Public Perception about Climate Change and Its Impact in Different Seasons: A Micro-level Community Based Study in the South-Western Vulnerable Coastal Area, Bangladesh

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Abstract

The southwestern coastal zone of Bangladesh is the most vulnerable area to climate change because of its dynamic geomorphology, poverty and reliance of many livelihoods on climate sensitive sectors. The study investigates the key determinants of micro-level community perception of climate change in different seasons and dimensions as well as their source of predictions. In this study, we have applied both qualitative and quantitative methods. Data were collected from both primary and secondary sources. A field investigation was performed in two Upazilas of the Bagerhat district and primary data were collected through personal interviews of 65 respondents with the structured questionnaire checklist. And secondary data were collected from journals, reports, and historical meteorological data. Findings reveal that there is a sharp economical gap among the interviewed people and 96% of them perceive the increase of heat intensity and extension of summer. 65% of respondents find the shortening of the winter season and feel the 3^{o}C increase of minimum temperature that also revealed by the historical meteorological data analysis. The climate data also exhibits the 742.8 mm shortage of total rainfall during monsoon within a decade that is supported by 71% of people. Less than 25% of respondents find difficulties with groundwater but more than 50% complain the irrigation water dries up very soon. Almost all the respondents consider social media and TV news as well as their various senses are the source of their perception about local climate change. More than 90% of respondents perceive cyclones and salinity are their major hazards and also predict that storm surge along with sea level rise would add to this group. Policymakers should emphasize the outcomes of such study and design a zone wise adaptation plan that reflects public opinion, values, and demand.

Keywords: Climate change impacts, Micro-level community perception, Season change, Southwestern coastal zone

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1. Introduction

There is very limited emphasis on the research of impact and perception of climate change at the community level however according to the UNEP's Global Environmental Outlook, climate change is the burning issue all over the world (Ravindranath and Sathaye, 2003). Climate change affects the natural ecosystems and socio-economic system of micro level communities, which are sometimes irreversible; result in changes at the macro level (Bhatti et al., 2006). Therefore, IPCC realize, recognize and focus on the impacts of climate change in different level and find that the communities of developing countries are more vulnerable and less adaptive to damages and other stresses related to climate change than developed countries (Maddison, 2007; Ravindranath and Sathaye, 2003). The effects of climate change are higher in magnitude in developing countries in terms of loss of life and relative effects on investment and the economy (Weigel, 1983). According to the Long-Term Climate Risk Index 2021 published by Germanwatch, Bangladesh is one of the most (7^{th}) affected countries by annual average natural calamities from 2000 to 2019 due to climate change (Kreft et al., 2019). Due to the global warming, the negative impact improves the ranking of Bangladesh in the context of increased and devastating floods in monsoon, increased drought due to reduced rainfall in winter, frequent cyclones and tropical storms, sea level rise, lower level of ground water, increased salinity, land and riverbank erosion (Chowdhury, 2011; Udwala, 2007).

The report published by MoEF in 2014 stated that impacts of climate change are not the same in every region of the country and south-western coastal districts are more vulnerable to climate change impacts because of the combined effect of gradual subsidence and sea level rise (Ahmed, 2010). The coastal zone of Bangladesh is the most vulnerable to climate change because of its geographic location, active delta and dynamic morphology, flat topography, high population density, high levels of poverty, and reliance of many livelihoods on climate sensitive sectors particularly-agriculture, fisheries and water resources (Karim and Mimura, 2008; Asada and Matsumoto, 2009; Smith and Leiserowitz, 2012). Climate change has a very adverse impact on the southwestern coastal and natural resources, agriculture, biodiversity, ecosystems, economy and widens the gap between rich and poor (Raghuvanshi et al., 2018). Eventually both rural and urban people of the coastal region of Bangladesh are more vulnerable to climate change because of their challenges of poverty, low infrastructural and technological development and high dependence on nature-based livelihood (Eriksson et al., 2009).

The perception of coastal vulnerable communities about the nature of climate change in different seasons, its intensity, impacts, and causes as well as the sources of their perception is crucial to explore (Mahmud and Uddin, 2017). Information on people perception is important for policy makers for a greater understanding of climate change impact and sustainable adaptive strategies, particularly in such vulnerable coastal communities (Hasan and Akhter, 2011).

People's realization of climate change form of human-environment interaction, functional ways of observing erratic changes, local causation behind changes in climate and its impacts. Thus, there is a growing need for a better understanding of the multi-faceted and complex linkages between climate change and public perception as well as the establishment of an international research community to address such issues.

The objective of the research is to listen, share and accommodate public knowledge, observation and perception about the effects of climate change in the southwestern coastal region. This study seeks to uncover the perception about climate change in various seasons like summer, winter and monsoon taking into consideration perception about agriculture, surface and ground water and the way people develop their perception regarding this.

2. Literature Reviews and Research Gap

The key researches, which were closely related to the focused study area and addressed the impacts of climate change, were reviewed for this study. Among them, Hussain & Ahmed (2020) examined the effectiveness of climate finance on the engagement of poor and marginal households in the southwestern coast of Bangladesh and found that climate finance recipient households engaged in more adaptation measures rather than others. An empirical study performed by Ali (2018) assessed that climate change was causing sea level rising and created salinity problem in the coastal areas of Bangladesh, which had caused damage to most of the agricultural production, fisheries and household and change of the occupation. He suggested that the developed countries that are responsible internally to increase climate change should support the affecting developing countries like Bangladesh to diminish climate change threat and also control over its phenomenon. Roy et al. (2020) explored the level and degree of practical implementation of the effectiveness of disaster risk reduction (DRR) processes in southwestern coastal Bangladesh. Their study addressed community perception and responsiveness as well as the role of both the local government and civil society and emphasized that all initiatives regarding disaster risk mitigation activities must involve and promote the local community. Rahman et al. (2013) found a substantial regional difference between coastal and other regions in terms

of continuous depletion and losses of resources. They revealed the significant regional disparity and lagging of the agriculture sector of this region by studying secondary data. Another study conducted by Islam et al. (2016) assessed the declination rice production in Bagerhat district due to the increased annual monsoon daily average and maximum temperature, seasonal total rainfall during 1989-2011 as well as the adverse effect of historical tropical cyclone "SIDR" held in 2007. Rahman and Kabir (2013) approached with the historical sequences in the landscape of saline tidal floodplain of Khulna and Shatkhira to understand the ecological settings and changes and indicated that the coastal embankments change the habitations, landscape and the settlement pattern which became vulnerable because of new hazards like a saline intrusion, tidal effects and flooding.

In the exiting literature, very limited information was found on the impact and perception of climate change at micro-level community focused. This is the first attempt at micro-level examining perceptions about climate change among the vulnerable southwestern coastal community in Bangladesh. Therefore, firstly, this study has filled up the dearth of the literature related to micro-level community in Bangladesh. Secondly, this study has examined perceptions from public opinion, which provide an understanding of the impact of regional, or global climate change in mangrove forest-based ecosystem along with the impact of climate change on micro-level community. And finally, this study finding will assist in further macro or regional level research for reviewing the relevant policies and institutional structures and frameworks and identifying the protection gaps.

3. Materials and Methods

Participatory Rural Appraisal (PRA) methods such as in-depth interviews along with previous literature reviews and historical meteorological data from open access were used to conduct the research, mentioned by Islam (2015).

The research was conducted through the sequential completion of respondent group selection, questionnaire design, and survey work and described both qualitative and quantitative ways. For quantitative analysis, primary data was collected from the local people in various villages (lowest rural geographic unit) of the selected Upazilas where household members who are adults (more than 18 years) and have literacy (ability to write a letter in any language) treated as the sampling unit.

A field investigation was performed in two phases in winter (20^{th}-25^{th} December 2019) and monsoon (10^{th}-16^{th} July 2020) and data had collected through personal interviews of 65 respondents with the structured questionnaire checklist related to

the indicators and perceptions in different seasons on the climate change (Mugambiwa and Dzomonda, 2018).

The respondents had selected through a multistage random sampling technique (Khan et al., 2018). The Climate Change Questionnaire (CCQ) was translated into the Bangla language by interviewers (Halady and Rao, 2010). All the questionnaire forms had been compiled, organized, checked carefully and irrelevant answers had been screened out. After analysing, the data extracted from primary sources were compared with the data from secondary sources. For secondary information, various types of open source data such as historical meteorological data, statistical data, and reports had been collected from various organizations.

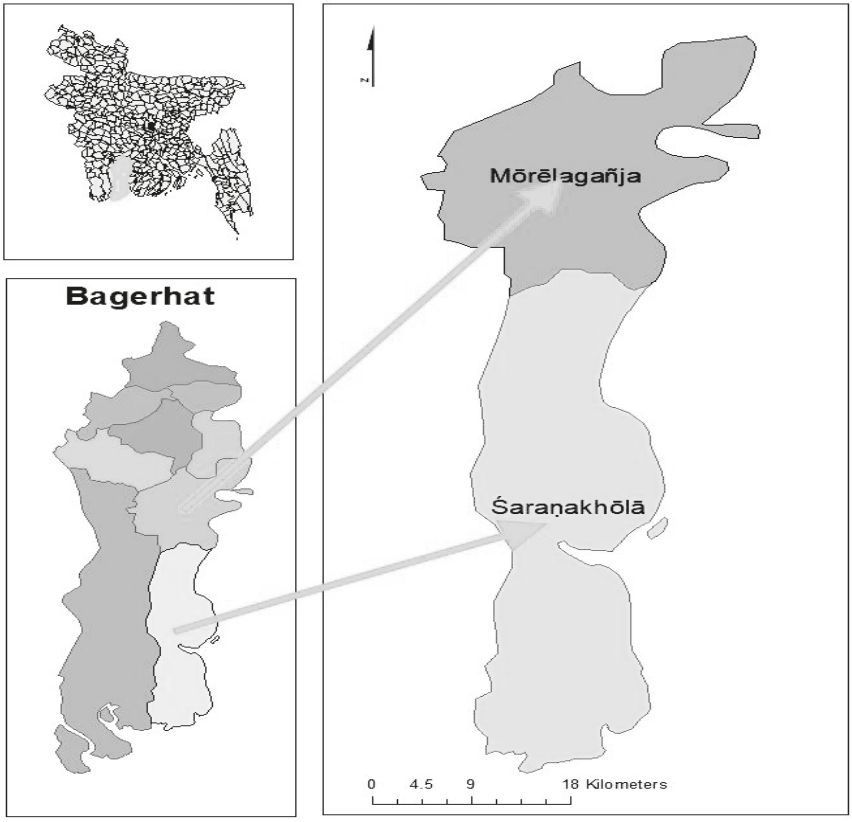

Figure 1: Location map of the study area (Morrelganj and Sarankhola)

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But during the interview, no hints on climate change were provided to the respondents to avoid possible biasness as indicated by Mertz O, et al. (2011). As the discussion was made on their perceptions of climate change, they had made some changes on their original view of climate change and adaptive measures. Data were analysed through qualitative and interpretive ethnographic tradition with special reference to cases.

Two upazilas (**Figure 1**) were selected as representative based on their ecological, geographical, meteorological, demographical and socio-economic condition. Morrelganj is one of the densely populated (639/km^2) upazila of Bagerhat district with a small municipality whereas 80% area (594.58 km^2) of Sarankhola lies in the Sundarban reserve forest area (BBS, 2013).

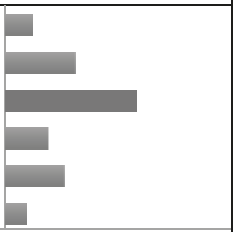
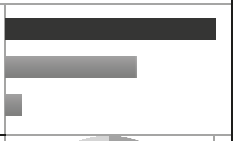
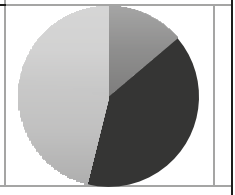
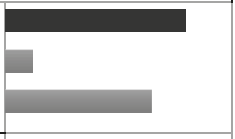
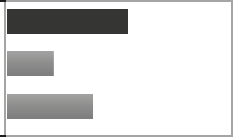
These two upazilas were selected purposively for the research because one has a semi-urban ecosystem and another has a rural mangrove forest ecosystem while both have a coastal riverine ecosystem. Administratively Morrelganj has four times (16) more unions than Sarankhola (4). The Pangunchi River cuts Morrelganj and its riverine area is 21.31 km^2. On the other hand, Sarankhola with a 7.78 km^2 riverine area is situated lengthwise west side Balaswar River, which separates the Khulna division from the Barisal division (BBS, 2013)

4. Result and Discussion

4.1 Qualitative Analysis/Descriptive Information of the Respondents

Patchen (2006) found that public perception, knowledge and attitude towards environmental issues varies on various personal characteristics such as gender, age, education, household size, occupation, family income and expenses which have a statistical effect on the probability of the respondents to perceive climate change (Khan et al., 2018). In Bangladesh, males are the head of the family and therefore most of the respondents involved in this sampling were males than females (Male=57%, Female=43%). Observing from the sampling frame in **Table 1**, the dominant sampling units (total 51 respondents) were above the age of 29 years, so that they could able to recall signs of patterns of climate changes in their communities.

Table -1: Demographic profile of survey respondents

		Total	Percentage	
Total number of respondents		N=65	100%	
Gender	Male	37	57%	
	Female	28	43%	
Age	19-28	14	21.54%	
	29-38	22	33.85%	
	39-48	19	29.23%	
	Over 49	10	15.39%	
Education	No formal education	5	7.69%	
	Class I-V	13	20%	
	Class VI-X	24	36.92%	
	Class XI-XII	8	12%	
	Graduation	11	16.92%	
	Post-graduation	4	6.15%	
Household	1-5 members	38	58.46%	
	6-10 members	24	36.92%	
	10+ members	3	4.61%	
Occupation	Agriculture	9	13.85%	
	Business	26	40%	
	Service	16	24.62%	
	Homemaker	14	21.54%	
Family Income (BDT/Month)	Less than 12,000	33	50.76%	
	Around 12,000	5	7.69%	
	More than 12,000	27	41.53%	
Family Expense (BDT/Month)	Less than 10,000	31	47.69%	
	Around 10,000	12	18.46%	
	More than 10,000	22	33.84%	

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Most of the respondents had high school level education where some of them completed Junior School Certificate (JSC) and other passed Secondary School Certificate (SSC). In the context of the number of educational institutions and literacy level, Sarankhola is always lagging behind Morrelganj (BBS, 2013).

Now large family becomes very rare in the society of Bangladesh, which can be considered a great success of the GoB. Here only 4.61% of people belong to those families consisting of more than 10 persons. Due to the lack of agricultural scope and a good river-based communication system, it is found that a major portion of respondents earn their livelihood by doing business. There is an economical gap between rich and poor is evidently seen in the data frame where almost 50% of people earn less than 12000 BDT and expend less than 10000 BDT per month, which is the indirect impact of climate change on the socio-economic condition of a community. So, they are the potential resources for climate change study and should be explored to account for the impacts of climate change on coastal lives and livelihood.

4.2 Perception of Weather Changes Compared to Five to Ten Years Ago

4.2.1 Present Intensity of the Heat During Summer

Most of the people's perception of the intensity of heat is increased and 26% of men and 18% of women feel that the temperature during the summer season is high and very high respectively. Women are greatly concerned with climate change and consider that it is to be a near threat to men and act differently (McCright, 2010; Carlton and Jacobson, 2013). The historical data about the maximum temperature of the Bagerhat district **(Figure 3)** also trends high from 35oC in April 2011 to 37oC in April 2020 without some exceptionally high peak of 39oC in 2010 and 2014. This 2oC increment of maximum during summer aliens parallel with the public perception. People perceive the changes depending on some reasons like farmers are unable work long in their agricultural field due to extreme heat as well as 94% of people perceive the increment of heat intensity and 72% in heat waves and 36 respondents complain that the summer is extended occupying the days from pre-monsoon and spring **(Figure 2)**.

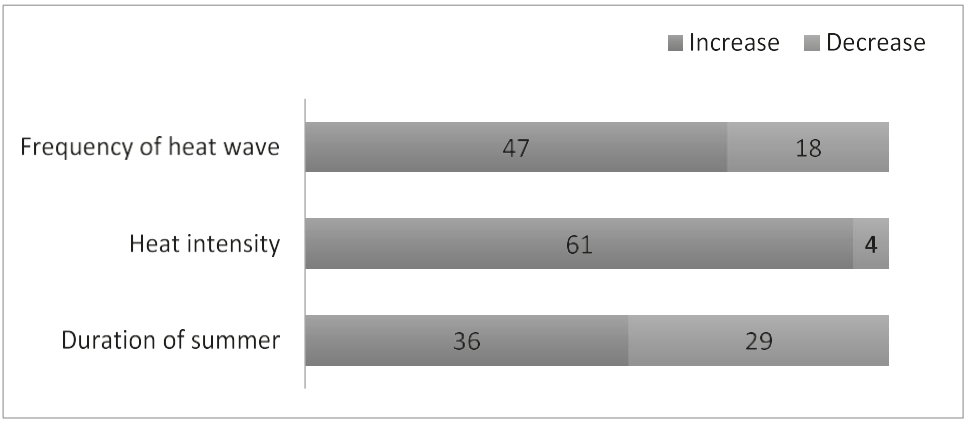

Figure 2: Perception of change in summer season depending on different phenomena

Figure 3: Graph of maximum temperature (^{0}C) from January 2010-December 2020 of Bagerhat district,Source:https://www.worldweatheronline.com/bagerhat-town-weather-averages/bd.aspx

4.2.2 Present Bitterness of Cold During Winter

The analysed meteorological data from figure 5 illustrates that the yearly minimum temperature of Bagerhat is gradually increased by 3^{o}C within this decade, which is shocking and alarming. In January 2010 the minimum temperature was 15^{o}C but it rises up to 18^{o}C, recorded in the same month of 2020. More than 65% of respondents find both the winter season and frequency of cold waves to be declined (**Figure 4**).

25% of men and 22% of women find that winter becomes warmer compared to five to ten years ago and 14% of men and 9% of women find it very low. 31 people out of 65 respondents do not notice the change of cold severity where 14% men and 8% women feel that the bitterness of winter becomes high. They may feel it due to the severe cold waves.

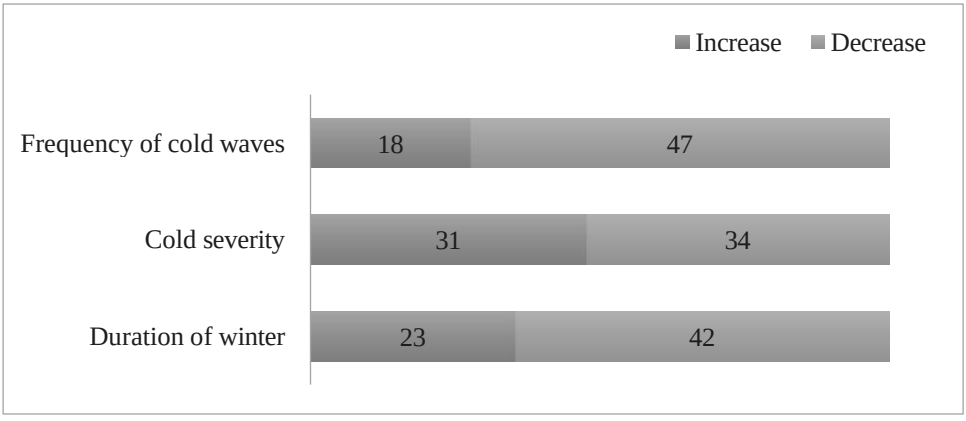

Figure 4: Perception of change in winter season depending on different phenomena

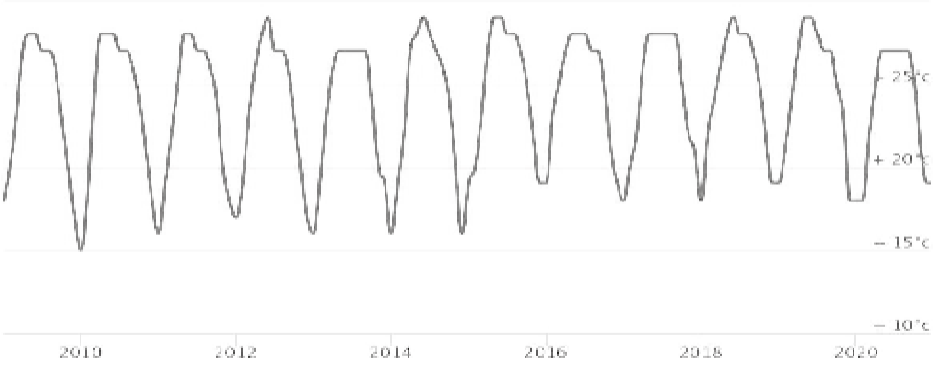

Figure 5: Graph of minimum temperature (^{0}C) from January 2010-December 2020 of Bagerhat district,Source:https://www.worldweatheronline.com/bagerhat-town-weather-averages/bd.aspx

4.2.3 Present Intensity of Rainfall During the Rainy Season

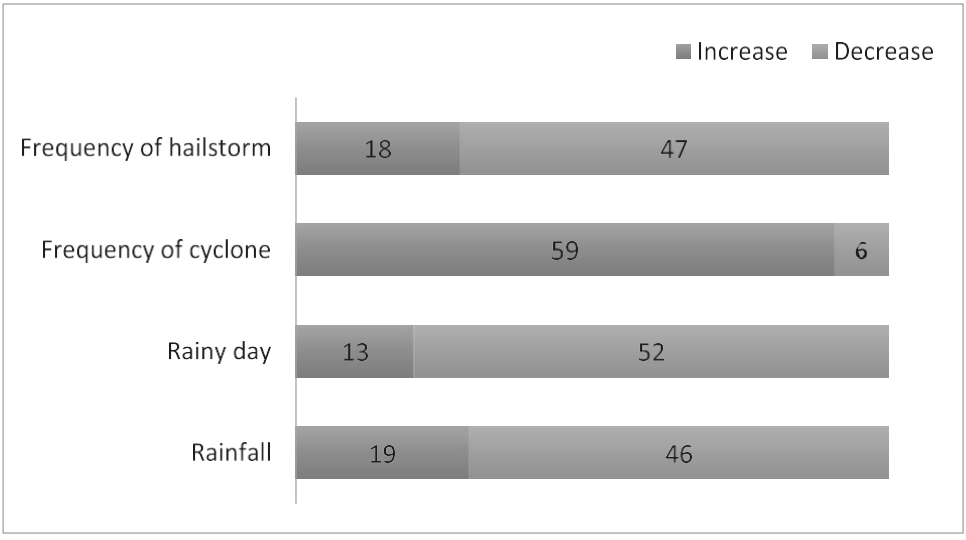

Figure 6: Perception of change in rainy season depending on different phenomena

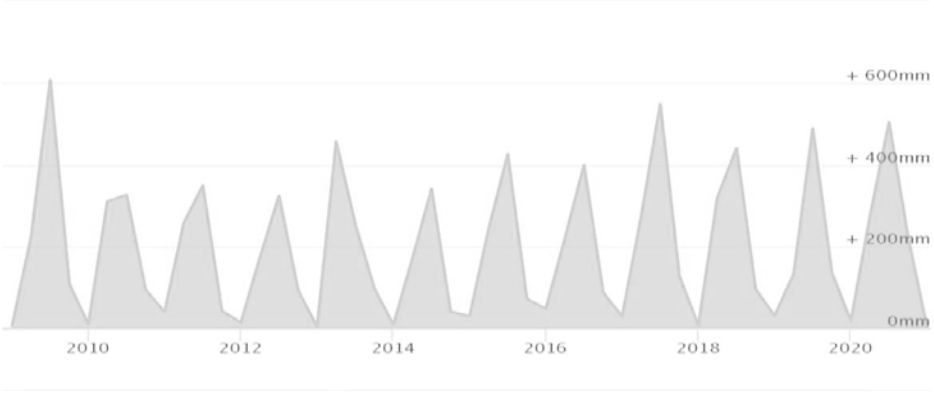

Figure 7: Graph of average rainfall (mm) from January 2010-December 2020 of Bagerhat district, Source: https://www.worldweatheronline.com/bagerhat-town-weather-averages/bd.aspx

Around 22% of male respondents perceive the intensity of rain is low which is lower than female respondents (25%). But few (8%) female think it remains normal where 20% of male support it. The average rainfall during monsoon in2009 (May-October) was 456.52 mm, which becomes 332.8 mm in 2019 (**Figure 7**) and 46 people support this decrement.

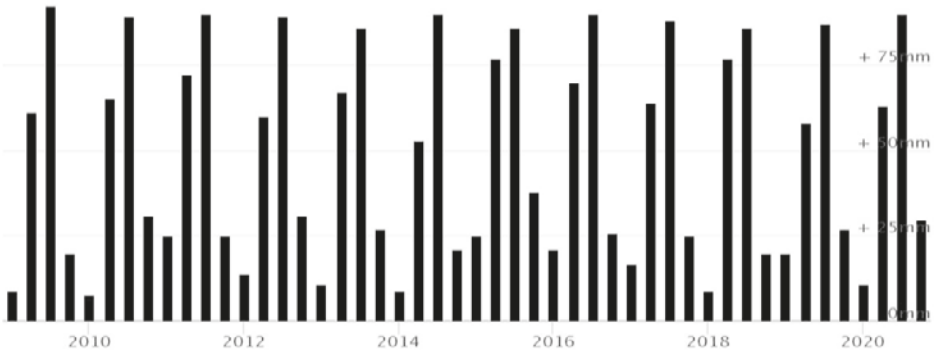

Figure 8: Graph of rainy days from January 2010-December 2020 of Bagerhat district, Source**:** https://www.worldweatheronline.com/bagerhat-town-weather-averages/bd.aspx

Table- 2: List of the Tropical Cyclone Hit Bangladesh in This Decade

Landfall Coast	Cyclone Name	Date	Month	Year	Category (SSHWS)	Wind Speed (km/h)
SW	Amphan	16-21	May	2020	5	260
	Bulbul	5-12	November	2019	3	195
	Fani	26-30	April	2019	5	280
	Titli	8-12	October	2018	3	195
SE	Mora	28-31	May	2017	1	150
	Roanu	19-23	May	2016		110
SW	Mahasen	16-21	May	2013		85
	Aila	26-27	May	2009	1	120
SE	Bijli	14-17	April	2009		95

Source: Joint Typhoon Warning Centre (JTWC)

Additionally, 52 people perceive the total rainy days during monsoon are also decreased (**Figure 8**). The historical rain data of the Bagerhat district (**Figure 8**) also exhibits that total rainy days were 159 days and 153 days respectively in 2009 and 2019. Although the total rainy days are decreased only 7 days, the amount of total rainfall is decreased by 742.8 mm during the rainy season. 47 people say that the frequency of hailstorms is decreased but maximum respondents (59 out of 65) agree that the frequency of cyclone in the southwestern coastal region has increased in high number because they are suffered almost every year by one or more category 3 to 5 tropical cyclone named Aila, Mahasen, Titli, Fani, Bulbul, and Amphan (**Table 2**). Their socio-economic damages are increased; however, they acknowledge that the Sundarban mangrove forest protected them as a shield and fatalities are minimized by early warning system.

4.2.4 Present Situation in Surrounding Water Resources

The water budget study by Zahid, et al. (2018) shows that the maximum depth to groundwater table in Bagerhat is not so changed under climate change condition because the river plays a significant role to adjust inflow and outflow. Around 58% of respondents find that there is no significant change to the water table in the tidal river but in ponds and canals during summer (**Figure 9**). This interconnection between the river and the aquifer provides drinking water to 75% of respondents where deep tube wells maintain good water pressure. A limited number of people (less than 25%) find water related difficulties in deep tube wells (**Figure 10**). The salinity level in southwestern coastal areas is increased with the coupled the effect of sea level rise (Khan et al., 2008) and shrimp farming. (Ali, 2006)

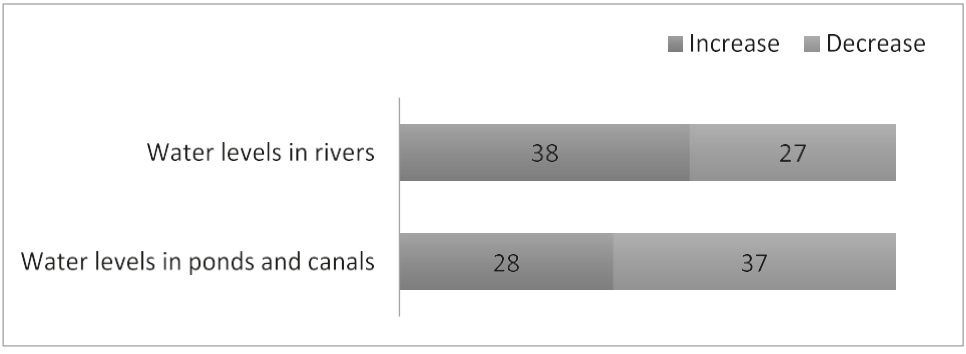

Figure 9: Perception change in surface water depending on different phenomena

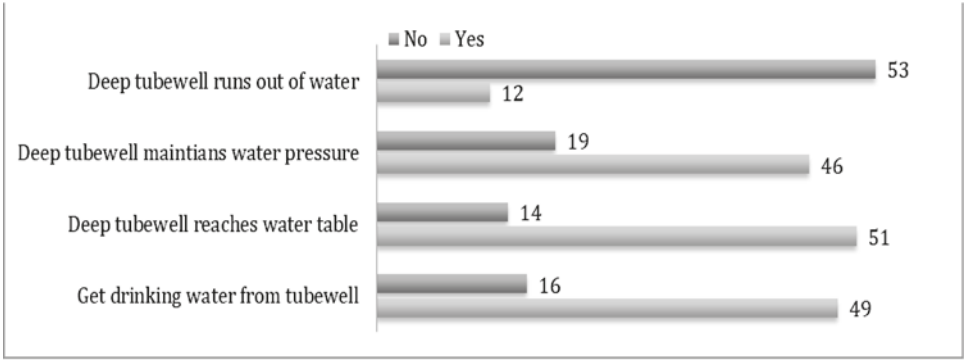

Figure 10: Perception change in groundwater depending on different phenomena

4.2.5. Present Situation in Agriculture

The change of agricultural characteristics plays one of the major roles regarding public perception about climate change. The respondents' perception regarding the impact of climate change in agriculture is identified through the effect of change in various phenomena related to cultivation and their return from farming (Khan et al., 2018). Response of sampled people revealed the majority of them (53) noted a significant decrease in the growth of the trees (**Figure 11**). More than 50% of people from total respondents admit that they can cultivate their land by rainwater but the irrigation water dries up very soon and filed become much drier. Moreover, cracks are formed in several agricultural fields and tender leaves of trees die in hot summer. However, a notable number of respondents (average 30) are not agreeing with that.

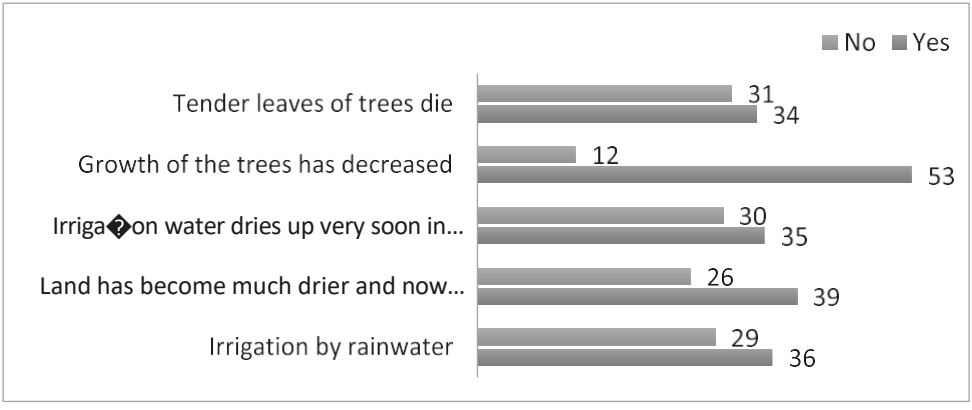

Figure 11: Perception change in agriculture depending on different phenomena

4.3 Perception about Present and Future Disasters

Present perception of the people from Morrelganj and Sarankhola indicates that cyclone and increased salinity in the surface and groundwater are the major hazards however all of these hazards are interrelated to each other results from climate change. They guess that storm surge would add this major group and drought; flood and sea level rise would remain the minor disasters as they are (**Figure 12**). Interestingly they think that water logging will no longer be their hazard, which is a subject to further detail research.

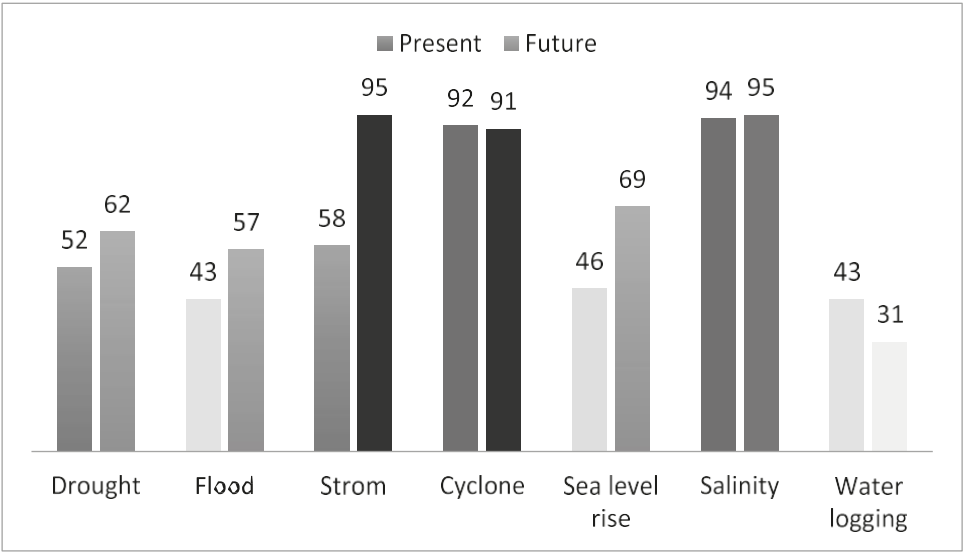

Figure 12: Local public perception about recent hazards and prediction about future hazards due to climate change

4.4 Source of Public Perception

All kinds of media play an important role in constructing people's concern about climate change and it also fluctuates with the amount of media coverage of a particular issue (Weigel, 1983; Mazrur and Lee, 1993). Most of the people (almost 60) get audio-visual evidence of changing global or regional weather pattern and their impact on the ecosystem by social media and TV news (**Figure 13**). Radio news is losing its popularity and newspaper works as a source for those people who have that much literacy level, patience and habit of reading.

Although different types of theoretical scale have been developed to measure people's psychological behaviours and environmental attitudes towards climate issues and changes (Maloney and Ward, 1973; Dunlap and Jones, 2003).

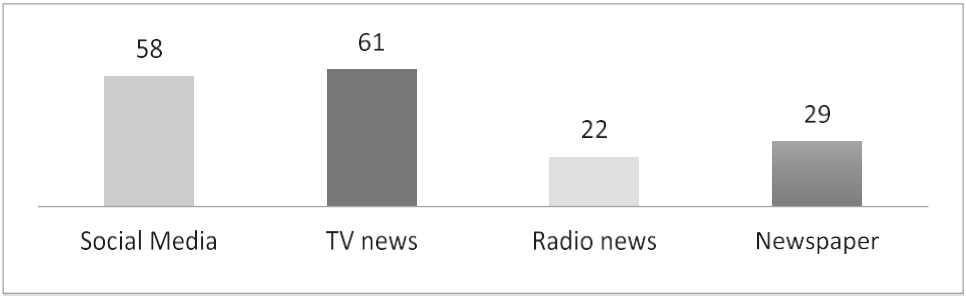

Figure 13: Various media sources of local public perception change on climate change

Feeling heat wave, tired and thirsty during summer while they are finding dewdrops presence with fog in winter are the main sensory source of their perception about climate change in their area (**Figure 14**). Some of them find winter arrives late comparing with previous years, with limited visibility of the sun due to dense fog. Even they cannot go outside of their house or feeling burning sensation and increased sweating because of extreme heat waves in summer.

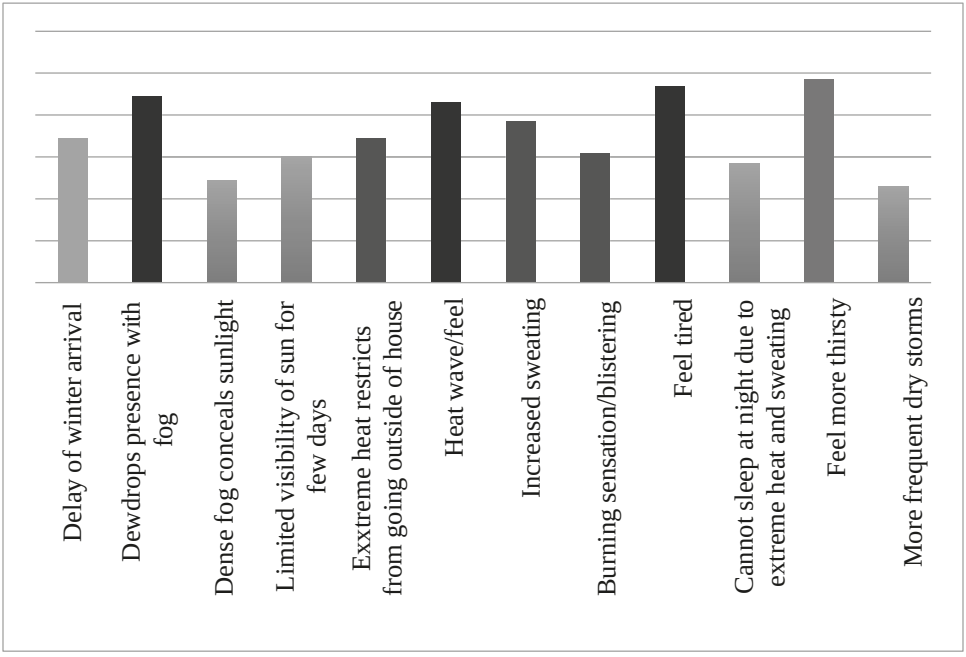

Figure 14: Various sensory sources of local public perception change on climate change

4.5 Public Perception about Climate Change

According to the Bagerhat district's meteorological statistics, the maximum summer temperature has increased by 2ºC and the minimum winter temperature has decreased by 3ºC over the past ten years. Rainfall and rainy days are both drastically declining during the monsoon season while rising during other seasons. Due to the blessings of the Balaswar River, despite the area being close to a coastal zone, where salinity in both surface and groundwater is rising and water quality is declining, there is no adverse effect on its hydromorphology for climatic change. People who live in this southwestern coastal region are extremely exposed to many kinds of natural disasters and risks, and almost every year they experience one or more category 3 to 5 tropical cyclones. They believe that because of the existing issue of increased salinity in their soil and water, sea level rise will worsen their misery. Moreover, due to the loss of irrigation water from ponds and canals, agricultural land is rapidly drying up and crop growth is slowing down. In addition to sensory information, social media, and television news, these underprivileged people also observe longer summers and shorter winters, an increase in cyclone activity, and a decrease in monsoon rain. The community is exposed to the effects of climate change, and its capacity for resilience is quite low.

5. Limitations, Conclusion and Recommendation

Our study has several strengths but the outcomes should not be generalized because of the small sample size and shorter period and area of study. One limitation of this empirical research is that it was based on the expressed information and opinion of the respondents, which may not be free from individual biases and prejudices. Further large-scale research studies on this topic need to be undertaken using a large sized sample across the southwestern coastal region of Bangladesh.

There is a consensus of perceived climate change variability among studies conducted in coastal areas, which found that respondents perceived a general increase in temperature, the intensity of heat, cyclones, duration of summer and a decrease in rainfall, winter season and agricultural production. Respondents' perceptions are consistent with meteorological data. They perceive that all aspects of their entire life are disrupted by hazards and negative impacts of climate change. They also think that the Sundarban mangrove forest, which is a blessing for them works as a shield protecting them and the early warning system by the government through social media and TV news minimize the fatalities. However, the poor infrastructure and resilience system increases the economic damages.

This micro-level study finding will assist in further macro or regional level research for reviewing the relevant policies and institutional structures and frameworks and identifying the protection gaps. Policymakers should emphasis on the outcomes of such study and design zone wise adaptation plan that reflects public opinion, values, and demand. Therefore, it is the utmost priority to be aware, resilient and protect these disregarded and afflicted vulnerable people of the southwestern coastal region from the climate induced hazards and problems.

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