International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 4 Issue 10, October-2015

Climate Change and its Impact on Nagpur's Water Supply

Shravankumar S M[A]
[A]Mtech Scholar National Institute of Technology
Nagpur 440010, India

Dr. A. D. Vasudeo[B]
[B]Proffessor National Institute of Technology
Nagpur-440010, India

***Abstract:-* Urbanization is one of the key defining features of humanity as a whole. The progressive migration of people from rural to towns and cities is a complex process inextricably tied to economic development and technological change in tandem with rapid urban sprawl. Cities are responsible for more than 70% of the total global energy consumption and more than 75% of the greenhouse gas emission which significantly increase the severity of climate change and energy security. Climate change is a growing concern with extensive implications for life on earth. Ecosystem and biodiversity, on which human existence depends, are increasingly facing multiple anthropogenic stresses caused by macro and micro climate change.**

Water resources are important to both society and ecosystems. Life on earth depends on a reliable, clean supply of drinking water to sustain health also there is need of water for agriculture, energy production, navigation, recreation, and manufacturing. In many areas, climate change has become ubiquitous and is likely to increase water demand in contrary to decrease in water supplies. This shift in balance would challenge water managers to simultaneously meet the needs of growing communities, sensitive ecosystems, farmers, ranchers, energy producers, and manufacturers. Many important economic activities, like producing energy at power plants, raising livestock, and growing food crops, also require water. The amount of water available for these activities may be reduced as Earth warms, and if competition for water resources increases.

Cities especially in developing countries like India are on the forefront for any impact due to climate change ranging from increasing surface temperature, metamorphosed wind, change in humidity and rate of evaporation, and as a consequence endanger the city with frequent extreme events like floods, droughts etc. The present work lays emphasis on impact of Climate Change on Nagpur city a fast growing Central India metropolitan, cradled among the vast natural resources which is mainly flanked by major and minor rivers like Kanha, Pench, and Nag etc.

Keywords: Climate Change, Urbanization, Water resources, Green House Gas, Artificial Neural Network, Temperature.

INTRODUCTION

The effects of urbanization and climate change are converging in dangerous ways. Cities are the engines for any economy in the world, they are catalyst for the ubiquitous spread of development and prosperity but also they have largest share in contributing to the consequences of climate change: although there are >5000 cities on earth's surface, these consume 80 per cent of the world's energy and produce more than 60% of all carbon dioxide and significant amounts of other greenhouse gas emissions, mainly through industrialization, which is driven by fossil fuels, hydro power and land grabbing after heavy deforestation etc.

Prediction of local rainfall is essential for estimating the probable effects of climate change and to undertake prudential measures. General Circulation Models (GCMs) provide the required data at a coarse scale, and these cannot be utilized for predicting the impacts over a small region. Hence, downscaling (the process of bringing down the coarse resolution data to a small region scale) has to be performed before the GCM data is used to assess the impacts. The most popular and efficient way of computational way is statistical downscaling. It includes (1) development of a statistical relationship between the predictors and the predictands, and (2) applying these relationships to the output of the GCM experiments to predict local climate for the future period. The statistics involved can be simple or extensive, but the final relationships are typically arrived at with some form of regression analysis (Chong-yu 1999). The approach or combination of approaches, used in a particular study, can be utilized to best reproduce the climate of another region. As compared to physically based downscaling techniques, these relatively compute with higher speed and the ease with which local climate variables can be derived.

STUDY AREA

Nagpur is situated in the heart of India impregnated with prodigious natural resources. The geographic location of Nagpur district extends from 20 °41 °N to 21 °41 °N latitude, and 78 °15 °E to 79 °45 °E longitude is girdled by stupendous dense forest which engulfs most alluring flora and fauna on the earth. It has been heralded as the "*Tiger Capital of India"*. Nagpur in accordance to Koppen climate classification has been classified as *tropical wet and dry climate,* with mostly dry conditions prevailing for most of the year. Nagpur has a climate, which has a tendency to reach the extremes as depicted in *Figure 2 Temperature Vs Years Plotted based on Data Provided by ND***C** from year 1933 to 2009 it can be observed that the peak or maximum temperature occurrences after 1950 have increased in contrast to prior to 1950, such extremities may become a boomerang for the consequences of climate change thus causing apocalyptic damages and hindering the disaster management efforts as, the consequences are difficult to predict and analyze, as no data or chronicles are available for customized analysis of the consequences of climate change impacts.

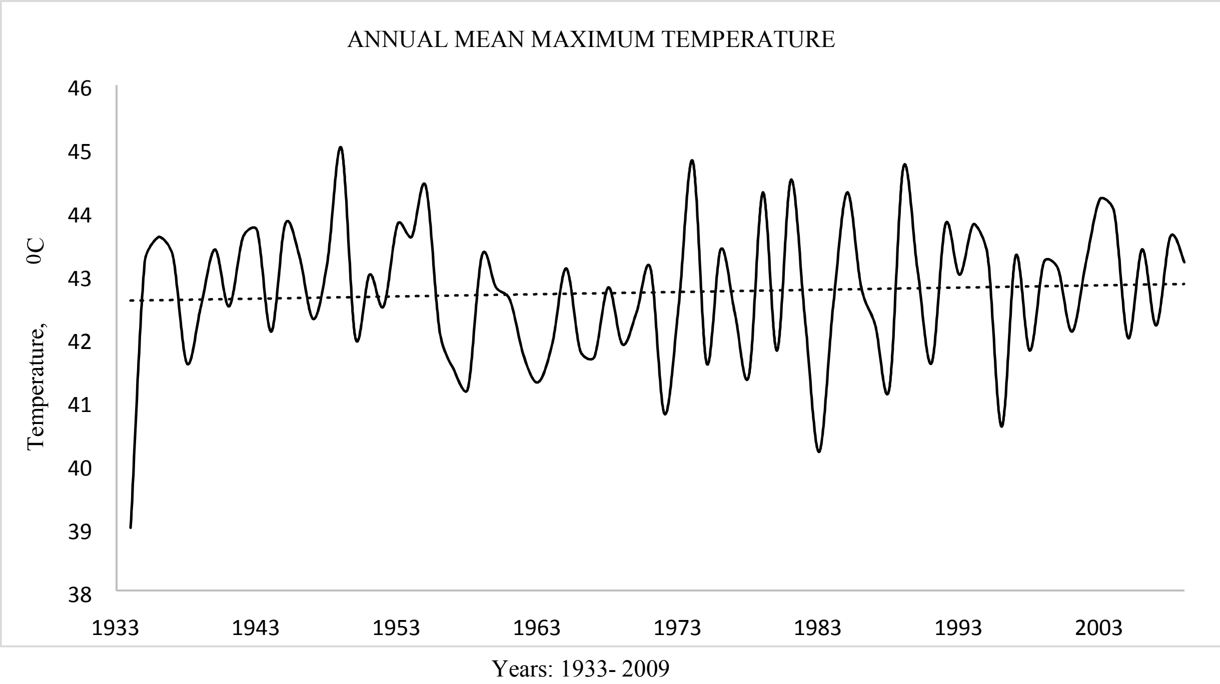

Figure 2 Temperature vs Years Plotted based on Data provided by National Data Center

Monsoon enriches Nagpur during the second week of June and brings relief from the sweltering dry heat; it's the major source for Nagpur's water supply. For Nagpur, the monsoon rains typically lasts from mid- June to early October and contribute more than 80% of the annual rainfall total. But in the last year 2014 it has seen a substantial deficit so , standing at about 37% below normal and close to the large deficit in experienced in 2009, which was, like 2002 before it, a year of substantial drought, bringing reduced crop yields and may hit its economy (http://theconversation.com/india-is-missing-its-monsoon-and-el-nino-could-be-theculprit-29133).

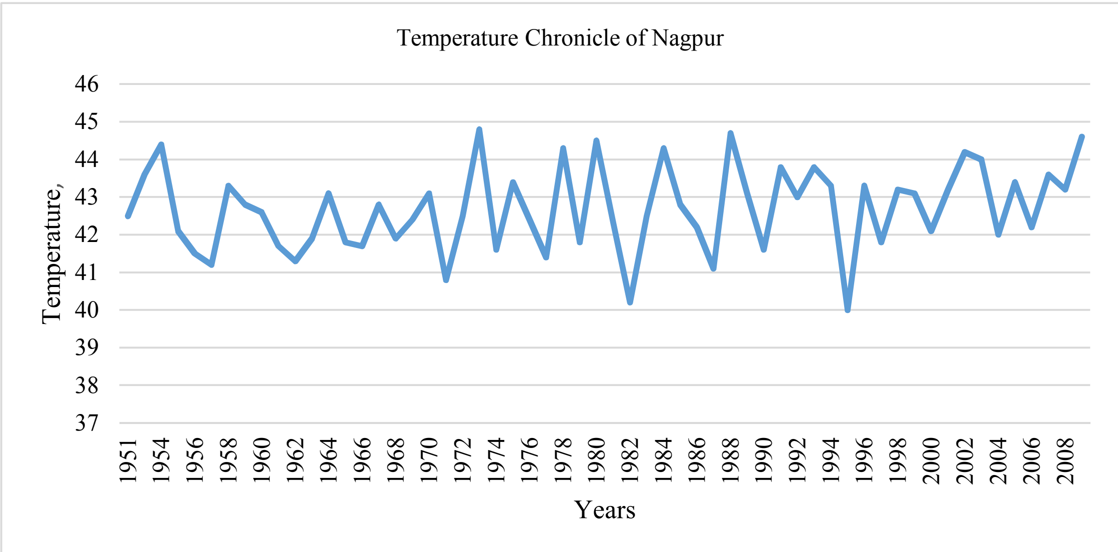

Figure 3 Nagpur Rainfall according to National Data Centre

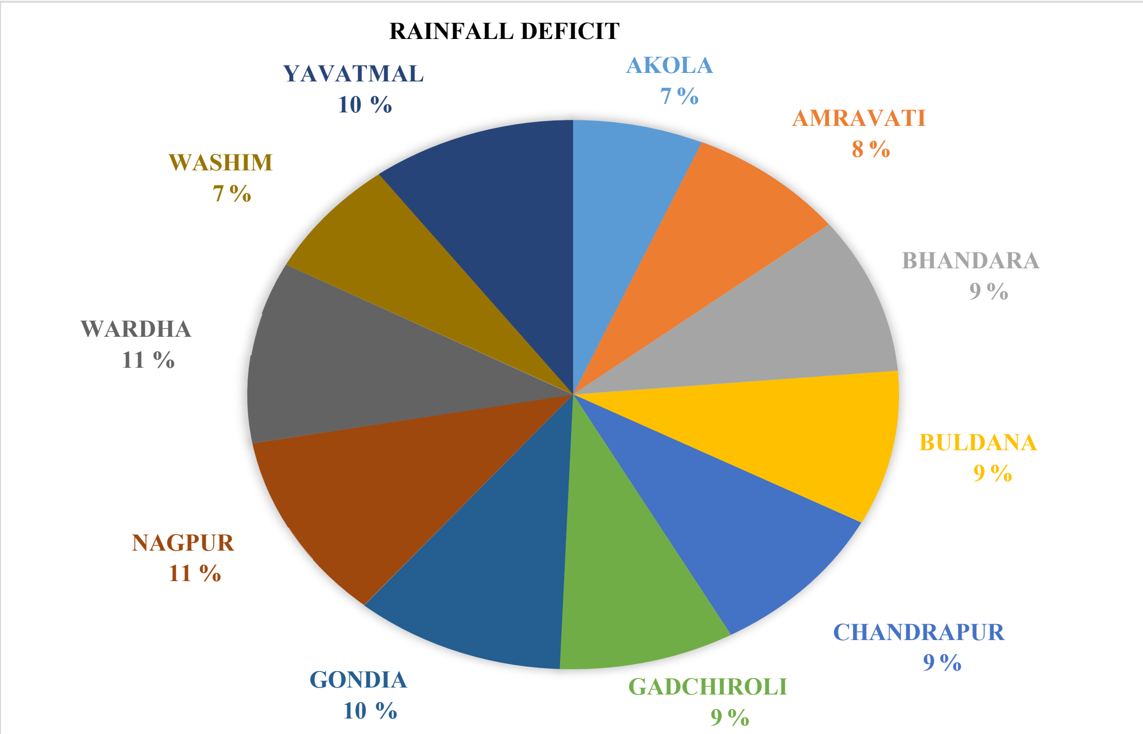

Figure 4 Monsoon Rainfall Deficit-2014 in Vidharbha Region

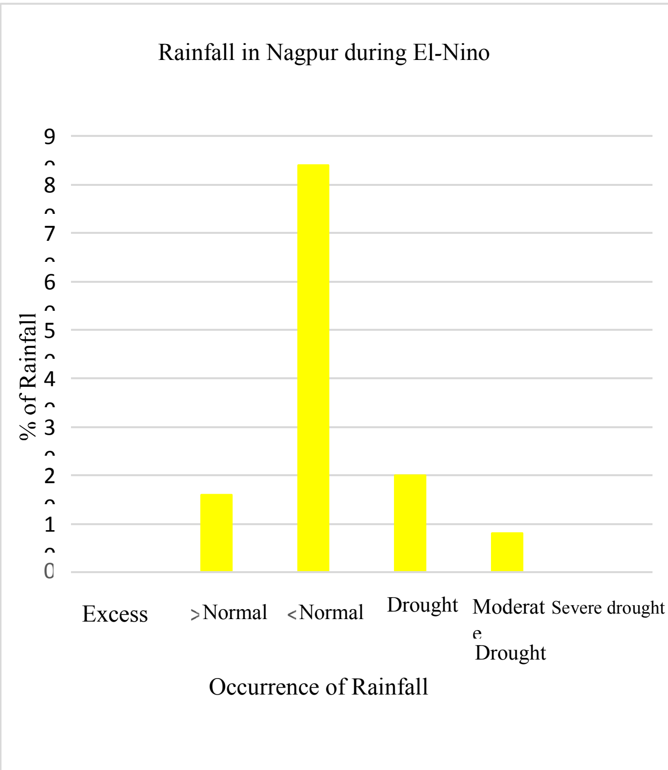

Figure 5 Nagpur Rainfall during El-Nino Episodes

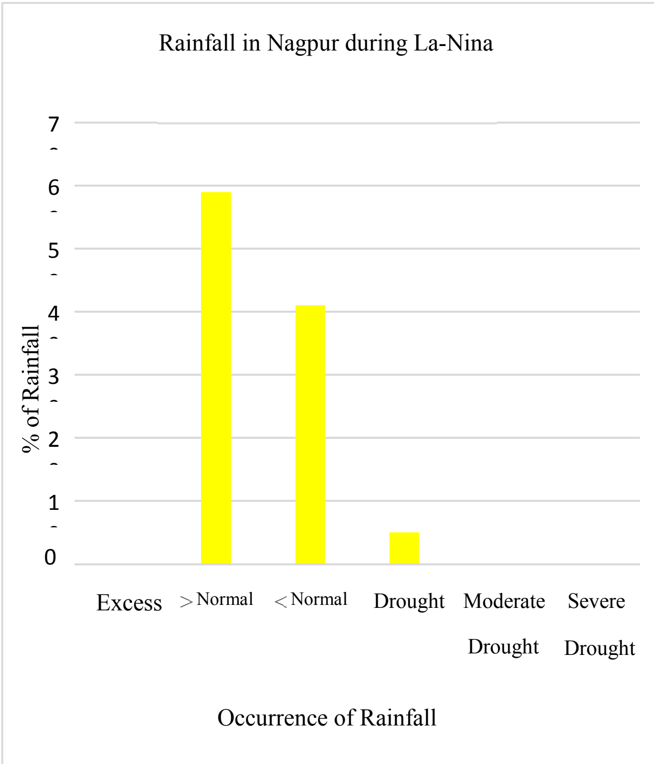

Figure 6 Nagpur Rainfall during La-Nina Episodes

The General Circulation Model (GCM) used in this study is the T63 version of the Canadian General Circulation Model (CGCM3.1). This is a third-generation coupled GCM developed at the Canadian Centre for Climate Modelling and Analysis (CCCma). The predictor data for the present-day (20C3M) and future simulations for the scenarios outlined by the Intergovernmental Panel on Climate Change (IPCC), viz. A1B, A2 and B1, on a monthly time scale for four grid points whose latitudes range from 20.77° N to 22.56° N and longitudes range from 78.94° E to 80. 75° E, were downloaded from the website http://www.cccma.ec.gc.ca/ data/cgcm3/cgcm3.shtml. ANNs are the mathematical models that mimic the pattern recognition and generalization capabilities of the human brain (Srinivasa and Gail 2005).
An ANN consists of multiple layers—an input layer, one or more hidden layers, and an output layer, in general. Each layer consists of different numbers of neurons depending on the requirement of the network. There are numerous types of networks, but a simple feedforward network trained by the Levenberg–Marquardt back-propagation algorithm (Hagan and Menhaj 1994) is used in this study. These data was simulated to an Artificial Neural Network (ANN) model developed on the data supplied by National Data Centre Relative Humidity, Wind Speed, and Temperature were used as *Predictors* and the Rainfall was as *Predictand*, of the available observed data for 59 years (1950–2009), data for the first 20 years (1950–1970) was used for calibrating the downscaling models, whereas the remaining data (1970–2009) was used for validating and testing these models. The parameters of each model were adjusted during calibration to obtain the best statistical agreement between the observed and predicted meteorological variables.

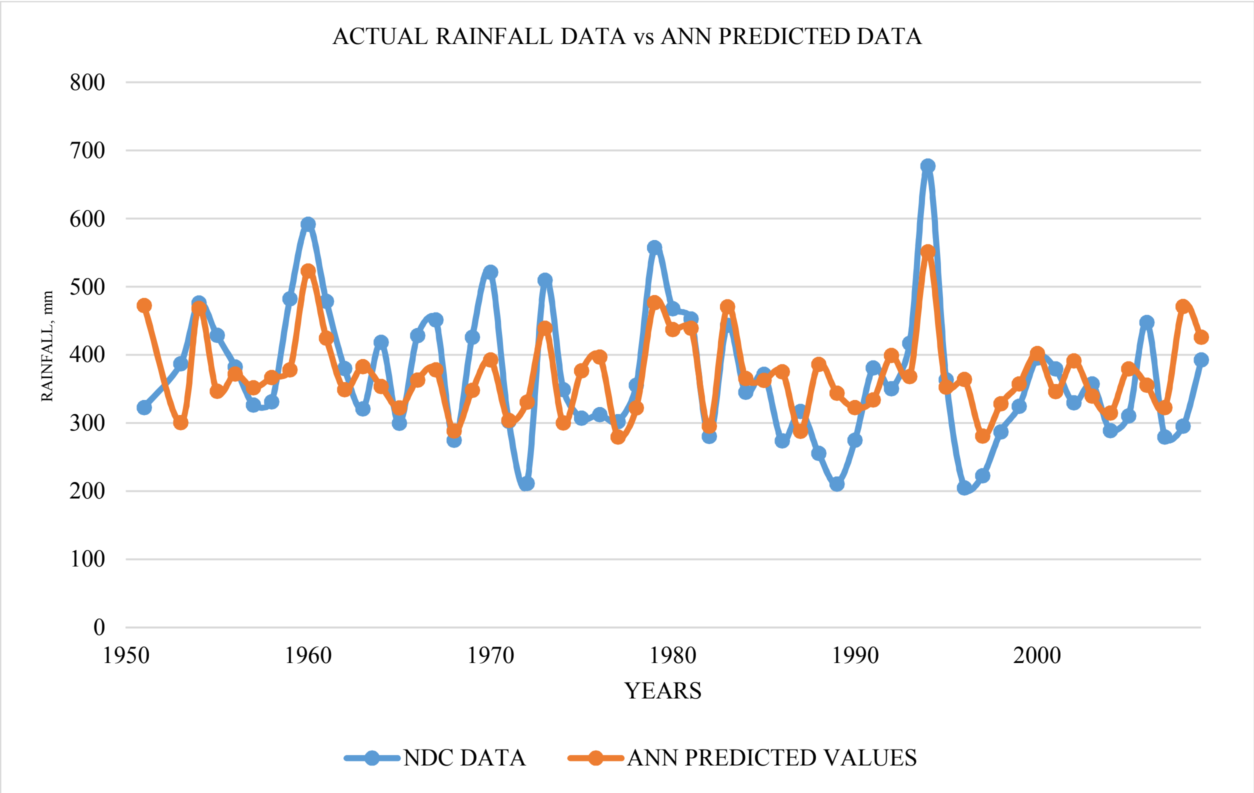

Figure 7 National Data Center (NDC) Observed DATA vs ANN PREDICTED DATA

RESULTS AND DISCUSSIONS

This literature has carried out a thorough analysis on the need to predict the Rainfall of Nagpur city which is a fastest expanding urban agglomeration, though the city is cradled among vast resources it will be soon dwindled if prudential measures are not taken.

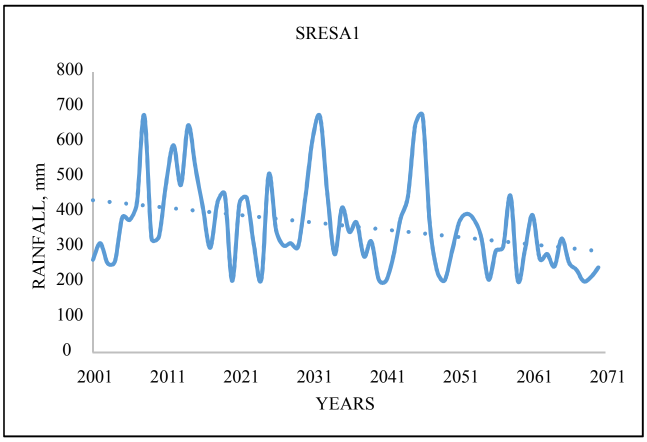

Figure 8 Rainfall Data from ANN prediction

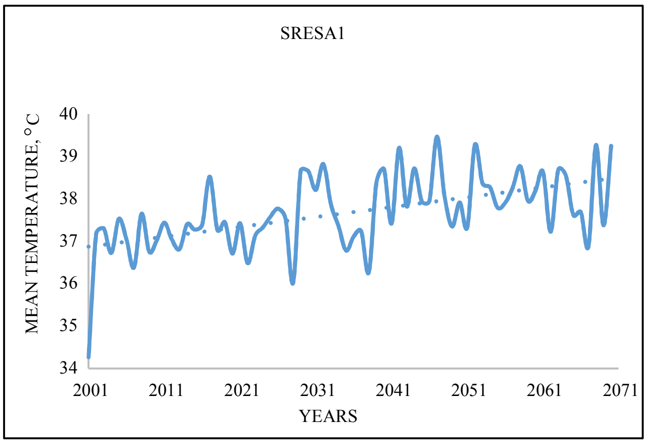

Figure 9 Mean Temperature GCM Data

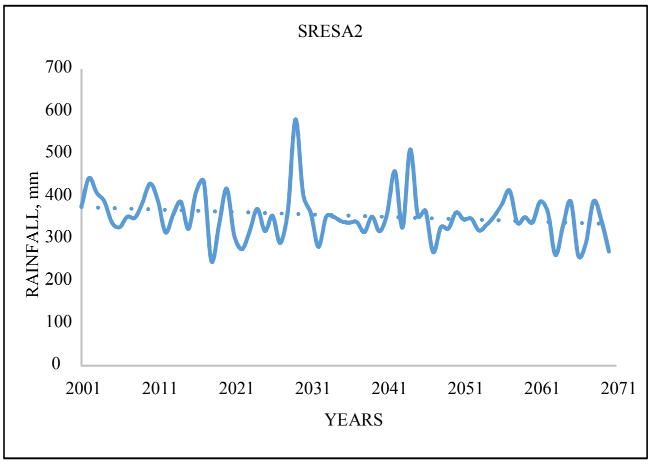

Figure 10 Rainfall Data from ANN prediction

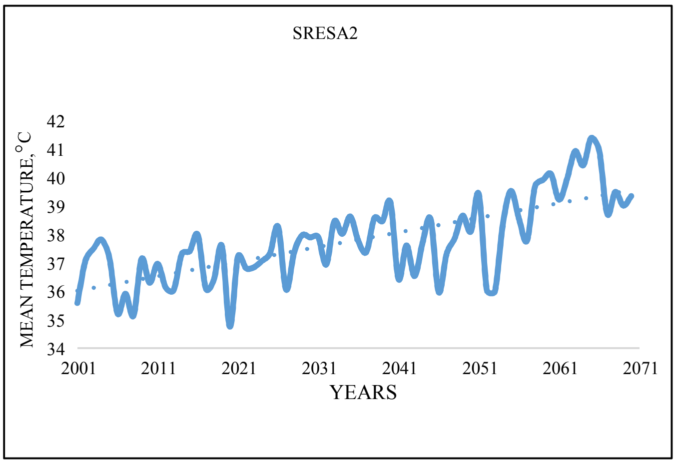

Figure 11 Mean Temperature GCM Data

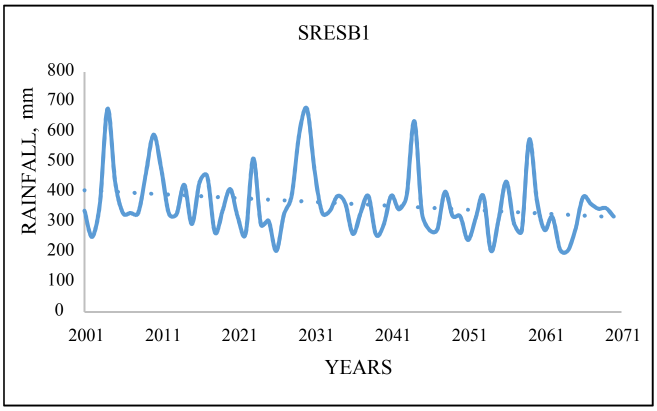

Figure 12 Rainfall Data from ANN prediction

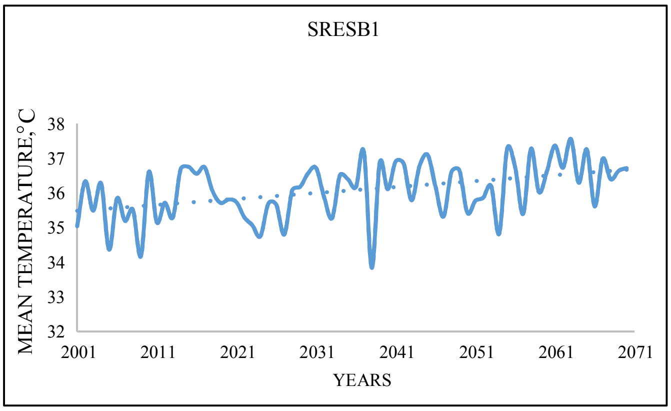

Figure 13 Mean Temperature GCM Data

CONCLUSION

Current water management infrastructure tends to be inflexible to changing circumstances as no consideration to the impact of climate change has been given. The strategic management of water resources is mostly based on obsolete population increase and to some extent losses and other paraphernalia e.g., Civic authorities of Nagpur have been planning to cater the further increase in demand of water supply through proposed Rahari barrage on Kanhan River, which will meet the water demand up to Year 2031. Kochi barrage and Jamghat will be required to be developed to meet water demand beyond 2031 for the projected population of 47, 50,000. But there is no approach to include the factors affecting due to change in climate, for instances it is common for cities to review past trends in order to anticipate heat waves and droughts and to develop plans to address spikes in electrical demand or in reservoir depletion, sustainable development or environmental friendly development, further a thorough research on Impact of continuous heat on energy systems; building materials, house orientations to the sun, roofing materials and construction, Building energy use, roof materials, Long term city government plans to replace roofing material and invest in energy wise materials and regulatory practices.

1. The sustainability of urban water management systems are designed to handle the varying and unpredictable conditions, this can be achieved through flexible and decentralized options in the water distribution system. Here a flexible system is one that has the potential to be an open system rather than a closed system. *Table 6* gives some examples of how a flexible urban water system would respond to changing conditions versus how a typical system would do so.
2. Decentralization is effective in making the risk less ubiquitous i.e., the risk dependent on one huge water treatment plant is now dependent on a more number of small scale operating water treatment plants, provided. Such approach is effective in operating as well as in maintaining. This tailor made approach has more flexibility and can be modified accordingly at any circumstances, decentralized treatment can be:

- ✓ Cost-effective and economical
- ✓ Avoiding large capital costs
- ✓ Reducing operation and maintenance costs
- ✓ Promoting business and job opportunities
- ✓ Green and sustainable
- ✓ Benefiting water quality and availability
- ✓ Using energy and land wisely
- ✓ Responding to growth while preserving green space
- ✓ Safe in protecting the environment, public health, and water quality
- ✓ Protecting the community's health
- ✓ Reducing conventional pollutants, nutrients, and emerging contaminants
- ✓ Mitigating contamination and health risks associated with wastewater

3. Strategic planning is a process able to deal with uncertainty and changing conditions, imperative in the context of climate change. It is necessary to have an integrated approach and a democratic approach, i.e., stakeholders should be taken into considerations during all phases of the decision making process, thus making a more accountable system and a holistic Integrated Urban Water Management (IUWM) approach.

REFERENCES

1. Nagpur Municipal Corporation's 24X7 Water Supply Project for Nagpur City.
2. Stationarity Is Dead: Whither Water Management? P. C. D. Milly[1] Julio Betancourt[2], Malin Falkenmark[3], Robert M. Hirsch[4], Zbigniew W[5]. Kundzewicz[6,] Dennis P[7], Lettenmaier[8,] Ronald J. Stouffer[9].
3. Climate of Nagpur, Dr. P. K. Nandankar, P. L. Dewangan, Mrs. R.V. Surpam
4. Cities and Climate Change: Responding to an Urgent Agenda, World Bank Report
5. Guide to Climate Change Adaptation in Cities, World Bank Report.
6. A model of Artificial Neural Network for the analysis of climate change, Vitoantonio Bevilacqua[1], Francesca Intini[2], Silvana Kühtz[3].
7. Adapting to Climate Change- STRENGTHENING THE CLIMATE RESILIENCE OF THE WATER SECTOR INFRASTRUCTURE IN KHULNA, BANGLADESH, ASIAN DEVELOPMENT BANK REPORT.
8. Artificial Neural Network Approach for Quantifying Climate Change and Human Activities Impacts on Shallow Groundwater Level —A Case Study of Wuqiao in North China Plain, Haorui Chen[1] , Shaoli Wang[2], Zhanyi Gao[3], Yaqiong Hu[4].
9. Long Lead Rainfall Prediction Using Statistical Downscaling and Artificial Neural Network Modeling, M. Karamouz[1], M. Fallahi[2], S. Nazif1 and M. Rahimi Farahani[3]
10. NMC Augmentation to Nagpur City Water Supply Scheme.