



CLIMATE CHANGE IMPACT ON TOURISM

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Abstract

Tourism is the second largest growing business area after information technology in the service sector of the global economy. Generally, tourism creates both direct and indirect employment for the people around the destination. Particularly tourism in Tamil Nadu – India has received a major thrust since last decades compared to other states. But the climate change resulting fluctuation in temperature and rainfall pattern causes the damages to the natural resources. This impact results in loss of vegetation, spreading infectious disease and waterborne diseases. To understand the impact of climate change in the tourist places, the trends in temperature and rainfall data are analyzed using statistical test namely Mann-Kendall (MK) trend detection test. 100 years and 50 years of monthly data for temperature and rainfall have been used. The hilly regions of Tamil Nadu i.e., The Nilgiris and Dindigul are chosen as the study area. This analysis results there is an increasing temperature for The Nilgiris district. These findings will be useful for environmentalists and tourist authority to avoid the future impacts.

1. Introduction

Global as well as regional climate has changed due to human activities like land use changes, industrial toxic effluents, forest fire and other impact activities. This consequence changes have massive impact on atmospheric

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events such as precipitation, temperature, air, water etc. [1] declared that earth is going through an intermediate zone of climate change, if this trend continues for as long as hundred years, climate will try to reset its eco-balance system and it results in floods, droughts and forest fires.

Trends in temperature and rainfall causes the direct impact on tourism sector. As we all known that the tourism resembles with four 'A's framework such as attraction, access, amenities and ancillary services so it is important to develop an adaptation and mitigation strategies using present and future forecasting information. To track the effects of climate change on human health 40 indicators are used and it resulted that the temperature raised three times higher than the average global temperature between the time period 2000 to 2016 [2]. This extreme temperature and fluctuation in rainfall causes impacts to both human and vegetation. In humans, adults can tolerate the extreme temperature and actively seek help by themselves but the children needs the adult support [3]. The current birthrate for world and India in 2021 are 17.873 and 17.377 per 1000 people [4]. By considering the birthrate factor of newborns and their health factor, climate change future impacts should be predicted and controlled. Population growth, urbanization, and industrialization during the last 30 years could be some of the reasons for warming trend in temperature that may lead to increased aridity during summer and spring seasons and will put more pressure on surface and ground water resources [5]. The deforestation activities not only reduce the forest cover but also release more carbon dioxide into the air, which in turn will be a prime cause of temperature rise and drop in rainfall. The recent worldwide trend on tourism, Asia scored six percent upward as interest destination among other countries [6]. To maintain the same ranking and to achieve forward, the climate change impacting environmental factors of tourism such as coastal zones tourism and mountain region tourism should be considered:

Worldwide climatologists are investigating to find a possible relation of climate change with anthropogenic behavior by studying trends in different climatic parameters [1]. According to [7], during the time (1901-2000) the increases in global surface temperature has occurred in two periods, namely 1910 to 1945 and 1976 to 2000. These two periods are referred as global warming periods and (1901-1909) and (1946-1975) have been referred as non-global warming periods [8]. The universal weather related disasters from

2007 to 2016 increased by 46% as compared with average time period from 1990 to 1999, particularly in Asia 4.8 billion people were affected and 500,000 died [2]. Furthermore, when global warming is increasing then there is a decreasing trend from high to medium rainfall and on the other hand, there is an increasing trend for heavy, very heavy and extremely heavy rainfall which is responsible for flood, landslides [9].

To analysis the trends in temperature and rainfall, Mann-Kendall (MK) trend test is used in this study. [10] highlighted that the non-parametric Mann-Kendall (MK) trend test stands out to be one of the best methods to detect trend in climatological variables. Non-parametric Mann-Kendall test a statistical procedure that is sound matched for analyzing trends in data over time [11]. Set the significance level to 95% ($\alpha = 0.05$) in Mann-Kendall test [1, 5, 12, 13]. Determined the trends in their studies using MK trend test. Hereby MK trend test is used to analyze the temperature data and rainfall data to understand the trends to avoid tourism impacts

2. Materials and Methods

1.1 Study area. Tamil Nadu is the southernmost state in the Indian sub-continent. Tamil Nadu covers over 1, 30, 000 sq.kms, representing nearly four percent of Indian Geographical area. The topography of Tamil Nadu consists broadly of the coastal plains of the east, with uplands and hills as one proceeds westward and with the plains accounting for a little more than half of area of the state. In this fabulous state, two of the tourist places are always having a plenty of tourists due to their low temperature condition i.e., one is Ooty in the district of The Nilgiris and the other is Kodaikanal in the district of Dhindigul. The Nilgiris is situated in the north-western corner of Tamil Nadu. Ooty town (Udhagamandalam town) is the headquarters of the taluk and of the district. The abrupt rise of The Nilgiris from the surrounding areas is very striking Doddabetta (2637m) is the second highest peak in India, south of Himalayas. Udhagamandalarn (Ootacamund) is popular hilly region in our study area having higher number of tourists is situated in a broad undulating valley at the foot of Doddabetta. Dindigul is the administrative headquarters of the Dindigul district. In this district, Kodaikanal is one of the very popular destination hill resorts and it is also called as the “Princess of Hill stations”.

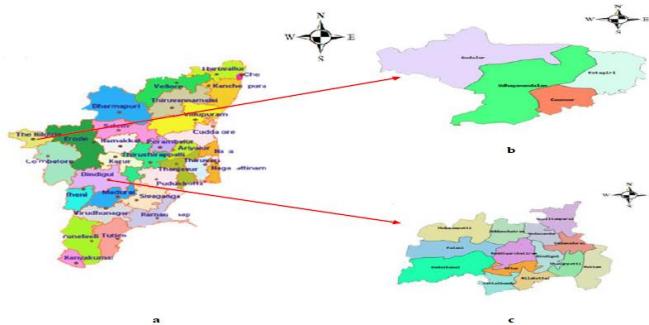


Figure 1. (a) Tamil Nadu Districts Map, (b) The Nilgiris Map, (c) Dindigul Map.

1.2 Data. In this present study, monthly average, monthly maximum and monthly minimum temperature data for the time period 1901 to 2000 and monthly average rainfall data for the time period 1953 to 2002 were collected through Open Government Data (OGD) Platform, India through the online link <http://data.gov.in>.

1.2.1 Data analysis – Trend Detection

Trend is defined as the general movement of a series over an extended period of time or it is the long-term change in the dependent variable over a long period of time. Statistical analysis namely Mann-Kendall test is recommended and used in this study.

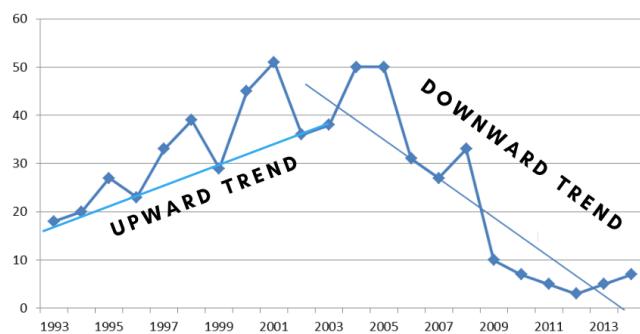


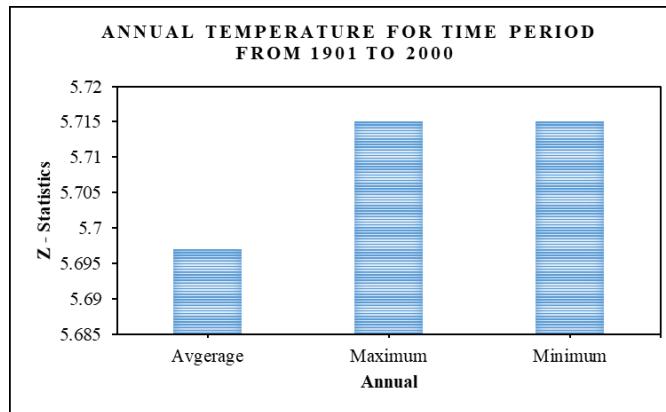
Figure 2. Upward and downward trends.

3. Results and Discussion

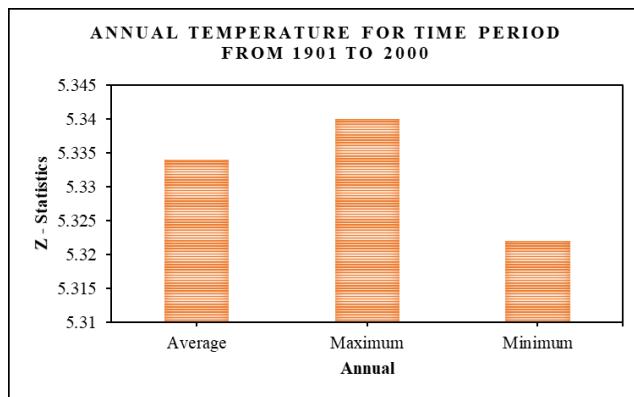
Tourism has complex relationship with weather and climate of destination country before the initiate the travel plan. To have wonderful travel, the unexpected temperature and rainfall pattern should not create any problem. This study analyzes the trend pattern from the historical 100 years temperature data and 50 years rainfall data to identify whether is there any fluctuation in the pattern. The eWater Toolkit is used to analyze the temperature and rainfall data to determine the trends in both study area.

1.3 Temperature Trend

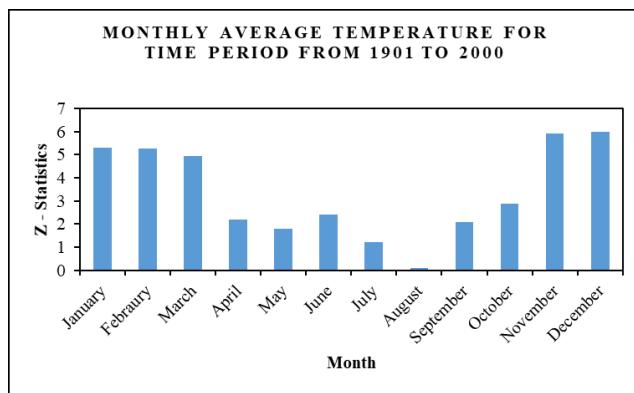
The temperature data run in the model to analyze the trends in the category of annual average, annual minimum, annual maximum, monthly average, monthly minimum and monthly maximum. The significant level considered here are 95% and 90%. The trends resulted only for the study area. The Nilgiris and there are no trends for Dindigul under any category. The resulted trends of The Nilgiris is under the category of monthly average, monthly minimum and monthly maximum corresponding significant level is 90% which is minimum allowed data limit considered.



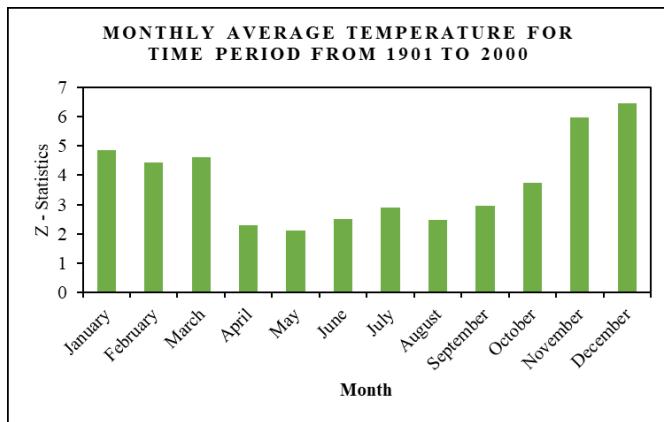
The Nilgiris - Annual Temperature (Average, Maximum, Minimum)



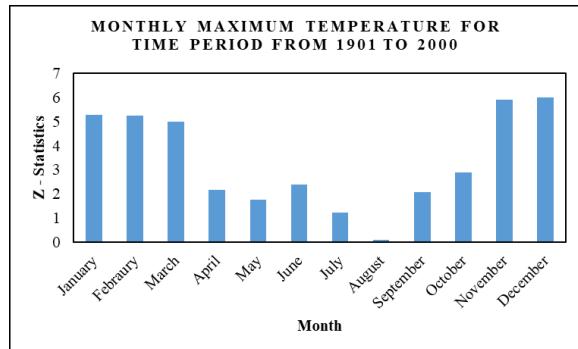
Dindigul - Annual Temperature (Average, Maximum, Minimum).



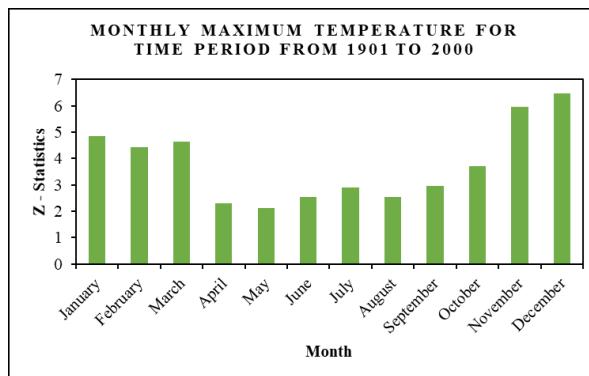
The Nilgiris – Monthly Average Temperature.



Dindigul – Monthly Average Temperature.



The Nilgiris – Monthly Maximum Temperature.



Dindigul – Monthly Maximum Temperature.

Figure 3. Annual and Monthly temperature series of The Nilgiris and Dindigul.

Table 1. Mann-Kendall test result for the temperature time series.

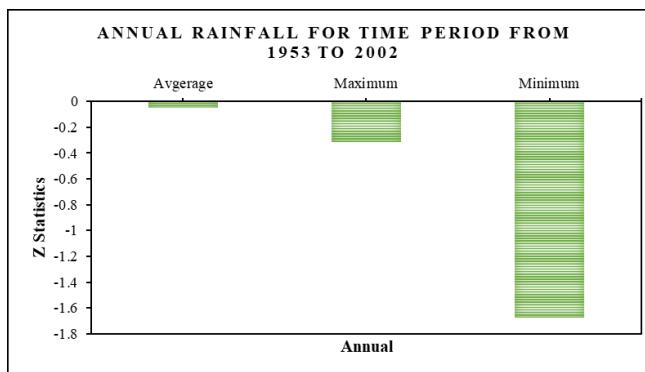
Study Area	Temperature Time Period	Result	Corresponding Month
The Nilgiris	Annual Average	No Significant Changes @ (0.05) and (0.10)	-
	Annual Minimum	No Significant Changes @ (0.05) and (0.10)	-
	Annual Maximum	No Significant Changes @ (0.05) and (0.10)	-
	Monthly Average	Significant Changes @ (0.10)	May
	Monthly Minimum	Significant Changes @ (0.10)	May

Dindigul	Monthly Maximum	Significant Changes @ (0.10)	May
	Annual Average	No Significant Changes @ (0.05) and (0.10)	-
	Annual Minimum	No Significant Changes @ (0.05) and (0.10)	-
	Annual Maximum	No Significant Changes @ (0.05) and (0.10)	-
	Monthly Average	No Significant Changes @ (0.05) and (0.10)	-
	Monthly Minimum	No Significant Changes @ (0.05) and (0.10)	-
	Annual Maximum	No Significant Changes @ (0.05) and (0.10)	-

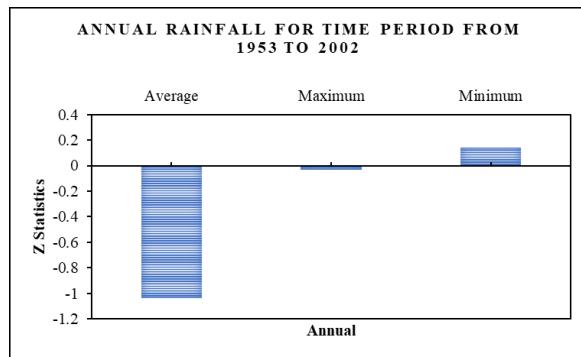
From the above trend analysis model for the time period of 1901 to 2000 shows that one of the two districts resulting in temperature. Hereby clearly confirming that the temperature for The Nilgiris is getting increased. This might directly decrease the number of tourists.

1.4 Rainfall trend

Due to lack of rainfall data, the model run only under the category of annual average, annual minimum and annual maximum. The significant level considered here are 95% and 90%. There are no trends resulted for both the study area.



The Nilgiris - Annual Rainfall (Average, Maximum, Minimum).



Dindigul - Annual Rainfall (Average, Maximum, Minimum).

Figure 4. Annual rainfall series of The Nilgiris and Dindigul.

Table 2. Mann-Kendall test result for the rainfall time series.

Study Area	Rainfall Time Period	Result	Corresponding Month
The Nilgiris	Annual Average	No Significant Changes @ (0.05) and (0.10)	-
	Annual Minimum	No Significant Changes @ (0.05) and (0.10)	-
	Annual Maximum	No Significant Changes @ (0.05) and (0.10)	-
Dindigul	Annual Average	No Significant Changes @ (0.05) and (0.10)	-
	Annual Minimum	No Significant Changes @ (0.05) and (0.10)	-
	Annual Maximum	No Significant Changes @ (0.05) and (0.10)	-

The Nilgiris temperature trend of significant changes at the level of 90% resulting that the increase in temperature started already between the time period of 1901 to 2000. It is necessary to take proper action to impact the vegetation, climatic factor, tourists and environmental problems.

4. Conclusion

From the above analysis, it is concluded that climate change initiated the impacts on temperature in the study area. If the temperature rises, the

consumption of energy like water, electricity will be increased and if the rainfall rises, the infrastructures and water network should be renovated to withstand on high floods. Therefore, this study of temperature and rainfall trends can help both the public and the government as precaution measures. This imply also socio-economic and environmental impacts; hence it is recommended to take immediate decision and action for now and future prevention measures on tourism industry that depends mainly on climate and natural environment. In the tourist spot, the ecofriendly products, easy access of transport with less carbon emission, food serving with recyclable items should be adapted and the accommodation sector should install the water and energy efficiency system. The policy makers should respond appropriately to face these challenges for maintaining the atmospheric greenhouse gases concentration to the allowable limit as per the global climate system. Future studies will be recommended with recent datasets to help the public and government in all the ways.

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