CHAPTER 1

INTRODUCTION

1.1 GENERAL

Climate (from Ancient Greek klima, meaning inclination) is commonly defined as the weather averaged over a long period of time. Climate encompasses the statistics of temperature, humidity, wind, rainfall, atmospheric pressure, atmospheric particle count and numerous other meteorological parameters in a given region over long periods of time. The standard averaging period is 30 years, but other periods may be used depending on the purpose. Climate also includes statistics other than the average, such as the magnitudes of dayï toï day or yearï toï year variations.

The climate of a location is affected by its latitude, terrain, altitude, ice or snow cover, as well as nearby water bodies and their currents. Climates can be classified according to the average and typical ranges of different variables, most commonly temperature and precipitation. The widely used classification criteria is the one originally developed by Wladimir Koppen. The Thornthwaite system, in use since 1948, incorporates evapotranspiration in addition to temperature and precipitation information and is used in studying the potential impacts of climate changes. The Bergeron and spatial synoptic classification systems focus on the origin of air masses defining the climate for certain areas.

Climate can be contrasted to weather, which is the present condition of climate parameters over periods upto two weeks. Meteorology is the interdisciplinary scientific study of the atmosphere that focuses on weather processes and forecasting. Studies in the field stretch back millennia, though significant progress in meteorology did not occur until the eighteenth century. The nineteenth century saw breakthroughs occur after observing networks developed across several countries. Breakthroughs in weather forecasting were achieved in the latter half of the twentieth century, after the development of the computers.

Meteorological phenomena are observable weather events which illuminate and are explained by the science of meteorology. These events are bound by the

rth's atmosphere: These are temperature, air, water teractions of each variable, and how they change in th's observed weather is located in the troposphere. Different spatial scales are studied to determine how systems on local, regional, and global levels impact weather and climatology. Meteorology, climatology, atmospheric physics, and atmospheric chemistry are subï disciplines of the atmospheric sciences. Meteorology and hydrology compose the interdisciplinary field of hydrometeorology. Meteorology has application in many diverse fields such as the water resources, agriculture, construction, military, energy production, transport, etc.

Climatology is the scientific study of climate, including the causes and longï term effects of variation in regional and global climates. Climatology also studies how climate changes over time and is affected by human actions. Climate models are used for a variety of purposes from study of the dynamics of the weather and climate system to projections of future climate.

1.2 CLIMATE PARAMETER BASICS

As climatology deals with aggregates of weather properties, statistics are used to reduce a vast array of recorded properties into one or a few understandable numbers. For example if one wished to calculate the daily mean temperature at a given place, through a number of methods, first one can take all recorded temperatures throughout the day add them together and then divide the same by the total number of observations. As an example one can take all hourly recordings of temperature sum them and divide by 24. This will yield an average temperature for the day.

A much simpler but less accurate method of calculating the daily mean temperature is actually the one that is in vogue. A simple average is calculated for the maximum and minimum temperatures recorded for the day. This method is the one most commonly employed because in the days before computers were used to measure and record temperature, special thermometers that operated on the principle of a bathtub ring were able to leave a mark at the highest and lowest temperature experienced since the last time that thermometer was reset. Each day human observers would be able to determine the maximum and minimum

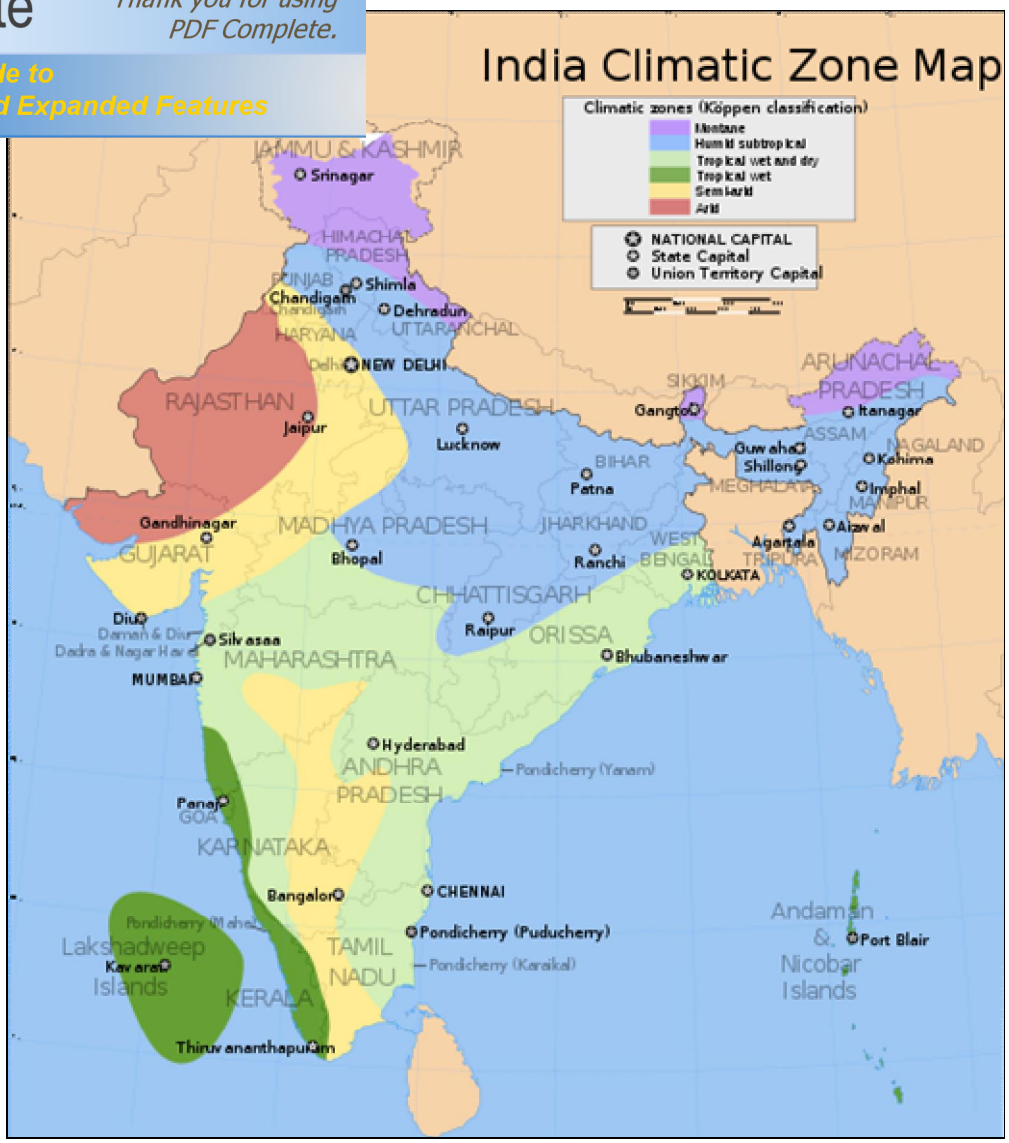
us 24 hours, but they would not know any of the other
d over that time span. Thus, for most of the period of
maximum and the minimum daily temperatures are known. Of course the numerical average calculated by the maximumï minimum method will differ somewhat from the one obtained by taking all hourly temperatures and dividing by 24. Even though computers are available now that can measure and record temperatures every second, one do not calculate mean daily temperatures using this more accurate method because this may change the method of calculating the means in the middle of our long term weather records. What would happen if the temperatures began to rise abruptly at the same point in the period of record that the method of calculating the mean temperature changed? One would not be able to know whether the change represented an actual change in climate or was just an artifact of a change in the method of calculating the mean temperature.

1.3 CLIMATE OF INDIA

The climate of India defies easy generalisation, comprising a wide range of weather conditions across a large geographic scale and varied topography. India is home to an extraordinary variety of climatic regions, ranging from tropical in the south to temperate and alpine in the Himalayan north, where elevated regions receive sustained winter snowfall. The nation's climate is strongly influenced by the Himalayas and the Thar Desert. Four major climatic groupings predominate, into which fall seven climatic zones that, as designated by experts, are defined on the basis of such traits as temperature and precipitation. Groupings are assigned codes according to the Köppen climate classification system as presented in Map 1.1.

The India Meteorological Department (IMD) designates four official seasons:

Winter, occurs during January to February. Summer or preï monsoon season lasts from March to May (April to July in northwestern India). In western and southern regions, the hottest month is April; for northern regions, May is the hottest month. Temperatures average around 32ï 40°C in most of the interior.



Map 1.1 India Climatic Zone

Monsoon or rainy season occurs from June to September. The season is dominated by the humid southwest summer monsoon, which slowly sweeps across the country beginning in late May or early June. July is the wettest month. Average daily temperature ranges between 16° C and 28° C.

Postï monsoon season lasts from October to December. South India typically receives more precipitation. Monsoon rains begin to recede from north India at the beginning of October. In northwestern India, October and November are usually cloudless. Parts of the country experience the dry northeast monsoon. Average temperature of the season is 17°C.

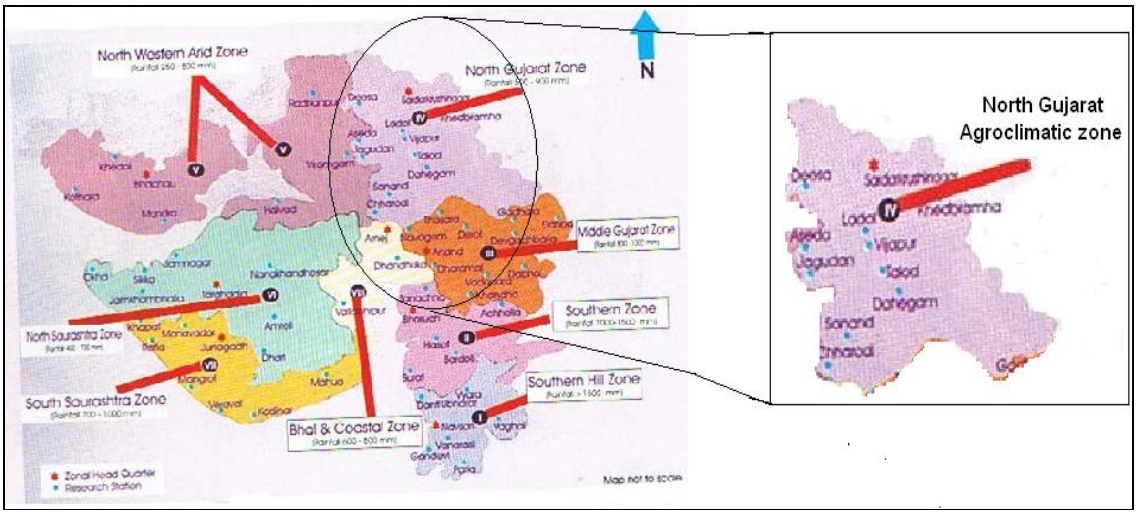
ich is still largely dependent upon rainï fed agriculture, one of the foremost concerns for the future. Most of 80% of their annual quota of rain from the southwest monsoon during the four months, June to September. The coastal areas in peninsular India receive rain from the northeast monsoon during October to December, which includes cyclonic storms.

1.4 CLIMATE OF GUJARAT

Gujarat State (Map 1.2) experiences diverse climate conditions In terms of the standard climatic types, tropical climates viz., subï humid, arid and semiï arid, are spread over different regions of the state. Out of total area of the state 58.60 % fall under arid and semiï arid climatic zone. The arid zone contributes 24.94 %, while the semiï arid zone forms 33.66 % of the total area of the state. The regions in the extreme north comprising the district of Kachchh and the western parts of Banaskantha and Mehsana, the northern fringe of Saurashtra (Jamnagar) and its western part have arid climate and the rest of the State has semiï arid climate. The districts of Valsad, Dangs, Surat, Vadodara and Kheda have subï humid climate. The principal weather parameters that build the climate of the State are rainfall and temperature, although others like humidity, cloudiness, dew and fog are also important from the agricultural point of view.

Map 1.2 State of Gujarat, India

Gujarat is divided into eight agroclimatic zones (Map 1.3). Table 1.1 gives the details of the agroclimatic zones prevailing in Gujarat. For the present study north Gujarat agroclimatic zone is considered.



Map 1.3 Study Area

Table 1.1 Agroclimatic Zones in Gujarat State

Sr. No.	Agro–climatic zone	Area (districts and talukas)	Type of soil	Crops grown
1	South Gujarat (heavy rain area)	Area south of river Ambica (1) Whole of Dang district (2) Part of Valsad district (excluding Navsari and Gandevi talukas) (3) Part of Surat district (Valod, Vyara, Uchchhal, Songadh and Mahuva)	Deep black soil with patches of coastal alluvial, laterite and medium black soil	Cotton, pearl millet, paddy, vegetables, horticultural crops and sugarcane
2	South Gujarat	Area between rivers Abmica and Narmada (1) Part of Valsad district (Navsari and Gandevi talukas) (2) Part of Surat district (kamrej, Nizar, Palsana, Bardolil, Mangrol and Mandavi talukas) (3) Part of Bharuch district (Ankleshwar, Valia, Junagadh, Rajpipla, Dediapada and sagabara talukas)	Deep black clayey soils	Cotton, pearl millet, wheat, vegetables, horticultural crops and sugarcane
3	Middle	Area between rivers Narmada and Vishwamitri	Deep black,	Cotton, pearl

		mahals district chmahals district dodara district (3) Part of Bharuch district (Bharuch, Amod and Jambusar talukas) (4) Borsad taluka of Kheda district	medium black to loamy sand soils	millet,great millet, tobacco, pulses, wheat, paddy, maize, and sugarcane
4	North Gujarat	Area between rivers Vishwamitri and Sabarmati and part of Mehsana, Ahmedabad and Banaskantha districts (1) Whole of Sabarkantha district (2) Part of Ahmedabad district (includes Dehgam, DasKroi and Sanand talukas) (3) Whole of Kheda district except Borsad and part of Khambhat and Matar talukas (4) Whole of Mehsana district and some parts of Patan (except Chanasama, Sami & Harij talukas (5) Part of Banaskantha district (Deesa, Dhanera, Palanpur, Danta and Wadgam talukas)	Sandy loam to sandy soils	Tobacco, wheat, great millet, vegetables, spices and condiments, oilseeds
5	Bhal and coastal areas	Area around the gulf of Khambhat and Bhal and coastal region in Bharuch and Surat districts (1) Olpad taluka of Surat district, (2) Hansot & Wagra talukas of Bharuch district (3) Dholka and Dhandhuka talukas of Ahmedabad district (4) Vallabhipur and Bhavnagar talukas of Bhavnagar district (5) Limbdi talukas of Surendranagar district	Medium black,poorly drained and saline soil	Groundnut, cotton, pearl millet,dry wheat pulse and great millet
6	South Saurasthra	(1) Whole of Junagadh district (2) Part of Bhavanagar district (Sihor, Ghogha, Savarkundla, Gariadhar, Palitana, Talaja and Mahuva talukas) (3) Part of Amreli district (Dhari, Kodinar, Rajula, Jafrabad, Khambha, Amreli, Babra, Lilia, Lathi and Kunkavav talukas) (4) Part of Rajkot district (Jetpur, Dhoraji Upleta and Gondal talukas)	Shallow medium black calcareous soils	Groundnut, cotton, pulses, wheat, pearl millet, great millet, sugarcane
7	North	(1) Whole of Jamnagar district	Shallow	Groundnut,

		district (Padadhari, Lodhika, ajkot, Wakaner, Morvi, Kotda and Sangani talukas) (3) Part of Surendranagar district (Wadhvan, Muli, Chotila and Sagalay talukas) (4) Part of Bhavnagar district (Gadhada, Umrala and Botad talukas)	medium black soil	cotton, wheat, pearl millet, great millet, sugarcane
8	North west zone	(1) Whole of Kachchh district (2) Malia taluka of Rajkot district (3) Halvad, Dhangadhra and Dasada talukas of Surendranagar district (4) Sami, Harij and Chanasama talukas of Mehsana district (5) Santalpur, Radhanpur, Kankrej, Diyodar Vav and Tharad talukas of Banaskantha district (6) Viramgam and Daskroi city of Ahmedabad district	Sandy and saline soil	Groundnut, cotton, wheat, pearl millet, great millet,

Source: http://agri.gujarat.gov.in/informations/agroï climatic.htm

1.6 OBJECTIVES OF PRESENT STUDY

The goal of the present study is to analyse the climate data for water resources and irrigation plannings for the irrigation projects in the north Gujarat agroclimatic zone.

The objectives of the present study are

1. To fill the missing climate data.
2. To determine the best fitted probability distributions for the given rainfall data set in order to ascertain the design rainfall at required return period for the region using the probabilistic approach.
3. To develop relationship between return period and one day and consecutive 2 to 7 & 10 days maximum rainfall to determine design rainfall at required return period for planning or re-examining various hydraulic stuructures and to determine the drainage coefficient for the region.
4. To develop relationship between one day and consecutive 2 to 7 & 10 days maximum rainfall to determine design rainfall given maximum one day rainfall.

l pattern and intensity of its concentration spatially in

ght pattern using improved technique of determining standardized precipitation index in order to predict the magnitude of droughts.

7. To evaluate the design storm raindepths by hydrometeorological and statistical studies for the catchment in the study area.
8. To determine climatic suitability of growing crops.
9. To determine the probabilities of dry spell lengths by evaluating different orders of Markov chain for planning the agriculture activities in the region.
10. To determine onset & withdrawal of monsoon and length of growing period using water balance approach.
11. To determine the sowing dates for the rainfed crops in the region.

1.7 OVERVIEW

The subsequent text of the thesis has been organised in the following chapters:

Chapter II deals with the literature review pertaining to the objectives of the present study. For achieving the foresaid objectives various literatures have been reviewed and presented here. Numerous research papers have been reviewed from various international and national journals, proceedings of conferences/ seminars/symposiums/workshops, covering various sections such as missing data, probability distributions, development of regression relationships, characteristics of climate data, regionalization based on spatial and temporal behaviour of rainfall, design storm from rainfall depths, drought analysis and crop planning for rainfed agriculture. Total 312, papers, books etc. are reviewed.

Chapter III presents the details of study area. North Gujarat agroclimatic zone is spread over seven districts namely Ahmedabad, Banaskantha, Gandhinagar, Kheda, Mehsana, Patan and Sabarkantha. Information related to the agriculture scenario, water resources, soil resources and cropping pattern is presented.

Chapter IV deals with the data collection. The climate data i.e. minimum and maximum temperatures, relative humidity, wind speed, sunshine hours and rainfall are collected. For agricultural analysis, data regarding onset of monsoon

ted. For water resources project analysis, data of the schemes in north Gujarat region are obtained.

Chapter V discusses the methodology adopted for analyzing the climate data in the study area. A detailed description of the approach for planning / re-examining the water resources and agricultural activities, in the region, for conducting the research as well as the analytical procedure in order to draw conclusions based on the climate data obtained, will be presented.

Chapter VI presents the results and analysis obtained using above mentioned methodology. A detailed analysis of the research, the explanation and findings are discussed.

Chapter VII concludes the thesis by discussing the overall contribution of the research in the context of related work in the area. It also presents recommendations for further research and development work.