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Developing a Composite Index for Vulnerability of Coastal Communities in Baler, Aurora, Philippines

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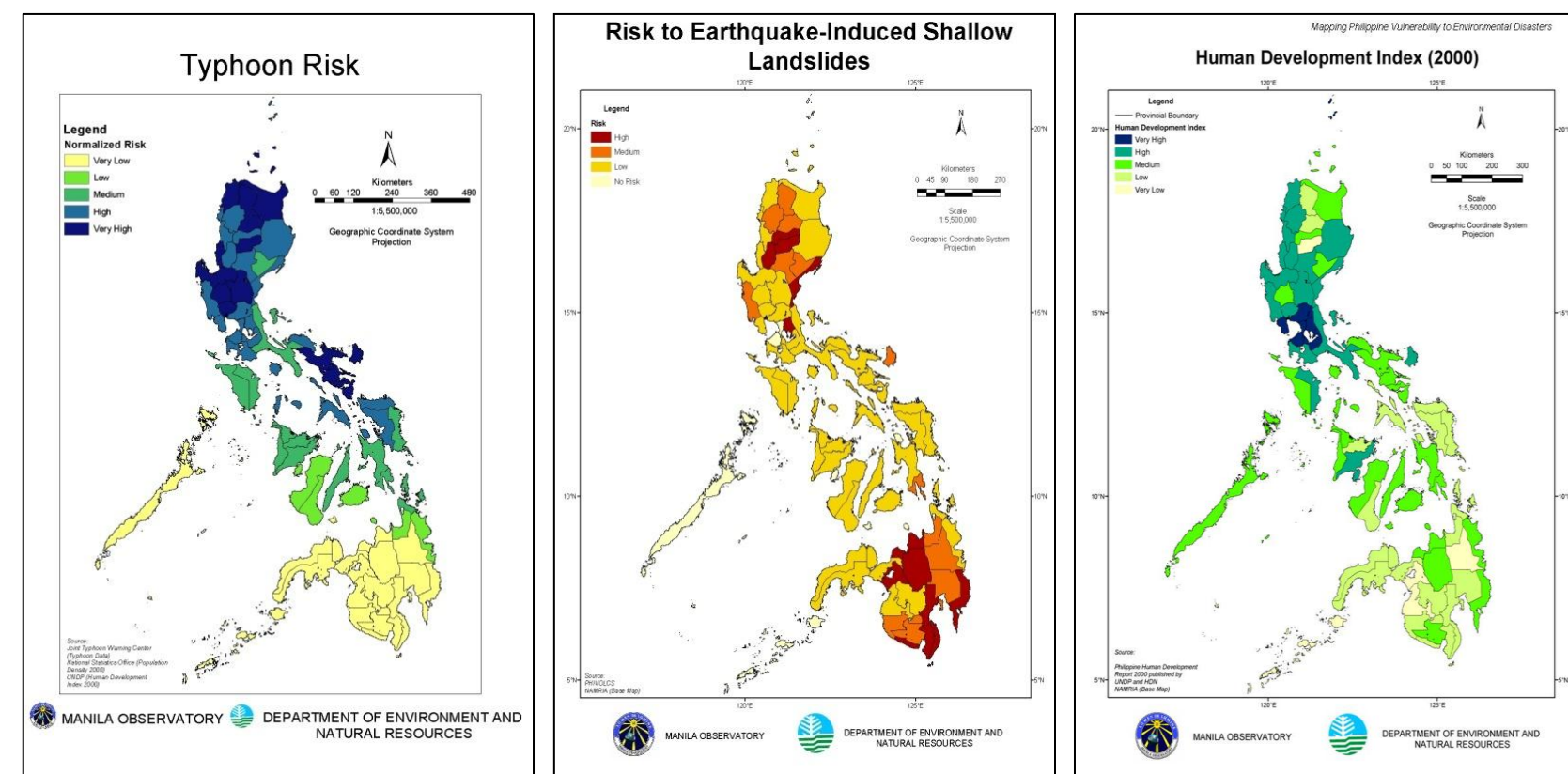[1]Hokkaido University Graduate School of Environmental Science
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Introduction

- Coastal communities of today, around the world, are experiencing unprecedented rate of effects from hazards due to changes in social and environmental systems such as increasing population, anthropogenic disturbances and global climate variations.
- The effects of changes are placing communities at increasing vulnerability from hazards. However their vulnerabilities vary according to factors inherent to them.

- The Philippines is among the areas in the world that are vulnerable to the effects of hazards because of social and environmental changes
- 822 of its 1502 municipalities (55%) are coastal, accounting for ~60% of the 90M populace.

Typhoon Risk / Risk to Earthquake-Induced Shallow Landslides / Human Development Index (2000)

Overview of Study Area

- Baler is one of the seven coastal municipalities in the Province of Aurora, Philippines
- Its coasts measure around 35 kilometers and shared by 5 villages (*barangays*)
- Characterized by social conditions shaped by factors such as unique geography with high natural ecology that is exposed to both natural and social hazards

Sabang / Buhangin / Reserva / Zabali / Pingit — AURORA / BALER
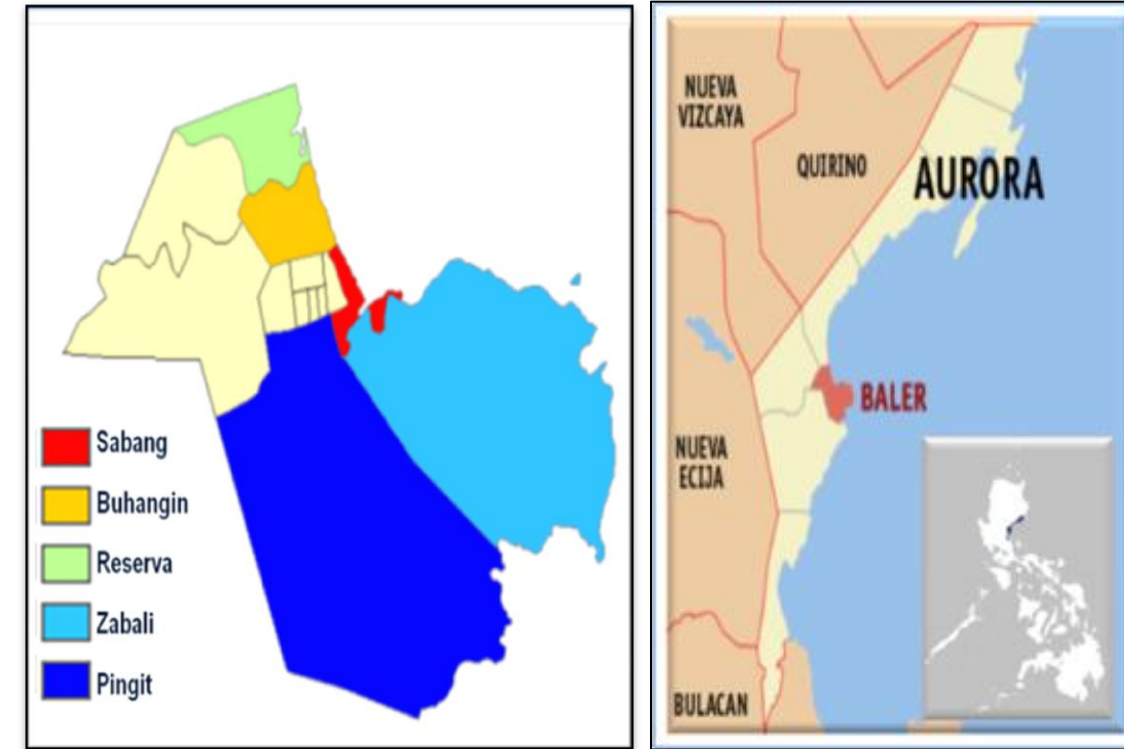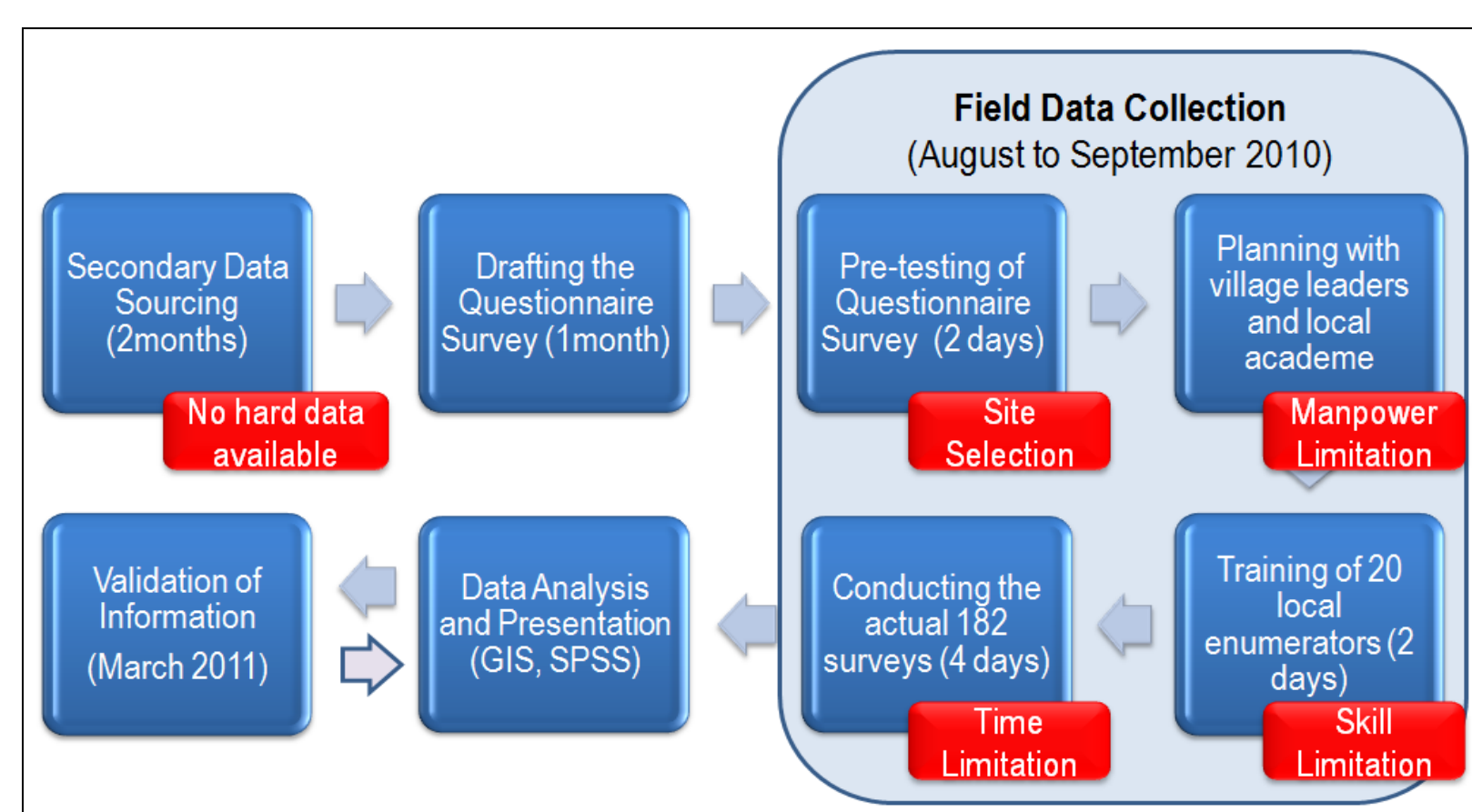
Objective:
Determine the factors that moderate the vulnerability of coastal communities to propose measures for adaptation and mitigation
a) Establish vulnerability criteria from its determinants
b) Categorize communities based on vulnerability index
c) Propose measures for community adaptation and local government planning

Methodological Concepts

Factors moderating vulnerability of coastal communities (modified from Buckle et al. 2001)
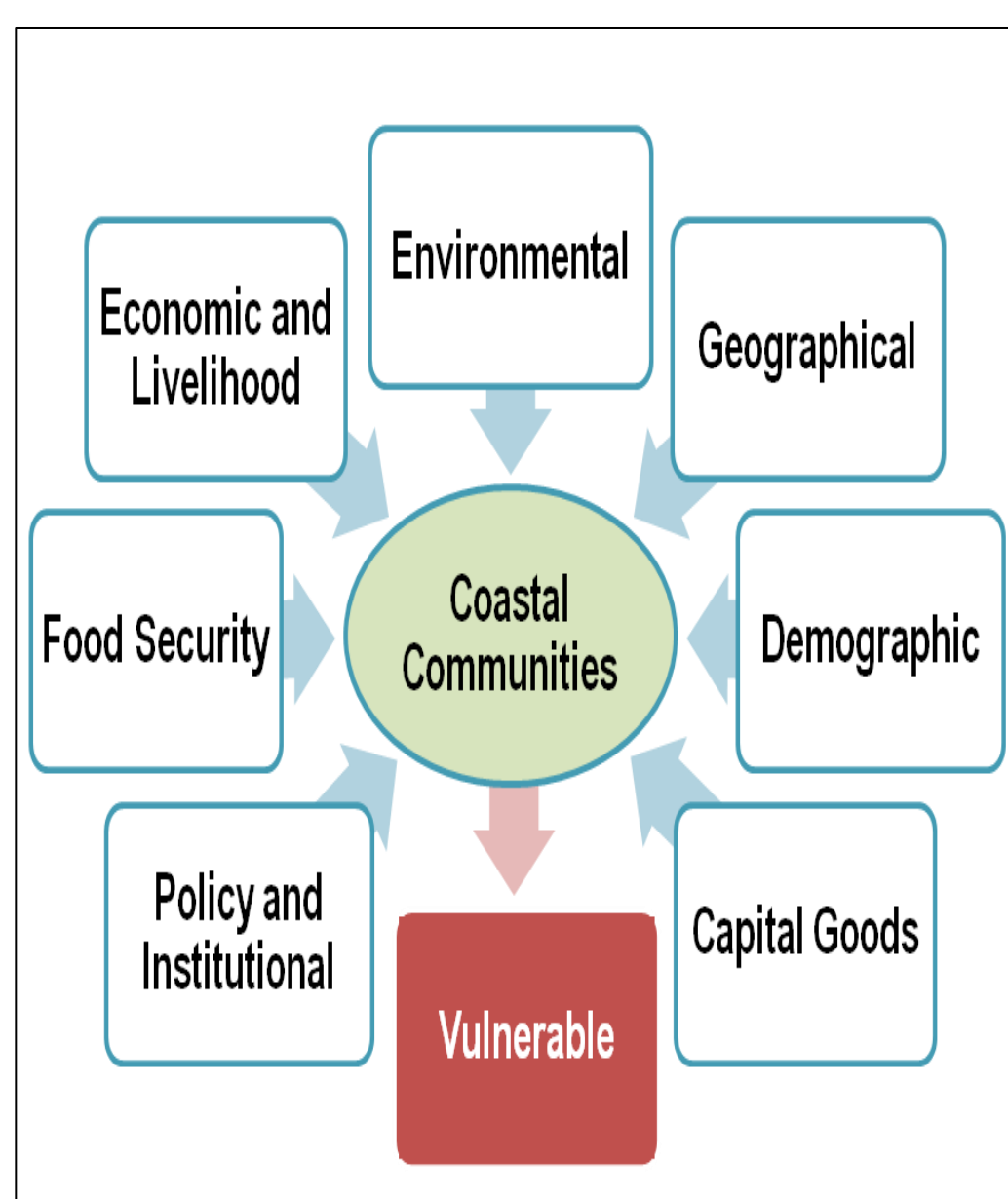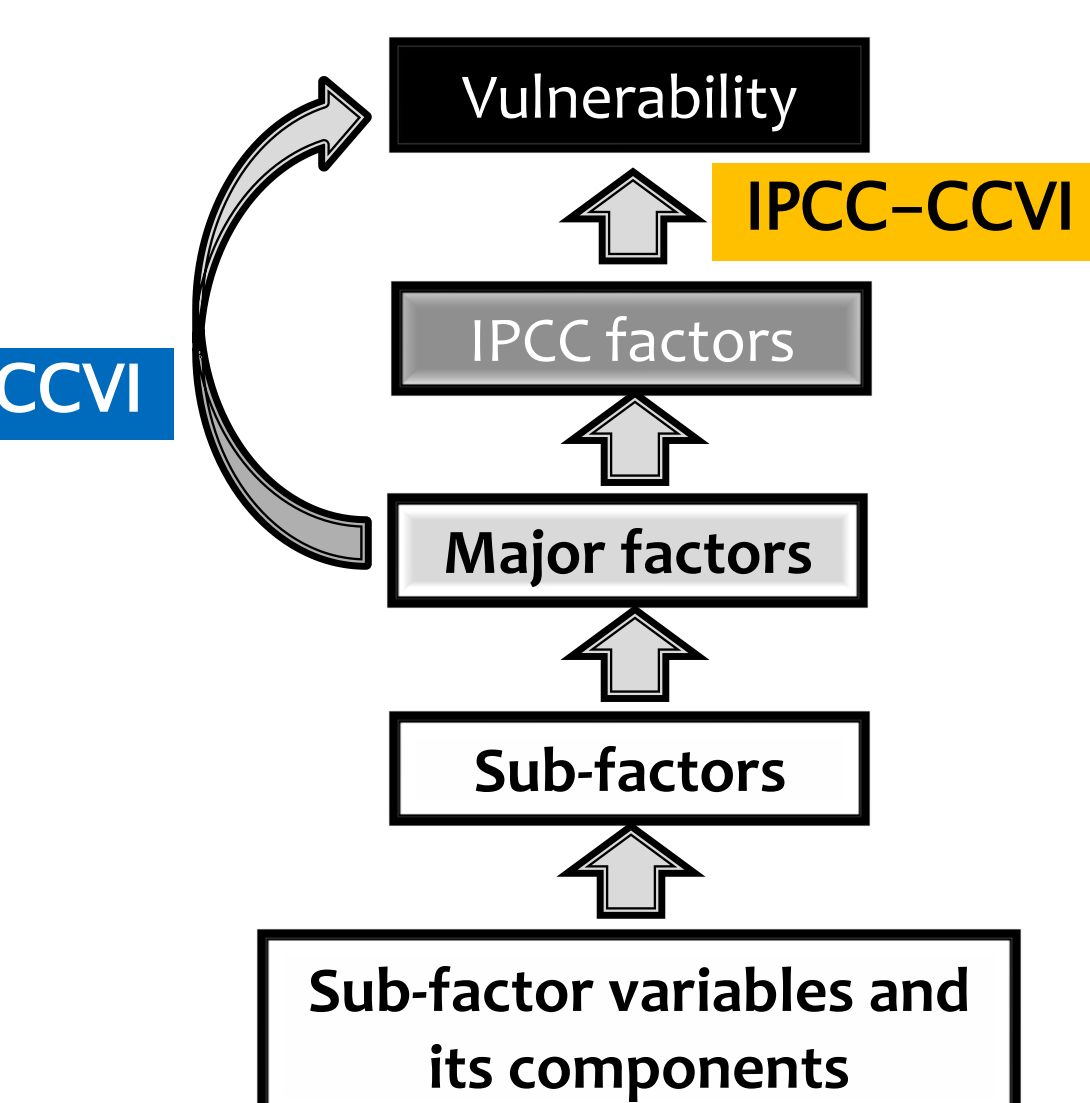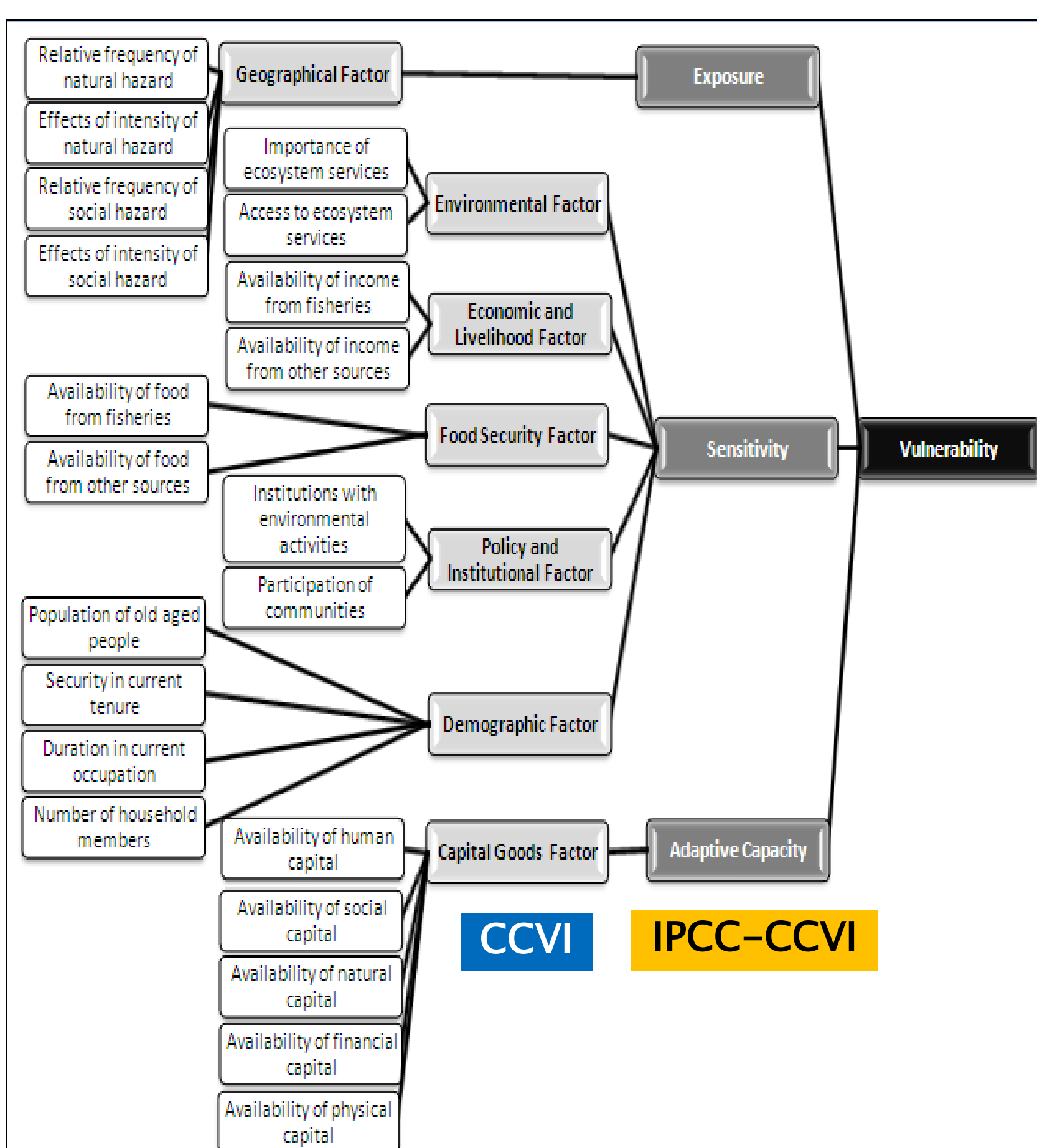
- Two composite indices of vulnerability were designed:
  - Coastal Community Vulnerability Index (CCVI)
  - Intergovernmental Panel for Climate Change-Coastal Community Vulnerability Index (IPCC-CCVI)
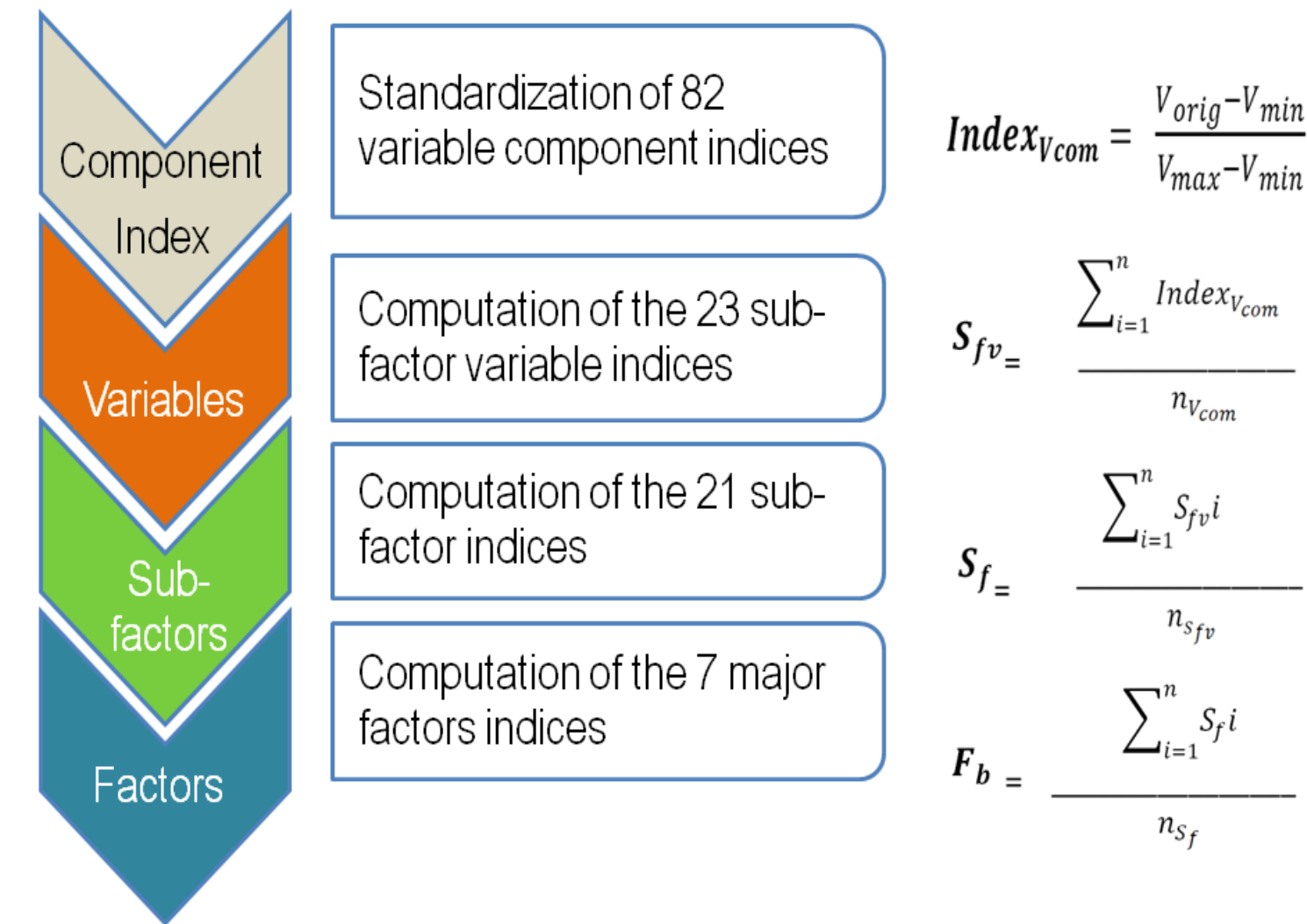
Steps in Data Collection:

Field Data Collection (August to September 2010): Secondary Data Sourcing (2months) → Drafting the Questionnaire Survey (1month) → Pre-testing of Questionnaire Survey (2 days) → Planning with village leaders and local academe; Validation of Information (March 2011) → Data Analysis and Presentation (GIS, SPSS) → Conducting the actual 182 surveys (4 days) → Training of 20 local enumerators (2 days). No hard data available / Site Selection / Manpower Limitation / Time Limitation / Skill Limitation

Inter-Linkage of Index Levels in Developing the Two Vulnerability Indices:

Process:
a) Assign indicators and variables for the seven major factors
b) Establish scales for measuring variables
c) Aggregate respondent's scores based on the scales and compute for the index

Process for Computing Index Values

Component Index → Variables → Sub-factors → Factors

- Standardization of 82 variable component indices
- Computation of the 23 sub-factor variable indices
- Computation of the 21 sub-factor indices
- Computation of the 7 major factors indices

$$Index_{Vcom} = \frac{V_{orig} - V_{min}}{V_{max} - V_{min}}$$

$$s_{fv} = \frac{\sum_{i=1}^{n} Index_{Vcom}}{n_{Vcom}}$$

$$s_f = \frac{\sum_{i=1}^{n} s_{f}i}{n_{sfv}}$$

$$F_b = \frac{\sum_{i=1}^{n} s_{f}i}{n_{sf}}$$

- **Sample Computation:** Social discrimination in Sabang

Variable Scales	n	V_{orig}	V_{min}	V_{max}	Vcom
5= Very Often 4= Often 3= Occasional 2=Seldom 1= Never	47	1.32	1	5	0.08

Frequency of All Types of Social Hazards	Vcom	s_{fv}	s_f
Human environmental destruction	0.42		
Social conflict	0.34	0.25	0.25
Social discrimination	0.08		
Social security	0.16		

Sub-factors of Geographical Factors	s_f	F_b
Frequency of Natural Hazards	0.54	
Intensity of Natural Hazards	0.90	0.58
Frequency of Social Hazards	0.25	
Intensity of Social Hazards	0.62	

Computing the CCVI and IPCC-CCVI

Computing the CCVI:

Coastal Community Vulnerability Index (CCVI) is computed based on the weighted average of the major factors

$$CCVI_b = \frac{\sum_{i=1}^{7} W_{F_b}i F_b i}{\sum_{i=1}^{7} W_{F_b}i}$$

Major Factors	Sub-factors
Geographical Factors	4
Environmental Factors	2
Food Security Factors	2
Economic and Livelihood Factors	2
Policy and Institutional Factors	2
Demographic Factors	4
Capital Good Factors	5

- **Sample Computation:** CCVI Sabang

Major Factors	F_b	W_{F_b}	$W_{F_b}F_b$	$\Sigma W_{F_b}F_b$	ΣW_{F_b}	$CCVI_b$
Geographical Factors (GF)	0.58	4	2.32			
Environmental Factors (EF)	0.54	2	1.08			
Food Security Factors (FF)	0.74	2	1.48			
Economic and Livelihood Factors (ELF)	0.62	2	1.24	11.21	21	0.53
Policy and Institutional Factors (PIF)	0.60	2	1.2			
Demographic Factors (DF)	0.51	4	2.04			
Capital Good Factors (CGF)	0.37	5	1.85			

Computing the IPCC-CCVI:

IPCC major factors (Exposure, Sensitivity and Adaptive Capacity) were established as new factor categories computed based on the weighted average of all major factors

$$IPCCF_b i = \frac{\sum_{i=1}^{n} W_{F_b}i F_b i}{\sum_{i=1}^{n} W_{F_b}i}$$

| IPCC Major Factors	Total Major Factor Composition	Sub-factors
Exposure (E)	Geographic Factors	4
Sensitivity (S)	Environmental Factors, Food Security Factors, Economic and Livelihood Factors, Policy and Institutional Factors, Demographic Factors	12
Adaptive Capacity (A)	Capital Goods	5

IPCC-CCVI (V)= (E-A)*S

- **Sample Computation:** IPCC CCVI Sabang

| Major Factors	F_b	W_{F_b}	$W_{F_b}F_b$	$\Sigma W_{F_b}F_b$	ΣW_{F_b}	$IPCCF_b i$	IPCC-CCVI
Geographical Factors (GF)	0.58	4	2.32	2.32	4	0.58	
Environmental Factors (EF)	0.54	2	1.08				
Food Security Factors (FF)	0.74	2	1.48				
Economic and Livelihood Factors (ELF)	0.62	2	1.24	7.04	12	0.59	0.12
Policy and Institutional Factors (PIF)	0.60	2	1.2				
Demographic Factors (DF)	0.51	4	2.04				
Capital Good Factors (CGF)	0.37	5	1.85	1.85	5	0.37	

Results and Conclusions

Indices of Major Factors, CCVI and IPCC-CCVI in Five Coastal Communities:
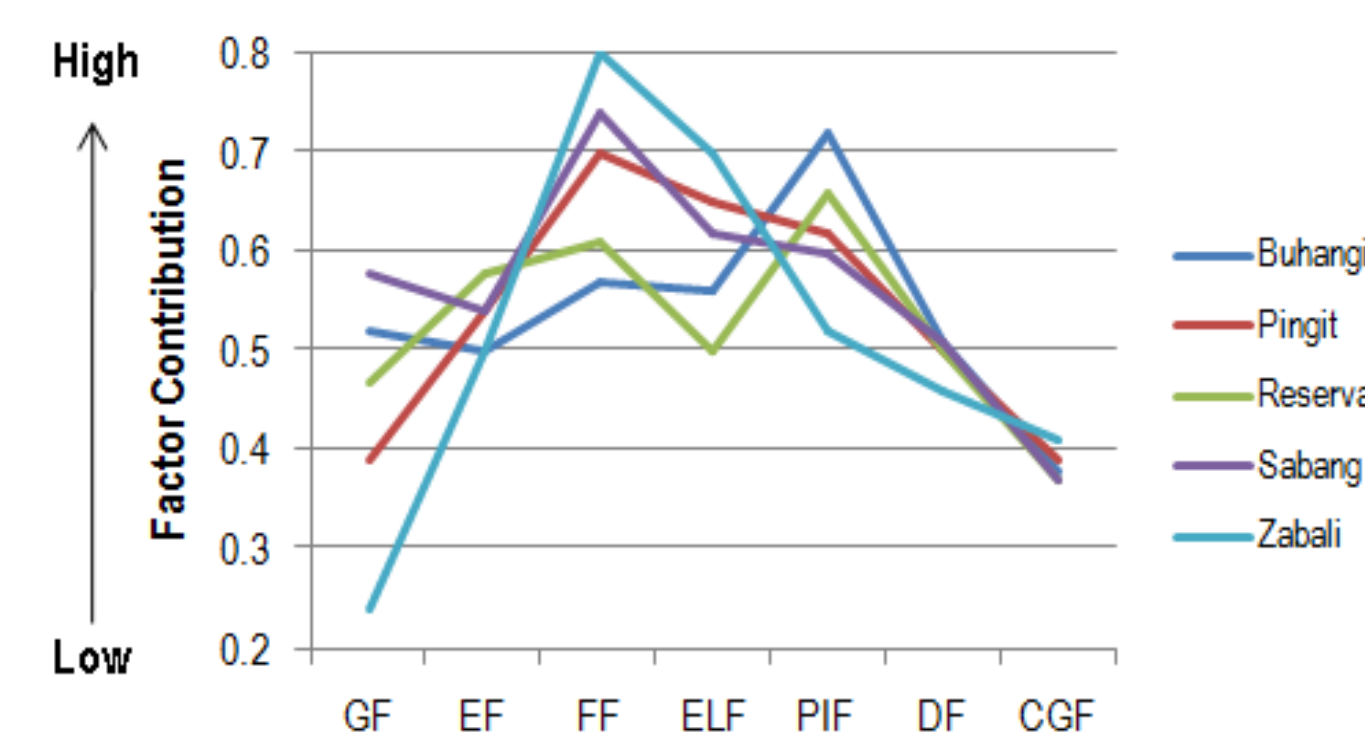
Variations in factor contribution to resulting CCVI in five coastal communities (Buhangin, Pingit, Reserva, Sabang, Zabali)
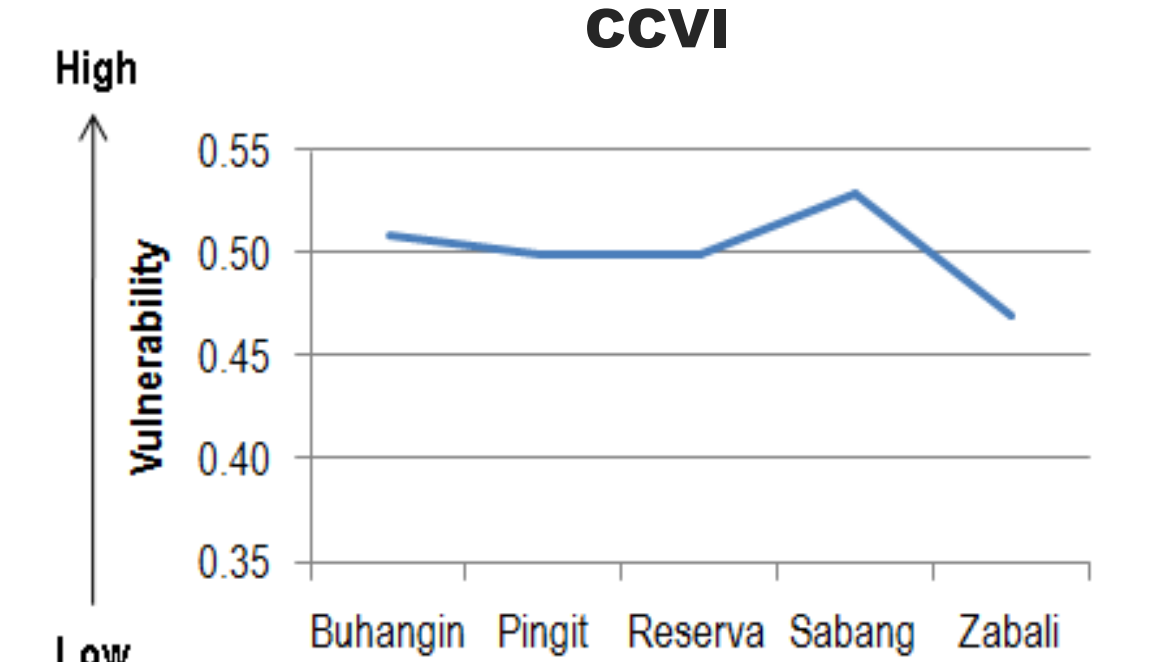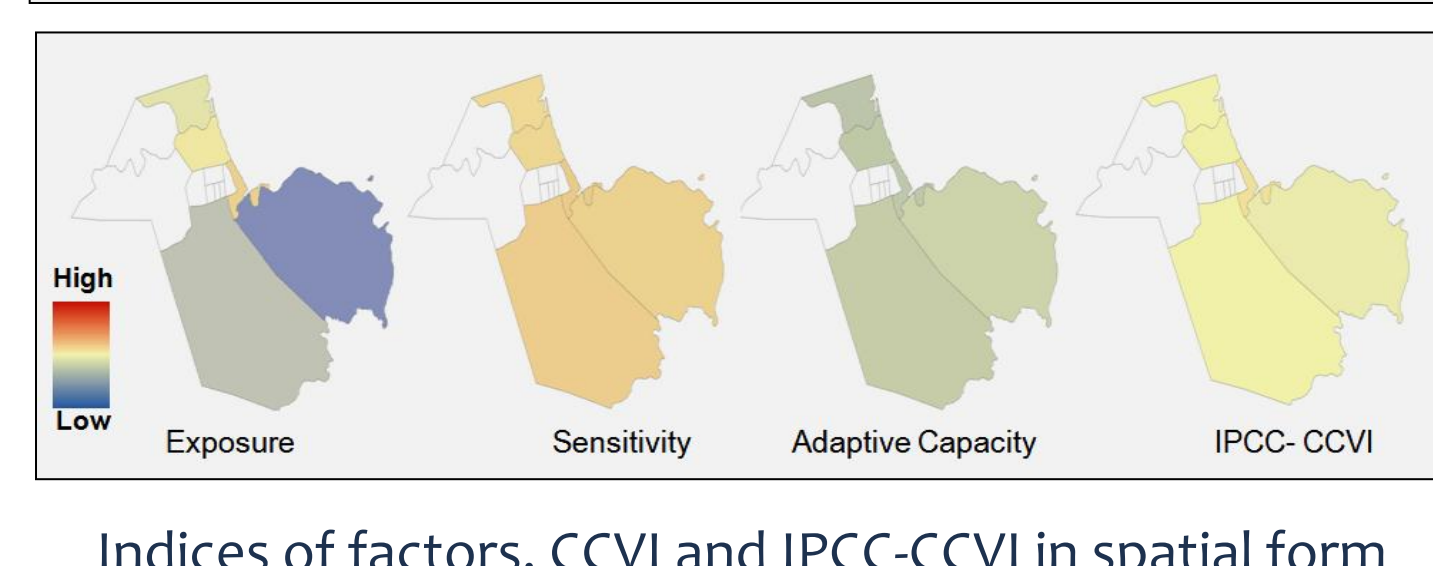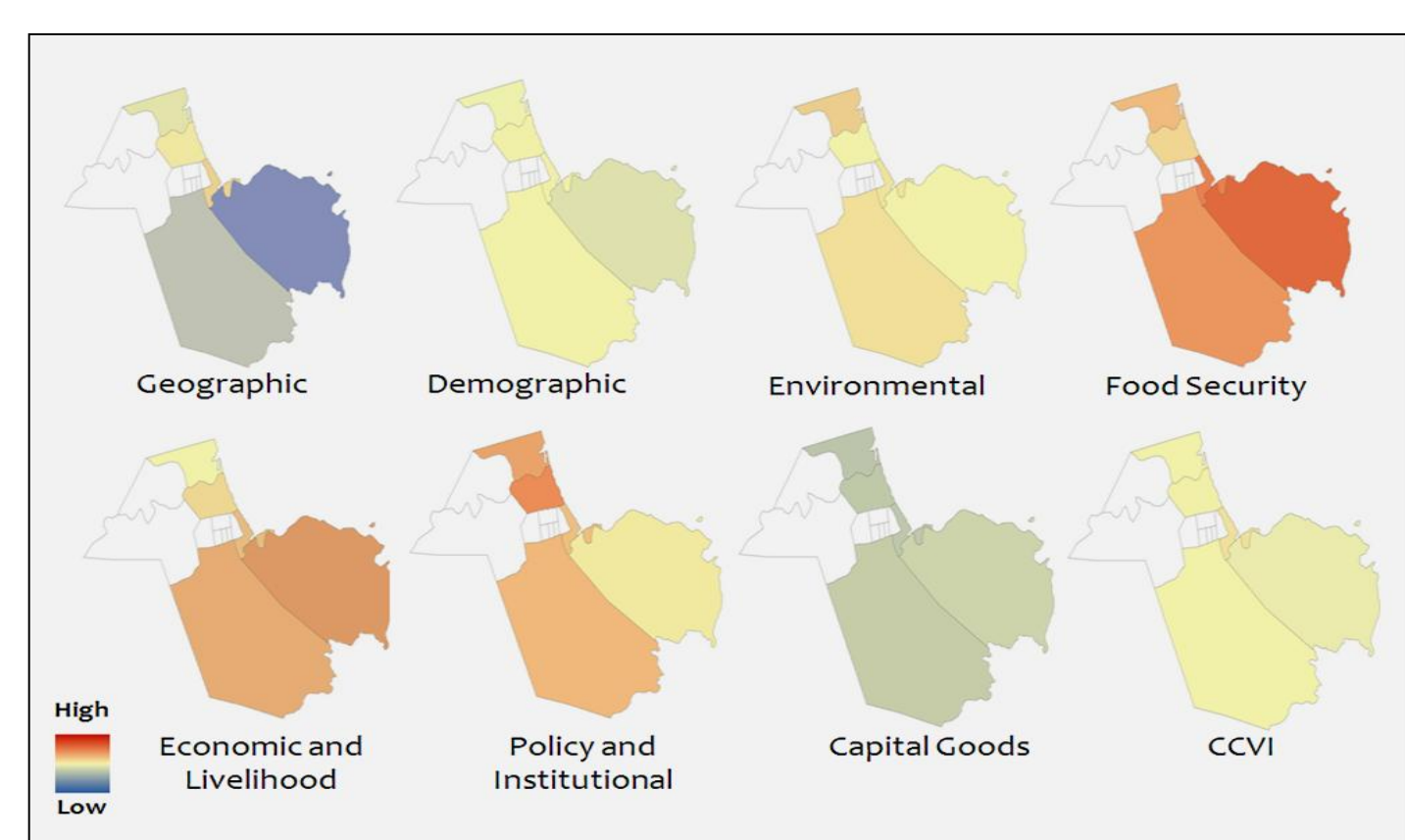

CCVI — The resulting CCVI showing Sabang (0.53) having the highest among coastal communities
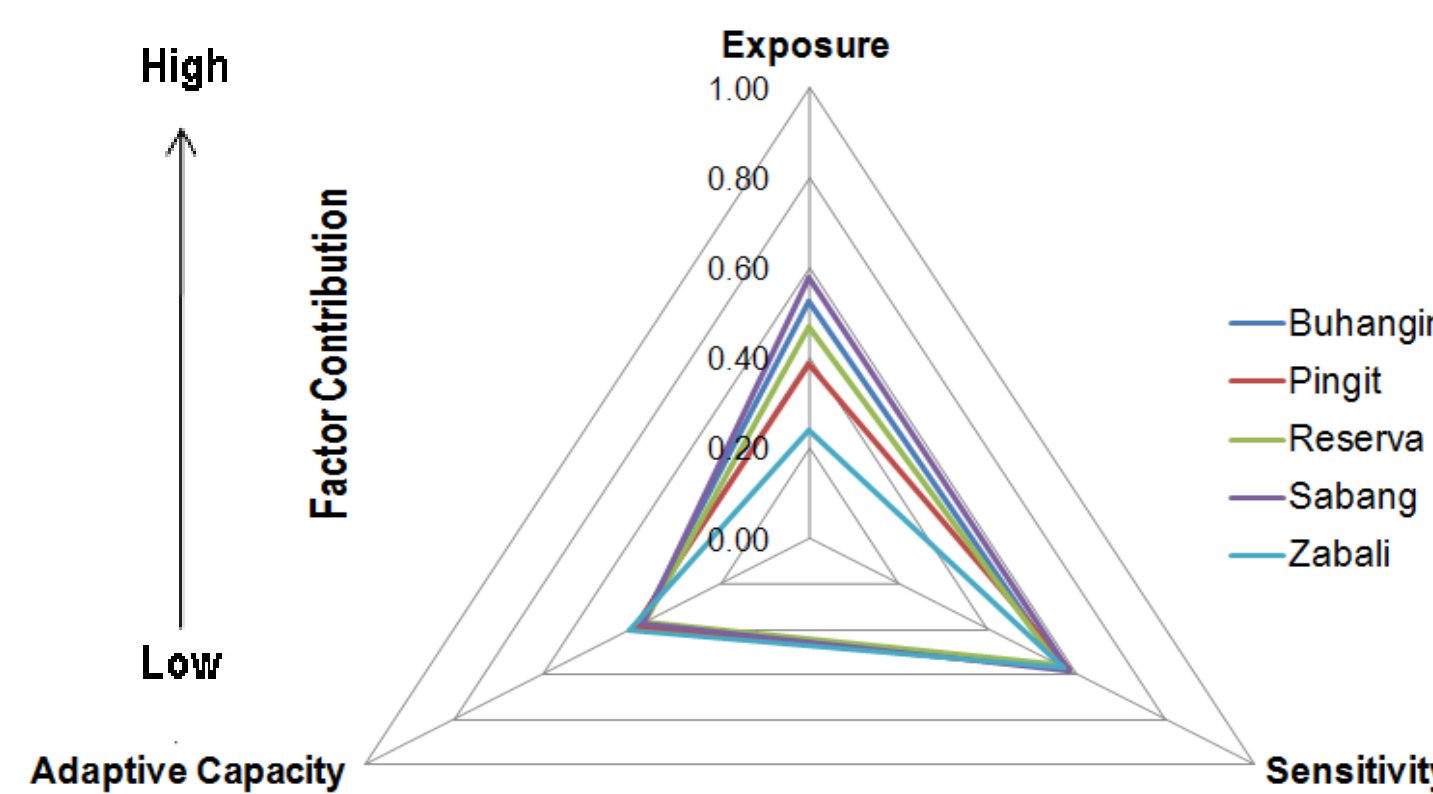
Variations in factor contribution to resulting IPCC-CCVI in five coastal communities
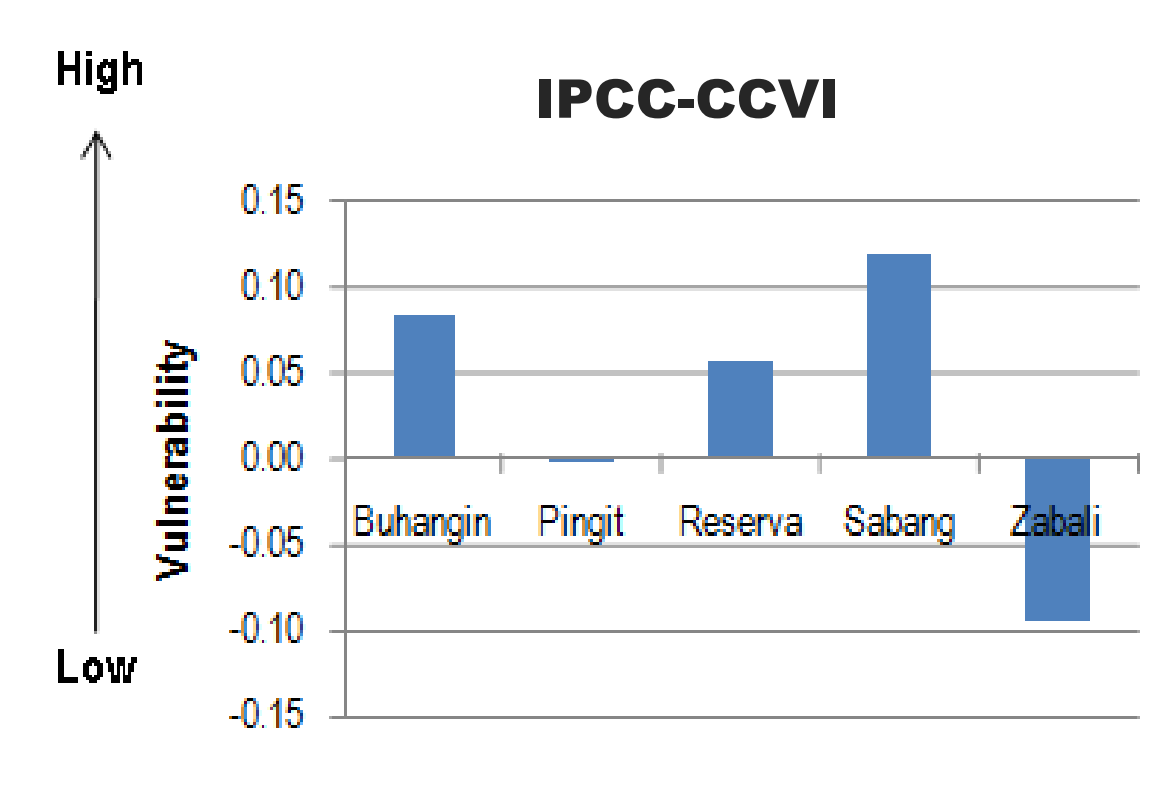
IPCC-CCVI — The resulting IPCC-CCVI showing Sabang (0.12) having the highest among coastal communities

Indices of factors, CCVI and IPCC-CCVI in spatial form

Conclusion:
- Sabang is the most vulnerable community based on the resulting CCVI and IPCC-CCVI
- The CCVI values do not show much difference since the high value factors were cancelled out by low value factors during the combination process
- The high contributing factors in CCVI include food security, economic, and policy and institutional factors
- The high contributing factors in IPCC-CCVI include exposure and sensitivity
- The method may be effective for rapid appraisal but its strength depends on the quality of data surveyed within a specific timeframe
- Future study must focus on development of methods:
  - for identifying suitable and objectively-set variables and indicators
  - for data gathering and analysis of relevant indicators, and with the use of statistical tools (i.e. factor analysis, PCA, regression analysis, etc.)