ISSN No:-2456-2165

Geographical Perspective of Changing Climatic Conditions in Pune Division of Maharashtra (1901 To 2013)

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Abstract:- The phenomenon like climate change is not only happen in India but also it is observed World-wide. The Pune division is one of the leading spatial unit on all fronts i.e. agriculture and its allied activities, industry, transportation, commerce etc. But past few years this division has suffering different problems which are arrived due to only changing climatic conditions. The climate change is a change in the statistical distribution of weather patterns when that change lasts for an extended period of time that is decades to millions of years. The present research work flash light on changing climatic conditions of Pune division with using Thornthwaite Moisture Index (TMI). The trends in the annual, decadal and tri-decadal average moisture condition in study area have been studied for the period of 1901 to 2013. The shifting of climatic conditions are analysed with 94 grid points (0.25° × 0.25°) over Pune division. The researchers also examine the of development of annual rainfall (mm) and mean monthly temperature (^{0}C).

Keywords:- *Climate, Change, Moisture Index, Rainfall, Temperature, Pune Division.*

I. INTRODUCTION

As per Intergovernmental Panel on Climate Change (IPCC) usage, climate change refers to a change in the state of the climate that can be identified by changes in the mean and or the variability of its properties and persists for an extended period, typically decade or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC) where climate change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods. According to Indian Meteorological Department (IMD), climate change refers to a statistically significant variation in either the mean state of the climate or in this variability, persisting for an extended period typically decades or longer.

The natural and anthropogenic process mechanisms caused by climate change. These natural factors are tectonic forces, earth orbital changes, ocean currents, solar output and volcanic eruption. The IPCC (2007) concluded with high confidence that anthropogenic warming over the last three decades has had a discernible influence on many physical and biological systems. The causes of climatic changes due to human activities are very significant because it makes more impact than natural incidences or phenomena. The human activities are land use change, deforestation, industrialization, urbanizations, agriculture and the burning of fossil fuels. There is strong evidence that the warming of the earth over the last half-century has been caused largely by human activity (The Royal Society, 2010). The impacts of climatic changes are in the form of rising temperature, precipitation pattern, glaciers melting, sea level rise, biodiversity loss, extreme weather events, water scarcity, threats to human health and food insecurity. Significant changes in physical and biological systems have already occurred on all continents and in most oceans, and most of these changes are in the direction expected with warming temperature (Rosenzweig, 2008).

- *Study Area*

The Pune division is located in south-west part of Maharashtra state. It lies between 15^0 45′ N to 19^0 0′ N latitude and 73^0 32′ E to 76^0 15′ E longitudes. The area under study comprises of five districts namely Pune, Sangli, Satara, Solapur, Kolhapur and the whole division has 58 tehsils. The Pune division is bounded by the Aurangabad district to the north and north-east, Thane district encircled by north and north-west. The west boundary of study area delimited by Raigad, and Ratnagiri district, Sindhudurg district enclosed in south and south-west part. The south and eastern boundary surrounded by Goa and Karanataka state and Osmanabad district delimited eastern boundary (fig. 1).

Physiographical, region can be divided in to three parts: hilly, plateau and lowlands. Sahyadrian ranges passes through Pune division; its slope decreases from west to east. In this region temperature varies in the different parts, the average temperature of the study area is 25.62^{0}C. An average annual rainfall in the Pune division is recorded 1239.09 mm. There are major two river basins; it includes Krishna and Bhima. The Pune division has total geographical area about 57, 275 km^2. The study area having 23,449,051 population as per 2011 census and out of the total population of the study area more than 58.76 per cent population has been located in rural areas and remaining population 42.24 per cent are living in urban areas. The population density and sex ratio are 403 persons per km^2 and 953 females per thousand males respectively according to 2011 censes.

ISSN No:-2456-2165

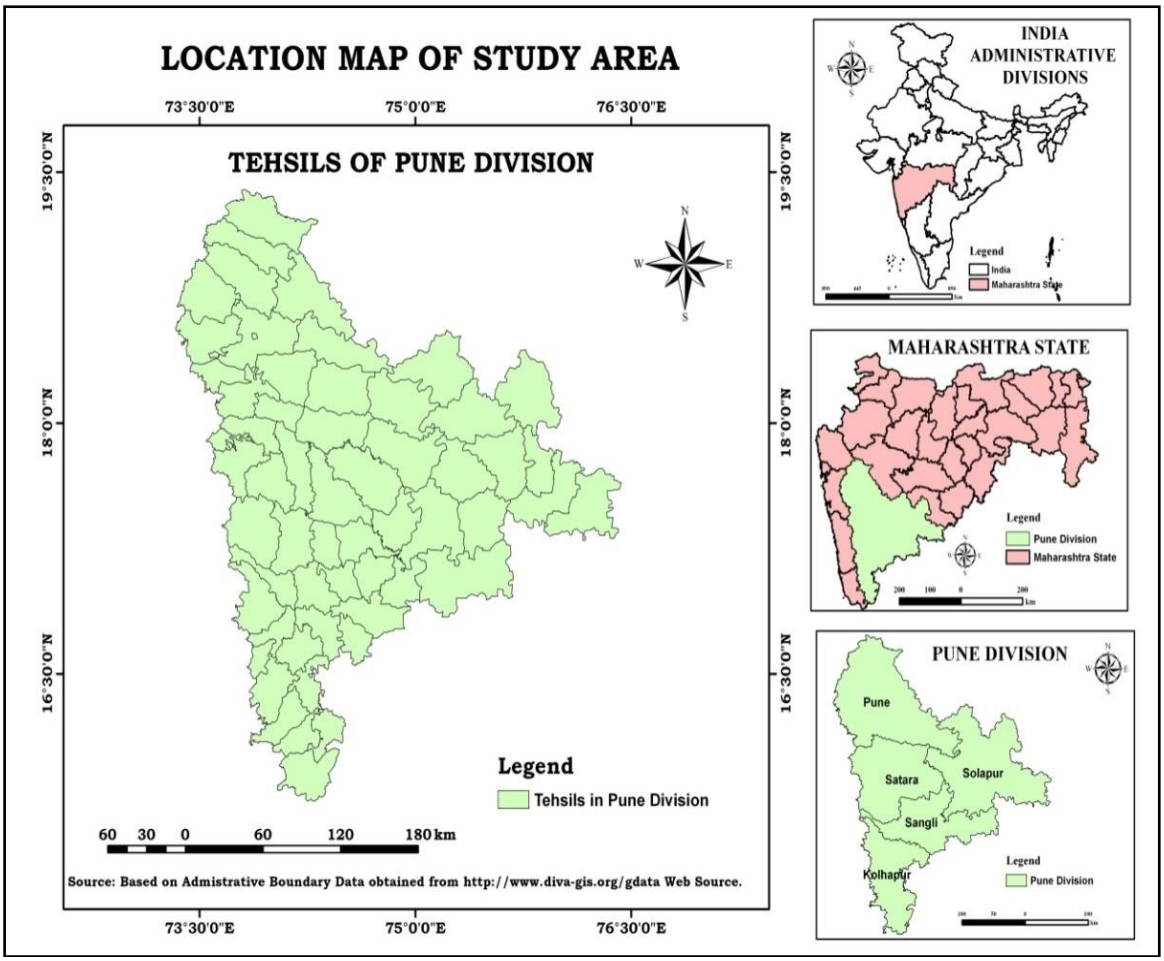

Fig. 1

➢ *Objective*

The main objective of the present research work is to study the shifting or changing climatic conditions of the Pune division of Maharashtra state.

➢ *Data Collection and Methodology*

The present study, month-wise data of temperature and rainfall of Pune division have been taken into consideration. Total, 113 years (1901 to 2013) span of time selected for the study. The data has been collected from secondary sources such as India water Portal (1901 to 2002) and the Global Weather Report (1979 to 2013). The trends of these moisture indexes have shown an annual average, an average of decadal and a tri-decadal average. The Thornthwait's method is used to draw potential evapotranspiration in the Pune division for the period 1901 to 2013 by using temperature and rainfall parameters. In order to study shifts in climate in Pune division, moisture index of Thornthwait's and Marther (1955) have been used. The Potential Evapotranspiration has calculated by Thornthwait's method (1955), which is as below:

$$PE = 1.6\,(10\,t / I)^{a}$$

Where, PE = potential evapotranspiration
t = mean monthly temp in ^{0}C
I = annual heat index ($\sum$ I)
I = monthly heat index is equal to $(t/5)^{1.514}$
a = non linear function of heat index, approximated expression,
a = annual rainfall $(0.000000675 * I^{3} - 0.0000771* I^{2} + 1.7921* I + 0.49239)$
Unadjusted PE (e) – obtained is for average 12 hours sunshine and a 30 days month.

The Moisture Index was carried out with the help of Thornthwait and Marther's method (1955). It is as given below:
Humidity Index (Ih) = WS / PE * 100
Aridity index (Ia) =WD / PE *100
Moisture Index (Im) = Ih- Ia
Where, PE = Potential Evapotranspiration
AE = Actual Evapotranspiration
WS = Water Surplus (Water Surplus = the sum of the monthly difference between precipitation (P) and ETp for those months; When P exceeds PE cm).
WD = Water Deficient (Water Deficiency = the sum of the monthly difference between ETp and precipitation (P) for those months; When PE exceeds P cm).

➢ *Shifting of Climatic Conditions in Pune Division*

The shift is measured by the changes in features associated with Moisture Index. Overall climatic is shifting during the last few decades in Pune division. The climatic parameters are studied to knowing the changing climatic conditions. Beside these another more valuable index such

as moisture index, which will help to confirm the actual shifting of climatic condition. The Thornthwaite Moisture Index (TMI) can be generally described as reflecting the aridity or humidity of the soil and climate, calculated from the collective effects of precipitation, evapotranspiration, soil water storage, moisture deficit and run off (Austroad, 2010). The present work is based on Thornthwaite's Moisture Index Method (1955) to determine the shifting or changing climatic conditions in the Pune division. For this purpose 113 years temperature, rainfall, relative humidity, solar radiation, wind velocity, cloud condition, vapour pressure, crop evapotranspiration, frost condition and wet day frequency etc. climatic factors are considered. Whereas, concern to sunshine data, it is assumed that 12 hours day times (actual sunshine period) and all climatic factors including sunshine 30 day (month) data used for determine the climate type of the Pune divistion.

Decade	Climate Type						
	A	B4	B3	B2	B1	C2	Total
1901-10	10	0	0	0	0	0	10
1911-20	7	0	2	0	1	0	10
1921-30	9	0	0	1	0	0	10
1931-40	9	0	0	0	1	0	10
1941-50	7	1	1	0	1	0	10
1951-60	8	1	1	0	0	0	10
1961-70	6	0	2	2	0	0	10
1971-80	7	0	1	1	1	0	10
1981-90	10	0	0	0	0	0	10
1991-00	7	3	0	0	0	0	10
2001-13	5	4	2	2	0	0	13
Total	85	9	9	6	4	0	113
Climate Shift (%)	75.22	7.96	7.96	6.19	3.53	0	100

Table 1:- The Climatic Conditions in Pune Division (1901 to 2013)
Source: The Global Weather Data (1901 to 2013)

As per Table 1. and Fig. 2, it is observed that in 113 years, there is dominance of Per humid or 'A' type climate in the considered period out of total years 75.22 per cent (85 years) represents per humid climatic type. It also shows up to 1981-90 decade the Pune division has same climatic condition. But after this decade climate type per humid (A) shifting towards B_4, B_3, B_2 and B_1 (Humid) climate types. These categories of climatic type are having shifting frequently 9 (7.96%), 9 (7.96%), 6 (6.19 %) and 4 (3.53%) respectively. It is clearly indicating that climate type of the Pune division is shift from per humid (A) to humid (B_4- B_1) climate.

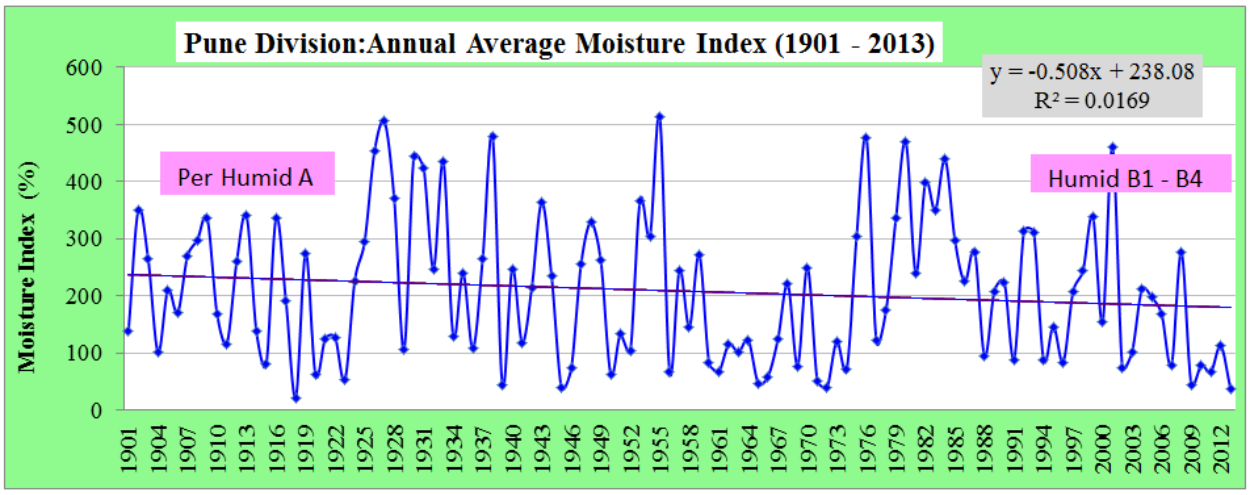

Fig 2

The moisture Index was decrease up to 57.40 percent over Pune division during 1901 to 2013 (Fig. 1.2). The rate of moisture index was 0.508 per year also shows decrease trend in study area. The highest and lowest moisture indexes were recorded (513.76) in 1955 and (22.13) in 1918 respectively. Its indicating, the climate of Pune division is shifted from weather 'A' (per humid) type climate in to drier B (humid) type of climate in the period of 113 years. The researchers have attempts to study the trend of moisture index with implementing annual average values and it is quite clearly reveals the shifting or changing climatic condition. The initial period particularly 1901 to 1925 there were not more changes in moisture index. Thereafter, there were maximum up and downs in moisture index 1926 to

ISSN No:-2456-2165

1957 (Fig. 2). The period 1957 to 2013 represents unevenness in climatic conditions of the study area.

The decadal change of moisture index for initial 25 years (1901 to 1925) was 'A' type (per humid) climate and it is shifting into dry (humid) 'B' type climate (drier humid) during 1925 to 2013. The lower moisture index was reported 118.37 per cent in 1961-1970, these years were under 'B_2' Climate, one year 'B_1' climate and 6 years shows 'A' type climate (fig. 1.3). The moisture index is higher (275.41 %) during 1981-1990, this 9 year under 'A' climate and one year are 'B_4' Climate. The decadal moisture index was decreased by 4.02 per cent from 1901 to 2011. In the decade, 1981 to 1991 represents wet per humid ('A') type climate which is dominant. Over all decadal changes in moisture index values shows that climate type of the Pune division is shifting from per humid ('A') to humid ('B_1-B_4') type climate. The trend of moisture index denoted declining from base decade (1901-10) to the last decade (2001-13).

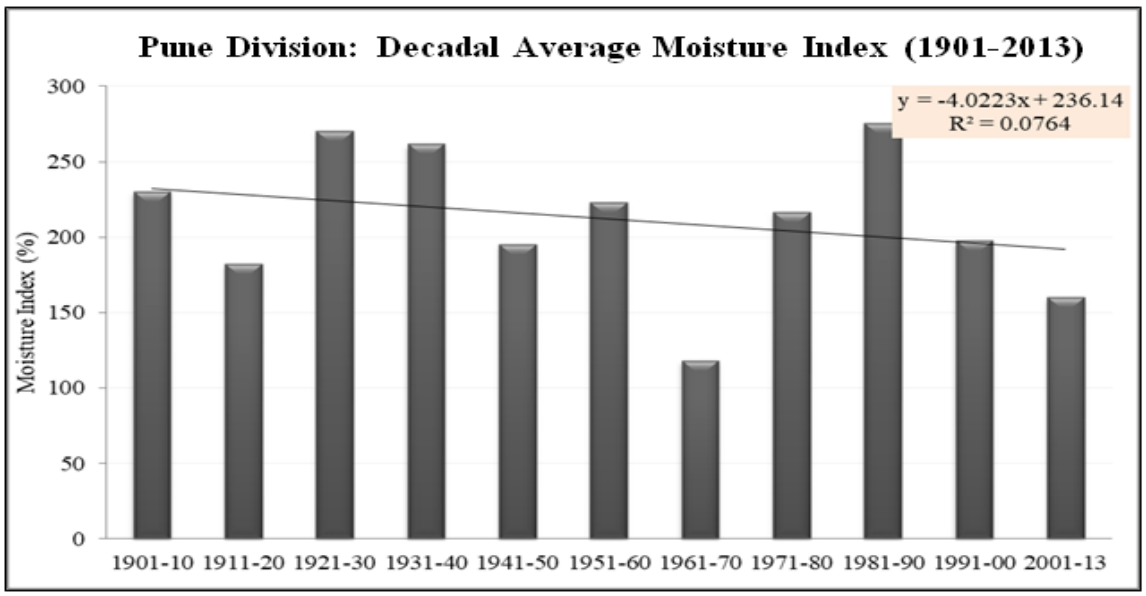

Fig. 3

Tri decadal moisture index is highest in 1901-30 (227.30%) and it is followed by 1931-1960 (226.86 %) remains high which come under 'A' type per humid climate. The next try decadal climate shifted from per humid 'A' to the humid 'B_4-B_1' climate. The moisture index has decreased at the rate of 16.99 per cent per 30 years (Fig. 4). The moisture index was 203.51 per cent in 1961-1990 and the last 20 years moisture index was reported 178.87 per cent which is indicating highly declined trend. It is observed that the decadal moisture index during 1911-20, 1961-70 and 2001-13 were less than the average due to the frequent droughts. Whereas, during 1921-30. 1931-40 and 1981-90, it was more than the average due to over rainfall (recurrent floods). Tri-decadal moisture index during 1901-1960 reveals high. While from 1960 to 2013, it is noticed low because of industrialization, urbanization, deforestation, increase in population, No. of vehicles etc. have been taken place in the study area and all these factors magnificently affecting on climatic conditions of Pune division and along with not only industrial sector of this area is responsible for such condition but also other areas of India and World nations cumulatively support to climate change in study area.

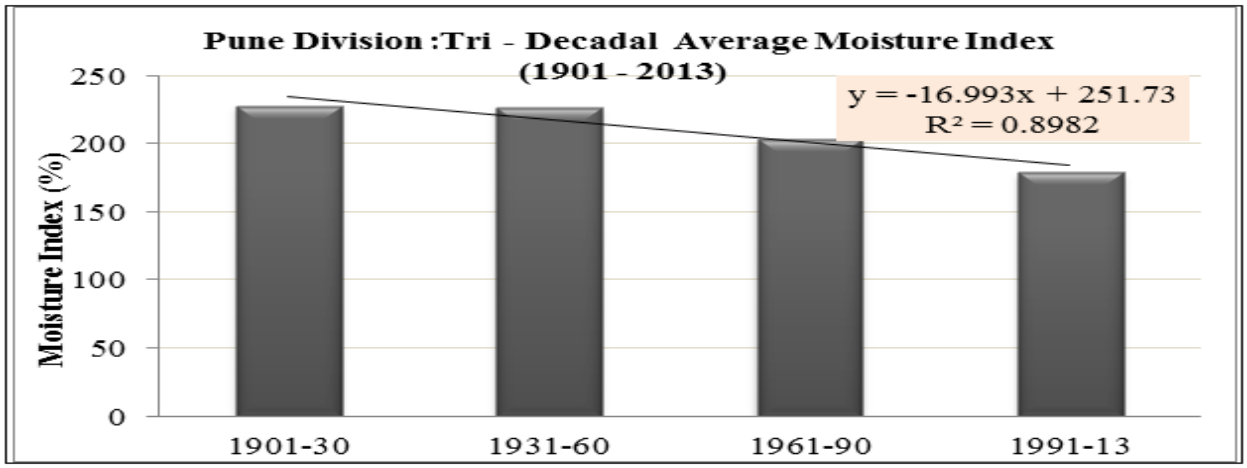

Fig. 4

II. CONCLUSION

It is concluded that moisture index indicates the shifting of the climate is happened in the Pune division. It is confirm through Moisture index which was decreased up to 57.40 per cent during the period of investigation. It is also clearly reveals that moisture index has been shifted from 'A' climate (per humid) to 'B_1-B_4' climate (drier humid). It means Pune division has been going to different stages of climatic changes i.e wet per humid to drier humid climate during 1901 to 2013.

REFRENCES

[1]. Challenges of Climate Change, (2016): Australian Center for International,Testing Climate Change Trend, Climate Research Journal, Sydney, Aus. pp.178
[2]. Climate Change, (2007): Synthesis Report (A Report of the IPCC), pp.2
[3]. Intergovernmental Panel on Climate Change (IPCC), (2001): "Working Group I to IIIrd Assessment Report", Cambridge University Press. Cambridge, UK, pp.881
[4]. IPCC, (2007): Climate Change, Fourth Assessment Report of the Intergovernmental Panel on Climate Change, pp.289-291
[5]. IPCC, (2012): Impacts, Adaptation and Vulnerability, Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK, pp.17.
[6]. Rosenzweig C., Karoly D., Vicarelli M., Neofotis P., Wu Q., Casassa G., Menzel A., Root TL., Estrella N., Seguin B., Tryjanowski P., Liu C., Rawlins S., and Imeson A., (2008): Attributing physical and biological impacts to anthropogenic climate change. Nature pp.453.
[7]. UNFCCC (United Nations Framework Convention on Climate Change) (2007): Impacts, Vulnerabilities and Adaptation in Developing Countries pp.8-12
[8]. https://globalweather.tamu.edu.
[9]. https://www.encyclopedia.com/earth
[10]. www.berkeleyearth.lbl.gov
[11]. www.imdpune.gov.in,ndc@imdpune.in
[12]. www.indiawaterportal.in,
[13]. www.tropomet.res.in
[14]. https://globalweather.tamu.edu.
[15]. www.berkeleyearth.lbl.gov
[16]. www.imdpune.gov.in,ndc@imdpune.in
[17]. www.indiawaterportal.in,
[18]. www.tropomet.res.in
[19]. www.wikipedia.org/wiki/climate_change_and_agriculture