ATHENA, VOLUME IV, JULY 2020 C.E. (ISSN: 2454-1605) pp. 34-41
www.athenajournalcbm.in

Urban Growth and its Impact on Temperature: A Case Study of the Baitarani Basin in Odisha

Siva Prasad Panda*, K. M. Sethy**, S. N. Tripathy***

Submitted: 04.05.2020. Revised: 17.06.2020. Accepted: 30.07.2020.

Abstract: *Urbanisation is a human activity that clearly modifies the earth system, involving artificial changes to the earth surface and increasing in energy consumption. Hence, urbanisation has a significant impact on climate in urban areas. Both urbanistion and industrialization are positively co-related. Human activities impact climate change through greenhouse gas emissions. This study concerns with the impact of urbanisation on temperature making a statistical relationship between the trend and population growth and increase in the intensity of temperature in the basin. Total number of urban centre is 2 in 1901 which increased to 12 urban centres in 2011. The decadal growth rate is 0% in 1911, 33.33% in 1921, 0% in 1931, 0% in 1941, 0% in 1951, 40% in 1961, 28.57% in 1971, 22.22% in 1981, 0% in 1991, 18.18% in 2001, and 26.7% in 2011. The concentrated growth has resulted in the increase in population and consequent pressure on infrastructure, natural resources and ultimately giving rise to increase in built up areas which causes a plethora of serious challenges such as climate change, urban heat island etc. The study of the rate of urbanisation growth gives the primary idea about the ineffective infrastructure planning and management in advance. An increasing pattern of temperature is observed in the basin. Temperature is increasing at a rapid rate in the interior area than the coastal area due to deforestation, mining, industrialisation and urbanization. Such nonlinear relationship between temperature and urbanization is also discussed. The latest assessments of the likely magnitude of the urban trend in available surface temperature records are summerised.*

Keywords: *Urbanisation, Industrialization, Baitarani Basin, Temperature, Built up Area, Urban Heat Island.*

* Research scholar, P.G. Dept. of Geography, Utkal University. e-mail: pandasivaprasad@gmail.com
** Professor, Department of Geography, Utkal University.
*** Professor (Retd.), Department of Geography, Utkal University.

Introduction

For the first time in human history, the total population of the world's cities exceeded the rural population[1]. Almost every city in the world is between 1-4^{0}C hotter than its surroundings. For every degree rise in temperature electricity generation rises by 2%-4% and smog production increases by 4%-10%. Human induced changes in landuse such as urbanisation among others affect both local and regional climate and even large scale atmosphere circulation[2]. It can be said that the first step to control or at least reduce the damages of global warming is to identify its features in any regions. Climate change and air pollution is an important factor affecting human health. So that, the accumulation of green house gases such as carbon dioxide, primarily from burning fossil fuels results in warming, which has an impact on air pollution, particularly on levels of ozone and particulates. Rapid urbanisation and unprecedented population growth were amongst significant world changes that took place by the end of the 20th century[3].

Furthermore, some of these studies are almost carried out in the field of urban heat island and its characteristics that is related to the intrinsic nature of the city (building density and materials as well as urban land use distribution) especially in the North America and Europe. Land use and land cover changes over time due to urbanisation is an important urban issue which should be take into consideration in urban research projects[4]. Demographers and human geographers predict that this growth in urban population will be continued in a way that by 2025, large cities and urban agglomerations will accommodate a vast majority of the world's population[5]. The process of urbanisation involves human activities that tend to alter chemical composition of the atmosphere, the thermal and hydrological properties of the Earth's surface as well as the aerodynamic roughness parameters. For instance, marshes are drained, local vegetation is removed and soil is eroded and surfaces are replaced by more impervious surfaces such as pavements, tarred roads and building roofs. Other human activities that encourage generation of green house gases such as building industries and increasing the number of automobiles are taking place in urban areas. These bring about increase in urban temperature compared with its rural areas the phenomenon termed "Urban Heat Island" (UHI). The climatic change experienced in urban areas to UHI created by land use changes from urbanisation. High temperature creates considerable discomfort and stress on man's level of performance and hence on his economic activities[6].

The negative impacts of urbanisation and increase in urban population disturb global biogeochemical cycles, accelerate climate change, and affect hydrologic regimes. However, natural ecosystems and environments are highly affected by the presence of urban areas[7]. Global warming continues to affect the whole world causing numerous adverse social and economic consequences. Now a day, climate change is considered as one of the most serious hazards to human's life[8]. Urbanisation and its consequences are the global phenomena and by the turn of the expected to live in urban centres. They also believe that most of this increase in urban population will occur in low and middle income countries[9].

Urbanisation is defined as the expansion of both city or metropolitan areas and the growth in the proportion of its population. Increase in population brings about increase in

size of urban area. World Urbanisation Prospects 2005 annual report described 20th century as witnessing the rapid urbanisation of the world's population as the global proportion of the urban population rose dramatically from 13% (220 million) in 1990 to (3.2 billion) in 2005. This has resulted in the shifting of residential area outward a process called suburbanization[10].

In the more developed regions the changes will not be as spectacular as in developing countries. Hence urban ecological issues are likely tie gain importance in the Third World countries. For instance smog is formed faster in cities because of the hot weather[11].

Urbanisation and Climate

Various authors at different times have emerged with different terminology to describe the formation of such new points of concentration outside downtown[12]. According to UN-Habitat 2006 annual report, majority of people worldwide will be living in towns or cities for the first time by the middle of 2007 (Urban Millennium) and by estimation 93% of urban growth will occur in Asia and Africa.

The negative influence of the rapid urban growth on climate is a concern for many researchers. Urban micro climate is the climate develops over a city and modified by variation in aspect, shape and form of the ground, soil moisture and surface vegetation[12]. These transitions were along with human's manipulation in the world natural environment[13]. The most pronounced and locally far reaching effects of man's activities on microclimate have been in cities[14].

The Study Area

The river Baitarani is one of the important east-flowing rivers of peninsular India located in northern Odisha. The river is flashy in nature having a total length of 355 km. and an area of 10,982 km^2. The basin is situated approximately between of 85^0 10′ and 87^0 03′ East longitude and between 20^0 35′ and 22^0 15′ north latitude. The basin is surrounded by the Brahmani basin on the south and west and Subarnarekha basin on the north, the Budhabalanga and the Bay of Bengal on the east. It covers an area of 10,982 km^2 of which 10, 246 km^2 (93.3%) lies in Odisha and 736 km^2 (6.7%) in Jharkhand. The northern portion comprises of rugged hilly terrain. The basin perimeter measures 622.22 km.

The geological setting of the hill catchment of the basin mostly includes rocks of Pre-Cambrian formation. The plain part of the basin is characterized primarily by sands with admixture of cobble and boulder in its upper part and alluvial soils, mostly silt and clay formed of recent alluvium, in the lower part.

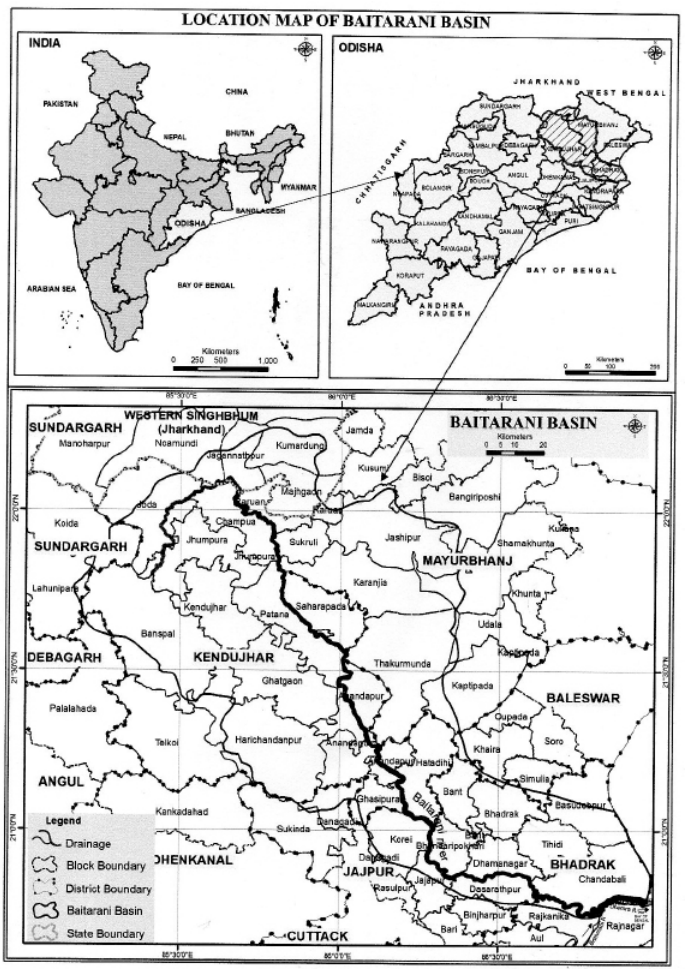
The Baitarani river receives a number of small tributaries along its course. The main tributaries of the river are the Kangira river, the Aradei river, the Khairi-bandhan river, the Deo river, the Kanjhari river, the Sita river, the Musal river, the Kusei river, the Salandi river which meet together and flow as Baitarani in Odisha. The tributaries have considerable contribution towards the discharge of the main stream, Out of which the tributaries, Salandi river and Khairi-bandhan river, are solely responsible for most of the sediment contribution to the Baitarani river.

Data Base and Methodology

Population and temperature data were utilised in this study. To understand and recognizing interactive effects between expansion rate of urbanity and global warming, two groups of technical data base are needed to conduct the current study.

- Urban population data (population and growth rate projected) were collected from the Census of India, Bhubaneswar and data were collected from 1901 to 2011.
- Month wise temperature data in the observation period (1977-2014) were collected from IMD, Bhubaneswar.

Fig.1



Urbanisation in the Baitarani Basin (1901-2011)

Trend was identifying using 5 and ten years moving average. Correlation and regression methods were used to investigate relationship between population and temperatures.

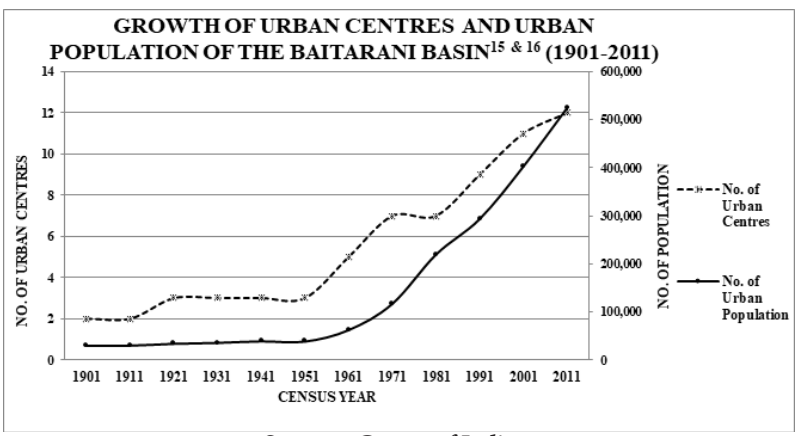
In 1901 only two urban centers (class-IV) were in the basin and in 2011 census, the number of urban centers became 12 (Fig. 2). The highest growth of urban centers is reported in the census year 1911-21 (33.33%) and zero figures is in five census years (1901-11, 1921-31, 1931-41, 1941-51, 1981-91). This figure indicated the expansion of the urban centers in the circle there by more and more rural areas are included in the towns increasing the percentage of urban population. Figure 2 reflects the population growth rate of the study area from 1901 to 2011. The urban inhabitants grew from 30,629 in 1901 to 4, 04,069 in the year 2011. Basin population more than thirteen times its size in 110 years and the growth rate varies from 75.34% (1971-81) to 0.51% (1941-51). The resultant effect of such growth led to rapid urbanisation within the study period and its implications on the micro climate of Baitarani basin cannot be overemphasized.

Temperature Trends in the Baitarani Basin

The trends of the five year and ten year moving average for annual, maximum and minimum temperature of the basin is discussed in this section. The annual temperature trend of the Baitarani basin for the period 1977-2014 is shown in figure 3. The trend line is rising due to urbanisation, deforestation, mining and growing industries. The pattern of trend observed in maximum temperature is increasing (Fig. 4). However the rising rate is higher at the interior area than the coastal area. The trend for minimum temperature is shown in figure 5. Fluctuation exists but the general trend shows a rise which becomes steady during the last decade.

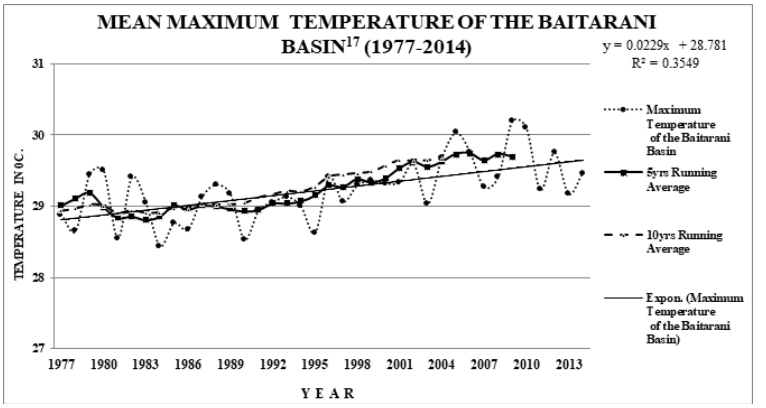
The findings above show that the variables (population growth and temperature) share one characteristics of a rise within the study period. However to be more precise about the strength of the relationship between variables correlation and regression analysis were carried out and results discussed.

Fig.2



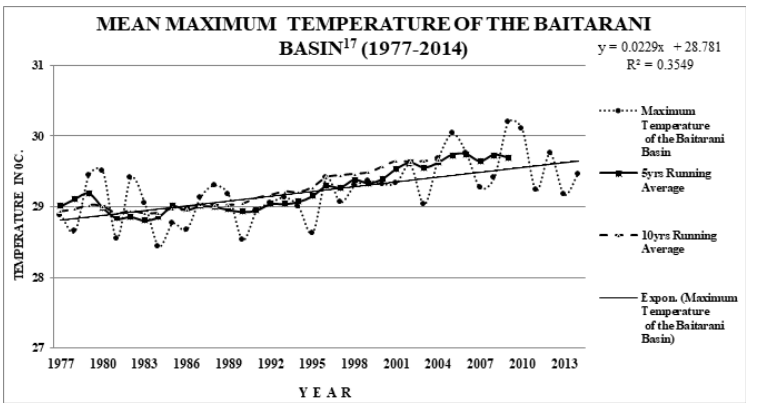
Source – Census of India

Fig.3



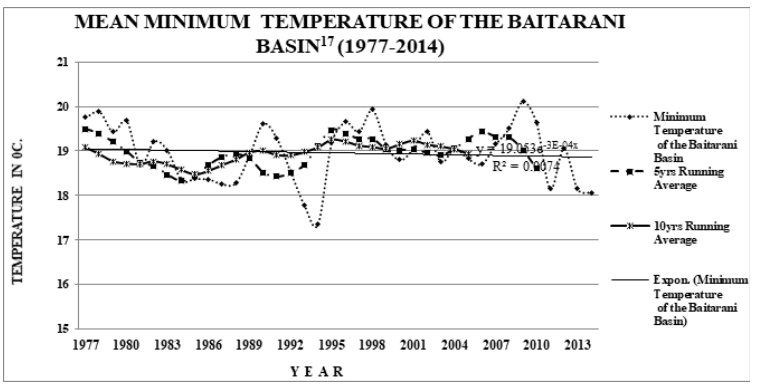
Source – IMD, Bhubaneswar

Fig.4



Source – IMD, Bhubaneswar

Fig.5



Source – IMD, Bhubaneswar

Results of Coefficient Correlation Analysis

The result of coefficient correlation is carried out. Positive relationship exists between urban centres and urban population (0.66), urban centres and annual temperature (0.47), urban centres and maximum annual temperature (0.88), urban population and annual temperature (0.78), urban population and maximum annual temperature (0.97). The implication is that as population raises tends to temperature rises. This finding has established the fact Baitarani basin is warmer and that the climate of the basin is being modified by the rapid urbanisation going on in the basin. The coefficient correlation analysis reflects population growth as a significant determinant of temperature in Baitarani basin.

Conclusion

The Baitarani basin is becoming warmer consequent of rapid urbanisation taking place in the area, the resultant effects of this on man's health and hence on his economy can be fatal if not curbed. Further research efforts should be geared towards finding ways of mitigating the negative effects of urbanisation on climate.

References:

1. Ahrens, C. Donald, (2005). *An Introduction to Weather, Climate and the Environment*, 8th Edition, International Student Edition, pp. 55-83, & 431- 457.
2. Bafghizadeh, Mohammad and Nagraz, H. (2010). The study of climate changes in Iran- A case study of Yazd District – *Annals*, Volume-XXX, No. 1 June, pp. 35-43.
3. Dubey, D.P. & Konojiya, M.L. (2000). Prediction of maximum temperature over Bhopal, *Vayumandal*, Vol. 32, No. 3-4, July-Dec, pp. 27-31.
4. Fouli, R.S. (1994). Effects of urbanisation on some meteorological elements in great Cairo region, Report of the technical conference on tropical urban climates, *WMO/TD*, No. 647, pp. 471-496.
5. Givoni, B. (1989). *Urban Design in Different Climates*, *WMO/TD*, Vol.. 346, Geneva.
6. Hansen, J.E. and Lacis, A.H. (1990). Sun and dust verses green house gases: An assessment of their relative roles in global climate change, *Nature*, No. 346, pp. 713-719.
7. J.M. Evans, and Silvia de Schiller, (1996). Application of Microclimatic Studies in Town Planning, *Atmospheric Environment,* Vol. 30, pp. 61-364.
8. Jones, P.D., Grusiman, P. Y., Coughlan M., Plummer N. Young, W.C and Karl, T.K. (1990). Assessment of urbanisation effects of surface air temperarure over land, *Nature.* Vol. 347, pp. 169-172.
9. Kerr, R.A. (1991). Global temperature hits record again, *Science*, Vol. 251, pp. 274-275.

10. Kumar, Manish; Kumar, Pankaj and Tripathy, D.K. (2012). Urban growth & its Impact on surface temperature in Greater Mumbai District, Maharashtra- A Geographical Analysis using Geospatial Techniques, *Annals*, National Association of Geographers, India, Vol. XXXII, No.2, December, pp. 71-81.

11. Khullar, D.R. (2008). *India-A Comprehensive Geography*, Kalyani Publishers, pp. 420-444.

12. Lansberg, H.E. (1956). *Physical Climatology*, 2nd ed., Gray Printing Co., Dubois, Pennsyvania, p. 201.

13. Levent Tuzin Baycan; Leeuwen Eveline; Rodenburg Caroline; Nijkamp Peter, (2004). Urban sustainability and green spaces, *Indian Journal of Regional Science*, Vol. XXXVI, 2004, No. 1, pp.1-6.

14. Olanrewaju, R. M. (2009). The Climate Effect of Urbanization in A City of Developing Country: The Case Study Of Ilorin, Kwara State, Nigeria. *Ethiopian Journal of Environmental Studies and Management,* Vol.2, No.2, pp. 67-72.

15. Pathak, C.R. (1993). Urbanization and Spatial Planning in India: Policy Issues, *Indian Journal of Regional Science*, Vol. XXV, No. 2, pp. 107-119.

16. Rath, P.K. (1995). Process of urbanisation in Orissa, *Spatial Dimensions of Geography*, Vol. XV, pp. 204-207.

17. Sarkar, D. & Sita, K. (1995). Trends in Temperature change in Bombay, *Spatial Dimensions of Geography*, Vol. XV, pp. 15-24.