IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

EXTREMENESS OF TEMPERATURE AND ITS IMPACT ON HUMAN SOCIETY THROUGH CASUALTY BY HEAT AND COLD WAVES IN SELECTED DISTRICTS OF WEST BENGAL

Dr. Amit Kumar Majumder

Ex-Research Scholar, Department of Geography, University of Calcutta, amitcugeo@gmail.com

Abstract: With increasing mean maximum temperature, decreasing mean minimum temperature, temperature related extreme weather events like heat wave and cold wave are increasing and causing adverse impact through human death. An effort is made to find out the adverse impact of increasing range of temperature by the means of heat and cold wave on human society of the study area. Annual range of temperature is increasing .Intensity of both events are increasing. Annual frequency of heat and cold waves are correlated with their annual casualty. Casualty of severe heat and cold waves are more than that of moderate intensity.

Key words: Temperature trend; Heat and cold waves; Casualty; Correlation

Introduction: Fluctuation in temperature extremes is a common phenomenon. When such fluctuation exceeds a certain limit heat and cold waves occur. Frequency, duration and intensity of heat wave are increasing with rising temperature. Average temperature of India has increased by 0.7°C (1901-2018).By the end of century , average temperature is expected to rise by 4.4°C and intensity of heat waves will increase (R.Krishnan et.al.)

With increasing frequency and intensity of heat and cold wave events, adverse impact on human, livestock and agriculture is hiking. Heat stroke is main reason of casualty especially to farmers, who remains exposed to heat waves. Footpath dwellers become victimised most by cold waves. In India, 17362 deaths by heat wave and 9596 deaths are enlisted by cold waves during 1970-2019(K. Ray et.al)

India Meteorological Department has defined and categorised heat and cold waves as follows.

Heat Wave: Type (A)-Normal Maximum temperature ≤40°C, Moderate heat wave: Day temperature 5°C-6°C above normal. Severe heat wave: Day temperature 7°C or more above normal. Type (B)-Normal maximum temperature >40°C, Moderate heat wave: Day temperature 3°C-4°C above normal, Severe-Day temperature 5°C or more above normal.

Cold Wave :(A)-Normal Minimum temperature is 10°C or more. Moderate cold wave: Night temperature 5°C-6 °C below normal. Severe Cold wave: Night temperature 7 °C or more below normal. Type (B)-Normal minimum temperature is <10 °C. Moderate Cold wave -Night temperature 3°C-4 °C below normal. Severe Cold wave - Night temperature 5°C or more below normal.

Study area: Study area lies at the southern part of Gangetic West Bengal (meteorological sub division) and touches the Bay of Bengal in two districts, Purba Medinipur and South 24 Parganas. Study area comprises North 24 Parganas, South 24 Parganas, Purba Medinipur, Haora and Kolkata.This area extends from $21^0$26' N to $23^0$01.02" N and $87^0$27' E to $89^0$09' E and encompasses about 20,419 sq. km area.

Study area is mainly destructed by rain and wind related disaster but considering frequency of heat and cold waves per 1000 sq.k.m. area is much more in Kolkata than the western districts. So, an attempt is done to determine the impact of temperature related extreme weather events even in Kolkata and its surrounding districts.

Objectives: The main objectives of the study area are as follows.

- To find out the temperature trend.
- To identify the frequency, duration and intensity of heat and cold wave events.
- To assess the casualty by heat and cold waves.
- To explore the correlation between frequency/intensity of heat and cold waves with their casualty.

Methodology: Normal of temperatures is calculated from 30 years (1981-2010) temperature data of 10 observatories on annual, seasonal, and monthly basis. Anomaly of temperature is determined for heat wave and cold wave occurring months. Range of temperature is determined from the difference of mean maximum and mean minimum temperature. Trends are analysed by linier least square method. Correlation between annual occurrences and annual casualty is determined from Pearson's correlation coefficient. Casualty by different intensity groups of heat and cold wave are compared by Mann Whitney U test for not been passed the normality test and assumption of homogeneity of variances.

Data Consideration: Temperature characteristics are determined from monthly mean maximum and minimum temperature from 1981 to 2010 of 10 observatories (Alipur, DumDum, Diamond Harbour, Canning, Sandheads, Sagar Island, Contai, Digha, Haldia, and Uluberia). Frequency, duration, intensity and casualty of heat and cold wave events are analysed from annual reports on Disastrous Weather Events(1981 to 2020).

Result and Discussion:

Temperature trend and anomaly: In Study area annual mean maximum temperature (r=0.498) and annual range of temperature is increasing significantly(r=0.496). Though annual mean minimum temperature is decreasing (r= -0.218, statistically insignificant). Mean maximum temperature(r=0.598) and mean minimum temperature(r=0.401) of hot season are increasing significantly. With it mean minimum temperature of winter season is significantly decreasing (r= -0.705). Mean maximum temperature of heat wave occurring months (April, May and June) is increasing significantly (r=0.685) and mean minimum temperature of cold wave occurring months (November, December and January) is decreasing significantly(r= -0.618).

Heat and cold wave occurrences: During 40 years (1981-2020) 38 heat wave incidents are recorded of which 28 are severe and remaining 10 are categorised as moderate heat wave. Decade of 2001-2010 has experienced the highest occurrences (18), 12 incidents in 1991-2000, 5 occurrences in 2011-2020 and 3 heat waves occurred in 1981-1990. The year 2005 has experienced repetitive claws of heat waves (7).May and June are the months of huge occurrences. North 24 Pagans (13) and Kolkata (12) faced more hit of heat waves. Number of heat waves in second 20 years (1981-2000) are more (23) than first 20 years (15). Most of the heat waves are of single day occurrence (30), 7 incidents are with two consecutive days. Only a single incident of heat wave is observed with four consecutive days. Annual frequency (r=0.112), and duration in days (r=0.122) are increasing but intensity (r= -0.110) of heat wave incidents are decreasing though these trends are not statistically significant.

In 40 years (1981-2020) 27 disastrous cold wave events are identified, of which 20 events have reached to severe intensity and rest 7 are of moderate intensity. A decade of 1991-2000 has witnessed 11 cold waves while its preceding and following two decades have experienced 7 and 9 incidents of cold wave respectively. First 20 years have contacted with double frequency of cold waves than that of the 2nd 20 years span. The year 2005 also highlighted for annual occurrences (5). All the cold wave events have found in the months of November to January. A hike in occurrences is seen in January (19).Highest slap of cold wave is noticed in Kolkata (13) and followed by Purba Medinipur (7).

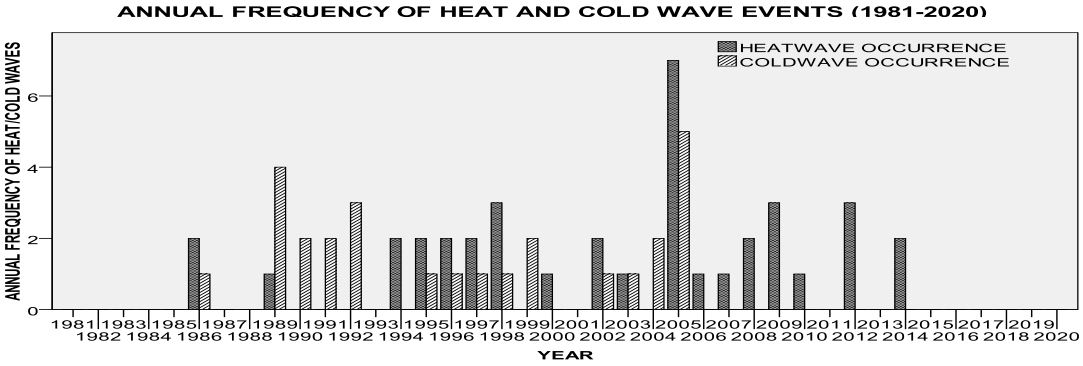

Figure 1: Annual frequency of heat and cold wave events (1981-2020)

No significant increasing trend is observed in annual trend of cold wave event. Among all cold wave event, 22 events are with single day, 4 events occurred with two consecutive days and only a single event is categorised with 4 consecutive days. Annual cold wave frequency (r= -0.206) and duration in days is decreasing (r= -0.256), though the trends are insignificant. Intensity of cold wave incidents are reducing significantly (r=-0.434).

Positive anomaly with 1°C or more is noticed in 24 years of which 14 years have identified as heat wave occurring months and negative anomaly with 1°C or more is determined in 20 years, from which cold wave incidents are marked with 11 years.

No significant correlation is established between mean maximum temperature of heat wave occurring months and frequency of heat wave events(r=0.147, significance-0.437). Also between mean minimum temperature of cold wave occurring months and frequency of cold wave events (r=0.166, significance-0.381).

1°C or more than 1°C positive departure from normal (positive anomaly) of mean maximum temperature of heat wave occurring months is identified in 22 years and in 20 years, 1°C or more than 1°C negative departure from normal (negative anomaly) of mean minimum temperature of heat wave occurring months is marked.

Two individual occurrences of heat and cold wave events per 1000 sq.km area in entire study area are determined.

Table 1: District wise variation in frequency of heat and cold waves per 1000 sq.km area and district frequency

	Haora		Kolkata		North 24 Parganas		Purba Medinipur		South 24 Parganas	
	Frequency/ 1000 sq.km	Frequency	Frequency/ 1000 sq.km	Frequency	Frequency/ 1000 sq.km	Frequency	Frequency/ 1000 sq.km	Frequency	Frequency/ 1000 sq.km	Frequency
Heat wave	6	8	65	12	4	13	3	10	1	5
Cold wave	1	1	71	13	1	3	2	7	1	3

Human Death by Heat and cold wave events: In the study area 94 human deaths and 51 injuries to people are reported by heat wave. Cold wave has snatched 67 human lives. Human death by heat wave in last 20 years (2001-2020) is 72 while 22 human deaths were enlisted in first 20 years (1981-2000). But in case of cold wave first 20 years have experienced more death (55) than the last 20 years. Decadal casualty by heat wave is highest (43) in the decade of 2001-2010 and followed by the decade of 2011-2020 (29) .In case of Cold wave, highest decadal death is observed during 1991 to 2000. In the decade of 1981-1990, 18 human deaths are reported.

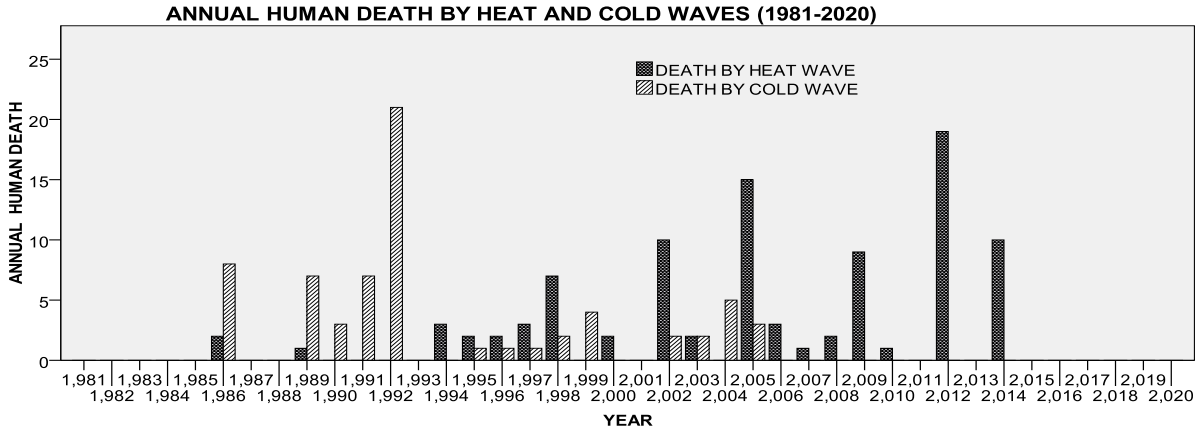

Figure 2: Annual number of human death by heat and cold waves (1981-2020).

Annual casualty by heat wave (r=0.228) is maintained an increasing trend and but casualty by cold wave(r= -0.264) is decreasing. The year 2012 and 2005 are marked for immense numbers of casualty by heat wave event, 19 and 15 deaths respectively. In 1992 cold wave took 21 human lives.

A severe heat wave, occurred on 2nd-3rd June, 2005 seized 11 human lives and in Kolkata and two 24 Pargans. Another 16 people were killed by a cold wave with severe intensity on 1st -2nd January, 1992 in Kolkata.

Casualty by heat wave in entire study area is 29 persons/10 million population and casualty by cold wave event is 21 persons/10 million population.

Table 2: District wise variation in casualty per 10 Million populations

	Haora	Kolkata	North 24 Parganas	Purba Medinipur	South 24 Parganas
Heat wave	31	43	29	36	16
Cold wave	5	69	40	42	11

Correlation between annual frequency/ intensity of extreme weather events and annual casualties by extreme weather events:

Such correlation is tested with two hypotheses.

First Hypothesis- "Higher the frequency of Extreme Weather Events greater the casualties"- To test the hypothesis Pearson's correlation coefficient is used as test statistics where annual frequency of heat or cold wave event is taken as independent variable and annual casualties by such event is selected as dependent variable. Null hypothesis (H_0) is assumed, there is no correlation between two variable (H_0: P=0).Alternative hypothesis (H_1) is assumed, a correlation exists (H_1:P≠0) between two variables.

A significant correlation {p≤0.5 (α), df-39} is observed in case of Heat wave(r =0.823) and Cold wave(r =0.658,) and null hypothesis is rejected. So, the hypothesis, higher the frequency greater the casualty is proved.

Table 3: Descriptive and regression for heat wave

Variables	N	Std. Deviation	Mean	Standardized Coefficients (Beta)	Significance
Annual heat wave occurrence	40	1.413	0.95	0.823	0.000
Annual heat wave casualty	40	4.383	2.35		

Table 4: Descriptive and regression for cold wave

Variables	N	Std. Deviation	Mean	Standardized Coefficients (Beta)	Significance
Annual cold wave occurrence	40	3.805	1.68	0.658	0.000
Annual cold wave casualty	40	1.185	0.68		

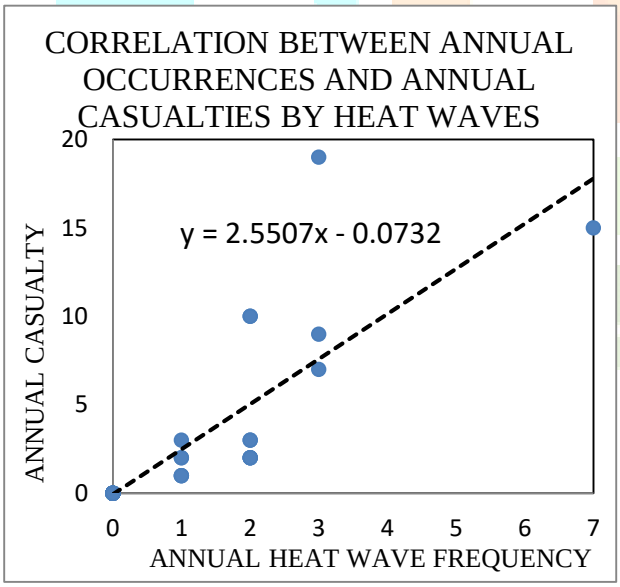

Figure 3: Correlation between annual frequency and annual casualty by heat wave

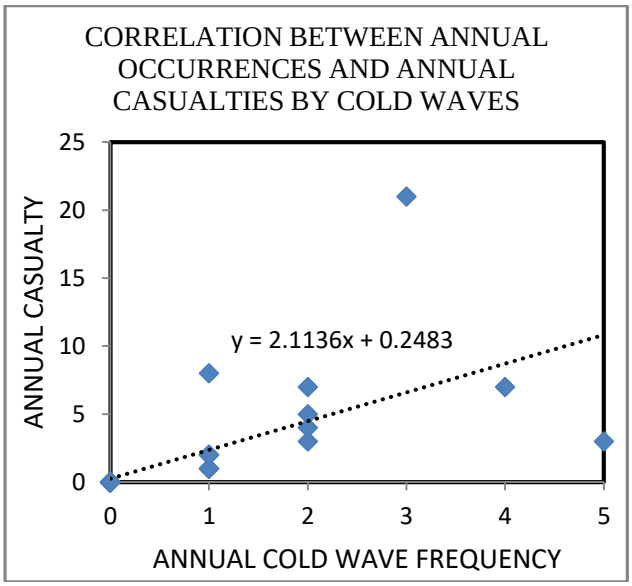

Figure 4: Correlation between annual frequency and annual casualty by cold wave

Second Hypothesis– "Higher the intensity of Extreme Weather Events greater the casualty". Null hypothesis (H_0) is assumed two subgroups (severe and moderate) of heat and cold wave are equal and alternative hypothesis (H_1) is two subgroups are not equal. Casualty data of two sub groups has not been passed normality test and assumption of homogeneity of variances, Mann Whitney U test is used. Mean rank of severe intensity of heat and cold wave events are greater than that of moderate intensity group. But the difference is not significant. Therefore, the hypothesis "higher the intensity greater the casualty" is not significantly proved for heat and cold wave.

Table 5: Casualty by different intensity subgroups of heat and cold wave events.

Events	Intensity	N	Mean Casualty	Mean Rank	Mann-Whitney U	Asymptotic Significance (2-tailed)	Conclusion
Heat wave	Severe	28	2.47	20.63	108.5	0.266	Null hypothesis of no difference is accepted Difference is insignificant
	Moderate	10	1.26	16.35			
Cold wave	Severe	20	2.90	15.28	44.5	0.126	
	Moderate	7	1.29	10.36			

Conclusion:

Mean maximum temperature of heat wave occurring months (April-June) is increasing and mean minimum temperature of cold wave occurring months is decreasing. Annual range of temperature is increasing. With it heat wave occurrences are also in hike. No such increment in frequency of cold wave is observed. Duration of heat wave is increasing but duration of cold wave in reducing. Intensity of both events is increasing. Number of human death by heat waves and cold waves are increasing. With it higher the annual frequency of heat wave and cold wave events greater the casualty is proved. Casualty by severe heat and cold wave is more than that of the moderate intensity. Following early warning and maintaining do's and don'ts mainly avoiding direct sunlight on heat wave days and to come under shelter and proper winter clothing during cold wave spell can minimise the adverse effect through casualty by heat and cold wave events. Advertisement on print media, frequently publication of do's and don'ts on daily news papers. In case of visual media all the advertisements regarding disaster will be during favourite programmes. Same advertisement for awareness will be done through social media.

References:

1. Mahdi, S.S. and Dhekale, B. (2016): Long term climatology and trends of heat and cold waves over southern Bihar, India, J.Earth Syst.Sci., pp.1557-1567 https://doi.org/doi10.1007/s12040-016-0762-2,

2. Majumder, A.K.(2023): Assessment of casualties and damages by extreme weather events in selected districts of West Bengal, Ph.D thesis , University of Calcutta.

3. Mandal, R.et al. (2019): Real time extended range prediction of heat waves over India, Scientific Reports , https://doi.org/10.1038/s41598-01945430-6

4. Mazdiyasni,O. et al.(2019):Heat wave intensity duration, frequency curve: A multivariate approach for Hazard and attribution analysis, Scientific Reports,9(1), pp.1-8 https://dx.doi.org/10.10381s41598-019-50643-w

5. National Disaster Management Authority,(2019):Guideline for preparation of Action plan-Prevention and Management of Heat waves, Government of India.

6. National Institute of Disaster Management (2021),Temperature related Disasters (Heat and cold wave): Implications for Health adaptation and resilience project report by National Institute of Disaster Management, Ministry of Home Affaires, Government of India, New Delhi,pp.3-5,10-12

7. Pai,D.S.,Nair, S.A.and Rareevan, M.(2016):Climatology and trends of cold waves over India during 1971-2010,Mausam, 67(3),pp.651-658.

8. Pai,D.S.,Nair,S.A.and Ramanathan,A.N.(2013): Long term climatology and trends of heat waves over India during the recent 50 years (1961-2010),Mausam,64(4),pp.585-604

9. Ramakrishna,Y.S.(2013):Heat and cold wave and their effects on agriculture and allied sectors in Rao,V.U.M.et.al.(eds.), Agro meteorological aspects of Extreme Weather Events-Research project on Agro meteorology, Hyderabad,pp.133-137.

10. Ray,K.et al. (2021) : An assessment of long term changes in mortalities due to extreme Weather Events in India-Acase study of 50 years data, 1970-2019,Weather and climate extremes, 32(100315),pp.1-10, https://doi.org/10.1016/j.wace.2021.100315

11. Rohini,P.,Rajeevan,M.and Mukhopadhdahay, P.(2019):Future projection of heat waves over India from CMIP5 models, Climate Dynamics,53,pp-975-988, https://doi.org/10.1007/10.1007/s00382-019-04700-9

12. Rohini,P.,Rajeevan,M.and Srivastava, A.K.(2016):On the variability and increasing trend of Heat waves over India, Scientific reports 6,26153,pp.1-9,https://doi.org/10.1038/srep26153

13. Sanjay.J.et.al. (2020):Temperature changes in India, in Krishnan.R.et.al (eds.),Assessment of climate over the Indian region –A report of the Ministry of Earth Sciences, Government of India,Springer,pp.21-45, https//doi.org/10.1007/978-981-15-4327-2_2

14. Subbaramayya,I.and Rao,D.A.S.(1976):Heat wave and cold wave days in different states in India, Indian Journal of meteorology, Hydrology, Geophysics,27(4),pp.434-440.