IMPACT OF CLIMATE CHANGE ON INCOME DIVERSITY : EVIDENCE FROM SOUTHERN PART OF BANGLADESH

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FEATURES OF COASTAL AREAS

Area : Nineteen (19) districts out of 64 comprising **20%** area of the country.

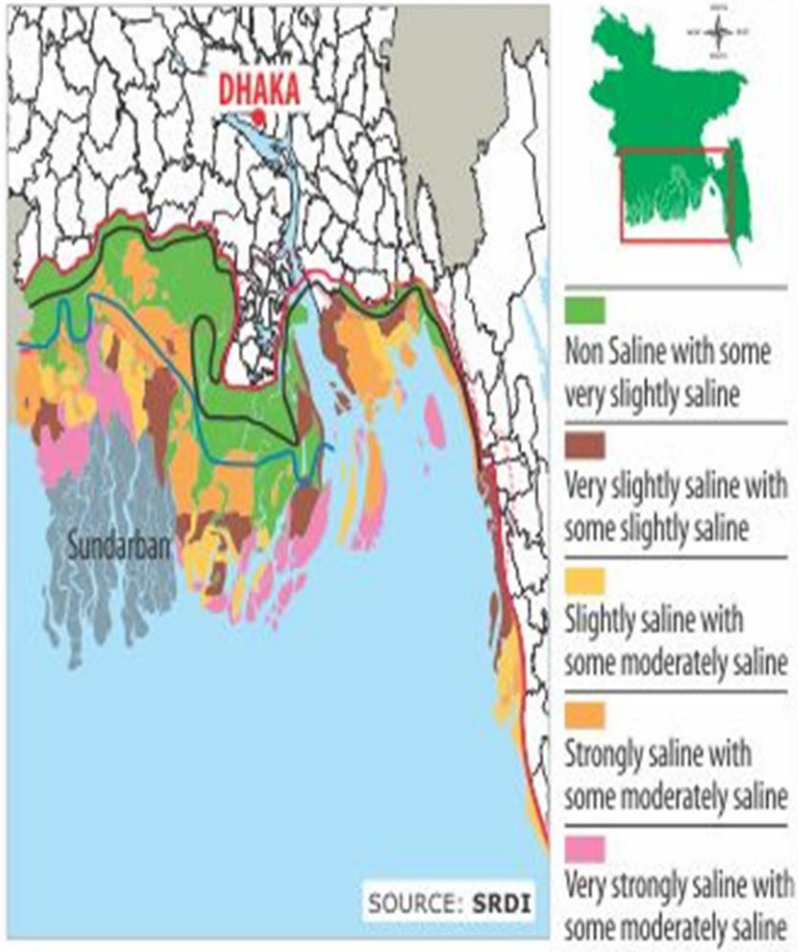
Coastline : 720 km long

Population : About **35.1 million** which represents **28%** of total population of which **52%** are absolute poor

Main Economic Activities : Shrimp farming, agriculture and salt farming

Other features :

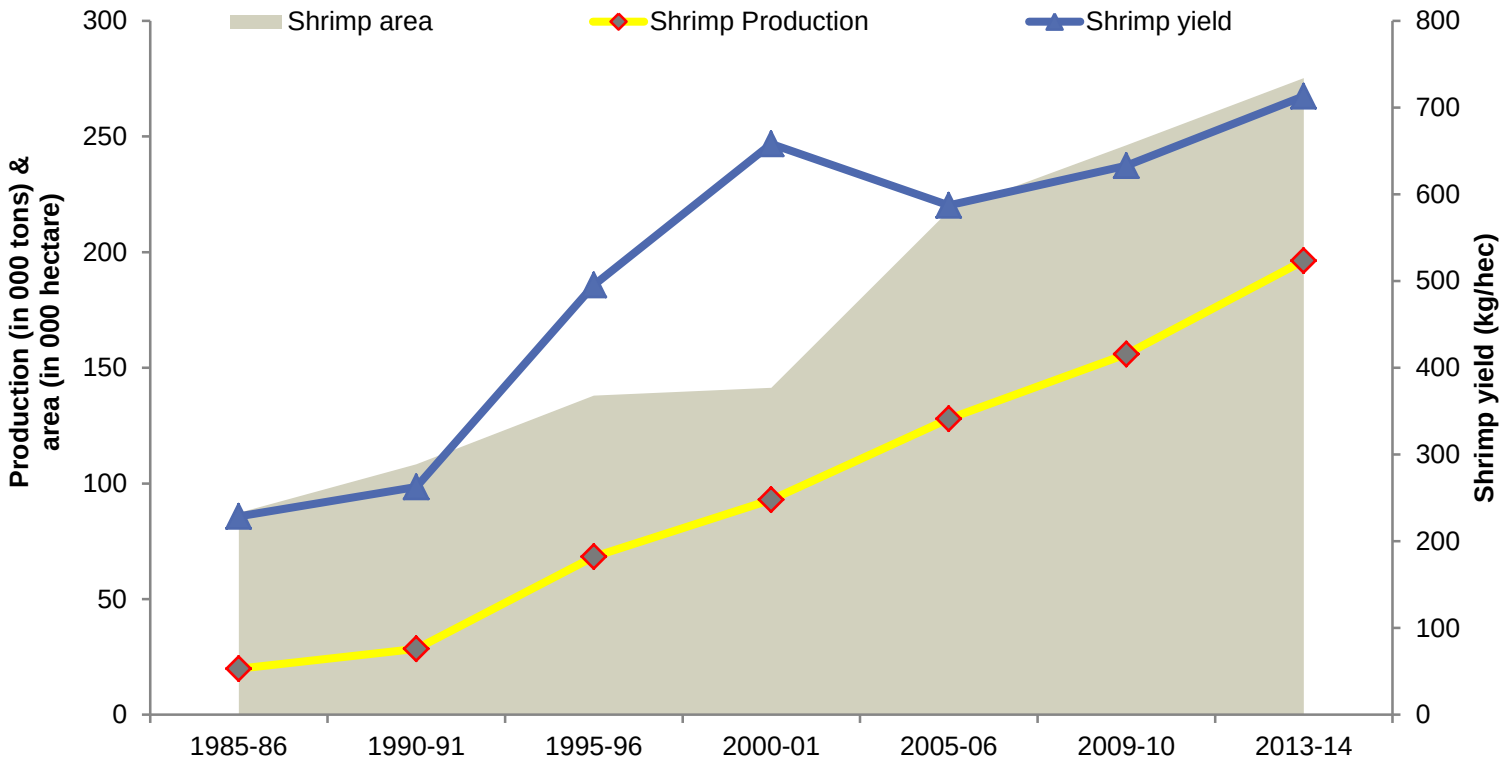
- Cyclones and tidal surges
- Insecurity of land tenure
- Conflict with shrimp farming
- Poor market access
- Loss of diversity



GOOD STORY IN SOUTHERN PART OF BANGLADESH (SHRIMP PRODUCTION)

- Bangladesh experienced a **boom in shrimp farming** during the **1980s** to feed growing international demand. It is known as **'white gold'**
- Bangladesh is today the **fifth-biggest** producer of shrimps in the world.
- **Second largest export** commodity of Bangladesh economy

GOOD STORY: SHRIMP PRODUCTION AND AREA EXPANSION TREND



Source: DoF statistical year book, from 1986 to 2014

BAD STORY / NEGATIVE CONSEQUENCE OF CLIMATE CHANGE

- Bangladesh is one of the **most climate vulnerable** countries in the world and climate change has various impacts such as river bank erosion, salinity intrusion, flood, fisheries destruction, loss of biodiversity, crop failure, etc.

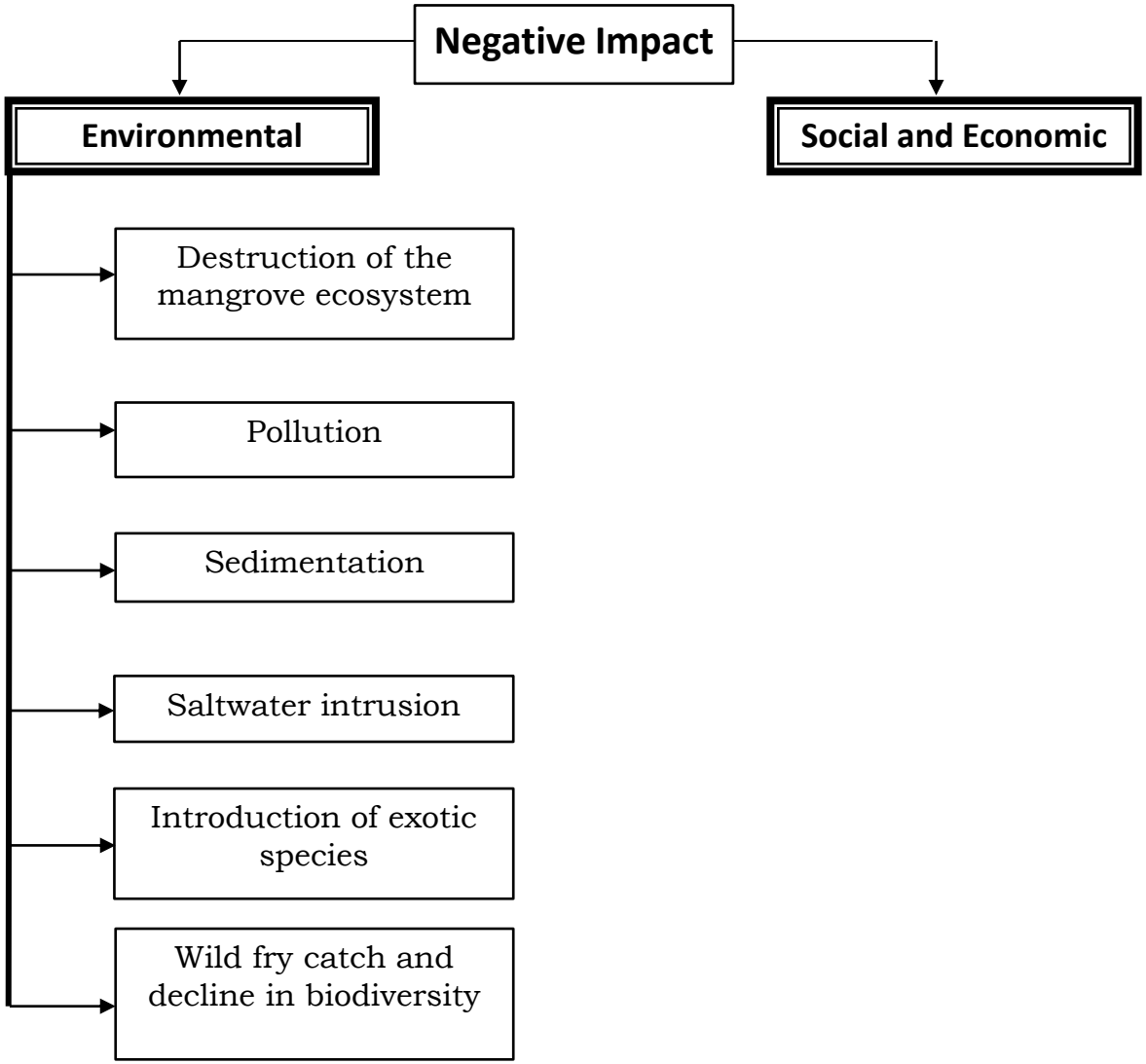
- About **72.8%** of the cultivable land in the coastal area was reported to be **affected by salinity**.

- **Increasing salinity reduce the crop production (2.50 % per year)**, tree growth (2 % per year) and vegetation coverage (1.87 % per year) (Dutta and Iftekhar, 2004).

- Species of **fruit and food producing trees decrease** in number due to **salinity increases**.

- **Water logging** due to unusual rainfall.

NEGATIVE CONSEQUENCE OF CLIMATE CHANGE



NEGATIVE CONSEQUENCE OF CLIMATE CHANGE

Negative Impact

Social and Economic

- Loss of land security
- **Changes in agricultural pattern which lead to vulnerability**
- **Changing sources of income, rural unemployment, inequality and migration**
- Social unrest and conflicts
- Food insecurity
- Social exclusion

RESEARCH QUESTIONS

At this state of affairs, the study asked for;

- ✓ **Is income of the people of the study area diversifying over the time?**
- ✓ **If yes; then, Is there any significant relationship between income diversity and climate change?**
- ✓ **If yes; how climate factors influence the income diversity of the study area?**

RELATED RESEARCH AND RESEARCH GAP

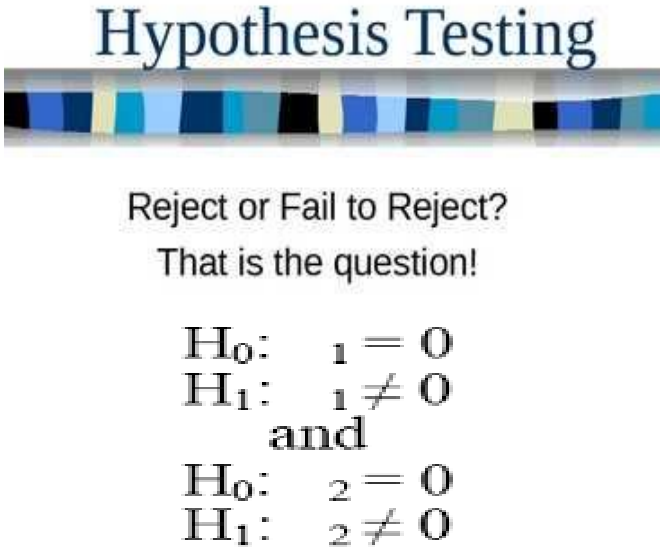
Author	Research on
Hossain (2014)	**Agro-biodiversity and Income diversification** in selected areas of Mymensing district of Bangladesh"
Barrett et al. (2001)	Income diversification, poverty traps and policy shocks in Coˆte d'Ivoire and Kenya"
Khan and Awal (2009)	"**Global warming and sea level rising**: impact on Bangladesh agriculture and food security"
M. S. Hossain, M. J. Uddin Basak et al. (2010) M. Fakhruddin (2013)	how the shrimp culture in Bangladesh is affecting the adjacent **environment as well as society** and management approach for it's sustainability by means of reviewing the available scientific literatures.
Abul Barkat, Shafique Zaman (2007)	**Contribution** of the Coastal Industries to the National Economy
M. Rafiqul Islam (2006)	Managing **diverse land uses** in coastal Bangladesh in institutional approaches
Kasia Paprocki & Jason Cons (2014)	Life in a shrimp zone: aqua- and other cultures of Bangladesh's coastal landscape
Mohammad Alauddin and M. Akhter Hamid, (2010)	The impact of the process has economic, social and environmental dimensions.

No research on effects of climate change on income diversity and vulnerability in coastal area.

GOING TO TEST / HYPOTHESIS

- **Income diversity didn't change during the last twenty years in the southern part of Bangladesh.**

- **There is no effect of climate change on income diversity.**



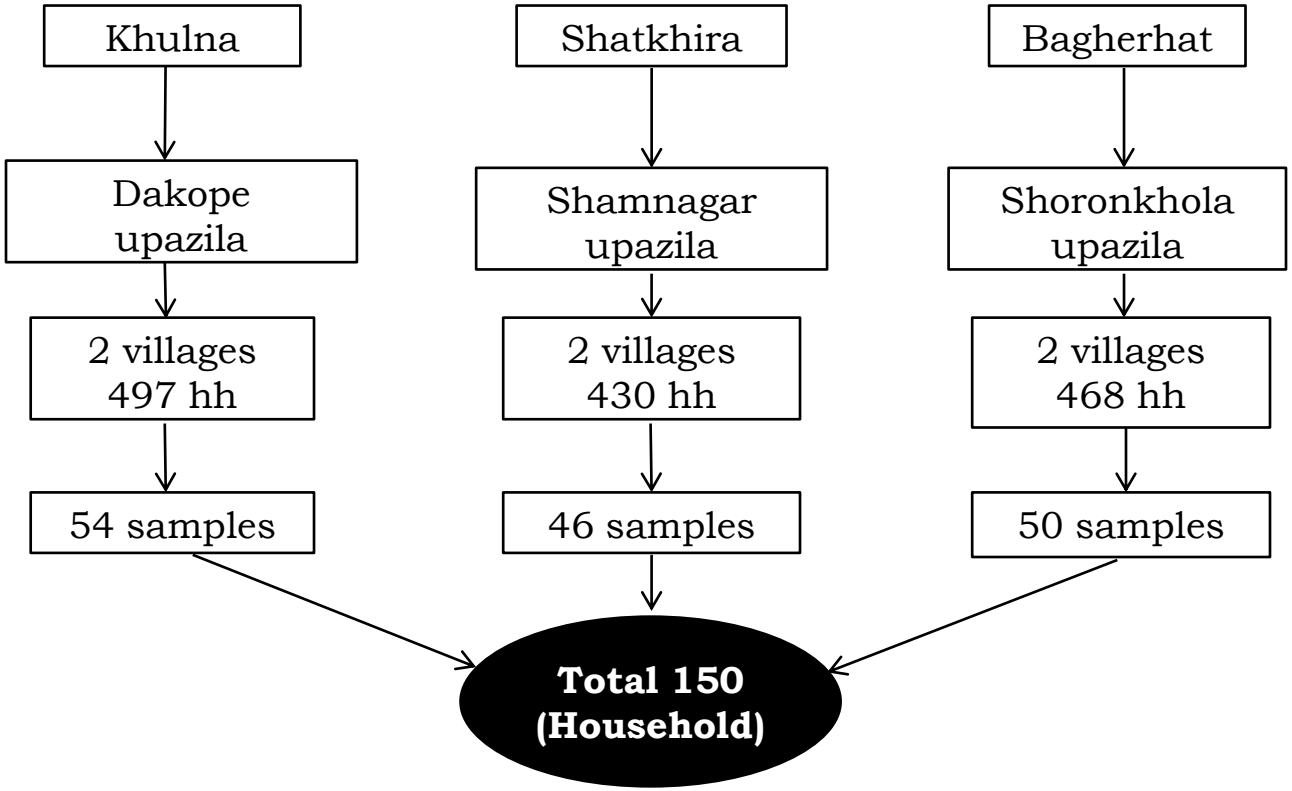
METHODOLOGY - I

- **Data Collection**
  - **Both primary and secondary**
    - **Secondary data : (Climate variables)** maximum temperature, minimum temperature, rainfall, salinity.
    - **Primary data : (Demographic Variables)** age, sex, education, occupation, own land, homestead area, HH asset, HH consumption, dependency, cultivable land, fellow land, pond/fish culture area, rented in/out, leased out/in, association member, income from different sources.

- **Data Periods**
  - **1995, 2005, 2014**

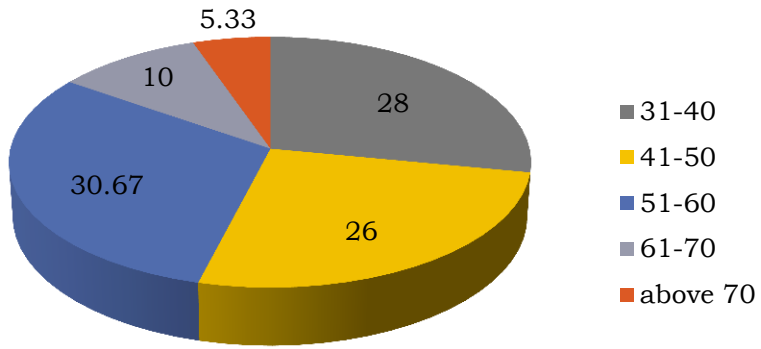
METHODOLOGY - I (CONT...)

- **Study area, sampling procedure and sample size**

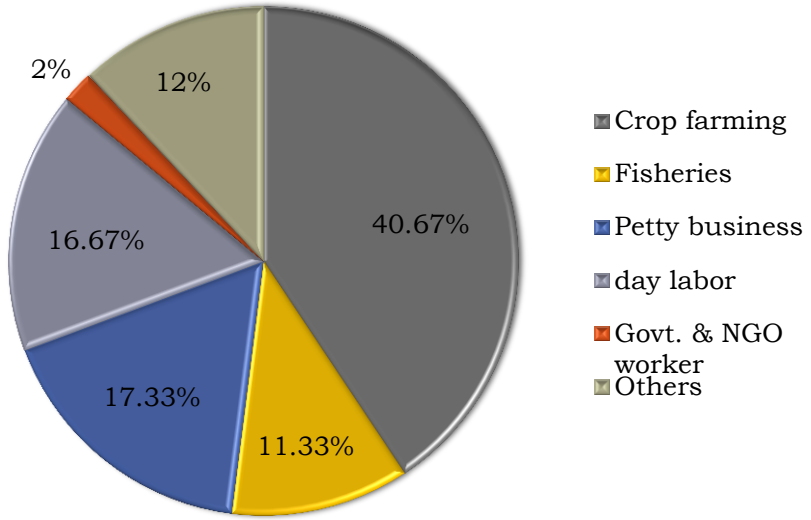


SOCIO-ECONOMIC STATUS FROM FIELD SURVEY

Age distribution (%)



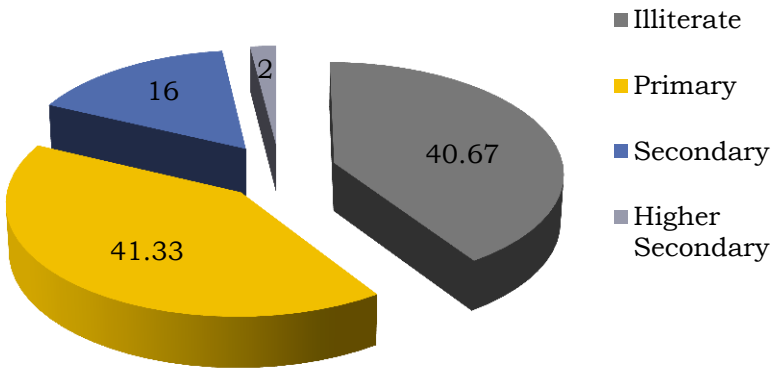
Occupational status



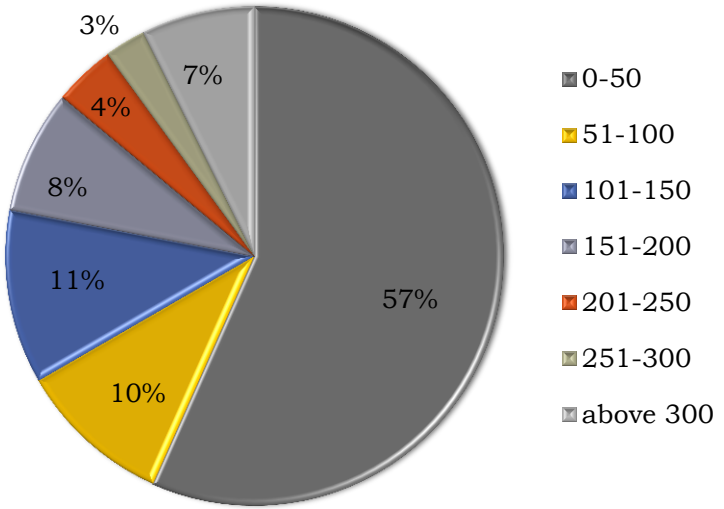
(Source: Field Survey, 2015)

SOCIO-ECONOMIC STATUS FROM FIELD SURVEY

Educational level (%)



Land ownership in decimal



(Source: Field Survey, 2015)

METHODOLOGY - II (ANALYTICAL TECHNIQUES)

- **Income diversity: Chang (1997)**

$$Income\ diversity\ index = \frac{1}{\sum_{i=1}^{n}\left(proportional\ contributions\ to\ total\ income\right)^2}$$

- **Type '66' livelihood strategy: Ellis, (2000)**

CONT...

Strategy	Category shares in total income	Strategy type
1	Crop income ≥ 66%	Principally crops
2	Livestock income ≥ 66%	Principally livestock
3	Fish income ≥ 66%	Principally fish
4	Non-farm income ≥ 66%	Principally non-farm
5	Crop income and livestock income together ≥ 66% Crop income < 66%, but (>/<) non-farm income or fish income Livestock income < 66%, but (>/<) non-farm income or fish income	Crop/ livestock
6	Crop income and fish income together ≥ 66% Crop income < 66%, but (>/<) non-farm income or livestock income Fish income < 66%, but (>/<) non-farm income or livestock income	Crop/fish
7	Crop income and non-farm income together ≥ 66% Crop income < 66%, but (>/<) livestock income or fish income Non-farm income < 66%, but (>/<) livestock income or fish income	Crop/non-farm
8	Livestock income and fish income together ≥ 66% Livestock income < 66%, but (>/<) crop income or non-farm income Fish income < 66%, but (>/<) crop income or non-farm income	Livestock/ fish
9	Livestock and non-farm income together ≥ 66% Livestock income < 66%, but (>/<) crop income or fish income Non-farm income < 66%, but (>/<) crop income or fish income	Livestock/ non-farm
10	Fish income and non-farm income together ≥ 66% Fish income < 66%, but (>/<) crop income or livestock income Non-farm income < 66%, but (>/<) crop income or livestock income	Fish/non-farm
11	All income sources are < 66%	Mixed

INCOME DIVERSITY INDICES OVER THE DECADES

Year	Mean Index value	Std. deviation
1995	1.51	0.58
2005	1.85	0.62
2014	1.95	0.57

t=6.62 (1995 vs 2005 & 2014)

t=4.92 (1995 vs 2005)

t=1.64 (2005 vs 2014)

Year	Khulna	Bagerhat	Satkhira
	Mean Index value	Mean Index value	Mean Index value
1995	1.55	1.45	1.51
2005	1.85	1.84	1.86
2014	1.92	1.93	2.02

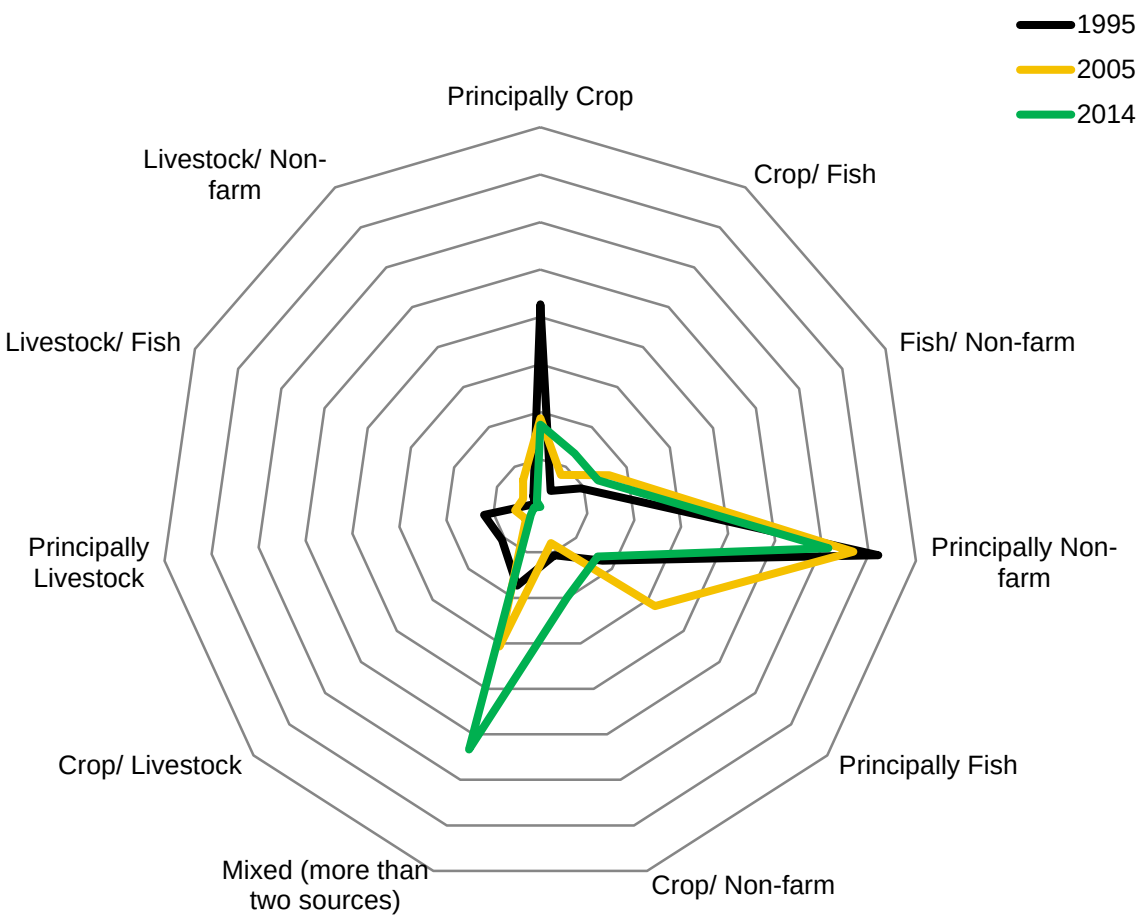
(Source: Field Survey, 2015)

'TYPE 66' DISTRIBUTION OF HOUSEHOLDS, BY INCOME SOURCES AND OVER THE DECADES (%)

Strategy type	Year		
	1995	2005	2014
Principally Crop	21.33	9.33	8.67
Principally Fish	**8.67**	**16.00**	**8.00**
Principally Livestock	6.00	2.67	0.67
Principally Non-farm	36.00	33.33	30.67
Crop + Fish	2.00	4.00	6.67
Crop + Livestock	5.33	2.00	1.33
Crop + Nonfarm	5.33	4.00	10.00
Livestock + Fish	0.67	2.00	0.00
Livestock + Nonfarm	1.33	3.33	0.67
Fish + Nonfarm	4.67	8.00	6.67
Mixed (more than two sources)	**8.67**	**15.33**	**26.67**
Total	**100**	**100**	**100**

(Source: Field Survey, 2015)

FIGURE : 'TYPE 66' DISTRIBUTION OF HOUSEHOLDS



(Source: Field Survey, 2015)

METHODOLOGY - III (ECONOMETRIC)

- **Random effects GLS regression**

$$y_{it} = \beta_0 + \beta x_{it} + \alpha_i + \varepsilon_{it}, \text{where } \varepsilon_{it} \sim IID\ (0, \sigma_\varepsilon^2) \text{ and } \alpha_i \sim IID\ (0, \sigma_\alpha^2)$$

- **Empirical model:**

$$\begin{aligned} y_{it} = {} & \beta_0 + \beta_1 salinity_{it} + \beta_2 maximumtemperature_{it} \\ & + \beta_3 minimumtemperature_{it} + \beta_4 rainfall_{it} + \beta_5 age_{it} \\ & + \beta_6 education_{it} + \beta_7 activemember_{it} + \beta_8 ownland_{it} \\ & + \beta_9 homesteadarea_{it} + \beta_{10} associationmember_{it} + \varepsilon_{it} \end{aligned}$$

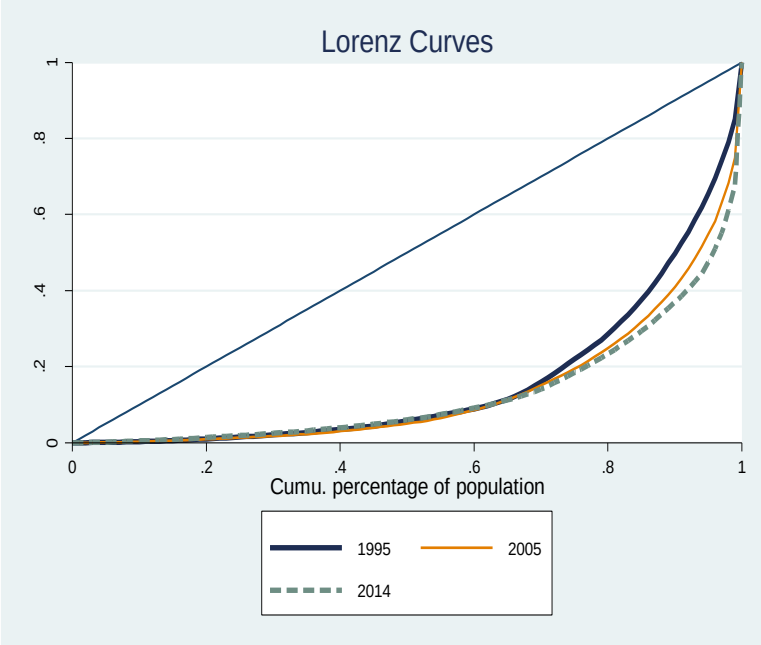
EFFECTS OF CLIMATE VARIABLES ON INCOME DIVERSITY (USING RANDOM EFFECTS MODEL)

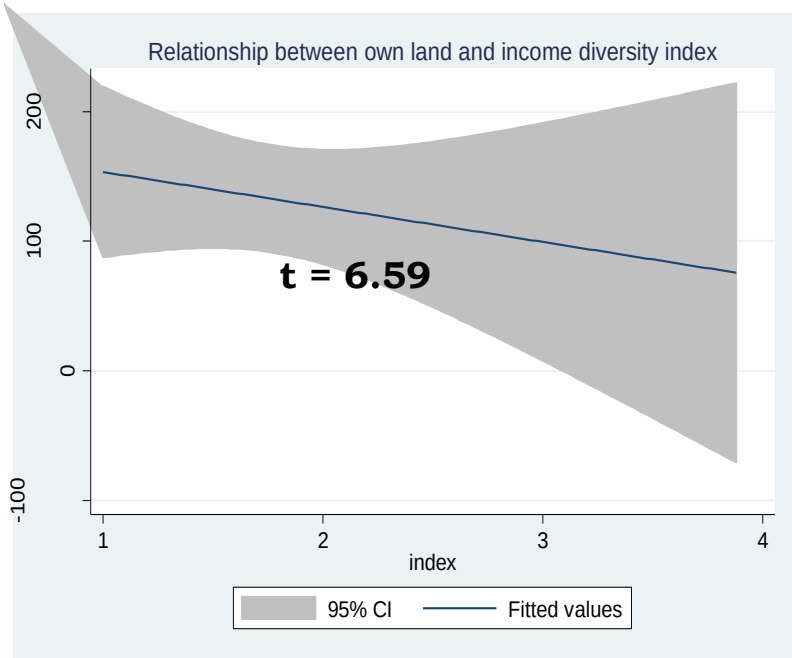
Variable	Co-eff.	Std. Err.	P-value (P>z)
Salinity	0.043***	0.013	0.001
Maximum temperature	-0.123	0.134	0.359
Minimum temperature	-0.004	0.083	0.96
Rainfall	0.004	0.003	0.128
Age	0.009***	0.003	0.007
Education	0.026***	0.009	0.003
Active member	0.003	0.012	0.771
Own land	-0.001***	0.000	0.006
Homestead area	-0.001**	0.000	0.033
Association member	0.110**	0.047	0.018
_cons	4.191	5.661	0.459
Wald chi2 = 34.90; Prob. > chi2 =0.0000; Number of observations =150			

*Notes: *, **, and *** indicate significance at the 10 percent, 5 percent, and 1 percent level, respectively*

(Source: Field Survey, 2015)

FIGURE : LAND DISTRIBUTION AND INCOME DIVERSITY





- Lorenz Curves:
  - ✓ Around 80% population held only 23% land
  - ✓ This unequal distribution increases over the time
- Income diversity is gradually increasing (statistically significant) with the decrease of land ownership

(Source: Field Survey, 2015)

WHY & HOW ?

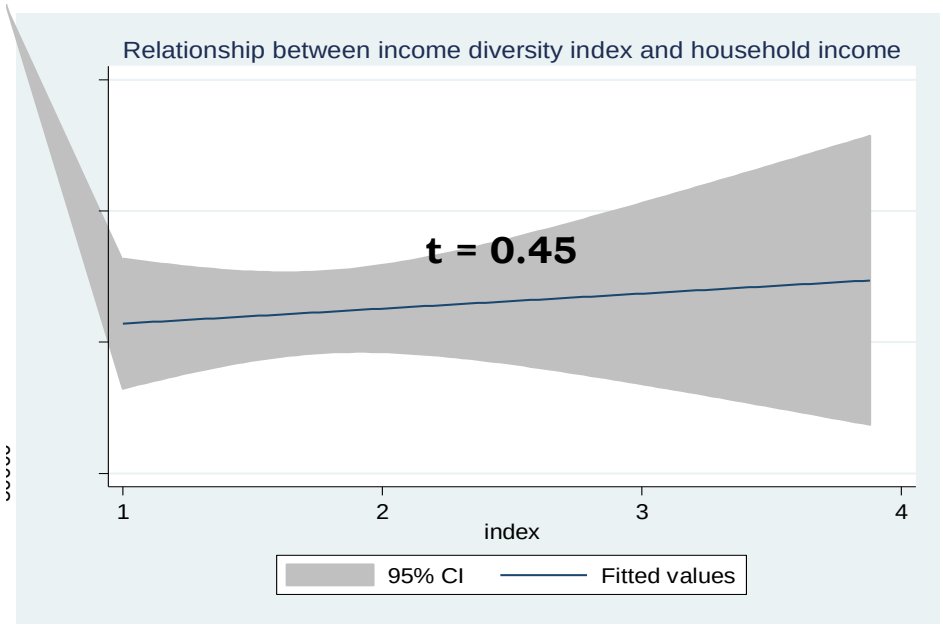
- **Multiple motives prompt households to diversify assets, incomes, and activities (Barrett et al, 2001a)**
  - **Push factors**
    - ✓ Risk management (Hoogeveen, 2001; Alderman & Pason. 1992)
    - ✓ Seasonality of agricultural activity (Sahn, 1989)
    - ✓ Reaction to crisis or liquidity constraints (Reardon et al, 1994)
    - ✓ High transaction costs (Omamo, 1998)
  - **Pull factors**
    - ✓ Benefits from complementarities between activities (Norman, 1974)
    - ✓ New income opportunities created by market development (Davis & Pearce, 2001)
    - ✓ Improvement of Infrastructure (Jalan & Ravallion, 1998), etc.

WHY & HOW ?

- **Typically people believe that, income diversity increases the household income.**
  - **Positive effects of Income diversity in developing countries (Ellis, 1999)**
    - ✓ **Seasonality:** reduce 'labor smoothing' and 'consumption smoothing' problem by utilizing labor and generating alternative sources of income in off-peak periods.
    - ✓ **Risk reduction:** the factors that create risk for one income source should not be the same as those that create risk for another.
    - ✓ **Higher income:** by making better use of available resources and skills.
    - ✓ **Asset improvement:** Cash resources obtained from diversification may be used to invest.
    - ✓ **Environmental Benefits:** by generating resources that are then invested in improving the quality of the natural resource base and by providing options that make time spent in exploiting natural resources.
    - ✓ **Gender benefits:** improve the independent income-generating capabilities of women.

- **But, this situation may change when "push factors" influence the income diversity.**

FIGURE : HOUSEHOLD INCOME AND INCOME DIVERSITY



- Although income sources has been diversified with climate change but people who diversified their sources of income cannot earn significantly more compared to less diversified farmers.
- Income diversification couldn't help to enhance poor's household income.

(Source: Field Survey, 2015)

QUOTES AND FURTHER STUDY POSSIBILITIES

“ Risk plays a key role in the diversification process and risks are major “push” factors that encourage households to turn to a more diversified portfolio of activities. ”

--- Carter, 1997

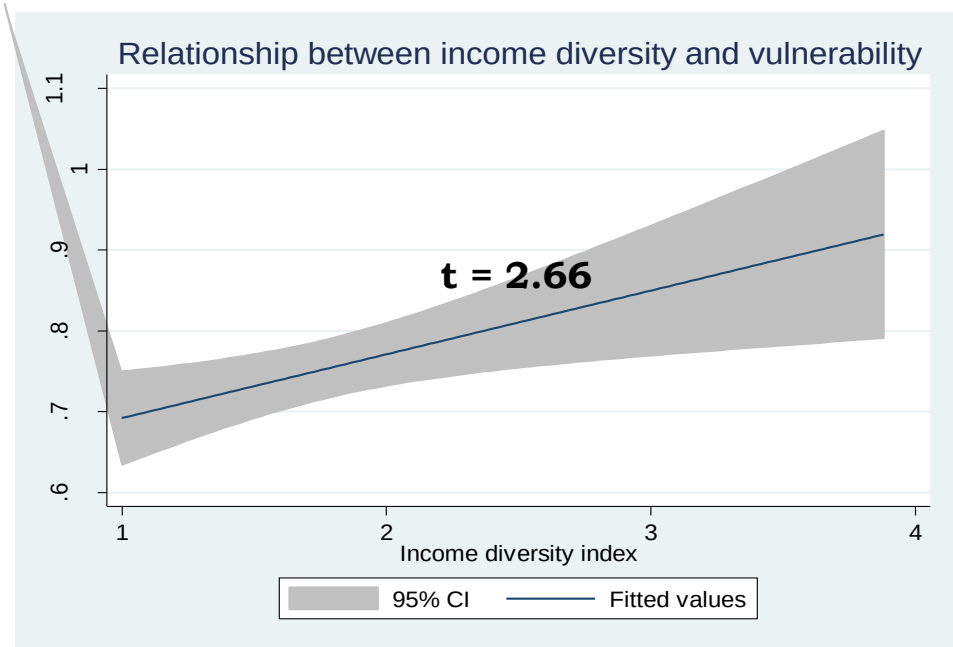
“ Employment can be a factor in self-esteem and indeed in esteem by others... If a person is forced by unemployment to take a job that he thinks is not appropriate for him, or not commensurate with his training, he may continue to feel unfulfilled and indeed may not even regard himself as employed. ”

--- Amartya Sen, 1975

- What about the vulnerability status of the study area?
- What about their adoption technology and/or adoption cost?
- Who will take these responsibility ? Developed countries or Country Govt.?

EXTENSION OF THE STUDY

- **Relationship between income diversity and income vulnerability**



What should be the policy to reduce vulnerability ?!?

(Source: Field Survey, 2015)

CONCLUSION

- Climate variable epically salinity has significant effects on income diversity.
- More diversified income groups cannot earn significant more income.
- Income diversity negatively related to ownership of land, i.e. framers who do not have land, goes for different livelihoods.
- Indicating poverty and vulnerability situation due to climate change.

RECOMMENDATIONS

- **Diversified livelihood is not solution in the study area.**

  - Established embankment to reduce salinity
  - Salinity tolerance rice and vegetable dissemination
  - Introduce cooperative system land management for reducing political influence
  - Credit support to the small shrimp farmers
  - Enabling environments for grassroots initiative
  - Targeting and safety nets

LIMITATION OF THE STUDY

Some of the data collected from respondents in this study may not be correct as they may not remember the historical data.

ACKNOWLEDGEMENTS

- Dr. Md. Akhtaruzzaman Khan & Md. Masudul Haque Prodhan
- All farmers
- Department of Agricultural Finance, BAU

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$$(\text{THANK YOU})^{n}$$

$$n \in N, n > 1$$

$$\text{YOU} \in \{Awesome\ People\ Set\}$$