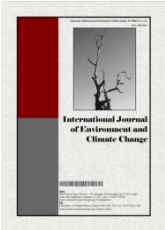

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Changing Rainfall and Swinging Tea Production: The Correlates and Perception of Social Ecology of Tea Garden

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Authors' contributions

This work was carried out in collaboration among all authors. Author DJ has conducted the study, and performed the primary data collection. Author SKA has designed the study and helped with the statistical analysis and the interpretation of the results. Author AM wrote the first draft of the manuscript and managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Tea is the second most commonly consumed beverages, after water, across the globe. However, the quality and aroma of the produce largely depends on different climatic factors like temperature, rainfall, altitude etc. Even a slight alteration in these climatic factors, affects the quality and production adversely. Climate change, a global challenge, is a big threat to the tea industry as well as its workers. With degraded quality and swinging production due to changing rainfall and temperature, hundreds of tea gardens have been closed down in the past few decades, putting livelihood of thousands of tea workers to question. This paper attempts to find how the changing rainfall and swinging tea production varies with the profile characteristics of the tea workers. The study was conducted in the Darjeeling, Kalimpong and Dooars districts of West Bengal with 90 randomly selected tea workers from nine randomly selected tea gardens, three each belonging to three different altitudes. All the results has been analyzed using statistical tools of correlation coefficient, multiple and stepwise regression and path analysis. The results shows that treatment and mobility are two important variable explaining the variation in perception on change in rainfall

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and perception on tea production respectively. It has also been found that variables like income, treatment and garments have been reliable predictors for estimating the change in rainfall whereas the variable mobility exhibits a positive and significant relationship with perceived change in tea production. The regression analysis showed that treatment has explained 19.4 per cent of total variation in case of perceived change in rainfall and mobility has explained 16 per cent of total variance in case of perceived change in tea production.

Keywords: Change in rainfall; climate change; mobility; tea production; treatment.

1. INTRODUCTION

Tea is one of the most consumed beverages in the world, next to water. India produces more than a quarter of world's tea, and West Bengal is the second largest producer in the country. Tea is an important economic determinant in the northern part of the state, more specific to regional economy. The economy of the Himalayan terrains are dictated by a trio, tea-tourism-trade. A survey in the tea farms of Assam shows that majority of managers of plantations as well as smallholders has reported adverse climatic conditions as major threats to tea growing operations [1]. Darjeeling tea, produced in the tea gardens of hilly regions Darjeeling in West Bengal, India, is world famous for its aroma and quality. With the swinging weather, changing climate and volatile socio-political equilibrium, both the economy and ecology of Darjeeling are impacted. Experiencing a decadence in ecological resilience and persistent unpredictability of both weather and market, dynamics of teagarden livelihoods and stability have well been discernible in the framework of respondent driven research. Quality of tea produced largely depends on the temperature variation in the region. Several authors have identified that climatic variation has influenced the quality of tea production to a great extent [2,3,4,5,6]. Even a slightest variation in the temperature deteriorates quality to a large scale [7,8,9]. Thus, climate change has a great impact on tea production as well as the quality of the produced. Northern part of West Bengal is known for its beauty of tea gardens. These gardens are located at varying altitudes, each distinct from one another in terms of social, ecological and economic temperament. Besides, being a physical demarcation of regions the altitude plays a pivotal role in assessing the impact of climate change on social, biological, ecological and economic well-being of the various tea gardens at the varying altitudes. Experimental studies conducted, help identifying the specific mechanisms effecting the tea productivity due to climatic variation, but fails to monitor the same impact occurring in farmers' field. Having this background in consideration, the objectives of this paper are, i) To assess the relationship between profile characteristics of the tea growers and impact of climate change on tea production, ii) To operate on a set of socio ecological variables for estimating their impact on rainfall change perception and tea production, iii) To estimate the level of interaction between set of predictor variables and perceived change in rainfall as well as perceived change in tea production.

2. METHODOLOGY

This study was conducted in three varied altitudinal regions of Darjeeling district (2042 m elevation), Kalimpong district (1247 m elevation) and Dooars (90-1750 m elevation) in West Bengal. This region is the major tea producing area of the state, and thus was selected for the present study. Also, the variation in the altitude of the region gives a picture of climatic as well as topographic factors influencing or affecting the tea production at different altitude in the state. The area was selected purposively because of its pertinence to the study. At present, Darjeeling has 87, Kalimpong has six and Dooars have 324 operating tea gardens. Simple random sampling design was used while selecting the tea gardens from the three altitudes. From each altitude, three tea gardens were selected, thus total 9 tea gardens were surveyed for collecting data for this study. A total of 90 respondents were selected using simple random sampling method from these nine tea gardens. A structured interview schedule was developed, pretested, modified and finalized for collecting relevant data for this study. All the independent variables were selected based on the pilot study results. The behavior of 17 independent variables like age, family size, formal education, status of home, nutritional status, wage, income, per capita income, diet, treatment, mobility, entertainment, garments, TV watching, mobile use, interaction with office personnel an interaction with others were studied against two dependent variable,

viz., perceived change in rainfall and perceived change in tea production to understand the effect of climate change in the life and livelihood of the people engaged in these tea gardens. Coefficient of correlation, regression analysis and path analysis were administered to interpret the outcomes.

3. RESULTS AND DISCUSSION

Table 1 reveals out of seventeen independent variables, variables like income, treatment and garments have been reliable predictors for estimating the change in rainfall. The vagaries of the rainfall has a huge impact on the ecological as well as the financial aspect of the tea gardens and its workers. The variable, mobile use, has been recorded as significant but negative correlation with perceived change in rainfall. This evinces that the amount of time one spends on mobile is reduced during the rainfall as the connectivity is poorer during these days.

Table 1. Relationship between the independent variables and perceived change in rainfall (n=90)

Characteristics	Correlation coefficient (r)
Age	-0.130
Family size	-0.137*
Formal Education	0.146
Status of Home	0.064
Nutritional status	-0.346
Wage	0.173
Income	0.374*
Per capita Income	0.353
Diet	0.315
Treatment	0.440
Mobility	0.351
Entertainment	0.208
Garments	0.385*
T.V. Watching	0.035
Mobile Use	-0.392*
Interaction with office personnel	0.174
Interaction with others	-0.125

**Correlation is significant at 0.05 level of significance*

The regression analysis (Table 2) depicts that, with the combination of 17 causal variables together, 62.2 per cent of the variance in the perceived change in rainfall has been explained.

The Stepwise regression analysis (Table 3) suggests that only one variable has been retained in the last step and contributed 19.4 per cent of the total variable explained. The terrains of Darjeeling hills are one of the highest recipient of annual rainfall, which makes the health ecology vulnerable to health hazards of different kinds, both perennial and seasonal in nature. Here, variable treatment has got the highest contribution because the perceived change in the rainfall further aggravates diseases and infections due to its damp weather, eventually leading to increase in the need for treatment.

The Path analysis (Table 4) decomposes the total effect into direct, indirect and residual effect of perceived change in rainfall against 17 exogenous variables. The variable formal education(X3) exerts the highest total effect(r). The variable status of home(X4) exerts the highest direct effect and the variable, formal education(X3) records the highest indirect effect on perceived change in rainfall (Y1). The variable wage(X6) has enrooted the highest indirect effect through as many as twelve exogenous variables. The path analysis depicts that 27.2 per cent variance in of Perceived change in rainfall (Y1) cannot be explained. The pattern of intensity of rainfall characterized the wage of the respondents, as working hours is disrupted due to the calamity. While the other parameters viz., status of home and formal education gives an insight into the vulnerability and resilience capacity of the respondents.

Table 5 reveals that out of the seventeen independent variables, only variable mobility exhibits a positive and significant relationship with the dependent variable, perceived change in tea production. This evinces that with the increase in tea production, financial stability of the respondents' increases, thereby indicating an increase in its mobility expenses. Besides, high frequency tourism activity in high altitude, decked beautifully with lush green biodiversity, promotes tourism, hence high intensity mobility as well.

The regression analysis (Table 6) depicts that, with the combination of 17 causal variables together, 61.9 per cent of the variance in the perceived change in tea production has been explained.

The stepwise regression analysis (Table 7) suggests that only one variable is retained in the last step and has contributed 16 per cent of the total variance explained. Here, variable mobility has got the highest contribution because, the tea production governs the financial stability of the respondents and the higher expenditure on mobility indicates better economic stability.

Table 2. Multiple regression analysis of perceived change in rainfall vs. 17 causal variables

Characteristics	Reg. Coeff. B	S.E. B	Beta	t value
Age	-0.329	1.502	-0.09	-0.219
Family size	-0.210	13.311	-0.00	-0.016
Formal Education	3.724	4.439	0.40	0.839
Status of Home	-3.972	6.311	-0.148	-0.629
Nutritional status	-0.005	0.004	-0.286	-1.165
Wage	0.105	0.320	0.138	0.328
Income	0.000	0.001	0.260	0.318
Per capita Income	0.000	0.003	0.027	0.039
Diet	-0.014	0.032	-0.299	-0.437
Treatment	0.034	0.090	0.111	0.381
Mobility	0.185	0.107	0.870	1.719
Entertainment	-0.260	0.127	-1.17	-2.038
Garments	0.113	0.081	0.804	1.400
T.V. Watching	-15.977	23.242	-0.19	-0.687
Mobile Use	-10.708	17.215	-0.15	-0.622
Interaction with office personnel	-18.183	23.713	-0.31	-0.767
Interaction with others	-2.101	9.965	-0.04	-0.211

R Square: 65.80 percent; Standard error of the estimate 31.81

Table 3. Stepwise regression analysis of perceived change in rainfall vs. 17 causal variables

Variables	Reg. Coeff. B	S. E. B	Beta	t value
Treatment	0.136	0.053	0.440	2.596

R square: 19.40 percent; Standard error of the estimate: 27.07

Table 4. Decomposition of total effects into direct, indirect and residual effect of perceived change in rainfall against 17 consequent variables

Variables	Total effect	Direct effect	Indirect effect	Highest Indirect effect
Age(x1)	0.456	-0.006	0.462	0.270(x6)
Family size(x2)	0.088	-0.097	0.185	-0.977(x2)
Formal education(x3)	0.859	0.025	0.834	0.387(x8)
Status of home(x4)	0.746	0.945	-0.199	0.944(x4)
Nutritional status(x5)	0.134	-0.048	0.182	0.517(x6)
Wage(x6)	0.001	0.125	-0.124	0.408(x9)
Income(x7)	0.001	-0.124	0.125	0.408(x9)
Per capita income(x8)	-0.417	-0.114	0.531	0.884(x2)
Diet(x9)	0.156	0.086	0.069	0.864(x9)
Treatment(x10)	0.137	0.5	-0.363	0.499(x10)
Mobility(x11)	0.149	0.039	0.110	0.677(x6)
Entertainment(x12)	0.109	0.009	0.100	0.316(x6)
Garments(x13)	0.249	0.047	0.202	0.202(x6)
T V watching(x14)	0.588	0.072	0.516	0.653(x6)
Mobile use(x15)	0.309	-0.155	0.464	0.472(x13)
Interaction with office personnel(x16)	0.133	-0.063	0.196	0.473(x8)
Interaction with others(x17)	-0.379	-0.526	0.147	-0.634(x16)

Residual effect: 27.20 percent

The path analysis (Table 8) decomposes the total effect into the direct, indirect and residual effect of perceived change in tea production against 17 exogenous variables. The variable mobility exerts the highest total effect(r). The variable interaction with office personnel exerts the highest direct effect and the variable mobility records the highest indirect effect on perceived change in tea production. The variable entertainment has enrooted the highest indirect effect through as many as six exogenous variables. The path analysis depicts that 27.8 per cent variance in perceived change in tea production cannot be explained. The increase in the tea production provides financial upliftment of the tea garden workers, thereby increasing their purchasing power for miscellaneous requirements like entertainment and mobility. This phenomenon has got another blades of reality. Higher mobility results into higher income, hence, can exert positive into better and higher proficiency to enhance productivity as well. However, this inference demands further and detail inquires to get a better trajectory of altitude functions embedded into the entire geodynamics.

Table 5. Relationship between the independent variables and perceived change in tea production (n=90)

Characteristics	Correlation coefficient (r)
Age	0.165
Family size	0.070
Formal Education	-0.074
Status of Home	0.113
Nutritional status	-0.241
Wage	0.250
Income	0.217
Per capita Income	0.110
Diet	0.271
Treatment	0.187
Mobility	0.400*
Entertainment	0.216
Garments	0.159
T.V. Watching	0.346
Mobile Use	0.006
Interaction with office personnel	0.195
Interaction with others	0.113

**Correlation significant at 0.05 level of significance*

Table 6. Multiple regression analysis of perceived change in tea production vs. 17 causal variables

Characteristics	Reg. Coeff. B	S.E. B	Beta	t value
Age	-0.577	1.244	-0.194	-0.464
Family size	12.044	11.021	0.525	1.093
Formal Education	-2.911	3.676	-0.381	0.792
Status of Home	5.836	5.225	0.264	1.117
Nutritional status	-0.001	0.003	-0.103	-0.417
Wage	0.069	0.265	0.110	0.260
Income	-0.002	0.001	-1.549	-1.885
Per capita Income	0.002	0.002	0.719	1.025
Diet	0.034	0.026	0.898	1.308
Treatment	0.076	0.074	0.297	1.020
Mobility	0.154	0.089	0.880	1.733
Entertainment	-0.046	0.106	-0.253	-0.437
Garments	-0.088	0.067	-0.756	-1.311
T.V. Watching	41.897	19.243	0.628	2.177
Mobile Use	-1.548	14.253	-0.028	-0.109
Interaction with office personnel	17.601	19.633	0.374	0.897
Interaction with others	-1.641	8.250	-0.042	-0.199

R square: 61.9 per cent; Standard error of the estimate: 23.46

Table 7. Stepwise regression analysis of perceived change in tea production vs. 17 causal variables

Variables	Reg. Coeff. B	S. E. B	Beta	t value
Mobility	0.070	0.030	0.400	2.309

R square: 16 per cent; Standard error of the estimate: 22.80

Table 8. Decomposition of total effects into direct, indirect and residual effect of perceived change in tea production against 17 consequent variables

Variables	Total effect	Direct effect	Indirect effect	Highest Indirect effect
Age(x1)	-0.348	0.003	-0.351	0.570(x13)
Family size(x2)	-0.291	-0.006	-0.285	-0.929(x13)
Formal education(x3)	-0.341	0.003	-0.344	0.475(x10)
Status of home(x4)	-0.096	0.004	-0.100	-0.581(x17)
Nutritional status(x5)	-0.666	0.003	-0.669	0.780(x9)
Wage(x6)	-0.002	-0.182	0.180	-0.705(x12)
Income(x7)	-0.002	0.180	-0.182	-0.705(x12)
Per capita income(x8)	0.610	-0.086	0.696	0.948(x12)
Diet(x9)	-0.754	-0.040	-0.714	-0.858(x6)
Treatment(x10)	-0.241	-0.041	-0.200	-0.416(x10)
Mobility(x11)	-0.876	-0.026	-0.850	0.982(x7)
Entertainment(x12)	-0.407	-0.027	-0.380	-0.471(x17)
Garments(x13)	-0.13	-0.003	-0.127	-0.863(x12)
T V watching(x14)	-0.209	0.003	-0.212	-0.760(x12)
Mobile use(x15)	-0.246	-0.016	-0.230	-0.948(x12)
Interaction with office personnel(x16)	-0.633	0.849	-0.641	0.849(x16)
Interaction with others(x17)	0.249	0.104	0.145	-0.473(x16)

Residual effect: 27.8 per cent

4. CONCLUSION

Social ecology of tea gardens in the terrains of Darjeeling is both agile and fragile. The brunt of global warming and climate change have become extremely conspicuous and being reflected in the changing pattern of rainfall and subsequently production behavior of tea gardens in altitude differentials, i.e. low, medium and high altitudes of Darjeeling terrains. The study was conducted on two very important aspects of ecology of tea gardens and these are perception on rainfall change and production behavior of tea gardens. The tea garden economy is the backbone of income, livelihood and well-being of thousands of tea garden workers as well as entrepreneurs. Altogether 90 respondents were selected using simple random sampling from three different terrains having different altitudes and the responses from the target individuals have been analyzed. Two variables, treatment and mobility, have come up as significant determinant for predicting changing rainfall as well as production behavior of tea gardens. The incessant rainfall sometimes beyond 3500mm annually tells upon general health status of the hill people which have been reflected in the perceived importance of treatment for the tea garden workers. When productivity shows an unpredictable swing due to the erratic pattern of rainfall and temperature, the workers breed on a trend for quitting tea gardens in search of better livelihood elsewhere and thus migration keeps shimmering. So, a micro level policy sounds eminent and important for the health care of the tea garden workers in one end, on the other, sustainable tea production as well as income generation need to be ensure.

CONSENT

As per international standard or university standard, participant's written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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