CHAPTER 1
CHAPTER - I
INTRODUCTION

In the recent past our country has been subjected to devastating droughts and floods. Environmental loss, social destruction and peoples miseries due to droughts and floods have reached an alarming state every year. As many as fourteen States of India are declared as drought effected areas in 1986. The annual expenditure on the natural disasters have been increasing at an alarming rate. In 1986 the central assistance to the natural disasters is about Rs.1,200 crores.

Drought undoubtedly is one of man's worst natural enemy. The term drought is defined as "the State where the rainless situation is extended for a long period with very low wet spells". According to V.P. Subramanyam, (1967) the meteorologist has defined drought as the rainless situation for an extended period during which some precipitation should normally have been received, depending upon location and season. The agricultural meteorologists consider drought as a shortage of moisture for crop. The hydrologists view it as being responsible for depression of surface and underground water levels or retardation of streams flow. The economists define drought as water shortage which adversely
affected the economy of the region. Thornth-Waite (1947) opines that drought can not be defined as shortage in rainfall alone. He has defined drought as a period of abnormal dry weather sufficiently prolonged for lack of water to cause serious hydrological imbalance. Linsley et al. (1959) have described drought as a substraigned period of time without significant period of rainfall. Drought is defined by various authors taking into consideration of rainfall, rainfall with mean temperature, soil water and crop parameters, climatic indices and estimates of evapotranspiration. Henry (1906), has defined drought as a state where 21 days or more when rainfall is 30 per cent or less of average for the time and place. Extreme drought is considered when rain-fall fails to reach 10 per cent of normal for 21 days or more. Looking more closely into the definitions based on rainfall, the British R.F. Organisation (1936) classified drought into absolute drought where atleast 15 consecutive days the rainfall is less than 25 mm, partial drought where atleast in 29 days the mean rainfall does not exceed 25 mm. per day and dry spell wherein 15 consecutive days the rainfall is not more than 1 mm.

Some of the definitions which have been given, based on the rainfall with temperature are by Long (1915), Demortone (1926), Koloskov (1925), Selyaninov (1930),
Koppen (1931), Thornthwaite (1931), Condra (1944), Popov (1948), Emberger (1955) and Budyko (1970). The definitions given by Russell (1896), Vambavel (1953), Thornthwaite and Mathur (1955), Penman (1961), Fitzpatrick (1965) and Palmer (1968) are based on soil, water and crop parameters. Sly (1970) used climatic moisture index for indicating the differences in water balance for climatic classification. Some meteorologists have used climatic data to develop measures for computing the extended severity of droughts. The works carried out by Dzendelevskii (1958) and Wallen (1967) show that the empirical aridity indices could be used in determination of drought over the years by climatologists, geographers, ecologists and others.

Droughts thus are comparatively short transient periods of inadequate or total absence of rainfall or available water for the normal biological activity. Aridity, on the other hand, is a climatic term applied primarily to the prolonged or permanent lack of water for established use and therefore depends upon the spatial distribution of rainfall. Drought climatology has emerged in recent years as a discipline of immense practical importance, since drought begins as the result a sequence of weather events. Culminating with the production of acute water shortages, the problems associated with droughts are numerous and
complex. "It is the drought climatologist to trace their origin and development and critically analyse various aspects like intensity, duration, spread, dissipation and frequency of occurrence etc." Droughts have regular life cycles. A study of Nature is the very important for taking suitable precautionary measures in the matter of conservation and utilisation of available water resources in drought affected areas. Thus the study of the duration of drought spell is important to determine the ultimate effect of the water shortage and economics of irrigation. In all the climatic zones there is a tendency for slight shifts in climatic types from year to year following fluctuations in the water balance. It is clear that even in such climatic zones slight rises in deficiency would significantly trip the water balance. Therefore predictability of water deficiencies and water surpluses in years and seasons will be of immense operational value in water use planning.

Rainfall is one of the important parameters to be considered in the analysis of droughts. Climatologists have established that the patterns of rainfall distribution over the earth are not accidental but are physically determined by general circulation of the atmosphere.
The amount and distribution of rainfall are also strongly governed by distribution, height and orientation of mountain ranges. The rainfall distribution over India subcontinent mainly depends on physical orientation of various mountain systems and differential heating and cooling of continents and adjoining ocean regions. The distribution of monsoon rainfall is not uniform in terms of space, but also exhibits strong variations in time.

The precipitation is an important factor in studying the systematic distribution of water resources over a region. Of all the climatic elements rainfall is widely measured by well distributed and organised network of rain-gauge situations. The surface water resources of any region can be evaluated by studying systematically the distribution of rainfall based on the data collected from rain-gauge stations over a period of time for computation of water balance of a region. The water supply through precipitation and water loss due to evaporation and evapotranspiration have to be carefully analysed. Agricultural activities are controlled by the timely occurrence of rainfall and any departure from average rainfall leads to a great distress. Therefore a careful analysis of this parameter is essential and the prerequisite for the analysis of droughts and management of crop and water resources over a region.
The study area for present problem is Cuddapah district. It is situated in Rayalaseema region. It is estimated that drought occurs once in three years in Rayalaseema district. Cuddapah district lies between 13° 43' to 15° 14' N of the Northern latitude and 75° 29' E of the Eastern longitude (Fig.1). This district is bounded on the north by Kurnool district, on the east by Nellore, on the south by Chittoor and on the west by Anantapur. The altitude varies from 269 to 3,787 feet above mean sea level. The geographical area of the district is 15,359 Sq. Kms. The total population of the district, as per 1981 census, is 19.33 lakhs. This district comprises 50 Mandalas. This district has been divided into 3 revenue divisions for the administration purpose i.e. Cuddapah, Rajampet and Jammalamadugu. The district constitutes more of hills like Palakondas, Vellikondas, and Seshachalam which are the extension of Eastern Ghats.

Cuddapah district offers dry climate with four seasons. The average annual rainfall in the district is 686.4 mm. which is 2.5 mm less than the State-average. The rainfall in north is confined to the months of May to November. September is the month with the highest rainfall. The maximum daily mean temperature is 23.8° C. February temperature begins to rise rapidly and May is the hottest month of the year.
The soil of the district has been classified into Red Ferroginous soils and black soil, and subdivided into clay, loam, black clay, black loam, black sand, red clay and red loams.

Cuddapah district is rich in minerals and it is the sole producing of high grade asbestos of chrysolite varieties in India. Lime stone, white clay and iron ore are also available in Cuddapah district. The world famous barytes are found in the district. The Cuddapah district is mainly drained by Pennar and its tributaries named Chitravati, Kunderu, Papagni, Sagleru, Cheyyaru, Bahuda, Pincha, Mandavi, Pullangi and Gunjaneru. The Kurnool - Cuddapah canal is the main source of canal irrigation. In this district the land utilisation is mainly confined to agriculture sector.

REVIEW OF LITERATURE:

Among the Indian authors who have contributed for the understanding of rainfall distribution, variability, frequency and reliability are Sinha (1959), Geogre and Vasudevan (1963), Ananta Krishnan and Rajagopala Chary (1964), Srinivasan (1964), Pardhasaradhi and Dhar (1970), Rao et. al. (1972). Studies on rainfall trends, rainfall pattern, rainfall differences and rainfall excess are carried out by George (1962), Bedekar and (1969),
Raghavender (1974) and Bishoi (1975). Studies on application of statistical techniques in the analysis of precipitation have been well documented by Dakshana Murthy (1964), Dikshit (1979), Bhargava et. al. (1964), Rama-Krishna Prasad and Narayan (1967) and Subramanyam and Viswanatham (1979). Some of the eminent agricultural climatologists who have made an attempt to study the relationship between rainfall and cropping pattern are by Sridaran and Ramachandran (1970), Ramana Rao and Murali Mohan Rao (1971), Saxena et. al. (1979) and Murali Mohan Rao and Thimma Gowda (1979). Sambasiva Rao and Kalavathi (1983) and Murali Mohana Rao and Ramakrishna Rao (1979) have clearly brought out the relationship between water balance elements and cropping pattern of Madurai district in Tamil Nadu and Karnataka State respectively. A good amount of work as drought climatology has been carried out by the meteorology and oceanography department of Andhra University, Waltair, under the guidance of late Professor V.P. Subramanyam. He has carried out studies on the problems of incidents and spread of continental droughts. Subramanyam has defined the term "drought climatology" as a study of origin and development of drought and a critical analysis of intensity, duration, spread and frequency of occurrence. Mooley et. al. have analysed the large scale drought areas in India, from 1871 to 1978, concluded that
there is an increase of about 25 per cent in the price of food grains in the year succeeding the drought year.

Subramanyam (1981) has described the regional techniques of study in drought climatology and usefulness, the monex programmes, in dealing with droughts. A National All India Symposium on drought prone areas was organised in January 1978 by the Department of Geography of the S.V. University, Tirupati, under the Directorship of Professor N.B.K. Reddy. There was a wide response from various Universities, research institutes, Central and State Governments. About 72 research articles were presented on various aspects of conceptual and historical, regional studies, planning and development of drought prone areas, relationship between rainfall and agriculture, relationship between hydrology and irrigation techniques, problems and reviews of drought prone area programmes and socio-economic factors of drought prone areas. Professor N.B.K. Reddy was kind enough to bring out the volume of proceedings in 1979 through Rayala-seema Geographical Society, Tirupati. He has concluded that the volume will be useful to the literature available on this subject of drought prone area programmes. Some of the articles which show a qualitative information on drought prone areas worth mentioning are by Subramanyam and Hemamalini (1979), Chowdary (1975), Arunachalam (1979), Venugopal and Geeta (1979) and N.B.K. Reddy and Singh (1979) and Reddy and Uttaraprabhu (1979). The above said
researchers have contributed various studies on conceptual and historical aspects of drought prone areas. Specific regional studies have been given by Subramanyam and Hemamalini on drought prone areas in Andhra Pradesh. Arunachalam (1979) and Mustafa (1979) have made studies on droughts in Maharashtra. Soundar Valli (1979) has studied the drought prone areas of the Tamil Nadu and Satapati (1979) of Bihar. The studies on planning and development of drought prone areas and strategies to develop them have been well described by Bhat (1979), Jaiswal (1979), Arunachalam (1979), Hymavathi and Reddy (1979) and Chowdary (1979). Narayana and Lakshminarayana (1979) have described the advantages and deficiencies of the D.P.A.P. in Cuddapah district and concluded that there is favourable impact on the economy of small and marginal farmers due to D.P.A.P. Programmes in the district. Till today, no serious attempt has been made on delimitations of droughts areal extension, intensity, frequency of occurrence and drought duration. Therefore in the present study an attempt has been made to study the drought climatology of the Cuddapah district.

OBJECTIVES:

The main objectives of the present study are:

1. to analyse the rainfall pattern, distribution, intensity, variability, ratio, and frequency on monthly, seasonal and annual basis;
2. to study the decadal variation in the rainfall distribution, intensity and variability;
3. to analyse the drought periods and intensity on monthly, seasonal and annual basis;
4. to map the spread of drought and desertification in the district based on the rainfall data collected over a period of 88 years;
5. to study the ground water level, variation, fluctuations, recharge, potential and ground water suitability of the district based on ground water level data collected over a period of 9 years, specific yield, rainfall and geographical areas; and
6. to suggest suitable water management practices based on the analysis of rainfall, droughts and existing surface and sub-surface water resources of the district.

**METHODOLOGY:**

The data pertaining to rainfall on monthly basis has been collected from the Indian Meteorological Department and rain-gauge stations present in the district for over a period of 88 years. The data has been collected from 9 stations which possess 88 years data. The data has been used to study the spatial distribution of rainfall, rainfall intensity, rainfall variability, rainfall ratio, and rainfall frequency. The statistical techniques described by Bhargava et al (1964) have been used. Studies also have been carried out on decadalwise to bring out variations.
among the decadal rainfall intensity and rainfall variability. The drought analysis have been carried out based on the rainfall method and water balance aridity indices method described by Thoranthwaite (1955). The ground water data collected on monthly basis over a period of 9 years from ground water department, Government of Andhra Pradesh, from 28 controlled wells has been used to map the ground water level variation, ground water level fluctuation, and ground water potential on monthly, seasonal and annual basis. Based on ground water salinity and alkalinity the ground water suitability of the district has been mapped using USS L classification. Computer technique has been used in analysing the rainfall data adopting various statistical techniques. The cartographic techniques have been adopted to represent the data in the suitable form.

SOURCE OF DATA:

The data has been collected from Indian Meteorological Department and rain-gauge stations and C.P.O. present in the district. The data on ground water level quality, specific yield, aquifer depth, ground water yield etc. has been collected from Ground Water division, Government of Andhra Pradesh, from 25 controlled wells and bore-wells dug in the district. The data on land use, irrigation etc., has been
collected from C.P.O. and Minor Irrigation Department of Cuddapah district, Government of Andhra Pradesh. The various programmes implementing in the district for the eradication of poverty during drought periods has been collected from D.R.D.A. of Cuddapah district.

ORGANISATION OF THE DISSERTATION:

In the first chapter an attempt is made to give a brief introduction of the problem on rainfall and droughts, study area, review of work, objectives, methodology, source of data and organisation of the dissertation.

In the second chapter a detailed discription of the profile of the district have been dealt with.

In third chapter analysis of rain-fall on monthly, seasonal and annual basis has been described.

In the fourth chapter the decadal variations among the rainfall distribution, rainfall intensity and rainfall variability has been dealt with.

An analysis on drought has been described on the monthly, seasonal and annual basis in the fifth chapter.

The ground water resources, variability, fluctuation, potential and quality etc., has been studied in the sixth chapter.
In the seventh chapter an attempt is made to suggest suitable methods for the management of water resources based on study of rainfall, droughts and surface and sub-surface water resources distribution in the district and in the last chapter the conclusions drawn out of the study have been summarised.