Workshop on Climate Change Research and Development

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بسم الله الرحمن الرحيم

Indicators of climate change in Sudan

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INTRODUCTION

Sudan's economy like many developing countries is dependent on Agriculture. Agriculture and the associated industries although not yet fully modernized, are the major employment sectors in the country. The dependency of the majority of farmers on rain fed agriculture and pasture has made the economy extremely vulnerable to the vagaries of weather. As a result, failure of rains and occurrence of drought during any growing season may lead to severe food shortages/loss of animals if there is lack of strategic planning. Climate plays a key role in socio-economic activities. The understanding of climatic conditions such as the occurrence of climatic extremes would be of benefit in early warning programs and mitigation procedures for food security.

Climate information constitutes a valuable resource for understanding the past space–time characteristics of all weather parameters sensitive to socio-economic development. In Sudan, rainfall is the most sensitive climatic element. Rainfall information is, therefore, required in the planning and management of most socio-economic activities through investigation of past, present and future rainfall characteristics. The past characteristics are vital in risk zoning and the general planning and management of all rainfall dependent activities.

The climate of the Horn of Africa, of which Sudan is an integral part, is complex in time and space. The region like many other parts of the tropics is prone to extreme climate events such as drought and floods. These events have had severe negative impacts on key socio-economic sectors. The impacts during the last few years include the devastating severe 1988, 1998/99 floods and the 1983\84 drought in the country that resulted into loss of life, damage to property and infrastructure, lack of food, fresh water, energy and many other basic needs of society. Extreme climatic conditions have been around with us and are here to stay.

GEOGRAPHY OF SUDAN.

Sudan, the largest country in Africa, covers an area of 2.5 million km2, located in north-east of Africa, between latitude 3°N and 23°N and longitude 21°45′E and 38 °30′E. Sudan borders ten countries (Egypt and Libya from the north, Chad and Central Africa Republic from the west, Democratic Republic of Congo, Uganda and Kenya from the south, Ethiopia Eritrea and Saudi Arabia from the east). The topography of Sudan is

generally plains, except for the presence of the Red-Sea chain hills in the east, Jebbel-Marra in the west, the Nuba Mountains in the south-central and swamps region in the southern part of the country.

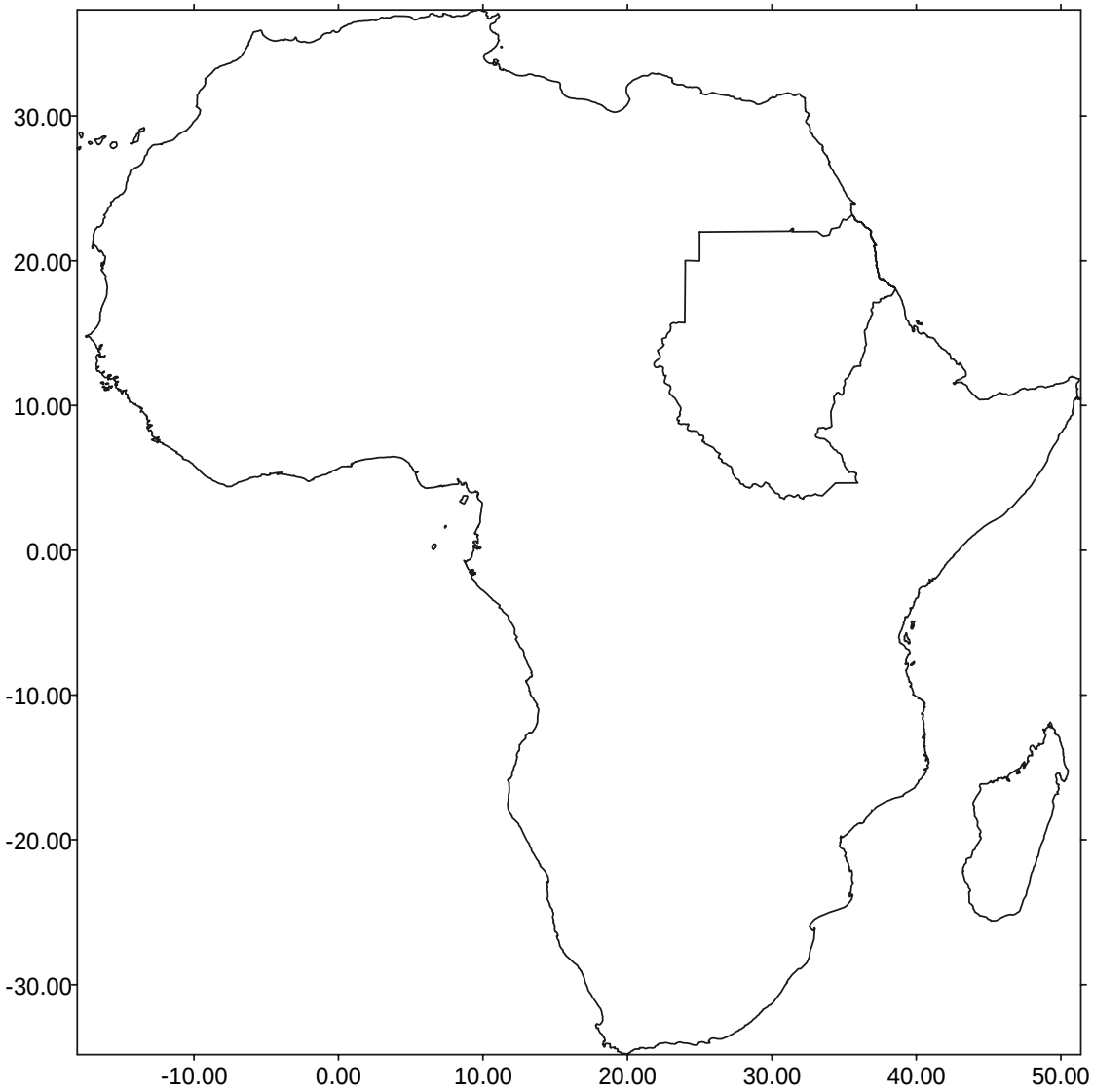

Figure 1. Position Of Sudan In Africa

CLIMATOLOGY OF RAINFALL IN SUDAN

Sudan has various climate types:

Tropical rain forest in the southern parts, which has two rainfall seasons in a year, the short rainy season (March-May) and the long rainy season (June-September). The mean annual rainfall (700-1000mm). Savannah grassland in the central parts, has one rainfall season (June-September). The mean annual rainfall (300-700mm). Semi-arid to desert in the northern parts, are much drier and have two season, dry cold season (November-February) and dry hot season (March-October). The mean annual rainfall (0-30mm). The Red-Sea coastal area: the rainy season occurs during winter (October-January). The mean annual rainfall (60-80mm).

During the advance monsoon, the high pressure systems tend to weaken and due to the direct radiation of the sun a thermal low develops over Sudan. The Inter-Tropical Convergence Zone (ITCZ) during this season is located in the extreme southern parts of the country. The rains over the country are usually associated with the movement of the (ITCZ). Rainfall in Sudan decreases with the increase in latitude. The rainy season begins in the southern parts of Sudan in March, while the northern parts onset of the rainy season in late June or beginning of July.

The (ITCZ) from March moves gradually northward and reaches it's extreme northern position in August. Most parts of the country are under the influence of the south-westerlies during this period which carry the moisture to the lower parts of the troposphere from Atlantic Ocean and Congo basin, and the easterlies in the mid-troposphere which inject this layer by moisture carried from Indian Ocean. In September the (ITCZ) moves southwards rapidly and the rainy season cease.

Sudan can be divided into two sectors of seasonal rainfall patterns. The southern sector has two (bimodal) rainfall seasons in a year, while the northern sector has one (unimodal) rainfall season. The bimodal nature corresponds with the northward and southward migration of the Inter-Tropical Convergence Zone (ITCZ). The first season occurs from

March to May (MAM), while the second season is observed from June to September

(JJAS). The northern sector rainfall season is observed from June to September (JJAS).

Due to topographic lifting caused by Ethiopian plateau in the east of the country and the effect of the Azores ridge of high pressure over the west, annual rainfall generally decreases from east to the west of the country. The isotachs depict a meridional orientation generally running from the northeast to southwest indicating the influence of the Ethiopian high land and the Azores ridge of high pressure.

Over the Red Sea coastal area the rainy season occurs during the winter period (October-January). The main factor affecting rainfall over this area is the Red Sea trough. The Red Sea trough develops when the Azores high pressure and the Arabian high pressure move closer to each other to form a convergence zone between them, combined with geographical feature of the area. The Red Sea trough intensifies during the interaction with low-pressure trough of the Mediterranean Sea depression. It lies along the Red Sea coast but may be displaced east or west depending on the intensification of the high-pressure systems.

THE MAIN FACTORS THAT INFLUENCE RAINFALL IN SUDAN

- The position and intensity of the Inter-Tropical Convergence Zone (ITCZ).
- Sub-tropical high pressure systems in the southwest Indian Ocean (Mascarene High), the St. Helena High in the southeast Atlantic Ocean, Azores/Sahara High in the North Atlantic Ocean and Arabian High to the northeast.
- Inter Hemispherical monsoonal wind systems.
- The Mediterranean Depressions associated with cold fronts that move eastward.
- Easterly and Westerly waves.
- Teleconnections with El-Nino Southern Oscillation (ENSO).

Data

In this paper we used historical data from the data bank of Sudan Meteorological Authority of rainfall for the whole country and temperature with different time scale. For the rain we used the climate normal data ,for the temperature we used long term data for Khartoum station which located in the central part of the country.

Temperature

Fig(2) and Fig(3) depict the deviation of maximum temperature anomalies from the normal at Khartoum which located in the central part of the country. From the graph it is clear that the maximum and minimum temperatures were increased during the last years.

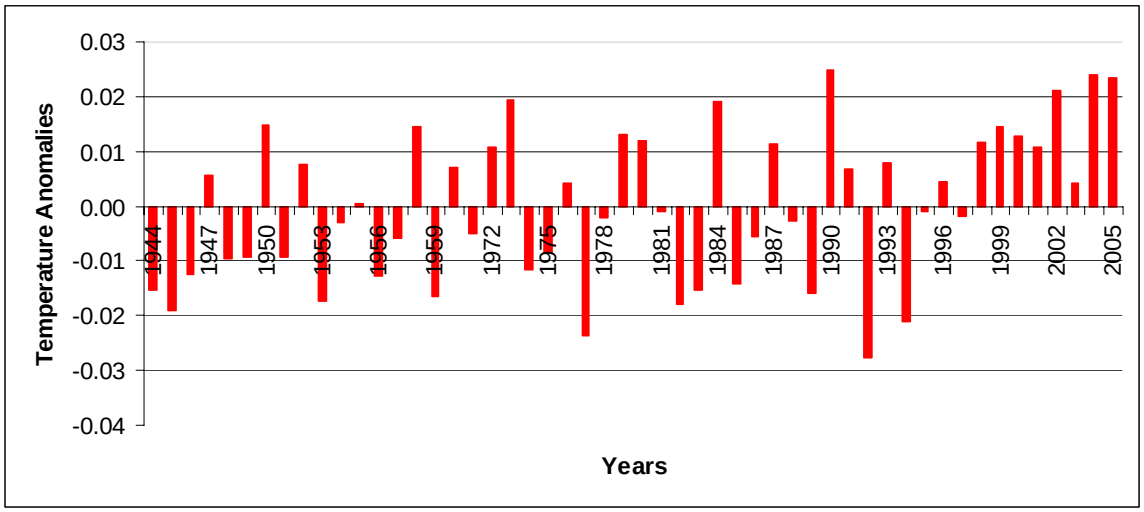

Fig (2) Deviation of maximum temperature from the normal at Khartoum

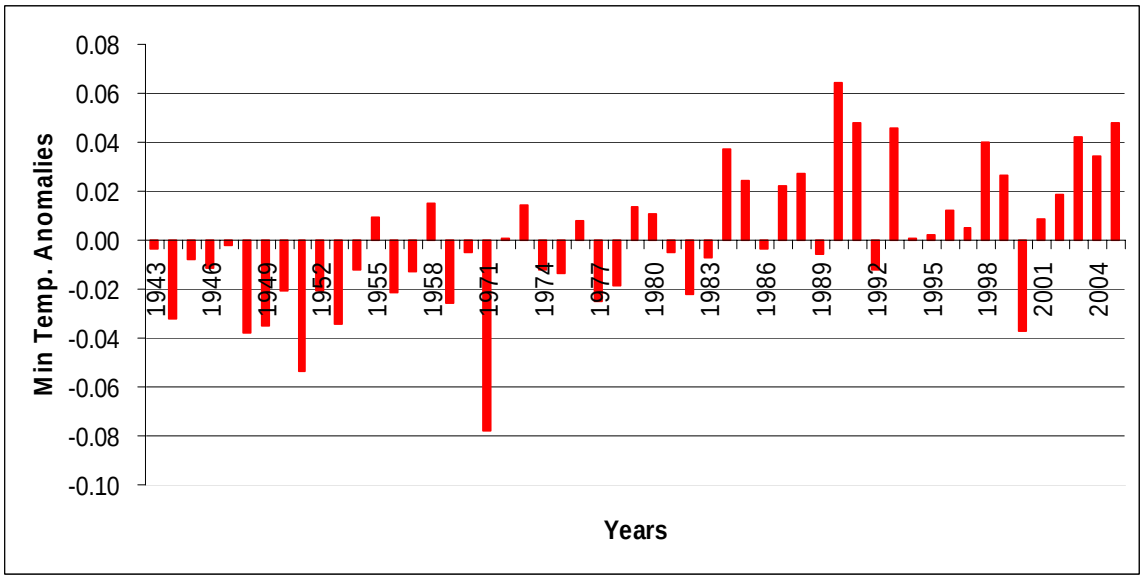

Fig (3) Deviation of minimum temperature from the normal at Khartoum

Rainfall

Fig(4,5,6,7) represents the rainfall normal for the period 1941-2000 starting from 1941-1970 ending by 1971-2000. In the normal 1941-1970 fig(4) the isotach 100 mm north of latitude 19N while isotach 1200 mm in the south west of the country cover a vast area. If we move to fig(5) which represent the period 1951-1980 we will find that the isotach 100 mm moved south words and the isotach 1200 mm is not there it disappeared from the chard. In fig(6) which represent the period 1961-1990 the isotach 1100 also disappear from the chart. In fig(7) both the isotachs 50mm and 1000mm moved south words. In general seems to be moving south word. Fig (8) depict a comparison between the normal of 1941-1970 and the normal of 1971-2000 the isotach of 200 mm and 500 mm moved by two in the east to three latitude degrees.

Conclusion:

From the analysis of Khartoum temperature and the analysis of the rainfall in Sudan it is clear that the temperature is rising in Khartoum during the last decade and the rainfall is experienced decreasing in rainfall amount from decade to decade. This is a good indicator that the climate is changing in Sudan.

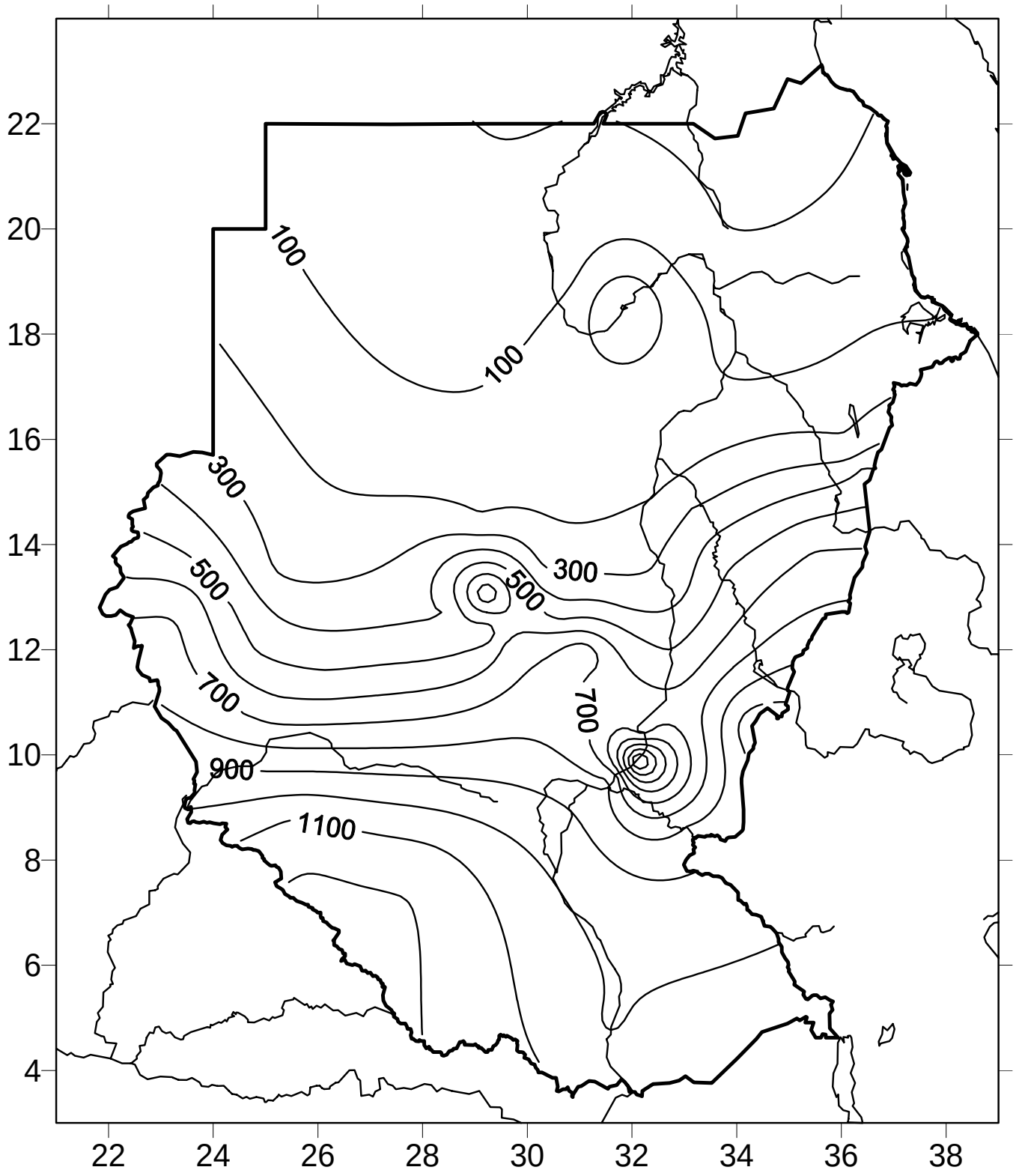
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Fig (4) the rainfall climate normal for the period 1941-1970

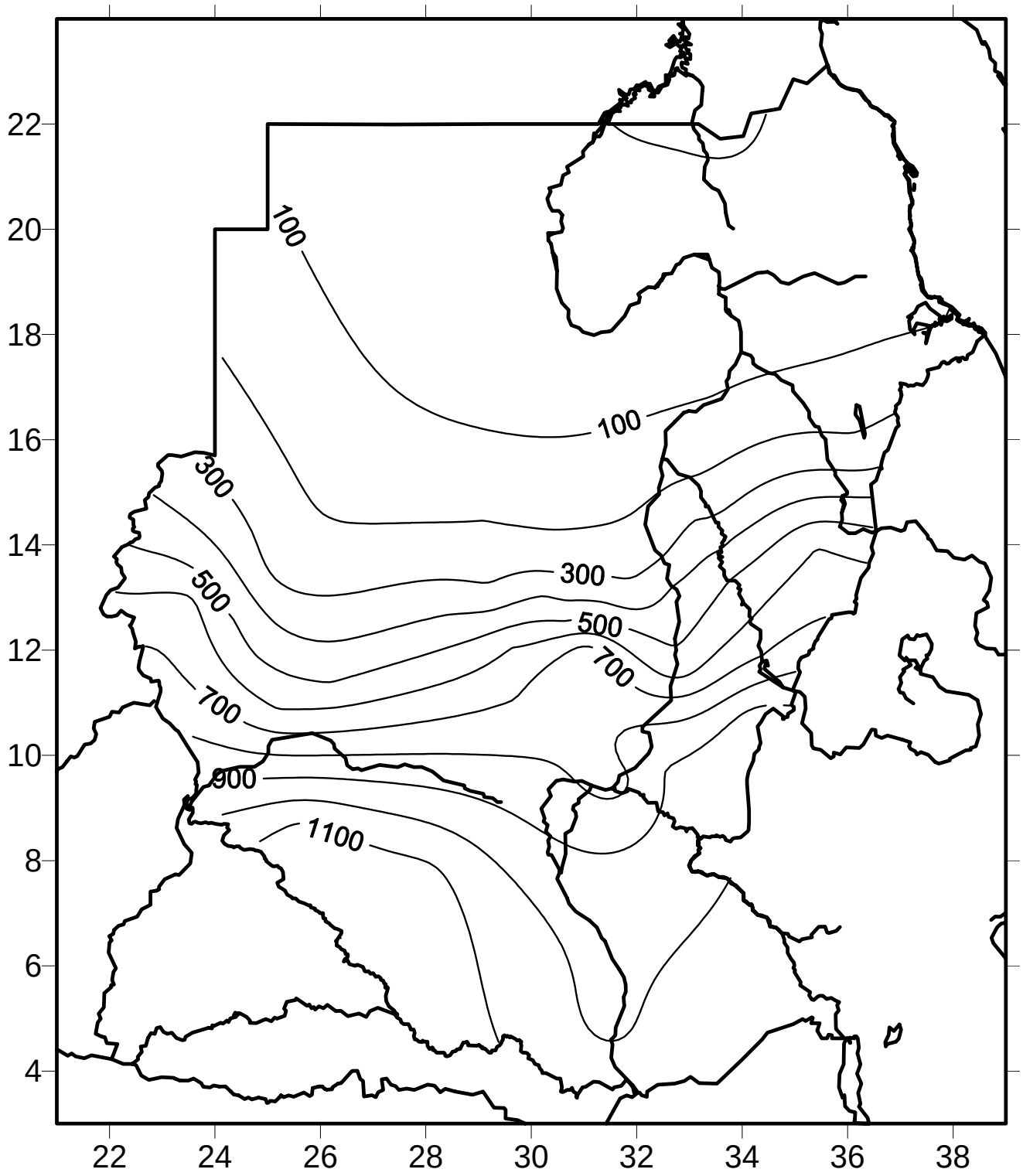


Fig (5) The rainfall climate normal for the period 1951-1960

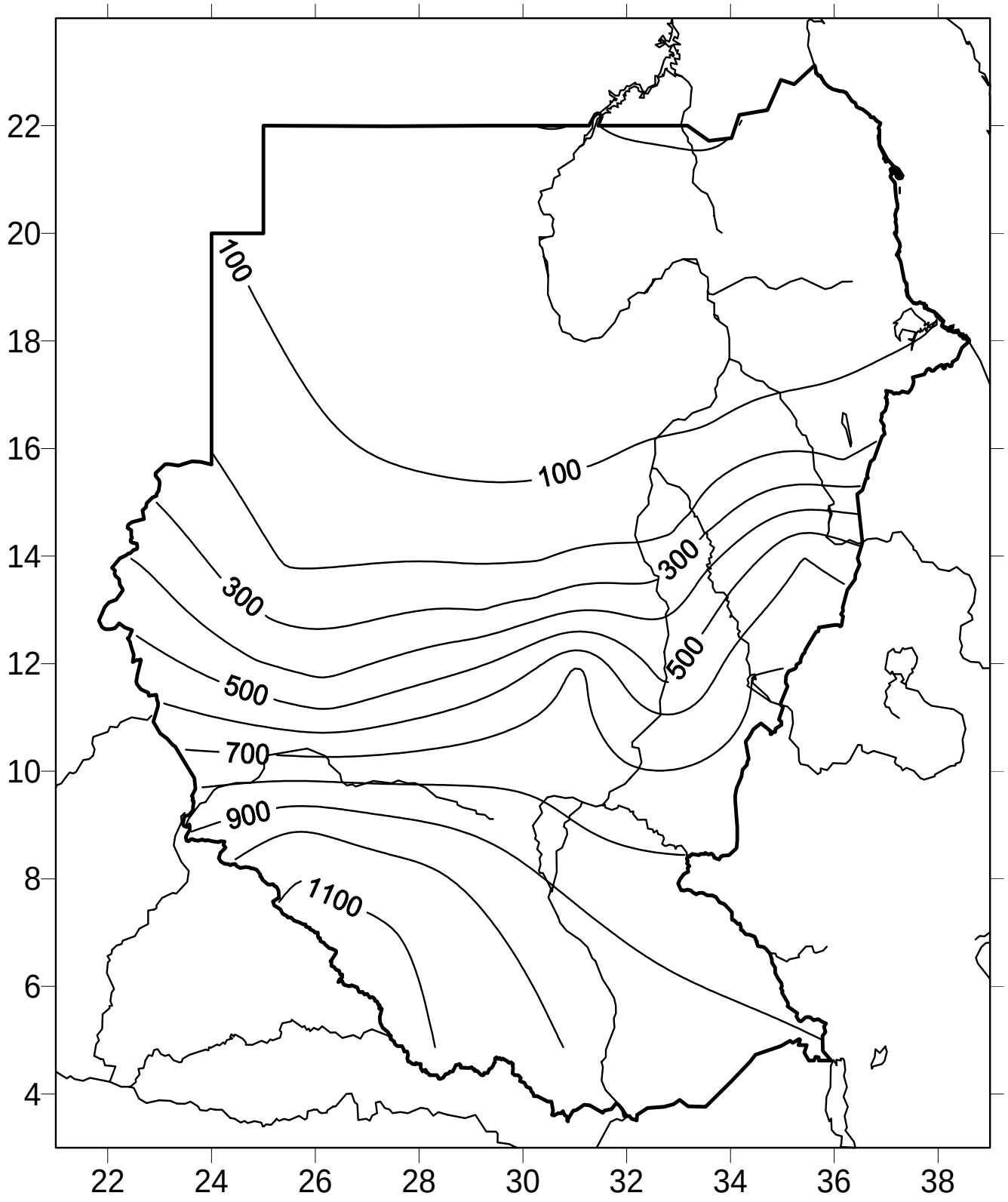


Fig (6) The rainfall climate normal for the period 1961-1990

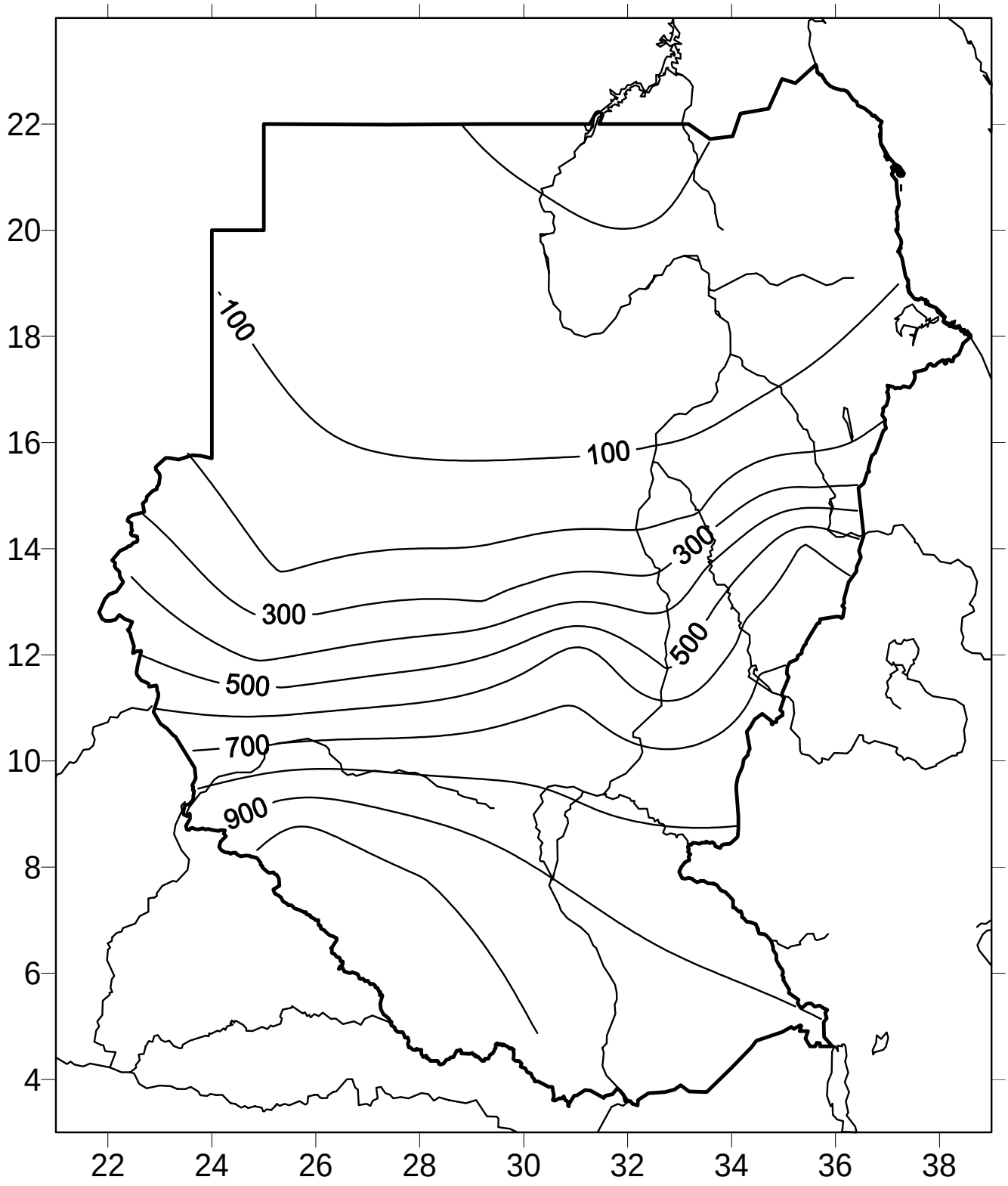
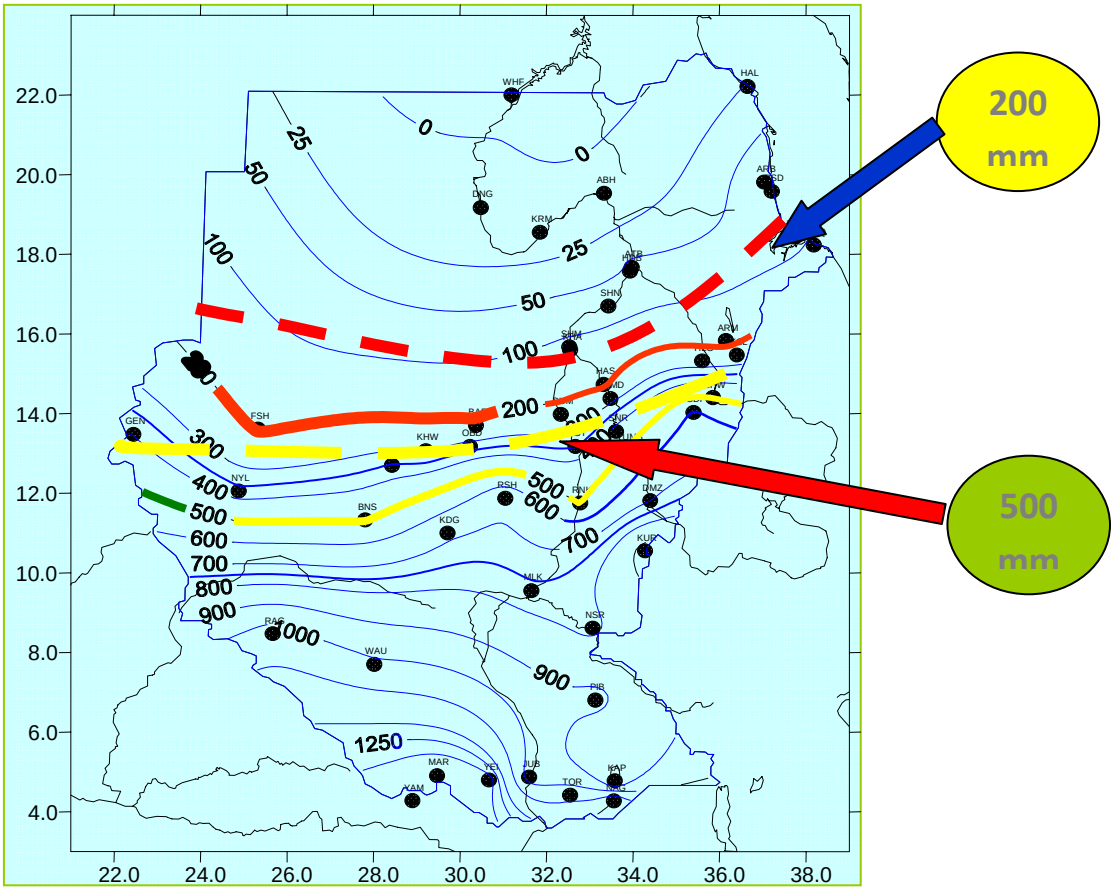


Fig (7) The rainfall climate normal for the period 1971-2000



Fig(8) Comparison between rainfall decades 1941-1970 and 1971-2000