Understanding the Effects of Climate Change on the 'Jangal Mahal' Forest Regions in West Bengal, India

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ABSTRACT- Against the backdrop of growing global climate concerns, this study attempts to comprehensively explore the impacts of climate change in the Jangal Mahal forest region of West Bengal, India through the perception of forest dependent communities. In this context, we have attempted to address climate change perceptions regarding impacts on forest ecosystems through descriptive statistics. We used primary data collected randomly from 241 households in 8 blocks of Jangal Mahal region of West Bengal. Data collection in this study was through questionnaire based personal in-depth interviews. We selected 10 indicators to measure household perceptions of climate change and the impacts of climate change on forests. The results show that households strongly agree with the increase in average temperature, increase in hot days, unpredictability of rainfall and climate change events but strongly disagree with changes in withdrawal of monsoon, longer winter season and increase in rainfall. It has also been observed that climate change is having severe negative impact on Non-timber forest product (NTFP) quality, soil fertility, wood supply, mortality of native plant species and forest density, but no serious impact on forest biological systems.

KEYWORDS- Climate Change, Forest, Jungal Mahal

I. INTRODUCTION

Climate change is the biggest challenge for countries to maintain sustainable livelihoods in the current century [9]. Over time, increasing temperatures and changing rainfall pattern are disrupting nature's natural balance. It poses many risks to life on earth. As per India Meteorological Department [4] data, the average temperature increased by 1.5°C between 1901-10 to 2011-18 in West Bengal and 0.6°C increased in India. Also theaverage rainfall in West Bengal decreased from 1107 mm in 1950 to 1026 mm in 2018.Side by side climate-related events such as heat waves, cyclones, storms, flash floods and droughts are also increasing year after year. India's rainfall has declined since the 1950s and the incidence of heavy rainfall has also increased [10]. India's economy is largely dependent on climate sensitive issues such as agriculture, water resources, biodiversity and forestry [5]. Forestry is the main effective option against climate change [8].Climate change will affect many natural disasters that threaten the health of forests. These include pest outbreaks, invasive species, wildfires and storms. Some disturbances occur quickly, such as changes in animal or plant populations and wildfires. Depending on current climate conditions, by 2100, in Europe excluding Russia, 28% of forests will lose their economic value and 34% of forests will decrease in economic value [2]. In the Southeast Asia, 40%–75% of forest cover has been lost due to climate change, particularly local temperature increases [7]. When forests are destroyed, the stored carbon is released into the atmosphere as carbon dioxide. Dean calculated in 2019, 4.8 billion tons of carbon dioxide was emitted each year between 2015 and 2017 worldwide [1]. In India, climate change events have caused dramatic forest loss in recent decades and the results show that annual forest loss has increased from 47 sq km in 2017 to a maximum of 2,503 sq km. However, there was a marginal decrease of about 1,900 square kilometers in 2018. The staggering forest loss totaled 20,472 sq km, which was 7.34% of the forest area. Importantly, forest loss in the Northeast was four times higher than in other regions [3]. Deforestation is associated with the greatest daily local temperature increase throughout the year and most affects forest dwellers during summer [6]. Therefore, forest ecosystems are strongly sensitive to climatic conditions, and thus they are clearly affected by climate change. Choosing an adequate climate change adaptation strategy and implementing the necessary measures accordingly requires incorporating public perception into a forest context.Perception of climate change involves how individuals or communities view and understand the changing climate patterns. This can range from awareness of temperature shifts and extreme weather events to recognizing the broader impacts on ecosystems and human societies. People's perceptions of climate change are influenced by their location, education, media exposure, and personal experiences and these perceptions can affect their willingness to take action to mitigate or adapt to climate change.Perception of climate change effects on households varies widely but often includes concerns about extreme weather events, rising energy costs, health impacts, and the need for adaptation measures like home insulation and sustainable practices. Public awareness and government policies play significant roles in shaping these perceptions. Perceptions

of climate change effects on forests include concerns about increased wildfires, drought stress, pests, and changing tree species composition. People's views on these effects are influenced by personal experiences and local observations. Understanding these perceptions is vital for effective forest management and climate change mitigation strategies.In essence, researchers explore household perceptions of climate change to bridge the gap between scientific knowledge and public understanding, ultimately contributing to more effective and socially inclusive climate policies and interventions.The conceptualization of climate change impacts on the 'Jangal Mahal' forest areas in West Bengal, India involves a comprehensive analysis of rising temperatures, altered precipitation patterns, and increased frequency of extreme weather events. This assessment considers potential effects on biodiversity, forest health, and local livelihoods. Key focus areas include understanding the vulnerability of endemic species, evaluating community resilience, and identifying policy gaps for sustainable adaptation. Collaborative efforts between stakeholders are crucial to developing strategies that address the multifaceted impacts and promote the conservation of 'Jangal Mahal' in the face of climate change.

II. METHODS

A. Study Area and Sampling Procedure

The study has been carried out in Junjal Mahal region in West Bengal, India. This is one of the dry regions of West Bengal. Junjal Mahal region is located at 21°45´N to 23°30´N latitudes and 85°45´E to 87°30´E longitude. The territory possesses a hot and humid tropical climate, a lateritic land surface with hard rock uplands, and unproductive soil. The forest is classified as a tropical dry deciduous forest, in other words, there is an abundance of deciduous trees like Shorea Robusta. Junjal Mahal covers 23 blocks under four districts of western part of south Bengal viz. Purulia, Bankura, Paschim Medinipur and Jhargram.A three-stage sampling method has been employed to select households under FPC for the study. In the first stage, 8 blocks out of 23 blocks under the Junjal Mahal region were randomly selected. After the randomly selection of 8 blocks, we have purposively selected at least two FPC in each blocks in the second

stage based on species characteristics and availability of NTFPs. Lastly, we have randomly selected at least 10 households every FPC. Primary data collection for the study has been conducted through a structured questionnaire.

B. Methodology

Total 241 households were surveyed from 19 Forest Protection Committees (FPCs) in study area. Data generated through questionnaires were analyzed using descriptive statistics. We are selected ten indicators to understand the perception of climate change of the households and perceptions of climate change impacts on forests. Each response is rated in a five- point scale by strongly agree, agree, neutral, disagree and strongly disagree. Scaling value is 5 for strongly agree and 1 for strongly disagree. High mean value of indicators means most of the households agree with the corresponding statements and low mean value means disagree with the statements. Quantitative categorical types of data were analyzed using percentages, frequency distributions and cross-tabulation; while quantitative continuous data were analyzed using mean and one-way ANOVA. F-test was used to see whether there were significant differences among different groups in relation to continuous variables, respectively. Data analysis has been conducted using SPSS software.

III. RESULTS

A. Description of sample households

Majority of the population (41.7%) belongs to the prime working age group and the population of children is the second highest population (25.4%) of the sample households in the study area. In terms of household size, 75.7% of households belong to small households with less than six members. About 52% of the population is female. Sex ratio and child sex ratio are in favor of women. Table 1 shows that 91.4% of the population is eligible for education which is 1160 out of 1270people, while others are under five years of age who are considered as non-eligible persons. Results show that 25.8% of the population is illiterate. An average education year per family is 4.88 which are very low and disadvantageous in terms of human capital.

Table 1: Socioeconomic characteristic of the sample households

Socioeconomic Characteristic	Number (%)
Population characteristic	
Total population	1270
Children (≤14 yr.)	323(25.4)
Early working age (15-24 yr.)	200 (15.8)
Prime working age (25-54 yr.)	528 (41.7)
Mature working age (55-65 yr.)	145 (11.4)
Elderly (>65 yr.)	74 (5.8)
Female gender	655 (51.6)
Sex ratio	1054
Child sex ratio	1118
Education status	
Non-eligible person	110 (8.6)
Illiterate	326 (25.8)
Literate	834 (65.6)
Average education yr. /hhs /eligible person	4.88
Family Size	
Small households (≤6 members)	183(75.7)

Large households (> 6 members)	58 (24.3)
House type of the households	
Hut	19 (7.8)
Kuccha house	165 (68.6)
Semi Pucca house	48 (20.1)
Pucca house	9 (3.6)
Toilet facility	
Yes	184 (76.4)
No	57 (23.6)
Drinking water source	
Community water tap	154(64.1)
Hand tube well	45 (18.4)
Open well	42 (17.5)
Caste	
General	43 (17.5)
SC	22 (9.1)
ST	142 (58.6)
OBC	34 (14.9)
Hindu HHs	233(96.8)
Assets status	
Average land holding (hectare) of the HHs	0.33
Average cultivation land(hectare) of the HHs	0.21
Average irrigated land (hectare) of the HHs	0.17
Households have no cultivated land	40 (16.5)
Average livestock unit (ALU) of the HHs	4.37

(Source: Primary survey)

Majority of the households (58.6%) belong to Scheduled Tribes (ST). The study finds that 76.4% of households have sanitation facility. Community water tap (64.1) is the prime source of drinking water followed by hand tube wall (18.4%) and open well (17.5%). That means 17.5% of households are at risk of life-threatening illness. By house type, 68.6% households live in kuccha house and 7.8% households live in huts. This means that about 76.4% of households are more susceptible to destruction due to storms, floods and other natural disasters. Household land holdings status indicates that 16.5% of households have no cultivable land. The remaining 83.5% households have marginal cultivable land which is 0.33 hectares per households and have low irrigation facilities (0.17 hectare). Three types of irrigation facility (mainly deep tube well, canal, tank) present this area. Livestock includes cows, buffaloes, sheep, chickens, pigs and goats etc. Livestock status is presented through Total Livestock Units (TLU) which is measured by FAO suggested sub-tropical livestock units. Results show that average TLU in the sample households is 4.37.

B. Households perception of climate change

In this section we attempt to address household's perceptions of climate change in the Jungal Mahal region of West Bengal. We considered household perceptions of climate change based on three main factors such as temperature, precipitation and climate related events. We have selected ten indicators to understand the perception of climate change of the households (follows the Table 2).It has been observed; mean value of two indicators is above 4 such as increase in average temperature and hot days increasing. That means households strongly agree with this statements. Mean value of four indicators is lower than 2 such as changes of monsoon withdrawal time, increasing number of hail, long winter season and increasing in rainfall. That means households strongly disagree with this statements.

Table 2: Percentage of household's distribution according to perception on climate change

Variables	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean
Increase in average temperature	1.7	0.9	3.2	32.6	61.6	4.49
Hot days increasing	1.8	4.2	8.6	27.1	58.3	4.36
Increase number of storms	8.8	14.2	4.9	46.5	25.6	3.51
Increasing the severity of the storms	9.8	20.2	8.8	38.5	22.7	3.31
Loo flowing days increasing	4.8	28.2	15.2	34.2	17.6	3.02
Changes of arrival monsoon	23.2	46.4	6.8	15.7	7.9	2.18
Changes of monsoon withdrawal time	26.7	57.9	1.1	11.2	3.1	2.07
Increasing number of hail	29.1	56.4	5.4	7.4	1.7	1.83
Long winter season	52.1	40.1	0.8	6.1	0.9	1.43
Increasing in rainfall	66.6	20.4	1.5	7.2	4.3	1.41

(Source: Own estimation)

Majority of the households (61.6 %) strongly agree with the statements of increase in average temperature and 32.6% households agree with this statements. Also, 58.3% households has found strongly agree and 27.1% households has found agree with the statement of hot days increasing over the years. Also most families agree with the statement of increasing Loo flow days in Jangal Mahal forest area year after year. That means extreme hot weather condition in summer season and negative effect on human and their livelihoods.Majority of the households (66.6%) disagree with the statement of rainfall increasing over the years and alsomajority of households disagree with the statements of 'changes of arrival monsoon' and 'changes of monsoon withdrawal time'. That means very low level of precipitation in rainy season and last few years shortage of rain as per given level. Forest vegetation and agricultural activities very much depends on level of precipitation. That's why forest and agriculture livelihood based households very much suffer these conditions.Majority of the households strongly agree with the statements of climate related events like increase number of storms, increasing the

severity of the storms over the years. These type of climate related events extra pressure on their livelihoods and may be increase their livelihood vulnerability.So we can say that, people highly perceive the phenomenon of climate change due to the increasing frequency and intensity of extreme weather events and scientific evidence supporting climate change. Additionally, the visible impacts on ecosystems services and communities contribute to a heightened awareness and concern about the consequences of climate change.

C. Perception about impact of climate change on forest

In this section we attempt to address the perception of the households surveyed about impact of climate change impacts on forest in the Jungal Mahal region of West Bengal. We selected ten indicators to measure perceptions of climate change impacts on forests (follows the Table 3). A high mean value of the indicators means that most households agree with the corresponding statement which means that climate change is having a serious negative impact on that issue and low mean value means climate change no serious impact on that issue.

Table 3: Percentage of household's distribution according to perception on impact climate change in forest

Variables	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean
Value of NTFPs is declining	3.6	19.9	1.9	39.9	34.7	3.81
Decrease in soil fertility	5.9	18.7	5.8	37.8	31.8	3.69
Timber supply is decreasing	7.1	20.1	7.1	37.1	28.6	3.57
Plant mortality is increasing	7.1	15.9	4.8	55.1	17.1	3.48
Native species are declining	13.8	21.6	2.9	26.8	34.9	3.45
Forest density is decreasing	15.1	27.2	3.9	24.5	29.3	3.21
Non-native species are increasing	21.8	33.5	2.9	18.5	23.3	2.71
Forest fires are increasing	28.9	56.1	5.6	2.8	6.6	1.95
Flowering and fruiting time is changing	36.3	49.1	6.3	7.2	1.1	1.79
Early ripening of forest fruit is increasing	38.2	50.2	7.1	3.5	1.1	1.72

(Source: Own estimation)

Almost all households perceived negative impacts of climate change on forests based on mean perception scores after assigning scores to the statements. The general perception of the people about climate change in the Jungal Mahal region of West Bengal also indicates that climate change is significantly affecting forest ecosystem services.We have found that, 34.7% households strongly agree and 39.9% households agree with the statement of value of NTFPs is declining over the years. This may be happen due to precipitation level decrease and average temperature increase over the years. Majority of the households agree with the statement of soil fertility decrease, because households more and more fertilizer use in agricultural land but output not increases as per expected level. 55.1% households agree with the statements of the plant mortality is increasingover the years. These happen due to increase number of storms as well as increase severity of the storms over the years in this region. In this region people observed the continuously medicinal plants as well as native species decrease over the years. Side by side 23.3% households and 18.5% households strongly agree and agree with the statements of non-native species are increasing over the years. Medicinal plants and others native plants are very much sensitive to climate change. So forest cannot significantly absorb the pollutant. This may be reason of

the disease outbreaks are increasing the forest area. Among the households, 29.3% households and 24.5% households agree and strongly agree with the statement of forest density decreasing over the years in this region. That's why the results of majority of households agree with the statement of timber supply is decreasing over the years and forest fringe communities observed the forest vegetation and non-timber forest product continuously fall.The perceptions of forest fringe communities' about of biological systems of forest are not so effect by changingclimate. Biological systems of forest included two variables. One is the flowering and fruiting time is changing over the years and another is early ripening of forest fruit is increasing over the years. Majority of households disagree with these statements. The incidence of disease in forest areas has not increased due to changes in local climate. These climate change-related changes did not reduce the number of pollinating species, including bees and bumblebees. Such changes have had no serious impact on both the socio-economic security of forest dwellers and the ecological resilience of the system.Another important statement is 'forest fires are increasing over the years' and majority of households (85%) denied this statement. That means still forest have to power to maintain the vegetation of the forest.

IV. CONCLUSION

Communities relying on the Jangal Mahal forest region in West Bengal, India, have acknowledged the influence of climate change on their local forests, aligning with scientific research findings. Most individuals in this group perceive adverse effects of climate change on both the living and non-living aspects of the forest environment, posing risks to their livelihoods. These risks include heightened hardships, reduced income, greater vulnerability to diseases, and diminished access to food and water. A substantial number of respondents believe that climate change will impact their livelihoods by reducing the collection of Non-Timber Forest Products (NTFPs), adversely affecting their food and medicinal needs. Understanding these implications is crucial for developing effective strategies to mitigate the adverse effects of climate change on both the environment and the well-being of the local population.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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