Perception on Impact of Climate Change on Forest Ecosystem in Protected Area of West Bengal, India

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Abstract

In the present exploration we identified perception of forest dependent communities in relation to impact of climate change on forest ecosystem in and around Chilapatta reserve forest in northern part of West Bengal, India. Purposive sampling method was used for selection of area and random sampling method was used for selection of respondent. The data collection in this study was through questionnaire based personal in-depth interviews. Almost all the respondents (94%) were farmers and rest had occupation other than farming. Almost all the respondents perceived negative impact of climate change on forest though the level of perception varies from very low to medium (0.23-0.52) based on average perception score after assigning score to individual statements. The level of perception on impact of climate change on forest ecology and forest flora of the community is low and very low as the average perception score is 0.39 and 0.23, respectively while, it is medium (0.52) for forest fauna. Alternately their perception on decreased stream/river flow and quick drying of seasonal streams or water bodies is based on their livelihood experience as they depend on these for their domestic and irrigation water use and fish catch for family diet.

Key Words: change, respondent, forest, ecosystem, livelihood

Introduction

One of the greatest challenges to livelihoods in the 21st century, particularly in developing countries, is the threat from climate change that could potentially reverse decades of development gains, such as those focused on achieving the Millennium Development Goals (IPCC 2007a; UNDP 2010). Human interference with the climate system is posing risks for human and natural systems (IPCC 2013; IPCC 2014). It is expected to affect functioning of eco-system services (including forestry and agriculture) and also expected to exacerbate the vulnerability of communities with adverse impacts on livelihood options (IPCC 2007b). People and societies have perceived and even adapted to changes in the climate differently, given diverse values and goals which is posing a serious threat to their livelihoods (Byg and Salick 2009; Salau et al. 2012; Arbuckle et al. 2013; IPCC 2014). Forests are the only viable option against climate change is now understood widely among scientists and public as well (McDaniels et al. 1996). Forest-dependent communities also describe a particularized social context in relation to global climate change because of their potential to become the target of potential institutional responses to climate change (Davidson et al. 2014).
Unfortunately, many people are still ignorant about the basic causal drivers of climate change and still remain unclear of how particular actions connect to the issue despite broad public education campaigns (McDaniels et al. 1996; Bord et al. 2000). The level of public knowledge on climate change needs to be clarified. Today it has become a major theme of research on public perceptions of climate change. The lack of appreciation for personal exposure to climate impacts may be understood by the lack of survey research on climate-affected populations whose answers might reflect more local concern (Vignola et al. 2012). Work on climate perceptions needs to be carried out in specific region to better understand which policies are most likely to resonate with public support, and which might be most difficult to implement. Therefore, an attempt was made in this study to identify perception of forest dependent communities in relation to impact of climate change on forest ecosystem in and around Chilapatta reserve forest in northern part of West Bengal.

**Materials and Methods**

**Study area**

The study was conducted at the fringe villages in and around Chilapatta Reserve Forest in Terai region of West Bengal, India. Chilapatta Reserve Forest spreading over 41 km² that lies within the forests of Cooch Behar Wildlife Division (Anon 2001) in Jalpaiguri district of West Bengal is located at northern fringe of the state in foothills of the sub-Himalayan mountain belts. Eight villages namely Kumar para, Uttar simlabari, Rawa basti, Chakwakheti, Baniya basti, Nepali basti, Andu and Dabri basti were selected to conduct the present study.

The forest is about 45 km away from Cooch Behar town, head quarter of Cooch Behar district well connected with National Highway no. 31C (highway cut across the forest). The villages are also well connected with all weather roads. The elevation of the working site as measured by GPS was latitude 26° 32.85’ N and longitude 89° 22.99’ E. Mean altitude of the area was 47 m above MSL. The region is sub-tropical receiving average annual rainfall of 250-300 cm from south-west monsoon of which 80% is received from June to August. The summer and winter temperature are mild with 34°C as the highest in the month of May while the lowest temperature is 7.5°C in the month of January (Fig. 1).

The total geographical area of Jalpaiguri district is 6,245 km² and proportion under forest is 48.5% (FSI, 1995-2013). The forests of the district are dominated by good quality Sal (*Shorea robusta*). Sal with associates like *Schima wallichii*, *Michelia champaca* and *Chukrasia tabularis* constitutes economically the most important component of these forests. These forests broadly fall into four categories, viz., riverain forests, plains forests, hill forests and Savannah forests. The plains forests have many distinct types, viz., scattered Sal and wet mixed forests, mature Sal forests, dry mixed type and wet mixed type. Near the streams and moist pockets, occur a type of evergreen forests known as North Bengal Tropical Evergreen Forests harbouring species like *Aesculus assamica*, *Eugenia formosa*, and *Dillenia indica*.

The district also has Gorumara, Chapramari and Buxa sanctuaries and Jaldapara National Park. The forest is inhabited by divergent communities with Indo-Mongoloid tribes consisting Raj Bangshis, Mech, Ravas, Totos, Limbus, Lepchas, Nageshias, Uraons and Mundas dependant directly or indirectly on its forest and are mainly agrarian subsistently growing paddy, jute and maize. All these various tribes have their distinct culture and beliefs (Government of West Bengal 2016).
Methodology

Sampling design

Purposive sampling method was used for selection of area and random sampling method was used for selection respondent. The sample size for the study was 100. The data collection in this study was through questionnaire based personal in-depth interviews (Frechtling et al. 1997). After construction of schedule, the same was discussed with the expert in the field of forestry, agricultural extension, agricultural statistics of the concerned academic departments of Uttar Banga Krishi Viswavidyalaya, Pundibari West Bengal India. A relevancy test for the questions and opinion statements were done by the experts for validity of opinion scales. The statements having more than 75% relevancy were selected for final study. A reliability test was also taken by split-half method and it was seen that the correlation between the odd and even numbered opinion statements were more than 0.80. Considering the experience of the pre-testing, necessary modification were made in the language of few questions. Thus the schedule was finalized. The knowledge questions were tested against the responses of ‘yes’ (1) and ‘no’ (0) indicating that the respondent having or not having awareness/knowledge on the specific question. The opinion statements were tested against a three point Likert scale (Kerlinger 1973) with responses of ‘agree’ (+1), ‘undecided’ (0) and ‘disagree’ (-1). Thus a list of 16 statements on perception on impact of climate change on forest ecology was selected for final study. Further, the change was perceived against a period prior to 30 years by spider diagram (Etwire et al. 2013; Pal et al. 2014). The level of change of climatic parameters and its impact before thirty years were regarded as standard perception in the present study.

Dependent variable

The sum of scores derived from each schedule was considered as dependent variable. Knowledge and adoption of adaptive practices was assessed by a simple index (Knowledge-adoption Index) which is also regarded as a dependent variable. It is calculated as the ratio between the sum of scores obtained from knowledge and adoption of the adaptive practices and sum of maximum scores obtainable.

Independent variables

Respondents were classified into two groups of 40-50 years and more than 50 years. As climate change perception requires a long experience over time frame, so 40 years has been considered here as the discriminating age. The respondents were classified as illiterate (no schooling), primary (up to four years of schooling) middle (up to nine years of schooling) and high (ten or more than ten years of schooling). On the basis of land holding respondent were classified into three groups having up to 100 decimal (1 decimal=33.33 m²), 100-200 decimal and > 200 decimal with score assigned as 1, 2 and 3, respectively. The collected data were processed, classified and tabulated. Further, the statistical treatments were applied in the light of objectives to arrive at conclusion. The statistical tools used for the precise and meaningful analysis and interpretation of the collected data are descriptive statistics (like frequency, per cent, mean, and standard deviation), correlation and student ‘t’ test following (Panse and Sukhatme 1967).

Results and Discussion

Profile of the respondents

Majority of the respondents were male (82%) and fewer female. Females generally felt shy to respond and mostly were comfortable to respond along with their male folk. Females who responded independently were only considering as who responded along with their male folk only repeated their counterpart’s view. Respondent with 40 years of age or above were interviewed and majority of them were above 50 years of age (53%) while rest were below 50 years.

Table 1. Distribution of respondent according to perception of impact on forest ecology

| Class                        | %   | Statistical implication |
|------------------------------|-----|-------------------------|
| Absolutely no negative impact (-16 to -11) | 0   | Mean=6.95               |
| No negative impact (-10 to -1)        | 0   | SD=3.38                 |
| Undecided (0)                  | 1   | Min=0                   |
| Having negative impact (1-10)     | 88  | Max=18                  |
| Absolutely having negative impact (11-16) | 11  |                         |

N=100; SD, standard deviation.
Majority of the respondents were literate (59%) i.e. have attended school up to primary level or more while rest of them were illiterate or not attended school at all. Almost all the respondents were farmers (94%) with land holding up to 100 decimal (83%), 100-200 decimal (11%) and rest with more than 200 decimal.

**Perception on impact of climate change on forest ecology**

Almost all the respondents perceived negative impact of climate change on forest (Table 1) though the level of perception varies from very low to medium (0.23-0.52) based on average perception score after assigning score to individual statements (Table 2). General perception of the people about the climate change in Kullu district of Himachal Pradesh, India also indicated climate change is affecting significantly the forest and vegetations (Vidya et al. 2015). Ecological knowledge in relation to climate science held by the indigenous people has also been documented from other parts of the world (King et al. 2008; Berkes 2009).

In this case one out of 100 respondents remained undecided. It can be concluded from the table 1 that the class “absolutely having negative impact” and “undecided” were inadequately represented while “absolutely no negative impact” and “no negative impact” did not have any place as perception of the respondents. The level of perception on impact of climate change on forest ecology and forest flora of the community is low and very low as the average perception score is 0.39 and 0.23, respectively while, it is medium (0.52) for forest fauna (Table 2; Fig. 3). However considering the specific impact statements on forest ecology (Table 2) related to decrease in area of Chilapatta Reserve Forest and decreased availability of water on water bodies in and around the forest almost all the respondents (98-100%) replied positively (statements AB1, AB5, AB7 and AB8).

Interestingly the perception of the respondents on decrease of forest area does not match with the Forest Survey of India records (Fig. 2) as it was reported that the forest area in Jalpaiguri district of West Bengal is continuously in-

### Table 2. Distribution of respondant according to perception statements on impact to forest ecology

| C | Statements | A | U | D | MS |
|---|------------|---|---|---|----|
| **Impact to forest abiotic ecological factors** | | | | | |
| AB1 | Forest area has decreased | 98 | 0 | 2 | 0.96 |
| AB2 | Soil erosion has increased in forest | 21 | 15 | 64 | -0.43 |
| AB3 | Forest litter has decreased over the years | 53 | 3 | 44 | 0.09 |
| AB4 | Climate change has decreased the soil fertility | 58 | 34 | 8 | 0.5 |
| AB5 | Flow of stream/rivers have decreased over the years | 99 | 0 | 1 | 0.98 |
| AB6 | Intensity of flash flood had increased over the years | 2 | 0 | 98 | -0.96 |
| AB7 | Seasonal stream dries up quickly | 99 | 0 | 1 | 0.98 |
| AB8 | Water bodies dries up quickly after rainy season | 100 | 0 | 0 | 1 |
| **Average perception Score (sub-category)** | | | | | 0.39 |
| **Impact on forest fauna** | | | | | |
| FN1 | Change/decrease in fish species in the forest river | 99 | 1 | 0 | 0.99 |
| FN2 | Birds are singing earlier now | 7 | 18 | 75 | -0.68 |
| FN3 | Increased incidence of some insect pest and diseases | 91 | 4 | 5 | 0.86 |
| FN4 | Increase in plant and animal mortality | 94 | 2 | 4 | 0.9 |
| **Average perception Score (sub-category)** | | | | | 0.52 |
| **Impact on forest flora** | | | | | |
| FL1 | Overall biodiversity in forest has decreased | 97 | 3 | 0 | 0.97 |
| FL2 | Earlier ripening of forest fruit/seed tree species | 20 | 27 | 53 | -0.33 |
| FL3 | Change in phenology | 20 | 24 | 56 | -0.36 |
| FL4 | Climate change has affected the injury of tree | 70 | 22 | 8 | 0.62 |
| **Average perception Score (sub-category)** | | | | | 0.23 |

N = 100; C, statement code; figures are in per cent; A, agree; U, undecided; D, disagree; MS, mean score.
creasing since 1990s (FSI, 1995-2013). Alternately their perception on decreased stream/river flow and quick drying of seasonal streams or water bodies is based on their livelihood experience as they depend on these for their domestic and irrigation water use and fish catch for family diet.

The scientific evidences from entire Himalayan regions that weather has become unpredictable and erratic, snow is melting rapidly and water sources are drying up (Chaudhary and Bawa 2011; Rawat 2013; Shukla et al. 2015) substantiate the risk perception of the community in this study. The perception that decrease access to water supplies poses risk to forest ecosystem and to livelihoods of forest based communities is also well validated by a recent study (Withana and Auch 2014).

Forest abiotic conditions (like increased soil erosion, increased intensity of flash flood and fertility) were not directly related to their livelihood either were recorded with negative or very low scores indicating very low level of perception on impact of climate change on these factors/conditions. The Himalayas constitute one of the 34 global hotspots of biodiversity, and are the source of the 8 largest rivers in Asia. Being a watershed for the land masses of China, India, Bangladesh, Bhutan, Nepal and Pakistan, the region constitutes the lifeline of billions of people. Thus the consequences of climate change on biodiversity, agriculture as well as on human well-being are likely to be severe (Chaudhary and Aryal 2009).

Perception relating to impact on forest fauna and flora (statements FN1, FN3, FN4 and FL1) are directly related to the livelihood of the respondents and their experience, were agreed upon to be impacted by climate change. This is because the respondents were victims of such situations and they agreed on these statements based on their past experiences. The respondents perceived decrease of fish population and decrease in catch over the past three decades based on their experience as they had been doing so from ages to fulfil their dietary requirements. The respondents also believed that the species they were catching over the years had changed. However they could not define the change as they were only concern with the fish catch but not the species they were catching. The perception on impacts of climate change on physiological growth and breeding behaviour of plants and animals or biodiversity by the community in the study is well supported by earlier scientific reports (Yu et al. 2010; Joshi and Joshi 2011).

They are also experiencing low crop yield or crop failure/mortality and increased mortality of their domestic animals on which they believe is due to increased incidences of insect pest and diseases and decreased fodder/diseases, respectively. Early ripening of crops observed by these people is consistent with early onset of flowering and growing season along with proliferation of weeds and pests observed in wild plants both by the local people and scientists (Supit et al. 2010; Joshi and Joshi 2011). Respondents also experienced scorching sun during summer along with deficiency of water due to lesser rains causing crop failure/mortality.
According to them if such situations occur nearby the forest where they live why not in the forest. Thus their perception of increased incidences of insect pest and diseases and mortality in the forest due to plant injury seems to be valid (Logan et al. 2003; Breshears et al. 2005). However, there are no scientific evidences reported from Chilapata Reserve Forest to validate their perception.

Additionally, now they are also not commonly sighting raptor birds like Kites, vultures and wild animals like fox, tiger, leopards, fox, wild boar, fishing cat, rhinoceros, bison and others which was a common sight over a past decade. This decrease in sightings of wild animals along with their belief of decrease in forest area made them to perceive decrease of overall faunal biodiversity in the forest. The situations like earlier bird singing and change in phenology or earlier ripening was not a direct concern for the respondents or not directly influencing their livelihood and so were not agreed by majority of them. Forest dependent or indigenous communities elsewhere also had experienced similar impacts of climate change on forest resources (Baul et al. 2013; Onyekuru and Marchant 2014; Kamruzzaman 2015). The spider diagram (Fig. 3) also clearly indicates low to medium perception level on impact of climate change (depending on various impact indicators) on forest ecology of forest dependent community inhabiting in and around Chilapatta Reserve Forest.

Conclusion

The forest dependent community of Chilapatta Reserve Forest have perceived the impact climate change on their surrounding forest. These perceptions are consistent and conform to the scientific findings generated by modern science in different parts of the world. Majority of these people perceived negative impact of climate change on forest biotic and abiotic environment along with risk on their livelihood through increased misery, decreased income, increase susceptibility to serious diseases and decreased availability of food and water. Majority of the respondents perceived that the impact of climate change on forest will influence on their livelihood through decreased fish catch, decreased NTFP collection and unhealthy unproductive cattle which will negatively influence their food and medicinal requirement. Given the perception of impact of climate change on forest ecology it is obvious for the respondents to perceive their livelihood impacts through such indicators.

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