Chapter 1
Introduction

1.0 Background

The rapid growing population in conjunction with very immediate developing urbanization has led to unplanned and uncontrolled expansion of Nanded and Parbhani which is resulted in the gradual loss of open and green spaces in the city. In the quest of meeting the great demand of urbanization, the city has been developing her infrastructure as well as built environment by continuous ignorance of nature which has hardly saved some of her natural spaces. Comparing with rural surroundings, this built environment of cities is mostly uncomfortable to her dwellers' experience. Expansion of unplanned urbanization and built

structure results cutting a large number of trees and converts the green areas in concrete surfaces.

Green spaces with vegetation have great environmental benefits and opportunities. Vegetation has potential to reduce environmental temperature. Its form and configuration influence solar radiation, temperature, air humidity and wind flow of an urban setting. Climate change is happening; no one is debating that fact anymore even though the reasons for change in climate (i.e. natural or anthropogenic) might be still debatable.

Global warming has accelerated in the recent years; while the past 100 years saw an increase of about 0.75°C, the rate of increase of temperature in the past 25 years has been over 0.18°C per decade. The warming has been observed more over land than oceans. This rise in temperature is leading to sea-levels rise, glaciers melt and changes in precipitation patterns (for example from 1900 to 2005, precipitation has increased in eastern parts of North America, northern Europe, northern and central Asia and southern Europe while it has declined in southern Africa, parts of southern Asia, the Sahel, and the Mediterranean). In general, extreme weather events are increasing in terms of their frequency and intensity.

The thesis has a mix of the global big picture, and the country level impact of climate change. Gupta(1997) has explained, “The problem of climate change is about the economy our production and consumptions system. Climate change is about society our lifestyles, our jobs, our food, our recreation. Climate change is about the environment about how land use changes affect the climate and how climate change affects species and ecosystems. Climate change is about so many issues and can be defined in so many different ways, that we often forget that climate change is also about water- water that makes our planet quite unique; water that makes life possible; water that makes the economy flourish. The link between climate and water is very critical”.

1.1 Earth's Atmosphere

The Earth is the only planet in our solar system that supports life. The atmosphere carries out the critical function of maintaining life-sustaining conditions on Earth. Energy from the sun (largely in the visible part of the spectrum, but also some in the ultraviolet and infra-red portions) is absorbed by the land, seas, mountains, etc. If all this energy were to be absorbed completely, the earth would gradually become hotter and hotter. But actually, the earth both absorbs and simultaneously releases it in the form of infra-red waves.

All this rising heat is not lost to space, but is partly absorbed by some gases present in very small (or trace) quantities in the atmosphere these gases re-emit some of this heat to the earth's surface. If they did not perform this useful function, most of the heat energy would escape, leaving the earth cold and unfit to support life. These heat-trapping gases are known as Greenhouse gases (GHGs) and these include - Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O), Chlorofluorocarbons (CFCs), Sulphur hexafluoride (SF6), Trifluoro-methyl sulphur pent fluoride (SF5CF3).

1.2 Climate Change

Climate is a critical factor in the lives and livelihoods of the people and socioeconomic development as a whole. Climate has shown warming of 0.89 (0.69 to 1.08)°C over the period 1901–2012 which is mainly attributed to anthropogenic activities (IPCC 2013). Further, it has projected that the global mean surface temperature and sea level may increase by 0.3°C to 1.7°C and 0.26 to 0.54 m for RCP 2.6, 1.1°C to 2.6°C and 0.32 to 0.62 m for RCP 4.5, 1.4°C to 3.1°C and 0.33 to 0.62 m for RCP 6.0 and 2.6°C to 4.8°C and 0.45 to 0.81 m for RCP 8.5 respectively by 2081-2100. The newer findings indicate that warming is more pronounced than expected. The impact would be particularly severe in the tropical areas, which mainly consist of developing countries, including India (Sathayeet al, 2006).

Change in the statistical properties of the climate system when considered over long periods of time, regardless of cause. As well as varying from place to place and from year to year seasonal weather also appear to oscillate over decadal to century timescale (Frank, 1998). The term sometimes is used to refer specifically to climate change caused by natural as well as human activities, as opposed to changes in climate that may have resulted as part of Earth's natural processes.

The impacts of climate change represent an additional stress in developing countries that are already facing pressures due to rapid urbanization, industrialization, and economic development. India is especially vulnerable to the impacts of climate change because of its large and growing population, a densely populated and low-lying coastline, and an economy that is closely tied to its natural resource base. Because climate records within India are generally only available over the past century or so, it is particularly important to exploit measures of climate change that can extend these records back in time.

Greg, (1988) has stated that a successful atmospheric management program requires the accurate forecast of the nature of, and potential change in the level of air pollution emissions. Phase prediction must take into account an atmospheric environment that could be affected by climatic changes than some air quality management strategic. Therefore, detailed knowledge of climate-pollutant relationship is essential.

The term climate change today is synonymous with anthropogenic global warming. Within scientific journals, however, global warming refers to surface temperature increases, while climate change includes global warming and everything else that increasing greenhouse gas amounts will affect. Now days, many scientists from various branches have focusing their views, especially causes and effect of such changes in climate very sensitively. Many of them have opined that such changes are affecting on each other and supporting to expand the adverse vicious circles.

Climate change has sensitive issue. According to Shravan et al., (1988) rainfall and temperature are two climatic factor elements, whose interplay causes all major variation. The same opinions have been observed many scholars like Malini and Nagalakshmi (1994), Greg (1997), Rafique (2002), Syiemlieh and Das (2004), Mankar (2010), etc. Especially, parameters like temperature and rainfall have special importance in day to day life of humans. According to Penchalaiah (1992), rainfall is an important ecological parameter to agriculture. In any region where agriculture is rain fed, rainfall influences the practices, types systems and productivity of farming (Penchalaiah et.al., 1992).

Increasing high temperature trends of the order of 0.60°C during last 112 years (IMD 2012) and increase in heavy rainfall events and decrease in low and medium rainfall events (Goswami et al., 2006) over India have been observed. Changes in precipitation and temperatures have also been defined by Dash et al., (2009), Arora et al., (2005), De et al., (2005), Guhathakurta and Rajeevan (2008), MoEF (2010), Jones and Briffa (1992), Kothawale et al., (2010), Tyagi and Goswami (2009) and others.

Climate change and, perhaps more importantly, human influence on the climate has been under scientific and public discussion for decades. Since the year 1990 the Intergovernmental Panel on Climate Change (IPCC) has published frequent assessment reports on global climate change. In the fifth report, whose Work Group I reportwas published in 2013 (IPCC, 2013) and Work Group II report was published in 2014(IPCC, 2014), it was stated that the global mean surface temperatures for the period2081-2100 may rise 0.3-4.8°C relative to 1986-2005, depending on the emissions. Thisdoes not mean a similar rise in temperature everywhere. Locally the average temperature may be unchanged, change by more than + 4.8 ℃ or even decrease by some amount and on top of this figure comes the possible seasonal or monthly variation.

While it is generally accepted that the consequences will present a challenge for humanity, not all areas will be affected equally. Some areas might benefit from the change, while others could be rendered unfit for human life. In order to better prepare for the coming changes, we need to be able to predict as accurately as possible how the climate will change in different areas. While it is true that some of the climate change is due to natural variation, the fifth IPCC report states that human influence on the climate change is not only clear, but it is also the dominant reason for the global warming observed between the years 1951-2010.

The change in trends of temperature and rainfall have been affecting many living and non-living things. After industrialization and urbanization, the changes in two parameters have been observed with spatio-temporal variations. Such variations have some local reasons at micro levels. Therefore, it is need to find out the local and micro leveled change that may affect on climate especially temperature and rainfall.

The monsoon season for the Maharashtra region is defined as the months of June–September (JJAS). For this study, we focus solely on these months since roughly 70–80% of the region's rainfall occurs during the monsoon, making this season of high importance to agricultural productivity and crop yields, water resources, and the health and well-being of Maharashtra's citizens. In the state of Maharashtra, a single drought (2003) and flood (2005) absorbed more of the budget than the entire planned expenditure on irrigation, agriculture and rural development from 2002–2007. Climate change is expected to increase the frequency of extreme events World Bank Report India (2008).

Maharashtra was one of seven regions of India found to have the highest vulnerability to climate change in the context of economic globalization TERI (2004). The single most important factor responsible for the deterioration of air quality in Nanded is the exponential increase in petrol and diesel fueled vehicles Shillewar and Nanware (2011).

1.3 Global Warming

According to the Third Assessment Report (Working Group II) of the Intergovernmental Panel on Climate Change continuing emissions of greenhouse gases are likely to result in significant changes in mean climate and its intra seasonal variability in Asia (IPCC, 2001). General circulation models (GCM) suggest that the area-averaged annual mean warming over Asia would reach about 3°C by 2050 and 5°C by 2080. When the cooling effects of sulfate aerosols are added to the models, surface warming is reduced slightly, reaching 2.5°C by 2050 and 4°C by 2080.

Seasonally speaking, warming over Asia is expected to be higher during northern hemisphere (NH) winter. Both the annual mean and winter season minimum temperature is expected to rise more than the maximum temperature in Asia, leading to a decrease in the diurnal temperature range (DTR) over these time periods. During summer, however, DTR is expected to increase, suggesting a rise in average summertime maximum temperature. When compared with other regions, the summertime DTR increase is expected to be significantly higher.

All GCM project an enhanced hydrological cycle resulting in rainfall increases over Asia due to continued growth in the emissions of greenhouse gases. A 7% increase is projected by 2050 and an 11% increase is projected by 2080. When the cooling effects of sulfate aerosols are added to the models the projected increase in precipitation is reduced to 3% in 2050 and 7% in 2080. As with temperature, precipitation increases are expected to be greatest during the NH winter. A decline in summer precipitation is expected in southwest Asia.

Because this area already receives so little precipitation, severe water-stress conditions resulting in expansion of the deserts are a possibility – when factoring in both the rise in temperature and loss of soil moisture. Increased temperatures can also affect the amount and timing of snowmelt and river flow in southwest Asia. In addition, global

warming could affect the role the tropical oceans play in the climate of the region as well as the character of winter storms that currently supply the majority of cold season precipitation.

Overall, southwest Asia appears to be highly vulnerable to anticipated climate change projections. Water stress is expected to be high with significant negative impacts on the agricultural sector. Agricultural productivity in southwest Asia is likely to suffer severe losses due to increases in temperature, soil moisture depletion, and the increased potential for severe drought – ultimately increasing the potential for food insecurity and famine. Adaptation strategies identified for southwest Asia include: (1) transition from conventional crops to intensive greenhouse agriculture, (2) improve conservation of freshwater supply for times of enhanced water stress, and (3) protect lakes and reservoirs (John E 2005).

1.4 Greenhouse Effect

The radiation absorbed by green gases is partly reemitted to the earth's surface. The net result is that the earth's surface gets heated. This mechanism is somewhat analogues to the way that glass keeps the air inside a greenhouse warm and thus is known as the Greenhouse effect.

Due to this the Earth's climate system constantly adjusts so as to maintain a balance between the energy that reaches it from the sun and the energy that goes from Earth back to space. This means that even a small rise in temperature could mean accompanying changes in cloud cover and wind patterns. Some of these changes may enhance the warming (positive feedback), while others may counteract it (negative feedback).

1.5 Rainfall Variation

The distribution of precipitation throughout the seasonal cycle is as important as the total annual amount of monthly or annual

precipitation when evaluating its impact on hydrology, ecology, agriculture or in water use. The seasonal distribution of precipitation is the results of revolution of earth resulting the unequal heating of the earth's surface over the year and resulted the atmospheric general circulation. The time and duration of the seasons of high precipitation at a place or watershed is most important for the planning and design of agriculture or water managements.

It is very much important to identify the historical changes in the mean annual precipitation. But even in the absence of changes in annual total precipitation, changes in the seasonal receipt of precipitation greatly affect partitioning of the water into runoff, evapotranspiration and infiltration and thus flood forecasting, stream discharge and ecosystem responses (Pulak and Elijabeth, 2012; Small et al, 2006; Xiao and Moody, 2004; Rosenberg et al, 2003; Epstein et al, 2002; Groisman et al, 2001).

Normally the frequency of occurrence of a heavy rainfall episode is designated by the term "return period", which refers to the average wait time needed to pass above a certain threshold at a given point (Temez, 1978). Due to the large natural variability of 'precipitation, it is necessary to have long series of records to estimate both the recurrence of extreme rainfall and the possible climatic trend (Kundzewicz and Robson, 2000; Lana et al., 2009).

The changing pattern of rainfall is also investigated by computing Seasonality Index of rainfall. The relative seasonality of rainfall represents the degree of variability in monthly rainfall throughout the year (Walter, 1967; Walsh and Lawer 1981; Livada and Asimakopoulos, 2005; Adejuwon, 2012). Spatial distribution of precipitation seasonality in the United States was studied by Finkelstein and Truppi (1991). Markham (1970) has proposed a quantities technique for measuring precipitation seasonality based on vector analysis. The understanding of seasonality pattern of precipitation and also identifying changes in seasonality index is very useful for agricultural planning.

Inconsistency in precipitation figures may provide a general gauge regarding changes in the accepted performance of ecologies. A key step in this process is the ability to reveal that a change or trend is present in the rainfall records. The linear relationship is the most common method used for detecting rainfall trends Hameed et al., (1997). On the other hand, the Mann–Kendall (MK) test has been widely used to evaluate a presence of a statistically significant trend in hydrological and climatologically time-series (Hirsch and Slack, 1984; Yue et al., 2002). Also, several interpretations have analyzed rainfall trends in semi-arid regions all over the world.

Particular of the notable heavy rainfall amounts ever recorded in 24 hours in the Maharashtra state is given below:

Table 1.1: Heaviest Rainfall in 24 Hours (ever recorded)

Sr. No.	Station	District	Rainfall (in mm)	Date
1.	Andheri	Mumbai Suburban	652.0	04.07.1974
2	Bhira (Obsy)	Raigad	713.0	24.07.1989
3.	Chiplun	Ratnagiri	533.4	04.06.1882
4.	Colaba (Obsy)	Mumbai City	575.6	05.07.1974
5.	Dapoli	Ratnagiri	535.4	03.06.1882
6.	Devgad	Sindhudurg	530.0	16.06.1992
7.	Gaganbawada	Kolhapur	499.0	24.07.1989
8.	Jawahar	Thane	553.7	05.08.1968
9.	Karjat	Raigad	605.0	18.07.1958
10.	Khandala (Obsy)	Pune	516.4	19.07.1958
11.	Khyrbund	Bhandara	620.0	01.08.1983
12.	Lonavala	Pune	578.0	23.07.1989
13.	Matheran	Raigad	657.3	24.07.1921
14.	Pen	Raigad	500.0	07.09.1973
15.	Roha	Raigad	629.9	18.06.1886
16.	Santacruz	Mumbai Suburban	944.2	27.07.2005
17.	Sriwardhan	Raigad	742.0	26.06.1968

Source: Collected by Researcher

1.6 Drought and Excessive Rainfall

A period of drought is defined as a year or season in which the total rainfall is less than 75 percent of the normal. It may further be classified as a year or season of 'moderate drought' if rainfall deficit is between 26 percent and 50 percent and a year or season of 'severe drought' when it is more than 50 percent. When, during a long period of years, droughts as defined above, occur on at least 20 percent of the years over an area, that area may be classified as a 'drought area'. If the frequency is 40 percent or more the area may be termed as 'chronically drought area'.

Severity of drought not only depends upon the order of rainfall deficiency in a single year, but also upon continued occurrence of deficient rain in successive years even though the deficiency in each such successive years may not be as high as in a single year.

Further, rainfall of less than 50 percent of the annual normal representing severe drought conditions occurred in various districts as indicated in Table 1.3, where actual rainfall expressed as percentage of normal rainfall is given against each district.

1.7 Excessive Rainfall

It may generally be said that rainfall, sufficiently in excess of the normal is a predominant factor for occurrence of floods. For the purpose of this description annual rainfall exceeding 125 percent of the normal is considered as excessive rain.

The following Table (iii) gives the comparison of Nanded and Parbhani districts wise and excessive rainfall years, highest annual rainfall (expressed as percentage of normal) with the year of occurrence.

Table 1.2:

District wise years of successive drought during (1941-1990)

Sr. No.	Years of successive Drought	Name of districts affected
1.	1985-1986	Ahmednagar
2	1984-1985	Akola
3.	1984-1985-1986	Aurangabad
4.	1945-1946, 1984-1985-1986	Beed
5.	1971-1972, 1984-1985	Buldhana
6.	1971-1972, 1984-1985	Gadchiroli
7.	1984-1985	Gondia
8.	1943-1944-1945, 1984-1985	Hingoli
9.	1971-1972, 1984-1985	Jalgaon
10.	1984-1985-1986	Jalna
11.	1971-1972	Kolhapur
12.	1971-1972	Latur
13.	1972-1973	Mumbai City
14.	1971-1972, 1984-1985	Nanded
15.	1951-1952, 1985-1986-1987	Nandurbar
16.	1971-1972, 1984-1985-1986	Osmanabad
17.	1951-1952, 1971-1972	Parbhani
18.	1981-1982, 1985-1986-1987	Pune
19.	1985-1986	Sangli
20.	1986-1987	Thane
21.	1984-1985	Wardha
22.	1971-1972	Washim
23	1971-1972	Yavatmal

Source: Computed by Researcher

Table 1.3: Year wise drought affected districts with their percentage

Sr. No.	Years of severe Drought	Affected Districts	Percentage of Drought
1.	1972	Ahmednagar	38%
2	1972	Aurangabad	46%
3.	1972	Beed	40%
4.	1941,1950	Hingoli	40%, 43%
5.	1972	Jalna	41%
6.	1972	Latur	34%
7.	1941	Mumbai City	42%
8.	1972	Nanded	41%
9.	1972	Osmanabad	36%
10.	1985	Pune	49%
11.	1968	Satara	45%
12	1972	Solapur	37%

Source: Computed by Researcher

Table 1.4

Year wise excessive rainfall with the year of occurrence

District	Years of Excessive Rainfall	Highest amount of rainfall (expressed as % of normal) with year
Nanded	1955, 1957, 1958, 1959, 1963, 1975, 1983, 1988, 1989. 1990	192.3 cm in 1983 (194%)
Parbhani	1942, 1955, 1961, 1963, 1975, 1988, 1989, 1990	137.4 cm in 1989 (149%)

Table 1.4 gives the district wise Successive years of Excessive Rainfall

1.8 Temperature Variations

A likely increase of 1°C Over the central plains of India during the monsoon season (Lal et al., 1995) and a greater increase in minimum temperature compared to the maximum (Lal et al., 1996) have been indicated. Analysis of the observed climate records globally has revealed that increase in global mean surface air temperature over land and sea combined of 0.4 to 0.8°C since the late 19th century. Generally, both day and night temperatures have risen, although night time temperatures have generally warmed more than day time temperatures.

Anthropogenic climate change has already caused a 1.4 °C increase of the average land surface air temperatures in central Europe since 1850 (IPCC 2007). Climate models estimate a further temperature rise of 1.1- 6.4 °C by 2100 (Christensen et al., 2007). With rising concentrations of carbon dioxide, it is understood that globally averaged temperatures are expected to increase. However, regional climate change could exhibit different behavior to this global average, and hence regional climate modeling techniques are used in order to identify the effect of climate change on a local scale.

1.9 Interdisciplinary Relevance

Change in trends of temperature and rainfall are basically natural process. In accordance with Dhar et.al. (1990), the rainfall distribution in contiguous Indian area is noted for its diversity both in space and time. Recently, the change in temperature and rainfall has much interdisciplinary significances. Change in urban morphology, vehicular burden, functional nature of urban place, vegetation cover etc. are affecting on them at micro level with spatio-temporal variations. It means that the proposed topic and their expected outcomes have interdisciplinary relevancies'.

1.10 Climate Change and the Water Cycle

This investigation states the impact of vegetation in urban air temperature and explores the possibility of vegetation configuration to maximize the cooling effect in urban open space in Nanded and Parbhani city. Again, the environmental criteria in Nanded and Parbhani City are also important for this study. India is in Warm Humid Tropics. Generally, she has six seasons according to natural, cultural and social activities. But climatically, the climate of Bangladesh can be divided into four seasons.

Climate change and, perhaps more importantly, human influence on the climate has been under scientific and public discussion for decades. Since the year 1990 the Intergovernmental Panel on Climate Change (IPCC) has published frequent assessment reports on global climate change. In the fifth report, whose Work Group I report was published in 2013 (IPCC, 2013) and Work Group II report was published in 2014 (IPCC, 2014), it was stated that the global mean surface temperatures for the period 2081-2100 may rise 0.3-4.8 °C relative to 1986-2005, depending on the emissions. This does not mean a similar rise in temperature everywhere.

Locally the average temperature may be unchanged, change by more than +4.8°C or even decrease by some amount - and on top of this figure comes the possible seasonal or monthly variation. While it is generally accepted that the consequences will present a challenge for humanity, not all areas will be affected equally. Some areas might benefit from the change, while others could be rendered unfit for human life. In order to better prepare for the coming changes, we need to be able to predict as accurately as possible how the climate will change in different areas.

1.11 Origin of the Problem

It is well known fact that human interferences are affecting various natural processes. Gadgil (2003) has stated that urbanization is a

universal phenomenon in the context of climatic variation and change. Villages are expanding to become towns, towns grow into sprawling cities and cities are merging into vast conurbations and megalopolises. This has affected urban environment adversely. Climatic changes are one of the serious problems. Rotation and revolution, unequal distribution of land and water, unevenness of the surface of the earth etc has resulted in a large number of climatic variations (Tigga and Malini, 2007).

On the other hand, the climatic variation in the monsoon rainfall during recent climatic epoch, on regional scale, associated with global warming due to anthropogenic and natural causes in the earth–atmospheric system (Dahale and Sabade, 1996). It means, now days, the change in temperature and rainfall is a global and local issue. Though, these two parameters have changing their global nature by world level natural and human activities, their trends have also varying on local scenario. Many times, local changes are not so flexible that they feel by the people. Therefore, it is need to analyze them at micro level with proper methodology on pure scientific approach.

Rainfall and atmospheric temperature play a predominant role in crop growth, development and final productivity. Globally, enhancement of the greenhouse effect may have led to changes in the hydrological cycle, such as increased evaporation, drought and precipitation, and it is likely that such would have a higher regional variation. Decreasing trend in monsoon seasonal rainfall was reported over many parts of the country. Due to greenhouse effect air temperatures are increasing and the increase is expected to be 2 to 4°C in the next 100 years.

1.12 Hypothesis

The climatic parameters like temperature and rainfall have spatio-temporal significances in their changing nature. It means some annual, seasonal and daily variations may observe with different trends at the two selected places, which will be associated with local changes.

1.13 Objectives

The following objectives have been designed for the present investigation. Though, the study has been concentrating at micro level with daily, weekly and monthly data, it will only possible on the availability of such kind of data from authentic data sources. Considering this fact, the objectives given below are presented at a primary manner, which would be reached with support of in-depth efforts.

- To understand the geographical parameters of the study area.
- To analyze the available climatic data with proper statistical methods and geographical models.
- To identify center-wise micro leveled changes in the trends and periodicities of temperature and rainfall.
- To evaluate the extreme situations of temperature and rainfall observed in the past.
- To recognize the local geographical reasons responsible for the changes or fluctuations in these trends.
- To try for design of simplest way for prediction of the selected climatic parameters.

1.14 Literature Review

Now the relationship of vegetation and four major components of the climatic features of environment, Solar Radiation, Air Temperature, Humidity and Air Flow discuses bellow.

According to Hossain and Nooruddin meteorologically the climate of Bangladesh is categorized into four distinct seasons Winter (cool dry), Pre-Monsoon (hot dry), Monsoon (hot and wet), Post-Monsoon (hot and wet), where Winter months (December to February) temperature 21-26° C, Pre-Monsoon (March to May) temperature max 34°C, Monsoon (June to September) avg. 31°C, Post-Monsoon (October to November)

temperature below 30°C (Ahmed, 1996). Average Relative Humidity is 60-80%. Radiation on a horizontal surface 5.00 kWh/ m2 and Air Flow 4.1m/s (Ahmed,1996).

Again, according to Wardoyo (2011), vegetation's also influenced the pattern of air movement through guidance, filtration, obstruction and deflection. Air movement sometimes depends on vegetation characteristic and configuration. Jacob and Rajvanshi (2006) examined results show there is indeed a clear warming trend, but it seems to be influenced by changes in the surroundings of the station (microclimate). Wind velocity and evaporation have also slightly decreased.

Akinsanola and Ogunjobi (2014) were noticed rainfall and temperature variability's in Nigeria using observations of air temperature and rainfall from 25 synoptic stations from 1971 -2000 (30 years). There have been significant increases in precipitation and air temperature in the country. Analyses of long time trends and decadal trends in the time series further suggest a sequence of alternately decreasing and increasing trends in mean annual precipitation and air temperature in Nigeria during the study period.

Karnewar and Kadam (2015) has investigate the temperature change in Parbhani city by analyzing data of annual maximum, minimum, mean temperature and by taking anomalies from 1969 to 2010. The study of linear trends indicates increasing trends in annual maximum, minimum and temperatures. During 1969-2010 annual maximum, minimum and mean temperature is on continues increasing. I.e. The linear trends in annual maximum temperature from 1969-2010 indicated the increasing trends.

Karnewar and Kadam (2015) has study the temperature trends of Nanded by analyzing data of annual maximum, minimum, mean temperature and by taking anomalies from 1969 to 2007. This analysis in

linear trends reveals that maximum temperature, mean temperature, and minimum temperature of Nanded increased during this period.

Large trees with spreading canopy can also provide shade and protect surface from direct radiation. Bueno-Bartholomei and Labaki found that, the structure of the crown, dimension, shape and colour of vegetation leaves influence reduction level of solar radiation (Bueno-Bartholomei and Labaki, 2005).

Mane (2014) detected from last few decades it has been seen that the climate change in Maharashtra proved to be awesome issue. It has left its impact on water resources, agriculture, human health, forest, coastal zones and species and natural areas. Also, sea level rise of one meter will inundate 0.18% of Maharashtra putting 1.3 million people at risk. Sugarcane yield in Maharashtra could go down by 30% under climate change. The cost of climate change related damages for Mumbai could be around Rs 2287 billion.

Nigel et al., (2015) have been undertaken in a small number of locations. Studies have used observations from the past to infer future changes, and have used numerical simulation models with climate change scenarios. The literature indicates that climate change poses risks to the delivery of water management, but that these risks depend on local catchment and water body conditions. The future impact of climate change on the water environment and its management is uncertain.

Pradhan (2014) are investigated in Gandhamardan hills range, Western Orissa, India. Observed rainfall is maximum and temperature is optimum, the herpes are abundant in the forest and with minimum rainfall and temperature. Pulak and Elijabeth (2012) investigate long rainfall data series of 100 years and districts in monthly and seasonal scales are constructed for analysis and then mean rainfall and

coefficient of variability are analyzed to get the spatial pattern and variability. long term changes of the seasonality index are recognized by the trend analysis.

Rathore et al., (2013) detected state level climate change trends over India during last 60 years. They investigated quantification of climate change trends with latest data (1951-2010) in respect of temperatures (Maximum, Minimum and Average), Daily temperature range and rainfall for each state of the country. Scudo, (2002) establishes that geometry, height, permeability and crown of the vegetation are the structural vegetal characteristic that influenced the controlling air movement. Evapotranspiration reduces air temperature that increases relative humidity. It is found that relative humidity is always higher in the green areas.

There is close relationship between vegetation and solar radiation. According to Wardoyo (2011), individual leaves of the vegetation allow, some radiation to be transmitted through them (20%), absorb some radiation (55%), and reflect some radiation (25%). The leaf absorbed the solar radiation and retransmitted it by evapotranspiration which increases relative humidity and reduces air temperature (Wardoyo, 2011).

Tree shade also helps to reduce the air temperature. Zahoor (1997) in Pakistan found that vegetation has significant influenced to local temperature and effective in reducing air temperature about 6 –7 °F. Vegetation in open space has low reflectance value that helps to reduce the air temperature in an urban surrounding. Vegetation does not radiate the long wave radiation which helps to maintain lower air temperature. Evapotranspiration reduces air temperature and increases relative humidity (Wardoyo, 2011).

World Bank (1998) investigated the rising temperature is damaging to agriculture and increasing precipitation is beneficial. These effects will vary by season and by region. There are regional impacts from warming even within India. Coastal and inland regions of Gujarat, Maharashtra and Karnataka are most negatively affected.

Zende et al., (2012) observed climate variability in semi-arid region of Western Maharashtra. It shows mixed trends of increasing and decreasing rainfall, which were statistically significant. Also, exception of few stations there was no statistically significant trend in the mean number of rainy-days per year. Increasing and decreasing monthly rainfall trends were found over large continuous areas in the study region.

Giri et al., (2012) outcomes exposed that during current decade (2001-09) the seasonal rainfall was decreased along with the rainy days. Also, the winter season mean minimum temperature and annual minimum temperature for the current decade (2001-09) was increased. However, the overall trends for rainfall and temperature are non-significant indicating no significant changes in rainfall and temperature at Yavatmal.

1.15 Scope of the Study

The present study pays attention to investigate the climatological phenomenon in Nanded and Parbhani city with reference Rainfall and Temperature. Attempt has also been made to suggest an rainfall and Temperature pattern and environmental impact in the study area.

1.16 Research Methodology

1.16.1 Period of Study

The present study was carried out in the Nanded and Parbhani cities in Marathwada area of Maharashtra. The study is a cross-sectional one, mainly based on primary data and secondary data. The field

investigation was carried out throughout the period of November 2011 to March 2015, which is the normal period.

1. 16.2 Area of the Study

The study region has been selected for present study due to various reasons. Firstly, region has diversified relief and amount of rainfall and spatiotemporal temperature variation. Secondly Parbhani is less urbanized as compare to Nanded.

1.16.3 Research Sampling Techniques

In Maharashtra, Nanded and Parbhani cities are important cities in terms of industry and agriculture, are situated in the central west part of Maharashtra. In these cities, Nanded city is considerably a large one. The samples were obtained from these cities. The study is conducted in these two towns selected by using random sampling method. In view of the above, the opinions of local inhabitants, a questioner's schedule is applied and regular interaction is done with the local people. The data collected from IMD Pune, agricultural department, cotton research center was carefully processed, edited and tabulated for analytical purposes through SPSS and Excel thoroughly.

1.16.4 Collection of Data

This study is based on both primary and secondary data. The Survey method, questionnaires', interview, observations and check list this method is used to primary data collection. Interview schedules designed for the purpose of data collection, were administered to randomly designated sample parts. The time reference of the data was 1969 to 2010.

The questionnaire was so designed as to overcome recall bias to the possible extent with various checks. The secondary data were collected from censes data, magazines, newspapers, thesis, project reports, annual reports, books published, unpublished data and from the

District Collector's Office, Tahsil Office, School of Earth Sciences, SRTM University, Nanded, various journals and websites these sources are used.

1.16.5 Tools of Analysis

In this study, various statistical techniques like tabular analysis and multiple regressions were applied to analyses the data and the results were interpreted accordingly. The analysis of above data is carried out in statistical software's like MS-excel and SPSS etc. According to statistical methods and their conversion, average and standard divisions and their correlation are used to find out new consequences (Gujarati, 1986).

Following methods and techniques was used for various purposes incurred in the study.

Auto-correlation Function for examining the temporal dependencies of temperature and rainfall, Cross-Correlations between Temperature and rainfall, Moving averages of rainfall and temperature Empirical Formulae designed by Thorthwaite (1948) for PE (Precipitation Effectiveness Index) and Empirical Formulae derived by Khosla (1976) for (Shravan Kumar et.al., 1988). Spearman's Rank Correlation Method

1.17 Limitations of the Study

This study analyses the issues with respect to the calendar year 2011 to 2015. The present study is basically exploratory in character and has the following limitations. The study has been based mainly on the primary data obtained. The data were collected by personal interview through a pre-tested interview schedule with the help of user's recall method subject to limited memory power of the respondents to give authentic data.

The secondary data were collected from censes data, magazines, newspapers, thesis, project reports, annual reports, books published,

unpublished data and from the District Collector's Office, Tahsil Office, School of Earth Sciences, SRTMU, Nanded, various journals and websites these sources are used.

1.18 Organization of Thesis

This thesis is organized into seven chapters as follows:

Chapter - I Introduction

This chapter presents the discussion on the various types of energysources, problem focus, objectives of the study and scope and limitations of the study. The methodology used for the collection, processing and analysis of data, and empirical models specified for the study is described in this chapter vigorously.

Chapter - II Geographical profile of Nanded and Parbhani City

This chapter deals with the brief description of geography (Climate including temperature, rainfall etc.) and geomorphology (Drainage, rock, mountains, soil type, soil depth etc.) of the Nanded and Parbhani city. It includes physical features of the Earth's crust as related to its geological features like the contours and the outer study of mountains and hillocks. Geomorphology deals with the study of highest and the last points of certain geographical areas too.

Chapter - III Climatic Data Analysis

This chapter focuses on the issues of climatological factors like temperature and rainfall. This also try to make future planning in batter way for to maintain the temperature and rainfall phenomenon in the study area presented in this chapter. This chapter also focuses the detail statistical analysis of the whole climatological data in different statistical methods.

Chapter – IV Analysis of Temperature Trends

This chapter deals with the analysis ofannual, seasonal, monthly, daily temperature trends in Nanded and Parbhani cities and extreme temperature events like heat waves, hot wave besides their trends. Various temperature phenomenon is applied are shown in this chapter in details for investigation purpose.

Chapter – V Analysis of Rainfall Trends

This chapter deals with the analysis of annual, seasonal, monthly, dailyrainfall trends in Nanded and Parbhani cities, the extreme rainfall events like heavy rainfall, intensity of rainy days and their trends are also studied.

Chapter – VI Reasons of Changing Trends of temperature and rainfall

The name of this chapter itself indicates that it showsgeographical and anthropological reasons of changing temperature and rainfall trends of Nanded and Parbhani cities,the relation between rainfall and temperature. It also includes prediction model for prediction of rainfall and temperature of the research area. So, all the details and probable rain fall and temperature of the study area are as shown in this chapter in particulars.

Chapter -VII Summery and Conclusions

This chapter deals with the summery and conclusion of comparative studies on temperature and rainfall trends of Nanded and Parbhani cities. The various factors influencing the climatologically issues like temperature and rainfall. A summary of work done and salient findings of the study are presented in details. Summery and conclusions are drawn after verifying the suggestions of the study and their implications are stated.

References

These express the references of various national, international journals and reports of various governmental and nongovernmental organizations. Finally references from books or chapters and various theses submitted to many universities from India and abroad.

1.19 Resume

The present chapter is mainly deals with introduction of topic and their association with basic geographical aspects of the region and also its multidisciplinary nature. The chapter includes introduction, review of literature aims and objectives, research methodology and techniques.

In addition to these, arrangement of text been discussed in brief. Subsequently such elaboration of present topic, it is need to highlight the basic geographical setup of the certain study area. For this, the second chapter has designed to devote for the same.