

# Comparison of Urban and Rural Adaptation and Mitigation in North-Western Region of Bangladesh

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## ABSTRACT

Different climate elements make the differences between the rural and urban climatic condition that is why, there exist different adaptation and mitigation policies between the two groups. Therefore, an optimum mitigation policy is crucial to reduce the impact of climate change and a favorable adaptation strategy is needed for minimizing the adverse effects of climate change which makes the economy stable. In response, this article tries to compare between urban and rural climate change adaptation behaviors by applying simple Pearson Chi-square ( $\chi^2$ ) test based on primary data series from field survey of the north western region of Bangladesh. Despite, insignificant result for some behaviors, the findings portrays significant differences between the urban and rural residents in terms of climate change adaptation and mitigation behaviors. The observations of Principal Component Analysis (PCA) display significant correlation between the adaptation and mitigation strategies for climate change for the residents from both areas. The findings of the study suggested improved technology and awareness, environmental based technologies and action research are recommended to combat against the adverse effects of climate change by minimizing the differences between the two groups for adaptation and mitigation strategies.

**Keywords:** Pearson Chi-square ( $\chi^2$ ) test, Principal Component Analysis (PCA).

## INTRODUCTION

With the significant negative economic impacts, climate change is one of the most vulnerable issues (Wheeler, 2013) in this situation that must be addressed immediately. The Swiss Re Institute warned south and southeast Asia as the most vulnerable to the effect of climate change which could wipe off the world's 18 percent GDP by 2050 (World Economic Forum, 2021). Global ecological system such as: water supply, biodiversity, ecosystem, soil erosion, cryosphere will be threatened by the adverse effects of climate change. Increased economic growth with higher income and output tends to cost more of the environment but improved technology and better planning of proper utilization of resources could minimize the cost of environment. Climate changes have costly impacts on both rural an urban region by changing infrastructure, health of people, livelihoods, and economy of a country. Urban region is the key supplier for 75 percent of global emissions with industrialization and transportation (UNEP) while rural households are the worst sufferer of climate change because of heavily reliance on climate sensitive resources. For the current world of globalization both the mitigation and adaptation are crucial by advocating smart policies to mitigate climate change and adjusting to the expected climate change (Lobell, D.B. 2014, Stern, 2007).

Bangladesh is one of the worst sufferer countries from the adverse effect of climate change (Huq et al., 2001, Rahman et al., 2003, Huq et al. 2007, M.T. Islam & M. Nursey-Bray, 2017) such as; sea level rise, drought, floods, cyclone, river erosion, water blockage etc. The Climate reality project reported that only 0.56 percent contribution to total global emissions make Bangladesh ranked as the 7<sup>th</sup> most climate change vulnerable country. The geographical state of Bangladesh is responsible for catastrophic natural disasters such as- cyclones, floods, storm, river erosion, and droughts. It has been projected that Bangladesh may lose 11% of its total land and 18 million people will be displaced for only sea level rise by 2050 (EJ Foundation). 61.82 percent people of total population of Bangladesh lives in rural area and the remaining are the urban dwellers (CEIC Data). Most of the rural people depends on climate sensitive resources which may reduce their productivity (Nelson GC, 2009)

and tend to migrate from rural to urban for better livelihoods to cope with the adverse effects of climate change. According to the government data 2015, Scholars found that rural residents spent nearly USD 2 billion annually on climate-related hazards. Additionally, the Bangladesh government's expenditure increased from USD 884 million in 2014 to USD 1.64 billion in 2018(Aljazeera, 2019). As a result of countrywide urbanization Bangladesh has 42 million city dwellers and if it continues to grow, half of total population of Bangladesh will live in urban areas (BIGD). Industrialization with urbanization waste management, supply of water infrastructure, lack of land are the key challenges for the urban residents(Li XM et al. 2017). In response to sustainable development for Bangladesh both climate change adaptation and mitigation are equally important. Climate change adaptation helps to reduce the adverse effects of climate change with the help of various adjustment strategies where as mitigation helps to reduce climate change by stabilizing greenhouse gas levels, lowering human interference with the climate system. However, many studies focused on factors to formal barricades as a reason of unproductive climate change adaptation (Næss et al., 2005; Glaas et al., 2010; Lebel et al., 2011; Upton, 2012; Biesbroek et al., 2013; Raymond and Robinson, 2013; Mandryk et al., 2015). The current study is based on the comparison of urban and rural adaptation and mitigation in North-Western Region in Bangladesh.

A study of Kondo Kayoko et al. (2020) related to mitigation and adaptation behaviors observed the relation between adaptation and mitigation behaviors in Japan and found a significant difference between the respondents who used air conditioning with a mitigation purpose and the respondents who used air conditioning with an adaptation purpose. Another study by M. Christopher (2013) emphasized on the land use change, future land acquisitions, population control and migration as adaptation and mitigation policy. Li Bingqin (2013) showed limited influence on urban climate change adaptation because of using climate change as an economic growth engine and undeveloped policies to mitigate. The assessment of Singh Chandni et al. (2020) showed how adaptation strategy varied rural to urban in flood management and community-based watershed management in India. Rana Md M. Parves & Iilina Irina N. (2021) focused on climate change causing migration from rural to urban influenced on cities of Bangladesh claimed systemic planning is vital for dealing with climate-induced migration.

Although a number of studies dealing with climate change and its effects, climate change and adaptation, effects of climate change adaptation, rural climate change adaptation & mitigation and urban climate change adaptation are available, studies related to differences between urban and rural climate change adaptation and mitigation are not available specially in case of Bangladesh. This study tried to achieve the stated objectives-to describe the socio-economic characteristics of the citizen of the north western area of Bangladesh, to identify the differences between urban and rural adaption and mitigation behavior among the study area, and to focus on policy implications among the study area.

## RESEARCH METHODS

### Survey Area and Survey Procedure

The associated research questions are addressed through primary data analysis which are collected from the urban and rural areas of the two districts of north western region of Bangladesh- Rajshahi and Chapainawabganj. The rationale behind selecting the area is that the region is characterized by - high temperature, very low rainfall which make the region severely drought prone and behavioral change of adaptation and mitigation strategies of the citizen. Cross-sectional field survey through face-to-face interview process with a set of questionnaires was conducted for data collection. Multistage random sampling was used to select 300 respondents.

**Table. 1:** Distributions of respondents by sample area

Area	Number of Respondents	Percentage of Total
Rajshahi (Urban)	75	25%
Rajshahi (Rural)	75	25%

Chapainawabganj (Urban)	75	25%
Chapainawabganj (Rural)	75	25%
Total	300	100%

**Source:** Field survey, 2021

That means 50 percent of total respondents are selected from urban and rural region respectively from each of the district. Secondary data through review of some literature were also utilized in the study.

### Method for Making Comparison

The study is based on focusing the comparison of urban and rural adaptation and mitigation in the study area. Pearson chi-square ( $\chi^2$ ) test was applied to confirm whether there are significant differences between them or not. Odetunmbi Oluwole A. et al. (2021) applied chi square test to observe the relationship between age and gender of those who tested positive to Hepatitis B virus and revealed that there was significant correlation between the two.  $\chi^2$  test is a statistical test, compares two variables for observing whether distributions of categorical variables differ from each other and investigates the nature of association (Agresti A 2002, Watson G S 1959, Odetunmbi O A et al. 2013, Adejumo A O et al. 2017). Assuming the null hypothesis is that there are no significant differences between the two group, the alternative hypothesis is that there are significant differences between the rural and urban climate adaptation and mitigation.

Symbolically,  $H_0$ : No difference between the two groups ( $H_0$  is null hypothesis)

$H_A$ : Difference between the two groups ( $H_A$  is alternative hypothesis)

In this case, if p-value (significant value) is smaller than the alpha value ( $\alpha=0.05$ ) the null hypothesis is rejected that there is no difference between the two groups, Simply the data suggests that there are significant differences between the rural and urban climate adaptation and mitigation. For the study, the chi square hypothesis is calculated in Statistical Package for Social Science (SPSS) software.

### Factor Analysis

Factor analysis extracts maximum common variance from an index of all variables and put them into a common score. Among the three types of factor analysis, Principal Component Analysis (PCA) is the most popular technique for the researchers. It helps to remove variance factor by factor. For example, firstly it extracts variance for the first factor (I), then for the second factor (II) and it continues to the last factor. Factor loading is the correlation coefficient for the specific variable and the factor, 0.7 or higher factor loading means the factor has removed sufficient variance from the variable.

Eigenvalues show how much variance can be represented by the factor loading out of total variance. In case of 70 percent of higher factor loading, eigenvalue shows that 30 percent variance can be explained by the other factor. In the current study, SPSS is used for Principal Component Analysis as a tool of factor analysis to determine which strategies load most in the northwestern region of Bangladesh.

## RESULTS AND DISCUSSIONS

### Descriptive Statistics

All the measuring variables in the study are qualitative variables and all the variables are converted to dummy variables for making them quantitative. The dummy variables taking 0 or 1 value make the analysis for finding significant differences between the two groups. A short description of the selected variables is stated in the Table 2.

**Table 2:** Description of the measuring scales

Variable	Modalities
Gender	0 = female, 1 = male
Formal Education	Years
Weather conditions have changed in last 10 years	0 = no, 1 = yes
Perceiving temperature have changed in last 10 years	0 = no, 1 = yes
How much has temperature changed	0 = no, 1 = yes
Perceiving rainfall has changed in last 10 years	0 = no, 1 = yes
Perceiving the temperature has changed in winter season in last 10 years	0 = no, 1 = yes
Having fluid frequently during heat wave	0 = no, 1 = yes
Using weather-based dresses	0 = no, 1 = yes
Avoiding going out on heat wave	0 = no, 1 = yes
Change in household expenditure for taking adaptation strategies	0 = no, 1 = yes
Avoiding direct Sunlight during heat wave	0 = no, 1 = yes
Planting trees for natural air	0 = no, 1 = yes
Increasing vegetation during heat wave	0 = no, 1 = yes
Using Sun cream during heat wave	0 = no, 1 = yes
Building Color	0 = no, 1 = yes
Using window glasses	0 = no, 1 = yes
Unplugging household appliances	0 = no, 1 = yes
Using public transport	0 = no, 1 = yes
Change in household expenditure for taking mitigation strategies	0 = no, 1 = yes
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**Comparison between Adaptation and Mitigation**

Table 3 displays the summary of the findings in which Pearson Chi-square ( $\chi^2$ ) results determine that there exist

significant differences between urban and rural residents in terms of climate change adaptation and mitigation strategies.

**Table 3:** Difference between rural and urban adaptation and mitigation

Variables	Pearson Chi- square ( $\chi^2$ )
Gender	6.54**
Formal Education	6.00***
Weather conditions have changed in last 10 years	10.99**
Perceiving temperature have changed in last 10 years	27.65**
How much has temperature changed	12.15***
Perceiving rainfall has changed in last 10 years	35.25***
Perceiving the temperature has changed in winter season in last 10 years	38.41***
Having fluid frequently during heat wave	43.83***
Paying attention to salt absorption during heat wave	50.00***
Temperature reduction	0.832*
Using weather-based dresses	84.72***
Avoiding going out on heat wave	2.175*
Change in household expenditure for taking adaptation strategies	49.37***
Avoiding direct Sunlight during heat wave	2.39**
Planting trees for natural air	1.72**
Increasing vegetation during heat wave	17.54***
Using Sun cream during heat wave	1.84**

**Note:** \*\*\*, \*\*, \* means significant at 1%, 5% and 10% level respectively.

At 1 percent level of significance the variables formal Education, how much has temperature changed, perceiving rainfall has changed in last 10 years, perceiving the temperature has changed in winter season in last 10 years, having fluid frequently during heat wave, having fluid frequently during heat wave, paying attention to salt absorption during heat wave, using weather-based dresses, change in household expenditure for taking adaptation strategies and change in household expenditure for taking adaptation strategies shows significant differences in terms of rural and urban residents; while gender, weather conditions have changed in last 10 years, perceiving temperature have changed in last 10 years, avoiding direct Sunlight during heat wave and using Sun cream

during heat wave show significant differences at 5 percent level of significance; besides temperature reduction and avoiding going out on heat wave display differences between the urban and rural dwellers and the remaining variables; building color, using window glasses, unplugging household appliances, using public transport and change in household expenditure for taking mitigation strategies do not reveal any significant differences.

### Factor Structure for Adaptation and Mitigation

The result of PCA shows the factor structure of the variables. Three factors namely avoiding going out on heat wave, avoiding direct sunlight and using sun cream are strongly associated to the latent variable factor I with high factor loading with the value of 0.765, 0.782 and 0.638 respectively, it also means that adaptation and mitigation are strongly correlated in case of avoiding going out on heat wave, avoiding direct sunlight and using sun cream.

**Table 4:** Factor structure for adaptation and mitigation

Items	Factor I	Factor II	Factor III
Avoiding going out on heat wave	0.765		
Avoiding direct sunlight	0.782		
Using sun cream	0.638		
Paying attention to salt absorption		0.736	
Unplugging households' appliances which are not in use		0.798	
Using public transport		0.601	
Using umbrella during heat wave			0.554
Reducing temperature by using fan, cooler, AC			0.738

Factors that paying attention to salt absorption, unplugging household appliances which are not in using and using public transport have the high factor loading for factor II. The variables paying attention to salt absorption, unplugging household appliances have a correlation co-efficient of 0.736, 0.798 and 0.601 with factor II. Factors namely using umbrella during heat wave and reducing temperature by using fan, cooler, AC have the factor loading in Factor III in the finding with 55.40 percent and 73.80 percent association.

### CONCLUSION AND POLICY IMPLICATIONS

The study reveals the comparison of urban and rural adaptation and mitigation strategies for climate change in north-western region in Bangladesh. The major findings of the study: climate has changed in the study area and individuals are experiencing its severe impact on their household expenditure, the significant values of Pearson Chi-square test represents the significant differences between urban and rural adaptation and mitigation strategies for climate change in north-western region in Bangladesh and Principal Component Analysis (PCA) portrays that there are significant relationship between the adaptation and mitigation strategies for respondents of the two district.

Based on the findings of the study and field survey experience, some implications of the findings can be drawn to face the adverse effects of climate change. Lives of the citizen of the study area as well as of Bangladesh are



directly adversely affected by climate change. Improved technology and awareness are recommended to combat risk. As mitigation is a long-term process, environmental based technologies such as bio- fuel, solar energy etc. should be used for urbanization and industrialization to mitigate the negative effect of climate change. Research and extension are the key methods to create the community awareness on climate change. There are few researches done in Bangladesh concerning climate change. Action research should be promoted and conducted in the future. Policy makers should emphasize the need for education to choose the efficient ways to adapt and mitigate the negative effects of climate change.

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