International Journal of Engineering Science Invention
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org ||Volume 6 Issue 9|| September 2017 || PP. 25-31

Trend Change Analysis of Surface Air Temperature over Assam, India

Mr. Partha Nath Dutta*[1] Dr. Tado Karlo [2] Mr. Mohon Daimary[3]
[1]*Research Scholar, Dept. of Physics, NERIST, Arunachal Pradesh, India,*
[2]*Associate Professor, Dept. of Physics, NERIST, Arunachal Pradesh, India.*
[3]*Dept of Physics, Silapathar Science College, Assam, India,*
Corresponding Author: Mr. Partha Nath Dutta

Abstract: *Temperature is one of the indicative factors of climate change which is a very important issues discussed in the recent two decades. The present research aimed at studying temporal and seasonal variation in surface air temperature over Dhubri, Guwahati, Silchar, Tezpur and Dibrugarh in Assam, India during the period 1979-2013. Trend in annual and seasonal temperature series is analyzed using Mann Kendall test. The analysis showed that the temperature trend, both annual and seasonal has increasing tendency during the period 1979-2013. The study showed that the annual mean temperature ranges between 24.14°c-25.67°c over all studied locations. Significantly high value of temperature is found for the month of August compared to all other months. A positive trend was studied for all four locations except Dhubri. It means that Assam is experiencing a rise in surface air temperature too. It might be due to the population growth, deforestation, industrialization etc. It is going to addition of global warming. Thus the research developed in this study could assist the prediction of the temperature over the studied locations.*

Keywords: *trend analysis, monthly mean temperature, annual mean temperature, regression*

Date of Submission: 05-08-2017 Date of acceptance: 25-09-2017

I. Introduction

Weather refers to short term change in atmospheric conditions, while climate deals with events happening over a much longer period [1]. In the last 10 decades global climate is changed significantly. The global mean surface air temperature has increased by 0.74°c during last century [2]. The rates of climate change are significantly different among regions (IPCC 2007) [3]. According to Hingane, Rupa Kumar and Rama Murty [4] during the last century, surface air temperature over India has shown significant increasing trend which is attribute to rise in maximum temperature. A long term investigation of seasonal and annual surface air temperature at six Indian industrial and non industrial cities have conducted and the result showed that the non industrial station did not show significant trend and there was either a cooling tendency or cessation of warming after the late 1950s at most of the historical cities [2]. The study on temperature over Indian cities indicates a straight warming trend between 1901 and 1990 [5]. In 1996 a study estimate rising trend of 0.084 and 1.391C per 100 years in the mean surface temperature calculated for Mumbai and Kolkata, respectively [6]. In 2002, Rupa Kumar and K. Krishna Kumar highlighted that the warming trends are visible during all the four seasons in all India mean surface air temperature during 1901 to 2001 from a network of 31 well distributed representative stations over India [7]. It shows the result of 0.04°c/decade and 0.05°c/decade higher rate of temperature increase during winter and post monsoon respectively. The west coast, north Andhra Pradesh and northwest India, witness for increasing trend in seasonal rainfall, while east India and Gujarat and Kerala witnessed decreasing trends in seasonal rainfall [8] is there. But it showed that all Indian rainfall and surface pressure showed no significant trend except some periodic behavior (Sinha Ray and De, 2003) [9]. The period nature of a deterministic component is characterized by its cyclic pattern, which exhibits an oscillatory movement and is repeated over affixed interval of time. However, a stochastic component consists of irregular oscillation and random effects, which are not accountable physically and is described by probabilistic concepts (Das, 2009) [10]. Various researchers, namely, Sinha Ray et al. (1997) [11]; Reddy and Kumar, (1999) [12]; Toth et al., (2000) [13]; Jha et al., (2003) [14]; Raja Kumar and Kumar, (2004, 2007) [15], [16]; Mishra and Desai, (2005) [17]; Bhakar et al., (2006) [18]; Dabral et al., (2008) [19]; Sherring et al., (2009), [20]; Kumar and Kumar, (2010) [21]; Dabral et al., (2014) [22]; and Dabral (2015) [1] also studied on trend analysis of surface air temperature.

Vegetation of any regions depends mainly upon the weather conditions, such as temperature rainfall etc. The north-eastern region of India which is one of most important bio-diversity rich regions of the world, contains about 8000 species of flowering plants and more than 500 species of orchids. The region is mostly a

tropical wetland and annual rainfall varies in the range of 200mm over parts of Assam to 12000mm over a few hillocks in Meghalaya [1, 23]. The present study focuses on the trend and changes of monthly and seasonal temperature series over five locations of Assam. The study is proposed -

(a) To determine variations in temperature pattern in the study area by using the mean of monthly and annual mean annual surface air temperature values for 35 years.
(b) To determine the effects of temperature variation in the study area.

II. Methodology

The study area Assam is located south of the eastern Himalayas as shown in the Fig. 1. It comprises the Brahmaputra and Barak river valleys along with the Karbi Aanglong and the Dima Hasao district. Guwahati (26°11′N, 91°47′E), city is situated between the southern bank of Brahmaputra River and the foothills of the Shillong Pleatue. Tezpur (26°37′N, 92°50′E) is on the banks of the Brahmaputra River. The town of the Dibrugarh (Mohanbari), (27°48′N, 95°02′) is situated in the southern part of the Assam. Silchar (Kumbhigram) (24°50′N, 82°51′E) town is located in the southern part of Assam It is belongs to Barak valley. Dhubri ($26^0$01′N, $89^0$59′E) is situated on western Assam near West Bangal (Table 1) and (Fig.1).

Table 1: Configuration of locations and period of data.

Stations	Stations code(*IMD)	Latitude(^{0}N)	Longitude(^{0}E)	Elevation (m)** msl	Period	Duration in years
Dhubri	42404	$26^0$01’	$89^0$59’	35	1979-2013	35
Guwahati	42410	$26^0$11’	$91^0$47’	55	1979-2013	35
Silchar	42619	$24^0$50’	$82^0$51’	29	1979-2013	35
Tezpur	42415	$26^0$37’	$92^0$50’	79	1979-2013	35
Dibrugarh	42314	$27^0$29’	$94^0$58’	106	1979-2013	35

* Indian Meteorological Department.
** Mean sea level.

The local factors including geographical position, variation in elevation, continental, marine and topographic influences, etc may have considerable impact on surface air temperature over Assam.
Data were collected on temperature for a period of 35 years, 1979-2013, for the above mention locations from different meteorological stations. The data collected were processed into monthly and annual mean values for all the studied locations on the formula-

$X=\sum(x_i)/n$ ……..….(i)

The integrity of the data were determined by collecting data from each of the data source and checking for inconsistencies and missing gap using linear regression equation to estimate the missing value using the variable values [9]. it may be written as follows:

$y = a + bx$……..……...…(ii)

Where:

$b = n\sum x - (\sum x)/n\sum x^2 - (\sum X)^2$ ……(iii)

$a = \sum y/n - b\sum bx/n = y^{/} - bX$ …… (iv)

Where:

a = intercept.
b = regression coefficient.
x = time in years.
X = mean time and
$y^{/}$ = the mean temperature value.

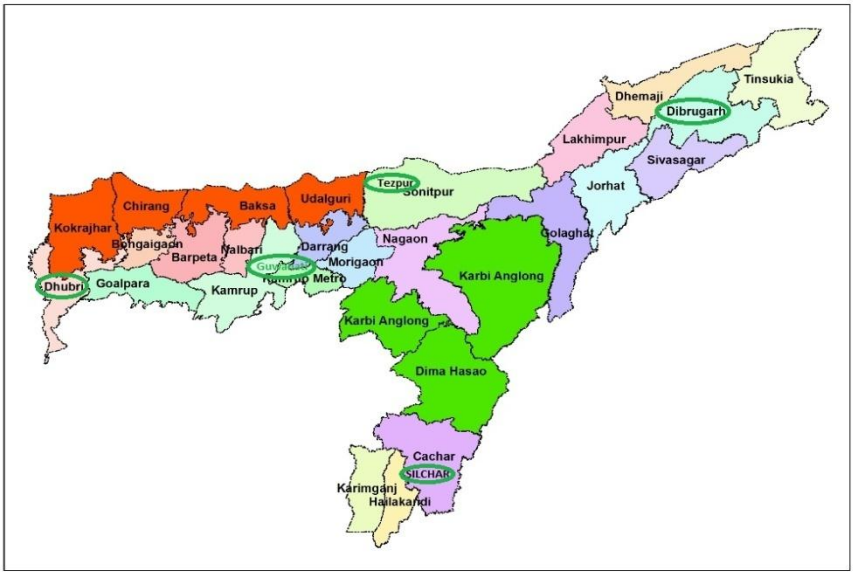

Figure 1: Map of Assam (studied locations Dhubri, Guwahati, Silchar, Tezpur and Dibrugarh).

The data collected were subjected to the statistical analysis using Microsoft office excel 2007 to determine the mean of annual and monthly values of temperature across the studied locations. Using analysis of variance, based on the formulae.

$S^2 = 1/n\sum(X_t-X)^2$……..……(v)

Analysis of variance were carried for testing whether the mean monthly temperature received in the region are same for the year 1969-2013 or significant and means where compared using least significant difference (LSD) at 0.04% probability level among locations, years and the months based on the formulae **:**

$LSD = t_\alpha\sqrt{MSE/r}$ ……..…(vi)

Where :

$t_\alpha = 0.04$ ……..……..(vii)

Mann Kendall test analysis of trend in climatologic and hydrologic time series is widely used by various researchers like, Tasusree Deb Roy and Kishore K. Das (2013) [3]; Kendall M.G, (1975) [24]; IPCC (2007) Climate change 2007 [25]; M. N. Dammo, B. S. U Abubakar and A. Y. Sangodoyin (2015) [26]. Amit Dhorde, Angra Dhorde and Alaka; S. Gadgil (2009) [27]; Tomozeiue et al., (2006) [28]; Kadioglu (1997) [29]; Salinger M.J. and Griffiths, G.M., (2001) [30]; Brunetti et al., (2000) [31]; Gadgil and Dhorde (2005) [32] and many others. The present study also used Mann kendall test to analyzed the trend of the time series. The Mann Kendall rank correlation is given by

$$S = \sum_{k=1}^{n-1}\sum_{j=k+1}^{n} sign(x_j - x_k)$$

$$sign(x_j - x_k) = 1 \text{ if } x_j - x_k > 0$$
$$= 0 \text{ if } x_j - x_k = 0$$
$$= -1 \text{ if } x_j - x_k < 0$$

…….(viii)

Where x_j represents data point at time j and x_k represents data point at time k.

III. Results and Discussion

3.1 Monthly Mean Temperature Analysis:

The present analysis showed the result that-

The mean temperature varied in between the mean temperature range (24.22°c-25.77°c among locations over the months (Table 2).

(i) (16.06°c-29.85°c) is the range of monthly mean temperature of maximum and minimum temperature. Silchar and Dibrugarh show the highest mean of maximum temperature and the minimum of minimum temperature.

(ii) As comparing the mean temperature the August is the warmest month across all five studied locations and January is the coldest month of the studied locations except Dibrugarh, which shows December as the coldest month of the year. Hence it is clear that monthly mean temperature lies the mean temperature of the month August and the month of January except Dibrugarh (Fig.2).

Table 2: Three half decades (1979-1988, 1989-198, 1999-2008,and half decade 2009-2013) the monthly mean annual temperature as the following, across locations.

Locations	Dhubri	Guwahati	Silchar	Tezpur	Dibrugarh
	^{o}C	^{o}C	^{o}C	^{o}C	^{o}C
Mean	24.79	25.77	25.14	24.94	24.22

3.2 Annually mean temperature analysis:

From the whole investigation the following points are observed;

(i) In case of the mean of annual mean temperature Silchar shows the maximum value of surface air temperature (25.67^{o}c) and Dibrugarh shows temperature (24.14^{o}c) which is the minimum across all five stations. So the range of surface air temperature of annual mean of mean temperature lies between (24.14^{o}c-25.67^{o}c).

(ii) The range of annual mean temperature of Tezpur is the highest range which is (22.98^{o}c-28.00^{o}c) and Dibrugarh shows the minimum range (24.02^{o}c-26.46^{o}c) amongst the locations, Silchar, Guwahati and Dhubri show the range (24.31^{o}c-27.03^{o}c), (23.70^{o}c-28.55^{o}c) and(23.69^{o}c-25.75^{o}c) respectively.

(iii) The annual mean temperature of all five locations shows the positive trend except the location Dhubri (Fig.3). It shows the positive trend or increment of 0.01247^{o}c in the whole locations, if taken the mean of all five locations or as a whole mean of all five locations.

Table 3: Mean average annual temperature for 35 (3 half decades) years in the five studied locations.

Decades	1st decade	2nd decade	3rd decade	Half decade	Mean(^{o}c)
Location	Annual mean temperature in (^{o}c)				
Period	1979-1988	1989-1988	1999-2008	2009-2013	
Dhubri	24.6759167	24.86175	24.65591667	24.9733333	24.79
Guwahati	24.4891667	25.194881	25.45508333	25.4283333	25.77
Silchar	25.9365278	25.3946667	25.8905	25.875	25.14
Tezpur	24.53625	25.0349286	24.98113636	25.2275	24.94
Dibrugarh	23.7304167	23.9721667	24.39941667	24.7825	24.22
Range(^{o}c)	23.7304167 - 25.9365278	23.9721667 - 25.3946667	24.39941667 - 25.8905	24.7825 - 25.875	

(iv) In first decade i.e., (1979-1988), second (1989-1988), third (1999-2008), and half decade (2009-2013) Silchar shows the highest value of annual mean surface air temperature among all locations and Dibrugarh shows minimum value of annual mean temperature (Table 3). Hence the range of the annual mean temperature lies between the location Dibrugarh and Silchar.

(v) The relative mean temperature increased from the period 1983-1986 and decreased from 1986-1991 and then, it start further increase from 1992 to 1998, and again decrease from 1998 to 2004 and so on gradually increase and decrease up to 2013 (Fig.4).

(vi) Relative mean temperature is maximumed in 1998 and it is minimum in 1983.

3.3 Maximum temperature:

From the analysis of maximum temperature it is noted that-

(i) Maximum temperature lies between the ranges (30.96^{o}c-35.46^{o}c).

(ii) Highest maximum temperature occurs in the location Guwahati and the minimum temperature observed at Dibrugarh. The highest mean of maximum observed at Silchar and the minimum of maximum temperature mean observed at Dhubri respectively.

(iii) The maximum temperature shows increase trend of significant 0.0259^{o}c across as whole in the studied locations, (Fig.5).

3.4 Minimum temperature:

In the case of minimum temperature-

(i) The highest value of minimum temperature occurs at Silchar and minimum at Tezpur, (11°c-24.96°) is the range of minimum temperature.

(ii) Mean of minimum temperature lays the range of (15.73°c-17.93°c), where Silchar and Dibrugarh show maximum and minimum of the mean of minimum temperature.

(iii) The minimum temperature shows a positive trend of 0.0113°c amongst the locations (Fig.6).

According to Kendrew, deforestation leads to decrease the minimum temperature as in the case of desert. But where other factors, e.g. urbanization, industrialization etc are more effective than deforestation, in those places minimum temperature trends to increase [33]. Goswami **(**2000) observed the decreasing trend of maximum temperature over Assam across different 9 locations in the period of 1986-1992 [34]. The increase or decrease of mean temperature depends upon the trends of maximum and minimum temperature and factor affecting these trends [34]. Tanusree Deb Roy and Kishore K. Das [3] observed the increase of minimum temperature at 0.001 level and maximum temperature significantly 0.01 level in Assam at different four locations in the period of 1981-2010. In 2009, Amit Dhorde, Angraha Dhrode and Alaka S. Gadgil observed the majority of the trends, both annual and seasonal showed increasing tendency in temperature during the last century indifferent four Indian cities [27]. While it is observed in the present study that the mean temperature increases 0.012471°c level and the maximum and minimum temperature both shows increase of 0.0259°c and 0.005°c respectively.

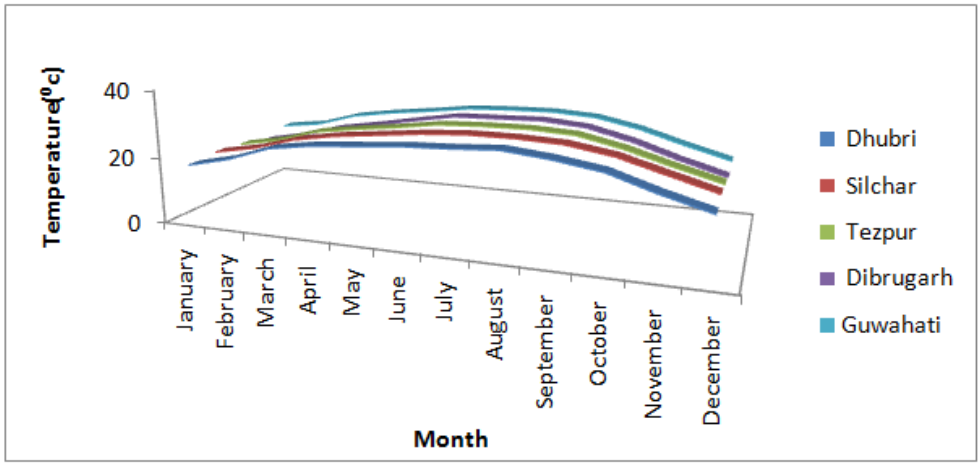

Figure 2: Change of pattern in change in monthly mean temperature.

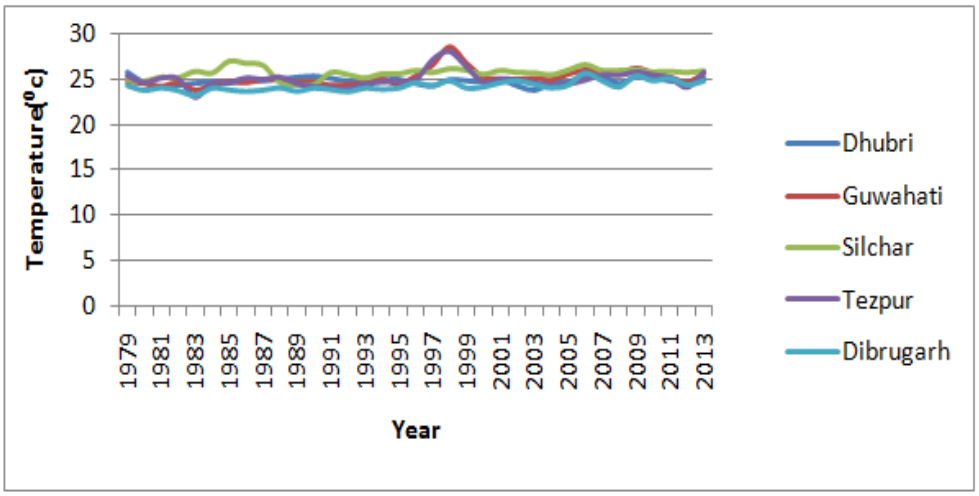

Figure: (3) Change of pattern annual mean temperature.

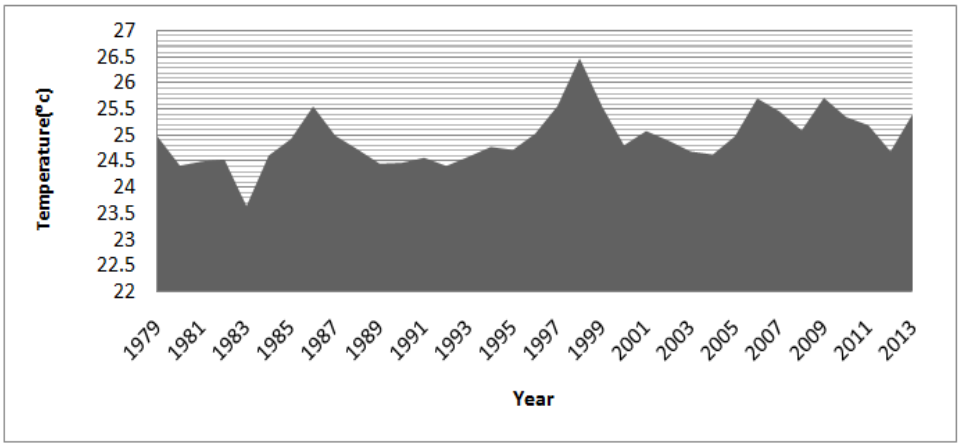

Figure: (4) Relative annual mean temperature of eall five studied locations across 35 years.

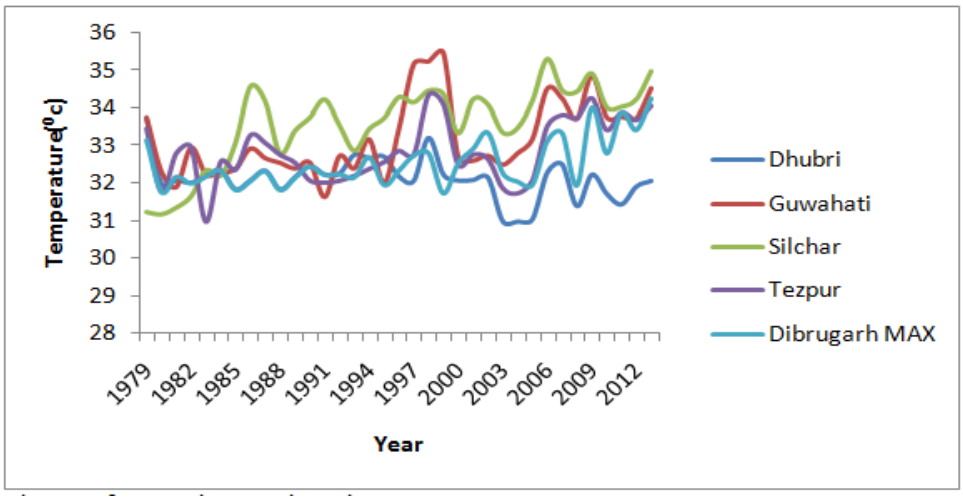

Figure: (5) change of pattern in annual maximum temperature.

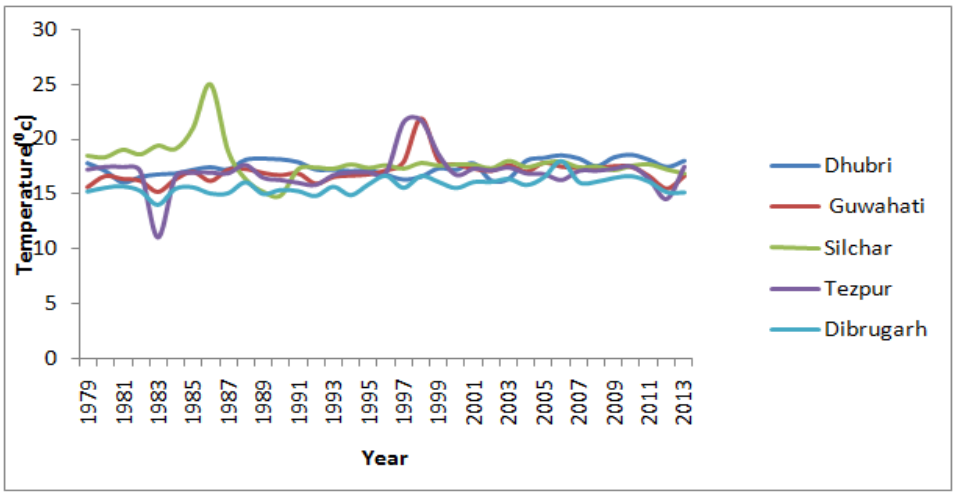

Figure: (6) Change of pattern in annual minimum temperature.

III. Conclusions

From the analysis of 35 years (1979-2013) at different five locations of Assam, India, results showed highly positive trend of 0.012471^{o}c in mean temperature across the studied locations. It is because the day time temperature is increasing and the night temperature also increasing over the studied locations. Most of the Assamese citizens depend on the economic activities that are temperature sensitive, so it is going to addition of global warming. Thus, the study in this research could assist the prediction of temperature over Assam.

References

[1]. Dabral P.P., Saring T. , Jhajharia D., 2016, Global NEST Journal, Vol 18, No 3, pp 494-507
[2]. Intergovernmental Panel on Climate Change (IPCC). Summary for policy makers in: climate change 2007: The Physical Science Basis. Contribution of Working Group 1 to the fourth assessment report of the intergovernmental panel on climate change (ed. By S. Solomon, D. Qin, M. Manning, Z. Chen, M Marquies, K. B. Averyt, M. Tignor and H.L. Miller). Cambridge University Press; 2007.
[3]. Deb Roy Tanusree,. Das, Kishore K, 2013, Temperature Trends at Four Stations of Assam during the period 1981-2010, International Journal of Scientific and Research Publications, Vol 3 No. 6, pp 1-3
[4]. Hingane, L.S., Rupa Kumar, K & Ramana Murty, V.Bh., 1985, Long term trends of surface air temperature in India, Journal of Climatology, 5, 521-528.
[5]. Ogolo EO, Adeyemi B. Variations and trends of some meteorological parameters at Ibadan, Nigeria. The Pacific Journal of Science and Technology. 2009;10(2):981– 987.
[6]. IPCC (2007). Climate change 2007: climate change impacts, adaptation and vulnerability. Working Group II contribution to the Intergovernmental Panel on Climate Change Fourth Assessment Report. Summary for policymakers, 23.
[7]. Rupa Kumar, K. Krishna Kumar, R.G. Ashrit, S.K. Patwardhan and G.B. Pant 2002, Climate change in India: Observations and model projections. A chapter in NATCOM book on Climate Change.
[8]. MOEF. 2004. India's initial national communication to the United Nations Framework Convention on Climate: Executive Summary, Ministry of Environment and Forest, Government of India.
[9]. Sinha Ray K.C. and De U.S. (2003), Climate change in India as evidenced from instrumental records, WMO Bulletin. **52**(1), 53-59.
[10]. Das G. (2009), Hydrology and soil conservation engineering including watershed management. PHI Learning Private Limited, New Delhi-110001.
[11]. Sinha Ray K.C., Mukhopadhyay R.K., Chowdury S.K. (1997), Trend in maximum minimum temperatures and sea level pressure over India. Paper presented in INTROPMET-97 held on 2-5 December, 1997 at IIT, Delhi (New Delhi), India.
[12]. Reddy K.M. and Kumar D. (1999), Time series of monthly rainfall for Bino Watershed of Ramganga River, Journal of Agricultural Engineering, **36**(4), 19-29.
[13]. Toth E., Brath A. and Montanari A. (2000), Comparison of short term rainfall prediction models for real time flood forecasting, Journal of Hydrology, **239**, 132-147.
[14]. Jha V., Singh RV. and Bhakar S.R. (2003), Stochastic modelling of soil moisture, Journal of Agricultural Engineering, **40**(4), 51-56.
[15]. Raja Kumar K.M. and Kumar D. (2007), Developed a time series modelling of daily rainfall during north-east monsoon season of Baptala, Andra Pradesh, Indian Journal of Soil Conservation, **35**(1), 21-25.
[16]. Raja Kumar K.N. and Kumar D. (2004), Stochastic modelling of daily rainfall for south west monsoon season of Baptala, Andra Pradesh, Journal of Agricultural Engineering, **41**(3), 41-45.
[17]. Mishra A.K. and Desai V.R. (2005), Draught forecasting using stochastic model, Stochastic Environment Research and Risk Assessment (Springer), **19**, 326-339.
[18]. Anderson, OD.1976. Time series analysis and forecasting, the Box-Jenkins Approach. Butterwarth, London.
[19]. Bhakar S.R., Singh R.V. and Ram H. (2006), Stochastic modelling of wind speed at Udaipur, Journal of Agricultural Engineering, **43**(1), 1-7.
[20]. Dabral P.P., Pandey A., Baithuri N. and Mal B.C (2008), Developed stochastic modelling of rainfall in Humid Region of North East India, Water Resource Management, **22**, 1395-1407.
[21]. Sherring A., Hafiz Ishtiyaq Amin, Mishra A.K. and Mohd A. Alam (2009), Developed a stochastic time series modelling for prediction of rainfall and runoff in Lidder catchment of South Kashmir, Journal of Soil and Water conservation, **8**(4), 11-15.
[22]. Kumar. M. and Kumar D. (2010), Developed multiplicative ARIMA modelling of monthly stream flow of Betwa river, Indian Journal of Soil conservation, **38**(2), 62-68.
[23]. Dabral P.P., Jhajharia D., Mishra P., Hangshing L. and Doley B.J. (2014), Time series modelling of pan evaporation: a case study in the northeast India, Global NEST Journal, **16**(2), 280-292.
[24]. Jhajharia D., Yadav B.K., Maske S., Chattopadhyay S. and Kar A.K. (2012), Identification of trends in rainfall, rainy days and 24 h maximum rainfall over sub-tropical Assam in northeast India, Comptes Rendus Geoscience, 344, 1–13.
[25]. Kendall M.G., 1975. Rank Correlation Methods, 4th edition. Charles Griffin, London, U.K.
[26]. IPCC (2007). Climate change 2007: climate change impacts, adaptation and vulnerability. Working Group II contribution to the Intergovernmental Panel on Climate Change Fourth Assessment Report. Summary for policymakers, 23.
[27]. M. N. Dammo, B. S. U. Ibn Abubakar and A. Y. Sangodoyin, 2015, Journal of Geography, Environment and Earth Science International 3(2): 1-8, 2015; Article no.JGEESI.18512.
[28]. Amit Dhorde, Anargha Dhorde1 and Alaka S.Gadgil, Long-term Temperature Trends at Four Largest Cities of
[29]. India during the Twentieth Century,2009, J. Ind. Geophys. Union (April 2009), Vol.13, No.2, pp.85-97.
[30]. Tomozeiu, R., Pavan, V. Cacciamani, C. & Amici, M., 2006. Observed temperature changes in Emilia-Romagna: mean values and extremes. Climate Research, 31, 217-225.
[31]. Kadioglu, M., 1997. Trends in surface air temperature data over Turkey. International Journal of Climatology, 17, 511-520.
[32]. Salinger, M.J. & Griffiths, G.M., 2001. Trends in New Zealand daily temperature and rainfall extremes. International Journal of Climatology, 21, 1437-1452.
[33]. Brunetti, M., Buffoni, L., Maugeri, M. & Nanni, T., 2000. Trends of minimum and maximum daily temperatures in Italy from 1865 to 1996. Theoretical and Applied Climatology, 66, 49-60.
[34]. Gadgil, A. & Dhorde, A., 2005. Temperature trends in twentieth century at Pune, India. Atmospheric Environment, 35, 6550-6556.
[35]. Kendrew, W.G., 1957, Oxford Clarndon Press.
[36]. U. D. Goswami,(2000), A study on some features of surface air temperature over Assam, M. Ph. Dissertation, Gauhati University.

International Journal of Engineering Science Invention (IJESI) is UGC approved Journal with Sl. No. 3822, Journal no. 43302.

Mr. Partha Nath Dutta. "Trend Change Analysis of Surface Air Temperature over Assam, India." International Journal of Engineering Science Invention(IJESI), vol. 6, no. 9, 2017, pp. 25–31.