The importance of the regional estimate is to establish the relationship

between the estimated flood values by frequency analysis (section a) against the catchment area of each station. To identify this relationship, Creager's constants (C) were estimated considering the different return periods and catchment area of each station. The results of estimation are tabulated in Table A.26. These constants can be utilized to estimate the correspondence flood values related to any structure (dam) catchment area using the estimated value from the nearest gauging station.

A.2.8.4 Envelope Curves

Another approach that can be used to understand the trend of floods in any basin is to draw an envelope curve on a regional plot (log-log scale) of maximum estimated flood by frequency analysis (section a) against drainage area of each station. Figure A.16 represents the envelope curves of regional flood frequency based on the catchment area of each of the selected 22 gauging stations. It is evidence from the curves that catchment areas are highly correlated to the estimated flood for different return periods.

Table A.1 List of the Main and Secondary Meteorological Network Stations

No	Station Name	Condition	Elevation, m	Latitude	Longitude
1	MST01_Veles	Secondary	175	41° 43 '	21° 46 '
2	MST02_Valandovo	Secondary	100	41° 19 '	22° 34 '
3	MST03_Tetovo	Secondary	462	42° 00 '	20° 58 '
4	MST04_Strumica	Main	224	41° 26 '	22° 39 '
5	MST05_Struga	Secondary	695	41° 11 '	20° 41 '
6	MST06_Solunska Glava	Main	2,540	41° 42 '	21° 25 '
7	MST07_Skopje Petrovec	Secondary	232	41° 57 '	21° 38 '
8	MST08_Skopje Zajcev Rid	Main	301	42° 01 '	21° 24 '
9	MST09_Resen	Secondary	881	41° 05 '	21° 01 '
10	MST10_Radovish	Secondary	380	41° 38 '	22° 27 '
11	MST11_Prilep	Main	673	41° 20 '	21° 34 '
12	MST12_Popova Shapka	Main	1,750	42° 01 '	20° 53 '
13	MST13_Ohrid	Main	760	41° 07 '	20° 48 '
14	MST14_Nov Dojran	Secondary	180	41° 13 '	22° 43 '
15	MST15_Mavrovo	Main	1,240	41° 42 '	20° 45 '
16	MST16_Makedonski Brod	Secondary	545	41° 31 '	21° 13 '
17	MST17_Lazaropole	Main	1,332	41° 32 '	20° 42 '
18	MST18_Kumanovo	Secondary	338	42° 08 '	21° 43 '
19	MST19_Krushevo	Secondary	1,230	41° 22 '	21° 15 '
20	MST20_Kratovo	Secondary	640	42° 05 '	22° 09 '
21	MST21_Kochani	Secondary	345	41° 55 '	22° 25 '
22	MST22_Kichevo	Secondary	620	41° 31 '	20° 58 '
23	MST23_Kavadarci	Secondary	260	42° 26 '	22° 02 '
24	MST24_Katlanovo	Secondary	60	41° 54 '	21° 42 '
25	MST25_Kriva Palanka	Main	691	42° 12 '	22° 20 '
26	MST26_Gostivar	Secondary	525	41° 48 '	20° 55 '
27	MST27_Gevgelija	Main	59	41° 09 '	22° 30 '
28	MST28_Delchevo	Secondary	630	41° 58 '	22° 46 '
29	MST29_Debar	Secondary	675	41° 31 '	20° 32 '
30	MST30_Demir Kapija	Main	125	41° 25 '	22° 15 '
31	MST31_Bitola	Main	586	41° 03 '	21° 20 '
32	MST32_Berovo	Main	824	42° 43 '	22° 51 '
33	MST33_Amzabegovo	Secondary	250	41° 49 '	22° 00 '
34	MST34_Shtip	Main	326	41° 45 '	22° 11 '
35	MST35_Trubarevo	Secondary	233	41° 59 '	21° 11 '

MST00_Name = Meteorological Station Name Applied by The Study Team and Republic Hydrometerological Institute – Meteorological Department

Table A.2 List of the Registered Rainfall Network Stations (1/7)

No.	Station Name	Elevation (m)	Latitude	Longitude	River	Year of Construction
1	RST100_Vrutok	691	41° 46'	20° 51'	Vardar	3.10.1953
2	RST104_Simnica	700	41° 46'	20° 51'	Vardar	
3	RST017_Gostivar-kl	525	41° 48'	20° 55'	Vardar	1.07.1945
4	RST122_Korito	1,420	41° 48'	21° 02'	Vardar	8.11.1954
5	RST112_Stenche	550	41° 53'	21° 00 '	Vardar	
6	RST098_Pirok	525	41° 55'	20° 55'	Vardar	12.11.1947
7	RST294_Popova Shapka	1,750	42° 01'	20° 53'	Vardar	10.12.1957
8	RST001_Tetovo-kl	462	42° 00'	20° 58'	Vardar	29.09.1949
9	RST061_Janchishte	395	42° 03'	21° 07'	Vardar	
10	RST060_Tearce	540	42° 05'	21° 03'	Vardar	
11	RST056_Odri	665	42° 08'	21° 06'	Vardar	
12	RST032_Vetersko	420	41° 49'	21° 43'	Vardar	
13	RST067_Butel-kl	295	42° 01'	21° 25'	Vardar	
14	RST105_Bukovikj-Kich	1,180	41° 39'	20° 58'	Vardar	
15	RST137_Belinbegovo	231	42° 00'	21° 35'	Vardar	
16	RST152_Kochilari	160	41° 40'	21° 52'	Vardar	
17	RST180_Crveni Bregovi	147	41° 32'	22° 05'	Vardar	
18	RST295_Shemshevo	380	42° 02'	21° 05'	Vardar	
19	RST101_Dobridol	575	41° 52'	20° 54'	Vardar	
20	RST062_Radusha	335	42° 05'	21° 13'	Vardar	
21	RST057_Jazhince	830	42° 10'	21° 11'	Vardar	
22	RST058_Gen.Jankovic	365	42° 09'	21° 18'	Vardar	
23	RST064_Vuchidol	285	42° 03'	21° 21'	Vardar	
24	RST116_G. Petrov-kl	262	42° 00'	21° 22'	Vardar	
25	RST124_Drzhilovo	870	41° 51'	21° 21'	Vardar	27.10.1954
26	RST063_Rashche	380	42° 01'	21° 15'	Vardar	
27	RST113_Grupchin	480	41° 58'	21° 08'	Vardar	
28	RST117_Nova Breznica	780	41° 53'	21° 17'	Vardar	
29	RST059_Brodec	960	42° 08'	21° 27'	Vardar	
30	RST065_Ljubanci	600	42° 07'	21° 28'	Vardar	
31	RST066_Brazda-Gluvo	390	42° 05'	21° 24'	Vardar	
32	RST077_Bulachani	510	42° 04'	21° 31'	Vardar	
33	RST002_Mrshevci	340	42° 01'	21° 39'	Vardar	
34	RST027_Skopje	240	42° 01'	21° 25'	Vardar	
35	RST136_Trubarevo	233	41° 59'	21° 31'	Vardar	
36	RST119_Gorno Vodno	720	41° 58'	21° 24'	Vardar	
37	RST120_Rakotinci	520	41° 57'	21° 25'	Vardar	19.04.1951
38	RST138_Drachevo-kl	255	41° 56'	21° 32'	Vardar	
39	RST121_Gorno Kolichani	635	41° 53'	21° 29'	Vardar	
40	RST145_Zelenikovo	230	41° 52'	21° 36'	Vardar	1.08.1946
41	RST148_Dolno Jabolchishte	940	41° 43'	21° 31'	Vardar	
42	RSTO29_Drenovo-Veleshko	660	41° 44'	21° 35'	Vardar	1.08.1945
43	RST149_Rashtani	380	41° 44'	21° 43'	Vardar	

Table A.2 List of the Registered Rainfall Network Stations (2/7)

No.	Station Name	Elevation (m)	Latitude	Longitude	River	Year of Construction
44	RST151_Veles	175	41° 43'	21° 46'	Vardar	01.01.1945
45	RST128_Nezhilovo	680	41° 39'	21° 28	Vardar	15.05.1945
46	RST150_Chashka	330	41° 39'	21° 40'	Vardar	
47	RST154_Nogaevci	160	41° 38'	21° 55'	Vardar	
48	RST134_Bogomila	510	41° 36'	21° 29'	Vardar	26.10.1949
49	RST155_Teovo	380	41° 35'	21° 35'	Vardar	15.08.1951
50	RST157_Vojnica	360	41° 36'	21° 45'	Vardar	01.07.1948
51	RST156_Izvor-Veleshki	290	41° 33'	21° 42'	Vardar	
52	RST037_Gradsko	164	41° 34'	21° 58'	Vardar	01.05.1945
53	RST033_Vladilovci	450	41° 31'	21° 45'	Vardar	01.01.1945
54	RST158_Dolno Chichevo	375	41° 33'	21° 53'	Vardar	24.06.1952
55	RST146_Ivankovci	480	41° 29'	21° 20'	Vardar	
56	RST255_Negotino	150	41° 29'	22° 06'	Vardar	01.05.1945
57	RST256_Dubrovo	110	41° 29'	22° 09'	Vardar	
58	RST038_Kavadarci-kl	265	41° 26'	22° 02'	Vardar	01.01.1945
59	RST041_Demir Kapija	107	41° 25'	22° 15'	Vardar	01.03.1945
60	RST039_Gorna Boshava	590	41° 17'	22° 08'	Vardar	
61	RST259_Barovo	480	41° 21'	22° 09'	Vardar	
62	RST260_Radanje	740	41° 16'	22° 14'	Vardar	
63	RST261_Doshnica	170	41° 22'	22° 14'	Vardar	01.06.1964
64	RSTO43_Udovo	75	41° 21'	22° 26'	Vardar	03.07.1945
65	RST262_Petrovo	340	41° 18'	22° 23'	Vardar	
66	RST263_Miravci	100	41° 18'	22° 26'	Vardar	
67	RST264_Smokvica	95	41° 16'	22° 29'	Vardar	
68	RST265_Sermenin	580	41° 13'	22° 21'	Vardar	24.01.1956
69	RST279_Gevgelija	59	41° 09'	22°30'	Vardar	20.08.1949
70	RST045_Valandovo	100	41° 19'	22° 34'	Vardar	03.01.1945
71	RST277_Organdzhali	440	41° 18'	22° 43'	Vardar	01.11.1947
72	RST276_Dedeli	180	41° 17'	22° 37'	Vardar	
73	RST281_Crnichani	200	41° 14'	22° 40'	Vardar	01.11.1947
74	RST278_Bogdanci	130	41° 12'	22° 35'	Vardar	
75	RST280_Stojakovo	40	41° 09'	22° 35'	Vardar	
76	RST140_Rzhanichano	260	41° 55'	21° 39'	Vardar	
77	Solunska Glava	2540	41° 42'	21° 25'	Vardar	
78	RST204_Izvor-Kichevski	760	41° 21'	20° 50'	Treska	19.06.1952
79	RST217_Chelopeci	590	41° 28'	21° 02'	Treska	
80	RST018_Kichevo-kl	620	41° 31'	20° 58'	Treska	01.10.1946
81	RST110_Zajas	790	41° 36'	20° 56'	Treska	23.06.1953
82	RST111_Oslomej	683	41° 34'	21° 00'	Treska	20.12.1948
83	RST207_Belica	760	41° 24'	20° 57'	Treska	
84	RST130_Sveto Rache	700	41° 32'	21° 05'	Treska	
85	RST023_Makedonski Brod	545	41° 31'	21° 13'	Treska	
86	RST129_Srbica	760	41° 35'	21° 02'	Treska	

Table A.2 List of the Registered Rainfall Network Stations (3/7)

No.	Station Name	Elevation (m)	Latitude	Longitude	River	Year of Construction
87	RST125_Jagol Dolenci	820	41° 38'	21° 01'	Treska	
88	RST132_Slatina	580	41° 35'	21° 11'	Treska	15.06.1952
89	RST126_Samokov	600	41° 41'	21° 09'	Treska	18.11.1947
90	RST131_Gorni Manastirec	520	41° 37'	21° 12'	Treska	
91	RST133_Lokvica	800	41° 34'	21° 17'	Treska	03.11.1954
92	RST123_Zdunje	420	41° 48'	21° 11'	Treska	
93	RST115_Lukovica	960	41° 53'	21° 10'	Treska	
94	RST114_Bojane	498	42° 00'	21° 12'	Treska	
95	RST118_Matka	298	41° 57'	21° 18'	Treska	01.01.1940
96	RST127_Gorna Belica	560	41° 41'	21° 19'	Treska	09.09.1947
97	RST206_Podvis	800	41°28'	20° 54'	Treska	
98	RST135_Strovija	715	41°34'	21° 25'	Crna Reka	14.11.1947
99	RST220_Brailovo	670	41° 29'	21° 29'	Crna Reka	
100	RST240_Prisad	900	41° 25'	21° 31'	Crna Reka	01.09.1946
101	RST221_Belo Pole	608	41° 25'	21° 24'	Crna Reka	14.12.1947
102	RST020_Cer	998	41° 25'	21° 05'	Crna Reka	01.11.1947
103	RST218_Dolno Divjaci	920	41° 24'	21° 12'	Crna Reka	11.11.1954
104	RST024_Krushevo	1230	41° 22'	21° 15'	Crna Reka	01.04.1945
105	RST226_Slavej	602	41° 20'	21° 25'	Crna Reka	
106	RST222_Dolenci	700	41° 19'	21° 06'	Crna Reka	01.01.1946
107	RST224_Rastoica	720	41° 20'	21° 12'	Crna Reka	24.11.1955
108	RST235_Rotino	1010	41° 04'	21° 13'	Crna Reka	01.07.1948
109	RST225_Krivogashtani	608	41° 20'	21° 20'	Crna Reka	21.04.1945
110	RST223_Zhvan	680	41° 18'	21° 07'	Crna Reka	
111	RST022_Slepche	650	41° 13'	21° 12'	Crna Reka	20.03.1949
112	RST229_Vardino	650	41° 14'	21° 15'	Crna Reka	01.11.1947
113	RST026_Topolchani	610	41° 14	21° 26'	Crna Reka	01.11.1946
114	RST228_Boishte	940	41° 12'	21° 06'	Crna Reka	01.11.1947
115	RST230_Svinjishte	760	41° 18'	21° 10'	Crna Reka	
116	RST232_Lopatica	655	41° 10'	21° 16'	Crna Reka	01.11.1947
117	RST231_Dolno Srpci	652	41° 11'	21° 22'	Crna Reka	19.06.1953
118	RST233_Dobrushevo	595	41° 10'	21° 29'	Crna Reka	06.08.1951
119	RST236_Crno Buki	595	41° 07'	21° 19'	Crna Reka	05.08.1951
120	RST238_Radobor	581	41° 07'	21° 27'	Crna Reka	
121	RST021_Kazhani	890	41° 04'	21° 09'	Crna Reka	01.01.1946
122	RST025_Bitola	586	41° 03'	21° 22'	Crna Reka	
123	RST239_Novaci	577	41°02'	21° 28'	Crna Reka	21.04.1945
124	RST286_Bukovo	790	41°00'	21° 20'	Crna Reka	01.10.1947
125	RST288_Gneotino	576	40° 59'	21° 29'	Crna Reka	30.06.1952
126	RST289_Porodin	596	40° 56'	21° 23'	Crna Reka	01.08.1948
127	RST290_Kremenica	585	40° 56'	21° 27'	Crna Reka	
128	RST287_Graeshnica	695	40° 54'	21° 21'	Crna Reka	12.11.1953
129	RST251_Suvodol	660	41° 04'	21° 32'	Crna Reka	20.11.1947

Table A.2 List of the Registered Rainfall Network Stations (4/7)

No.	Station Name	Elevation (m)	Latitude	Longitude	River	Year of Construction
130	RST291_Tepavci	710	41° 00'	21° 34'	Crna Reka	
131	RST055_Bach	610	40° 56'	21° 34'	Crna Reka	
132	RST292_Germijan	590	40° 55'	21° 32'	Crna Reka	01.10.1946
133	RST028_Prilep	673	41° 20'	21° 34'	Crna Reka	
134	RST247_Bonche	780	41° 14'	21° 36'	Crna Reka	06.11.1947
135	RST030_Makovo	690	41° 07'	21° 37'	Crna Reka	01.11.1946
136	RST253_Iveni	980	41° 03'	21° 39'	Crna Reka	
137	RST293_Skochivir	580	40° 58'	21° 39'	Crna Reka	
138	RST244_Pletvar	980	41° 22'	21° 39'	Crna Reka	01.09.1946
139	RST031_Dunje	590	41° 15'	21° 42'	Crna Reka	22.10.1949
140	RST248_Chanishte	600	41° 10'	21° 42'	Crna Reka	01.01.1949
141	RST252_Staravina	860	41° 05'	21° 44'	Crna Reka	01.11.1949
142	RST254_Budimirci	740	41° 03'	21° 44'	Crna Reka	19.11.1947
143	RST241_Nikodin	580	41° 27'	21° 44'	Crna Reka	
144	RST245_Carevikj	450	41° 21'	21° 46'	Crna Reka	
145	RST249_Vrpsko	660	41° 14'	21° 49'	Crna Reka	
146	RST250_Beshishte	910	41° 08'	21° 47'	Crna Reka	15.11.1947
147	RST036_Rozhden	925	41° 11'	21° 57'	Crna Reka	.
148	RST258_Begnishte	500	41° 21'	22° 00'	Crna Reka	
149	RST246_Sheshkovo	620	41° 22'	21° 55'	Crna Reka	
150	RST034_Drenovo-Kavadarci	340	41° 25'	21° 54'	Crna Reka	
151	RST243_Vozarci	180	41° 26'	21° 56'	Crna Reka	
152	RST219_Debrishte	650	41° 29'	21° 19'	Crna Reka	
153	RST242_Manastirec	145	41° 29'	21° 57'	Crna Reka	
154	RST084_Luke	970	42° 19'	22° 18'	Pchinja	
155	RST085_Dubrovnica	840	42° 17'	22°206'	Pchinja	
156	RST009_Kriva Palanka	691	42° 12'	22°20'	Pchinja	21.09.1945
157	RST089_Konopnica	650	42° 11'	22° 18'	Pchinja	
158	RST083_Ogut	940	42° 19'	22° 12'	Pchinja	
159	RST087_Petralica	720	42° 13'	22° 12'	Pchinja	01.08.1948
160	RST088_Ginovci	470	42° 10'	22° 09'	Pchinja	15.08.1948
161	RST008_Kratovo-kl	610	42° 05'	22° 09'	Pchinja	11.06.1946
162	RST006_German	1340	42° 17'	22° 07'	Pchinja	
163	RST086_Gulinci	750	42° 13'	22° 05'	Pchinja	16.11.1947
164	RST007_Trnovec	720	42° 08'	22° 03'	Pchinja	06.11.1947
165	RST092_Turalevo	620	42° 04'	22° 08'	Pchinja	
166	RST005_Stracin	680	42° 09'	22° 02'	Pchinja	
167	RST081_Shopsko Rudare	460	42° 04'	22° 00'	Pchinja	
168	RST068_Zhegljane	600	42° 16'	21° 24'	Pchinja	
169	RST073_Dragomanci	420	42° 13'	21° 52'	Pchinja	
170	RST074_Staro Nagorichani	440	42° 12'	21° 50'	Pchinja	
171	RST004_Vojnik	310	42° 10'	21° 52'	Pchinja	
172	RST079_Klechevci	300	42° 07'	21° 51'	Pchinja	

Table A.2 List of the Registered Rainfall Network Stations (5/7)

No.	Station Name	Elevation (m)	Latitude	Longitude	River	Year of Construction
173	RST082_Gradishte	580	42° 01'	21° 54'	Pchinja	
174	RST071_Vaksinci	450	42° 12'	21° 40'	Pchinja	
175	RST072_Kumanovo	338	42° 08'	21° 43'	Pchinja	01.03.1945
176	RST003_Romanovci	400	42° 05'	21° 42'	Pchinja	
177	RST080_Pchinja	290	42° 02'	21° 46'	Pchinja	
178	RST139_Gorno Konjare	250	41° 58'	21° 44'	Pchinja	10.11.1953
179	RST141_Katlanovska Banja	260	41° 54'	21° 42'	Pchinja	01.04.1953
180	RST069_Belanovce	900	42° 14'	21° 34'	Pchinja	
181	RST070_Lipkovo	425	42° 09'	21° 36'	Pchinja	
182	RST076_Matejche	480	42° 07'	21° 36'	Pchinja	
183	RST078_Umin dol	505	42° 05'	21° 36'	Pchinja	
184	RST090_Uzem	880	42° 13'	22° 26'	Pchinja	01.08.1948
185	RST010_Sasa	920	42° 05'	22° 38'	Bregalnica	01.03.1948
186	RST096_Kostin Dol	685	42° 02'	22° 38'	Bregalnica	15.11.1947
187	RST097_Dramche	710	42° 01'	22°43'	Bregalnica	
188	RST091_Mushkovo	1160	42° 06'	22°15'	Bregalnica	20.10.54
189	RST095_Nebojani	1100	42° 03'	22° 27'	Bregalnica	01.09.1952
190	RST093_Probishtip	550	42° 00'	22° 12'	Bregalnica	
191	RST094_Lesnovo	890	42° 01'	22° 14'	Bregalnica	20.08.1948
192	RST161_Zletovo	490	41° 59'	22° 15'	Bregalnica	07.11.1947
193	RST163_Nivichani Kochansk	540	41° 57'	22° 21'	Bregalnica	
194	RST183_Istibanja	380	41° 56'	22° 30'	Bregalnica	
195	RST042_Kochani-kl	345	41° 55'	22° 25'	Bregalnica	11.06.1945
196	RST162_Puzderci	460	41° 57'	22° 09'	Bregalnica	
197	RST164_Sokolarci	330	41° 54	22° 17'	Bregalnica	
198	RST168_Ularci	300	41° 52'	22° 16'	Bregalnica	
199	RST166_Gorno Trogerci	580	41° 51'	22° 10'	Bregalnica	
200	RST167_Dolni Balvan	285	41° 48'	22° 12'	Bregalnica	20.07.1948
201	RST143_Dolno Gjugjanci	440	41° 58'	22° 58'	Bregalnica	
202	RST142_Krushica	520	41° 55'	21° 50'	Bregalnica	18.05.1946
203	RST144_Mezdra	345	41° 55'	21° 56'	Bregalnica	
204	RST159_Njemanjica	440	41° 55'	22° 01'	Bregalnica	15.01.1952
205	RST160_Mechkuevci	470	41° 55'	22° 04'	Bregalnica	01.08.1945
206	RST165_Erdzhelija	253	41° 50'	22° 02'	Bregalnica	
207	RST147_Lozovo-Dzhumajlija	280	41° 47'	21° 54'	Bregalnica	
208	RST153_Kishino	420	41° 43'	21° 55'	Bregalnica	
209	RST193_Vladimirovo	840	41° 43'	22° 48'	Bregalnica	
210	RST050_Berovo-kl	824	41° 43'	22° 51'	Bregalnica	01.08.1949
211	RST192_Pehchevo	1010	41° 46'	22° 53'	Bregalnica	01.10.1946
212	RST191_Mitrashinci	900	41° 47'	22° 46'	Bregalnica	01.10.1946
213	RST052_Crnik	900	41° 49'	22° 54'	Bregalnica	01.10.1949
214	RST190_Razlovci	675	41° 51'	22° 47'	Bregalnica	15.06.1952
215	RST187_Trabotivishte	658	41°54'	22° 49'	Bregalnica	

Table A.2 List of the Registered Rainfall Network Stations (6/7)

No.	Station Name	Elevation (m)	Latitude	Longitude	River	Year of Construction
216	RST186_Grad	700	41°56'	22° 51'	Bregalnica	27.11.55
217	RST049_Delchevo-kl	630	41°58'	22° 46'	Bregalnica	01.05.1945
218	RST189_Laki	780	41°48'	22° 40'	Bregalnica	28.10.1947
219	RST188_Blatec	700	41°50'	22° 35'	Bregalnica	20.07.1948
220	RST185_Vinica	410	41°53'	22° 31'	Bregalnica	26.10.1947
221	RST171_Zrnovci	340	41°51'	22° 27'	Bregalnica	
222	RST169_Teranci	390	41° 51'	22° 22'	Bregalnica	
223	RST178_Koshevo	800	41° 42'	22° 21'	Bregalnica	
224	RST170_Radanje	380	41° 47'	22° 17'	Bregalnica	
225	RST175_Shashavarlija	770	41° 43'	22° 11'	Bregalnica	
226	RST040_Shtip	326	41° 45'	22° 11'	Bregalnica	01.03.1946
227	RST257_Konche	580	41°30'	22° 24'	Bregalnica	01.12.1948
228	RST182_Dedino	600	41° 34'	22° 27'	Bregalnica	19.09.1951
229	RST181_Piperevo	560	41° 34'	22° 16'	Bregalnica	03.11.1947
230	RST176_Lakavica	415	41° 38'	22° 16'	Bregalnica	01.10.1952
231	RST174_Dragoevo	370	41° 41'	22° 09'	Bregalnica	
232	RST173_Doljani	390	41° 42'	22° 12'	Bregalnica	01.01.1952
233	RST172_Novo Selo - Shtip	252	41° 44'	22° 11'	Bregalnica	
234	RST035_Sveti Nikole	270	41° 52'	22° 57'	Bregalnica	01.05.1945
235	RST184_Grlani	830	41° 56'	22° 37	Bregalnica	1.11.1947
236	RST272_Borisovo	320	41° 33'	22° 55'	Strumica	
237	RST266_Veljusa	400	41° 28'	22° 34'	Strumica	01.12.1948
238	RST268_Gradashorci	240	41° 29'	22° 38'	Strumica	
239	RST198_Dobrashinci	280	41° 32'	22° 41'	Strumica	
240	RST196_Edrenikovo	320	41° 30'	22° 36'	Strumica	
241	RST270_Ilovica	290	41° 28'	22° 49'	Strumica	
242	RST195_Kalu|erica	390	41° 34'	22° 31'	Strumica	
243	RST177_Kozbunar	1130	41° 44'	22° 29'	Strumica	50.12.1946
244	RST275_Kosturino	435	41° 21'	22° 37'	Strumica	14.12.1946
245	RST271_Monospitovo	207	41° 25'	22° 46	Strumica	
246	RST197_Nivichani - Strumica	660	41° 36'	22° 41'	Strumica	
247	RST046_Novo Selo - Radovis	1060	41° 43'	22° 35'	Strumica	
248	RST051_Novo Selo - Strumic	240	41° 25'	22° 53'	Strumica	13.06.1945
249	RST194_Podaresh	320	41° 37'	22° 33'	Strumica	
250	RST179_ Prnajlija	660	41° 40	22° 25'	Strumica	
251	RST044_Radovish-kl	380	41° 38'	22° 27'	Strumica	01.04.1946
252	RST267_Rich	580	41° 27'	22° 32'	Strumica	22.06.1946
253	RST274_Smolari	380	41°233'	22° 54'	Strumica	
254	RST273_Stinik	780	41°28'	22° 56'	Strumica	10.07.1946
255	RST269_Strumica-kl	223	41° 27'	22° 40'	Strumica	18.08.1945
256	RST048_Hamzali	290	41° 30'	22° 45'	Strumica	1.12.1948
257	RST199_Babini Kolibi	1160	41° 37'	22° 54'	Struma	1.10.1946
258	RST200_Dvorishte	930	41° 36'	22° 55'	Struma	01.10.1956

Table A.2 List of the Registered Rainfall Network Stations (7/7)

No.	Station Name	Elevation (m)	Latitude	Longitude	River	Year of Construction
259	RST014_Mavrovi Anovi	1240	41° 42'	20° 45'	Radika	01.06.1946
260	RST109_Gari	1120	41° 30'	20° 41'	Radika	
261	RST108_Galichnik	1340	41° 36'	20° 39'	Radika	
262	RST107_Dolno Kosovrasti	620	41° 32'	20° 35'	Radika	
263	RST102_ Zhirovnica	920	41° 40'	20° 36'	Radika	20.06.1951
264	RST099_Krakornica	1500	41° 45'	20° 42'	Radika	
265	RST013_Lazaropole	1332	41° 32'	20° 42'	Radika	15.10.1948
266	RST106_Rostusha	720	41° 37'	20° 36'	Radika	03.08.1946
267	RST103_Trnica	1060	41° 43'	20° 42'	Radika	
268	RST205_Slivovo	890	41° 24'	20° 51'	Crni Drim	02.11.1949
269	RST075_Bajlovci	630	42° 14'	21° 58'	Crni Drim	
270	RST201_Belanci	700	41° 29'	20° 33'	Crni Drim	
271	RST016_Belchishte	775	41° 18'	20° 50'	Crni Drim	
272	RST012_Vevchani	975	41° 14'	20°36'	Crni Drim	1.11.1947
273	RST208_Boroec	940	41° 17'	20°36'	Crni Drim	15.11.1947
274	RST209_Lukovo	650	41° 22'	20° 36'	Crni Drim	
275	RST203_Pralenik-Kodzhadzhi	1150	41° 26'	20° 37'	Crni Drim	01.01.1952
276	RST212_Mesheishte	790	41° 14'	20° 47'	Crni Drim	26.11.1955
277	RST211_Struga-kl	695	41° 20'	20° 41'	Crni Drim	
278	RST202_Dzhepishte	740	41° 26'	20° 32'	Crni Drim	01.03.1945
279	RST011_Debar-kl	675	41° 31'	20° 32'	Crni Drim	01.08.1946
280	RST213_Kuratica	1100	41° 15'	20° 54'	Ohrid.Ez.	13.06.1953
281	RST214_Openica	840	41° 11'	20° 53'	Ohrid.Ez.	20.11.1947
282	RST015_Ohrid	760	41° 07'	20° 48'	Ohrid.Ez.	
283	RST215_Peshtani	720	41° 01'	20° 49'	Ohrid.Ez.	27.06.1951
284	RST210_Radolishta	780	41° 10'	20° 37'	Ohrid.Ez.	
285	RST053_Sveti Naum	698	40° 55'	20° 45'	Ohrid.Ez.	
286	RST284_Asamati	860	40° 59'	21° 03'	Prespa.Ez.	01.07.1948
287	RST285_Brajchino	1020	40° 54'	21° 10'	Prespa.Ez.	30.061951
288	RST227_Izbishte	980	41° 08'	21° 00'	Prespa.Ez.	23.12.1947
289	RST054_Nakolec	850	40° 54'	21° 07'	Prespa.Ez.	
290	RST216_Pokrvenik	980	41° 02'	20° 57'	Prespa.Ez.	
291	RST234_Resen-kl	881	41° 05'	21° 01'	Prespa.Ez.	01.07.1946
292	RST283_Stenje	855	40° 57'	20° 54'	Prespa.Ez.	
293	RST019_Carev Dvor	864	41° 03'	21° 01'	Prespa.Ez.	
294	RST047_Nov Dojran-kl	180	41° 13'	22° 43'	Dojran.Ez.	01.03.1951
295	RST282_Stari Dojran	160	41° 11'	22° 43'	Dojran.Ez.	

RST000_Name= Rainfall Station Name Identified Based on Agreement
Between the Study Team and RHI

Table A.3 List of the Measured Meteorological Parameters for the Main and Secondary Meteorological Stations

No	Station Name	Pr	Cl	T			P	W	S	RH	E	R	Sun	Soil Tm
				Av.	Max	Min								
1	MST01_Veles	+	+	+	+	+		+	+	+				
2	MST02_Valandovo	+	+	+	+	+		+	+	+				
3	MST03_Tetovo	+	+	+	+	+		+	+	+				
4	MST04_Strumica	+	+	+	+	+	+	+	+	+			+	+
5	MST05_Struga	+	+	+	+	+		+	+	+				
6	MST06_Solunska Glava	+	+	+	+	+	+	+	+	+			+	
7	MST07_Skopje Petrovec	+	+	+	+	+	+	+	+	+				
8	MST08_Skopje Zajcev Rid	+	+	+	+	+	+	+	+	+	+	+	+	+
9	MST09_Resen	+	+	+	+	+		+	+	+				
10	MST10_Radovish	+	+	+	+	+		+	+	+				
11	MST11_Prilep	+	+	+	+	+	+	+	+	+			+	+
12	MST12_Popova Shapka	+	+	+	+	+	+	+	+	+			+	
13	MST13_Ohrid	+	+	+	+	+	+	+	+	+	+		+	
14	MST14_Nov Dojran	+	+	+	+	+		+	+	+			+	
15	MST15_Mavrovo	+	+	+	+	+		+	+	+			+	
16	MST16_Makedonski Brod	+	+	+	+	+		+	+	+				
17	MST17_Lazaropole	+	+	+	+	+	+	+	+	+			+	
18	MST18_Kumanovo	+	+	+	+	+		+	+	+				
19	MST19_Krushevo	+	+	+	+	+		+	+	+				
20	MST20_Kratovo	+	+	+	+	+		+	+	+				
21	MST21_Kochani	+	+	+	+	+		+	+	+				
22	MST22_Kichevo	+	+	+	+	+		+	+	+				
23	MST23_Kavadarci	+	+	+	+	+		+	+	+				
24	MST24_Katlanovo	+	+	+	+	+		+	+	+				
25	MST25_Kriva Palanka	+	+	+	+	+	+	+	+	+			+	+
26	MST26_Gostivar	+	+	+	+	+		+	+	+				
27	MST27_Gevgelija	+	+	+	+	+	+	+	+	+	+		+	+
28	MST28_Delchevo	+	+	+	+	+		+	+	+				
29	MST29_Debar	+	+	+	+	+		+	+	+				
30	MST30_Demir Kapija	+	+	+	+	+	+	+	+	+				
31	MST31_Bitola	+	+	+	+	+	+	+	+	+	+	+	+	+
32	MST32_Berovo	+	+	+	+	+	+	+	+	+			+	+
33	MST33_Amzabegovo	+	+	+	+	+		+	+	+				
34	MST34_Shtip	+	+	+	+	+	+	+	+	+	+		+	+
35	MST35_Trubarevo	+	+	+	+	+	+	+	+	+				

+	Data Available in The Meteorological Station	
Pr	Precipitation	mm
Cl	Cloud	0 to 10
T	Temperature	°C
P	Pressure	hPa
W	Wind Speed	m/sec
S	Snow	mm
RH	Relative Humidity	%
E	Evaporation	mm
R	Solar Radiation	MJ/ m^2. sec
Sun	Sunshine Duration	hrs

Table A.4 Inventory of the Rainfall Network Stations for the Missing Years of Records (1/4)

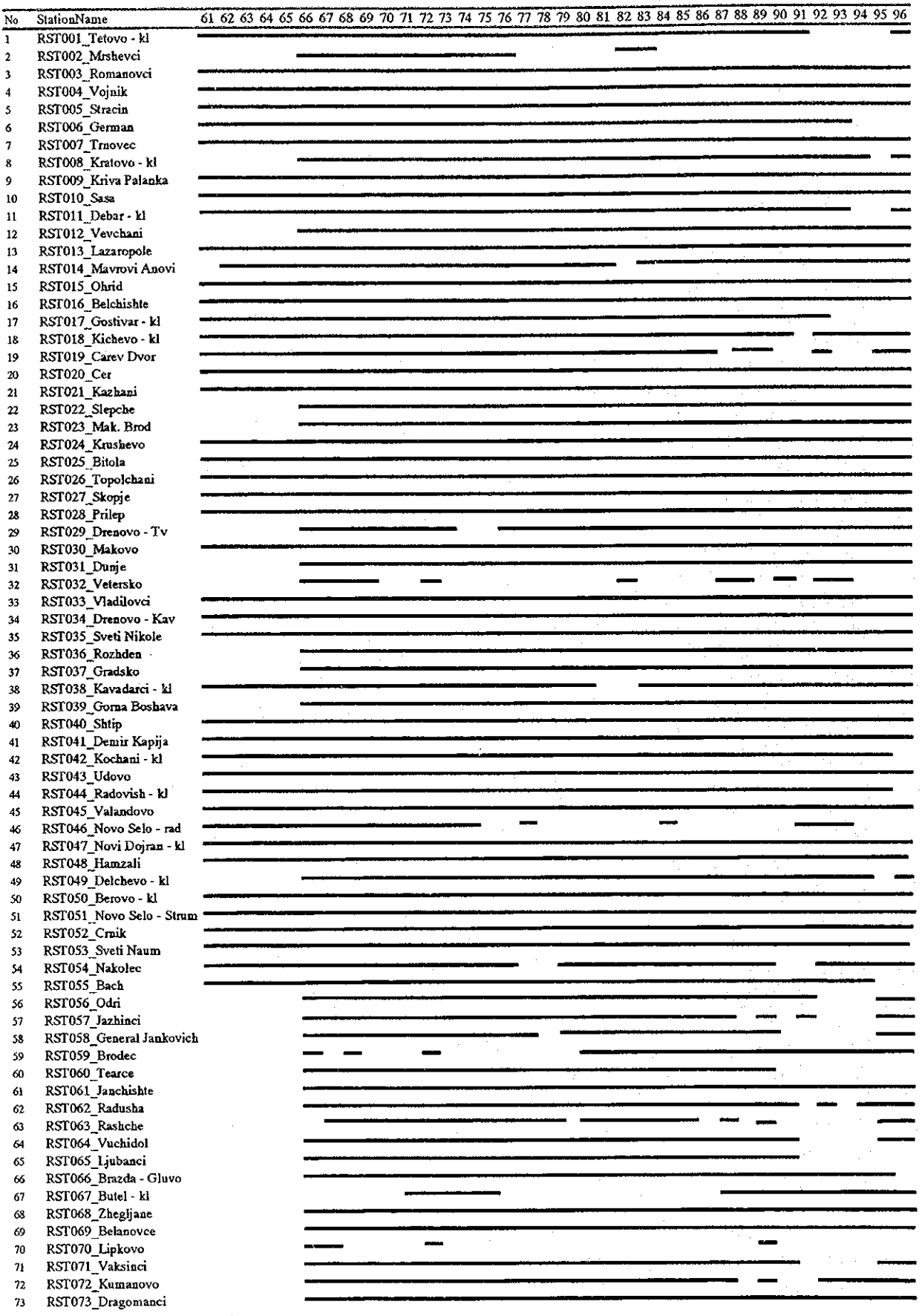


Table A.4 Inventory of the Rainfall Network Stations for the Missing Years of Records (2/4)

No	StationName	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
74	RST074_Staro Nagorichani																																				
75	RST075_Bajlovci																																				
76	RST076_Matejche																																				
77	RST077_Bulachani																																				
78	RST078_Umni Dol																																				
79	RST079_Klechevci																																				
80	RST080_Pchinja																																				
81	RST081_Shopsko Rudare																																				
82	RST082_Gradishte																																				
83	RST083_Ogut																																				
84	RST084_Luke																																				
85	RST085_Dubrovnica																																				
86	RST086_Gulinci																																				
87	RST087_Petralica																																				
88	RST088_Ginovci																																				
89	RST089_Konopnica																																				
90	RST090_Uzem																																				
91	RST091_Mushkovo																																				
92	RST092_Turalevo																																				
93	RST093_Probishtip																																				
94	RST094_Lesnovo																																				
95	RST095_Nebojani																																				
96	RST096_Kostindol																																				
97	RST097_Dramche																																				
98	RST098_Pirok																																				
99	RST099_Krakornica																																				
100	RST100_Vrutok																																				
101	RST101_Dobridol																																				
102	RST102_Zhirovnica																																				
103	RST103_Trnica																																				
104	RST104_Simnica																																				
105	RST105_Bukovikj - Kich																																				
106	RST106_Rostusha																																				
107	RST107_Dolno Kosovrasti																																				
108	RST108_Galichnik																																				
109	RST109_Gari																																				
110	RST110_Zajas																																				
111	RST111_Oslomej																																				
112	RST112_Stenche																																				
113	RST113_Grupchin																																				
114	RST114_Bojane																																				
115	RST115_Lukovica																																				
116	RST116_Gjorche Petrov - kl																																				
117	RST117_Nova Breznica																																				
118	RST118_Matka																																				
119	RST119_Gorno Vodno																																				
120	RST120_Rakotinci																																				
121	RST121_G. Kolicani																																				
122	RST122_Korito																																				
123	RST123_Zdunje																																				
124	RST124_Drzhilovo																																				
125	RST125_Jagol Dolenci																																				
126	RST126_Samokov																																				
127	RST127_Gorna Belica																																				
128	RST128_Nezhilovo																																				
129	RST129_Srbica																																				
130	RST130_Sveto Rache																																				
131	RST131_Gorni Manastirec																																				
132	RST132_Slatina																																				
133	RST133_Lokvica																																				
134	RST134_Bogomila																																				
135	RST135_Strovija																																				
136	RST136_Trubarevo																																				
137	RST137_Belinbegovo																																				
138	RST138_Drachevo - kl																																				
139	RST139_Gorno Konjare																																				
140	RST140_Rzhanichino																																				
141	RST141_Kat. Banja																																				
142	RST142_Krushica																																				
143	RST143_Dolno Gjugjanci																																				
144	RST144_Mezdra																																				
145	RST145_Zelenikovo																																				
146	RST146_Ivankovci																																				
147	RST147_Lozovo - Dzhumajl																																				
148	RST148_Dolno Jabolchishte																																				

Table A.4 Inventory of the Rainfall Network Stations for the Missing Years of Records (3/4)

No	StationName	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
149	RST149_Rashtani																																				
150	RST150_Chashka																																				
151	RST151_Titov Veles																																				
152	RST152_Kochilari																																				
153	RST153_Kishino																																				
154	RST154_Nogaevci																																				
155	RST155_Teovo																																				
156	RST156_Izvor - Tv																																				
157	RST157_Vojnica																																				
158	RST158_Dolno Chichevo																																				
159	RST159_Njemanjica																																				
160	RST160_Mechkuevci																																				
161	RST161_Zletovo																																				
162	RST162_Puzderci																																				
163	RST163_Nivichani - Koch																																				
164	RST164_Sokolarci																																				
165	RST165_Erdzhelija																																				
166	RST166_Gorno Trogerci																																				
167	RST167_Dolni Balvan																																				
168	RST168_Ularci																																				
169	RST169_Teranci																																				
170	RST170_Radanje																																				
171	RST171_Zrnovci																																				
172	RST172_Novo Selo - Shtip																																				
173	RST173_Doljani																																				
174	RST174_Dragoevo																																				
175	RST175_Shashavarlija																																				
176	RST176_Lakavica																																				
177	RST177_Kozbunar																																				
178	RST178_Koshevo																																				
179	RST179_Prnajlija																																				
180	RST180_Crveni Bregovi																																				
181	RST181_Piperevo																																				
182	RST182_Dedino																																				
183	RST183_Istibanja																																				
184	RST184_Grljani																																				
185	RST185_Vinica																																				
186	RST186_Grad																																				
187	RST187_Trabotivishte																																				
188	RST188_Blatec																																				
189	RST189_Laki																																				
190	RST190_Razlovci																																				
191	RST191_Mitrashinci																																				
192	RST192_Pehchevo																																				
193	RST193_Vladimirovo																																				
194	RST194_Podaresh																																				
195	RST195_Kalugjerica																																				
196	RST196_Edrenikovo																																				
197	RST197_Nivichani - Strum																																				
198	RST198_Dobrashinci																																				
199	RST199_Babini Kolibi																																				
200	RST200_Dvorishte																																				
201	RST201_Belanci																																				
202	RST202_Dzhepishte																																				
203	RST203_Pralenik - Kodzhadzhik																																				
204	RST204_Izvor - Kich																																				
205	RST205_Slivovo																																				
206	RST206_Podvis																																				
207	RST207_Belica																																				
208	RST208_Boroec																																				
209	RST209_Lukovo																																				
210	RST210_Radolishta																																				
211	RST211_Struga - kl																																				
212	RST212_Mesheishte																																				
213	RST213_Kuratica																																				
214	RST214_Openica																																				
215	RST215_Peshtani																																				
216	RST216_Pokrvenik																																				
217	RST217_Chelopeci																																				
218	RST218_Dolno Divjaci																																				
219	RST219_Debrishte																																				
220	RST220_Brailovo																																				
221	RST221_Belo Pole																																				
222	RST222_Dolenci																																				

Table A.4 Inventory of the Rainfall Network Stations for the Missing Years of Records (4/4)

No	StationName	61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
223	RST223_Zhvan	
224	RST224_Rastoica	
225	RST225_Krivogashtani	
226	RST226_Slavej	
227	RST227_Izbishte	
228	RST228_Boishte	
229	RST229_Vardino	
230	RST230_Svinjishte	
231	RST231_Dolno Srpci	
232	RST232_Lopatica	
233	RST233_Dobrushevo	
234	RST234_Resen - kl	
235	RST235_Rotino	
236	RST236_Crno Buki	
237	RST237_Bitola - El	
238	RST238_Radobor	
239	RST239_Novaci	
240	RST240_Prisad	
241	RST241_Nikodin	
242	RST242_Manastirec	
243	RST243_Vozarci	
244	RST244_Pletvar	
245	RST245_Carevikj	
246	RST246_Sheshkovo	
247	RST247_Bonche	
248	RST248_Chanishte	
249	RST249_Vrpsko	
250	RST250_Beshishte	
251	RST251_Suvodol	
252	RST252_Staravina	
253	RST253_Iveni	
254	RST254_Budimirci	
255	RST255_Negotino	
256	RST256_Dubrovo	
257	RST257_Konche	
258	RST258_Begnishte	
259	RST259_Barovo	
260	RST260_Radanje	
261	RST261_Doshnica	
262	RST262_Petrovo	
263	RST263_Miravci	
264	RST264_Smokvica	
265	RST265_Sermenin	
266	RST266_Veljusa	
267	RST267_Rich	
268	RST268_Gradashorci	
269	RST269_Strumica - kl	
270	RST270_Ilovica	
271	RST271_Monospitovo	
272	RST272_Borisovo	
273	RST273_Sitnik	
274	RST274_Smolari	
275	RST275_Kosturino	
276	RST276_Dedeli	
277	RST277_Organdzhali	
278	RST278_Bogdanci	
279	RST279_Gevgelija	
280	RST280_Stojakovo	
281	RST281_Crnichani	
282	RST282_Stari Dojran	
283	RST283_Stenje	
284	RST284_Asamati	
285	RST285_Brajchino	
286	RST286_Bukovo	
287	RST287_Graeshnica	
288	RST288_Gneotino	
289	RST289_Porodin	
290	RST290_Kremenica	
291	RST291_Tepavci	
292	RST292_Germijan	
293	RST293_Skochivir	
294	RST294_Popova Shapka	
295	RST295_Shemshevo	

Table A.5 Average Annual Total Rainfall Depth for Successive 1-Year Period for Drought Analysis (1/2)

Units: mm

Station	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
RST003_Romanovci	494	767	648	519	475	595	431	557	508	524	516	716	402	546	484	644	296	515
	(15)	(34)	(31)	(20)	(11)	(28)	(7)	(25)	(16)	(22)	(19)	(33)	(5)	(24)	(13)	(30)	(2)	(18)
RST004_Vojnik	626	753	653	690	500	544	405	499	470	514	483	659	353	565	412	468	324	446
	(29)	(35)	(31)	(34)	(21)	(24)	(9)	(20)	(16)	(23)	(18)	(32)	(6)	(27)	(10)	(15)	(5)	(14)
RST005_Stracin	432	638	537	650	490	415	474	516	623	532	553	564	382	491	442	554	340	392
	(11)	(33)	(24)	(36)	(17)	(9)	(15)	(21)	(31)	(23)	(25)	(27)	(7)	(18)	(13)	(26)	(2)	(8)
RST006_German	633	507	567	813	639	841	661	662	869	893	701	675	503	437	496	556	372	652
	(15)	(9)	(11)	(30)	(16)	(31)	(19)	(20)	(33)	(34)	(23)	(22)	(8)	(5)	(7)	(10)	(2)	(17)
RST007_Trnovec	492	680	610	725	552	664	556	525	636	744	576	1229	706	855	846	711	634	331
	(11)	(27)	(20)	(30)	(16)	(26)	(18)	(13)	(25)	(32)	(19)	(35)	(28)	(34)	(33)	(29)	(24)	(6)
RST009_Kriva Palanka	613	677	606	676	593	769	535	562	656	681	532	647	498	641	669	682	582	712
	(18)	(28)	(16)	(27)	(14)	(34)	(9)	(11)	(23)	(29)	(8)	(21)	(6)	(20)	(26)	(30)	(13)	(33)
RST010_Sasa	595	1074	1028	904	782	1038	745	746	990	923	705	1077	576	904	857	807	650	791
	(7)	(35)	(33)	(29)	(20)	(34)	(16)	(17)	(32)	(30)	(14)	(36)	(6)	(28)	(26)	(24)	(11)	(21)
RST011_Debar - kl	680	1039	1096	899	908	1050	796	535	1062	1019	772	880	469	967	543	634	839	1101
	(14)	(29)	(32)	(25)	(26)	(30)	(21)	(8)	(31)	(28)	(19)	(24)	(7)	(27)	(10)	(13)	(23)	(33)
RST013_Lazaropole	930	1342	1482	1110	1013	1151	898	920	1117	1324	868	1045	615	1096	768	757	856	1260
	(15)	(34)	(35)	(25)	(18)	(28)	(11)	(13)	(26)	(33)	(9)	(21)	(1)	(24)	(3)	(2)	(7)	(31)
RST015_Ohrid	509	985	1092	744	742	894	618	665	705	737	738	654	383	726	571	385	584	751
	(6)	(35)	(36)	(28)	(27)	(33)	(14)	(18)	(20)	(24)	(26)	(16)	(1)	(22)	(9)	(2)	(11)	(30)
RST016_Belchishte	691	1261	1422	956	1017	1231	825	747	1000	880	838	811	549	939	636	508	628	919
	(15)	(35)	(36)	(30)	(33)	(34)	(21)	(17)	(32)	(25)	(23)	(19)	(5)	(29)	(11)	(2)	(10)	(27)
RST018_Kichevo - kl	601	980	1142	989	739	884	691	742	906	858	874	853	568	816	682	492	629	728
	(12)	(34)	(36)	(35)	(23)	(31)	(20)	(24)	(32)	(29)	(30)	(28)	(10)	(26)	(18)	(4)	(13)	(22)
RST020_Cer	572	1110	1130	910	789	893	766	719	823	890	900	921	548	887	743	645	582	947
	(4)	(35)	(36)	(28)	(16)	(25)	(15)	(12)	(20)	(24)	(26)	(29)	(3)	(23)	(14)	(7)	(6)	(31)
RST021_Kazhani	765	1138	1122	1054	779	1096	828	873	811	874	654	820	605	921	789	591	644	867
	(16)	(36)	(35)	(32)	(18)	(34)	(22)	(26)	(20)	(27)	(12)	(21)	(7)	(31)	(19)	(6)	(9)	(25)
RST024_Krushevo	461	982	989	859	483	660	730	735	747	701	804	889	525	949	759	697	620	917
	(1)	(34)	(35)	(26)	(2)	(11)	(15)	(17)	(18)	(14)	(25)	(27)	(3)	(31)	(19)	(13)	(6)	(30)
RST025_Bitola	414	750	720	627	386	596	602	520	546	561	608	742	368	596	533	554	365	602
	(4)	(34)	(31)	(26)	(3)	(20)	(21)	(10)	(13)	(16)	(23)	(33)	(2)	(19)	(11)	(14)	(1)	(22)
RST026_Topolchani	430	773	671	621	376	519	645	647	698	602	466	562	400	613	244	388	365	536
	(10)	(36)	(30)	(26)	(5)	(18)	(28)	(29)	(32)	(24)	(11)	(21)	(9)	(25)	(1)	(6)	(4)	(19)
RST027_Skopje	478	741	619	541	371	394	542	486	467	392	474	552	419	555	450	599	301	437
	(18)	(36)	(33)	(24)	(2)	(9)	(25)	(20)	(16)	(8)	(17)	(26)	(10)	(27)	(13)	(32)	(1)	(12)
RST028_Prilep	435	713	741	698	490	568	468	521	488	508	507	647	425	588	524	505	414	574
	(10)	(33)	(35)	(32)	(17)	(24)	(13)	(22)	(16)	(20)	(19)	(29)	(8)	(26)	(23)	(18)	(5)	(25)
RST030_Makovo	446	754	791	681	518	688	620	581	554	614	504	656	384	554	545	499	450	589
	(5)	(33)	(36)	(29)	(15)	(30)	(24)	(20)	(17)	(23)	(13)	(26)	(4)	(18)	(16)	(12)	(6)	(21)
RST033_Vladilovci	309	605	1049	741	512	409	488	655	551	318	405	325	399	357	388	511	290	438
	(2)	(32)	(36)	(35)	(26)	(18)	(23)	(33)	(30)	(3)	(17)	(4)	(16)	(9)	(13)	(25)	(1)	(21)
RST034_Drenovo - Kav	441	891	712	631	528	630	563	495	416	506	708	541	457	575	526	609	358	609
	(10)	(36)	(34)	(30)	(19)	(29)	(22)	(15)	(7)	(16)	(33)	(20)	(11)	(24)	(18)	(26)	(5)	(27)
RST035_Sveti Nikole	355	656	540	469	352	379	313	459	398	403	319	627	366	513	434	494	265	484
	(12)	(36)	(31)	(25)	(11)	(15)	(9)	(23)	(18)	(19)	(10)	(35)	(13)	(29)	(21)	(27)	(3)	(26)
RST038_Kavadarci - kl	378	639	692	483	390	540	460	464	434	431	496	510	282	555	411	320	262	370
	(13)	(35)	(36)	(26)	(14)	(32)	(22)	(23)	(21)	(19)	(27)	(30)	(4)	(33)	(16)	(6)	(2)	(11)
RST040_Shtip	352	641	487	529	461	477	440	514	366	422	473	637	317	726	514	440	301	365
	(8)	(34)	(22)	(28)	(18)	(21)	(16)	(25)	(11)	(14)	(19)	(33)	(5)	(36)	(26)	(17)	(3)	(9)
RST041_Demir Kapija	458	743	657	495	385	685	544	517	598	449	482	535	384	637	440	485	359	540
	(13)	(35)	(28)	(17)	(7)	(32)	(22)	(19)	(26)	(12)	(15)	(20)	(6)	(27)	(11)	(16)	(2)	(21)
RST042_Kochani - kl	384	693	554	561	529	561	506	448	476	545	360	651	420	493	561	589	430	509
	(6)	(35)	(26)	(28)	(22)	(27)	(18)	(13)	(15)	(24)	(5)	(34)	(8)	(16)	(29)	(31)	(10)	(19)
RST043_Udovo	314	1008	748	766	490	669	487	707	719	560	633	644	405	728	450	573	521	836
	(1)	(35)	(30)	(31)	(12)	(23)	(11)	(24)	(25)	(15)	(19)	(21)	(4)	(28)	(7)	(17)	(13)	(32)
RST044_Radovish - kl	359	801	692	637	482	631	548	529	471	495	536	646	354	486	403	321	220	325
	(18)	(36)	(35)	(33)	(25)	(32)	(31)	(29)	(24)	(27)	(30)	(34)	(17)	(26)	(21)	(14)	(6)	(15)
RST045_Valandovo	387	930	783	718	409	815	608	567	554	511	516	725	331	600	496	496	487	702
	(6)	(36)	(32)	(30)	(8)	(35)	(26)	(21)	(20)	(18)	(19)	(31)	(2)	(22)	(16)	(17)	(14)	(29)
RST047_Novi Dojran - k	400	852	788	748	455	785	450	559	646	589	460	743	395	599	566	639	530	702
	(3)	(36)	(33)	(31)	(7)	(32)	(6)	(14)	(25)	(18)	(8)	(30)	(2)	(20)	(16)	(24)	(13)	(28)
RST048_Hamzali	396	702	480	564	432	659	445	494	461	576	526	651	382	542	460	530	447	578
	(7)	(36)	(18)	(25)	(11)	(33)	(12)	(20)	(16)	(26)	(22)	(32)	(6)	(24)	(15)	(23)	(13)	(27)
RST050_Berovo - kl	452	822	719	643	559	665	544	572	499	498	538	681	467	649	566	594	447	687
	(5)	(36)	(33)	(23)	(15)	(26)	(14)	(17)	(11)	(10)	(13)	(28)	(7)	(24)	(16)	(20)	(4)	(30)
RST051_Novo Selo - str	575	856	739	615	502	706	567	575	446	590	655	683	457	531	265	670	510	806
	(17)	(33)	(30)	(21)	(8)	(28)	(15)	(16)	(5)	(20)	(23)	(25)	(6)	(12)	(1)	(24)	(9)	(32)
RST052_Crnik	651	969	1005	39	700	861	800	680	579	566	510	730	363	571	510	339	528	637
	(24)	(35)	(36)	(1)	(27)	(34)	(31)	(26)	(19)	(16)	(11)	(28)	(5)	(17)	(12)	(3)	(13)	(23)
RST053_Sveti Naum	621	1047	1315	967	972	1464	989	860	813	1021	908	924	672	950	722	861	949	1157
	(7)	(33)	(35)	(28)	(29)	(36)	(30)	(21)	(18)	(32)	(24)	(25)	(9)	(27)	(13)	(22)	(26)	(34)
RST054_Nakolec	396	921	907	663	554	672	538	694	656	674	558	643	472	643	507	483	463	502
	(13)	(36)	(35)	(30)	(23)	(31)	(22)	(33)	(29)	(32)	(24)	(28)	(17)	(27)	(20)	(18)	(15)	(19)
RST055_Bach	374	757	705	508	349	437	464	560	444	473	342	630	372	586	571	577	382	523
	(7)	(35)	(33)	(15)	(4)	(10)	(13)	(24)	(11)	(14)	(3)	(29)	(6)	(27)	(25)	(26)	(9)	(20)
Total Point	408	1275	1175	1029	606	1007	686	759	800	823	701	1013	280	912	591	651	322	868
Total Ranking	(9)	(36)	(35)	(31)	(13)	(28)	(17)	(21)	(23)	(24)	(19)	(29)	(2)	(26)	(12)	(15)	(4)	(25)

Table A.5 Average Annual Total Rainfall Depth for Successive 1-Year Period for Drought Analysis (2/2)

Units: mm

Station	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
RST003_Romanovci	522	587	661	510	634	487	465	334	545	466	574	367	1632	483	420	438	848	283
	(21)	(27)	(32)	(17)	(29)	(14)	(9)	(3)	(23)	(10)	(26)	(4)	(36)	(12)	(6)	(8)	(35)	(1)
RST004_Vojnik	310	545	661	443	627	441	486	306	560	429	619	376	476	510	317	388	789	295
	(3)	(25)	(33)	(13)	(30)	(12)	(19)	(2)	(26)	(11)	(28)	(7)	(17)	(22)	(4)	(8)	(36)	(1)
RST005_Stracin	499	605	644	506	643	438	597	381	483	415	581	369	526	443	363	354	632	270
	(19)	(30)	(35)	(20)	(34)	(12)	(29)	(6)	(16)	(10)	(28)	(5)	(22)	(14)	(4)	(3)	(32)	(1)
RST006_German	592	741	866	709	809	491	673	385	731	633	1099	1101	786	401	71.7	653	703	603
	(12)	(27)	(32)	(25)	(29)	(6)	(21)	(3)	(26)	(14)	(35)	(36)	(28)	(4)	(1)	(18)	(24)	(13)
RST007_Trnovec	610	468	617	537	733	435	555	314	490	526	619	292	468	1288	221	231	503	226
	(21)	(8)	(22)	(15)	(31)	(7)	(17)	(5)	(10)	(14)	(23)	(4)	(9)	(36)	(1)	(3)	(12)	(2)
RST009_Kriva Palanka	705	664	698	539	620	451	595	408	649	514	772	444	612	567	360	442	803	660
	(32)	(25)	(31)	(10)	(19)	(5)	(15)	(2)	(22)	(7)	(35)	(4)	(17)	(12)	(1)	(3)	(36)	(24)
RST010_Sasa	801	807	703	763	620	644	798	561	766	672	871	612	729	450	483	574	942	410
	(23)	(25)	(13)	(18)	(9)	(10)	(22)	(4)	(19)	(12)	(27)	(8)	(15)	(2)	(3)	(5)	(31)	(1)
RST011_Debar - kl	1132	1114	1895	810	224	32	1.2	584	783	593	740	542	714	422	243	739	742	27.3
	(35)	(34)	(36)	(22)	(4)	(3)	(1)	(11)	(20)	(12)	(17)	(9)	(15)	(6)	(5)	(16)	(18)	(2)
RST013_Lazaropole	1313	1055	1517	925	1061	1022	1125	1039	947	898	909	850	975	866	817	782	1238	1162
	(32)	(22)	(36)	(14)	(23)	(19)	(27)	(20)	(16)	(10)	(12)	(6)	(17)	(8)	(5)	(4)	(30)	(29)
RST015_Ohrid	893	746	855	584	667	733	738	589	623	486	586	509	659	484	480	547	716	927
	(32)	(29)	(31)	(10)	(19)	(23)	(25)	(13)	(15)	(5)	(12)	(7)	(17)	(4)	(3)	(8)	(21)	(34)
RST016_Belchishte	957	885	825	617	544	815	934	717	775	649	637	612	648	510	591	574	847	428
	(31)	(26)	(22)	(9)	(4)	(20)	(28)	(16)	(18)	(14)	(12)	(8)	(13)	(3)	(7)	(6)	(24)	(1)
RST018_Kichevo - kl	918	679	768	551	670	583	827	637	687	543	681	457	702	542	527	298	460	568
	(33)	(16)	(25)	(8)	(15)	(11)	(27)	(14)	(19)	(7)	(17)	(2)	(21)	(6)	(5)	(1)	(3)	(9)
RST020_Cer	1090	902	943	719	873	830	1021	794	793	574	813	651	735	646	463	648	1066	386
	(34)	(27)	(30)	(11)	(22)	(21)	(32)	(18)	(17)	(5)	(19)	(10)	(13)	(8)	(2)	(9)	(33)	(1)
RST021_Kazhani	1086	895	866	620	63.3	196	52.1	396	744	647	845	672	904	728	646	767	883	406
	(33)	(29)	(24)	(8)	(2)	(3)	(1)	(4)	(15)	(11)	(23)	(13)	(30)	(14)	(10)	(17)	(28)	(5)
RST024_Krushevo	1109	889	975	788	909	651	792	731	774	650	773	637	779	669	606	605	620	959
	(36)	(28)	(33)	(23)	(29)	(10)	(24)	(16)	(21)	(9)	(20)	(8)	(22)	(12)	(5)	(4)	(7)	(32)
RST025_Bitola	836	621	842	690	734	510	608	483	562	455	570	516	693	560	426	541	666	675
	(35)	(25)	(36)	(29)	(32)	(8)	(24)	(7)	(17)	(6)	(18)	(9)	(30)	(15)	(5)	(12)	(27)	(28)
RST026_Topolchani	751	629	729	556	672	580	574	494	516	389	473	479	515	473	343	398	700	317
	(35)	(27)	(34)	(20)	(31)	(23)	(22)	(15)	(17)	(7)	(12)	(14)	(16)	(13)	(3)	(8)	(33)	(2)
RST027_Skopje	572	494	671	425	578	453	460	390	481	372	524	375	567	579	388	388	705	536
	(29)	(21)	(34)	(11)	(30)	(14)	(15)	(7)	(19)	(3)	(22)	(4)	(28)	(31)	(6)	(5)	(35)	(23)
RST028_Prilep	718	652	782	476	614	470	518	455	420	295	429	368	453	414	343	349	684	608
	(34)	(30)	(36)	(15)	(28)	(14)	(21)	(12)	(7)	(1)	(9)	(4)	(11)	(6)	(2)	(3)	(31)	(27)
RST030_Makovo	762	704	783	513	660	459	491	487	488	479	666	556	644	597	376	355	718	303
	(34)	(31)	(35)	(14)	(27)	(7)	(11)	(9)	(10)	(8)	(28)	(19)	(25)	(22)	(3)	(2)	(32)	(1)
RST033_Vladilovci	531	429	383	345	709	419	444	393	527	391	537	353	494	333	369	385	603	356
	(28)	(20)	(11)	(6)	(34)	(19)	(22)	(15)	(27)	(14)	(29)	(7)	(24)	(5)	(10)	(12)	(31)	(8)
RST034_Drenovo - Kav	667	742	707	561	605	348	427	440	573	475	507	366	477	463	262	339	628	252
	(31)	(35)	(32)	(21)	(25)	(4)	(8)	(9)	(23)	(13)	(17)	(6)	(14)	(12)	(2)	(3)	(28)	(1)
RST035_Sveti Nikole	547	556	546	507	463	457	146	288	379	372	430	257	392	313	291	313	531	270
	(33)	(34)	(32)	(28)	(24)	(22)	(1)	(5)	(16)	(14)	(20)	(2)	(17)	(7)	(6)	(8)	(30)	(4)
RST038_Kavadarci - kl	58.2	265	424	433	639	376	408	347	506	416	288	346	504	471	329	334	527	472
	(1)	(3)	(18)	(20)	(34)	(12)	(15)	(10)	(29)	(17)	(5)	(9)	(28)	(24)	(7)	(8)	(31)	(25)
RST040_Shtip	540	538	553	393	650	365	431	328	475	324	500	295	514	366	290	316	609	501
	(30)	(29)	(31)	(13)	(35)	(10)	(15)	(7)	(20)	(6)	(23)	(2)	(27)	(12)	(1)	(4)	(32)	(24)
RST041_Demir Kapija	664	668	694	557	824	417	433	367	713	560	439	383	553	311	370	477	664	500
	(30)	(31)	(33)	(24)	(36)	(8)	(9)	(3)	(34)	(25)	(10)	(5)	(23)	(1)	(4)	(14)	(29)	(18)
RST042_Kochani - kl	647	547	640	518	572	437	511	286	448	410	449	427	535	331	318	357	708	497
	(33)	(25)	(32)	(21)	(30)	(11)	(20)	(1)	(12)	(7)	(14)	(9)	(23)	(3)	(2)	(4)	(36)	(17)
RST043_Udovo	843	1031	643	862	647	598	567	469	728	447	484	468	539	432	324	729	720	366
	(33)	(36)	(20)	(34)	(22)	(18)	(16)	(9)	(27)	(6)	(10)	(8)	(14)	(5)	(2)	(29)	(26)	(3)
RST044_Radovish - kl	274	449	316	204	242	177	208	135	319	231	303	338	419	218	312	393	528	400
	(9)	(23)	(12)	(3)	(8)	(2)	(4)	(1)	(13)	(7)	(10)	(16)	(22)	(5)	(11)	(19)	(28)	(20)
RST045_Valandovo	680	785	603	604	691	453	469	324	604	378	397	491	422	340	386	472	797	427
	(27)	(33)	(23)	(25)	(28)	(11)	(12)	(1)	(24)	(4)	(7)	(15)	(9)	(3)	(5)	(13)	(34)	(10)
RST047_Novi Dojran - k	630	818	615	790	579	561	496	387	724	430	424	637	519	463	479	593	675	699
	(22)	(35)	(21)	(34)	(17)	(15)	(11)	(1)	(29)	(5)	(4)	(23)	(12)	(9)	(10)	(19)	(26)	(27)
RST048_Hamzali	622	643	611	587	660	470	422	243	515	343	345	431	481	325	229	454	691	401
	(30)	(31)	(29)	(28)	(34)	(17)	(9)	(2)	(21)	(4)	(5)	(10)	(19)	(3)	(1)	(14)	(35)	(8)
RST050_Berovo - kl	698	766	690	635	686	477	576	389	657	520	594	460	574	431	380	486	728	678
	(32)	(35)	(31)	(22)	(29)	(8)	(19)	(2)	(25)	(12)	(21)	(6)	(18)	(3)	(1)	(9)	(34)	(27)
RST051_Novo Selo - str	697	762	701	886	913	516	589	336	733	621	542	566	464	520	354	582	881	387
	(26)	(31)	(27)	(35)	(36)	(10)	(19)	(2)	(29)	(22)	(13)	(14)	(7)	(11)	(3)	(18)	(34)	(4)
RST052_Crnik	589	825	860	663	743	496	573	361	633	556	551	504	627	413	318	500	788	364
	(20)	(32)	(33)	(25)	(29)	(8)	(18)	(4)	(22)	(15)	(14)	(10)	(21)	(7)	(2)	(9)	(30)	(6)
RST053_Sveti Naum	1020	722	837	547	763	683	841	712	655	488	693	572	806	519	422	888	799	394
	(31)	(14)	(19)	(5)	(15)	(10)	(20)	(12)	(8)	(3)	(11)	(6)	(17)	(4)	(2)	(23)	(16)	(1)
RST054_Nakolec	604	578	328	376	162	76	276	534	703	80.5	57.4	469	432	173	161	231	347	149
	(26)	(25)	(10)	(12)	(6)	(2)	(9)	(21)	(34)	(3)	(1)	(16)	(14)	(7)	(5)	(8)	(11)	(4)
RST055_Bach	699	721	779	594	665	354	514	532	521	451	662	513	539	377	338	22.2	540	510
	(32)	(34)	(36)	(28)	(31)	(5)	(18)	(21)	(19)	(12)	(30)	(17)	(22)	(8)	(2)	(1)	(23)	(16)
Total Point	1038	1018	1060	696	920	434	635	313	765	365	667	362	733	379	157	358	1042	460
Total Ranking	(32)	(30)	(34)	(18)	(27)	(10)	(14)	(3)	(22)	(7)	(16)	(6)	(20)	(8)	(1)	(5)	(33)	(11)

Table A.6 The Estimated Areas for Each Station Using Thiessen Polygon Network (1/6)

VARDAR Unit: km^2

No.	Station Name	B1	B2	B3	B4	B5	B6	B7	Total
1	RST100_Vrutok	192.1						38.2	230.3
2	RST017_Gostivar - kl	135.6							135.6
3	RST122_Korito	101.3	34.6						135.9
4	RST112_Stenche	106.4							106.4
5	RST098_Pirok	189.7							189.7
6	RST294_Popova Shapka	229.0							229.0
7	RST001_Tetovo - kl	134.2							134.2
8	RST061_Janchishte	92.9							92.9
9	RST056_Odri	131.9							131.9
10	RST062_Radusha	79.3							79.3
11	RST057_Jazhinci	52.1							52.1
12	RST058_General Jankovich	81.8		9.2					91.0
13	RST064_Vuchidol	78.8							78.8
14	RST124_Drzhilovo	189.7	21.5						211.2
15	RST065_Ljubanci	70.0		36.1					106.0
16	RST066_Brazda - Gluvo	54.0							54.0
17	RST077_Bulachani	74.6							74.6
18	RST149_Rashtani	190.4							190.4
19	RST027_Skopje	70.1							70.1
20	RST136_Trubarevo	108.7							108.7
21	RST120_Rakotinci	115.8							115.8
22	RST145_Zelenikovo	180.3		3.1					183.3
23	RST029_Drenovo - Tv	192.8							192.8
24	RST150_Chashka	100.0							100.0
25	RST154_Nogaevci	99.8			82.0				181.8
26	RST155_Teovo	201.0				18.4			219.5
27	RST157_Vojnica	126.7							126.7
28	RST037_Gradsko	92.7			7.5	17.3			117.5
29	RST033_Vladilovci	78.4				121.8			200.2
30	RST255_Negotino	196.8							196.8
31	RST038_Kavadarci - kl	78.7				12.0			90.7
32	RST041_Demir Kapija	150.7							150.7
33	RST047_Novi Dojran - kl	27.7							27.7
34	RST039_Gorna Boshava	264.0				0.6			264.6
35	RST259_Barovo	112.4							112.4
36	RST014_Mavrovi Anovi	120.7	22.7					117.0	260.5
37	RST261_Doshnica	118.2							118.2
38	RST043_Udovo	125.7							125.7
39	RST262_Petrovo	97.1							97.1
40	RST264_Smokvica	100.7							100.7
41	RST265_Sermenin	230.8							230.8
42	RST279_Gevgelija	14.3							14.3
43	RST045_Valandovo	88.5							88.5
44	RST277_Organdzhali	78.7							78.7
45	RST278_Bogdanci	87.9							87.9
46	RST280_Stojakovo	41.9							41.9
47	RST140_Rzhanichino	69.7		10.0					79.6
Total		5554.3	78.8	58.3	89.4	170.2	0.0	155.2	6106.2

Table A.6 The Estimated Areas for Each Station Using Thiessen Polygon Network (2/6)

TRESKA Unit: km^2

No.	Station Name	B1	B2	B3	B4	B5	B6	B7	Total
48	RST217_Chelopeci		67.6						67.6
49	RST117_Nova Breznica	9.8	80.0						89.8
50	RST018_Kichevo - kl		67.4						67.4
51	RST110_Zajas	33.1	176.6						209.6
52	RST020_Cer		124.9			13.9			138.8
53	RST113_Grupchin	53.5	41.6						95.1
54	RST130_Sveto Rache		82.7						82.7
55	RST023_Mak. Brod		15.8			0.2			16.1
56	RST129_Srbica	12.0	100.7						112.7
57	RST132_Slatina		98.8						98.8
58	RST126_Samokov	17.2	176.6						193.8
59	RST133_Lokvica		92.0			2.3			94.3
60	RST123_Zdunje	19.1	136.1						155.1
61	RST115_Lukovica	25.5	136.2						161.8
62	RST114_Bojane	48.3	32.1						80.3
63	RST118_Matka	26.8	71.1						97.9
64	RST127_Gorna Belica	51.2	149.9						201.0
65	RST206_Podvis		127.1						127.1
Total		296.3	1777	0.0	0.0	16.4	0.0	0.0	2090.0

Table A.6 The Estimated Areas for Each Station Using Thiessen Polygon Network (3/6)

CRNA REKA Unit: km^2

No.	Station Name	B1	B2	B3	B4	B5	B6	B7	Total
66	RST135_Strovija		31.6			128.4			160.0
67	RST221_Belo Pole					173.3			173.3
68	RST158_Dolno Chichevo	16.6				69.2			85.7
69	RST218_Dolno Divjaci		9.1			81.2			90.4
70	RST024_Krushevo					96.5			96.5
71	RST226_Slavej					144.1			144.1
72	RST222_Dolenci		16.5			138.6			155.1
73	RST224_Rastoica					84.9			84.9
74	RST022_Slepche					149.8			149.8
75	RST026_Topolchani					131.4			131.4
76	RST228_Boishte					115.0		63.9	178.9
77	RST231_Dolno Srpci					115.5			115.5
78	RST233_Dobrushevo					114.4			114.4
79	RST236_Crno Buki					145.9			145.9
80	RST021_Kazhani					181.0		23.9	204.9
81	RST025_Bitola					152.8		0.2	153.0
82	RST239_Novaci					109.1			109.1
83	RST290_Kremenica					73.5			73.5
84	RST287_Graeshnica					120.3		22.4	142.7
85	RST251_Suvodol					109.1			109.1
86	RST055_Bach					103.5			103.5
87	RST028_Prilep					165.1			165.1
88	RST247_Bonche					119.4			119.4
89	RST030_Makovo					96.6			96.6
90	RST293_Skochivir					154.1			154.1
91	RST244_Pletvar	6.5				163.0			169.5
92	RST031_Dunje					151.6			151.6
93	RST248_Chanishte					93.8			93.8
94	RST254_Budimirci					206.2			206.2
95	RST245_Carevikj					168.5			168.5
96	RST250_Beshishte					186.2			186.2
97	RST036_Rozhden	35.9				259.2			295.0
98	RST258_Begnishte	60.9				62.3			123.3
99	RST246_Sheshkovo					111.6			111.6
100	RST034_Drenovo - Kav					101.5			101.5
101	RST219_Debrishte		33.4			81.6			115.0
102	RST242_Manastirec	12.6				72.3			84.9
Total		132.5	90.7	0.0	0.0	4730	0.0	110.4	5063.9

Table A.6 The Estimated Areas for Each Station Using Thiessen Polygon Network (4/6)

PCHINJA Unit: km^2

No.	Station Name	B1	B2	B3	B4	B5	B6	B7	Total
103	RST084_Luke			54.4					54.4
104	RST075_Bajlovci			162.2					162.2
105	RST142_Krushica	35.2		72.7	13.5				121.4
106	RST085_Dubrovnica			137.0					137.0
107	RST089_Konopnica			148.6	13.2				161.8
108	RST083_Ogut			74.2					74.2
109	RST088_Ginovci			104.7					104.7
110	RST008_Kratovo - kl			104.7	40.6				145.3
111	RST006_German			60.0					60.0
112	RST086_Gulinci			70.7					70.7
113	RST005_Stracin			101.4					101.4
114	RST081_Shopsko Rudare			124.4	15.0				139.4
115	RST074_Staro Nagorichani			154.2					154.2
116	RST004_Vojnik			74.7					74.7
117	RST079_Klechevci			87.1					87.1
118	RST082_Gradishte			79.2	41.2				120.4
119	RST071_Vaksinci			86.5					86.5
120	RST072_Kumanovo			94.1					94.1
121	RST080_Pchinja			105.7					105.7
122	RST139_Gorno Konjare	2.4		93.1					95.6
123	RST141_Kat. Banja	13.8		94.4					108.3
124	RST069_Belanovce			99.6					99.6
125	RST076_Matejche	4.7		82.2					86.8
126	RST078_Umni dol	35.0		66.0					101.0
Total		91.2	0.0	2332	123.5	0.0	0.0	0.0	2546.2

Table A.6 The Estimated Areas for Each Station Using Thiessen Polygon Network (5/6)

BERGALNICA Unit: km^2

No.	Station Name	B1	B2	B3	B4	B5	B6	B7	Total
127	RST096_Kostindol				123.5				123.5
128	RST097_Dramche				78.8				78.8
129	RST091_Mushkovo			21.9	115.0				136.8
130	RST199_Babini Kolibi				119.5		5.0		124.5
131	RST095_Nebojani			45.9	236.9				282.8
132	RST161_Zletovo				219.6				219.6
133	RST183_Istibanja				108.6				108.6
134	RST042_Kochani - kl				145.5				145.5
135	RST168_Ularci				149.7				149.7
136	RST167_Dolni Balvan				116.0				116.0
137	RST144_Mezdra	1.3			108.4				109.7
138	RST159_Njemanjica				242.4				242.4
139	RST147_Lozovo - Dzhumajlija	110.7			171.3				282.0
140	RST050_Berovo - kl				146.3				146.3
141	RST192_Pehchevo				121.0				121.0
142	RST191_Mitrashinci				119.8				119.8
143	RST052_Crnik				81.1				81.1
144	RST190_Razlovci				110.9				110.9
145	RST186_Grad				88.6				88.6
146	RST049_Delchevo - kl				100.1				100.1
147	RST188_Blatec				141.2				141.2
148	RST171_Zrnovci				124.7				124.7
149	RST178_Koshevo				91.8		1.0		92.7
150	RST170_Radanje				90.5				90.5
151	RST175_Shashavarlija				55.5				55.5
152	RST040_Shtip				105.1				105.1
153	RST257_Konche	71.8			111.1				182.9
154	RST181_Piperevo	44.5			121.4				165.9
155	RST176_Lakavica				99.7				99.7
156	RST174_Dragoevo	54.2			143.6				197.8
157	RST173_Doljani				53.6				53.6
158	RST184_Grljani				126.8				126.8
Total		282.5	0.0	67.7	3968	0.0	5.9	0.0	4324.1

Table A.6 The Estimated Areas for Each Station Using Thiessen Polygon Network (6/6)

STRUMICA — Unit: km^2

No.	Station Name	B1	B2	B3	B4	B5	B6	B7	Total
159	RST198_Dobrashinci						78.3		78.3
160	RST196_Edrenikovo				4.9		80.4		85.4
161	RST270_Ilovica						75.3		75.3
162	RST195_Kalugjerica				41.6		92.0		133.6
163	RST177_Kozbunar				61.6		70.6		132.2
164	RST275_Kosturino	33.3					51.8		85.1
165	RST271_Monospitovo	19.4					85.6		105.0
166	RST197_Nivichani - Strum				6.5		196.2		202.6
167	RST046_Novo Selo - rad				54.7		115.2		169.9
168	RST051_Novo Selo - strum						60.7		60.7
169	RST044_Radovish - kl				45.1		82.9		128.0
170	RST267_Rich	43.3			26.5		56.6		126.3
171	RST274_Smolari						68.2		68.2
172	RST273_Stinik						55.3		55.3
173	RST269_Strumica - kl						83.8		83.8
174	RST048_Hamzali				0.8		76.7		77.5
Total		96.0	0.0	0.0	241.6	0.0	1330	0.0	1667.2

CRN DRIM — Unit: km^2

No.	Station Name	B1	B2	B3	B4	B5	B6	B7	Total
175	RST102_Zhirovnica							237.1	237.1
176	RST013_Lazaropole		31.5					192.4	223.9
177	RST106_Rostusha							97.1	97.1
178	RST205_Slivovo		89.0					114.8	203.7
179	RST016_Belchishte		5.0			1.9		159.2	166.1
180	RST012_Vevchani							131.5	131.5
181	RST209_Lukovo							189.1	189.1
182	RST203_Pralenik - Kodzhadzhik		2.9					125.8	128.7
183	RST212_Mesheishte							110.1	110.1
184	RST211_Struga - kl							92.2	92.2
185	RST202_Dzhepiste							33.0	33.0
186	RST011_Debar - kl							101.9	101.9
187	RST213_Kuratica					10.0		120.2	130.1
188	RST214_Openica							115.5	115.5
189	RST015_Ohrid							159.0	159.0
190	RST215_Peshtani							183.3	183.3
191	RST210_Radolishta							88.7	88.7
192	RST053_Sveti Naum							63.7	63.7
193	RST284_Asamati					7.9		115.9	123.8
194	RST054_Nakolec							186.0	186.0
195	RST234_Resen - kl					0.5		143.7	144.2
196	RST283_Stenje							117.2	117.2
197	RST019_Carev Dvor							91.7	91.7
Total		0.0	128.3	0.0	0.0	20.2	0.0	2969	3117.5

Total	6453	2075	2458	4423	4937	1336	3235	24915

Table A.7 Average Annual Basin Rainfall based on Thiessen Polygon Network

Units: mm

Year	B1	B2	B3	B4	B5	B6	B7	Average
1961	495.60	632.22	544.49	455.90	469.14	505.35	603.68	529.48
1962	897.74	1114.81	641.12	813.49	827.92	933.68	1076.95	900.82
1963	921.30	1209.63	581.38	732.63	844.68	878.70	1201.79	910.02
1964	732.98	975.02	703.98	557.06	729.33	766.68	895.18	765.75
1965	595.19	834.56	531.12	591.96	506.40	663.40	845.81	652.63
1966	639.64	695.97	584.18	572.98	592.63	719.90	942.19	678.21
1967	541.33	579.46	492.45	504.48	549.17	515.27	758.46	562.95
1968	651.09	632.46	519.11	485.39	548.46	531.02	830.79	599.76
1969	643.82	698.37	592.88	522.28	532.44	564.29	977.99	647.44
1970	625.56	756.67	581.86	556.29	574.17	582.70	1042.34	674.23
1971	610.28	727.94	499.67	472.50	534.39	577.25	877.38	614.20
1972	699.23	876.87	637.06	648.79	633.50	677.82	887.66	722.99
1973	429.75	532.06	411.72	403.56	417.88	411.88	525.70	447.51
1974	637.19	805.98	593.32	582.46	634.50	580.19	993.99	689.66
1975	552.39	660.65	506.95	501.27	574.56	521.53	660.68	568.29
1976	587.75	630.78	609.61	579.87	514.01	559.61	563.28	577.85
1977	423.47	546.17	414.38	398.75	410.21	339.83	752.51	469.33
1978	627.62	829.00	529.45	554.65	598.89	626.86	1039.29	686.54
1979	684.60	874.12	558.32	657.41	809.18	690.98	1096.30	767.27
1980	667.38	794.63	616.79	668.66	624.27	753.03	927.31	721.73
1981	716.74	832.51	659.30	647.58	746.41	582.58	1001.22	740.91
1982	559.87	500.83	498.71	545.20	546.04	603.57	635.93	555.74
1983	663.10	758.20	603.43	696.69	600.24	682.47	754.80	679.85
1984	532.07	665.65	454.11	454.05	449.26	367.82	791.11	530.58
1985	569.99	717.76	505.34	547.55	531.44	509.42	889.33	610.12
1986	477.59	592.93	354.09	370.66	461.45	306.28	797.63	480.09
1987	584.84	584.01	527.57	549.96	561.21	592.88	787.08	598.22
1988	463.78	529.57	443.15	469.48	455.70	460.50	604.71	489.56
1989	512.77	534.99	565.38	545.41	510.41	505.95	591.97	538.12
1990	396.32	504.08	343.35	423.32	398.50	493.14	591.53	450.03
1991	545.55	622.05	488.65	589.72	514.83	526.87	758.25	577.99
1992	433.19	509.11	396.85	364.95	399.41	355.59	457.78	416.70
1993	405.33	463.26	341.36	361.16	362.18	300.19	576.13	401.38
1994	505.72	507.99	367.26	421.14	379.24	507.20	595.97	469.22
1995	737.55	826.10	657.96	660.38	654.54	598.90	867.92	714.76
1996	379.44	404.24	331.26	337.95	314.89	346.53	496.94	373.04
Average	587.44	693.35	519.10	534.60	550.32	559.44	797.16	605.91

Remark: B1: Vardar River main stream, B2: Treska River, B3:Pchinja River
B4: Bregalnica River, B5:Crna River, B6:Crn Drim River
B7: Strumica River

Table A.8 Mean Monthly Rainfall for the Main and Secondary Meteorological Network Stations (1961-1996)

Units: mm

No	Station Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	RST279_Gevgelija	55.4	56.9	63.1	53.6	63.1	42.2	36.0	35.2	31.6	64.0	81.3	84.9	667.2
2	RST045_Valandovo	45.0	46.8	48.1	51.1	65.3	34.7	36.4	32.4	32.1	56.0	76.6	58.7	583.2
3	RST041_D. Kapija	54.0	44.0	47.6	46.0	56.8	38.4	34.6	23.1	29.4	47.6	59.3	64.3	545.1
4	RST151_Veles	32.3	29.7	34.5	36.1	51.9	43.5	38.0	27.4	24.7	40.0	48.1	38.1	444.3
5	RST047_Dojran	46.2	49.0	56.3	54.1	56.7	47.0	36.7	33.8	31.4	57.2	86.0	68.2	622.7
6	RST269_Strumica	38.4	39.3	40.5	49.0	60.6	39.1	41.6	31.5	34.9	48.4	61.5	62.6	547.4
7	RST136_Trubarevo	32.7	35.5	36.8	45.0	63.4	53.1	35.9	26.9	41.5	41.8	48.4	47.0	507.9
8	RST027_Skopje	37.9	33.7	39.8	44.5	56.9	44.2	36.7	26.6	35.3	42.1	53.6	53.8	505.2
9	RST165_Erdzhelija	27.9	25.6	32.4	44.0	50.0	38.7	39.2	31.3	31.8	38.7	38.1	44.2	441.7
10	RST038_Kavadarci	35.5	33.0	37.0	38.7	54.4	39.9	37.9	23.5	28.3	38.5	49.1	45.2	460.9
11	RST141_Kat. Banja	31.8	35.5	38.0	47.7	58.3	45.2	50.1	28.3	33.4	40.8	46.0	50.6	505.7
12	RST040_Shtip	29.2	27.6	32.9	42.9	55.5	41.0	39.4	31.6	29.9	44.3	48.6	44.1	467.0
13	RST072_Kumanovo	36.6	31.1	36.3	41.2	59.5	45.5	54.1	30.9	43.0	39.3	48.8	44.0	510.3
14	RST042_Kochani	35.2	34.9	37.2	44.2	56.1	47.9	44.5	36.4	30.1	42.5	58.8	46.7	514.5
15	RST044_Radovish	30.8	34.2	38.3	39.0	44.1	32.0	30.7	21.1	25.3	39.6	47.5	41.0	423.6
16	RST001_Tetovo	72.4	59.5	64.3	56.0	65.2	40.6	37.9	37.4	41.5	59.6	88.6	89.0	712.0
17	RST017_Gostivar	82.4	75.4	78.1	61.5	63.7	46.6	43.6	33.3	43.8	77.0	99.9	88.0	793.5
18	RST023_M. Brod	58.7	54.3	55.1	55.7	63.4	43.3	37.3	32.3	36.3	59.9	78.9	63.9	639.1
19	RST025_Bitola	49.8	48.2	48.3	47.3	59.7	38.0	40.4	33.6	37.9	57.9	71.2	70.5	602.6
20	RST018_Kichevo	76.8	60.9	70.7	55.4	62.2	49.3	40.5	39.2	47.1	71.0	103.9	91.4	768.4
21	RST049_Delchevo	31.1	35.4	36.8	47.0	62.8	54.8	49.0	43.4	37.5	49.5	54.6	44.7	546.6
22	RST008_Kratovo	49.2	47.9	49.8	62.1	67.5	60.1	62.7	37.5	45.6	54.3	70.3	56.0	663.2
23	RST028_Prilep	36.1	36.0	42.1	47.8	60.4	48.1	41.0	30.9	34.8	49.1	63.1	45.7	535.0
24	RST011_Debar	76.4	73.7	91.2	74.4	74.8	43.3	39.8	34.9	56.5	88.3	112.9	120.1	886.2
25	RST009_K. Palanka	38.1	39.4	43.5	55.1	71.9	65.7	56.3	45.3	47.5	44.0	61.3	49.1	617.3
26	RST211_Struga	100.0	68.9	77.7	57.3	64.7	34.1	28.0	32.0	49.4	83.4	103.5	81.7	780.8
27	RST015_Ohrid	65.2	64.8	61.3	54.2	58.3	38.0	26.9	31.3	44.0	69.8	100.7	80.0	694.3
28	RST050_Berovo	38.9	40.5	42.4	49.0	69.9	58.5	49.1	45.2	38.0	44.8	62.5	55.1	593.8
29	RST234_Resen	70.9	60.1	54.4	49.7	70.7	38.0	29.7	29.2	48.2	78.4	91.1	73.3	693.5
30	RST024_Krushevo	62.4	65.1	67.4	65.7	81.0	55.6	47.4	40.6	46.8	75.2	96.2	81.4	784.8
31	RST014_Mavrovi	100.8	83.5	95.4	88.7	79.1	54.0	50.6	43.7	60.5	85.0	141.0	125.9	1008.3
32	RST013_Lazaropole	97.2	89.0	101.9	91.4	84.5	58.2	48.9	50.4	70.7	94.9	145.6	126.2	1059.1
33	RST294_Pop. Shapka	63.1	53.4	63.2	80.7	94.9	71.8	66.5	59.1	72.4	86.6	104.2	85.7	901.4
34	RST127_Gorna Belica	46.2	39.9	50.4	48.9	64.8	49.3	45.6	38.7	41.6	48.4	106.3	60.1	640.3
	Average	52.5	48.6	53.3	53.7	63.9	46.5	42.1	34.6	40.7	57.6	76.7	67.1	637.3