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Impact and vulnerability assessment on climate change of Jessore and Mymensingh districts in Bangladesh

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Abstract

A survey of Jessore and Mymensingh district, the study assesses the inclusive scenario of climate change and its impact over 30 years (From 1981 to 2016). The objective of the study is to assess the overall condition of Jessore and Mymensingh district over last three decades which is being influenced by changing climate pattern. The research area is comprised of ten sub-districts in the Jessore and Mymensingh district, two separate geographic regions in Bangladesh, where climate change literature has highlighted as prone to accelerated degradation. Four-hundred (400) respondents participated in the questionnaire survey, both quantitative and qualitative data were collected and analyzed using SPSS, the data were also used to calculate weighted indexes for rankings and to perform logistic correlation. Results showed that climate change, a critical global environmental challenge which showed rigorous impacts as "extreme temperature" in both Jessore district and Mymensingh district. In case of climate change vulnerability "water resources" was brutally vulnerable to climate change in both Jessore and Mymensingh district followed by another four resources. Moreover, the climate risks most frequently addressed in existing studies were associated with "risk of natural disaster" in Jessore district and "surface water quality" in case of Mymensingh district. Conversely "fish farming" was the most operational adaptation measures to climate change in Jessore district and in Mymensingh district "use of different crop varieties" was mostly percept by the respondents. In case of constraints related to adaptation measures "Lack of proper awareness" was the most terrible constraints to climate change adaptation faced by the respondents regarded as top in ranking order, followed by other adaptation constrains in Jessore district and "Limited knowledge about adaptation measures" in case of Mymensingh district. Also, questionnaire survey was done in ten (10) different GOs and NGOs in Jessore and Mymensingh district for the accurateness of the consequence of climate change in the study regions which also disclosed that increased temperature, erratic precipitation, increase ground water uses, increased flood frequency, drought frequency etc. were some major consequences of climate change in the two study districts. These results provide policy makers and development service providers with important insight, which can be used to better target interventions which build, promote or facilitate the adoption of adaptation mechanisms with potential to build resiliency to changing climate and resulting environmental impacts.

Key words: Climate change, impact, vulnerability, adaptation, Bangladesh

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Introduction

The world's climate has always changed between hotter and cooler periods due to various factors. Although the basic science is now clear, the full range of effects due to human influenced climate change is

still not fully understood. South Asia is the most vulnerable region of the world to climate change impacts (McCarthy *et al.*, 2001). In South Asia, Bangladesh is a country of Tropic of Cancer and has a tropical monsoon climate characterized by heavy seasonal rainfall, moderately warm temperatures and high humidity (Ahmed, 2006). Although Bangladesh is the country least responsible for climate change, it is extremely vulnerable to this climate change impacts. Bangladesh is considered one of the countries that is the most vulnerable to climate change because of its location in the tropics, dominance of complaining, low elevation from sea level, high population density and low economic and technological capacity (Huq and Rabbani, 2011; IPCC, 2007; Parvin *et al.*, 2008; Pouliotte *et al.*, 2009; Shahid and Behrawan, 2008). Temperatures have been increasing in Bangladesh, particularly during the monsoon season, for the last three decades (Sarker *et al.*, 2012). Moreover, the country is predicted to experience an increase in average daily temperature of 1°C by 2030 and 1.4°C by 2050 (IPCC, 2007; Selvaraju *et al.*, 2006). Rainfall has become progressively more variable and demonstrated its uneven distribution. The number of days without rain is increasing despite the total annual rainfall essentially remains the same (Rokonuzzaman *et al*., 2018; Islam *et al.,* 2017). This erratic pattern produces extreme events, such as floods and drought, thunderstorms and lightning which have noticeable adverse effects on crop yield, especially rice yields (Khatun *et al.*, 2016; Rahman *et al.*, 2018; Sarker *et al.*, 2012; UNDP, 2007). As a result, rice production is likely to decline by 8–17% by 2050 (BBS, 2011; IPCC, 2007).

Long-term climatic variability has influenced sowing date, crop duration, crop yield and management practices in rice production (Lansigan *et al.*, 2000). The demand of water for irrigation is very sensitive to climate change that affects agricultural production, mostly on rice production (Rokonuzzaman *et al.,* 2018; Schlenker *et al.*, 2007). Many scientists have already anticipated that more frequent and more intense or severe weather events will result in increased deaths, injuries and diseases in developed countries, but the biggest impact will be felt in low-lying, heavily populated areas such as Bangladesh, particularly when coupled with sea level rise, river bank erosion, metal pollution, pesticide residues etc. (Islam *et al*., 2017; Khatun *et al*., 2016; Uddin *et al*., 2016; Islam *et al*., 2015a; Islam *et al.,* 2015b; McCarthy *et al.*, 2001).

For mitigating the future demand, research from different angles on climate change vulnerability is very much crucial in addition, it should be given emphasize on awareness growing about the climate change impacts which makes their lives vulnerable. So, to represent the climate change status of Bangladesh author selected 2 representative districts like, Jessore and Mymensingh for this study. Jessore and Mymensingh are two different areas, located in two different corners of Bangladesh. So, these two areas from two different locations can help to evaluate the climate change impacts easily as they two had different climate pattern due to their different locations and different adaptation strategies followed the people and it also helps to make a proper comparison between the two districts which may help to show some suggestions for the betterment of Bangladesh.

Materials and Methods

***Study Location*:** The study was conducted in five sub-district of Jessore district, including Jessore sadar (435.22 km^2), Jhikargacha (307.96 km^2), Keshabpur (258.44 km^2), Manirampur (444.20 km^2) and Sharsha (336.28 km^2) and five sub-districts of Mymensingh district, including Mymensingh sadar (345.88 km^2), Gauripur (374.07 km^2), Ishwarganj (286.19 km^2), Dhobaura (251.05 km^2), Fulbaria (402.41 km^2) (BBS, 2011). The map of Jessore district showing the study sub-districts and map of Mymensingh district showing study sub-districts have been presented in the Figure 1.

***Sampling and Socio-economic Information*:** An interview schedule was prepared for collection of data from the respondents keeping the objectives of the

study in mind. Data for the study were collected through personal interview, from November 2017 to June 2018.

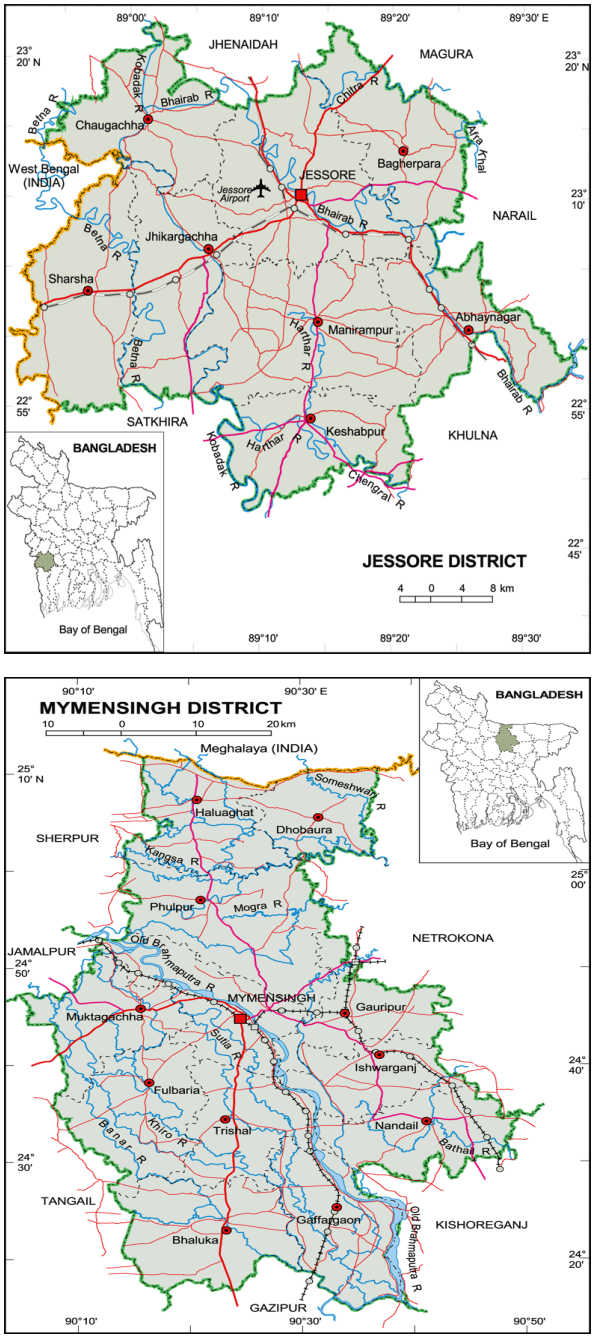


Figure1. Map of the study areas of two districts (Source: Local Government Engineering Department's Website).

During the collection of data, both primary and secondary sources were considered. Primary data were collected from respondents. secondary data were collected from Bangladesh Meteorological Department (BMD) and literature review of various published papers. Information was collected from 200 respondents of the study sub-district of Jessore district and 200 respondents of the study sub-district of Mymensingh district. Respondents were selected through simple random sampling method. All of the data were collected considering on the respondents' age, educational qualification, occupation, their farm size and equal in gender.

Formulation Techniques

***Major impacts of climate change of the study area observed by the respondents*:** Besides having calculated the "impacts of climate change" score for each of 200 respondents of each district, an effort was also made to compare the changes. An impact of climate change index (CI) was developed to fulfill this objective using the following formula:

$CI = N_1*3 + N_2*2 + N_3*1 + N_4*0$

CI = Impact of Climate Change Index.

N_1 = Number of respondents observed the high impact of climate change.

N_2 = Number of respondents observed the medium impact of climate change.

N_3 = Number of respondents observed the low impact of climate change.

N_4 = Number of respondents observed the impact of climate change not at all.

The CI for each of the climate change patterns ranged from 0 to 600 for each district (Uddin *et al.*, 2014).

***Vulnerability of the resources of the study area to climate change observed by the respondents*:** For calculating the "extent of vulnerability of resources to climate change observed by respondents" score for each of 200 respondents for each district, an effort was

also made to compare the relative vulnerability of resources to climate change. A vulnerability of resources to climate change index (VI) was developed in the same way as impact of climate change index (CI).

Effects of climate change observed by the respondents: For calculating the "extent of effect of climate change observed by respondents" score for each of 200 respondents of each district, an effort was also made to compare the relative effect of climate change. An effect of climate change index (EI) was developed in the same way as impact of climate change index (CI).

Extent of adaptation to climate change of the study areas observed by the respondents: For calculating the "extent of adaptation to climate change observed by respondents" score for each of 200 respondents of each district, an effort was also made to compare the relative adaptation to climate change. An adaptation to climate change index (AI) was developed in the same way as impact of climate change index (CI).

Extent of constrains to climate change adaptation of the study areas observed by the respondents: Having calculated the "extent of constrains to climate change adaptation observed by respondents" score for each of 200 respondents of each district, an effort was also made to compare the relative constrains to climate change adaptation. A constrains to climate change adaptation index (CAI) was developed to fulfill this objective using the following formula:

$CAI = N_1*2 + N_2*1 + N_3*0$

CAI = Constrains to Climate Change Adaptation Index

N_1 = Number of respondents observed 'Agree' to constrains to climate change adaptation

N_2 = Number of respondents observed 'Neither agree nor disagree' to constrains to climate change adaptation

N_3 = Number of respondents observed 'Disagree' to constrains to climate change adaptation.

CAI for each of the constraints to climate change adaptation observed by respondents ranged from 0 to 400.

Extent of opinion about different activities related to climate change of the study areas observed by the respondents: Having calculated the "extent of opinion about different activities related to climate change observed by respondents" score for each of 200 respondents of each district, an effort was also made to compare the relative opinion about different activities related to climate change. An opinion about different activities related to climate change index (ACI) was developed in the same way as constraints to climate change adaptation (CAI).

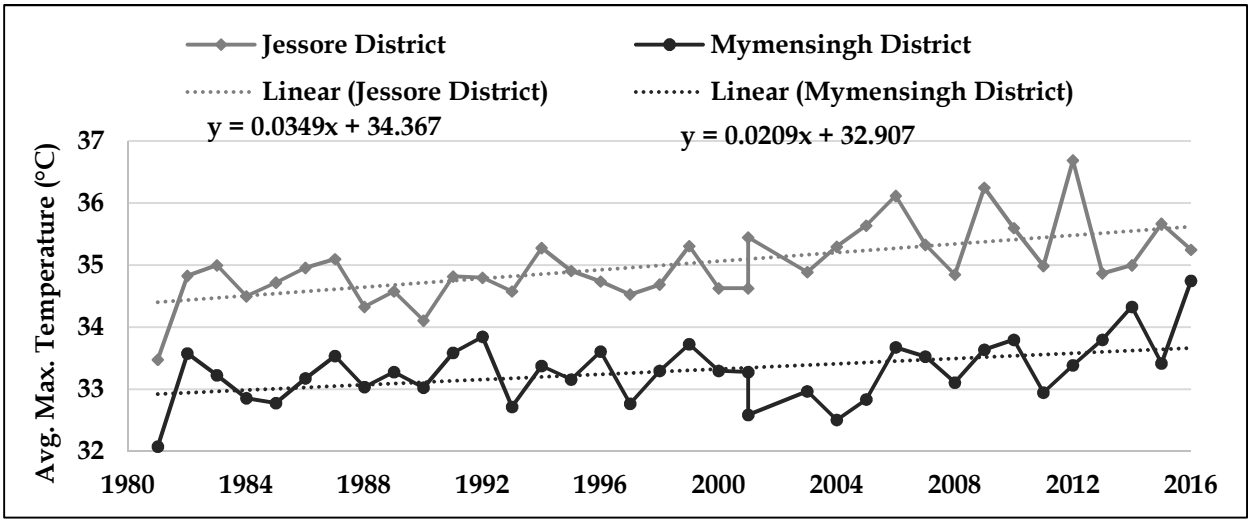
Correlation analysis: In order to test the formulated hypotheses of the study, person's product moment Correlation Co-efficient (r) was used. Through this statistical treatment, nature of the relationship between the dependent and independent variables was determined. Also, t-test was done to make comparison between the two districts overall climate condition.

Results and Discussion

***Climatic Variables of the Two Districts*:** The climatic data comprised of annual average maximum and average minimum temperature for the period of 1981-2016, annual rainfall for the period of 1981-2016 and annual humidity for the period of 1981-2016 of Jessore and Mymensingh districts. From the maximum temperature data (Figure 2), it can be seen that Annual maximum temperature was increased in both districts. Annual average maximum temperature in Jessore was increased by 0.0349°C/year with its annual maximum 34.367°C and in Mymensingh district annual average maximum temperature was increased by 0.0209°C/year with its annual maximum 32.907 °C.

The annual average minimum temperature data (Figure 3) also showed increasing trend in both districts. In Jessore the annual average minimum temperature was increased by 0.046°C/year with its annual minimum 16.429°C and in Mymensingh the annual minimum

temperature was decreased by 0.0174°C/year with its annual minimum 17.313°C. The similar increasing trend for maximum temperature from year 1964 to 1991 in Jessore district was found by Kabir (2015) in cases of the impact of climate change on agriculture, especially in Jessore and Sathkhira districts according to farmers' mitigation strategies to climate change; evidence from farmer level data. Also, Rahman *et al.* (2017) found in impacts of temperature and rainfall variation in rice productivity in major ecosystems of Bangladesh, that the temperature of Mymensingh district was increasing and the maximum (0.07°C per decade) and minimum (0.21°C per decade) temperatures note a pronounced rise in dry region when compared to other regions.



Fig**ure** 2. Comparison between the annual average maximum temperature in Jessore and Mymensingh Districts from 1981 to 2016 (Source: BMD).

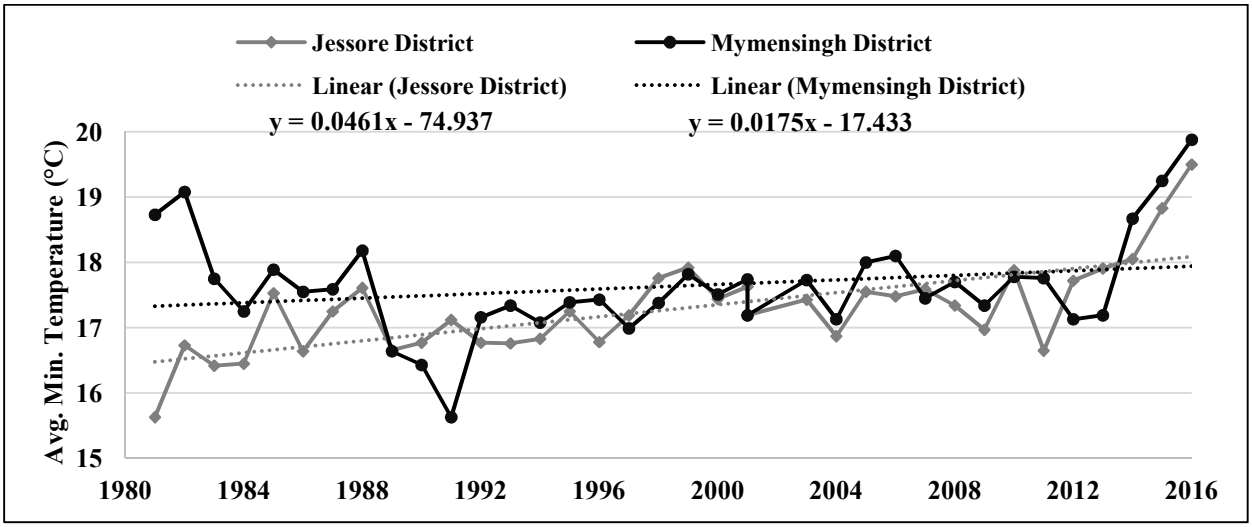


Figure **3.** Comparison between the annual average minimum temperature in Jessore and Mymensingh Districts from 1981 to 2016 (Source: BMD).

After that the annual total rainfall data showed decreasing trend in both districts (Figure 4). In Jessore annual total rainfall was decreased by 7.5474 mm/year with 1812.3 mm and in case of Mymensingh annual total rainfall was decreased by 11.071 mm/year with 2512.6 mm. Kabir (2015) found that the total mean annual rainfall has increased in Bangladesh while it has decreased for greater Jessore in the study of impact of climate change on agriculture, especially in Jessore and Sathkhira districts according to farmers' mitigation strategies to climate change; evidence from farmer level data. Also, Rahman *et al.*(2017) found that the rainfall anomalies (mm) was increasing in Mymensingh district from year 1961 to 2007 in his impacts of temperature and rainfall variation on rice productivity in major ecosystems of Bangladesh.

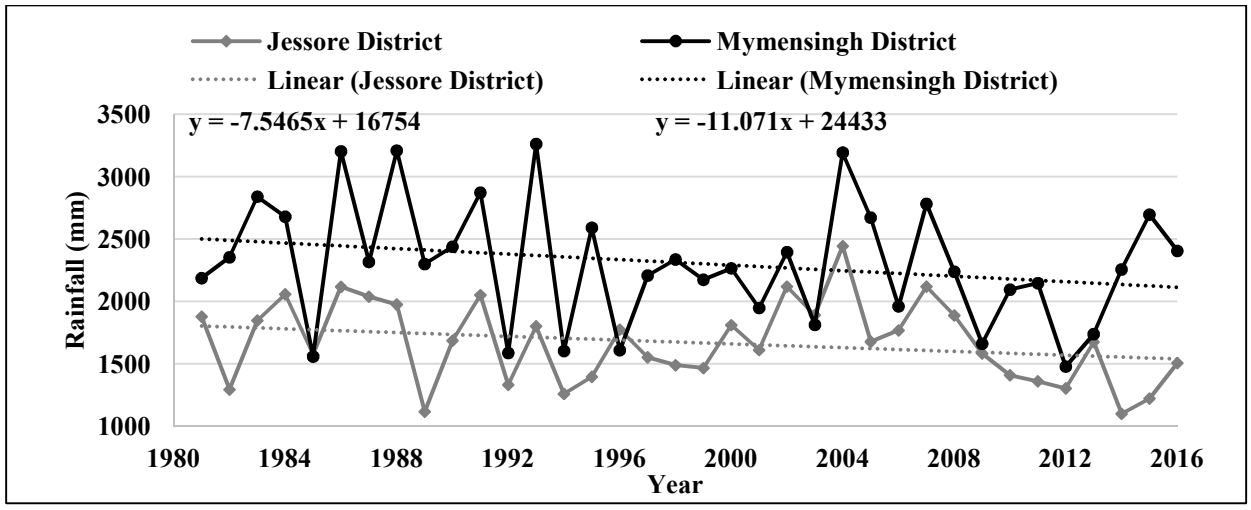


Figure 4. Comparison between the annual average rainfall in Jessore and Mymensingh districts from 1981 to 2016 (Source: BMD).

Then in case of relative humidity the curve of relative humidity (Figure 5) in Mymensingh district goes lower than the Jessore district. It showed an increasing trend in case of Jessore district and decreasing trend in Mymensingh district. Annual relative humidity in Jessore district was increased by 0.1497%/year with its relative humidity 75.72% and in Mymensingh annual relative humidity was decreased by 0.0397%/year with its relative humidity 79.06%. In case of Jessore district it also showed a massive decrease in the annual humidity percentages in the year of 1982, 1989 and 2015. In case of Mymensingh district the data showed a virtually unfluctuating condition, but it showed a massive fall in the year of 2014. Raufe (2015) also found significant change in relative humidity in Jessore district in his research entitled analysis of changing agricultural pattern in Jessore: environmental and social aspects. After analyzing this entire climatic information author decided to conduct this study to know the impact, vulnerability and adaptation measures due to this change of climatic variables through peoples and GOs/NGOs personnel's perception in the two study districts.

Climate change pattern experienced by the respondents and their perceptions about the overall effects of climate change

Respondents' perception about the overall effects of climate change: The perception of the respondents was scored and converted into percentages. The result showed that from all the factors increased temperature had the highest effect on Jessore district. After that

irregular rainfall, increased cyclone, increased health hazard, dead rivers had nearly similar extent of effect. Then effects of increased flood, seasonal drought, increased salinity and impact on food had medium kind of effects and then crop failure, sea level rise, river erosion had low effects (Figure 6) in Jessore district. In case of Mymensingh district also increased temperature had the highest effect.

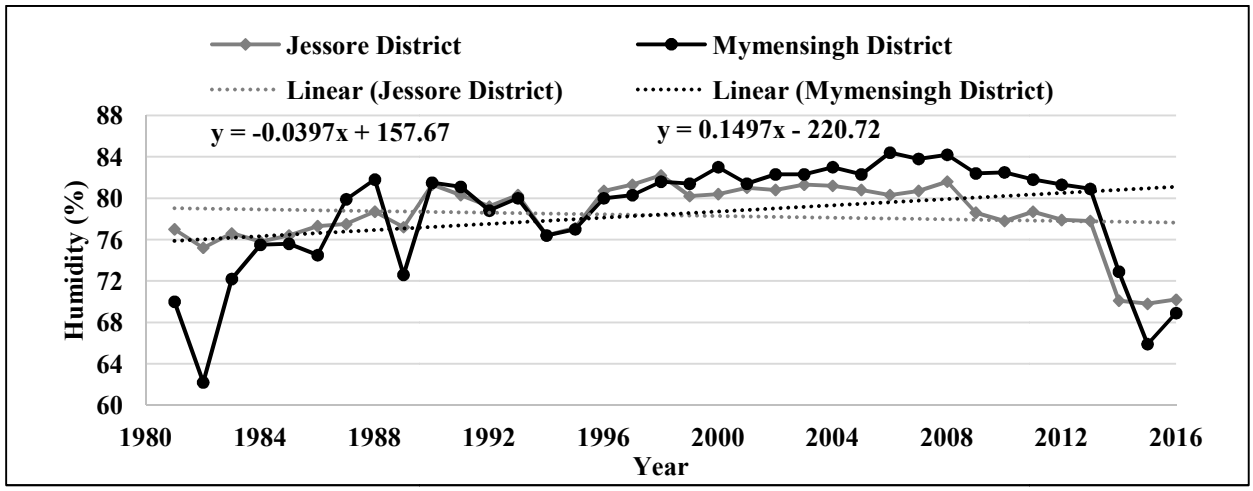


Figure 5. Comparison between the annual average humidity in Jessore and Mymensingh districts from 1981 to 2016 (Source: BMD).

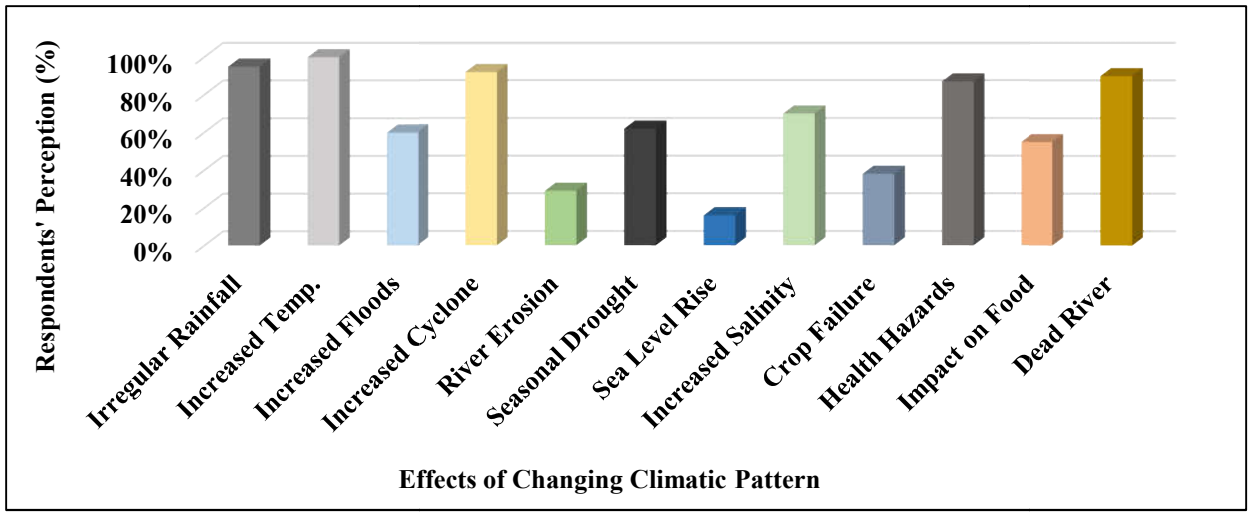


Figure 6. Observed effects of climate change on different parameters over 30 years in Jessore districts.

Other impact had medium range of effect but here no effect of increased salinity and effect of sea level rise had seen (Figure 7). The Intergovernmental Panel on Climate Change (2007) forecasts that developing countries, like Bangladesh, will continue to be affected by extreme weather variability such as temperature, severe water shortage, and flood-inducing rainfall events during the coming decades. Weather variability and sea-level rise are the most pressing predicted consequences of climate change with a 0.6 °C global temperature change, 2% to 3% precipitation increase of the tropical latitudes and 3% precipitation decrease in subtropical areas within the 20th century. Scenarios predict global temperature could increase between 1.4

°C and 5.8 °C by the end of the 21st century. About 10 to 25 millimeters of sea-level rise was observed over the 20th century and models predict continued rise in a range of anywhere from 20 to 90 centimeters within the 21st century.

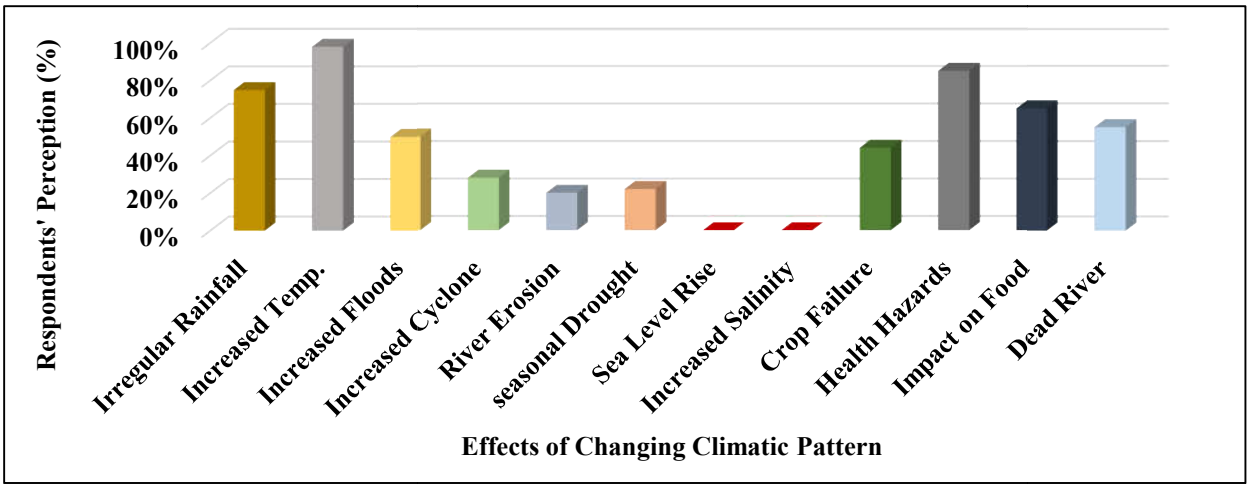


Figure 7. Observed effects of climate change on different parameters over 30 years in Mymensingh districts.

***Impact of Climate Change*:** After calculating the "extent of impact of climatic change" scores for each of 200 respondents in each district, an effort was also made to compare the relative impacts. Impacts score for each statement was calculated by using Impact of Climate Change Index (CI). The CI could range from 0 to 546 for Jessore district and 0 to 444 for Mymensingh district, where 0 indicating no impacts and 444 and 546 indicating maximum impacts of a single statement on impact of climate change as witnessed by respondents. From the Figure 8, it was seen that "Extreme temperature" was the most severe impact faced by the respondents regarded as top in ranking order, followed by next four impacts in both Jessore district and Mymensingh district. Also, Kabir *et al.* (2016) found that a majority of knowledgeable participants felt excessive temperature as the change of climate, from the research conducted in the seven different villages of Bangladesh instance of knowledge and perception about climate change and human health: findings from a baseline survey among vulnerable communities in Bangladesh. Uddin *et al.* (2014) in their article about factors affecting farmers' adaptation strategies to environmental degradation and climate change effects: a farm level study in Bangladesh, also presented problem confrontation index to summarize the problems identified by farmers and defined that increased use of irrigation was ranked first and thus most important, among farmers' adaptation strategies to climate change.

Vulnerability of Resources to Climate Change: After calculating the "extent of vulnerability of resources to climate change" scores for each of 200 respondents in each district, an effort was also made to compare the vulnerability of resources to climate change. In this index, it was found that "water resources" was the most vulnerable resources to climate change in both Jessore and Mymensingh district. After that low land areas and urban areas were more vulnerable to climate change.

In a study entitled of analysis of changing agricultural pattern in Jessore: environmental and social aspects by Raufe (2015) was found that ground water recharge was very high in Jessore district so water resources was very vulnerable to climate change and also agricultural land were vulnerable to climate change. Also Tehrani and Reza (2014) found in case of climate change adaptation and vulnerability assessment of water

resources systems in developing countries: a generalized framework and a feasibility study in Bangladesh that due to land use changes water resources become more vulnerable. Uddin *et al.* (2014) in their article about factors affecting farmers' adaptation strategies to environmental degradation and climate change effects: a farm level study in Bangladesh, also presented problem confrontation index to summarize the problems identified by farmers and defined that increased use of irrigation was ranked first and thus most important, among farmers' adaptation strategies to climate change.

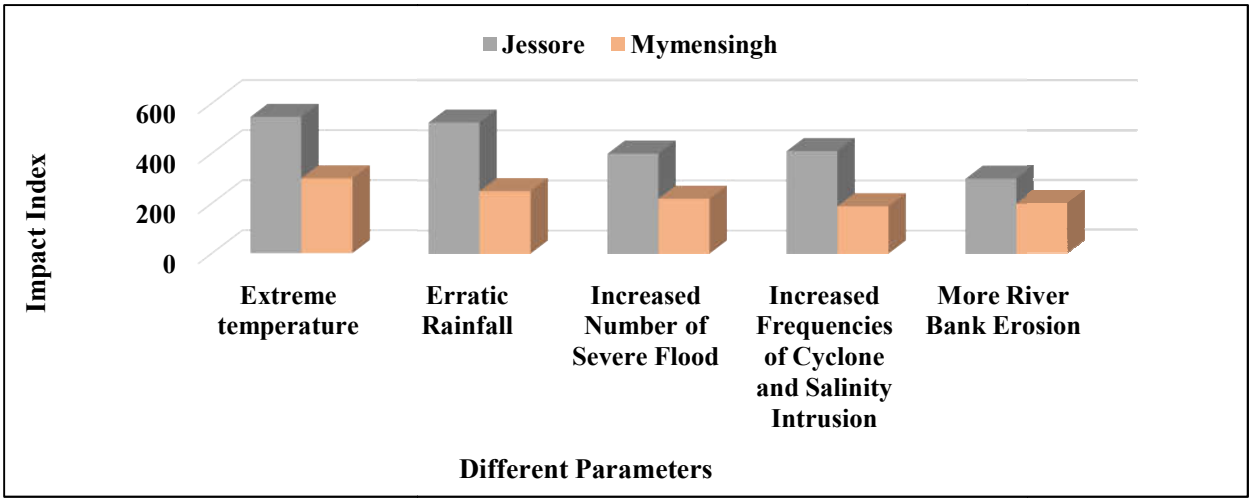


Figure 8. Comparison between impact index over different parameters of Jessore and Mymensingh districts.

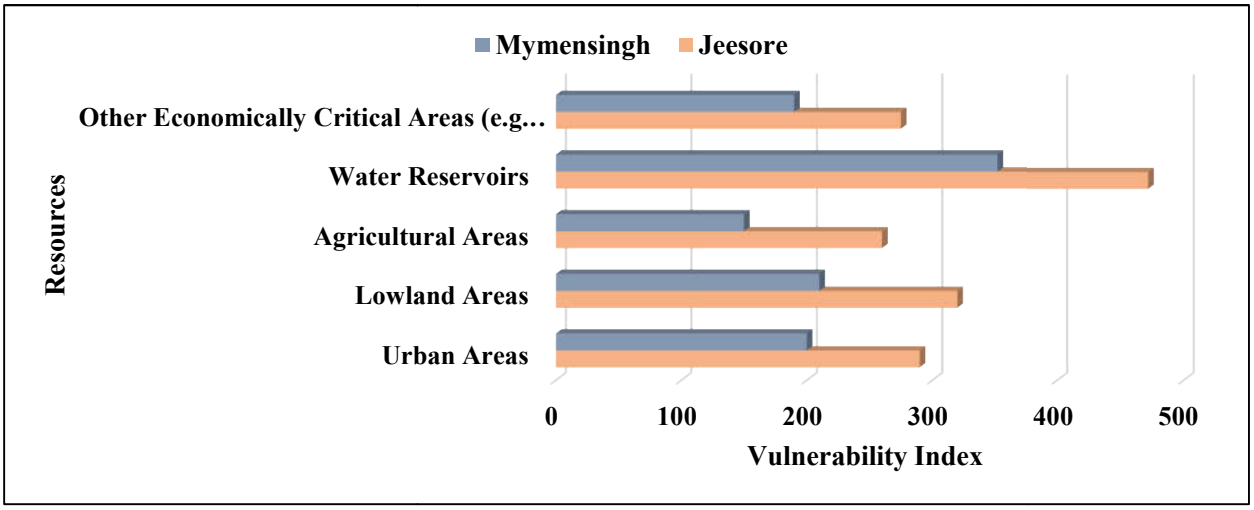


Figure 9. Comparison between vulnerability index of resources to climate change in Jessore and Mymensingh districts.

***Effects of Climate Change*:** After calculating the "extent of effects of climatic change" scores for each of 200 respondents in each district, an effort was also made to compare the relative effects. Effects score for each statement was calculated by using Effects of Climate Change Index (EI) and displayed in Figure 10. The EI could range from 0 to 482 for Jessore district and 0 to 340 for Mymensingh district, where 0

indicating no effects and 340 and 482 indicating maximum effects of a single statement on the effect of climate change as observed by respondents.

From the data it was seen that in case of Jessore district "risk of natural disaster" had the most severe effect faced by the respondents regarded as top in ranking and on the other hand "Surface water quality" was the most severe effect of climate change faced by the respondents of Mymensingh district. Dewan (2013) conducted a research on community perceptions and adaptation to climate change in coastal Bangladesh and found that the southwestern Bangladesh perceives and encounter climate related hazards such as cyclones, storm surges, sea level rise, salinity intrusion and erosion. Also, the Asia foundation (2012) conducted climate change perception survey on five coastal and hilly regions of Bangladesh and found that drought, salinity, riverine and flash flood were the main effects of climate change in this area.

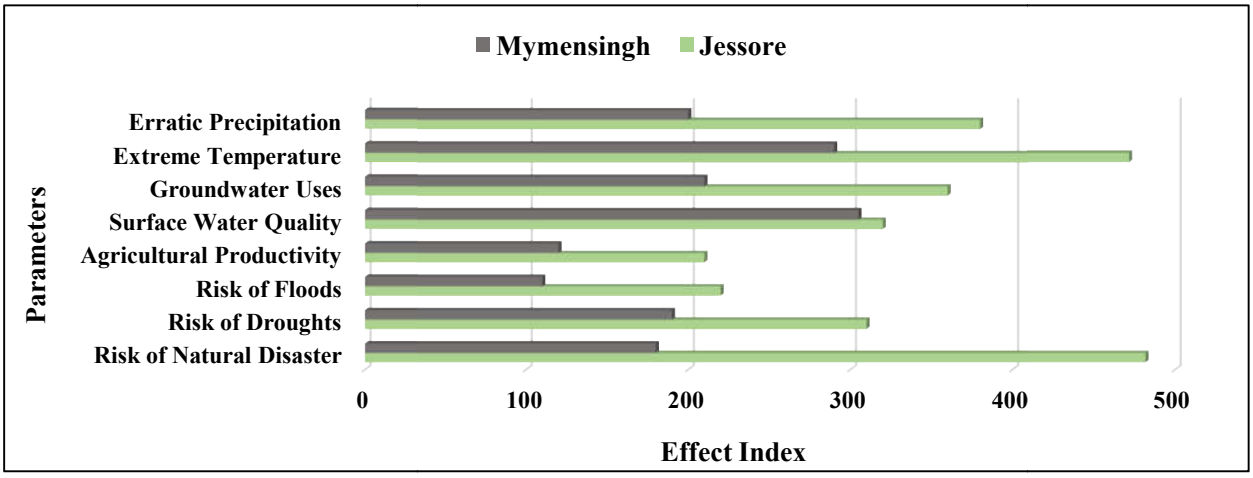


Figure 10. Comparison between effects index of climate change in Jessore and Mymensingh districts.

***Adaptation to Climate Change*:** After calculating the "extent of adaptation to climatic change" scores for each of 200 respondents in each district, an effort was made to compare the relative adaptation measures. Adaptation to climate change score for each statement was calculated by using Adaptation to Climate Change Index (AI) and presented in Figure 11. The AI could range from 0 to 494 for Jessore district and 0 to 344 for Mymensingh district, where 0 indicating no adaptation to climate change 344 and 494 indicating maximum adaptation to climate change of a single statement on adaptation to climate change as observed by respondents.

From the index, it was found that in Jessore "fish farming" was the most operational adaptive measures to climate change faced by the respondents regarded as top in ranking order and in Mymensingh district "use of different crop varieties" was the most operational adaptive measures to climate change faced by the respondents. Kabir (2015) conducted study on the impact of climate change on agriculture, especially in Jessore and Sathkhira districts, according to farmers' mitigation strategies to climate change; evidence from farmer level data and stated that more irrigation, short-duration rice, supplementary irrigation, changing planting date, agro-forestry, use of different crop varieties, non-rice crops etc. were some adaptive measures in Jessore and Sathkhira.

Also, the Asia foundation (2012) stated in their report on climate change perception survey that people generally adapt social forestry building embankments, homestead plinth, raising Salinity resilience and rain

water harvesting. Uddin *et al.* (2014) in their article about factors affecting farmers' adaptation strategies to environmental degradation and climate change effects: a farm level study in Bangladesh, also presented problem confrontation index to summarize the problems identified by farmers and defined that increased use of irrigation was ranked first and thus most important, among farmers' adaptation strategies to climate change.

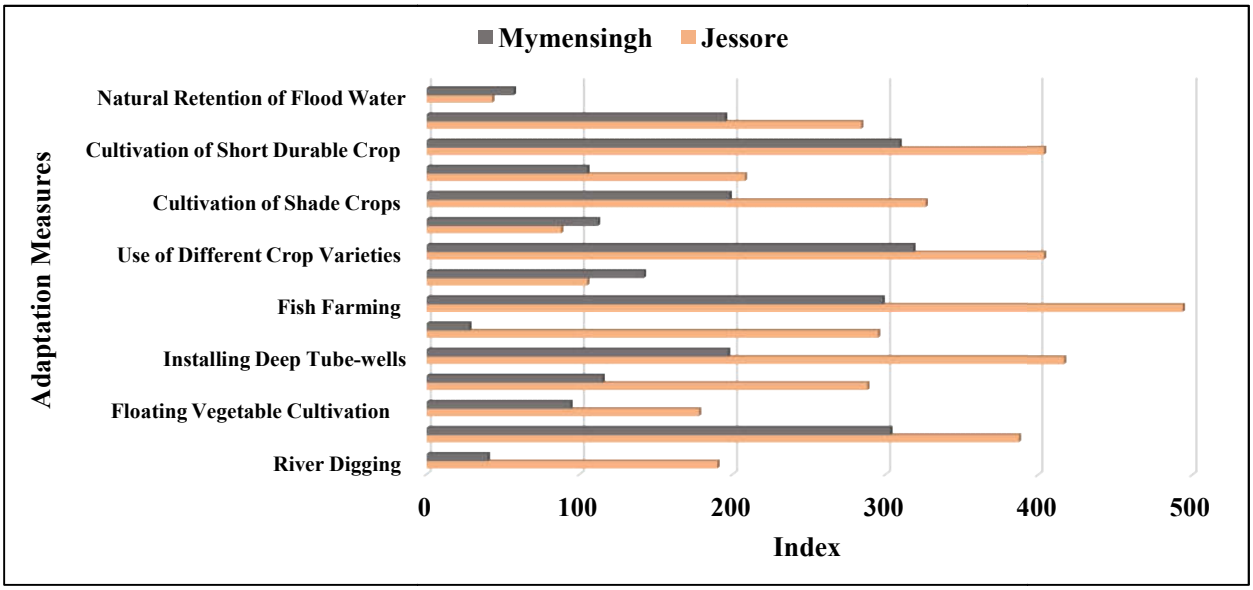


Figure 11. Comparison between adaptation to climate change index in Jessore and Mymensingh districts.

***Constraints to Climate Change Adaptation*:** After calculating the "extent of constraints to climate change adaptation" scores for each of 200 respondents in each district, an effort was also made to compare the relative constraints. Constraints to climate change adaptation score for each statement was calculated by using Constraints to Change Adaptation Index (CAI) and showed in Figure 12. The CAI could range from 0 to 290 for Jessore district and 0 to 328 for Mymensingh district, where 0 indicating no influences and 328 and 290 indicating maximum influences of a single statement on constrains to climate change as observed by respondents.

"Lack of proper awareness" was the most severe constraints to climate change adaptation faced by the respondents in Jessore district and "Limited knowledge about adaptation measures" was the most severe constraints faced by the respondents of Mymensingh district. Kabir (2015) found result in case of impact of climate change on agriculture, especially in Jessore and Sathkhira districts, according to farmers' mitigation strategies to climate change; evidence from farmer level data that accessibility and usefulness of climate information, the institutional environment and the socio-economic situation of households affect farmers' capacity to adapt to climate change. He also stated that farmers outlined the most important barriers as a lack of weather information, a lack of knowledge on appropriate adaptation strategies and a lack of credit (money or savings). Other important barriers area lack of own land, a lack of irrigation water and labor shortages.

Uddin *et al.* (2014) in their article about factors affecting farmers' adaptation strategies to environmental degradation and climate change effects: a farm level study in Bangladesh, also presented problem confrontation index to summarize the problems identified by farmers and defined that lack of

available water (both irrigation and drinking) was the most severe problem of the farmers in the region studied in terms of adoption of climate change adaptation strategies.

***Opinion about Activities Related to Climate Change*:** After calculating the "extent of opinion about activities related to climate change" scores for each of 200 respondents in each district, and effort was also made to compare the relative opinions. Opinions score for each statement was calculated by using Opinion about Activities Related to Climate Change Index (ACI) and exhibited in Figure 13. The ACI could range from 0 to 332 for Jessore district and 0 to 272 for Mymensingh district, where 0 indicating no opinion and 272 and 332 indicating maximum opinion about activities related to climate change of a single statement on activities of climate change as observed by respondents.

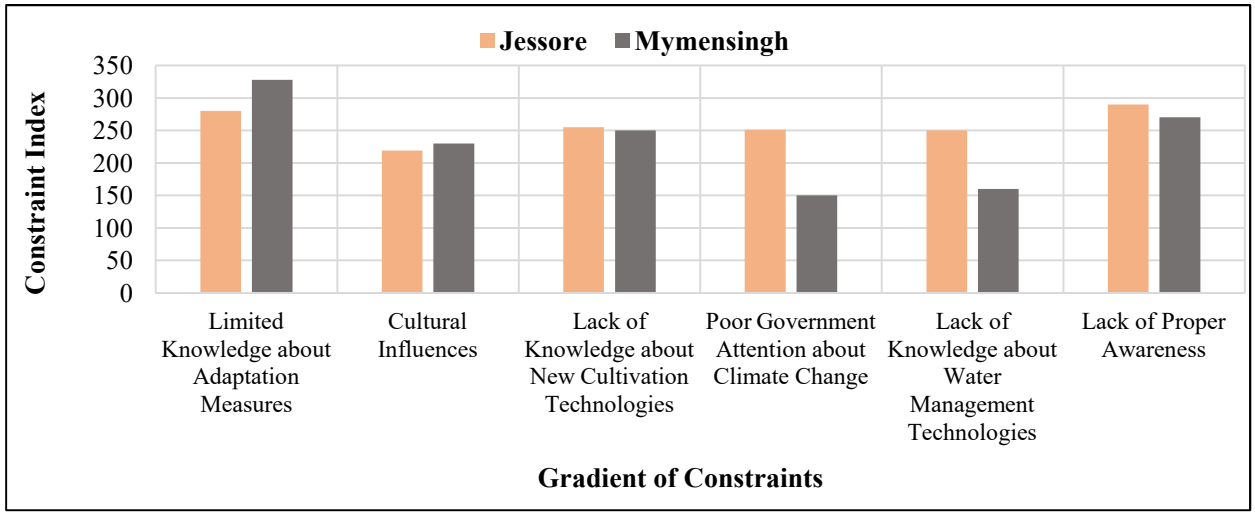


Figure 12. Comparison between indexes of constraints to climate change adaptation in Jessore and Mymensingh districts.

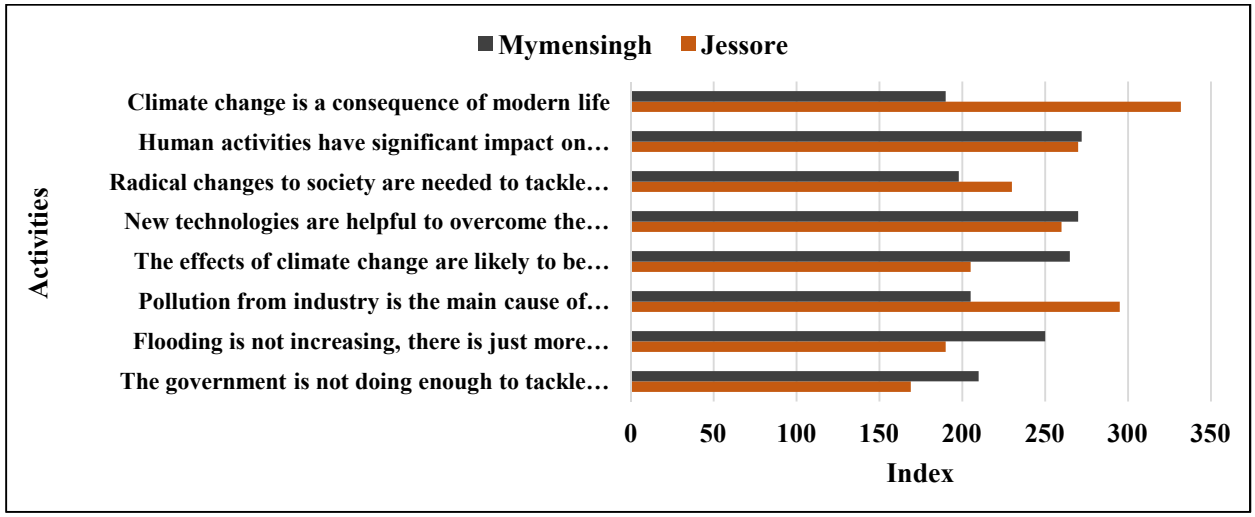


Figure 13. Comparison between indexes of activities related to climate change adaptation in Jessore and Mymensingh districts.

Here in case of Jessore district "Climate change is a consequence of modern life was the most common opinion on activities related to climate change percept by the respondents regarded as top in ranking order, followed by next other opinions and on the other hand "Human activities have significant impact on global temperatures" was the most common opinion on activities related to climate change percept by the respondents of Mymensingh district.

GOs/NGOs Activities and Their Perceptions about Climate Change

Impact index of climate change in Jessore and Mymensingh district: The collected data about climate change perception of the GOs and NGOs personnel were calculated into indexes and showed (Figure 14). This data showed that the impact index over different resources in both Jessore and Mymensingh district. It also showed that the impact was highest in the" low land areas" of both Jessore and Mymensingh district. After that in Jessore district after low land areas the urban and military area and then agricultural, others and industrial areas faced climate change impact. But in case of Mymensingh district the urban area, then the agricultural and then the industrial, military and other areas were faced the impact of climate change.

Vulnerability index of resources to climate change in Mymensingh and Jessore district: The vulnerability data (Figure 15) showed that in both districts the highest vulnerability to climate change on natural parameter was "increase in temperature" but the scenario is quite low in Mymensingh than the Jessore district. In case of Jessore district after increased temperature, increase of ground water recharge, decrease in precipitation, increase in drought frequency, and increase in flood frequency played a vital role. After that in Mymensingh district decrease precipitation, increase in ground water recharge, increase in drought frequency, increase in precipitation also played a severe role.

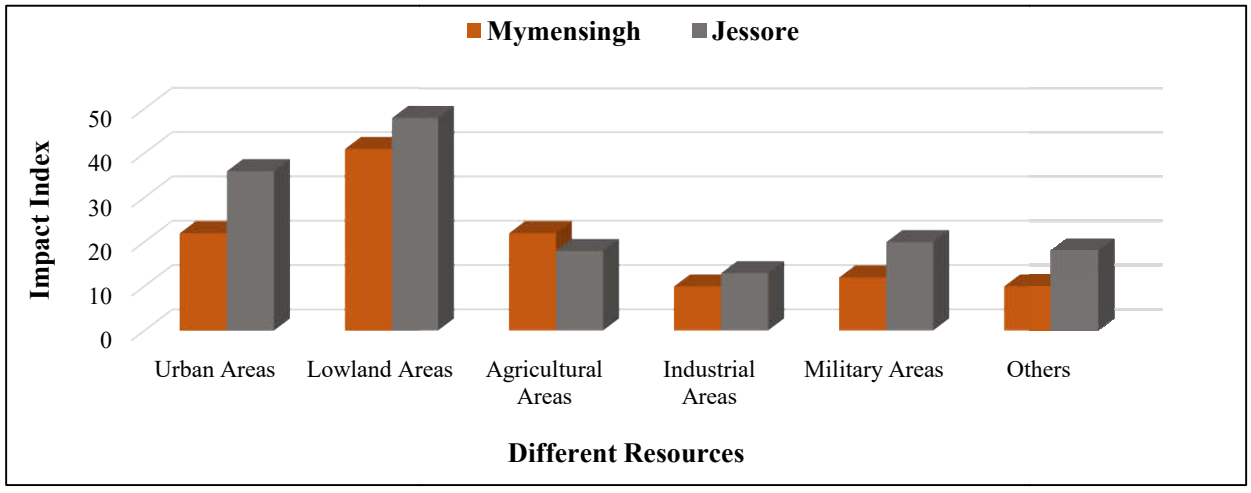


Figure 14. Impact index of Jessore and Mymensingh districts on different resources of this area.

Raufe (2015) stated in his thesis paper entitled analysis of changing agricultural pattern in Jessore: environmental and social aspects that ground water recharge and excessive temperature create great vulnerability for the resources of Jessore district. He gathered information from the NGOs and stated that excessive use of ground water for agriculture cultivation makes contamination of arsenic. In Jessore average 40% tube well is affected by arsenic for more use of ground water (DPHE, Jessore-2012) which affected different area like Keshabpur, Jhikargacha and Manirampur upazila.

Adaptation measures for climate change in Mymensingh and Jessore district: From the personnel's perception the relation between adaptation measures and indexes (Figure 16) were made, where in Jessore district "protection against temperature variability" was highly adapted by the respondents as author mention previously that on the basis of personnel's perception increased temperature was the major impact of climate change in this district but in Mymensingh district "general adaptation measures was highly adaptive by the people because this region had faced comparatively less impact of climate change than Jessore stereographical position so awareness developing programs were the main adaption measure followed by respondents of this district.

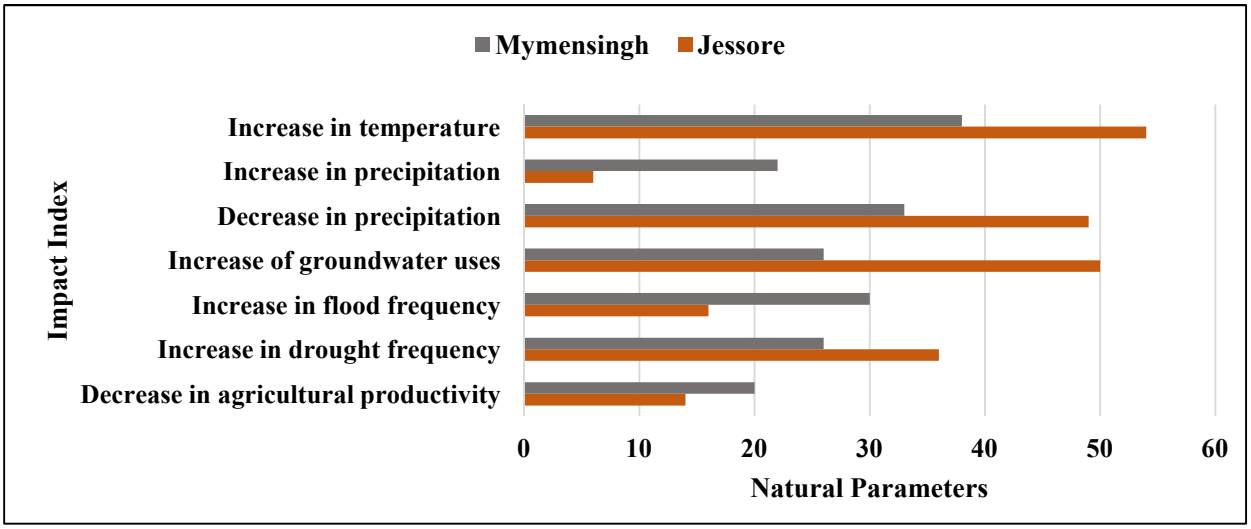


Figure 15. Vulnerability of resources to climate change index of Jessore and Mymensingh districts on the natural parameters.

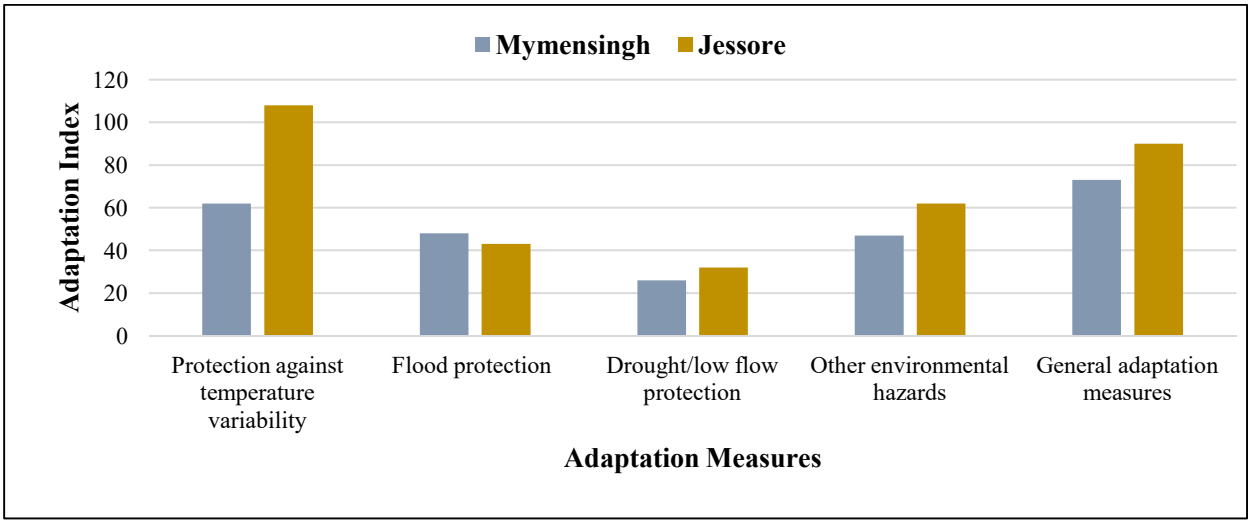


Figure 16. Relationship between adaptation index and adaptation measures in both Jessore and Mymensingh districts.

Conclusion

The inclusive study concluded that the climate of the two-study district Jessore and Mymensingh were changing latterly as all the climatic factors indicated a changing trend. Furthermore, the changing trend triggered great impact or vulnerability or effects alike increase in temperature, irregular rainfall, flood, cyclone, salinity, seasonal drought, health hazard, river erosion, impact on food, dead river, effect on agricultural land, low land, water reservoir, urban areas, ground water recharge, surface water quality and so many belongings of these districts. So appropriate adaptation measures were obligatory to be taken to evade these portents of climate change and people of these district were in progress in case of taken those adaptive measures such as social forest, natural retention of flood water, use of different cultivation technologies, crop rotation, floating vegetable cultivation, fish farming, building cyclone center, building embankment etc. but still little more awareness is needed in these case as climate change is a new concern for our country.

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