**Climate Change, Social Stress and Violent Conflict**
**State of the Art and Research Needs**

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# Exploring the relationship between climate awareness and adaptation efficacy for anticipatory adaptation against the impacts of sea level rise on livelihood security in coastal Bangladesh

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## Structure of Presentation

| Section | | Key focus |
|---|---|---|
| 1 | | Statement of the Problem and Objective, |
| 2 | | Research Hypothesis |
| 3 | | Research Design: Data collection, Indicator selection, and Statistical tests for reliability and usability of data. |
| 4 | | Principal Component Analysis (PCA) for identifying the factors that explain the variances |
| 5 | | Result and Discussion: Multiple OLS Regression Model's Output |
| 6 | | Policy implications and concluding remarks |
| | | Future research direction |

# 1. Statement of the Problem:

- IPCC unequivocally states that Climate is changing (IPCC, 2007).
- Climate change- changes in long term average conditions, greater variability within the range of “normal conditions” and changes in the types of extreme events (Hare, 1991).
- Climate change may leads to SLR of even 1 meter by the end of this century.
- Bangladesh is one of the few countries most vulnerable to SLR impacts.
- SLR impacts: Increase frequency and intensity of storm and surge, perpetual salinity intrusion, coastal inundation,
- Failure to adapt will lead to mass displacement; ultimately CC-SLR refugee.

# 1. Statement of the Problem:

- For adaptation *in situ* strong "adaptation efficacy" is a precondition (Grothmann and Patt 2005; Grothmann and Reusswig, 2006)

- Adaptation efficacy is personal belief about one's ability to adapt considering the full context of vulnerability.

- Various socio-economic (Adger, 2003, 2005; Brooks et al. 2005; Steel et al. 2005; Leiserowitz, 2006), cultural and behavioral (Adger, 2003, 2005; Brooks et al. 2005; Grothmann and Patt 2005; Grothmann and Reusswig, 2006; Blennow and Persson 2009), and communications and networking (Mimura, 1999; Steel et al. 2005; Kurita *et al.,* 2006; Perry, 2007; Collins and Kapucu, 2008; Cretikos *et al*., 2008; Leal, 2009) factors influence adaptation efficacy.

- However, influence of climate knowledge on adaptation efficacy is not assessed quantitatively.

## Objective of the Research

- This research is aimed to explore if adaptation efficacy of coastal people of Bangladesh to secure their livelihood against the impact of CC-SLR is influenced by “climate awareness”.

## Research Hypothesis

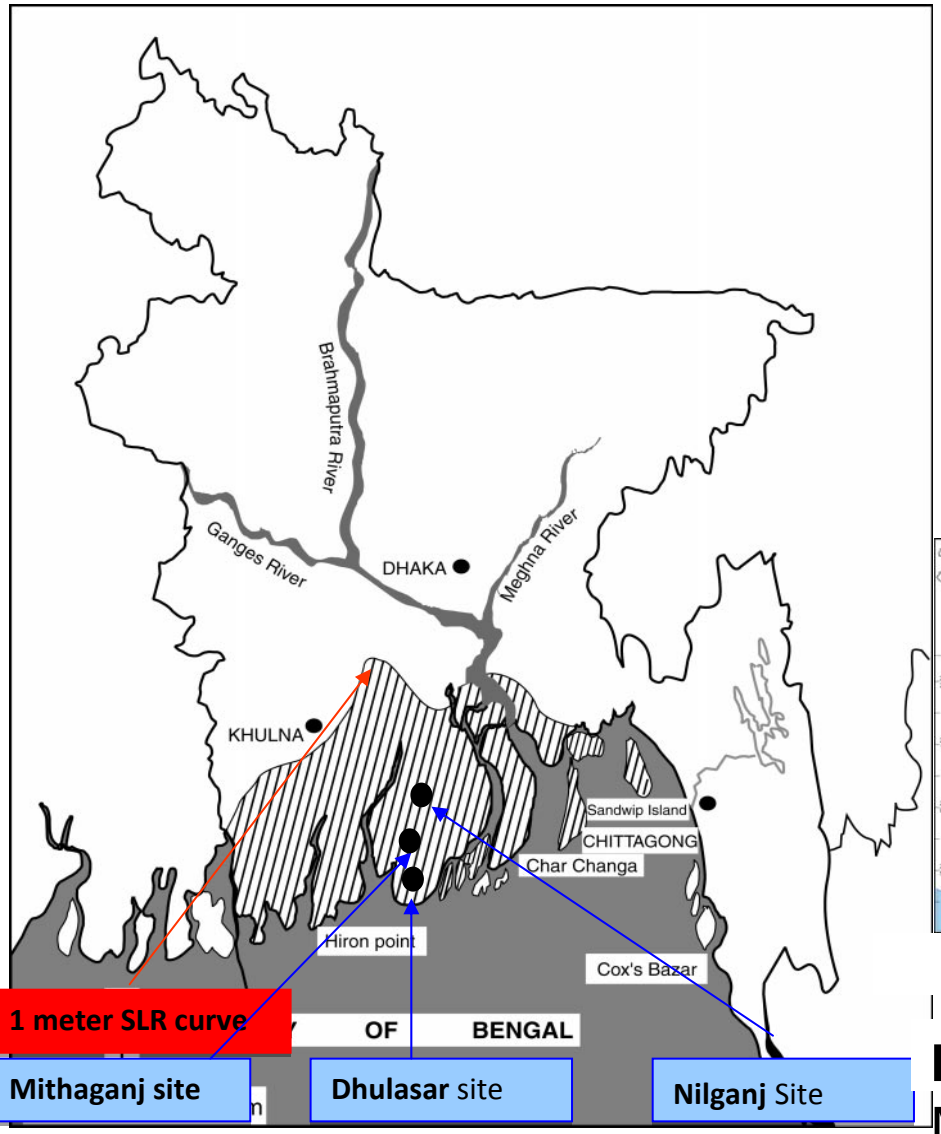
- “Climate awareness” has positive influence on adaptation efficacy (H1).

## Research Design

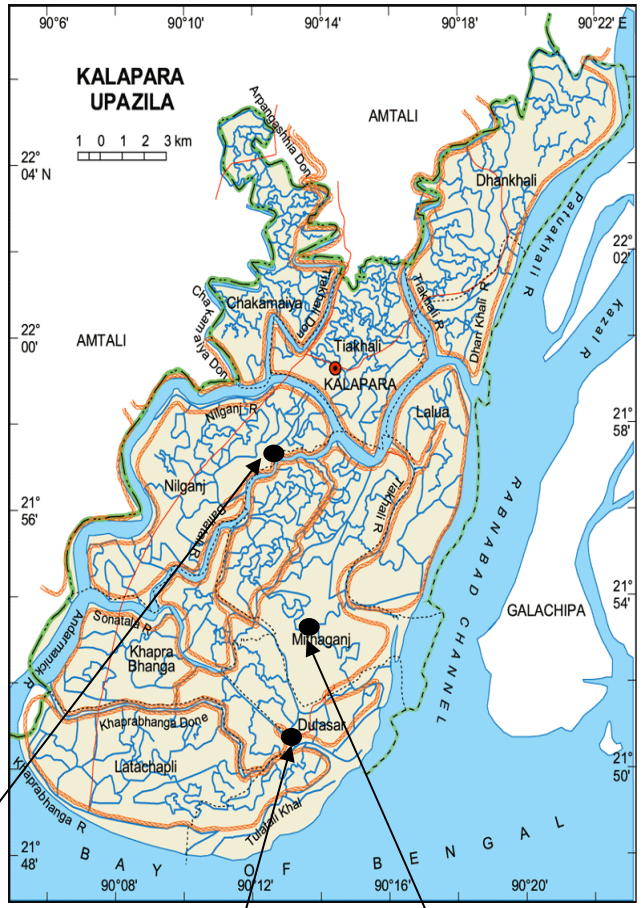
### Data and information gathering:

- Altogether 285 HH were randomly selected for questionnaire survey. All respondents are from 3 sites (Dhulashar UP, Mithaganj UP and Nilganj UP) in Kalapara Upazila (Sub-district) of Patuakhali District. Located only 5 to 20 km from the coastline and above 0.25 m (contour) from MSL.

Study sites in relation to Bangladesh:








Source: Islam (2003).

**Figure 1.2** Study sites: in Dhulasar, Mithaganj and Nilganj "Union Parishad"

Figure 1.1 Study sites in relation to Bangladesh and the Bay of Bengal Coast (Adopted from Ali, 2003)

# Indicator selection for climate awareness:

Climate awareness is measured in three dimensions:

- Familiarity with climate change/weather extreme signal *(in short "familiarity")*
- Perception about climate change-sea level rise (CC-SLR) events *(in short "perception")*
- Tacit/intuitive knowledge about the impacts of sea level rise *(in short "knowledge"*

| Dimension | Reliability (Cronbatch alfa) | Indicator used to prepare index |
|---|---|---|
| 1. Experience/ Familiarity with CC/Weather extreme | 0.93 | 10 questions [following IPCC: WG II 2001b: 15; Vedwan and Rdoades, 2001; Adger *et al.*, 2003: 182-183; and Nerem *et al.* 2006: 5-7] |
| 2. Perception/ belief about CC-SLR events | 0.71 | 5 questions [following Steel et al. (2005: 43, 48), Leiserowitz (2006: 65-66), Blennow, and Persson (2009: 101) |
| 3.Tacit/intuitive knowledge about SLR impacts | 0.75 | 10 questions [Following Smith (1997: 252), Choudhury *et al*. (2005), Steel et al. (2005: 43, 48), Wilbanks *et al*. (2007: 216-218) and Tol *et al*. (2008: 438-439) |

| Scale of measurement of | | Indicator/Variable |
|---|---|---|
| Familiarity with climate change/weather extreme signal | | Respondent's familiarity with: |
| Scale: | | Longer duration of summer |
| 1 = Cannot remember if heard about/felt or observed | | Summers are felt warmer than earlier |
| 2 = Heard from others | | Shorter duration of winter |
| 3 = Felt/observed by own | | Winters are getting less cooler than earlier |
| | | Winter starts late than the normal timing |
| | | Untimely rain fall are more pronounced than earlier |
| | | Frequency of stormy even is increasing |
| | | Salinity of water in rivers & canals are increasing |
| | | High tides are encroaching new and new areas |
| | | Migratory birds are less seen in winter than earlier |
| Note: In each cases to summarize the scale value 1, 2, 3 are weighted as (1/3 = 0.33, 2/3 = 0.67, and 3/3 = 1 respectively) | | |

| Scale of measurement of | | Indicator/Variable |
|---|---|---|
| Perception about CC-SLR event | | Respondent's perception about: |
| Scale: | | Accelerated sea level rise |
| 1 = There is doubt; no need to think at all | | Rapid/more inward shift of coastline |
| 2 = Distant and uncertain; still we may start thinking if really happen | | Permanent encroachment of new areas by saline water |
| 3 = We must act from now no matter the extent of uncertainty | | Increased frequency & magnitude of stormy even and surge |
| | | Acute scarcity of salt free/sweet water for drinking |
| | | Acute scarcity of salt free/sweet water for drinking |
| Note: In each cases to summarize the scale value 1, 2, 3 are weighted as (1/3 = 0.33, 2/3 = 0.67, and 3/3 = 1 respectively) | | |

| Scale of measurement of | | Indicator/Variable |
|---|---|---|
| Tacit/intuitive knowledge about SLR impact | | Respondent's ability to identify at least 1 potential negative impact of SLR associated with: |
| Scale: | | Crop production/horticulture |
| 1 = No/inaccurate response | | fisheries |
| 2 = Accurate response but only able with the aid of surveyor | | Livestock |
| 3 = Accurate response without any aid | | Settlement/homestead |
| | | Physical infrastructure |
| | | Off-farm economic activity |
| | | Public health |
| | | Social mobility |
| | | Other than the above |
| | | Ability to identify positive impact of any kind |

# Measuring Adaptation efficacy:

| Dimension | Reliability (Cronbatch alfa) | Indicator used to prepare index |
|---|---|---|
| Adaptation efficacy | 0.75 | 5 questions [Following Kelly & Adger, 2000; Yohe & Tol, 2002; Grothmann and Patt (2005), Grothmann and Reusswig 2006; Smith and Wandel, 2006; Tol and Yohe, 2007] |

# Measuring Adaptation efficacy:

| Scale of measurement of Adaptation efficacy | | Indicator/Variable |
|---|---|---|
| Adaptation efficacy | | Given the impact of SLR, how strongly the respondent believe that adaptation against – |
| | | |
| Scale: | | Salinity free drinking water will be possible |
| 1 = Do not think possible any way | | Inward shift of coastline will be possible |
| 2 = May be possible only with external assistance | | Stormy events and surge will be possible |
| 3 = External assistance may help; without that possible as well | | Disrupted social & physical mobility will be possible |
| | | Threat of livelihood security will be possible |
| Note: Note: In each cases to summarize the scale value 1, 2, 3 are weighted as (1/3 = 0.33, 2/3 = 0.67, and 3/3 = 1 respectively) | | |

# Construction of Climate awareness indices and adaptation efficacy index:

- Weighted mean score index of each of the three dimensions of climate awareness and adaptation efficacy for each of the respondents are computed using the formula $\sum Wi/n$ (Wi = individual's weighted score (either of 0.33, 0.67 and 1.0) for each question, n = number of question).

- After determination of individual's weighted mean score, by using the formula $\sum Wifi/\sum fi$ (where Wi = individual's weighted score for each question, fi = frequency of that particular score) weighted average mean (index) is prepared for each of the three dimensions of climate awareness and climate adaptation efficacy for a comparison.

- Three indices related with climate awareness are later used as predictor variable along with other variables selected from factor analysis to predict the variances in climate adaptation efficacy of the respondents.

# Indices of three dimensions of climate awareness and climate adaptation efficacy

| Dimension of climate awareness | | Weighted average mean index (out of 1) | | Standard deviation |
|---|---|---|---|---|
| Familiarity with climate change/extreme signal | | 0.85 | | 0.14 |
| Perception about CC-SLR event | | 0.75 | | 0.10 |
| Tacit/intuitive knowledge about SLR impact | | 0.74 | | 0.11 |
| Climate adaptation efficacy | | 0.68 | | 0.26 |

# Factor Analysis: identifying the factors/variables to be used in "adaptation efficacy" model

- Initially altogether 21 factors/variables were loaded in (PCA). Among these 13 factors/variables were coded following dummy coding as illustrated by Hardy and Bryman (2004) while 8 variables are measured in their respective SI units.
- Finally 20 factors/variables are loaded in PCA.
- The factor analysis is statistically valid (Field, 2005). Because, the determinant (e.g. 4.73E-05) of correlation matrix > 0, the Kaiser-Meyer-Olkin value for sampling adequacy was 0.57, and the Bartlett's test of sphericity was significant at 0.000. Further a total of 20 variables for a sample size of 285 meets the requirement for factor analysis (i.e. 5:1 case/variable ration as recommended by Coakes and Steed 2001) as well.

- Total 8 components having *Eigenvalue* >1 were extracted using varimax rotation with Kaiser normalization to maximize intra-component variances as suggested by Tabachnick and Fedell (1996). These eight components explained almost 72% of the variances which is much higher than the threshold recommended by Hair *et al.* (2006). Component wise loading factor (loading factor <0.20 is not shown) of variables are presented in the ANNEX I.

# Component wise factor loading

- 1st component: "attachment with coastal environment", constitutes 3 variables/factors that explains 13.89 % of the variances.
- 2nd component: "wealth and social standing" constitutes 4 variables/factors that explains 13.51 % of the variances.
- 3rd component: "social networking" constitutes 2 variables/factors and explains 9.57 % of the variances.
- 4th component has 2 variables/factors characterized with "access to print media for flood information" explains 7.89% of the variances.
- 5th component "coping and adaptation with recurrent hazard" includes 3 variables/factors and explains 7.70% of the variances.
- 6th component has 2 variables/factors characterized with "spatial and demographic causes of exposure to climatic hazard" explains 7.47% of the variances.
- 7th component is related to "exposure potential of dry spell due to types of occupation" includes 2 variables/factors and explains 6.42% of the variances.
- 8th component is characterized as "gender difference in electronic media use for climate information" constitutes 2 variables/factors explains 5.61% of the variances.

# Result of Multiple regression model:

**Variable entered in Multiple Regression Model**

- The adaptation efficacy index developed earlier is used as dependent variable.
- The independent variables are drawn from the PCA analysis cited earlier and the three indices of climate awareness (i.e. familiarity index, perception index, and knowledge index).

- Backward method of multiple regression analysis is done to single out the predictors from each of the eight broad categories of factor and climate awareness indices.

- The advantage of backward method of regression analysis is that all the independents/predictors variables are entered at a time and the model removes the insignificant one (more) predictor(s) having p value 0.10 or more in each iteration process. At the end of necessary number of iteration(s) of process stop and the model offers only the predictors that significantly explain the variance of dependent variable (George and Mallery, 2006).

# Result of Multiple regression model:

**Output of Regression Model:**

- ❑ All together 7 factors statistically significantly explain 45 percent of the variations in climate adaptation efficacy of respondents [F (22, 262) = 27.61, $p<0.0001$, $R2 = 0.45$].
- ❑ Model output is free of colinearity influence. Tolerance value in most cases 0.80 and above and variance inflation factors (VIF) much lower that 10.
- ❑ Factors related with *attachment with coastal environment* – age (B= 0.008, $p<0.01$) of the respondent and number of time changed settlement (B= 0.052, $p<0.10$) are significant predictors of variances in climate adaptation efficacy.
- ❑ Among the w*ealth and social standing* related indicators total farmland holding (-0.01, $p<0.10$ is significant predictor of variance.
- ❑ Similarly among the *social networking* factors- often need contact with local officials (-0.11, $p<0.001$) is significant predictor.
- ❑ Likewise, among the factors characterized with *spatial and demographic causes of exposure to climatic hazard*- distance from the coast (km) (B= 0.006, $p<0.05$) is significant predictor.
- ❑ Among the factors relate with c*oping and adaptation with recurrent hazard* (dummy)- frequent adaptation against dryer condition (B= -0.089, $p<0.01$) is a significant predictor.

# Result of Multiple regression model:

**Output of Regression Model:**

- However, among the three dimension of *climate awareness* only perception about CC-SLR event (B= 1.28, $p<0.001$) is significant predictors of adaptation efficacy.
- Contrary to expectation of this research, finding unveils that climate familiarity and tacit/intuitive knowledge about the impacts SLR have no significant impact on climate adaptation efficacy of the respondents.

- Among all factors that affect climate adaptation efficacy positively, perception about CC-SLR event is the strongest one ($\beta= 0.51$, $p<0.001$), followed by age ($\beta= 0.33$, $p<0.001$) and distance from the coast ($\beta= 0.10$, $p<0.05$).

- Among all factors that affect climate adaptation efficacy negatively, habit of seeking external assistance such as contacting with local authority to solve problem is the strongest one ($\beta= -0.17$, $p<0.001$), followed by frequent adaptation against dryer condition ($\beta= 0.16$, $p<0.001$) and salinity intrusion ($\beta= 0.10$, $p<0.05$).

# Policy Implication and Concluding remarks

- Among the climate awareness dimensions only one dimension i.e. perception about CC-SLR event is statistically highly significant predictor of people's climate adaptation efficacy. However, influences of other two dimensions are not very significant. Nonetheless this finding is robust from two considerations.
- First, it will reemphasis to initiate of climate awareness program before implementation of any adaptation measures where there is need for involvement of local community.
- Second, it will bring the climate awareness issue in the forefront of debate about broader issue of adaptation against climate CC-SLR for livelihood security.
- However, as livelihood security encompasses more than just earning opportunity or food security other findings of this research need to accounted with due merit.
- For example, people who have changed settlement location more times than who does less or not changed at all have demonstrated more climate adaptation efficacy. It means peoples who had moved inward from the coast feel them more confident to face the CC-SLR impacts in future.

# Policy Implication and Concluding remarks

- Similarly people have been living far from the coast demonstrated more adaptation efficacy against CC-SLR than people living close to the coast.
- Someway both the findings are giving the same message i.e., to secure livelihood from the threat of CC-SLR some people might start evacuating from the coast to resettle more inward which might result in mass displacement in the long run.

- It might happen even earlier as because people who have been encountering natural disaster for years, for example, salinity intrusion, and seasonal dry spells are already in their pick of coping range to secure their natural resources based livelihood. Any additional episode of same kind of disaster which is more likely in future will severely erode their adaptation efficacy which is already exhausted as they think they are crossing their copping threshold.

## Future direction of Research

- As finding concludes carefully designed intervention needs to be initiated without further delay to let the coastal people be aware about the CC-SLR adaptation. This would help them leave out any wrong conception about CC-SLR which will help enhancing adaptation efficacy which in turn would encourage them anticipatory adaptation against future SLR.

- However, this finding gives a new direction of research for exploring the relationship among climate adaptation efficacy and preference for various measures of adaptation for securing livelihood from the threat of CC-SLR in coastal Bangladesh.

ANNEX 1. Factor loading Matrix:

| *Variable- Factors loading* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Duration of living (yr) | 0.95 | | | | | | | |
| Age of respondent (yr) | 0.83 | | | | | | | |
| Changed settlement since birth (freq.) | -0.74 | | | | | | | |
| Total farm land (ha) | | 0.89 | | | | | | |
| Total yearly income (BDT) | | 0.87 | | | | | | |
| Possession of television (dummy) [a] | | 0.76 | | | | | | |
| Education of respondent (yr of schooling) | -0.33 | 0.57 | | | | | | |
| Habit of personal contact with official (dummy) [a] | | | 0.88 | | | | | |
| Membership status of any entity (dummy) [a] | -0.20 | | 0.87 | | | | | |
| Variance (%) | 13.89 | 13.51 | 9.57 | 7.89 | 7.70 | 7.47 | 6.42 | 5.61 |
| Cumulative variance (%) | 13.89 | 27.40 | 36.97 | 44.86 | 52.56 | 60.04 | 66.46 | 72.07 |

| *Variable- Factors loading* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Use of newspaper for weather knowledge (dummy) [a] | -0.23 | 0.24 | -0.22 | 0.70 | | | | |
| Adaptation with recurrent flood (dummy) [a] | | | 0.22 | 0.57 | | 0.38 | | 0.28 |
| Recurrent exposure to saline water (dummy) [a] | | | | 0.23 | -0.80 | | | -0.80 |
| Recurrent exposure to rainfall (dummy) [a] | | | | 0.26 | 0.69 | | | 0.69 |
| Peer/community as source of knowledge (dummy) [a] | 0.31 | | -0.31 | | 0.45 | 0.25 | | 0.45 |
| Distance from the coast (km) | | | | | | 0.85 | | |
| Household size (number) | 0.56 | | | | | -0.59 | | |
| Adaptation with recurrent dry spell (dummy) [a] | | | | | | | 0.85 | |
| If agriculture & allied livelihood (dummy) [a] | | -0.23 | | -0.44 | | | 0.53 | 0.20 |
| If respondent is male (dummy) | | | | | | | | 0.68 |
| Regular access to radio (dummy) [a] | | | -.21 | | | | -0.31 | 0.66 |
| Variance (%) | 13.89 | 13.51 | 9.57 | 7.89 | 7.70 | 7.47 | 6.42 | 5.61 |
| Cumulative variance (%) | 13.89 | 27.40 | 36.97 | 44.86 | 52.56 | 60.04 | 66.46 | 72.07 |

# Annex II: Multiple regression model of effects of factors on climate adaptation efficacy

| | | | | | | | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|
| Independent variables (N =285) | Coefficient B[a] (β)[b] | Std. Error | t statistics | Sig. | Tolerance | VIF |
| (Constant) | -.669 | .120 | -5.557 | .000 | | |
| Age of respondent (yr) | 0.008*** (0.33) | .001 | 6.573 | .000 | .797 | 1.25 |
| No. of time changed settlement (number) | .052* (0.09) | .029 | 1.794 | .074 | .763 | 1.31 |
| Total farmland (ha) | -0.010* (0.09) | .006 | -1.782 | .076 | .856 | 1.17 |
| Often need contact with local officials (dummy) | -0.115*** (-0.17) | .031 | -3.762 | .000 | .930 | 1.08 |
| Distance from the coast (km) | 0.006** (0.10) | .003 | 1.995 | .047 | .843 | 1.19 |
| Frequent adaptation against saline water (dummy) | -0.052** (-0.10) | .025 | -2.109 | .036 | .921 | 1.09 |
| Frequent adaptation against dryer condition (dummy) | -0.089*** (-0.16) | .026 | -3.435 | .001 | .878 | 1.14 |
| Perception about CC-SLR events (index) | 1.28*** (0.51) | 0.122 | 10.473 | .000 | .851 | 1.17 |
| F | 27.61*** | | | | | |
| DF | (22, 262) | | | | | |
| R2 (Adjusted R2 ) | 0.45 (0.43) | | | | | |

Note:
Dependent variable: Climate adaptation efficacy (index);
[a] Unstandardized regression coefficient;
[b] Standardized regression coefficient;
*significant at 0.10; **significant at 0.05; ***significant at 0.01-0.001.

# Thank You