4. CLIMATE DATA

4.1. Introduction

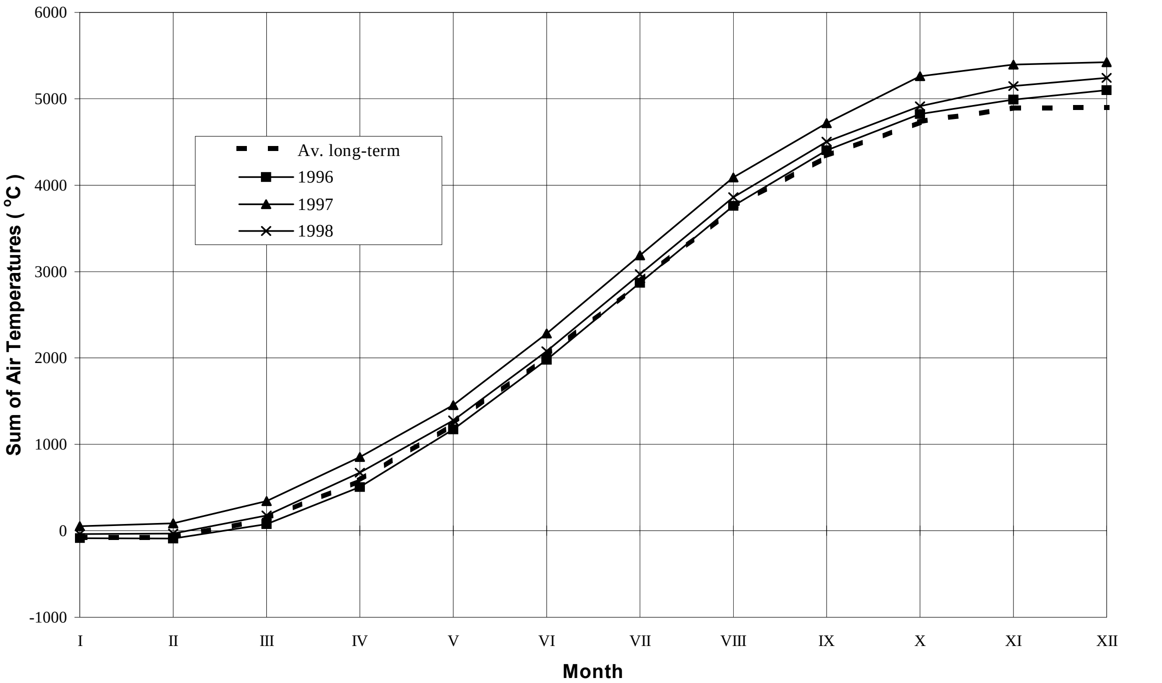
The Aral Sea basin, located in the centre of Eurasia, covers the zone of subtropical latitudes and the southern limit of temperate latitudes. Location of the area in the zone of intra-continental deserts, long distances from seas and oceans create a clearly expressed continental climate.

Measurements and assessments within WUFMAS covered about 80,000 ha of irrigated land in the Central Asian region in characteristic climatic zones. In the north from N44°53´ (farm 01, Kazakhstan) to N37°34´ in the south (farms 17 and 18, Turkmenistan), and in the west from E62°11´ (farms 16 and17, Turkmenistan) to E74°33´ in the east (farm 08, Kyrgyzstan). The range in altitude was from 75 mamsl (farm 28, Uzbekistan) to 958 mamsl (farm 08, Kyrgyzstan) (Table 1). Out of the 24 farms surveyed, 14 are located in the Syrdariya river basin and 10 in the Amudariya river basin. For the sake of comparability, trends in the change of climate parameters are shown for those farms where data are available for the whole period of 1996-1998. Mean monthly climatic data during the survey period 1996-1998, are calculated as averages of data from 12 meteorological stations that are closest to the survey farms for comparison with the equivalent long-term mean.

4.2. Air Temperature

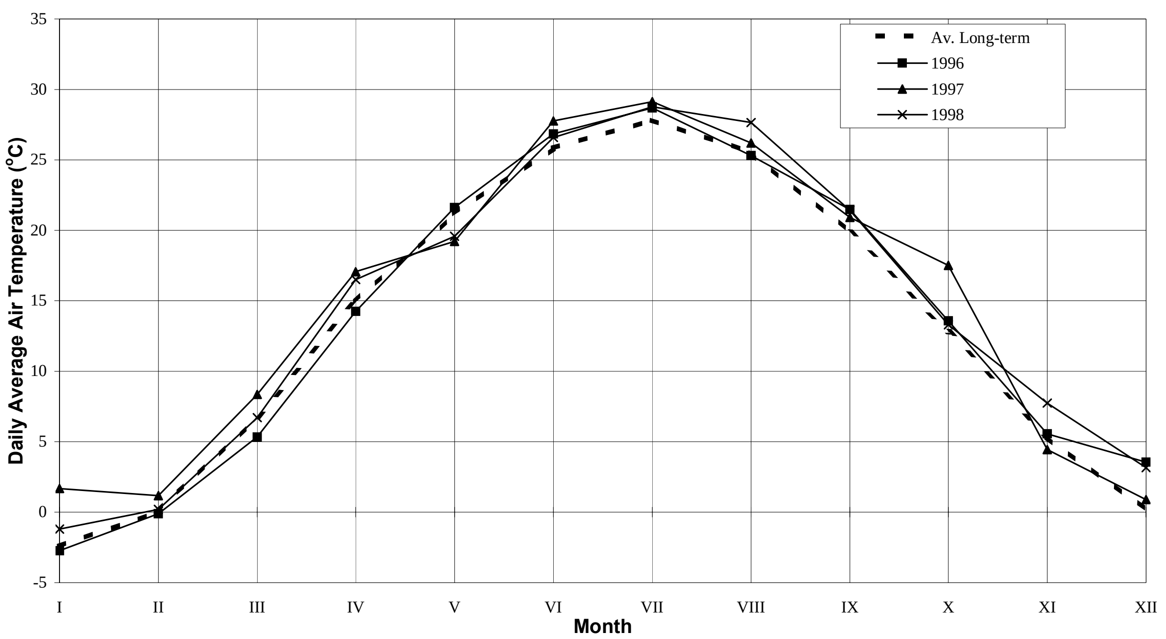
Trends in the change of air temperature regime in the region are illustrated in Figure 4.1.

Figure 4.1 Integral Curves of Air Temperature
(Avearge by 12 Meteostations)



During all three years of monitoring sum of temperatures was above the sum of long-term average temperatures. 1996 was the closest year to the long-term average year. The summer of 1997 was the hottest one. The coldest month during this period was January 1996 with temperatures ranging from –10.7°C (farms 01 and 02, Kazakhstan) to 4.3°C (farms 21 and 22, Uzbekistan). The highest recorded average monthly air temperature is observed in July, ranging from 24.4°C (farms 07 and 08, Kyrgyzstan) to 31.9°C (farms 21 and 22, Uzbekistan). In July 1997 average monthly air temperature was above long-term average, ranging from 26.7°C (farms 07 and 08, Kyrgyzstan) to 32.4°C (farms 21 and 22, Uzbekistan).

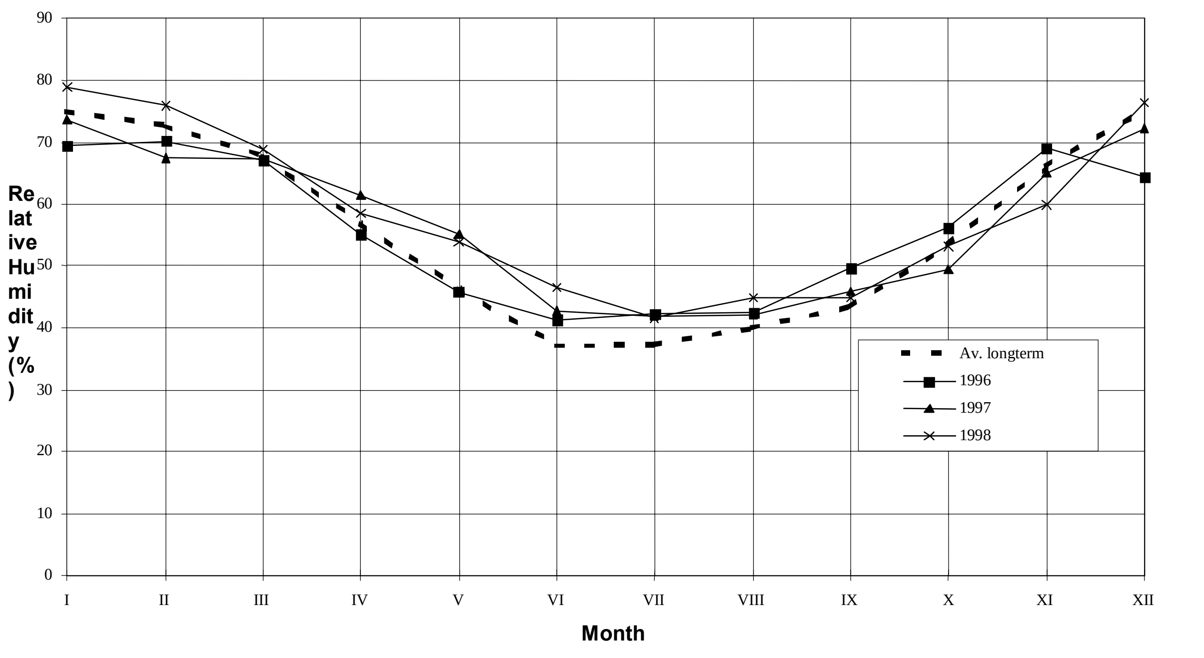
Figure 4.2 Daily Average Air Temperature (by 12 meteostations)



4.3. Relative Air Humidity

The pattern of seasonal change inversely reflects change in air temperature, being high in winter months and low in summer months.

Figure 4.3 Daily Average Relative Humidity of Air (By 12 Meteostations)



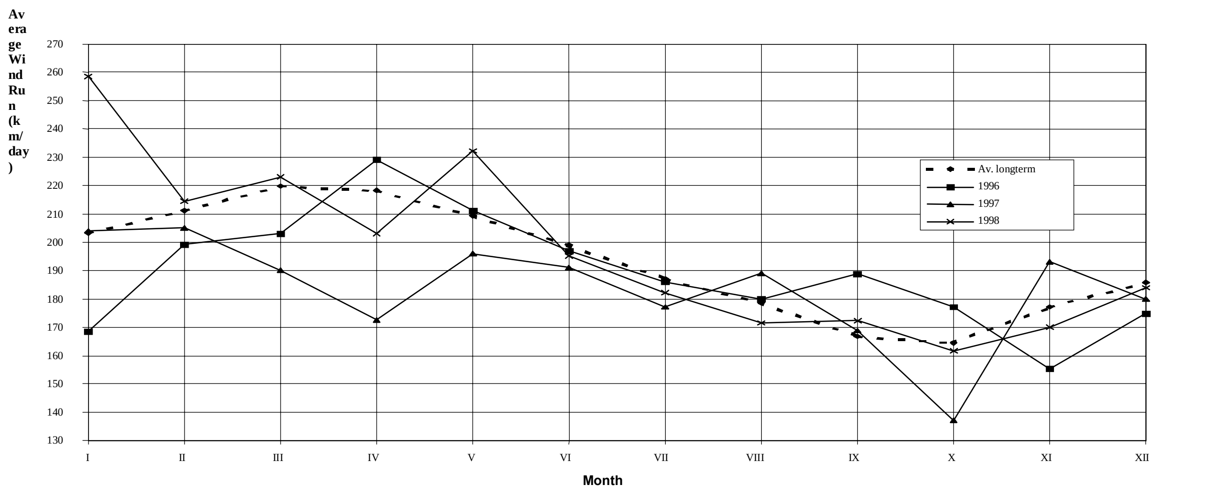
Comparison of means of values measured during the period from 1996 to 1998 with long-term average data (Figure 4.3) shows that all three years have been more humid during summer and drier during winter (except 1998). From long-term data the highest humidity occurs in December and January, ranging from 84 percent (farms 33 and 34, Uzbekistan) to 64 percent (farms 21 and 22, Uzbekistan). During the survey period, the highest humidity was observed in January 1998, ranging from 94 percent (farms 23 and 24, Uzbekistan) to 68 percent (farms 21 and 22, Uzbekistan).

The lowest humidity generally occurs in July, ranging from 22 percent (farms 21 and 22, Uzbekistan) to 49 percent (farms 03 and 04, Kazakhstan). During the survey period, the lowest humidity was observed in June - July 1997, ranging from 26 percent (farms 01 and 02, Kazakhstan) to 48 percent (farms 27 and 28, Uzbekistan).

4.4. Wind Speed

According to the values of average monthly wind speed the region is classified as a zone of moderate winds with between 175 and 425 km/day, as shown in Figure 4.4. However, some farms fall in the zone of light winds (farms 03 and 04 in Kazakhstan, and 07 - 10 in Kyrgyzstan), with generally less than 175 km/day.

Figure 4.4 Daily Average Wind Run (km/day)



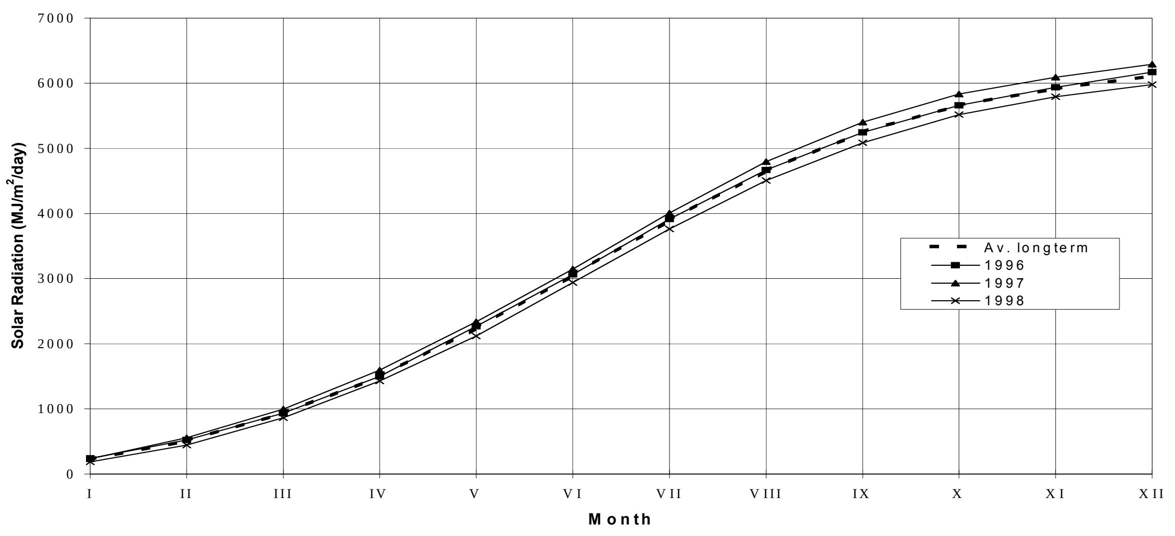
The long-term averages show that the quietest period is September-October, with winds varying from 86 km/day (farms 33 and 34, Uzbekistan) to 243 km/day (farms 01 and 02, Kazakhstan). During the survey period, the least wind occurred in November 1997, ranging from 26 km/day (farms 33 and 34, Uzbekistan) to 181 km/day (farms 01and 02, Kazakhstan).

The windiest period generally is from January to May, with average wind up to 346-363 km/day (farms 01 and 02, Kazakhstan;14 and 37, Tadjikistan). April 1996 was the windiest month during the survey, when the range of wind speed varied from 95 km/day (farms 33 and 34, Uzbekistan) to 328 km/day (farms 01 and 02, Kazakhstan; 27 and 28, Uzbekistan).

4.5. Solar Radiation

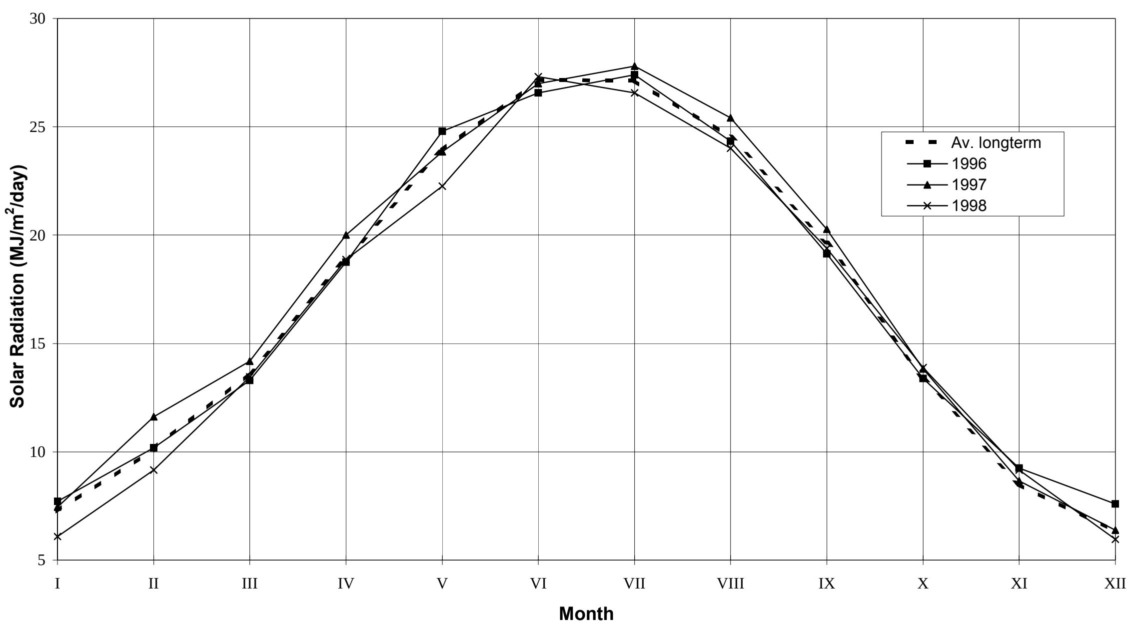
Change in solar radiation is determined by seasonal variation in day length, which is greatest in June-July (Figure 4.5). Meteorological stations record sunshine hours, and long-term means enable solar radiation to be calculated. Radiation values during mid-summer range from 25.2 $MJ/m^2/day$ (farms 07 and 08, Kyrgyzstan) to 28.6 $MJ/m^2/day$ (farms 21 and 22, Uzbekistan). Solar radiation values are minimal in December - from 5.2 $MJ/m^2/day$ (farms 27 and 28, Uzbekistan) to 8.2 $MJ/m^2/day$ (farms 17 and 18, Turkmenistan).

Figure 4.5 Integral Curves of Solar Radiation (Average by 12 Meteostation)



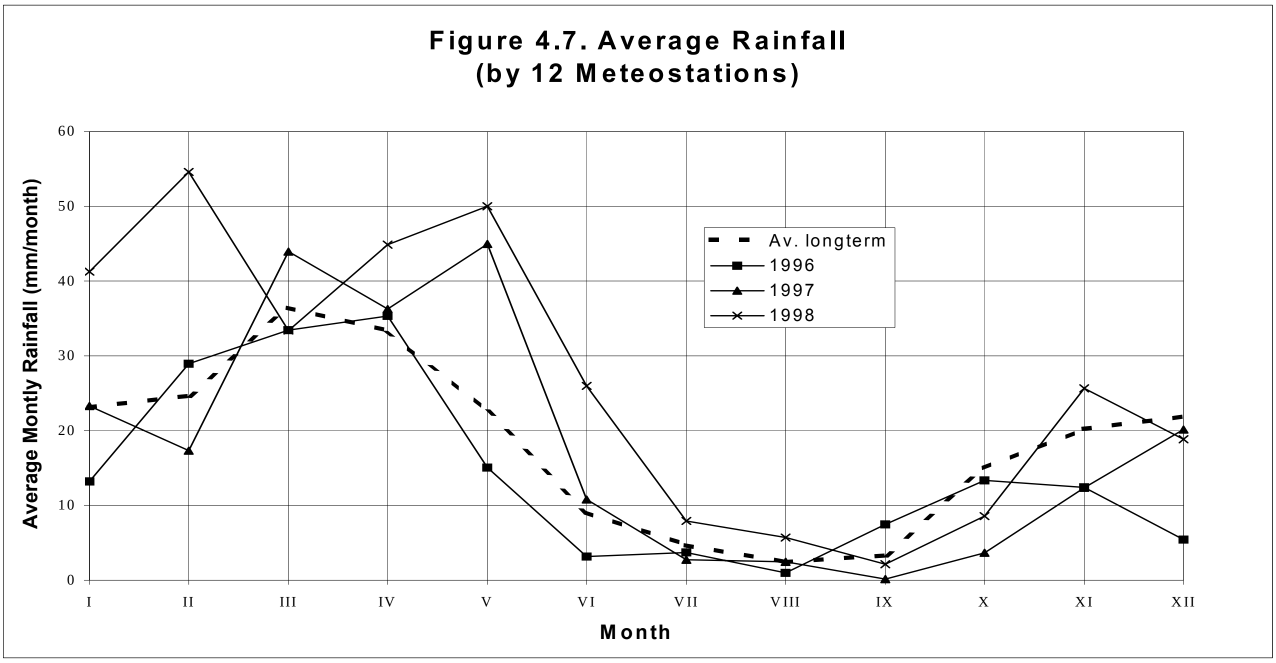
The values of average daily solar radiation from measured sunshine hours in the period 1996 - 1998 are characterized as following: in 1996 they were close to the long-term averages, in 1997 above and in 1998 below the long-term averages. The maximum was observed in July 1997, ranging from 26.7 $MJ/m^2/day$ (farms 27 and 28, Uzbekistan) to 28.6 $MJ/m^2/day$ (farms 23 and 24, Uzbekistan). Minimal values were observed in December 1998 in the range from 4.9 $MJ/m^2/day$ (farms 01 and 02, Kazakhstan) to 8.0 $MJ/m^2/day$ (farms 21 and 22, Uzbekistan).

Figure 4.6. Average Daily Solar Radiation (by 12 Meteostations)



4.6. Rainfall

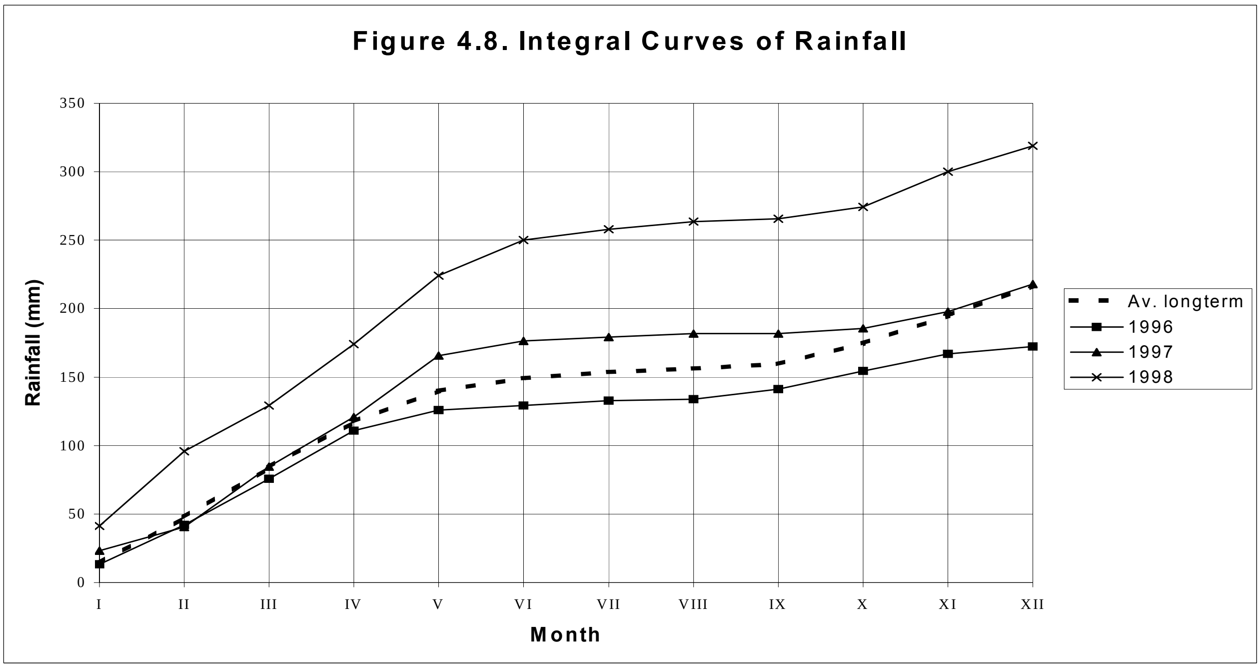
Most rain falls in the months of March and April as shown in Figure 4.7. Maximum monthly rainfall varies from 15 mm/month (farms 27 and 28, Uzbekistan) to 63-72 mm/months (farms 23 and 24, Uzbekistan; 07 and 08, Kyrgyzstan).



The driest month is August, with no rain falling on farms 17 and 18 (Turkmenistan) and farms 21, 22, 35 and 36 (Uzbekistan), rising to a long-term average of 13 mm in Kyrgyzstan (farms 07 and 08).

During the 1996-1998 maximum precipitation was observed in February 1998 within the range from 10.4 mm (farms 27 and 28 (Uzbekistan) to 108 mm (farms 17 and 18, Turkmenistan). The driest month was September 1997 with no rainfall on any farms except farms 27 and 28 (Uzbekistan) which received 1.7 mm.

The wettest year was 1998 год, the driest one was 1996, 1997 was the closest to the long-term average year, as shown on Figure 4.8.



4.7. **Reference Crop Evapotranspiration (ET_0)**

Crop evapotranspiration was calculated on the basis of latitude and altitude, and average monthly values of air temperature, relative humidity, wind speed, and sunshine hours using the Penman-Montieth method, available in the CROPWAT 7.0 program (FAO, 1997).

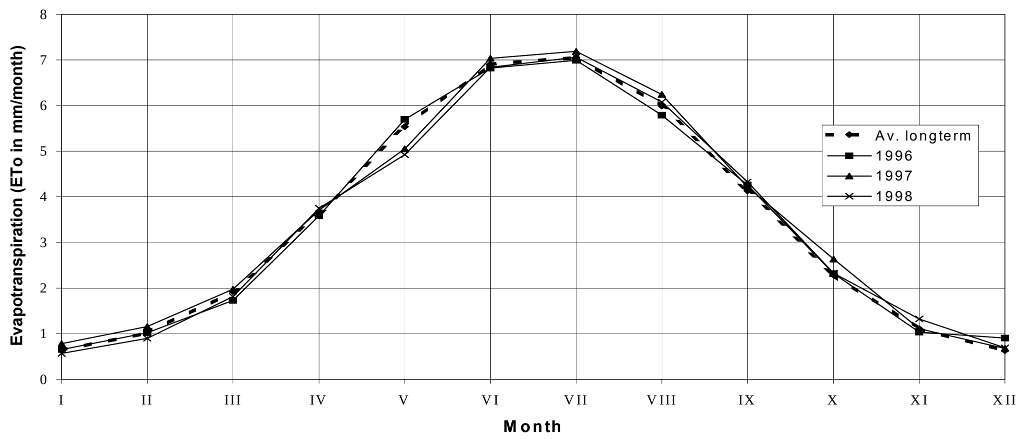


Figure 4.9 Reference Crop Evapotranspiration (ETo)

As shown in Figure 4.9, evapotranspiration is greatest in July, values calculated from long-term data averages ranging from 5.6 mm/day (farms 33 and 34, Uzbekistan) to 8.9 mm/day (farms 14 and 37, Tadjikistan). Values are least in December-January, ranging from 0.4 mm/day (farms 01 and 02, Kazakhstan) to 1.0-1.1 mm/day (farms 21 and 22, Uzbekistan).

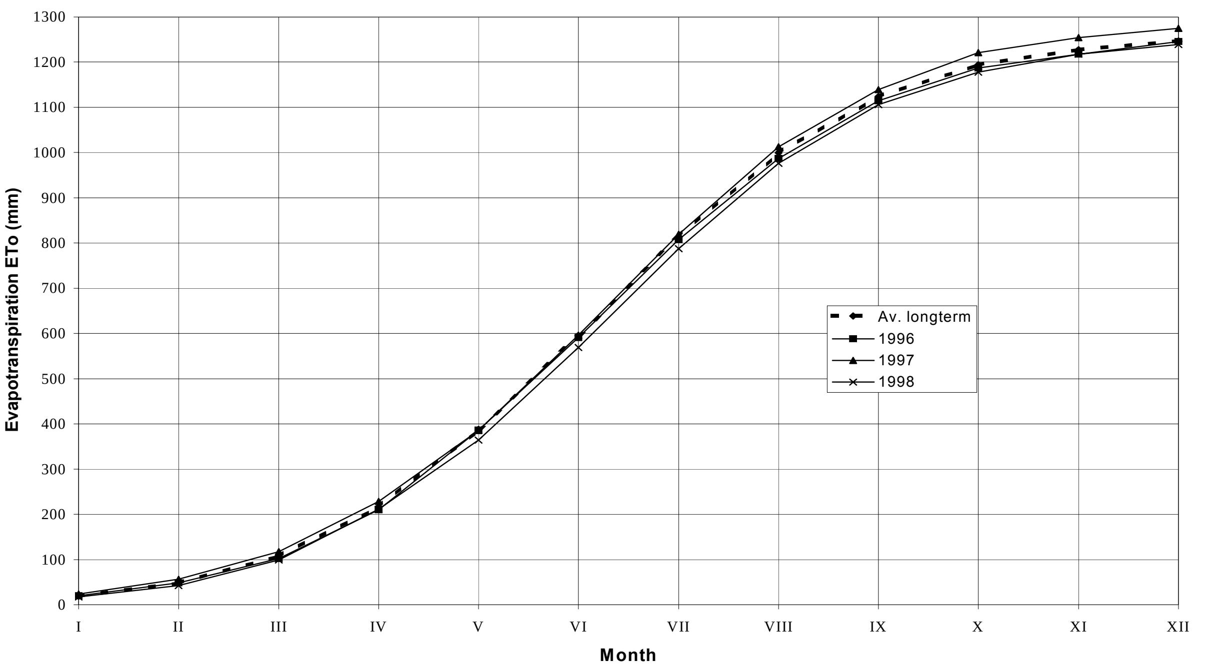


Figure 4.10 Integral Curves of Reference Crop Evapotranspiration (ETo)

Values calculated from measured climate data during the 1996-1998 were mostly higher than the corresponding long-term values. Maximal values were observed in July 1997 in the range from 5.4mm/day (farms 33 and 34, Uzbekistan) to 9.2 mm/day (farms 21 and 22, Uzbekistan). Minimal evapotranspiration was observed in January 1998 in the range from 0.3 mm/day (farms 27 and 28, Uzbekistan) to 1.1 mm/day (farms 21 and 22, Uzbekistan).

Sum of evapotranspiration in 1996 was closest to the long-term average, that of in 1997 was higher and in 1998 below the long-term averages (Figure 4.10).

4.8. Deficiency of Soil Moisture

Deficiency of soil moisture, calculated as difference between reference crop evapotranspiration and sum of rainfall during certain period reflects indirectly the need of artificial wetting of irrigated land.
From long-term data peak of moisture deficiency is observed in July (Figure 4.11), ranging from 155mm/month (farms 07 and 08, Kyrgyzstan) to 273mm/month (farms 14 and 37, Tadjikistan). Maximal moisture deficiency during 1996-1998 was observed in July 1997, ranging from 161 mm/month (farms 33 and 34, Uzbekistan) to 284 mm/month (farms 21 and 22, Uzbekistan).
As compared with long-term average, moisture deficiency was higher in 1996 and 1997 (except in May 1997) and less in 1998.

Figure 4.11 Moisture Deficiency (ETo-Rainfall)