4.2. Precipitation

4.2.1. Types and amounts

Precipitation is mostly in the form of rainfall, although occasional snowfall has been recorded in the Yemeni and Asir highlands.

Fisher and Membery (1998) report the regular occurrence of fog in the western highlands, the Dhofar region, and the central desert of Oman. The contribution of this 'occult precipitation' from fog, mist, low clouds, or dew, to the regional waterbalance might be doubtful. However, these sources of hidden precipitation can help significantly in creating, at a micro-scale, improved conditions for more productive and diverse plant life, particularly grasslands and woodlands.

The distribution of the mean annual precipitation is shown in Figure 6. Generally speaking, precipitation levels are associated with elevation. The highest rainfall occurs in the Yemeni highlands and Asir mountains, and to a lesser extent in the mountains of northern Oman. The lowest precipitation is recorded in the low-lying areas of the Rub al Khali, the Najd in the north of the Peninsula, and the northern Red Sea coast.

4.2.2. Seasonal patterns

During winter the region is under the influence of polar continental air masses that originate in Central Asia. The influx of these air masses is accompanied by dry weather with generally clear skies and fairly low temperatures. Occasionally the Peninsula is affected by polar maritime air coming from the North Atlantic. These air movements are the remainder of the mid-latitude depressions that have already traversed North Africa and the Mediterranean. They are the main source of winter rainfall.

During summer the Peninsula is influenced by tropical continental air masses, which bring hot and very dry air from Egypt and Sudan. These air masses allow the region to become a stable high-pressure zone and source of tropical continental air. Cloudless skies, low humidity, very high temperatures (often >45°C), intensive surface heating, and dust characterize the weather system during summer (Fisher and Membery, 1998). The Indian monsoon system exercises some activity in summer, particularly in parts of Yemen, southwestern Saudi Arabia, and coastal Oman. However, its influence is limited by the strong tropical continental air mass, which prevails over the Peninsula at the time.

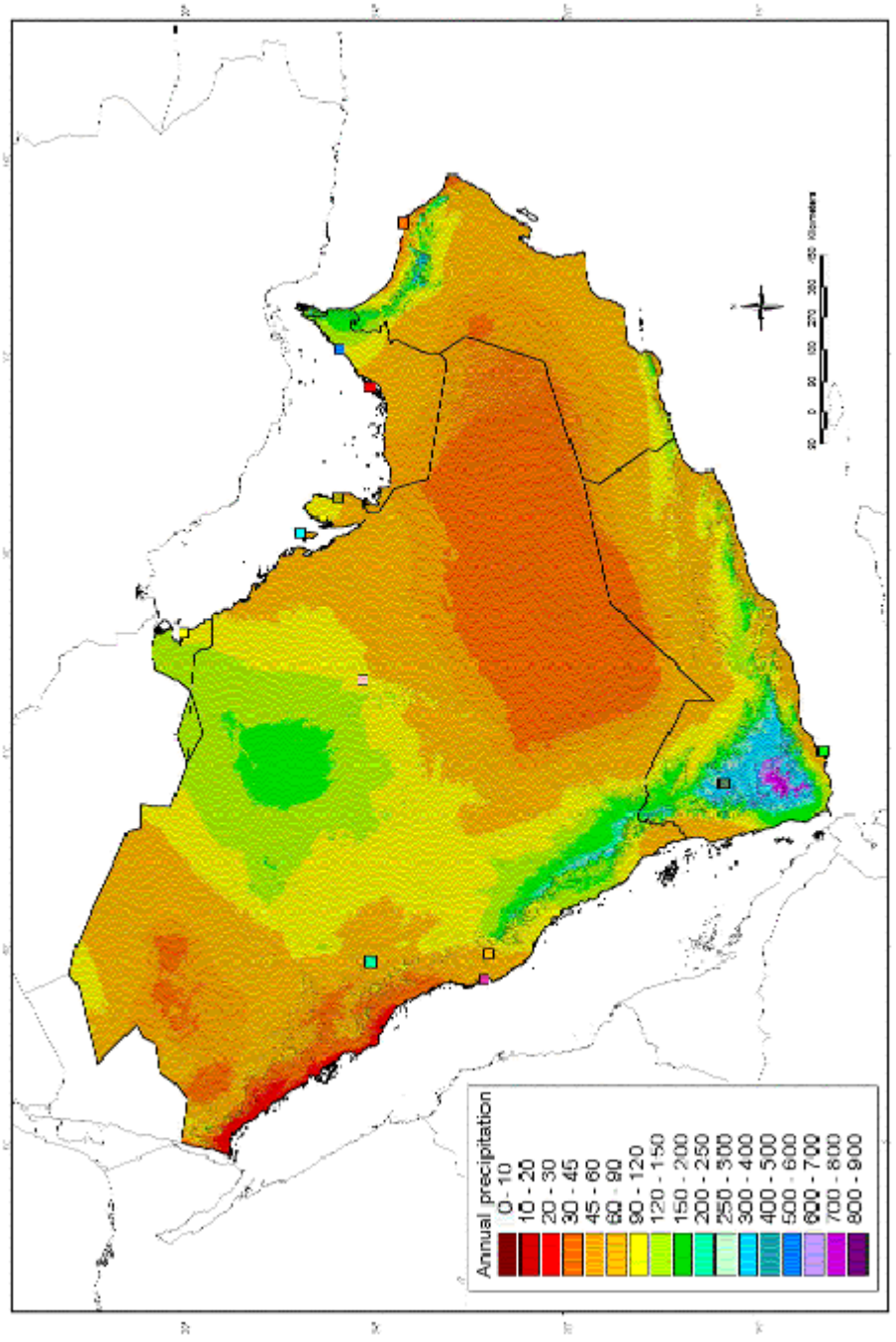

Fig. 6: Mean annual precipitation (mm^2)

The seasonal distribution is shown in Figures 7a-7d as the percentage of the annual rainfall that falls in each of the four seasons. This distribution is explained by the prevalence of one or another weather system at different times of the year.

Figure 7a shows the influence of the winter rainfall pattern, which is common throughout Europe, North Africa, West Asia, and Central Asia. Figure 7b shows the importance of spring rainfall (also largely associated with the westerly systems) for the central landmass of the Peninsula. Figure 7c shows the area of influence of the Indian monsoon, with peaks in the Yemen highlands and the Dhofar area in southern Oman. Autumn does not contribute much rainfall, except in the northern Red Sea coast region (Figure 7d).

4.2.3. Variability

As in other arid parts of the world, high rainfall variability is the norm and the impact of drought severe. Variability affects the amount and distribution of rainfall at different time scales.

Figure 8 shows a typical example of inter-annual variations for Muscat, time period 1893-1978, an unusually long dataset for the Arabian Peninsula. A typical characteristic of rainfall in the arid zones is its negative skew. This means that the probability of having rainfall below the mean is higher, but compensated for by few high rainfall events, as represented by the peaks in Figure 8. The probability distribution of annual precipitation in Muscat, as approximated by a log-normal transform, is shown in figure 9.

This figure shows that the probability of exceeding the mean (105 mm) is only 40%, illustrating the greater likelihood of smaller rainfall amounts.

At smaller time scales, variability increases even more. Figure 10 shows, for each month of the year, the mean rainfall and the amounts that might not be exceeded in one year out of four (2nd decile), and in four years out of five (8th decile).

In the same figure it can be noted that between April and October, the 8th decile is lower than the mean. This demonstrates that in areas (or times of the year) with very low rainfall, the concept of an average rainfall pattern is a statistical artifact. It is caused by the lumping together of a few high-rainfall events with very low probability, with numerous low-rainfall events with high probability.

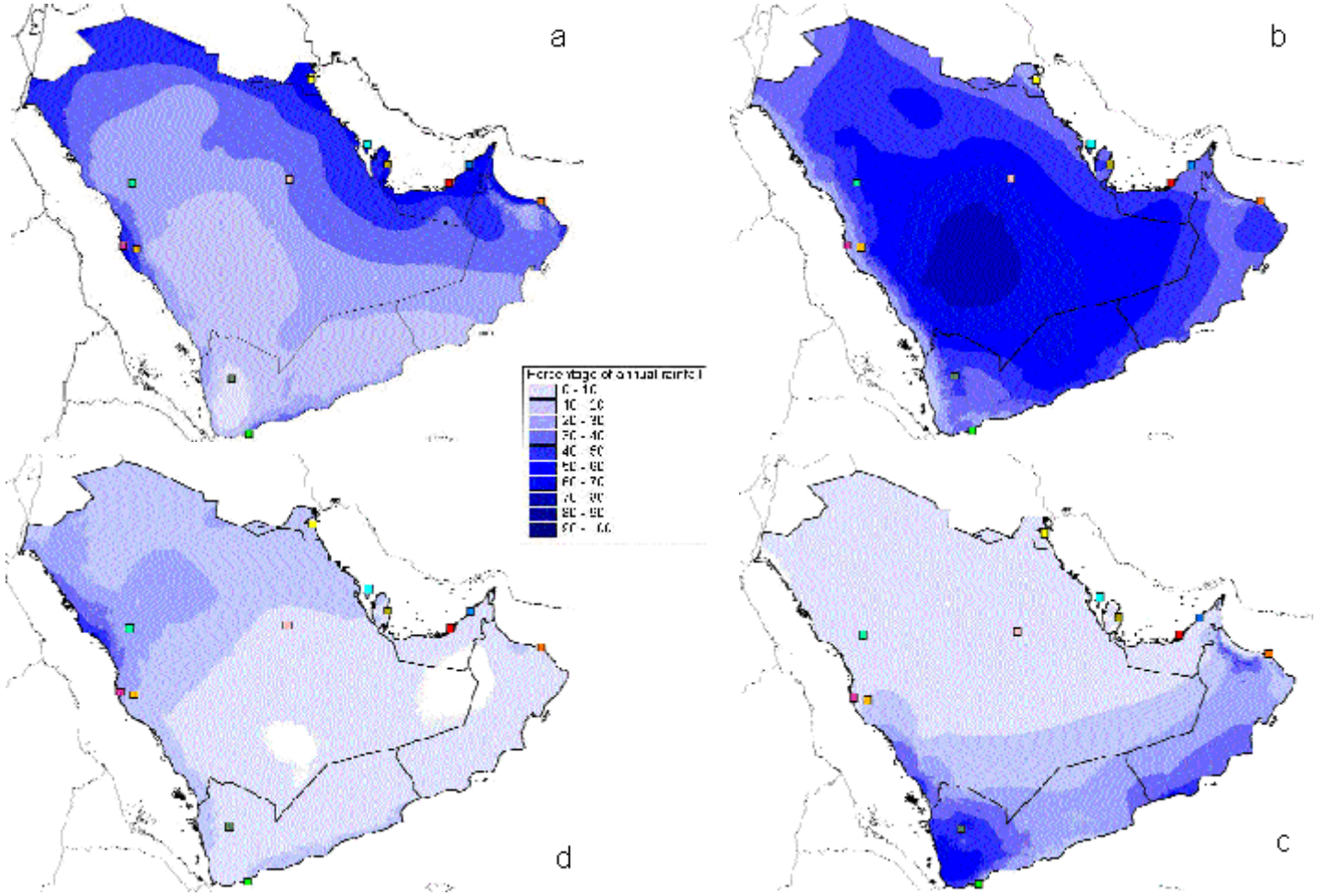

Fig. 7: Seasonal distribution of precipitation. Clockwise from top left: winter (a), spring (b), summer (c), autumn (d)

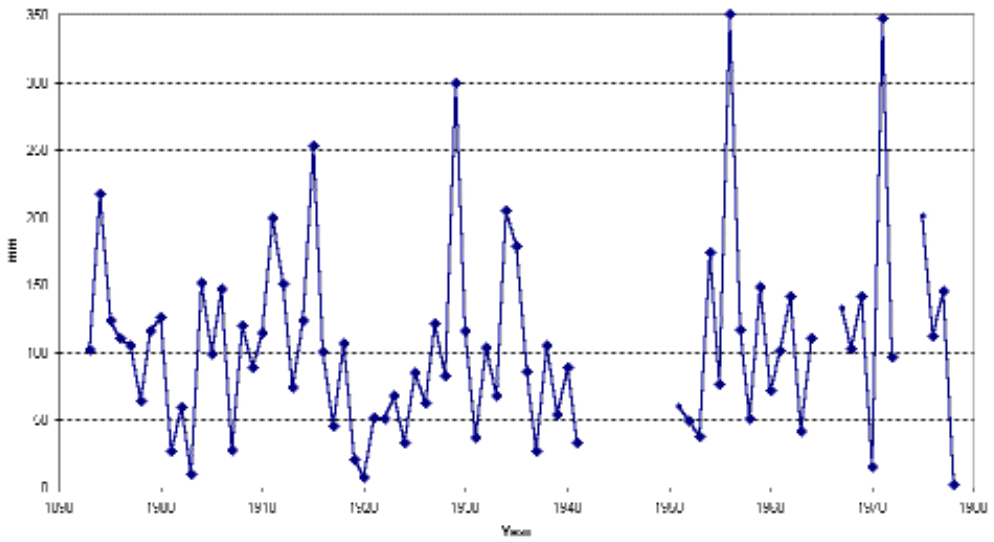

Fig. 8: Variability of annual rainfall, Muscat, Oman (period 1893-1978)

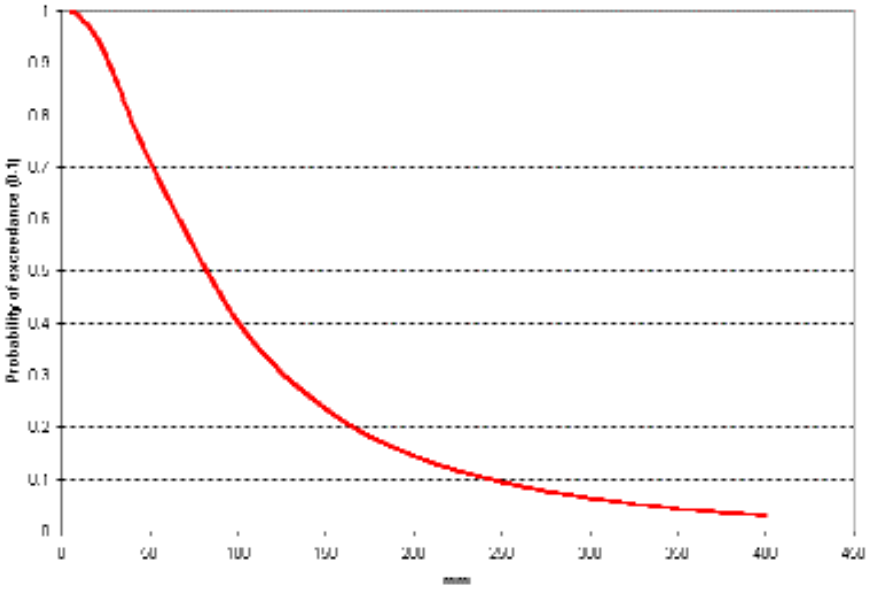

Fig. 9: Probability distribution of annual rainfall, Muscat, Oman (period 1893-1978))

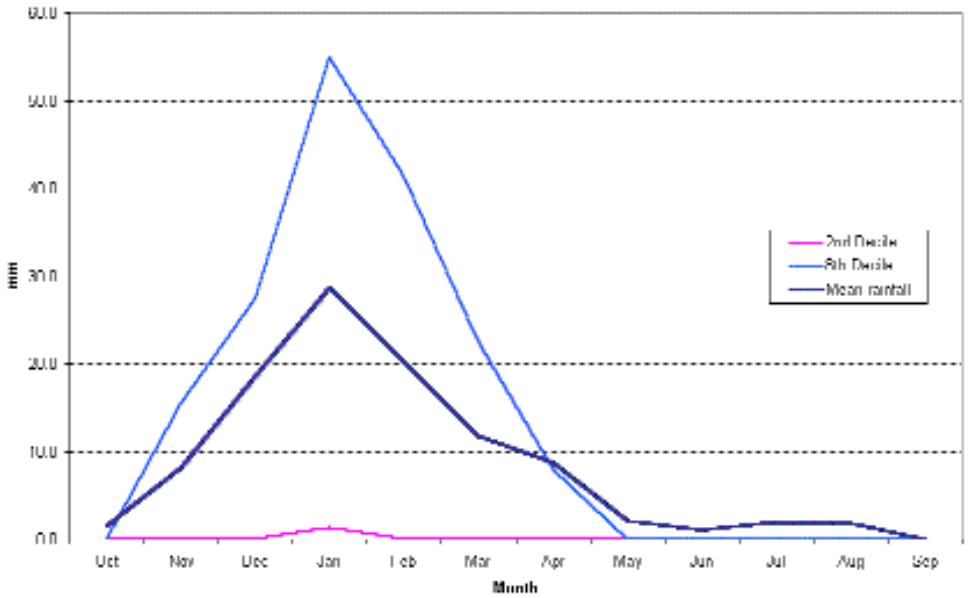

Fig. 10: Variability of monthly rainfall, Muscat, Oman (period 1893-1978)

The nature of individual rainstorms is such that they are often of limited spatial extent with considerable gradients in intensity and amount. This implies that in large areas in the middle of a 'rainy season,' the pattern in reality might be one of intense rains separated by dry conditions or light falls (Jackson, 1977). This 'spottiness' of rainfall has also been suggested by Fisher and Membery (1998).

The implication of increasing rainfall variability with decreasing time scale is of fundamental importance to our understanding of vegetation growth, biomass productivity, and climatic adaptation in the Arabian Peninsula. Since temperature is usually not limiting, growth and flowering occurs whenever and wherever water is available, irrespective of time of year and 'statistical' dry and wet periods.