

Women's role in adaptation to climate change in Bangladesh

by Momtaj Bintay Khalil

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University of Technology Sydney
Faculty of Institute for Sustainable Futures

January 23, 2021

CERTIFICATE OF ORIGINAL AUTHORSHIP

I Momtaj Bintay Khalil declare that this thesis, is submitted in fulfilment of the requirements for the award of PhD, in the Institute for Sustainable Futures at the University of Technology Sydney.

I certify that this thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

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Momtaj Bintay Khalil

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Finally, I dedicate this thesis entirely to my children who I believe would face the world that we leave for them by acting on issues like climate change and sea level rise. I hope the knowledge created through this thesis is a small contribution to that mammoth task of creating a better world for future generations.

Dedication

To my children ***Aydin*** and ***Naeela***,
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List of publications during candidature

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1. Khalil, M. B., Jacobs, B. C. (2021). Understanding place-based adaptation of women in a post-cyclone context through place attachment. *Environmental Development*. 38: 100644. <https://authors.elsevier.com/c/1d6Pd7sr2rDINV>
2. Khalil, M. B., Jacobs, B. C., McKenna, K., & Kuruppu, N. (2020). Female contribution to grassroots innovation for climate change adaptation in Bangladesh. *Climate and Development*, 12(7), 664-676. DOI: 10.1080/17565529.2019.1676188
3. Khalil, M. B., Jacobs, B. C., & Kuruppu, N. (2016). Grassroots Technologies and Community Trust in Climate Change Adaptation: Learning from Coastal Settlements of Bangladesh. In: Leal Filho W. (eds), *Innovation in Climate Change Adaptation* (pp. 297-311). Springer International Publishing, London.

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Conference proceedings

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3. Khalil, M. B., Jacobs, B. C., McKenna, K., & Kuruppu, N. (2018). 'Female contribution to grassroots innovation for climate change adaptation in Bangladesh'. International Conference on Global Warming and Climate Change (GlobeWarm 2018). 4-5th October 2018. Bangkok, Thailand.
4. Khalil, M. B., Jacobs, B. C., Kuruppu, N. (2015). 'Grassroots technology and community trust in climate change adaptation: learning from coastal settlements of Bangladesh'. World Symposium on Climate Change Adaptation. (WSCCA, 2015). 5-6 September 2015. Manchester Metropolitan University, UK.
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Awards during candidature

1. 'Best student presentation award' and 'Sessions best presentation award'- earned from a conference presentation in International Conference on Global Warming and Climate Change (GlobeWarm 2018), Bangkok, Thailand
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Preface

My PhD has not been a comfortable journey. I have encountered many obstacles and challenges throughout the whole process. Coming from a different background, culture and language, are challenges not easily overcome. Each time I managed to handle a challenge, I realized how much I had learned.

First, in my research as I have worked with vulnerable people in the context of climate change, every time my encounters with the community members through the fieldwork or the data remind me that I came from a place called Khulna, which is a region of frequent sea-level rise. I have seen how every year we got into trouble with increasing water issues, even a bad patch of a week or so in the rainy season can disrupt our lives enough to feel the vulnerability we endure. My personal experience inspired me to take up challenging topics related to climate change as a thesis, including gender dimensions. In the coastal villages in Bangladesh, situations are much worse than my relatively privileged life; men and women are affected disproportionately over there by the effects of climate change, and they have learned and strengthened to deal with nature by birth. Their adaptive strategies are also different, especially women face challenges in various ways. My intimate encounters with climate marginalized people in Gabura, Bangladesh have given me the opportunity to reconsider the adaptation challenges faced by women in particular.

There were some other difficulties I encountered with the literature on local and indigenous knowledge, which shaped my research later significantly. I was introduced to the literature on indigenous local knowledge by my PhD supervisors, especially I

came to learn a lot about Indigenous communities in Bangladesh coastal context who survived by utilising their own traditional knowledge and technology. They recommended a lot of constructive literature about indigenous knowledge (e.g. Sillitoe, 1998; 2006; Warren and Cashman, 1988; Warren, 1991), which helped me understand the concepts. My interest in the concept of local knowledge has been further enhanced by my former co-supervisor Dr Natasha Kuruppu's research on the adaptation strategy of a small island community through the application of local knowledge. This concept of indigenous or local knowledge inspired me to think more about how the coastal communities of Bangladesh survive with their own local knowledge and grassroots technologies – I must acknowledge that these knowledges vary and differ across contexts. Later in the first phase of my PhD, one of my book chapters on 'grassroots technology based on local knowledge adaptation' was awarded the second position in an international conference in Manchester, London, which was a strong motivation to move forward.

I learned more by attending several seminars in Australia led by e.g., Dr Neil Adger and Dr Terry Cannon, working on Bangladeshi coastal context; and Dr Sandie Suchet-Pearson working on indigenous knowledge in the Australian context. This concept of local knowledge and social capital further shaped the adaptation of these climate vulnerable people after a disaster in the coastal context of Bangladesh. I also learned about these concepts from my different informal encounters with my countryman, Dr Rabiul Islam of Macquarie University, Australia. Together these different encounters and experiences strengthened me. Later my first journal paper from my PhD brought me the 'best paper award' and 'session best presenter award' in International

Conference on 'Global Warming and Climate Change' at Bangkok, it was really inspiring!

My field work started in January 2016 in the remote coastal areas of Bangladesh, which was challenging, because it was the hardest task for me as my three-month-old 'baby bump' was accompanying me in the fieldwork. This hardship was further exacerbated as during the fieldwork I also had to travel back and forth to Dhaka, for the conference presentation¹. Reaching the survey area of Gabura Union was not an easy task due to a lack of safe and reliable transport system. I had to take multiple modes of transportation, for example, I reached the remote coastal Union by boat, had bumpy motorbike rides to reach the different villages, and finally walked on the dirt road to reach my participants, while my 'inner angel' gave me the emotional endurance - all the experiences added extra value throughout the whole journey. I felt sorry for those rural women who I saw were pregnant and who face these kinds of challenges on an everyday basis – I could feel for them. At the same time, getting all the opportunities in life made me feel privileged. Eventually, after completing the data collection process, I arrived in Sydney when my baby bump was seven months old, yet all the memories, the feelings filled my heart with tears and joy and at the same time, I enjoyed the journey navigating all the challenges.

¹ Before reaching at the study area, I interviewed some academics and disaster experts, both in Khulna and Dhaka (including first week of February a conference attendance in Dhaka) who were involved working in a similar field in the coastal context of Bangladesh, that led me to think more deeply about the study context.

The adaptation experience from the climate-affected women, their contribution at the family level, living alone with minimal resources with children when the husband is absent, uncertainty of living in the coastal areas, even though having lost all livelihoods resources, living with their new hope is genuinely inspiring. Their generosity, positive attitude, warm receptions, as they patiently spent time with me and shared with me their horrific experiences of cyclone Aila, have inspired and enriched my research that explores the different ways they adapt after cyclones. These women inspired me to realize that they possess strong adaptive capacities, but their social-cultural norms simply at times hinder their adaptation, reduce their abilities. All the experiences from my fieldwork have shaped my research on gender dimensions based on climate change, these experiences fascinate me to think in more detail about the contributions of climate-vulnerable women that remain often unrecognized. Over the past decade, since cyclones Sidr, Aila, the latest most intense cyclones, Bulbul and Amphan, have devastated the lives and livelihoods in the coastal areas (especially women in my case). However, the adaptive experience of women to extreme climate events that I explored in my research could be an example for future cyclone adaptive solutions and its path.

Momtaz Bintay Khalil

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Table of Contents

CERTIFICATE OF ORIGINAL AUTHORSHIP	I
ACKNOWLEDGEMENT	II
DEDICATION	V
LIST OF PUBLICATIONS DURING CANDIDATURE.....	VI
PREFACE	VIII
TABLE OF CONTENTS.....	XIII
LIST OF FIGURES	XVII
LIST OF TABLES	XIX
ACRONYMS AND GLOSSARY OF TERMS.....	XX
GLOSSARY OF TERMS	XXIII
ABSTRACT	1
CHAPTER 01: INTRODUCTION.....	3
1.1 RESEARCH BACKGROUND: WOMEN’S ROLE IN CLIMATE CHANGE ADAPTATION	3
1.2 STUDY CONTEXT: GABURA	10
1.3 THEORETICAL DISCUSSION.....	15
1.3.1 <i>The importance of local knowledge</i>	15
1.3.2 <i>Roles of social capital</i>	16
1.3.3 <i>Place attachment, dependency and identity</i>	17
1.3.4 <i>Access to local resources and livelihood capitals</i>	18
1.4 RESEARCH GAP	19
1.5 RESEARCH QUESTIONS	22
1.5.1 <i>Research methodology</i>	24
1.6 STRUCTURE OF THE THESIS.....	25
CHAPTER 02: LITERATURE REVIEW	35
TOWARDS A THEORETICAL PERSPECTIVE	35
2.1 WOMEN’S ROLE IN ADAPTATION TO CLIMATE CHANGE.....	35
2.1.1 <i>Autonomous adaptation</i>	40

2.2	THE ROLES OF LOCAL KNOWLEDGE	42
2.2.1	<i>Innovation</i>	44
2.3	THE CONTRIBUTION OF SOCIAL CAPITAL.....	45
2.3.1	<i>Bonding social capital</i>	46
2.3.2	<i>Bridging social capital</i>	47
2.3.3	<i>Linking social capital</i>	48
2.4	PLACE ATTACHMENT, PLACE IDENTITY AND PLACE DEPENDENCY.....	51
2.5	LIVELIHOOD CAPITALS IN SUPPORT OF WOMEN’S PLACE-BASED ADAPTATION	54
2.6	CONCLUSION.....	56
CHAPTER 03: METHODOLOGY		57
3.1	STUDY AREA PROFILE	58
3.2	STUDY APPROACH	69
3.3	DEFINING THE STUDY AREA	71
3.4	POSITIONALITY AND LIMITATIONS.....	75
3.5	SAMPLING PROCEDURE AND PARTICIPANT SELECTION	78
3.5.1	<i>Data collection procedures</i>	80
3.5.2	<i>Household head questionnaire survey</i>	86
3.5.3	<i>Focus group discussion (FGD)</i>	88
3.5.4	<i>Semi-structured household interviews</i>	89
3.5.5	<i>Semi-structured interviews with NGOs officials</i>	93
3.5.6	<i>Key informant interviews (KII)</i>	94
3.5.7	<i>KII with academics and disaster practitioners</i>	96
3.5.8	<i>Participant observations</i>	96
3.6	TRANSCRIPTION	97
3.7	ANALYSIS AND CODING.....	98
3.8	DATA DOCUMENTATION.....	100
3.9	ETHICAL CONSIDERATIONS	101
CHAPTER 04: GRASSROOTS TECHNOLOGIES AND COMMUNITY TRUST IN CLIMATE CHANGE ADAPTATION: LEARNING FROM COASTAL SETTLEMENTS OF BANGLADESH.....		103
CHAPTER 05: FEMALE CONTRIBUTION TO GRASSROOTS INNOVATION FOR CLIMATE CHANGE ADAPTATION IN BANGLADESH.....		121

CHAPTER 06: LINKING SOCIAL CAPITAL AND GENDER RELATIONSHIP IN ADAPTATION TO A POST-CYCLONE CONTEXT	139
ABSTRACT.....	141
1 INTRODUCTION	142
2 SOCIAL CAPITAL RELATIONSHIP	146
2.1 <i>Bonding social capital</i>	149
2.2 <i>Bridging social capital</i>	149
2.3 <i>Linking social capital</i>	150
2.4 <i>Linking social capital and gender relationship gap</i>	151
3 METHODOLOGY AND STUDY AREA	154
4 RESULTS: SOCIAL CAPITAL TYPOLOGY AND GENDERED RELATIONSHIPS IN POST-CYCLONE CONTEXT	158
4.1 <i>Linking relationships</i>	161
4.2 <i>Bridging relationships</i>	166
4.3 <i>Bonding relationships</i>	168
5 DISCUSSION.....	174
6 CONCLUSIONS.....	179
7 REFERENCE.....	180
CHAPTER 07: UNDERSTANDING PLACE-BASED ADAPTATION OF WOMEN IN A POST-CYCLONE CONTEXT THROUGH PLACE ATTACHMENT	189
CHAPTER 08: GENERAL DISCUSSION	207
8.1 LOCAL KNOWLEDGE AND GRASSROOTS INNOVATION	209
8.2 EXPLORING FEMALE CONTRIBUTION TO GRASSROOTS INNOVATION	210
8.2.1 <i>Changed gender roles based on local knowledge and social capital</i>	212
8.2.2 <i>Roles of local knowledge and social capital</i>	213
8.3 EXAMINATION OF SOCIAL CAPITAL	215
8.3.1 <i>The roles of three forms of social capital (linking-bridging-bonding)</i>	216
8.4 UNDERSTANDING PLACE-BASED ADAPTATION THROUGH PLACE ATTACHMENT	219
8.4.1 <i>Intersection of place attachment, livelihood capitals and women’s adaptation</i>	220
8.5 REFLECTIONS ON THE FINDINGS	223
CHAPTER 09: CONCLUSION	227
<i>Methodologically</i> ,.....	227
<i>Empirically</i> ,.....	228

<i>Theoretically</i> ,.....	229
<i>In practice</i> ,.....	232
9.1 FINAL NOTES: SOME SPECIFICITIES, LIMITATIONS AND FUTURE RESEARCH	233
BIBLIOGRAPHY	239
APPENDICES	277
APPENDIX I: ETHICS APPROVAL LETTER	277
APPENDIX II: A LETTER OF CONSENT WAS APPROVED BY UTS, HREC.	278
APPENDIX III: A LETTER OF CONSENT (IN BENGALI) WAS APPROVED BY UP CHAIRMAN.....	279
APPENDIX IV: LETTER OF APPROVAL (IN BENGALI) BY THE UP CHAIRMAN	280
APPENDIX V: CONSENT LETTER FOR KEY INFORMANTS INTERVIEWS (KII)	281
APPENDIX VI: A CONSENT LETTER FOR FOCUS GROUP DISCUSSION (FGD) WITH THE PARTICIPANTS.....	282
APPENDIX VII: QUESTIONNAIRE SURVEY.....	283
APPENDIX VIII: FOCUS GROUP DISCUSSIONS AND KEY FEMALE PARTICIPANTS.....	293
APPENDIX IX: WATER RESOURCE MANAGEMENT BY WOMEN AND CHILDREN	294
APPENDIX X: WEEKLY LOCAL HAAT (MARKET) AT GABURA UNION	295
APPENDIX XI: GRASSROOTS TECHNOLOGY AND LOCAL RESPONSES	296
APPENDIX XII: FEMALE CONTRIBUTION TO AGRICULTURAL INNOVATION IN SALT-BASED SOIL	298
APPENDIX XIII: 'PLACE ATTACHMENT STRATEGIES OF CLIMATE MIGRANT COMMUNITIES IN URBAN INFORMAL SETTLEMENTS: LEARNING FROM KHULNA RUPSHA SLUM, BANGLADESH.'	299

List of Figures

CHAPTER 01

FIGURE 1.1: GABURA UNION, THE STUDY LOCATION IN SHYAMNAGAR UPAZILA OF KHULNA DIVISION. 12

Chapter 03

FIGURE 3.1: THE STUDY VILLAGES OF GABURA UNION 59

FIGURE 3.2: WATER PRESERVATION TECHNOLOGY AND OPEN AND RAISED PLATFORM LATRINES..... 62

FIGURE 3.3: THE SUNDARBANS, ADJACENT TO THE STUDY LOCATION OF GABURA UNION 65

FIGURE 3.4: CHANGING LIVELIHOOD PATTERNS AFTER AILA. 67

FIGURE 3.5: THE PHYSICAL INFRASTRUCTURE OF GABURA UNION AFTER AILA..... 68

FIGURE 3.6: GABURA JETTY TO GABURA UNION CROSSING THE RIVER AND LINKING STREETS. 72

FIGURE 3.7: WALKING AND TALKING INTERVIEW WITH PARTICIPANTS..... 84

CHAPTER 04

FIGURE 21.1: CONCEPTUAL FRAMEWORKS LINKING TO LOCAL KNOWLEDGE, LIVELIHOOD RESOURCES, COMMUNITY TRUST AND GRASSROOTS TECHNOLOGIES.....113

FIGURE 21.2: LOCATION OF GABURA ISLAND IN SHYAMNAGAR UPOZILA OF KHULNA DIVISION, WHICH IS THE SITE OF FIELD STUDIES IN BANGLADESH.....114

FIGURE 21.3: EXAMPLES OF GRASSROOTS TECHNOLOGIES OBSERVED IN GABURA. (A) TYING DOWN BOATS TO SECURE FROM STORM SURGE; (B) RAISED PLINTH HEIGHT OF THE HOUSES; (C) TETHERING TO SECURE HOUSE ROOFS; (D) PROTECTION OF MUD WALLS FROM RAINFALL; (E) PLUMBING MODIFIED TO ALLOW UPSTAIRS TOILET DURING FLOODING; AND, (F) TANKS FOR RAINWATER HARVESTING AS DRINKING PURPOSE.....115

Chapter 05

FIGURE 1: GABURA UNION, SHYAMNAGAR UPAZILA, KHULNA DIVISION, BANGLADESH.....127

FIGURE 2: EXAMPLES OF WOMEN'S CONTRIBUTION TO LABOUR AND INCOME GENERATION THROUGH MAKING HANDMADE PRODUCTS AND WORKING OUTSIDE HOME.....130

FIGURE 3: WOMEN'S CONTRIBUTION IN AGRICULTURAL INNOVATIONS THROUGH NGO SUPPORTS.....131

FIGURE 4: CONCEPTUAL FRAMEWORK FOR INFORMED AUTONOMOUS ADAPTATION MEDIATED THROUGH THE FEMALE HOUSEHOLD'S CONTRIBUTIONS AND NGOS INTERVENTIONS.....133

Chapter 06

FIGURE 1: THE THREE FORMS OF SOCIAL CAPITAL RELATIONSHIP (BONDING, BRIDGING AND LINKING).....	148
FIGURE 2: GABURA UNION, THE STUDY LOCATION IN SHYAMNAGAR UPAZILA, KHULNA DIVISION.	154
FIGURE 3: PARTICIPANTS (%) THAT RATED EACH OF THE THREE TYPES OF SOCIAL CAPITAL AS ‘STRONG’ BEFORE AND AFTER CYCLONE AILA.	159
FIGURE 4: THE CHI ² ANALYSIS OF THE OBSERVED AND EXPECTED DISTRIBUTION THAT RATED BY PARTICIPANTS (%) EACH OF THE THREE TYPES OF SOCIAL CAPITAL AS ‘STRONG’ BEFORE AND AFTER CYCLONE AILA.	160
FIGURE 5: SUMMARY OF HOW THE THREE FORMS OF SOCIAL CAPITAL OPERATE IN A POST-CYCLONE CONTEXT.....	177

Chapter 07

Figure 1: A conceptual framework of place attachment.....	194
Figure 2: Gabura Union, the study location is in Shyamnagar Upazila, Khulna Division, Bangladesh.....	197
Figure 3: The Sundarbans, adjacent to the study location of Gabura Union.....	198
FIGURE 4: THE ROLE OF PLACE ATTACHMENT FOR PLACE-BASED ADAPTATION IN POST-CYCLONE CONTEXT.....	203

Chapter 08

FIGURE 8.1: REFLECTION OF THE FINDINGS (WOMEN’S ROLE IN ADAPTATION TO CLIMATE CHANGE)	224
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List of Tables

CHAPTER 01

TABLE 1.1: STATEMENT OF AUTHORSHIP.....	26
TABLE 1.2: CONTRIBUTION OF EACH AUTHOR IN EACH PUBLICATION	27

CHAPTER 03

TABLE 3.1: GENERAL INFORMATION ABOUT THE VILLAGE	74
TABLE 3.2: SAMPLING PROCEDURES, METHODS AND PARTICIPANT SELECTION.....	80
TABLE 3.3: METHODS, DATA SOURCES AND DATA CONTRIBUTIONS IN CHAPTERS	85
TABLE 3.4: ATTRIBUTES OF STUDY, PARTICIPANT SELECTION FROM DIFFERENT HOUSEHOLDS AND PROCEDURES OF DATA COLLECTION.....	87
TABLE 3.5: FEMALE RESPONDENTS IN SEMI-STRUCTURED INTERVIEWS.....	91
TABLE 3.6: SEMI-STRUCTURED INTERVIEWS WITH NGO OFFICIALS.....	94
TABLE 3.7: KEY INFORMANT INTERVIEWS	95

CHAPTER 04

TABLE 4.1: STATEMENT OF AUTHORSHIP	104
TABLE 21.1 GRASSROOTS RESPONSES DURING THE POST-DISASTER SITUATION IN GABURA, BANGLADESH.....	116-117

CHAPTER 05

TABLE 5.1: STATEMENT OF AUTHORSHIP	123
TABLE 1: SAMPLING PROCEDURES AND RECRUITING OF RESEARCH PARTICIPANTS.....	128
TABLE 2: CHANGES IN WOMEN’S LIVES BEFORE, DURING AND AFTER AILA.....	132

CHAPTER 06

TABLE 6.1: STATEMENT OF AUTHORSHIP	140
TABLE 1: BONDING, BRIDGING AND LINKING SOCIAL CAPITAL AND THEIR RELATIONSHIPS.....	145
TABLE 2: SUMMARY OF SOCIAL CAPITAL RELATIONSHIP (BEFORE AND AFTER AILA)	172

CHAPTER 07

TABLE 7. 1: STATEMENT OF AUTHORSHIP	191
TABLE 1: TYPES OF LIVELIHOOD CAPITALS AND ROLES	196

Acronyms and Glossary of Terms

Action Aid	International NGOs work against poverty and injustice
AGB	Administrative Geography of Bangladesh
BBS	Bangladesh Bureau of Statistics
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BGB	Border Guard Bangladesh
BRAC	Bangladesh Rural Advancement Committee
BDT	Bangladesh taka
Caritas Bangladesh	An international NGO working on humanitarian assistance and disaster management
CCA	Climate Change Adaptation
CBA	Community Based Adaptation
CBO	Community Based Organization
CIM	Climate Induced Migration
CREL	Climate-Resilient Ecosystems and Livelihoods
CNRS	Center for Natural Resource Studies
COP	Conference of Parties
CSA	Climate Smart Agriculture
DFID	Department for International Development
DAM	Dhaka Ahsania Mission
DPHE	Department of Public Health Engineering
DRR	Disaster Risk Reduction
ECCP	Environment & Climate Change Program
FGDs	Focus Group Discussions

FDMC	Friendship Disaster Management Committee
GOB	Government of Bangladesh
HH	Household Head
IPCC	Intergovernmental Panel on Climate Change
ICCCAD	International Centre for Climate Change and Development
IFAD	International Fund for Agricultural Development
IIED	International Institute for Environment and Development
INGO	International Non-Governmental Organization
JCF	Jagroni Chakra Foundation
JJS	Jagrata Juba Shangha, a social environmental development organization
KII	Key Informant Interviews
KU	Khulna University
KUET	Khulna University of Engineering & Technology
LG	Local Government
LSP	Local Service Provider
LT	Local Trainer
MOEF	Ministry of Environment and Forest
MDG	Millennium Development Goals
NGOs	Non-Governmental Organizations
NGF	Nowabenki Gonomukhi Foundation
NRM	Natural Resource Management
Oxfam	An international NGO work on climate disaster management
PSF	Pond-Sand-Filter
PKSF	Palli Karma Sahayak Foundation

QDA	Qualitative Data Analysis
RU	Rajshahi University
RWHS	Rainwater Harvesting System
SSI	Semi Structured Interview
Susilon	A local NGO working for coastal resource management
UNFCCC	United Nations Framework Convention for Climate change
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Education, Scientific and Cultural Organizations
UNICEF	United Nations International Children’s Emergency Fund
UNISDR	United Nations International Strategy for Disaster Reduction
UNO	Upazila Nirbahi Officer
UP	Union Parishad
UPC	Union Parishad Chairman
URP	Urban and Regional Planning
USAID	US agency for International Development
USD	United States dollar
Uttoron	A local NGO, work with costal local community
WASH	Water, Sanitation and Hygiene
WaterAid	An International NGO, focused on water, sanitation and hygiene
WEF	World Economic Forum
Winrock International	A nonprofit organization that works with people
WHO	World Health Organization
WVB	World Vision Bangladesh

Glossary of terms

Bazar (Market) An important marketplace where people regularly gather to buy or sell local products in the context of village. Male community members in particular gather every day in the *bazar* to purchase, smoke, play cards or take tea.

CREL (Climate Resilient Ecosystem Livelihoods) An important project of USAID in the coastal context of Bangladesh. The project worked to improve the livelihood and environment with men and women of resource dependent families in the coastal areas.

CNRS (Centre for Natural Resource Studies) An NGO working for the conservation of ecosystems and the promotion of community-based adaptation through the management of natural resources for the coastal settlements of Bangladesh.

District (first tier of administrative unit) Formed by local Government in Bangladesh. Bangladesh has 64 districts.

Division (First-level administrative seat in Bangladesh). Bangladesh has 8 divisions in total. Khulna is one of the eight division and 3rd largest city.

Gram (Village) A village/ *gram* is administratively a clustered community or the smallest social unit. Each village is designated as a ward. A union consists of nine villages.

Haat (A weekly local open-air market) In the rural context, *haat* is an important gathering place that is held once or twice a week.

Immobility (Not moving) Climate induced immobility is framed as ‘non-evacuation behaviour’ applicable to women in the coastal context of Bangladesh.

Kacca road (Muddy road) In the context of the village, most of the connecting roads are unpaved/ muddy roads which create problems for people during the rainy season.

Kheya Ghat (*Jetty*) A platform from where the boat puller receives people for crossing river.

Latrine (Known as pit latrines) Latrine distributed by Local Govt. or NGOs to ensure safe sanitation for poor coastal households in Bangladesh, manufactured with three concrete rings and a slab.

Matbar (The village informal local leader, called Morol or Matbor). Matbor plays an important role to solve social problems in village context.

Nakshi Kantha (Handmade sewing traditional products) Produced by rural women. BRAC is helping to empower the rural women by involving them in this production.

Parishad (Council) Formed by local Govt. Union Parishad chairman within the Upazila is considered as the member of the parishad

Para (Neighbourhood) An important relational fabric in a community in a village context, especially in women-to-women neighbourhood relationships.

Post-Aila (After cyclone Aila in 2009 is the period of 'post-Aila') Refers to the aftermath of Category 1 Cyclone 'Aila' that hit the South-western Bangladesh in May 2009.

PSF (Pond-sand-filter) Widely used as for the filtration of pond water as for alternative safe water sources, such as for cooking purposes in coastal context. **Pucca road** (paved roads of cement or brick) In coastal village context paved roads are uncommon.

Salish (Traditional mechanism for village dispute settlement, less formal than the village court)

Samaj (society) Religious community which helps to structure local village societal organization.

Sari (Traditional long cloth) An everyday cloth for South Asian women in rural context, a cultural identity.

Soil salinity (Rising sea levels cause soil salinity) In coastal context of Bangladesh soil salinity has had a major impact on the agricultural sector and drinking water sources. Climate change poses a major soil salinization risk.

Salt-tolerant vegetables (Salinity resistant crops) Due to the high level of soil salinity in the coastal areas, it is unsuitable to produce normal traditional crops, that transform to grow salt tolerant crops, such as, eggplant, bottle gourd, chilli, squash.

Union Parishad/ Union council (Called as Union or rural council) Formed under the local Government, a smallest rural administrative unit. A union council consisting of a chairman and twelve members. Three member seats are reserved for women. There are 4554 unions in Bangladesh. Each Union has nine wards.

Union Members (An important role of a union in village context). Union Parishad consists of twelve members among them three seats are reserved for women.

Upazila (Sub-district) Second lowest tier of administrative unit of local Government in Bangladesh. Bangladesh has 492 *upazilas*. Upazilas are further divided into union *parishads* (UP).

Uthan (Courtyards). In rural context, the domestic outdoor space or a shared courtyard space in between the houses is called *uthan*, where the women spend important day-time activities and the domestic chores.

Ward (Electoral subdivision). Usually, a village is designated as a Ward. Each Union consists of nine wards.

Abstract

Women in Bangladesh are highly exposed to the effects of climate change. Bangladesh is a cyclone and flood prone area; where coastal women are deprived of access to resources (e.g. information, knowledge and education). Women's vulnerabilities are further exacerbated by socio-cultural and religious factors that lead to a lack of communication with outside actors. The contribution of women to climate change adaptation has been largely ignored across all levels of society, by members within the family, community, policymakers and beyond; thus, women's capacity for adaptation is heavily constrained.

This thesis reports a mixed method study in the coastal village of Gabura Union under Shyamnagar *upazila* of Satkhira district in Bangladesh; an area that is at risk of frequent severe cyclones. For example, Aila in 2009 and Sidr in 2007 have ongoing impacts on communities, such as soil salinity because of prolonged period of seawater inundation. This study explores women's adaptation to climate change through analysis of empirical data under several theoretical threads: the role of local knowledge, the contribution of types of social capital and the significance of place attachment in understanding of women's place-based adaptation.

The thesis firstly highlights the ways women develop livelihood capacities by engaging with aid agencies and developing innovative adaptation strategies based on their local knowledge and social relationships, in the absence of their male community members. Secondly, among the three most commonly identified forms of social capital (e.g. bonding, bridging and linking); bonding capitals are found to be loosened after a major

catastrophe due to male community members' out migration. Over time, developing linking social capital with NGOs helps strengthen bridging social capitals with other community women through development of novel livelihood responses. A third area of the thesis highlights the role of place and how women's attachment to place helped enhance their adaptation responses by making use of a range of livelihood capitals.

Overall, the findings support calls to reconsider the role of women in adaptation to climate change and provide recommendations for considering the intersection of gender and climate change adaptation. In this regard, the thesis establishes the importance of strengthening and broadening linking social capital to develop more gender inclusive adaptation responses (e.g. to ensure women and men can participate in climate change programs equally) to develop tailored adaptation action in a post-disaster context.

Keywords: Bangladesh, women, local knowledge, social capital, place attachment, place-based adaptation and climate change

Chapter 01: Introduction

1.1 Research background: women's role in climate change adaptation

“Aila almost stopped our life. It took away everything: house, household belongings and stopped my children’s education. My husband has lost his agricultural lands and he started fishing and collecting shrimp from the Sundarbans after Aila. Sundarbans is our only hope to be alive. But going to the Sundarbans daily isn’t easy as the tiger is threatening to lives. So, he started travel to the nearest city for income sources and left me and my three children here. The hardship is unimaginable here after Aila. But moving to city for the whole family is more difficult. Need money for renting a house and to buy foods. Here we have our land and NGOs help us rebuilt a new house. I get support from my neighbours, and we share our household belongings. So, it is better to remain in the village with my three children.”

[Alo, 43 years old female household]

The difficulties experienced by Alo and other women in supporting their families after natural disasters resonate with the struggles of many women in coastal villages in Bangladesh. These women belonged to farming families, who after major cyclones had their agriculture-dependent livelihoods disrupted as the families’ lands became inundated by sea water (Bernier et al., 2016; Paul, 2013). Having failed to secure

alternate options for livelihoods, often male family members left the villages for nearby urban centres to find employment (Mallick and Vogt, 2014). Migration of whole families is seen as high risk; therefore, mostly male family members take on the journey. But for the women household members who are left behind in the villages, an uncertain life awaits, as there is scarcity of and competition for the depleted and miniscule resources in the post-cyclone period (Ayeb-Karlsson et al., 2018). This is not an easy life; often these women are left with responsibilities to feed their extended family members and children; they are burdened with the responsibilities to care for the elderly and household chores (Denton, 2002; Rahman, 2013). This research focuses on the post-cyclone period to explore the role of women in adaptation to climate change in the context of coastal villages in Bangladesh.

Bangladesh² is highly vulnerable to changing climate (Agrawala et al., 2003) with a high population³ density (Bangladesh Population, 2020) facing a number of ongoing environmental hazards and climate change challenges every year (Huq & Rabbani, 2011). Islam and Rahman (2015) reported that approximately 35 million people from the coastal zone of Bangladesh are exposed to climate change impacts annually. Bangladesh is ranked the fifth highest disaster-risk country in the world due to its

² Bangladesh is located 20° to 26° north and 88° to 90° East. West, north and east is bordered by India, on the south-east by Myanmar, and on the south by the Bay of Bengal (Agrawala et al., 2003; adopted from Wikipedia). Most of the country is low-lying land comprising mainly the delta of the Ganges and Brahmaputra rivers. Floodplains occupy 80% of the country 's total land.

³ According to UN data and by Worldometer Report Bangladesh population (2020) is estimated 164 million, ranks eighth most populous country of the world.

exposure to sea level rise⁴ (Ahmed and Kelman, 2018; Garschagen et al., 2016). Its geographical settings and low-lying deltaic morphology⁵ expose large areas of the country to rising sea levels (Agrawala et al., 2003; Ahmed and Kelman, 2018; Karim & Mimura, 2008). Bangladesh is the third most vulnerable country to sea level rise projections, and it is reported that almost seven million people (i.e. nearly 20% of the total population) are living below sea level (Agrawala et al., 2003; Karim and Mimura, 2008), which predisposes the country to risk from extreme weather events such as cyclones.

Historically, extreme weather events associated with climate change, such as, cyclones, flooding and storm surges⁶ are the common climate disasters⁶ in coastal areas (Agrawala et al., 2003; Ahmed & Kelman, 2018; Garschagen et al., 2016; World Bank Group, 2017). The consequences are threatening the lives and livelihoods of coastal people, causing economic damage and leaving negative impacts on the country's ecosystems (such as the Sundarbans, the mangrove forest adjacent to the study area) and damaging multiple sectors of the economy, including agriculture and physical infrastructure (Mallick et al., 2017, Shameem et al., 2014; Alam & Collins,

⁴ On an average, sea level is rising by 10-12 cm per decade (Bhuiyan & Dutta, 2012), whereas, in the twentieth century globally sea level rose 11-15 cm (reported by Dangendorf et al., 2017 and Kulp & Strauss, 2019).

⁵ Lands formed as a result of sedimentation exposed to sea level rise (Agrawala et al., 2003; Huq et al., 1995). 32% of the country's total land area is coastline and about 23% of country's total land is flooded (Karim and Mimura, 2008).

⁶ Bangladesh has a long history associated with climate disasters (e.g. cyclone and flooding) which takes a big death toll every year. For example, the cyclone of 1876 seems to have been the deadliest on record, killing 200,000 people (Jakobsen et al., 2006 p304), cyclone Bhola in 1970 killed more than 300,000 people; cyclone Gorky in 1991 one of the world's major natural disaster and death toll exceeded 145,000 (Ikeda, 1995; Haque & Blair, 1992). Other large-scale floods occurred in 1961, 1963, 1965, 1987 and 1988, hit in Bangladesh coast and take away lives and impacts on livelihoods, the economy and infrastructure (Haque & Blair, 1992; Haque et al., 2012). Such events are projected to become more severe as a consequence of climate change (IPCC WG1, 2013)

2010). In particular, the south-western coastal parts of Bangladesh (e.g. including Khulna, Satkhira, Pirozpur, Borguna, Potuakhali etc.) are at high risk of cyclone damage and sea level rise projections almost every year (Bacmeister et al., 2018; Huq & Rabbani, 2011; Karim and Mimura, 2008).

In relation to the adjustment to sea level rise and to the expected climatic stimuli (e.g. cyclones and flooding), adaptation is an important strategy for the coastal settlements (Ayers, 2011; Pelling and High, 2005; Smit et al., 2000). It should be noted that while disaster risk reduction was not the focus of this thesis, it is a concept that is closely related to adaptation, resilience, and vulnerability (Janssen and Ostrom, 2006), particularly in understanding the impact of climate change on women (Jordan, 2019). The relationships among these concepts are extensively covered in the literature on disaster risk reduction (DRR). DRR is a systematic approach to identifying, assessing and reducing the risks of disaster (such as an extreme climate event) by reducing socio-economic vulnerabilities to disasters as well as dealing with the environmental and other hazards that trigger disasters. DRR may address and encompass vulnerability, adaptation and resilience; however, the latter concepts are broader in that they may be in response to a range of drivers other than natural hazards (Cannon and Muller-Mahn, 2010; Janssen and Ostrom, 2006; Smit and Wandel, 2006).

For the coastal settlements of Bangladesh adaptation is an important strategy as vulnerability is high (Ayers, 2011; Pelling and High, 2005; Smit et al., 2000). Adaptation is the adjustment of a system to cope with the consequences of climatic stimuli. The IPCC (2014) defined adaptation as, “the process of adjustment to actual or expected climate change and its effects”. This adjustment encompasses the changing climate,

ecology, environment, socio-economic system and so forth (Burton et al., 2005; Briggs, 2005; IPCC, 2007; Smit and Pilifosova, 2003). Adaptation and adaptive capacity are interrelated terms used to describe the adjustments made to cope with the changing climate and to reduce vulnerability (Adger, 2003; Pelling and High, 2005; Smit and Wandel, 2006). To reduce the impacts of climate change and to increase adaptive capacity, adaptation solutions need to be managed and implemented at local levels (such as, local agricultural production for farmers), as the impacts are mostly experienced by local people at the grassroots level (Adger et al., 2003; Ayers & Forsyth, 2009; Ayers, 2011; Cannon and Muller-Mahn, 2010; Huq & Reid, 2007). Women in coastal settlements are considered more vulnerable than men, as their experiences of climate-related extreme events and the adaptation challenges are very different from those of men (Cannon, 2002; Denton, 2002; Jordan, 2019).

In response to adaptation challenges in a coastal context, adaptation can be autonomous or planned (Fankhauser et al., 1999). Autonomous adaptation is a community-based adaptation process, important for the local coastal people to adapt (Adger, 2001; Huq and Reid, 2007). Autonomous adaptation refers to spontaneous, dynamic, natural, localized and short-term processes (Fankhauser et al., 1999; Smit et al., 2002). Adger et al. (2003) indicated that autonomous adaptation in developing countries is facilitated by social capital and access to the natural resources. In Bangladesh, for people living under extreme poverty, planned adaptation is often limited. For example, farmers in coastal areas apply their own local knowledge to autonomous adaptation for crop production (Younus, 2010, 2012); and often there is a lack of appropriate policy support and planning processes to boost production (Rahman and Hickey, 2019). Women's adaptation in a coastal context happens

autonomously mostly at household level, due to social and cultural barriers within Bangladesh society (Dasgupta et al., 2010; Khalil et al., 2020).

Women in coastal Bangladesh, are highly exposed to climate change impacts; in particular, to sea level rise (Cannon and Muller-Mahn, 2010; Cannon, 2002; Sultana, 2010) and they are one of the most marginalized groups to climate change impacts in general (Alston, 2014, 2015; Dankelman, 2008). Ninety percent of the victims of climate-related extreme events are women (Dankelman & Jansen, 2010). Research shows how the effects of climate change are disproportionately borne by women (Alston, 2015; Roehr, 2007). For example, coastal women suffer relatively higher exposure to food insecurity, health hazards, face poor sanitation and water resource management (Sultana, 2010; Sultana, 2014), scarcity of alternative livelihoods (Mallick et al., 2014), and are marginalized as labourers to a greater extent than men (Haider, 2014; Rahman, 2013; Tanny & Rahman, 2016). In addition, multiple forms of deprivation occur as women are routinely dominated by the patriarchal society in which their decision-making roles are limited (Alam & Rahman., 2017; Denton, 2002; Haider, 2014). Social and cultural barriers restrict women's skill development and limit their abilities to formulate adaptation pathways (Dasgupta et al., 2010; Jordan, 2019). As a result, women are facing more challenges in disaster preparedness with little scope to participate in any activities and limited access to resources (e.g. education, knowledge, information) compared to males in the household (Alam & Rahman, 2014; Rahman, 2013).

Moreover, women are excluded from receiving timely critical information on emergency management due to limited access to information (Ahsan et al., 2016;

Parvin et al., 2019) and fail to evacuate due to immobility (Ayeb-Karlsson, 2020). This unequal gender context disproportionately affects women, which in turn adds to their vulnerability to climate change (Cannon, 2002; Pearse, 2017). Denton (2002) argued that while climate change is a threat to life; gender inequality is also a threat that creates greater vulnerability for some sections of society than for others. In the search for better livelihoods every day, at least thousands of Bangladeshis move to cities seeking a safer life from extreme weather events (Islam and Hasan, 2016). In most cases, a significant portion of male migration to cities is linked to attempts to secure livelihoods and women are immobile and left destitute with their children (Ayeb-Karlsson et al., 2018; Kartiki, 2011). However, these extreme climate events can reportedly trigger positive change in gender roles and in adaptation action, as women take on more household workload (i.e. due to male out-migration); specifically, women may become active in skills development on climate change preparedness and mitigation measures (Jost et al., 2016).

My thesis explores this changing context of women's roles in adaptation (e.g. like Alo in Gabura, the story described above) and their contributions to grassroots innovations for climate change adaptation in the post-cyclone Aila context. There has been some recent research exploring the social capital relationships in the post-disaster context in coastal Bangladesh (Islam & Walkerden, 2015 and Islam & Walkerden, 2017). Also, it is recognised that power imbalances between male and female community members in coastal settings often lead to women's immobility and confinement to home (Ayeb-Karlsson, 2020a and Ayeb-Karlsson et al., 2020). However, there has been limited focus on the role of social capital and the influence of gender in understanding of climate change adaptation in Bangladesh. In considering that research gap, this thesis

examined how women adapt to changing climate by using their own local knowledge and place-based resources for adaptation, and how social capital relationships play an important role in helping women to engage in alternative livelihoods using place-based resources in a post-disaster context.

This chapter starts with a quote of a women from Gabura Union, who was severely affected by cyclone Aila. She shared her levels of hardship and survival experience in the post-cyclone context, and as described above, her account covers the research problem of the thesis. In the following sections, this chapter covers the research background and study context (section 1.2), outlines the theoretical discussions (section 1.3), describes the research gap and some specific aims that I tried to fill (section 1.4), elaborates the research questions (section 1.5), and finally concludes the chapter with a section outlining the thesis structure (i.e. an overview of each chapter in section 1.6).

1.2 Study context: Gabura

My study takes place at Gabura Union (see Figure 1.1) in the south-western coast of Bangladesh under Shyamnagar *Upazila* of Satkhira District in Khulna Division Bangladesh (See, Gabura Union, 2015; more details are explained in methodology, Chapter 03). Gabura Union is completely surrounded by water with two rivers located on northern and western boundaries isolating the union as an island. The southern part is close to the world's biggest mangrove forest, Sundarbans. The Union covers an area of 85.5 square km (33 square miles) and the total population is about 38,825

which consists of nine (09) Wards and 15 villages (See, Gabura Union, 2015). The fieldwork adopted a mixed method approach which covered seven villages (see Figure 3.1). Gabura faced two major climatic disaster events, Sidr⁷ in 2007 and Aila⁸ in 2009. Aila caused a severe disruption to the Gabura island lives and livelihoods and considerable loss of life, particularly among women and children (Roy et al., 2009; UNISEF, 2010).

⁷ Cyclone Sidr was a category 4 tropical cyclone, that struck the southwest coast of Bangladesh on November 15, 2007, with heavy rain and a wind speed of 260 m/h. Paul and Dutt (2010) reported that at least 3447 people were killed and 55,000 were physically injured. Most people did not respond to the initial warning system, causing severe damage to livelihoods and agriculture lands and increased the death toll (Paul, 2012; Paul, 2014).

⁸ Aila is a category 1 cyclone took shape and struck the southwest coastal region on May 25, 2009, with the wind speeds of 65-75 mph. The cyclone affected 14 districts, most of which were in Satkhira, approximately affected people were 3.9 million and 190 people died in total (See Gabura Union, 2015). Gabura is one of the most affected union in Shyamnagar *Upazila* by the cyclone. Livelihoods were completely destroyed, as the embankment was severely damaged, and some parts were overtopped, killed large numbers of livestock and left permanent waterlogging of settlements and left all the agricultural lands saline (Roy et al., 2009).

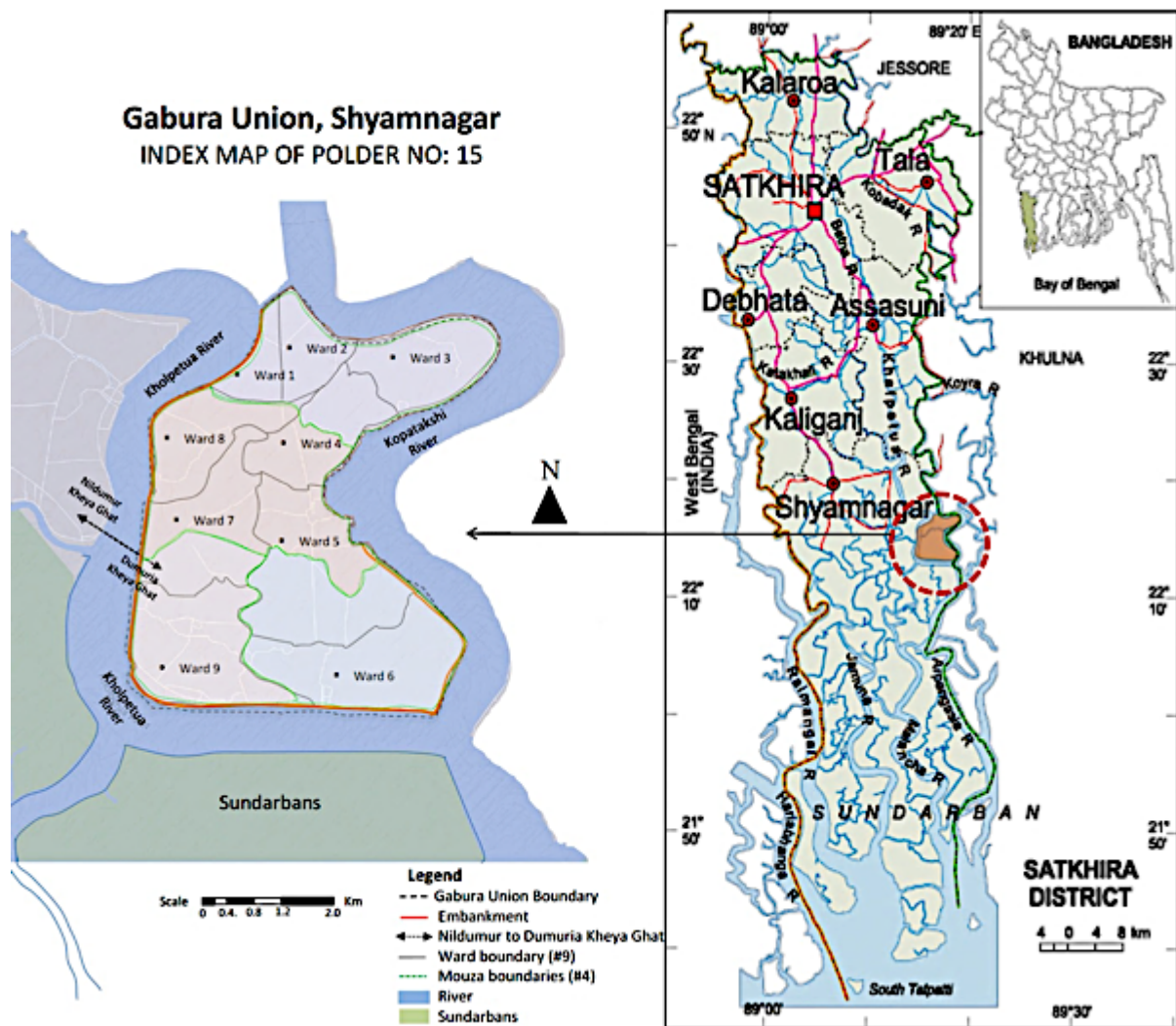


Figure 1.1: Gabura Union, the study location in Shyamnagar Upazila of Khulna Division.

Source: Redrawn by author, adopted from Banglapedia, 2014,

Aila completely disrupted Gabura island's ecology. It changed the livelihood structures and severely damaged croplands and mature fruit trees. It devastated local food production (Mallick et al., 2011; Zakaria et al., 2014). The local infrastructures (e.g. houses, roads, bridges etc.) were damaged; agriculture was destroyed and shrimp cultivation was flooded (Mallick et al., 2011; Roy et al., 2009). The damage to embankments in multiple locations worsened the existing situation by causing long-

term inundation and salinized the croplands (Alam et al., 2015). Cyclone Aila in Gabura not only devastated life, livelihoods and property (Kartiki, 2011) but also caused climate-induced displacement⁹ of the population (Mehedi et al., 2010). For example, most notably, the cyclone pushed the many wage-earning male community members from the villages to the city searching for better livelihood solutions and earning opportunities (Mallick & Vogt, 2014). Mallick and Vogt (2014) reported that 38% of male community members moved to nearby cities. A trend of previous studies suggests that while husbands migrated to cities and left women in the village, this situation forced an extra household workload on women's shoulders related to the search for livelihoods and collection of drinking water etc. (Rahman, 2013; Sultana, 2010). However, this migration situation creates more difficulties for a woman in the coastal region (Ayeb-Karlsson, 2020; Ayeb-Karlsson et al., 2018) due to her limited access to the outside world for assistance (Rahman, 2013). The consequences of these social changes in the context of post-cyclone Aila will be examined for the women of Gabura.

⁹ Climate induced displacement (CID) is a common pattern of migration in the context of climate change in Bangladesh (Mehedi et al., 2010). There are many causes of climate driven displacement (e.g. social, economic, political and other environmental factors) (Black et al., 2013; Mallick & Siddiqui, 2015). Alam & Miller (2019) and Mallick and Vogt (2014) mentioned population displacement can be divided in two groups: seasonal migration and environmental disruptions. People who migrate from one place to another (especially from villages to cities) are sometimes called climate refugees. They are relocated for economic change or improved living or are sometimes driven by climate change or environmental disasters (e.g. cyclone, floods).

In post-Aila¹⁰ Gabura, long term inundation of farmlands, the agricultural-based background of villagers, male community member's migration outside the villages and the interventions by aid organizations intersect requiring a rethink of women as active agents in adaptation rather than passive recipients of assistance. Women in coastal settlements are the primary actors in their domestic premises, and are able to secure basic needs from their surroundings (e.g. food, homestead fuel, fodder and wild fruit) (Denton, 2002; Rahman, 2013). Women play an important role in coping with climate extremes under severe resource limitations in post-cyclone context. A number of studies, for example, Beneria and Sen (1981); Boserup (2007), have rejected the view of women as passive victims, rather they emphasised women's active roles in agriculture to enhance local economic development. While extreme weather events may be key drivers of change (Pelling, 2010), coastal communities' capacity to adapt is mediated by their access to resources, such as natural and physical capital. How Aila stimulated Gabura women to adapt the management of their domestic situations through a range of novel strategies and their dependency on the natural resources of the Sundarbans is explored in this thesis.

In the following section, I will briefly discuss relevant theories used throughout my thesis based on women's role in adaptation to climate change, triangulating on four conceptual areas critical to the adaptation responses of Gabura women:

¹⁰ After cyclone Aila in May 2009 is the period of 'post-Aila'. In post-Aila period, women faced more challenges in social, technical problem and challenges in WASH sector (e.g., for safe water collection) (Alam and Rahman, 2019). In addition, in post-Aila, coastal people still use hanging-uncovered and pit latrines which regularly affect health issues (Alam and Rahman, 2019).

1. The importance of local knowledge for grassroots adaptation,
2. The role of and changes in social capital, particularly the relationships developed between Gabura women and NGOs,
3. Place attachment, dependency and identity (Scannell & Gifford, 2010), which become important in light of women's relative inability to migrate post-cyclone, and
4. Access to local resources, as livelihood capitals, that can be used, interchanged and transformed in support of adaptation responses.

1.3 Theoretical discussion

1.3.1 The importance of local knowledge

Local knowledge is a place-based resource defined as a community's knowledge transmitted orally over generations in a given locality; often considered synonymous with indigenous, traditional or cultural knowledge of a community (Agrawal, 1995a; Bicker et al., 2004; Ellen et al., 2000; Sillitoe, 2006). In coastal areas of Bangladesh, the ultra-poor¹¹ who are landless are highly dependent on place-based resources to cope with climate change (Amundson, 2015). Similar lessons are drawn by Alam et al. (2015) and Jabeen et al. (2010), who suggested that grassroots experiences and local knowledge can help to reduce vulnerability to extreme weather conditions. Islam et al. (2018) recently examined the coping and adaptation strategies of some coastal

¹¹ Extremely poor people live in extreme poverty they called ultra-poor people. A quarter of the total population in Bangladesh is highly vulnerable and live under extreme poverty (Ahmed et al., 2006). The frequent consequences of climate change and climate disasters are the cause of vulnerability.

villages of Bangladesh and indicated that coastal people's adaptive solutions are related to their local knowledge and assisted by social networks with the local NGOs. Some scholars, e.g., Misra, (2017, 2018) and Chowdhury et al. (2011), suggested women make a significant contribution to sustainable agriculture and farming practice in Bangladesh in a changing climate where NGOs see women as effective role players. In my case study, I will examine the dependency of local actors, i.e. women in coastal areas, on local knowledge to find innovative solutions for adaptation.

1.3.2 Roles of social capital

Social capital is broadly defined as social connections and networking relationships (Adger, 2003; Pelling & High, 2005). Social capital is associated with a range of terms, such as: 'trust', 'values', 'ties' 'trustworthiness', 'connections', or 'networks', and these relationships have been defined by multiple disciplinary backgrounds (Bourdieu, 1989; Coleman, 1988; Islam & Walkerden, 2014; Putnam, 1995; Woolcock, 2004). Three common forms of social capital relationships (bonding, bridging, and linking) are described (Woolcock 2001; Woolcock and Narayan 2000) in general, and by Islam and Walkerden (2014, 2015) in a developing world context. 'Bonding' social capital is a homogeneous relationship, a sense of belonging and relationships between immediate family and relatives. 'Bridging' social capital is a heterogeneous relationship and social contacts with non-intimate individuals, developed among community insiders and outsiders who are acquaintances (relatives, friends and neighbours). 'Linking' social capital describes the vertical relationships across social hierarchies that occur between a community of 'insiders' (e.g. family, relatives,

neighbourhood) and 'outsiders' (e.g. NGOs, aid agencies, government) (Woolcock, 2004; Woolcock & Narayan, 2000). It is important to understand how social capital operates among actors in a post-disaster context, especially in Bangladesh, and how social capital can support and strengthen the role of women in adaptation. This thesis will explore the changes in social capital following cyclone Aila to explain how NGOs influenced women to make connections to enhance women's adaptive capacity.

1.3.3 Place attachment, dependency and identity

Place-based adaptation is explored through the lens of place attachment theory (Amundsen, 2015), following the three dimensions of the place attachment concept - 'people, place and process' - described by Scannell and Gifford (2010). Place attachment is conceptualised in multiple ways according to various scholars, such as, 'place identity' (Lalli, 1992; Ujang, 2012), 'place making' (Lynch, 1980), and 'place dependence' (Dixon & Durrheim, 2000). The role of place attachment is important here in understanding place-based adaptation and its influence on women's adaptive capacity (Khan et al., 2018), because, unlike men, women are constrained by their socio-cultural context to remain in place, and therefore must rely on a limited range of local resources to support their livelihoods. The people and place dimensions shape the process dimension leading to the transformation of livelihood capitals into different forms of capital (e.g. Ellis, 2000; Lipton, 1980, 1984). Coastal people's livelihoods are linked to the Sundarbans mangrove ecosystem services as a source of livelihood resources (e.g. fish, shrimp, crab, honey, wood, fuel) (Kibria et al., 2019; Getzner and

Islam, 2013); where alternative livelihood opportunities are limited (Islam, 2006; Scoones, 1998).

1.3.4 Access to local resources and livelihood capitals

Livelihood capitals are the place-based resources available to individuals and communities. Five types of livelihood capitals (i.e. human, natural, physical, social and financial) (DFID, 1999; Ellis, 2000; Scoones, 1998) are important for the coastal communities in developing countries to ensure their basic needs. For example, natural capital refers to the stock of natural resources provided by nature; human capital refers to knowledge, education, skill and empowerment; social capital includes social connections, relationships and networks; physical capital refers to the stock of manufactured 'production' (e.g. houses, infrastructure), and financial capital refers to wealth and access to the economy (DFID, 1999; Scoones, 1998). The availability of these capitals and the ability to use, combine and convert them to support adaptation determines adaptive capacity (Ellis, 1999, 2000). For example, in coastal context of Bangladesh, 'Sundarbans ecosystems' are the source of local livelihoods and place-based natural capital (Shameem et al., 2014). Exploring how these local resources, in combination with specific types of social capital, are transformed (Adger et al., 2003) into novel forms of physical capital (e.g. agricultural technology) and how women use, combine and transform these assets in formulating adaptation responses, and ultimately improve economic wellbeing for coastal women, is a contribution of this thesis.

1.4 Research gap

A growing body of literature addresses the impacts of climate change in the context of Bangladesh (Agrawala et al., 2003; Ahmed and Kelman, 2018; Karim and Mimura, 2008). The vulnerability to cyclones and flooding and the recovery period after a disaster are identified as important (Adger et al., 2003; IPCC, 2007). However, existing studies have often failed to address long-term adaptation pathways to climate change, as most aid agencies¹² and NGOs are less involved in long-term disaster preparedness activities (i.e DRR). Rather some NGOs are involved in short-term assistance for immediate recovery or resolution, and in most cases are interested in making some improvements to the immediate post-disaster economic situation (Masud-All-Kamal & Hassan, 2018).

There is significant gender gap in recognising women in coastal Bangladesh in policy responses due to socio-cultural restrictions that constrain women to stay at home (Ayeb-Karlsson et al., 2020; Dankelman, 2008; Jordan, 2019; Rahman, 2013). Policy makers have paid limited attention to gender neutral perspectives in coastal areas (Denton, 2002; Dankelman, 2008), and also there is limited in-depth research in relation to gender and social capital (especially among women and NGOs). My thesis has examined the need for gender differentiated policies on climate adaptation, i.e. policies and practices that treat men and women separately rather than a uniform approach that in practice favours men. Communities might fail to recognize the unique

¹² There have been various aid agencies involved in gender and disaster risk reduction programmes. In most cases the foreign aid agencies (e.g., including UN agencies) are not directly connected to the local community but are involved with local NGOs (Khalil et al., 2020). My thesis focuses primarily on the role of NGOs who are involved directly with local people on a long-term basis.

contribution of women in adaptation challenges to climate change due to gender inequality and most importantly, the patriarchal mind-set that limits women's role and access to information and technology (Alston, 2014; Alam and Rahman, 2017; Rahman, 2013). Previous research identified rural coastal women as the passive recipients of aid; and to some extent, they are treated inequitably (e.g. deprivation of relief interventions, less access to livelihood capitals) (Alam and Rahman, 2014). Without strong linking ties with NGOs (Islam & Walkerden, 2015), women may be deprived of assistance.

There has been some research examining post-cyclone adaptation in the Bangladesh context. For example, Alam and Rahman (2014; 2019) examined women's preparedness, risk and loss, cultural and conditional behaviour, adaptability and recovery capacity from the natural disasters. In particular, Alam and Rahman (2019) examined the opportunities and challenges for sustainability in a WASH programme pursued in a post-disaster period, and the strategies adopted by government and NGOs. Alam and Rahman (2017) argued that although women are not often able to gain proper support from the external agencies, their recovery and coping attitudes are commendable. My thesis engages with these works and extends the existing knowledge by examining the roles of social capital in women's adaptation to a post-disaster context. In the rural context, women's engagement outside home is not seen in a favourable light due to cultural prejudice. My thesis tries to debunk this thinking. This current gap relating to adaptation in the long-term disaster recovery process needs to be addressed. Given the above-mentioned context, my thesis contributes to three research gaps summarised below, to enhance future adaptation responses.

1. The gender gap in long-term recovery in a post-disaster context

I aim to explore adaptation in a long-term recovery context after a major disaster. For example, the role of social capital and local knowledge sharing by the local community (i.e. bottom-up approach) with aid agencies is missing in most previous studies. The changing dimensions that favours women in working outside of home through the social relationships could provide the solution for the long-term recovery after a disaster.

2. The importance of gender in understanding the contribution of the three forms of social capital in disaster recovery.

My research will examine the relationships between community insiders and outside actors (especially among women and NGOs) through examining changes in the three forms of social capital (bonding, bridging, linking relationships) in post-cyclone context. In particular, my research aims to identify the role of women in these insider-outsider relationships in the post-disaster context. I aim to identify gender-specific climate change adaptation challenges, and how these influences linking social capital relationships in building other forms of social capital as long-term adaptation solutions.

3. The role of local knowledge and place-based livelihoods resources for women's adaptation.

Local knowledge and place-based livelihoods resources play an important role in adaptation (Ellen et al., 2000; Feldman and Welsh, 1995). My thesis aims to explore how local knowledge and a range of place-based resources are useful and mobilised through the intersection with gender in coastal areas. The use of a place attachment lens (place, people and processes) (Scannell & Gifford, 2010) could enlighten women-

place dynamics and help localised adaptation techniques in combination with linking social capital, another gap discussed above. While these coastal women are living with limited livelihoods resources, their local knowledge and local livelihood capitals (e.g. natural and human capitals) are valuable resources and effective pathways that could enhance adaptive capacity.

In the following section, I set out specific research questions aligning with the identified gaps.

1.5 Research questions

The objective of this thesis is to explore women's contribution to climate change adaptation. In search of the main objectives the following research questions are designed based on the key theme 'women's role in adaptation to climate change' in a Bangladesh context and some relevant key sub themes that arise from my fieldwork of this thesis. Research questions are structured based on the key theme and sub themes and to fill the research gaps.

The broad research question (BRQ) is framed as:

BRQ: 'What is the contribution of local knowledge and social capital to women's place-based adaptation in post-cyclone context of Bangladesh?'

The broad research question of this thesis addresses three key empirical threads and will be answered in three key findings chapters. The three findings chapters are written in the form of three journal papers.

The broad research question has been subdivided into multiple sub research questions (SRQ).

SRQ 1: *How does local knowledge contribute to the creation of grassroots technologies?*

Chapter 4 partially addressed SRQ 1. This published book chapter describes the theoretical roles of local knowledge and community trust and identifies grassroots technologies that are the outcomes of climate change adaptation. This book chapter is interlinked to the first findings chapter (i.e. Chapter 5).

SRQ 2: *How do women contribute to grassroots innovation through local knowledge dissemination and building network relationships with NGOs?*

Chapter 5 covers SRQ 2. Chapter 5 describes the roles of local knowledge and social capital in a post-cyclone context to explore female contributions to climate change adaptation.

SRQ 3: *What is the role of linking social capital in helping to reconstruct other forms of social capital to support women's adaptation in post-cyclone context?*

Chapter 6 addressed SRQ 3. Chapter 6 describes the three forms of social capital (bonding, bridging, and linking) and their dynamics that contribute to women's adaptation responses in post-cyclone context.

SRQ 4: *How does place attachment contribute to women's use of livelihood capitals for adaptation in post-cyclone context?*

Chapter 7 addressed SRQ 4. Chapter 7 describes the theory of place attachment and the roles of local livelihood capitals that influence women's place-based adaptation in post-cyclone context.

1.5.1 Research methodology

In this thesis, I adopted a mixed method approach comprising both qualitative and quantitative methods (Creswell and Clark, 2007; Johnson et al., 2007) following a snowball sampling procedure at Gabura Union under Shyamnagar Upazila in Satkhira district at 2016. The majority of the data were collected through applying qualitative methods, following a face-to-face household interviews, structured, semi-structured and key informant interviews and some focus group discussions. Ultimately, this method allowed for a thorough understanding of the participant's experiences and views (Creswell, 1999, 2002; Dunn, 2005). The key informant interviews from the fieldwork involved local experts including the members of local government, community-based organizations (CBOs), some local and international NGOs, academics, disaster experts and practitioners from different fields. All the participants were selected purposively.

The second part of data collection consisted of a household questionnaire survey (Creswell & Clark, 2007; Long & Nelson, 2013). On an average, 60% of survey respondents were female households in this survey. Most of the questions related to the relevant themes (i.e. strength of social capital relationships among household male-female members and NGOs).

Another important part of data collection involved gathering the emerging stories from participating women in their own words through walking and talking interview methods (Clark & Emmel, 2010; Kinney, 2017) and close observation, that helped me to refine the research questions, selection of literature reviews and finally to articulate the findings chapters. Together the qualitative and quantitative methods and the components were complementary to construct a detailed understanding of the study context.

1.6 Structure of the thesis

This thesis is structured as a hybrid model (see, UTS: Graduate Research Candidature Management, Thesis Preparation and Submission Procedures, 2019). This process adopts a thesis by compilation which is structured in a combination of chapters with some publications/ publishable works (i.e. papers). The structure includes the following chapters (e.g. an introduction, a brief literature review chapter, a chapter to justify methods and research questions, some chapters based on publications/ publishable works (i.e. published and under review) that present results, a discussion chapter and a conclusion chapter.

Table 1.1 shows the statement of authorship of the publication/ publishable works (e.g. title of publication, authorship, publication outlet, and publication status) and Table 1.2 shows the contribution of the publications' co-authors.

Table 1.1: Statement of Authorship

Chapter name	Title of paper	Authorship	Publication outlet	Publication status
Chapter 4: Book chapter 1	<i>Grassroots technologies and community trust in climate change adaptation: learning from coastal settlements of Bangladesh</i>	Momtaj Bintay Khalil, Brent C Jacobs, Natasha Kuruppu	Khalil, M. B., Jacobs, B. C., & Kuruppu, N. (2016). Grassroots Technologies and Community Trust in Climate Change Adaptation: Learning from Coastal Settlements of Bangladesh. In: Leal Filho W. (eds), <i>Innovation in Climate Change Adaptation</i> (pp. 297-311). Springer International Publishing, London.	Published
Chapter 5: Paper 1	<i>Female contribution to grassroots innovation for climate change adaptation in Bangladesh</i>	Momtaj Bintay Khalil, Brent C Jacobs, Kylie McKenna, Natasha Kuruppu	Khalil, M. B., Jacobs, B. C., McKenna, K., & Kuruppu, N. (2020). Female contribution to grassroots innovation for climate change adaptation in Bangladesh. <i>Climate and Development</i> , 12(7), 664-676. DOI:10.1080/17565529.2019.1676188	Published
Chapter 6: Paper 2	<i>Linking social capital and gender relationship in adaptation to a post-cyclone context</i>	Momtaj Bintay Khalil, Brent C Jacobs, Kylie McKenna	Submitted to <i>'International Journal of Disaster Risk Reduction'</i>	Under revision
Chapter 7: Paper 3	<i>Understanding place-based adaptation of women in a post-cyclone context through place attachment</i>	Momtaj Bintay Khalil, Brent C Jacobs	Khalil, M. B., Jacobs, B. (2021). Understanding place-based adaptation of women in a post-cyclone context through place attachment. <i>Environmental Development</i> . 38:100644. https://authors.elsevier.com/c/1d6Pd7sr2rDINV	Published

Table 1.2 shows the contribution of the co-authors in each publication (e.g., data collection, data analysis, conceptual development, writing, literature review, supervision and manuscript edits).

Table 1.2: Contribution of each author in each publication

Book chapter 1 (Chapter 4)	Data collection	Data analysis	Conceptual development	Writing and literature review	Supervision	Manuscript edits
<i>Grassroots technologies and community trust in climate change adaptation: learning from coastal settlements of Bangladesh</i>	100% Khalil	85% Khalil Assistance in data analysis: 10% Jacobs 5% Kuruppu	85% Khalil Assistance in conceptual development: 10% Jacobs 5% Kuruppu	80% Khalil Assistance in writing: 15% Jacobs 5% Kuruppu	70% Jacobs 30% Kuruppu	100% Jacobs
Author's signature						
<p>Production Note: Signature removed prior to publication. Momtaj Bintay Khalil (Corresponding author)</p> <p>Production Note: Signature removed prior to publication. Brent C Jacobs</p> <p>Production Note: Signature removed prior to publication. Natasha Kuruppu</p>						

(Continued)

Table 1.2 (Continued)

Paper 1 (Chapter 5)	Data collection	Data analysis	Conceptual development	Writing and literature review	Supervi- sion	Manuscript edits
<i>Female contribution to grassroots innovation for climate change adaptation in Bangladesh</i>	100% Khalil	85% Khalil Assistance in data analysis: 10% Jacobs 5% Kuruppu	85% Khalil Assistance in conceptual development: 10% Jacobs 5% Kuruppu	80% Khalil Assistance in writing: 15% Jacobs 5% Kuruppu	70% Jacobs 30% McKenna	80% Jacobs 20% McKenna
Author's signature						
<p>Production Note: Signature removed prior to publication. Momtaj Bintay Khalil (Corresponding author)</p> <p>Production Note: Signature removed prior to publication. Brent C Jacobs</p> <p>Production Note: Signature removed prior to publication. Kylie McKenna</p> <p>Production Note: Signature removed prior to publication. Natasha Kuruppu</p>						

(Continued)

Table 1.2 (Continued)

Paper 2 (Chapter 6)	Data collection	Data analysis	Conceptual development	Writing and literature review	Supervision	Manuscript edits
<i>Linking social capital and gender relationship in adaptation to a post-cyclone context</i>	100% Khalil	90 % Khalil Assistance in data analysis: 10% Jacobs	90% Khalil Assistance in conceptual development: 10% Jacobs	85% Khalil Assistance in writing: 15% Jacobs	80% Jacobs 20% McKenna	90% Jacobs 10% McKenna
Author's signature						
<p>Production Note: Signature removed prior to publication. Momtaj Bintay Khalil (Corresponding author)</p> <p>Production Note: Signature removed prior to publication. Brent C Jacobs</p> <p>Production Note: Signature removed prior to publication. Kylie McKenna</p>						

Paper 3 (Chapter 7)	Data collection	Data analysis	Conceptual development	Writing and literature review	Supervision	Manuscript edits
<i>Understanding place-based adaptation of women in a post-cyclone context through place attachment</i>	100% Khalil	90% Khalil Assistance in data analysis: 10% Jacobs	90% Khalil Assistance in conceptual development: 10% Jacobs	85% Khalil Assistance in writing: 15% Jacobs	100% Jacobs	100% Jacobs
Author's signature						
<p>Production Note: Signature removed prior to publication. Momtaj Bintay Khalil (Corresponding author)</p> <p>Production Note: Signature removed prior to publication. Brent C Jacobs</p>						

The thesis is organized over nine chapters to shape the research design: described below.

Chapter 1 introduces the research on ‘women’s role in adaptation to climate change’ in Bangladesh climate change context. In this chapter, I described the basic information of my thesis that is outlined in section 1.1 covered study context and problem; section 1.2 covered the research background; 1.3 covered a brief theoretical discussion; the research gap is described in section 1.4; the research questions are briefly outlined in section 1.5. The research questions are structured based on the research methods, research findings and data collections from field work and refined based on literature reviews. Finally, a sub-section describes the structure of my thesis as outlined in section 1.6.

Chapter 2 is a literature review. Relevant literature is reviewed in each findings chapter; whereas chapter 2 provides a brief review that involves the main key theme on ‘women’s role in adaptation to climate change’ and which is outlined in four sub themes: 1. the importance of local knowledge, 2. the contribution of social capital, 3. place attachment, dependency and identity and 4. access to local livelihood capitals in support of women’s place-based adaptation to climate change.

Chapter 3 provides the methodological discussion of the thesis. This thesis adopted a mixed method approach (i.e. both qualitative and quantitative approach). The methodology chapter has been divided into three sections. In the first section I introduced the study area profile, author’s positionality and the limitations of the thesis. In the second section, a description of the study approach covers participant selection and their formal position in the community (where appropriate). Four data collection

methods are described: household questionnaire survey, focus group discussion, in-depth structured, semi-structured and face-to-face walking-talking interview methods and key informant's interviews. In the third section, data analysis is described following the components of the coding analysis, transcription and the ethical considerations of the thesis.

Chapter 4 presents a published book chapter (Khalil et al., 2016). This chapter described the roles of local knowledge, social capital and livelihood resources as important elements for the poor coastal community's development of grassroots technology for climate change adaptation. A pilot survey was used for this study based on a preliminary field observation in early 2015. This chapter is linked to the first findings chapter (i.e. Chapter 5) and addresses a sub-research question (SRQ 1, section 1.5). This chapter identifies grassroots technologies as the outcomes of the Gabura coastal community's contribution to adaptation through using their local knowledge and building trust relationships with NGOs. The chapter concludes by presenting a conceptual framework that informs autonomous adaptation as an important decision-making process for grassroots innovation for the poor coastal community's adaptation strategies in a post-cyclone context. The findings of this chapter are further elaborated in the following chapter (see Chapter 5), which led me to think deeply on women's roles in grassroots innovation

Chapter 5 presents the first findings chapter from the main field study, which was published in the journal '*Climate and Development*' (see Khalil et al., 2020). It covers partly the broad research question and a sub-research question (i.e. BRQ and SRQ 2 in section 1.5) based on the stories of Gabura women in the context of post-cyclone

Aila using qualitative methods. The chapter demonstrates how the roles of local knowledge and social capital contribute to women's grassroots innovation for climate change adaptation. The chapter described the relevant literature on local knowledge, social capital and gender in relation to climate change. This chapter provides empirical evidence and insight to encourage greater consideration of female contribution to climate change adaptation at a household level and the support provided by social capital. The absence of male household members through migration to cities for employment, created opportunities for Gabura women to develop new adaptation strategies (e.g., saline tolerant agricultural practices) supported by NGOs and aid agencies. The chapter concludes with a conceptual framework that informs place-based autonomous adaptation through female contribution to climate change.

Chapter 6 presents the second findings chapter. The chapter is submitted to a journal and is currently undergoing revision by authors. The chapter briefly reviews the theory behind three forms of social capital (i.e. bonding-bridging-linking) conceptualized by Woolcock (2001) and Putnam (2000), in understanding of women's role in post-cyclone adaptation. This chapter addresses partly the broad research question and a sub-research question (SRQ 3, in section 1.5) following a mixed method approach to understand the differences between women and men in the types and strength of social capital relationships before and after the cyclone. This chapter explores how linking relationships with NGOs contributed to strengthen bonding and bridging relationships among community women, which helps women to survive in a post-cyclone context through empowerment, in light of the absence through migration of their husbands.

Chapter 7 presents the third findings chapter, which is published in the journal '*Environmental Development*' (see Khalil and Jacobs, 2021). This chapter addressed the final sub-research question (SRQ 4, in section 1.5) based on qualitative data gathering; women's own place-based stories in the post-cyclone context are described here. This chapter explores women's place-based adaptation through the lens of place attachment theory. Place attachment is relevant because, unlike men, Gabura women are constrained by their socio-cultural context to remain in place following cyclone Aila, while males migrated to cities for income opportunities. Therefore, women must rely on a limited range of local resources to survive. So, the roles of place attachment and local livelihood capitals contribute to the construction of novel livelihoods that influence women's place-based adaptation in post-cyclone context. This chapter concludes by developing a conceptual framework on people-place-process following the 'place attachment' theory conceptualized by Scannell and Gifford (2010).

Chapter 8 summarizes and discusses the overall findings of the three results chapters of my thesis. The aim of this chapter is to look back on the discussion of the results sections that have been provided through the description of the emerging stories collected from the field work. The chapter has integrated the discussion of the three findings chapters. Overall, the whole discussion synthesizes the findings as a coherent story of post-disaster life for Gabura women.

Chapter 9 concludes the thesis. Here I summarize the key findings of the thesis and its contribution to knowledge by reflecting on women's role in climate change adaptation. The chapter presents a synthesis of the conclusions with some research recommendations to support some further empirical research on the gender gap in

understanding of long-term post-disaster recovery and in recognizing gender-differences in the use of social capital in climate change adaptation. Overall, the chapter concludes that rethinking of women's contribution to climate change adaptation in future trajectories is required to understand their problems, the limitations of the current study and to support future policy formulation in understanding the adaptation challenges to climate change in Bangladesh.

Chapter 02: Literature review

Towards a theoretical perspective

This chapter presents an overview of the theoretical perspectives of the main themes of my thesis. A multi-theoretical approach (e.g. Metcalfe and Woodhams, 2012; Quinlan et al., 2016) was used in my research that provides in-depth insights on gendered dimensions of climate change adaptation as they relate to and are shaped by four conceptual areas: 1. the roles of local knowledge, 2. contribution of types of social capital, 3. the significance of place attachment, and 4. utilisation of livelihood capitals in understanding of women's contribution to climate change adaptation. Given the nature of this PhD thesis as a hybrid model, the historical development of theory and elements of the literatures are mainly documented in the finding chapters (i.e. Chapters 4, 5, 6 and 7) as papers to operationalise the analysis and interpretation of the data.

Here I provide an overview of literature of the relevant theories following a multi-theoretical approach.

2.1 Women's role in adaptation to climate change

Much of the research on women's role in climate change adaptation falls under the theme of gender issues. Women face unexpected challenges in various climate change contexts of their daily lives (Alston 2014; Ayeb-Karlsson et al., 2020; Bui et al., 2018; Cannon, 2002; Dankelman, 2008; Enarson, 2012, Jordan, 2019). In the context

of climate-related events, women in general face relatively greater consequences than men and historically have been marginalized in discussion of issues such as food security, water resources management, health risks, poor sanitation and waterborne diseases (Cannon, 2002; Cutter, 2017; Tanny and Rahman, 2016; WHO, 2009; WHO, 2014; UNICEF, 2010). It is well documented that in developing countries, rural women participate less in external activities, and this hinders access to resources, information, financial capital, and community-based adaptation strategies. (Alam and Rahman, 2017; Cramer et al., 2016; Rahman, 2013). Women's development is generally heavily constrained due to socio-cultural inequalities (Ayeb-Karlsson et al., 2019; Dankelman, 2008; Jordan, 2019; Nielsen and Reenberg, 2010); even socio-cultural-religious¹³ restrictions are sometimes barriers to entrepreneurship for women (Akhter and Sumi, 2014).

Climate change affects men and women individually and the challenges faced by each gender vary with their families, social networks and environmental surroundings (Alston, 2014; Arora-Jonsson, 2011; Cannon, 2002). Women in the developing context are rarely able to apply their resolutions to decision-making roles in adaptive actions during climate disasters, largely driven by male dominance of these pursuits (Boserup, 2007; Denton, 2002; Roehr, 2007). These unequal power relations keep women out

¹³ The predominance of Islam as the major religion means that it plays a significant role in shaping socio-cultural values in Bangladesh, especially for women (Miller, 1995). This may well be because almost all Bangladeshis are Muslim (though perhaps with varying degrees of strictness), in which case religion and culture are almost inseparable (Miller, 1995). Even if that is the case, religion deserves some mention. Sometimes the strictness of socio-cultural factors impacts women's access to outsources (Akhter and Sumi, 2014).

of the public sphere and consequently slow down adaptation (Sultana, 2014; McKinney and Fulkerson, 2015).

Women in coastal Bangladesh are highly exposed to the effects of climate change (Alam and Rahman, 2017; Ayeb-Karlsson et al., 2019; Cannon, 2002; Jordan, 2019). Women are relatively vulnerable, especially to sea level rise (e.g. floods and cyclones) and at greater risk than their male members of the family (Cannon, 2002; Rahman, 2013; Sultana, 2010). For example, coastal women are considered vulnerable in food security (Mittal and Sethi, 2009; Parvin and Ahsan, 2013), water resource management (Sultana, 2010) face additional health risks (Tanny and Rahman, 2016); often work under poor conditions as day-labourers for survival (Alam and Rahman, 2014) and fail to evacuate during disasters due to immobility (Ayeb-Karlsson, 2020). Women's vulnerability is further exacerbated by their predominantly impoverished, poor and marginalized local social settings, cultural, and religious factors (Alam & Collins, 2010; Dankelman, 2008; Jordan, 2019; Rahman, 2013; Sams, 2019). As a result, women's contribution to vulnerability reduction through adaptation goes unrecognized and the opportunities for coastal women to work outside the home are limited, leading women to be less visible in adaptation actions and having limited access to resources, such as knowledge, information and education (Alam and Rahman, 2017; Arora-Jonsson, 2011; Rahman, 2013).

In the context of climate change in Bangladesh, preparedness and mitigation measures for extreme weather events are predominantly a male role. Women are less likely to receive critical information during the emergency management cycle (Ahsan et al., 2016; Parvin and Ahsan, 2013). For example, only a third of women in coastal

settlements routinely receive the evacuation orders in response to imminent tropical cyclones (Parvin et al., 2019). In most cases women are not permitted to evacuate due to male power and social domination (Ayeb-Karlsson, 2020). Communities (especially male household members) may fail to recognize the unique contribution of women to climate change adaptation due to gender inequality (Jost et al., 2016; Sams, 2019). Moreover, policymakers pay less attention to the application of gender-neutral approaches to policy in coastal areas (Alam and Rahman, 2014; Nasreen, 2004; Nasreen, 2012; Rahman, 2013). For example, women are not involved in mainstreaming adaptation in planning (Ayers et al., 2014). Gender should be taken more seriously to understand the impacts of climate change and target adaptive capacity deficits is frequently advised (Nelson et al., 2002).

The World Bank (2000) reported that women's empowerment is essential for economic development through policy action to reduce vulnerabilities. Despite the challenges to climate change that women face, some scholars have emphasized that extreme climatic events can bring about positive changes in some women's roles and relationships. Patt et al. (2009) suggest that women have sufficient decision-making capacity to participate in adaptation planning. For example, extreme events have encouraged women to become more active in skills development through networking with NGOs (Boserup, 2007; Moreno and Shaw, 2018; Viswanath, 2019). Over the last two decades, women's involvement with NGOs and networks has increased economic stability (Islam, 2014; Patt et al., 2009). Boserup (2007) and Rahman (2010) highlighted the contribution of women to economic development through agricultural practice.

Ayeb-Karlsson et al. (2020) and Ayeb-Karlsson (2020) recently noted that immobility trapped climate affected women in Bangladesh emotionally and affects their mental health. Women in coastal Bangladesh can better adapt depending on local natural resources, (i.e. the Sundarbans) (Roy, 2012). In most cases, male members' migration to cities for livelihoods (Kartiki, 2011; Mallick and Vogt, 2014) encourages women to work outside the home to survive (Alam and Rahman, 2017). This immobility means that women in relatively disadvantaged coastal regions of Bangladesh (such as the Sundarbans region) are heavily dependent on the local natural resource base to support adaptation (Roy, 2012) following extreme climate events. How this situation is exacerbated in many cases by male household member's migration to urban areas in search of better livelihood prospects (Kartiki, 2011), requires further investigation. Despite the challenges face by women, in the long run they appear to possess the capacity to become involved in decision making roles in resource management, production and distribution of manufactured goods (Ahmed et al., 2012; Djoudi and Brockhaus, 2011). Several authors (e.g. Alam and Rahman 2014, Alam and Rahman, 2017; Denton, 2002) have suggested that women are in a unique position to make a significant contribution to climate change adaptation because of their close connection to the domestic context. The factors that contribute to the activation of women's latent capacity is also an area requiring deeper study. My thesis explores the perspective of women as active role players in adaptation challenges to climate change, and this study explores a reconsideration of women's contribution to climate change adaptation in the absence of the male family members, who have migrated to the city for the livelihoods and economic opportunities.

2.1.1 Autonomous adaptation

Adaptation is the adjustment of a system to cope with the effects of climate change in both short-term and long-term processes (Adger et al., 2003; Smit and Wandel, 2006). IPCC (2007) defined adaptation as 'the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities'. Adaptation is closely related to adaptive capacity, the preconditions needed to enable adaptation, and it can be classified as autonomous or planned adaptation (Adger et al., 2003, Smit and Wandel, 2006). Autonomous adaptation can be a spontaneous, automatic, dynamic, natural, localized, immediate or short-term process (Smit and Wandel, 2006). In response to adaptation challenges, autonomous adaptation is important for local coastal people (Adger, 2001; Malik et al., 2010). Historically, communities in poor coastal areas tend to adapt through immediate or short-term solutions rather than long-term planned strategies because planned strategies are often uncertain and entail financial imposts (Adger et al., 2003; Smit et al., 1999; Smit and Wandel, 2006). Smit et al. (2000) described autonomous adaptation as consisting of household 'bottom-up' approaches rather than outside 'top-down' approaches or policy support that responds to multiple climate stimuli. In the developing context, autonomous adaptation is an immediate, spontaneous response to climate change stimuli consisting of local responses (Adger et al., 2003; Fenton et al., 2017; Smit and Wandel, 2006). For example, the timing of sowing, harvesting and planting, and changes in the patterns of crop production depend on spontaneous responses and autonomous adaptation (Blakeney, 2020; Malik et al., 2010).

Autonomous adaptation can involve gender dimensions. Nelson et al., (2002) argued that men and women not only experience climate change extreme events differently but also, they adapt individually, which leads to unequal outcomes. In general, the prevailing view is that due to the limited role of women in public decision-making, community adaptation is largely the domain of male actors, (Djoudi and Brockhaus, 2011; Jordan, 2019). Conway (2015) argues that unequal social policies undermine autonomous adaptation and lead to unequal outcomes. When women are effectively empowered with timely information, they can contribute to disaster recovery in adaptation challenges through better preparedness and management (Alston, 2014). Although the consequences of climate change have had long-term negative impacts on communities, cyclones are a strong driver of change that challenges by coastal women to increase their adaptive capacity (Pelling, 2010).

Parvin and Johnson (2015) highlighted local responses are more effective for adaptive solutions to the poor coastal communities like Bangladesh, as the top-down approach has failed at the grassroots level. Examples drawn by Rahman and Hickey (2019) and Rahman et al. (2018), highlighted the importance of local-level adaptation actions in response to climate change adaptation in Bangladesh context. Islam et al. (2018) drew attention to the importance of local knowledge as necessary for immediate or short-term coping strategies and for adaptive solutions in coastal settlements of Bangladesh. Autonomous approaches are transformed into community based adaptive solutions based on local knowledge (Adger 2001; Fankhauser et al., 1999). For example, Kuruppu (2009) describes an example of Kiribati women who adjusted to a limited household budget by selling handicrafts and food items to generate informal income in an autonomous way. Grassroots responses are embedded in

community's local knowledge (Alam et al., 2015). In Bangladesh, grassroots technologies are the outcomes of autonomous application of local knowledge by poor coastal communities to fill the gap in adaptation to climate change (Alam et al., 2015; Islam et al., 2018; Rahman and Hickey, 2019); women could be the efficient mobilizers of local knowledge through autonomous activation of their adaptive capacity. This idea will be explored through my thesis.

2.2 The roles of local knowledge

Local knowledge is a resource of a community that is defined as knowledge, transmitted orally in a given locality and reflects accumulation of knowledge over many generations (Bicker et al., 2004). Local knowledge is considered to be synonymous with indigenous knowledge (Ellen et al., 2000; Sillitoe, 2006), ecological knowledge (Berkes et al., 2000); traditional or cultural knowledge of a community (Bicker et al., 2004) and different from scientific knowledge (Agrawal, 1995b; Mercer et al., 2007). Local knowledge is an effective vehicle in a cross-cultural context for active participation of the 'internal' (local people) and the 'external' (NGOs and other outside actors) communities (Sillitoe, 2006). Several studies acknowledged that local knowledge is effective for crop production and cultivation, for example, in African farming communities (Blakeney, 2020; Mapfumo et al., 2016). Warren & Cashman (1988) and Blakeney (2020) emphasized the importance of indigenous knowledge for the local communities in seasonal decisions, such as, to strengthen the stability of agriculture, where scientific knowledge has failed (Agrawal, 1995b).

Scholars suggested that the integration of indigenous knowledge and scientific

knowledge could reduce disaster risk (e.g. Agrawal, 2014; Mercer et al., 2007; Mercer et al., 2010). Bahaduri and Kumar (2009) reported individual motivations for grassroots innovation in the Indian context, which were formed with institutional support. The 'honeybee network', is an example of an innovative approach in the Indian context that helps local communities improve their existence by sharing their knowledge with outsiders (Gupta et al., 2003). Local knowledge is often seen as an authentic reflection of local culture and daily lives and livelihoods of local residents, even the least privileged member of a community may have some knowledge to share in their practices (Orlove et al., 2010). Hayami and Ruttan, (1985) described the development of innovation as associated with interactions among local resources, cultural endowments and institutional knowledge.

In the coastal Bangladesh, in response to climate change, socio-economically disadvantaged people mostly rely on local knowledge and local-level adaptive solutions (Barua and Rahman, 2017; Islam et al., 2018) that are heavily dependent on access to place-based resources (Amundsen, 2015). Local knowledge can help reduce the risk of extreme weather conditions, as local people know their context and local changes in climate (Alam et al., 2015; Jabeen et al., 2010). For example, the application of local knowledge helps coastal communities local-level adaptation strategies for agricultural development (e.g. introducing salt tolerant crops production from normal crops farming) (Rashid et al., 2014). Some scholars acknowledged women's connection to local knowledge and see women as important mediators in mobilizing of local knowledge in sustainable agriculture practice (Feldman and Welsh, 1995). Chowdhury et al. (2011); Misra, (2017) and Fenton et al. (2017) emphasized this in relation to sustainable agriculture and farming practice in Bangladesh with a

changing climate, and NGOs found women effective groups in adaptation to climate change. Dankelman (2010) emphasised that women in coastal areas are at extreme risk of climate change, but they can make significant contributions through their hard work in fulfilling their domestic responsibilities and sharing local knowledge with outsiders.

In my thesis, exploring the use of local knowledge can aid understanding of how women cope with change, its relevance to their changed lives in a post-cyclone context and how they find innovative solutions for adaptation.

2.2.1 Innovation

'Innovation' is a broad discipline and a vital term strongly related to my thesis. The concept of 'diffusion of innovations' by Rogers (1995) and Rogers et al. (2014) is essential in understanding the adoption of innovative ideas and technology. In my thesis, the concept of innovation is employed to explore coastal women's role in adopting new ideas and technologies to the changing climate. For example, how women coped with soil salinity by adapting and improvising new technologies and developing grassroots innovation using their traditional knowledge and local technology (Khalil et al., 2020), when husbands are absent or present in the area (Khalil and Jacobs, 2021) was explored. Other significant small-scale innovations adopted by coastal women include manufacture of shell-handicrafts by women on Zanzibar Island in Tanzania (Frocklin et al., 2018); small-scale fishing techniques adopted by fisherwomen in the north coast of Java (Yaro, 2013); and salt-tolerant agricultural innovation by women on the island of Gabura (Khalil et al., 2020).

2.3 The contribution of social capital

Social capital has been defined in many ways by social scientists and used by several scholars, such as, 'social ties', trust, 'values', 'networks', 'connections', 'relationships', 'strong ties' or 'weak ties' (Adger, 2003; Bourdieu, 1989; Burt, 2001; Coleman, 1988; Narayan, 1999; Putnam, 1995, 2001; Woolcock, 2001, 2004; Woolcock and Narayan, 2000). Tzanakis (2013) revised the theoretical definitions of Putnam, Bourdieu and Coleman identified 'trust' as an important quality of social capital that enables networks. Nooteboom (2006) suggested trust has an intrinsic value to support the local communities through institutional support. Both 'trust' and 'networks' can work together for 'sharing of knowledge'.

In my thesis, I chose a general overlapping definition applied to climate change: social capital as the relationship of trust and social networking between actors for climate change adaptation (Adger, 2003; Pelling and High, 2005). Woolcock (2001), Woolcock (2004) identified the importance of social capital is commonly differentiated at three levels - bonding, bridging and linking relationships. The theoretical basis of the three forms of social capital (bonding, bridging and linking social capital) is important to understand the relationships explored in my thesis. Bonding social capital (strong ties) is based on relationships among families and close relatives; Bridging relationships are horizontal, weak ties that work to connect neighbours and very localized community members (Putnam, 2001; Woolcock, 2001). Linking networks are vertical ties that connect communities on a larger scale across social hierarchies, such as various government and aid agencies (Islam and Walkerden, 2014, 2015). Islam and Walkerden (2015) and Masud-All-Kamal & Hassan (2018) recognized that bonding

and bridging relationships work through food sharing, providing comfort to communities in the post-cyclone Sidr context of Bangladesh. Although bridging ties break down over time; bonding relationships are always useful in Bangladesh coastal context and do not break down (Islam and Walkerden, 2014). Creation of alternative income opportunities are created and establishment of other domestic and local cost-saving actions through linking relationships with NGOs plays a significant role in preparedness and recovery in Bangladesh (Islam and Walkerden, 2014).

2.3.1 Bonding social capital

Bonding social capital is a horizontal and strong tie, a sense of trust and connections between family, relatives and close friends (Narayan, 1999; Woolcock, 1998; Woolcock, 2001 p 72). It develops through the most homogeneous relationships and a sense of kinship among family members (Narayan, 1999; Woolcock, 2001 p 72). In the context of Bangladesh, this bonding social capital is important for immediate physical and emotional support among family, neighbours or close friends during the post-disaster recovery period (Hsueh, 2019; Islam and Walkerden, 2014). Due to socio-cultural and religious restrictions in Bangladesh, women have limited mobility (Ayeb-Karlsson, 2020) and are restricted from working outside the home, compared to men (UN Women, 2014; Rahman, 2013). As a result, they become emotionally attached to the family and form strong bonding ties among other members of the family (Dankelman, 2008), as they feel bonding relationships provide a social safety net through family formation (Hawkins and Maurer 2010). Moreover, they feel a sense of social security and financial relief associated with marital status (Alston, 2015). Islam

and Walkerden (2014) noted that bonding relationships are always useful in the context of Bangladesh, especially as they support the provision of basic necessities of the family (i.e. food supply) in the immediate response to recovery processes.

2.3.2 Bridging social capital

Bridging relationships play an important role in connecting dissimilar groups with non-intimate individuals and acquaintances (i.e., relatives, close friends and neighbours) (Granovetter 1973; Woolcock, 2001 p.72). Granovetter (1983) defined bridging relationships by the terms 'strong tie', 'weak tie' and 'absent tie' and these ties vary with the strength of networks. Bridging relationships are important in transmitting novel information with connecting people and outside the family group (Granovetter, 1973; Woolcock, 2001). Some recent studies suggest that bridging relationships enable access to resources and information, facilitated through social networks (Hsueh, 2019; Monteil et al., 2020).

Some authors suggest in Bangladesh climate change context, bridging relationships are a particular type of social network between neighbours in a community to support their livelihoods and to recover from losses after natural disasters (Islam and Walkerden, 2014; Jordan, 2015). Monteil et al. (2020) suggests that social capital bridges the gap between people through linked social relations and in many cases, overlaps with networks to reduce vulnerabilities, especially during the post disaster recovery phase. Sharing household resources, belongings and other necessities (i.e. food, shelter, water resources) is a common bridging practice among rural women in Bangladesh context (Islam and Walkerden, 2014; Jordan, 2015). In some cases,

bridging networks are important for immigrants for their employment and income opportunities (Lancee, 2010); similar example is applicable for coastal men who have relocated to the city for livelihoods. Ganapati (2012) suggested that bridging connections among women could strengthen their capacity towards empowerment to reduce vulnerability.

2.3.3 Linking social capital

Linking social capital embedded in social networks and relationships (Lin, 1999a; Putnam, 1995), often refers to the vertical relationships and represents 'weak ties' among community insiders and outsiders (Woolcock, 2001). In developing countries, linking social capital represents 'strong ties', as the link with NGOs provides resource access, community empowerment and economic development (Adger, 2003; Islam, 2016). Ramirez-Sanchez and Pinkerton (2009) identified networks, links and kinship as important attributes in coastal fishing communities for economic development. Trust and networks are the important component for the community's successful relationships in a disaster recovery phase (Kawamoto and Kim, 2019; Nakagawa and Shaw, 2004; Ramirez-Sanchez and Pinkerton, 2009).

Linking relationships are an important network for poor coastal people in Bangladesh for reducing the impacts of climate change (Islam, 2016; Murtaza, 2012; Zohir, 2004; Masud-All-Kamal and Hassan, 2018). This relationship encourages the establishment of new social networks and connections with outside actors (e.g. NGOs) for knowledge production and are therefore key drivers of women's empowerment in climate

adaptation (Kabeer, 2005, 2011). Over the past two decades, NGOs have become increasingly important agents in Bangladesh through facilitated social support for female-led business opportunities to enhance economic flexibility (Mojumder and Panday, 2019) and women's empowerment (Islam, 2016; Murtaza, 2012; Zohir, 2004). Islam and Walkerden (2015) emphasised the policy implications of linking networks through strengthened bonding and bridging networks among coastal people during a disaster recovery phase in Bangladesh; linking relationships with NGOs enhanced the recovery of disaster victims by contributing support to physical and financial capital. These findings are further supported by Agrawal (2015) and Azim and Sultan (2010). In the South Asian context, women's empowerment was enabled through successful economic outcomes through linking networks (Kabeer, 2005, 2011).

Linking social capital is often missing during recovery phases of a disaster because of the unequal power relationships among actors, which limits the establishment of effective networks with the community (Islam & Walkerden, 2015; Masud-All-Kamal & Hassan, 2018). For example, often, post disaster relief interventions (e.g. food aid distributions) are linked to local corruption practises in the distribution of international aid and can lead to significant lack of trust in policy makers among local communities (Aase, 2019; Mahmud & Prowse, 2012), especially during the process of relief distribution (Aase, 2019; Masud-All-Kamal & Hassan, 2018). This happens because of the aid agencies' surface level understanding of recovery and the top-down nature of response design, which often fails to acknowledge the contribution of local grassroots communities in coastal areas (Parvin and Johnson, 2015). It is often claimed that people who maintain better connections with political community members get more access to resources - a common nepotism practice of Bangladesh

(Mahmud and Prowse, 2012). For example, fishing is a major livelihood for coastal communities, but the local communities often fail to get fair prices for production due to the nepotism of political agents, putting the livelihoods of many at risk (Islam, 2011). Aid agencies often engaged in lucrative relief interventions rather than aid-centric preparedness and mitigation activities (Aase, 2019), which create short-term financial opportunities for some 'connected' community members, but have long-term impact on disaster preparedness (Islam and Walkerden, 2015; Masud-All-Kamal and Hassan, 2018). In most cases, coastal women are treated inequitably through the deprivation of relief materials and less access to livelihood capitals (Alam and Rahman, 2017). Some negative aspects of linking ties have also been noted. For example, linking social capital may hamper the development of appropriate institutional policy frameworks as strong linking ties are associated with corrupt practices (Mahmud and Prowse, 2012).

Despite that, several studies have shown that NGOs have become important actors in community's empowerment (Islam, 2016; Murtaza, 2012); in particular, NGOs are seeking to empower women in climate adaptation challenges (Labonte, 2004; Islam, 2016). Historically, in the context of micro-credit programs in Bangladesh women are the majority target groups of NGOs, especially when they intervene in micro-finance as they find women are more reliable and trustworthy than men in utilizing the money and repayment (Pitt & Khandker, 1998). In summary, social capital is important in building adaptive capacity and in reducing vulnerabilities to climate change, but the contribution of the three forms of social capital (bonding-bridging-linking) is less addressed than a focus on individual social networks (Fine, 2010; Jordan, 2015).

In my thesis, how women are central to many of these post-disasters localized adjustments in maintaining social capital relationships (i.e., bonding, bridging and linking) can be seen as important dynamic in post-cyclone recovery context.

2.4 Place attachment, place identity and place dependency

The concept of attachment to place emerged from the discipline of environmental psychology (Altman, 1990; Dixon & Durrheim, 2000). Place attachment is conceptualized in multiple ways, such as, 'sense of place' (Hay, 1998), 'place identity' (Lalli 1992; Ujang, 2012), 'place making' (Lynch, 1980), 'place dependence' (Dixon and Durrheim, 2000) etc. Place attachment is defined by Hidalgo and Hernandez (2001 p 274) as 'a positive affective bond or link between an individual and a specific places'. Altman and Low (1992) conceptualised place attachment through multiple ideas such as, topophilia, place identity, genres of places, sense of place, rootedness, community sentiment and identity. An important dimension of place attachment is the place itself - that is connected to social and physical or environmental insights (Kyle et al., 2004). Social place attachment is the strongest social relationship and kinship in and around the family (Storie et al., 2019) and physical attachment is the 'rootedness among those who do not hold close attachment'. Place attachment is associated with environmental perception (Rollero and De Piccolli, 2010), where people are emotionally and culturally connected (Altman and Low, 1992). Some indigenous societies of the Pacific Islands have been forced to relocate due to climate change, but in most cases they face difficulties with their belongingness, where people are attached to their land, and their own culture (Campbell, 2014)

Scannel and Gifford (2010) conceptualised place attachment in three dimensions: 'person, place and process'. The person dimension can involve both individuals and groups; at the individual level, personal connections may be formed with a place, while at the group level, place attachment may refer to the symbolic meanings of place that a group can share among its members (Low, 1992). The 'process' dimension is concerned with how individuals and groups are emotionally related to a place and the nature of psychological interactions that occur with that particular setting. Sometimes, a person's bond contains cognitive elements such as memory, belief, meaning and knowledge that make the place important (Blunt and Varley, 2004).

Place attachment can be understood with the aligned concepts of 'place identity' and 'place dependence' (Kyle et al., 2004; Ujang, 2012). Place identity leads to sense of individual's self-identity (Proshansky, 1978), rootedness and a sense of belonging to a place (Williams et al. 1992). Physical, cultural and emotional attachment shape the identity of a place (Ujang, 2012; Williams et al. 1992). People who have lived in a place for a long-time, may develop an attachment to that place; those individuals form a strong place-based identity and a behavioural consistency among people-place relationships is also described as place-dependency (Altman & Low, 1992; Dixon and Durrheim, 2000; Williams and Vaske, 2003). For example, Australian Aboriginal communities have place-based social, environmental and cultural identity that has existed for thousands of years (Suchet-Pearson et al., 2013).

Both 'place identity' and 'place dependence' can co-evolve and trigger adaptive actions by understanding the values of resources of a particular place in two ways. First, an individual's dependence on the available resources (e.g. natural capital) of a

place, leads to an individual's understanding of place values and care for the place's resources and surroundings (Williams et al., 2013). Second, many aid organizations are helping those resources dependent people (especially women) through skill development to utilize and transform the natural capital into a range of livelihoods assets (Kabir et al., 2012).

In coastal Bangladesh, for example, the natural capital of Sundarbans is a strong support of livelihoods resources and embodies significant values for the coastal communities (Getzner and Islam, 2013). In most cases, male family members migrated to the city for livelihoods opportunities and women are trapped in the place due to socio-cultural restrictions (Ayeb-Karlsson, 2020; Ayeb-Karlsson et al., 2020). The natural capital of the Sundarbans is a great support for these women to survive and facilitate livelihoods and influences place dependence (Roy, 2012; Roy, 2019). For example, the attachment of coastal women to place and place-based natural resources (the Sundarbans) facilitates local livelihoods (e.g. fishing or crab fattening farming) (Roy, 2019). Availability of livelihood capitals influences coastal people's place dependence through the contribution of livelihood resources and a source of economic wellbeing (Iftekhhar and Islam, 2004; Shameem et al., 2014). Consideration of the person dimension helps to understand the ways that individuals or groups relate to a place through their social, physical and natural settings (Williams et al., 1992; Patterson and Williams, 2005). Application of place attachment theory may help to understand how marginalised women in proximity to that place (i.e. in Gabura) and are able to sustain their families in a post-disaster context by capitalising on limited and accessible place-based resources.

2.5 Livelihood capitals in support of women's place-based adaptation

Place attachment theory enables exploration of the intersections between place-based livelihood capitals (resources) and place-based adaptation. From a gender perspective, women are important actors in place-based adaptation and landscape management. A number of researchers have suggested that women have a special relationship and close connection to place and nature (Agrawal, 1992, 2000; Jackson 1993; Rollero and De Piccoli, 2010; Roy, 2012; Mies and Shiva, 1993; Warren, 2000). This women-nature relationship helps women to be conservationists and to adapt with their surroundings in landscape management (Narayanan and Kumar, 2007). Basu (1995); Gaard and Murphy (1998) and Mies and Shiva (1993) theorized 'feminism' and 'ecofeminism' perspectives and identified the critical nexus between women and nature. Mies and Shiva (1993) noted that women have a close relationship with the environment and a knowledge of biodiversity. Gaard & Murphy (1998) and Gaard (2011) described women as vulnerable to the exploitation of the environment and male-dominated society (Jordan, 2019).

In recognising the management of natural resource from a gendered dimension, place attachment is important. In developing countries, especially in rural areas of coastal Bangladesh, women are closely connected to their context and their local experience helps them survive by collecting their basic needs (e.g. food, fuel, fodder etc.) from the surrounding areas (Roy, 2012; Rahman, 2013). In relation to the effects of climate change, Meinzen-Dick et al. (2014) emphasized women's greater consciousness to

natural resource management can bridge the cultural gap and lead to sustainable practices in disaster management. Women's involvement in the role of domestic activities enhances place-based adaptation through influence on domestic planting and conservation of biodiversity (Colfer and Minarchek, 2013; p418). Bhandari (2013) mentioned women can play an important role in decision making of livelihoods transitions. In many cases, husbands take migration pathways to the city for their livelihoods and economic opportunities (Mallik et al., 2017; Mallick and Vogt, 2012). There is an opportunity to understand place as natural capital in which other forms of capitals are embedded and which enables women in the processes of adaption.

'Livelihood capitals' are place-based resources, consisting of five types of capitals (i.e. human, natural, physical, social and financial) (Chambers and Conway, 1992; DFID, 1999; Ellis, 2000; Scoones, 1998). A number of studies noted that women have a role to play in the ensuring positive outcomes in resource management and can achieve economic wellbeing through empowerment (i.e. human capital) and social capital support (Ahmed et al. 2012; Boserup, 1971; Djoudi and Brockhaus, 2011). For example, several NGOs in Bangladesh are associated with the natural capital of Sundarbans and support women to access its natural capital to establish livelihoods (e.g. in fishing and crab farming) (Roy, 2012; 2019).

In coastal Bangladesh, there are limited range of resources available to support place-based adaptation and women have to rely on their access to local natural resources (Roy, 2012). In post-cyclone context, male household member's migration to the city affects the changing dimensions of women's work outside the home as coastal women struggle to make a living and rely on a limited range of local natural resources (e.g.

resource collection from the Sundarbans) (Khalil and Jacobs, 2021; Roy, 2012). How the mobility of male household members to the city affects the changing dimensions of women's work outside the home and their access and utilisation of local livelihood capitals requires further study.

The concept of 'place attachment' (Scannel and Gifford, 2010) helps to analyse how women can use and manage the livelihood capitals (Ellis, 2000) at household level through their relationship to place and the contribution of social capital to support the interchange of other capitals from one form into another to achieve livelihood outcomes and better adaptation to climate change.

2.6 Conclusion

These four dimensions of literature reviewed in my thesis (i.e., roles of local knowledge; contribution of social capital relationships; place attachment lens and livelihood capitals transformation) are relevant to each other in support of women's place-based adaptation in a post-cyclone context. Exploration of these four conceptual areas should provide a deeper insight into gendered dimensions of adaptation in a post-cyclone context for Gabura coastal communities. Women's contribution to grassroots innovation and their roles in adaptation challenges to climate change provide a rich area for further study. Exploration of the context, gendered dimensions, and the relevant multiple issues embedded in this place may help illustrate the main theme of women's role in adaptation to climate change.

Chapter 03: Methodology

To examine women's role in adaptation to climate change in a post-cyclone context, this research adopted a mixed method approach comprising qualitative and quantitative data collection (Creswell & Clark, 2007). This approach was selected as it provides an understanding that realities are both socially constructed and subjective (Given, 2008). It ensures that primary data collection is both context specific and directly relevant to the research aims (Kitchin & Tate, 2013). It also allows for the use of secondary data to establish the context of the research in literature within both the global and domestic setting. This research should be viewed through a lens that recognises that knowledge is socially constructed and largely impacted by power relationships and how these factors interact. Specifically, that differing worldviews and values held by the women and other community members and aid agencies are likely to create differences in their understanding of what engagement with and actions towards adaptation should entail.

This chapter is divided into three sections. In the first section, I will describe the study area profile, my positionality (and its limitations) and the limitations of the study area. In the second section, the study approach, selection of participants and the information gathered from the participants are described. Five methods of data collection are described: household questionnaire survey, focus group discussion, in-depth semi structured and face-to-face household interviews, key informant interviews (e.g. household's members, NGOs officials, academics and disaster practitioners), and participant's observation through 'walking and talking' interviews supported with

photographic evidence. In the third section, the data analysis is described including transcription, analysis and coding, data documentation and the ethical considerations.

3.1 Study area profile

This study took place at Gabura Union¹⁴ under Shyamnagar *Upazila*¹⁵ of Satkhira district¹⁶ in Khulna division¹⁷, Bangladesh (see Figure 3.1). Gabura is considered an island (Polder-15) surrounded by two rivers the Kholpetua and the Kopotakho on northern and western boundaries, and an embankment was elevated and encircling the whole island, which is controlled by a sluice gate (Gabura Union, 2015). The Union is isolated from the 'mainland' region of Shyamnagar, as an island, which is currently on the fringe of the Sundarbans¹⁸ (enlisted as UNESCO World Heritage Sites), the

¹⁴ The Union Gabura was established in British period. It is about 27 Km from *Upazila* (sub-district) head quarter and 82 km from Satkhira district head quarter (see Gabura Union, 2015) The Union of Gabura consists of a chairman and twelve members with three member seats are restricted for women. Nine seats represent nine wards and each reserved seat assigned to three wards in each Union *Parishad*. The Union *Parishads* (Councils) are formed by the local Government (LG) and have a close link with the Administrators for the source of income (Aminuzzaman, 2010; Bangladesh Bureau of Statistics, 2010; Local Government Division, 2009). Gabura Island is the south-western coastline of Bangladesh. The southern area was part of the Sundarbans.

¹⁵ The *upazilas* (sub-district) are the second lowest tier of administrative unit of local government in Bangladesh (Administrative geography of Bangladesh, 2020). Shyamnagar is mostly affected union during cyclone Aila.

¹⁶ Districts (*Zila*) are the first tier of administrative unit of local Government in Bangladesh (Administrative geography of Bangladesh, 2020). Satkhira is one of the most affected districts during Aila.

¹⁷ Divisions are the administrative seat in Bangladesh. Khulna Division is one of the eight division and 3rd largest city (Administrative geography of Bangladesh, 2020). It forms the greater Bengal Delta and the south-west part of Bangladesh. It has an area of 22,285 sq. km and the population is about 1.56 million (see Mitra et al., 1994). Khulna divisions is split into 10 districts and has developed as a regional trading hub due to connected to Mongla port. Sundarbans are located in Khulna which creates extra geographical advantages as a tourist spot.

¹⁸ Sundarbans, occupy a large landmass and a dense forest, stretched across Bangladesh and India, covered an area of approximately 6,000 sq km in the Bangladeshi part (Uddin et al., 2013 p.153).

world's largest mangrove forest (Roy et al., 2013). In the past 20 years, two major cyclones, Sidr in 2007 and the super cyclone Aila in 2009, affected this island.

Gabura Union, Shyamnagar (Villages are mentioned)

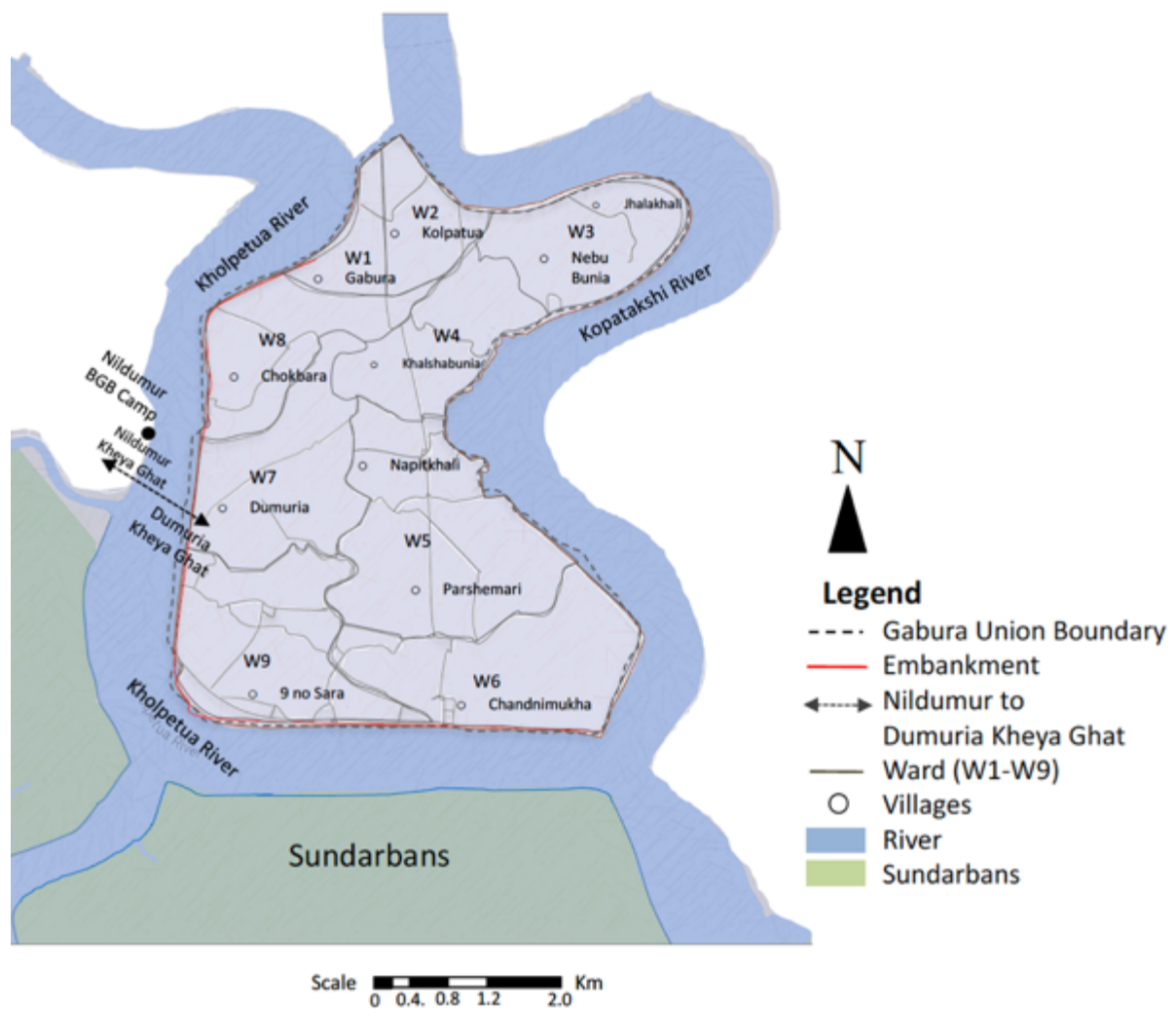


Figure 3.1: The study villages of Gabura Union

Source: Map adapted from Banglapedia, 2014, redrawn by author.

Gabura was one of the most severely affected unions in Shyamnagar during cyclone Aila (category 1 cyclone) in 2009 (See Gabura Union, 2015). Cyclones, heavy rainfall, and tidal waves hit this area of the world almost every year and affect the people, damage their houses and crops, and increase their suffering, which ensures they are considered poor/ultra-poor (Roy et al., 2009). In particular, the storm surge from cyclone Aila damaged the island, due to high tidal surge, broke down the embankment¹⁹ and left permanent water logging (Roy et al., 2009). The failure of the infrastructure (i.e. breaking of the embankment in several places) in Gabura may have exacerbated long-term inundation (for up to 2/3 years), causing widespread salinization of the island's surface soils, and as a result, the destruction of agricultural land (Alam et al., 2015; Khalil et al., 2020). Roy et al. (2009) also reported that Aila resulted in 190 fatalities and at least 7,000 injuries across the Khulna and Satkhira Districts, and more than 1 million people were left homeless.

Gabura Union covers an area of 85.5 sq. km (33 sq. miles). It consists of 15 villages, 9 wards, 4 mouzas²⁰ and has a total population of 38,825 (Gabura Union, 2015) that comprise approximately 7,491 households with relatively equal male-female ratio

¹⁹ Embankment is the main connection inside the village and to protect the villages from the flooding. During Aila the embankment collapsed in several places, and as a result flood water and rivers overflowed inside villages causing water logging (see Gabura Union, 2015). It was reported by Auerbach et al. (2015) that the embankment in the coastal belt is a kind of silt barrier and interrupted sediment deposition through separation of the floodplains from adjacent rivers. It is reported that for over two years after Aila, thousands of people had to live on the embankment until it was repaired.

²⁰ Mouza consists of one or more settlements or some villages. Gabura Union has 4 mouzas (Dumuria, Khalsebunia, Pershemari and Gabura) (See Figure 1.1, in introduction) (Gabura Union, 2015).

(male: 19,307 and female: 19,518) (Gabura Union, 2015). Seven villages²¹ were covered for this study (see Figure 3.1). The literacy rate is 35.9%, of which 38.8% are male and 33.2% female; around 96% of the population is Muslim and the remainder are Hindu (Gabura Union, 2015). The area is frequently subject to tidal surges, cyclones, annual flooding and salinity intrusion (Alam et al., 2015; Mallick et al., 2011).

Historically, Gabura Island and its populations have been both socio-economically and biophysically vulnerable. The major sources of vulnerability stemmed from a failure of local authorities to prioritize health issues, forcing communities to use salinized water, as all the drinking water sources (i.e. tube wells) were damaged permanently due to soil salinization²² after Aila (see figure 3.2) (Mallick et al., 2011; Gabura Union, 2015). Lack of a healthy water supply system led communities to rely on unhealthy water sources (e.g. contaminated ponds), which caused many water-borne diseases (Mallick et al., 2011). Recently, in some villages, some NGOs have installed improved water infrastructure (World Bank, 2017) and alternative sources such as rainwater harvesting and pond water filtration with PSF²³ (pond-sand-filter) for cooking water supply (Gabura Union, 2015). Rainwater is the only source to meet the demand for drinking water in the rainy season. In summer, due to ground water salinity (Hoque et

²¹ The seven villages (Dumuria, Chokbara, 9 no Sara, Chadnimukha, Napitkhali, Jhalakhali, Nebu Bunia) of Gabura from different wards were chosen to cover a diverse impact of cyclone Aila (Figure 3.1). The total population is about accordingly (2840, 2428, 5593, 2678, 1363, 689, 449) (Gabura Union, 2015).

²² Climate change is a risk factor for soil salinization at coastal Bangladesh. It is reported and tested by Dasgupta et al. (2015), soil salinity will be projected 39% by 2050 in coastal Bangladesh.

²³ Installation of PSF (Pond-Sand-Filter) installed by NGOs (e.g. DPHE, Water Aid) is a source of surface water filtration (e.g. pond water) and helping coastal community as for drinking and cooking water purpose. While the whole domestic water sources are damaged by soil salinization during cyclone Aila, installation of PSF helps to get access of potable water sources to the coastal settlements (Islam et al., 2013; Rahman and Islam, 2018).

al., 2019) women (wearing *sari*²⁴) walked several miles for the collection of drinking water (Rahman, 2013; Sultana, 2010). Toilets were submerged during Aila, which forced the community to use open latrines connected to ponds (see Figure 3.2). As a result, pond water was contaminated and diarrhoea broke out among the community (Roy et al., 2009). The whole community faced a lack of proper sanitation, requiring households to use unhygienic latrines. After the cyclone, some households used pit latrines²⁵ and some families shared tin-shed raised toilets (Figure 3.2).

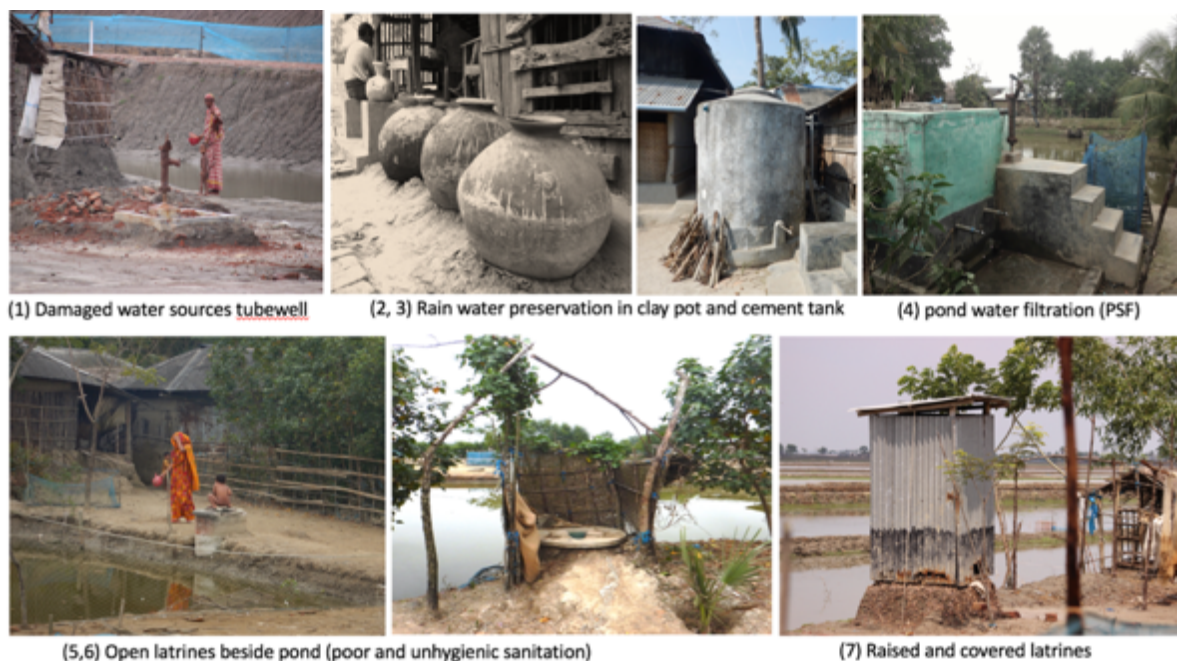


Figure 3.2: Water preservation technology and open and raised platform latrines.

Source: Author

²⁴ *Sari* is an everyday garment for most Bengali women in the rural context of Bangladesh. Women draped sari around their body and cover their head end of other part. It is claimed that wearing a sari makes coastal women less mobility, puts them in physical danger (e.g. they can't swim or evacuate) during cyclone and increase high risk of death (Ikeda, 1995; Juran & Trivedi, 2015 p 607)

²⁵ Pit latrines are designed as concrete sanitation for coastal communities as affordable, hygienic and healthy sanitation system. WASH and WaterAid helps provide hygienic sanitation and water supply to coastal communities.

The socio-spatial shifts caused by the long-term inundation post-Aila resulted in significant male migration outside Gabura Island in search of alternate livelihoods (Mallick et al., 2014; Mallick and Siddique, 2015). The socio-economic situation deteriorated after Aila. The male community members suffered from lack of work in winter and this is the reason for the large level of seasonal male migration (Gabura Union, 2015). The Union has two major occupational groups: farmers and fishermen. Traditional agricultural practices were ruined due to prolonged water logging and soil salinity. Therefore, food production was disrupted due to inundation and soil salinity, causing food insecurity in the years following Aila (Roy et al., 2009; Mallick et al., 2011). Limited employment opportunities ensured reliance on subsistence livelihoods (Mallick et al., 2011). After Aila, livelihoods changed to crab fattening (i.e. 40% people), shrimp farming (16% people), and day labour (23% people); children were also engaged in fishing and boating that resulted in an increase in absenteeism from school (Gabura Union, 2015). Three medium-sized weekly local *Haats*²⁶ (markets) sit temporarily next to the embankment and some villagers (especially male members) are involved in small trades (see Appendix X: Weekly local *haat*). These weekly local *haats* are an important place supporting the local business opportunities to the Gabura coastal community. Children were seen to be involved in carrying/ selling the local products in the weekly market.

²⁶ *Haat* is a weekly local open-air market for the rural coastal settlements. There are three (03) weekly local *haat* occurs once or twice in a week. It is an important place as the villagers wait for the weekly *bazar*. The produce (e.g., fish, shrimp, crab, handmade products) is carried out by vans, boat from villages or nearby unions (e.g. from Munshigang union) and sometimes from city.

The geographical orientation of coastal Bangladesh comprises a low-lying coastline landmass because almost 65% of the landmass is flood plains (Mallick et al., 2005). The southern part of the union was once part of the Sundarbans, which is the largest mangrove forest²⁷ in the world and is located on the south-west corner of Gabura across a river and extending into Khulna region (see Figure 3.3) (Iftekhar & Islam, 2004; Roy et al., 2013). Sundarbans contains various ecosystems, which provide natural resource-based livelihoods and economic dependence for the coastal settlements in Bangladesh (Abdullah et al., 2016; Sarker et al., 2019; Roy, 2012). These resources include fishing, crab and shrimp collection, firewood and honey collection, golpata, timber and straw collection for housing (Getzner & Islam, 2013; Iftekhar & Islam, 2004). Around 19% of people in Gabura are dependent on Sundarbans for fishing and natural resource collection (Gabura Union, 2015).

²⁷ The mangrove forests of Sundarbans covering 17% of the total land area in Bangladesh, according to Ministry of Environment and Forests (MoEF) (MoEF, 2005)

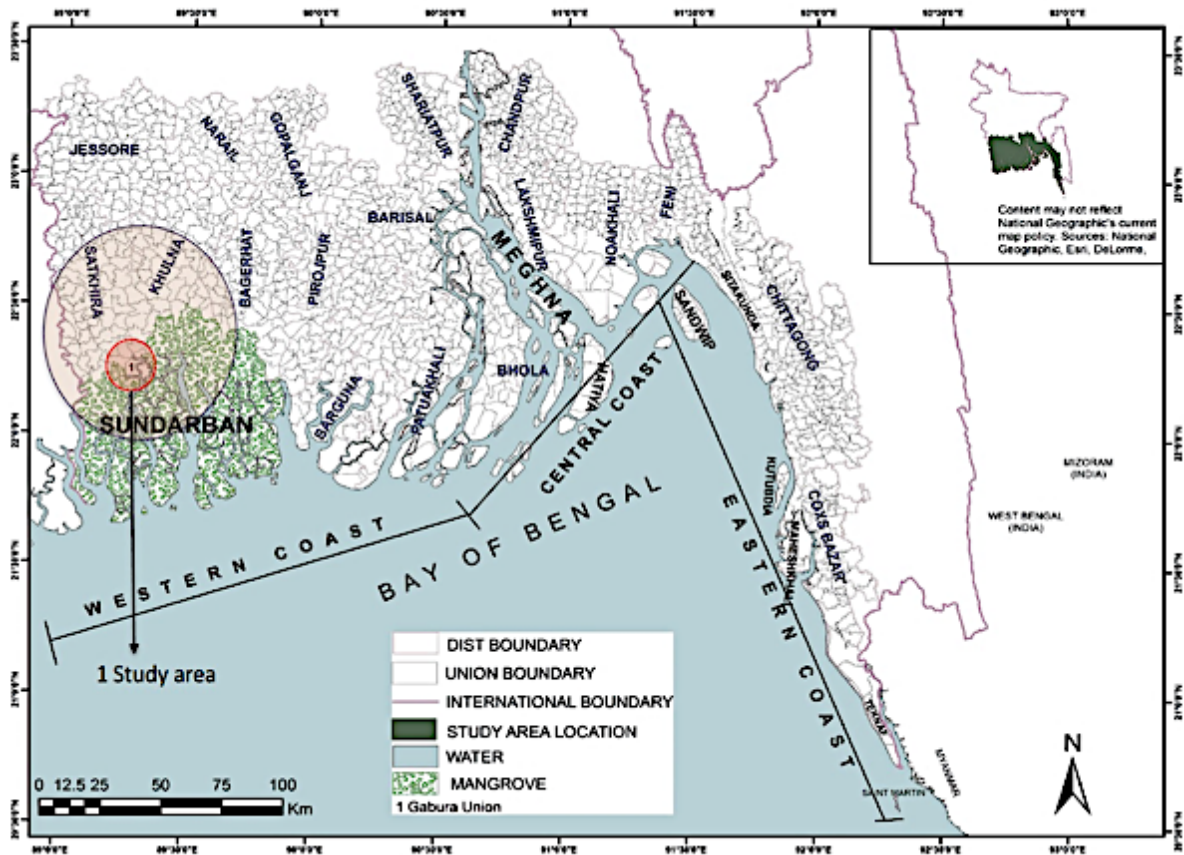


Figure 3.3: The Sundarbans, adjacent to the study location of Gabura Union

Source: Map adapted from Quader et al. (2017), Banglapedia, (2014)

Gabura was considered an isolated island protected by the Sundarbans natural barriers from any oncoming cyclones building up in the sea and making landfall (Alam et al., 2015). Sundarbans mangroves act as a bio-shield for the coastal settlements and protect the coastal areas to limit the impacts of extreme climate events (i.e. cyclones and tidal surges) (Agrawala et al., 2003; Dasgupta et al., 2019; Iftekher & Islam, 2004; Sarker et al., 2010). Prior to Aila, the livelihoods of Gabura were mostly agriculture and fishing based in local rivers and collection of natural resources from the Sundarbans (Mallick, 2011). However, due to the drastic disruption and the salinity intrusion of the island, the ecology and the livelihoods changed dramatically, and the

natural balance was disrupted (Iftekhhar, 2006). Sea level rise and climatic variabilities increase vulnerabilities of coastal areas (e.g. Gabura) and reduce ecosystem services of Sundarbans (Agrawala et al., 2003; Iftekhhar, 2006). The species and the natural balance were disrupted in Sundarbans, mostly due to flooding and cyclones, (Roy et al., 2009). In particular, cyclones Sidr (2007) and Aila (2009) reduced mangrove reforestations and increased soil salinization threatening local ecosystems (Sarker et al., 2019; Islam, 2006; Roy et al., 2009), and causing loss of habitat and ecosystem services (Shameem et al., 2014; Agrawala et al., 2003).

More than 75% of people in Gabura are living below the poverty line (See Gabura Union, 2015). Cyclone Aila was particularly devastating to coastal people, causing damage to embankments in multiple locations (Mallick et al., 2005) which worsened the situation through long-term inundation by sea water turning the island from 'green to grey' (Alam et al., 2015). This disruption to local ecosystem services fundamentally changed the livelihood patterns (e.g. from farmers to fisherman) (see Figure 3.4) of the population by forcing new divisions of labour along the lines of gender, within and outside of the island (Mallick, 2011; Mallick et al., 2017). Children were forced to drop out of schools and were engaged in household work (see Appendix IX), and women were also found searching for new livelihoods to survive, such as day labour (see Figure 3.4) (Khalil et al., 2020; Khalil and Jacobs, 2021). Under climate change, these sources of vulnerability are likely to be amplified by increased frequency or intensity of extreme climate events (e.g. Bacmeister et al., 2018) although, as reported by Brammer (2016), poor urban planning and population growth have, to date, had greater significance. Gabura, therefore, provides an ideal case study for exploring

adaptation strategies used by the vulnerable communities especially women in the post-Aila period.



Figure 3.4: Changing livelihood patterns after Aila.

Source: Author

The physical infrastructures (See Figure 3.5), such as embankments and inadequate cyclone shelters, were widely damaged during Aila (Mallick et al., 2011). The majority of people did not receive cyclone warning information and timely evacuation orders due to inadequate infrastructural support (i.e. lack of access to cyclone shelter) (Ahsan et al., 2016; Parvin et al., 2019). Mallick et al. (2011) observed that religious buildings (i.e. the areas 53 mosques) are the major types of infrastructure at Gabura Union (see Figure 3.5). Mosques act as the predominant source for community information. However, only males have access to mosques, so that, overall, women remained less informed about cyclone evacuation orders (Ahsan et al., 2016); only a third of women had received the evacuation order on the eve of Aila (Parvin et al., 2019, p.4), leading to gender-bias in disaster preparedness. Moreover, movement of people was

restricted through inadequate major road infrastructure (i.e. roads were sited on exposed embankments) and the Union has only 2 km *pucca* road (cement and brick made road) with the rest *kacha* road (muddy road) (70km) (see Gabura Union, 2015).

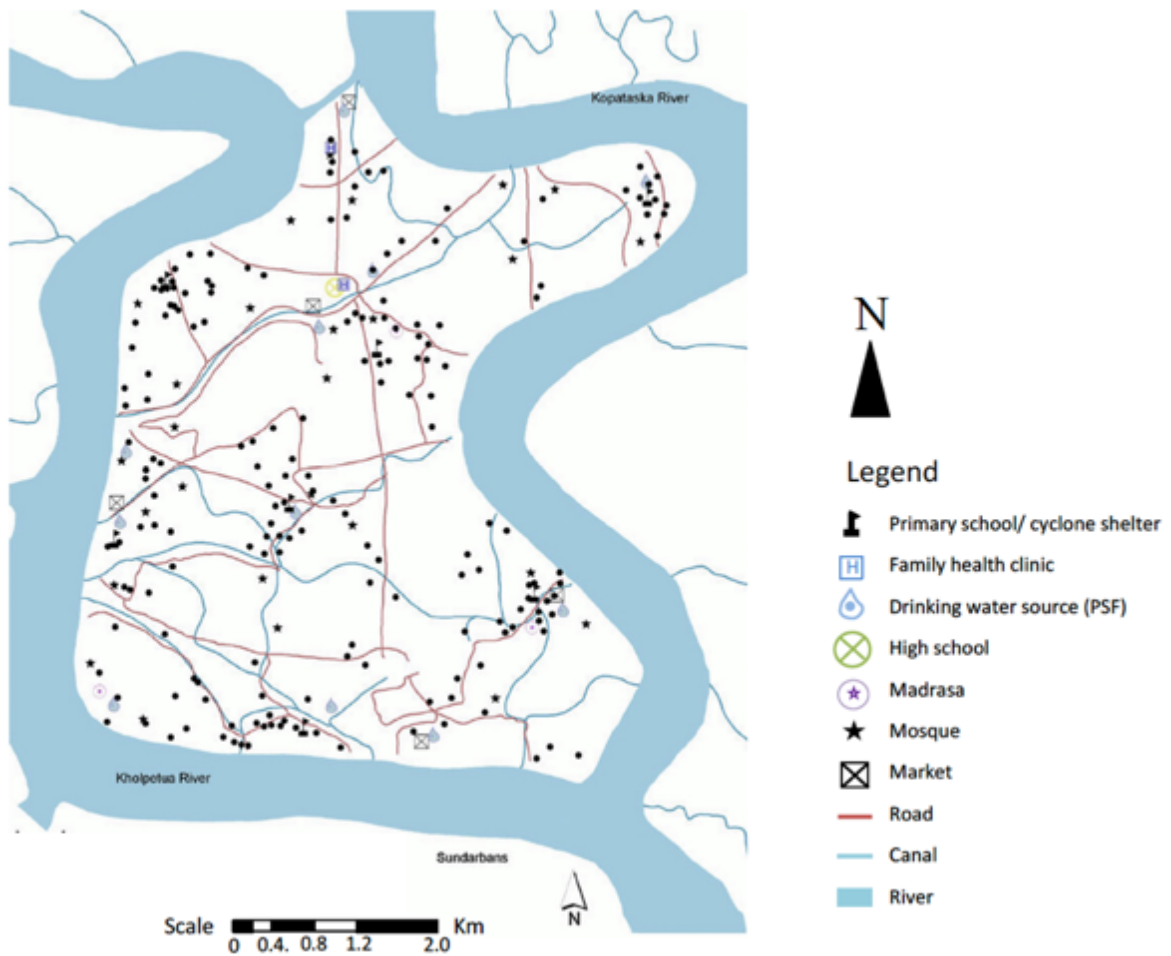


Figure 3.5: The physical infrastructure of Gabura Union after Aila

Source: Map adapted from Mallick et al. (2011) and Banglapedia (2014)

Lack of buildings such as schools that might act as ‘make-shift’ alternative cyclone shelters, failed to meet the community’s requirements (Gabura Union, 2015; Mallick

et al., 2011). Inadequate numbers of cyclone shelters (i.e. schools), which were far away from embankment, are not evenly distributed across the island and did not cover all village households during the cyclone. People living far away could not reach the shelters in time of need (Mallick, 2014; Parvin et al, 2019). Originally, six cyclone shelters (i.e. Primary school) were available, but these were damaged due to high tidal surge during Aila. For women, such uneven spatial distribution discourages them to make use of the shelters because they are restricted by patriarchal socio-cultural norms from travelling far away from home and therefore most women remained at home during the cyclone due to this immobility (Ayeb-Karlsson, 2020a and Ayeb-Karlsson, 2020b).

3.2 Study approach

The fieldwork was conducted at Gabura Union between January to April 2016. I devised a mixed method approach (i.e. qualitative and quantitative data analysis) (Creswell and Clark, 2007). Creswell, (2002), Creswell and Clark (2007), Johnson et al. (2007) and Williams (2007) defined a mixed method approach as the combination of knowledge, i.e. 'theory' and 'practise', from the fieldwork that attempts to identify 'multiple viewpoints, perspectives, positions and standpoints' of a researcher of qualitative and quantitative research. Each individual constructs their knowledge and experience through their social interactions embedded within these shared discourses (Given, 2008), especially to see how these factors interact to influence decision-making.

In this study, data collected during fieldwork comprised qualitative and quantitative methods and analysis (Creswell, 1999; Creswell and Clark, 2007; Johnson and Onwuegbuzie, 2004). Creswell (1999, 2002) described quantitative research as 'explanatory' where the components of data collection are from interviews, analysis, intervention of an experiment and the result of the study; whereas qualitative research that is 'exploratory' includes data collection, analysis and visual information (e.g. pictures, videos etc.). Both approaches are equally important in this research. Qualitative research seeks to understand the contextual analysis and examine the experience and the stories of people (Creswell and Miller, 2000). Denzin and Lincoln (2008) state that qualitative research 'involves an interpretive, naturalistic approach to the world'. This approach helps identify emerging themes and stories from local communities. Qualitative analysis may involve in-depth interviews and a visual observational protocol (e.g. taking photographs, video tapes and maintaining a field diary) (Creswell, 1999, 2002). Ultimately this method was selected for my study to give greater insight into the subjective perspective of the participants (Dunn, 2005) and to allow deeper understanding of the contextual causes of a situation to be gained (Leech & Onwuegbuzie, 2007; Rubin & Rubin, 2011).

Both open ended (for qualitative analysis) and closed ended (for quantitative analysis) questions were combined to elicit information on the present and prior situations of participants (Hennink et al., 2010). Quantitative method is important for detailed comparative analysis and information (Long & Nelson, 2013), and design in theory and practise (Greene et al., 1989; Guthrie & Hall, 1984). The questionnaire surveys used in this thesis aimed to identify local perceptions of life in Gabura before and after the impacts of cyclone Aila, and the adaptation that occurred because of those impacts

in the period after Aila. A number of key themes emerged from this research and through the survey. The qualitative data underwent thematic analysis in five phases, i.e. data collection, analysis and coding, searching themes, data documentation recordings and reviewing (Saldana, 2015). However, from the fieldwork the thematic analysis of the gendered dimensions and climate change adaptation came out as a specific *emergent* theme and that became the focus of my study. The analyses of qualitative and quantitative data revealed in-depth insights toward development of a rich picture of the Gabura community post-cyclone Aila with a specific focus on the role of women in adaptation.

3.3 Defining the study area

The Union Gabura is hard to reach due to the lack of proper transportation and internal communication facilities. I reached the survey area Shyamnagar *Upazila* by bus (110 km away from Khulna) from Khulna to Munshigang Union²⁸; van puller²⁹ and sometimes motorcycles are the only vehicles on the earthen roads linked to some villages, which is running from Nildumur *Bazar*³⁰ at Munshigang Union to Nildumur

²⁸ Munshigangang Union is located in Shyamnagar *Upazila* in Satkhira district. It is the nearest Union of Gabura. The union is located on the bank of Malonchi river and Sundarbans in the South. It is about 39 sq. Km. The Malonchi River separated the union from Sundarbans (profile of Munshigang Union, 2014). The total population is about 31832 with 7206 households. The main occupation is agriculture, fishing, day labourer and small trades.

²⁹ Van is a popular mode of transport and less costly vehicles for pulling passengers in villages contexts of Bangladesh (see Figure 3.6). It is a kind of tricycle rickshaw to carry people (4/5 passengers) and transport goods (Gabura Union, 2015). It is also a source of income for rural children.

³⁰ Nildumur *Bazar* (Market) is located beside Nildumur BGB (Border Guards Bangladesh) Camp at Munshigang Union (see Figure 3.1), connected to Nildumur *Kheya Ghat* to cross the Kholpetua river is the only way to take a boat from Nildumur *Kheya Ghat* to reach to Gabura Union. It is an important public place, crowded market including *kacha bazar* (raw market), small shops, tea stalls and local food shops.

*Kheya Ghat*³¹ through crossing the Kholpetua River by boat/trawler to reach Gabura Jetty (see Figure 3.6). Boat is the only means of transportation to reach Gabura Jetty and enter into Gabura Union across the Kholpetua River. The boat pullers are from Gabura and Munshigang Unions and most were farmers before Aila.



1) The Kholpetua river separated the Union from the mainland of Shvannaagar



2) Gabura jetty to get access to Gabura Union



3) Van, the internal transport of the villages



4) Muddy earthen road in rainy season

Figure 3.6: Gabura Jetty to Gabura Union crossing the river and linking streets.

Source: Author.

Almost all the villages are linked to the unsealed road and some roads are brick soling consisting of earthen and single brick paved roads. The surface of these roads is

³¹ Nildumur *Kheya Ghat*, where the boatmen cross the river Kholpetua, receive people by boat to get access Gabura Jetty to enter into the Gabura Union (see Figure 3.6). This *ghat* is the only way to travel to Gabura Union by boat.

uneven with holes, no drains, and is mostly flooded during rainy season. Van, motor bike and cycle are the only modes of transport for these uneven roads inside the village; accordingly, the only way to commute for the villagers is to move on foot (see Figure 3.6). During the rainy season, people face many difficulties to move inside the villages due to the unsealed earthen roads becoming muddy and slippery. However, to identify participant households and the concerned persons through observation and conversation, I undertook a reconnaissance survey along the major outline of the Union following the embankment and the major paths to get access into the villages. Later I expanded my contacts with potential participants. To initiate contacts, I was open to making conversation with the villagers while walking, and this approach helped me to become familiar to the villagers to facilitate easy access. I spent about 4 months stay at Barsha Resort³², located at Munshigang Union. Sometimes traveling to Khulna to discuss the related issues of my fieldwork data with academics from Khulna University and KUET. During this time, I continued to conduct interviews with NGOs officials in Khulna who were involved in activities in Gabura.

Seven villages in Gabura (i.e. Dumuria, Chokbara, 9 no Sara, Chadnimukha, Jhalakhali, Napitkhali, Nebu Bunia) were covered in this fieldwork to encompass the diverse impacts and changes caused by Aila. The participants were selected purposively. A few participants were also selected from the nearest Munshigang

³² Barsa Resort is located at Munshigang Union, close to Nildumur *bazar* (market) at Gabura Union. The resort maintains a network and trust relationship with customers. It possesses a good reputation by the tourists and a source of information for the tourists about cyclone affected villages, people and context.

Union, in the village of Hanrinagar Bazar to understand the female contributions in that location. According to information supplied by community people, the villages connected to the embankment are in better condition (e.g. Dumuria, Chokbara, 9 no Sara, Chadnimukha), as they receive more assistance from the NGOs and other institutions. In such conditions, I continued to explore some villages that received less benefit from contact with outsiders to re-establish their livelihoods after Aila. I observed that some villages (e.g. Nebu Bunia, Jhalakhalil, Napitkhali) located far away from the embankment were disadvantaged due to their location and limited transport access to these villages. These villages were less connected with the outside world, were not getting financial relief and sometimes had limited access to resources from the NGOs and government institutions. I closely observed their livelihood position in post-cyclone context.

Table 3.1 gives the basic information of seven villages in Gabura in this study.

Table 3.1: General information about the village

Name of villages	Ward no	Population	No of Household (HH)	Distance from UP (Union Parishad)
Dumuria	07	2840	597	7.00 km
Chakbara	08	2428	551	11.00 km
9 No Sara	09	5593	1189	12.00 km
Chadnimukha	06	2678	635	8.00 km
Napitkhalil	05	1363	283	13.00 km
Jhalakhali	03	689	155	14.00km
Nebu Bunia	03	449	99	15.00 km

Source: Gabura Union, 2015

3.4 Positionality and limitations

In 2015, I was an outsider to the research participants in Gabura. I began engaging with the community through a pilot study in early 2015³³, in preparation for a larger study conducted in 2016. I had no prior relationship with the participants in this area. In fieldwork, positioning through gender and cultural perception, class etc. are important considerations in the development of a connection between the researcher and research participants (Janssens et al., 2006; Mullings, 1999). In that context, I am viewed by participants as an educated woman. I was born in this region, so I was not seen as culturally much different to these communities, or at the least I knew the cultural dynamics that prevailed in these communities. I also speak the same language (i.e. Bengali).

My multi-positionality shaped the research by facilitating easy access in a number of ways. Firstly, I possessed similar culture (i.e. Bengali) and language (i.e. Bangla) to this community that helped me to explain my research clearly to them. Secondly, being brought up in Khulna meant that I held regional attachment similar to the participants. Thirdly, being female, allowed me to gain easy access to women participants without

³³ These preliminary field observations in early 2015 consisted of a pilot survey, an important part of this research, which led me to have a greater understanding of the context and identify my research participants and which later enabled the scoping of my primary PhD data collection conducted in 2016. This preliminary survey helped to test the relevance of some of my conceptual ideas in the participant context with a small number of preliminary interviews. Subsequently, based on this study, a book chapter was published in 'Innovation in climate adaptation' by Springer (see Ch. 4, Khalil et al., 2016).

cultural restrictions imposed through gender. However, being an outsider remained a constant challenge throughout the research. Traditionally, women in rural areas possess limited ability to go outside and are restricted from being involved with outsiders. The female participants felt comfortable to sit with me during the focus group discussions and interviews to share their stories and their struggle relating to the present and prior situation of Aila.

The focus group discussions took place at the participants' houses, household courtyard and sometimes on the veranda (see Appendix VIII). I sat on the ground on their home-produced handmade mats. They felt proud to share these products with me. The households offered a chair to sit on but I rather preferred to comfortably sit on their mats on the ground with the participants that established an equal relationship of trust among us. Sometimes they offered some cookies and *sarbat* (sweet water) to me and I accepted the food gladly. Eventually a trusted relationship was established with the families that allowed me to engage in purposive dialogue with household participants as part of the interview process. There was a non-verbal bond created between these disaster-affected women and me during this field survey that allowed me to engage deeply with them to collect their stories.

As a female researcher, I faced some particular challenges³⁴ to introduce myself to the male household members in the study villages. Some complexities arose in the

³⁴ I faced some challenges with male respondents in my field survey, some undergraduate research students, male (03) from URP, KUET were involved in questionnaire survey with the male respondents (40% households who were male), which was a great support for me as a female researcher in an area that is socio-culturally limited.

initial stage of group discussions with the 'male household members' (e.g. Henry, 2003; Wolf, 1996). It was not easy to present my research; especially to the elderly male citizens in the village, as women's active engagement outside their private domain and with outsiders is unusual to them. Wolf (1996) mentioned, 'research by women, with women and for women' is challenging'. In addition, male community members were not used to taking instructions from women, as 'empowerment of women threatens masculinities' (Jackson, 2013). It took time to explain the purpose of the research as they did not trust me or believe in the value of climate-related training or skill development and disaster preparedness. They generally believed that changes in weather were out of their control. In addition, during discussions, a few elderly male members tried to offend me because of my gender.

Moreover, the male households' heads tried to restrict the female household member's involvement in multiple ways in the group discussions. Their mind-set was, women should stay at home take care of children and be involved in household activities (Rahman, 2013). Sometimes they also provided confusing statements that hindered female contributions about male member's strong domination of females in household activities (Denton, 2002; Jordan, 2019). This interference meant that discussion activities in the interview process took a long time to start. These experiences were generally common in group discussions during the fieldwork.

However, despite these challenges from a patriarchal society mind-set, I was able to discern that women's contributions to the family remained largely invisible to the male household members. The misconception of climate change and a number of paradoxes from male household members inspired me to change my research

intention from a general study of grassroots adaptation to an exploration of the gendered dimensions of adaptation (Mohanty, 1999; Nelson et al., 2002) and the unrecognized role of women's contributions to post-disaster recovery (Patt and Suraz, 2009). Accordingly, I became more engaged with the female participants and made concerted efforts to establish trusting relationships to enable continued discussions on a day-to-day basis.

3.5 Sampling procedure and participant selection

The participants were selected from the villages through the 'snowball sampling' technique (Atkinson & Flint, 2004; Baltar & Brunet, 2012). Initially, participants were selected at random, however, this process was subsequently expanded through snowball sampling procedures and the participants were selected purposively from the seven villages. Early interviews were undertaken with the randomly selected participants. Later, with the help of some local NGOs and through recommendations of community elderly participants, a few participants were selected through individuals actively working at Gabura since cyclone Aila. Some household women were chosen who were divorced and some were 'tiger widows' (husbands killed by tigers), facing several types of social problems, struggling to survive along with children without husbands. Some elderly citizens (both male and female) were identified in this research who had a long-term relationship with the village and have better knowledge about the climate change patterns. The final group of participants was identified on the basis of emerging stories in each focus group discussion. Through this process, female respondent's contribution was identified and an overall understanding of

women's role in adaptation challenges in post cyclone context in the absence of their husbands was achieved. Some households were also identified based on my past knowledge of the study area as I had established connections with community members through some previous research.

Overall, four categories of participants from the seven villages were engaged in my research. Firstly, the villages that were connected to the embankment (i.e. Dumuria, Chokbara and 9 no Sara) where women were well connected with NGOs after Aila. Secondly, the women whose husbands had migrated to the city after Aila and established a link with NGOs following Aila to survive (Chokbara, 9 no Sara, Dumuria, Jhalakhali). Thirdly, some elderly citizens from some villages (i.e. Dumuria, Jhalakhali, 9 no Sara, Chadnimukha) who had a long-term experience of living within their village and surviving in their locations. Fourthly, some villages located far away from the embankment (i.e. Napitkhali, Jhalakhali, Nebubunia) that received limited assistance and had compelling survival stories about the post-Aila context.

Some demographic information was collected from NGOs through the structured and semi-structured interviews and some from female households, such as levels of male household members' migration to the city, and numbers of women forced to take up work outside of home to survive post-cyclone. In addition, I continued to closely observe the daily livelihoods within these villages.

Table 3.2 shows the sampling procedures, methods and participant's selections for the research.

Table 3.2: Sampling procedures, methods and participant selection

Categories	Nos	Sampling methods
Households	110	Selected at random in snowball sampling and through NGOs and community female participants' recommendation
Focus groups discussions	4	Participants were selected purposively
Semi-structured interviews	35	Participants were selected purposively
Key Informant Interviews (local participants)	20	Mostly selected after completion of FGD and few were selected through recommended by local NGOs and community
KII (local Government)	7	UP Chairman, Members of UP, Morol (<i>Matbar</i>) and Morol's wife, Members (Female)
KII (NGOs officials in local level)	8	Selected purposively NGF, Susilon, FDMC, CREL, CNRS, World Vision, JCF, Uttoron, Dhaka Ahsania Mission.
KII (NGOs official in national level)	6	Selected purposively (CREL, CNRS, World Vision, Uttoron, JJS, PKSF)
KII (INGOs officials)	4	USAID, Winrock International, UK aid,
KII (Academics)	7	Academics from KU, KUET, RU (involved in Gabura research)
KII (Disaster practitioners)	3	Disaster practitioners and researchers who are involved in Gabura research

Source: Field observation, household survey at Gabura and Munshigang Union

3.5.1 Data collection procedures

In this research, the fieldwork was designed to encompass the diverse impacts and changes to Gabura communities caused by cyclone Aila, and to understand the female contributions and gender relationships to adaptation across a range of different villages.

First, the majority of data was collected through applying qualitative research methods (Creswell, 2002; Denzin and Lincoln, 2008; Hennink et al. 2010; Maxwell, 2004). This method consisted of follow-up face-to-face household interviews, structured, semi-structured and key informative interviews and few focus group discussions. The qualitative analysis through the face-to-face in-depth interviews enabled the collection of detailed stories (Corbin and Strauss, 2008) from the female household heads. Semi-structured interviews are more casual in nature, this helps the participant feel more comfortable and therefore provide more open responses than a formal structured interview (Longhurst, 2003).

Overall, in total thirty-five (35) face-to-face semi-structured interviews were conducted with the female and male household heads in seven different villages. The household interviews were devised relevant to age group (i.e. 20 to 65), including elderly citizens (male and female), widow, divorced, housewife, homemaker, home tutor, local trainer, entrepreneur and season-based worker. Four focus group discussions were conducted to obtain more in-depth and detailed data from the participants to understand the actual challenges. All the discussions took place inside the participant's house (on the floor), on *uthan*³⁵ (domestic yard) and some were at working places beside roadside fields, as chosen to suit the participant's convenience.

³⁵ *Uthan* is a Bengali term, an important physical and functional feature in a rural context, where houses occupy a domestic and outdoor yard called *uthan* (Ahmed, 2012). Household women spend valuable day-time domestic activities on *uthan* with neighbourhood women through seat-to-seat chat while husbands are out of work, and sometimes raising livestock, vegetables gardening and other daily activities. A row of houses shared this common outdoor space as a 'courtyard'.

The second part of the research adopted a quantitative research method (Creswell and Clark, 2007). Quantitative approaches consisted of a structured questionnaire survey (Creswell and Clark, 2007; Creswell, 2002) of households. Both open-ended and close-ended questions were carried out in this process (Hennink et al., 2010). In total 110 household questionnaire surveys and interviews were undertaken among male and female household heads, with male household members absent in 66 cases. On average, 60% female households were represented in this questionnaire survey. The questionnaire survey consisted of five sections (i.e. demographic, local knowledge, social capital, adaptation technologies and livelihood capitals) (see Appendix VII: Questionnaire survey). The core section was designed to identify the strength of three forms of social capital (bonding, bridging and linking) among male, female households and NGOs to aid in understanding the gender dimensions and women's contribution to climate change adaptation in post-cyclone context that I described in my second findings chapter (see Chapter 6). Quantitative method was important for detailed comparative analysis and information (Long & Nelson, 2013). This method was selected, in my case study area, to get a comparative analysis of male and female household member's relationships. Most of the questions in the quantitative method were connected to the relevant data application that helped me to measure the strength of social capital relationships among the household male-female members.

Another important part of data collection was based on 'walking and talking interview method' (Alam et al., 2020; Anderson, 2004; Clark and Emmel, 2010; Kinney, 2017). Following this method, I remained engaged in the background and involved in a close observation of women's adaptation challenges, their livelihood situation and their

contribution to everyday life in the post-cyclone context (Alam et al., 2020). Two women, an NGO worker³⁶ and a male member (see Figure 3.7) who supported this interview process, walked with me from village to village and helped to find potential participants. I have documented some detailed stories of participant's everyday life and livelihoods and these were further documented through taking photographs (with the participant's consent) of some potential participants when we were passing through, as photographs are the best way to describe this method (Alam et al., 2020; Clark and Emmel, 2010).

³⁶ The NGO worker had been engaged in the context and with Gabura women for more than five years. 'It took me more than a year to be comfortable in a trusting relationship with the village women', NGO officer mentioned. He organized a monthly group meeting for both men and women in the community. Initially it started with a male participant, 6 to 12 months later, the participants increased from 10 to 35 (mostly women, i.e., numbering 30) in a year. The women of Chokbara village started call him 'Friend'.



1) The woman took part in a walking interview (her household activities)



2) The woman took part in a walking interview (her domestic garden)



3) An NGO official took part in a walking interview (a water treatment plant was established by his NGO)

Figure 3.7: Walking and talking interview with participants.

Source: Pictures were taken by author with participant's permission

This walking method helped to document the detailed stories about how women are engaged with the context, possess intimate links to their domestic context, and attachment with the place and surrounding landscape and their daily livelihoods. Overall, I explored women's relationship with their family members in the household, with the neighbourhood in the community and how these women are working together with the NGOs in a trusting relationship with the outside world in post-cyclone context. The overall situation after Aila is described in my findings chapters (see Chapters 5, 6

and 7). This observation was most appropriate in this research to collect a few emerging success stories of women in their own words through close observation in every encounter. This approach helped me to refine the research questions, selection of literature reviews and finally to articulate the findings chapters.

Table 3.3 below shows the methods and data sources that contributes to findings chapters.

Table 3.3: Methods, data sources and data contributions in chapters

Methods (Mixed method)	Data sources	Data contribution in chapters
Qualitative	Semi-structured and face-to-face household interviews, focus group discussion, KIIs with local households, NGOs officials, academics and disaster practitioners, through participant's observation and photographs	All chapters Especially in findings chapter 5, 6 and 7 and partly in book chapter 4
Quantitative	Number of respondents of questionnaire survey (n=110) were completed	Findings chapter 6
Walking and talking interviews	Two female household head, an NGO official and a male household head were encountered in walking interviews Taking photographs	Findings chapter 7 and partly in findings chapter 5 and 6

Source: Author's summary, based on field survey in 2016

Each discussion started with the introduction of my project and informing the participants on the requirements, seeking their consent to participate in this research as required (under University of Technology Sydney, Human Research Ethics Consent (HREC) approval). This approach was useful to learn the local experience based on communities' adaptation and challenges during the recovery phase in the post-cyclone context. The semi-structured interviews were designed to be open-ended

questions. Based on four emerging themes from fieldwork (e.g. women and climate change, roles of local knowledge, social capital relationships and attachment to place) the research questions were refined. The theoretical analysis continued based on new insights and the emerging themes from the fieldwork and the findings chapters answered the research questions and defined the theory. The intent of this mixed method data analysis was to see how the data fit with the theory and practice and to fulfil the requirements of this research.

3.5.2 Household head questionnaire survey

The primary data were collected by questionnaire survey through snowball sampling with a few through NGO's and senior citizen's recommendations. Male household heads were absent in 66 households out of 110 households. Ninety household questionnaires surveys were carried out at Gabura Union from seven different villages, most affected by Aila, a further 10 were conducted at Munshigang Union, and the remainder (10) were conducted on the embankment to see the comparative scenarios based on different locations (Table 3.4).

Table 3.4: Attributes of study, participant selection from different households and procedures of data collection

Villages	Participants	Procedure of data collection
Gabura Union Villages: Dumuria, Chokbara, 9 no Sara, Chadnimukha, Jhalakhali, Napitkhali, Nebu Bunia	110 household questionnaires were filled, male households were absent in 66 cases Female households were (ages 20-65) including widow and elderly 60% female and 40% male	Through snowball sampling, After completion of FGDs, walking and talking interviews Through local NGOs and community's recommendation.
Munshigang Union Village: Harinagar Bazar	6 female and 4 males	Household's recommendation from Gabura

Source: Author's fieldwork, Gabura and Munshigang Union, 2016

Surveys were paper based, and respondents were assisted to fill out the forms by six research assistants (both male and female, graduates from URP, KUET) who had academic field survey experience. Given that many of the respondents were not highly educated, the survey was administered verbally in Bengali language (*Bangla*) by two research assistants (a male and a female, from URP- KUET)³⁷, who wrote down the answers, and the survey questions were readjusted accordingly (see Appendix. VII: Questionnaire survey). Each interview lasted on average 30-40 minutes.

³⁷ The male and female research assistants were both involved in the questionnaire survey and where needed the research assistants were gender-matched. For example, in those contexts where the female participants were uncomfortable in the presence of the male research assistant, the male research assistant left the venue. A similar strategy was taken for male participants. Also, the survey was piloted among the first ten participants in the first week and the survey questions were readjusted accordingly.

3.5.3 Focus group discussion (FGD)

Focus group discussion was a suitable methodological approach for the qualitative research and connection between theory and practice, and to guide later fieldwork (Hennink et al., 2010; Williams and Katz, 2001). FGDs were important here to generate data, to select the key participants in a purposive way for further communication with researchers (Barbour, 2007).

In total, four focus group discussions were performed in four different villages (i.e. Dumuria, 9 no Sara, Chokbara and Chadnimukha) in Gabura Union (see Appendix VIII). The FGDs took place in the same types of settings as the surveys. The number of participants in each FGD were not less than seven and not exceeding 10 people. A range of different income tier households were involved in each FGD (e.g. fishermen, boat puller, farmer, motor bike driver, day labourer, season based worker etc.). Moreover, they included elderly citizens from each village, female entrepreneurs, LSPs (Local Service Provider), and LTs (Local Trainer) in the community. Both male and female participants were ensured in each FGD, although male members' participation was limited compared to females due to male outmigration to the city for livelihood opportunities.

The duration of each FGD including the standard ethics protocol was on average not more than 90 minutes. Consent was sought from the participants through a written official letter before starting the focus group discussions (see Appendix: VI). Important

information from FGD's was preserved by taking notes during each discussion³⁸ and audio recording according to the participant's consent. Some interviews were followed-up after each FGD and sometimes informal discussions continued after finishing each FGD and established a trusted relationship among with the village participants, especially with female participants that helped to develop a greater understanding on the research themes and enabled easier access in collecting interesting stories from the female participants.

3.5.4 Semi-structured household interviews

The potential study homes and the key female respondents were identified through local NGOs and community elderly citizens, and after completion of each focus group discussion. In addition, snowball sampling helped to identify further potential participants. The stories were collected through face-to-face semi-structured interviews with local households. Semi-structured interviews are essentially guided conversations, where the interviewer extracts information from the participants through preparing a list of questions to ask over the course of the interview (Longhurst, 2003). This semi-structured interview method was selected rather than a structured interview, as it provides a degree of flexibility for the participants to discuss topics (Longhurst, 2003). This information was then used to help answer the research questions (Creswell, 2002; Dunn, 2010).

³⁸ Among the four (04) focus group discussions, the undergraduate research assistants (both a male and a female) were present in two FGD, and helped taking the notes. Some interviews were followed-up after each FGD.

The discussion was started with the introduction of my project and understanding the requirements of this research through maintaining research ethics. The stories were collected in three phases: In the first phase, initially the first twelve (12) households were selected through snowball sampling (including divorced, tiger widow). In the second stage, eight (08) households were selected through NGOs and a few senior citizen's recommendations. Snowball sampling continued to identify further interviewees (Rose, 1985). In the third stage, the remaining fifteen (15) further interviews were selected after completion of each FGD to explore the themes/ stories that emerged during the FGDs on network relationships with the NGOs and women, and most importantly, female contributions on future preparedness for adaptation challenges to climate change. The length of interviews including the standard ethics protocol was 60-90 minutes. In total, thirty-five (35) female and male participants were chosen from seven villages in semi-structured household interviews who contributed to climate change adaptation in multiple ways in post-cyclone context. Some female respondents were selected and engaged in multiple interviews (e.g. semi-structured interviews, focus group discussion and walking interviews) and are noted in the following Table 3.5³⁹.

³⁹ The women I interviewed, mentioned in the Table 3.5, varied in level of education, many of them were with limited or no education. Due to the snowball sampling nature of participants selection, I acknowledge that the literacy level of participants is not proportionate to the village level literacy among women. There was no question asked of the participants about how their literacy affected their engagement with NGOs. Nor was there any eligibility criteria set by NGOs about level of literacy. In addition, it does not require a high level of literacy for women to practice vegetable gardening. However there needs to be further research into how women's level of literacy influences their linking relationship with NGOs. Moreover, some of these women took the leading role as local trainers and adopted some new agricultural practices (e.g. tower method farming) introduced by NGOs (see Khalil et al., 2020).

Table 3.5: Female respondents in semi-structured interviews

No	Part. name (Pseudonym)	Village name	Age	Education	Occupation	Contribution
1	Hasina	Dumuria	49	Class 6	Ex female member of a ward	Play leadership roles in the community (e.g. encouraged women in group meeting after Aila)
2	Shower	Dumuria	32	Class 3	Homemaker (divorced)	Contributes to household work and catches fish and shrimp fries from river bank
3	Khadija	Dumuria	62	No education	Senior citizen	She has experienced in the context and faced multiple cyclones.
4	Lily	Dumuria	21	HSC pass	Student, self entrepreneur	Produced handicrafts and work with NGOs and took multiple trainings.
5	Rani	Chokbara	40	Class 5	Trainer (LSP)	Train up other women on salt tolerant vegetable gardening through NGO's support.
6	Jasmin	Chokbara	45	Class 6	Entrepreneur, Local trainer	Train up other women with NGOs support.
7	Jobeda	Chokbara	35	Class 5	Local trainer (LT)	Take training on crab farming and salt tolerant vegetable gardener.
8	Rekha	Chokbara	36	Class 4	Entrepreneur, homemaker	Engage with the women's platform of the community and creates handicrafts.
9	Reba	Chokbara	38	Class 3	Vegetable gardener (tiger widow)	Taking training on vegetable gardening and work in a crab fattening farm.
10	Alo	9 no Sara	44	Class 5	Self-entrepreneur	Salt tolerant vegetable gardener, handicrafts producer, Trained up on farming and fishing.

(Continued)

Table 3.5 (continued)

11	Maya	9 No Sara	32	SSC pass	Teacher, home maker	Teaching students at home and contributes to family income
12	Nuri	9 No Sara	38	Class 4	Homemaker, day labourer	Contributes to family income and received training on vegetables cultivation.
13	Moni	9 no Sara	60	Class 2	Senior citizen	Experienced in context.
14	Shahana	Chadnimukha	39	No education	Day labourer, (tiger widow)	Contributes to family income
15	Sara	Chadnimukha	33	Class 2	Homemaker, work outside	Work at crab fattening firm
16	Flower	Chadnimukha	39	Class 4	Day labourer, divorced	Contribute to family income and working at crab fattening firm
17	Ruby	Jhalakhali	38	No education	Homemaker (husband is dead)	Contribute to household work, catch shrimp fries and fish from riverbank
18	Rina	Jhalakhali	31	Class 2	Day labourer (tiger widow)	Contribute to household income
19	Sayma	Nebubunia	32	No education	Homemaker, work outside	Work at a crab fattening farm and contribute to household income
20	Tara	Nebubunia	37	Class 2	Homemaker (tiger widow)	Contribute to household activities
21	Queen	Harinagar Bazar, Munshigang	44	Class 6	Self-entrepreneur, homemaker	Vegetables gardener and handicrafts producer
22	Happy	Harinagar Bazar, Munshigang	35	Class 3	Local trainer, homemaker	Vegetables gardener and work at a shrimp farm

Source: Author's summary from fieldwork, 2016

3.5.5 Semi-structured interviews with NGOs officials

The interviews with the NGO officials (e.g. CREL, CNRS, Susilon, World Vision, Winrock International and FDMC) helped to understand their contribution to improve networking relationships with the female household members in the community. Some issues emerged about women and the NGOs in post-cyclone context: 1) How women are involved with the NGOs after their husbands have migrated to the city and to survive. 2) What challenges were identified for women's climate adaptation supported by NGOs (e.g. salt tolerant climate smart farming methods, fish cultivation, handicrafts production etc.), whereas before Aila women were rarely involved with the NGOs; and 3) Why women want to be empowered to change their situation.

Some important relevant issues were identified through interviewing the NGOs. Such as, what kinds of challenges the community people faced during the cyclone, the actions that were taken through NGOs after the disaster during recovery phase, and what kinds of problems and gender issues affect adaptation. Semi-structured interviews took place in offices of NGOs and INGOs officials. The interviews were conducted separately and were voice recorded with due consent.

Table 3.6 shows the semi-structured interviews undertaken with NGOs officials conducted in Gabura and Munshigang unions and at NGO's head offices in Khulna.

Table 3.6: Semi-structured interviews with NGO officials

NGOs	Number of interviews	Total
NGOs officials: Local	PKSF (01), Uttoron (01), NGF (02), JJS (01), DAM (02), JCF (01), BRAC (02)	10
INGOs official: International	CREL (02), CNRS (02), Susilon (01), FDMC (01), World vision (01), Winrock International (01)	08
Total		18

Source: Fieldwork at NGO's offices in Khulna, Gabura and Munshigang Union, 2016.

3.5.6 Key informant interviews (KII)

The interviews with the key informants were conducted mainly in Gabura and a few in Munshigang Union. In total, 43 key informant interviews were conducted involving local political leaders (Gabura UP Chairman, members of UP, local village leader (Morol and Morol's wife), LSP (local service provider, female and male), LT (local trainer, female and male), NGO officials and INGOs officials, climate change field experts and university academics and disaster practitioners. Some important information about the context of Gabura (i.e. Govt. policy and implementation) came out through the discussion with UP Chairman and council members as they are experienced in the study area. Some household's male, female and elderly citizens were selected as key informant interviews through focus group discussion. On average, each interview lasted around 60-90 mins.

Table 3.7 shows the number of participants selected for the key informant interviews in Gabura and few in Munshigang Union.

Table 3.7: Key informant interviews

Participants	Nos
Local Government: UP Chairman (01), Member of UP (02), village local leader: Morol (<i>Matbar</i>) ⁴⁰ and Morol's wife (02), Members of Female: current and previous (02).	07
Senior citizens (2 male, 2 female)	04
Female household head	06
Male household head	02
LSP (02 female, 01 male), 02 females from Munshigang Union	05
LT (2 female, 1 male) Gabura and Munshigang Union	03
Local teacher (female)	01
Student (female)	01
INGOs officials	04
Disaster practitioners	03
Academics (University teachers and researcher)	07
Total	43

Source: Gabura and Munshigang Union, 2016

These participants (above in the Table 3.7) are the key actors and contribute directly or indirectly to the Gabura community. Their experiences and feedback were important to understand the adaptive challenges that helped me to connect with theory and practice in my research.

⁴⁰ Morol is an informal village local leader called '*Matbar/ Matobbar*' ('*gram/ samaj er matha*') in Bengali, in the village context of Bangladesh (Lewis and Hossain, 2017). *Matbar* plays an important role in settling community's socio-religious disputes, land disputes, local political conflict and other small-scale discussion with a village level meeting called '*salish*' (Hossain, 2006).

3.5.7 KII with academics and disaster practitioners

Seven academics were interviewed from multiple universities and from different disciplines such as KU (Khulna University), KUET (Khulna University of Engineering & Technology) and RU (Rajshahi University) who were involved in researching in climate change in Bangladesh context over the last 12-15 years. Academics from KUET and KU were chosen because they were experts researching local knowledge in the Gabura context. Their practical field level experiences and insightful knowledge provided me with the rationale to think more deeply about my theoretical interpretation of local knowledge and social capital that influenced me to work on gender perspectives of climate change.

A semi-structured open-ended questionnaire was used and each interview lasted 60-90 minutes although some discussions continued for up to two hours.

3.5.8 Participant observations

Participant observations (Jorgensen, 2015) allowed me to observe the villages and the community's actual settings as closely as possible without disturbing their normal life during post-cyclone context. Participant observations through the walking interview method were captured in three ways: firstly, photographs were taken where possible for documenting further stories; secondly, notes were taken concurrently in a field diary for further analysis; and thirdly, sometimes informal discussion continued with the male and female household's head in the participant's house. My physical engagement through walking interviews through village-to-village helped me to

understand the situation in the whole Union, and to observe very closely the community's situation and the livelihoods conditions of the women after Aila. Numbers of emerging themes and success stories of women (several role models in adaptation challenges) have been documented through photographs. All the discussion, stories and information during interviews were audio recorded concurrently with proper consent of the participants and the observations were noted in a field diary in accordance with standard ethics protocols. Proper consent was undertaken from the UP chairman and from the household head members through a written official letter to conduct this detailed approach.

3.6 Transcription

Pseudonyms were used during data transcription and participants were given the option to choose their own pseudonyms (Allen and Wiles, 2016). Transcripts were coded with the common Bangladeshi names (pseudonyms) and no personal information was added in the stored research documents or in published material. Audio recordings and notes from interviews and focus group discussions and key informant interviews were translated (i.e. from Bengali to English) and transcribed. As the survey was administrated in Bengali language (*Bangla*) and most data were collected in Bengali language. I did all the transcriptions maintaining standard transcription protocols as advised by Creswell (2002) and Creswell and Clark (2007). The visual materials from the field documented through photographs (e.g. participants' photos were taken during interviews, through walking and talking interviews and from focus group discussions) were cross-referenced to accompanying texts. I captured

nearly 5000 photos during fieldwork. These photographs were also organised according to dates, places and people I met, and saved on computer. I often consulted the photos during data analysis and kept a description of the documented photos recorded at the time of capture in a notebook where I noted participant observation to help recall the context. Participants recorded narratives helped contextualise the photos.

Interview recordings were translated, transcribed and anonymized (Jenks, 2011; Jenks, 2018). Transcribed data underwent several rounds of manual thematic analysis. Moreover, the stories collected through face-to-face interviews and one-on-one semi-structured interviews with the participants illustrated different perspectives and these were recorded in their stories. The stories from the participants were collected in informal style (noted in field diary using local language 'Bengali' and recorded concurrently). Due to the limited literacy of most participants, engaging them in conversation was the most comfortable way to elicit information. The written notes and the questionnaire forms were produced in both local native language and English where necessary.

3.7 Analysis and coding

Coding and analysis were not based on preconceived ideas rather followed 'issues and responses' of participants from the study area (Auerbach and Silverstein, 2003; Vogt et al., 2014). The data were analysed and coded by using NVivo, a qualitative data analysis (QDA) software (Welsh, 2002; Wong, 2008), and selected quantitative data were analysed by using histogram and chi square test of independence (Ugoni

and Walker, 1995). The first stage of the data analysis process involved transcribing the participant interviews. The qualitative data were coded into themes that related to the research aims and questions (Creswell & Clark, 2007). A deductive method was used to assume key themes from the literature, these data were then cross referenced with the themes from the participant's knowledge and experiences, extracted through the interviews. The quantitative data were used to further contextualize and support the thematic areas. Finally, these coded data were organised in relation to the research question. It was informing, to create the structure of the results and discussion sections.

The data analysis was 'inductive' (Creswell, 1999; Creswell and Clark, 2017; Thorne, 2000), that is, from the ground up, rather than relying on theories. I remained consistent in my stance of not being prescriptive or theory-driven in the research. Throughout the fieldwork I sought data and stories in every encounter with participants.

The emerging themes were then organized according to the mixed method fieldwork findings and data collections (Castro et al., 2010). It was important to transfer the collected data and participants recorded voice to an abstract form and narrow down the emerging ideas by connecting to the literature reviews (Jorgensen, 2015). It was also important to review the experts thinking and to associate these with the literature and connect to participants' viewpoints.

3.8 Data documentation

In the data analysis phase, the themes were identified for content analysis and the coded transcripts into sub themes (Castro, et al., 2010). All the data collected from fieldwork were brought back to Australia, stored securely on computer in a password protected file following the UTS standard ethics protocol. The original data have been stored securely in password protected electronic files. All physical materials were stored in files in a locked cabinet on university premises. Moreover, the hard copies of the questionnaire surveys are preserved properly in the closed files. Also, the final destruction/disposal of the data will follow the standard confidential waste management protocol.

The interpretation of data was based on a combination of coding summaries and the descriptive stories, which provided direct quotes from participants to illustrate central themes. The entire data set was coded under the five core categories: women and climate change, roles of local knowledge, the contribution of social capital, place attachment and livelihood capitals transformation. Quantitative data were analysed in MS Excel and converted to tables, pie charts and histograms.

To meet the initial research objective based on the data to hand the research questions were revised under a single broad research question and subdivided into four sub research questions (see Chapter 1, section 1.5). The research questions, emerging themes, ideas and the stories from the participants' observation and data collections are inserted in the findings chapters (see Chapter 5, 6, 7).

3.9 Ethical considerations

The field survey and research study protocol were approved by the Graduate Research School Ethics Committee; University of Technology Sydney were designed clearly to avoid the risk to all participants. To participate in this research, consent letters were approved under the UTS HREC approvals⁴¹. The University ethical protocols provided by UTS, HREC (Human Research Ethics Committee) were followed strictly and attached (see Appendix I: Ethics Approval Letter, and Appendix II: A letter of Consent approval). In this regard, I also continued to consult with my supervisors regularly.

In accordance with HREC approval written consent was granted through the study area Union *Parishad* Chairman's official letter (in Bengali) (see Appendix III: Letter of consent approved by UP Chairman) and a letter of approval (in Bengali) (see Appendix IV: Letter of approval by UP Chairman) to conduct the field survey in Gabura Union with the local community in the villages. A letter of consent was approved from NGOs officials to consult with them in key informant interviews (see Appendix V) involved in Gabura Union since Aila in 2009. Further another consent letter was approved by the Chairman to explain the study's purpose to the participants for the focus group discussion (see Appendix VI). The ethics procedures surrounding the questionnaire survey included that their names would not be published, that they can withdraw from

⁴¹ The standard human research ethics has been maintained with the relevant UTS policies and guidelines by the National Statement on Ethical Conduct in Human Research Involving the Australian Code for the responsible Conduct of Research (PDF, 652Kb), as approved by the University of Technology Sydney, Human Research Ethics Committee. The referral number of ethics application is (ETH15-0006), attached in Appendix I.

the interviews or focus group discussion at any time, that participants would be identified through a pseudonym, and that names would not be attached to any photographs used in publications.

Chapter 04: Grassroots technologies and community trust in climate change adaptation: learning from coastal settlements of Bangladesh

Chapter four is a published book chapter focused on the grassroots technologies as the adaptation outcomes developed by poor coastal communities that evolve from autonomous decision-making processes. This chapter addresses the following sub research question: '*How does local knowledge contribute to the creation of grassroots technologies?*'. A pilot survey was used for this study which was based on preliminary field observations (in early 2015), which led me to have a greater understanding of the context and identify my research participants. This enabled the scoping of my PhD study conducted in 2016. The chapter describes a brief literature review of the roles of local knowledge and community trust and identifies grassroots technologies as the outcomes of post-cyclone adaptation. This chapter is linked to chapter 5, which explored gendered dimensions of these factors (especially female contribution to grassroots innovation).

The published chapter is attached in the following pages.

Table 4.1: Statement of authorship

Title of paper (Chapter 4)	Grassroots technologies and community trust in climate change adaptation: learning from coastal settlements of Bangladesh
Publication status	Published
Publication details	Khalil, M. B., Jacobs, B. C., & Kuruppu, N. (2016). Grassroots Technologies and Community Trust in Climate Change Adaptation: Learning from Coastal Settlements of Bangladesh. In W. Leal Filho (eds), <i>Innovation in Climate Change Adaptation</i> (pp. 297-311). Springer, Cham.

Author's contribution

Name of principal author (Candidate)	Momtaz Bintay Khalil
Contribution	Data collection and analysis Literature review Conceptual development Writing of manuscript Revision of drafts Acted as corresponding author

Co-author's contribution

Name of first co-author	Brent C. Jacobs
Contribution	Supervised development of work Assistance in data analysis Guidance in literature review Assistance in conceptual development Assistance in manuscript evaluation and edits
Name of second co-author	Natasha Kuruppu
Contribution	Supervised development of work Guidance in literature review Manuscript evaluation and edits

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Abstract

This paper reports doctoral research that explores grassroots technologies as an asset for poor coastal communities of Bangladesh, how local knowledge contributes to the creation of such technologies, and how they can be useful to build a community's trust in its own adaptive capacity. Bangladesh is one of the most disaster vulnerable countries in the world due to its deltaic morphology and frequent climate-induced hazards (storm surge, annual flooding, salinity intrusion, frequent cyclones, etc.). Southwestern coastal settlements are especially vulnerable because people considered among the poorest in the world inhabit them. To cope with climate extremes under severe resource limitations, grassroots technologies evolve over generations from autonomous decision-making processes and creative experimentation. However, communities often fail to recognize the value of these technologies and may have little trust in their innate capacity for climate change adaptation.

A conceptual framework will be presented that identifies the interactions among grassroots technology, local knowledge, community trust and climate change adaptation. The framework will be validated in case studies of specific grassroots technologies identified through field observations, and explored through qualitative methods to understand the importance of indigenous knowledge to the development of community-based climate coping strategies.

Keywords

Grassroots technologies Local/indigenous knowledge Community trust
Climate change adaptation

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Chapter 21

Grassroots Technologies and Community Trust in Climate Change Adaptation: Learning from Coastal Settlements of Bangladesh

Momtaj Bintay Khalil, Brent C. Jacobs, and Natasha Kuruppu

Abstract This paper reports doctoral research that explores grassroots technologies as an asset for poor coastal communities of Bangladesh, how local knowledge contributes to the creation of such technologies, and how they can be useful to build a community's trust in its own adaptive capacity. Bangladesh is one of the most disaster vulnerable countries in the world due to its deltaic morphology and frequent climate-induced hazards (storm surge, annual flooding, salinity intrusion, frequent cyclones, etc.). Southwestern coastal settlements are especially vulnerable because people considered among the poorest in the world inhabit them. To cope with climate extremes under severe resource limitations, grassroots technologies evolve over generations from autonomous decision-making processes and creative experimentation. However, communities often fail to recognize the value of these technologies and may have little trust in their innate capacity for climate change adaptation.

A conceptual framework will be presented that identifies the interactions among grassroots technology, local knowledge, community trust and climate change adaptation. The framework will be validated in case studies of specific grassroots technologies identified through field observations, and explored through qualitative methods to understand the importance of indigenous knowledge to the development of community-based climate coping strategies.

M.B. Khalil (✉) • B.C. Jacobs

Institute for Sustainable Futures, University of Technology Sydney, Building 10, Level 11, 235 Jones Street Ultimo, PO Box 123, Broadway, NSW 2007, Australia
e-mail: Momtaj.B.Khalil@student.uts.edu.au

N. Kuruppu

Institute for Sustainable Futures, University of Technology Sydney, Building 10, Level 11, 235 Jones Street Ultimo, PO Box 123, Broadway, NSW 2007, Australia

Institute for Global Health, United Nations University, IIGH Building, UKM Medical Centre, Jalan Yaacob Latif, Bandar Tun Razak, 56000 Cheras, Federal Territory of Kuala Lumpur, Malaysia

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297

Keywords Grassroots technologies • Local/indigenous knowledge • Community trust • Climate change adaptation

Introduction

Bangladesh is one of the most vulnerable countries to sea level rise¹ due to its very low elevation, deltaic morphology (Agrawala et al. 2003). The long coastline comprising 32 % of the country's total area² (Karim and Mimura 2008) has exposed a large population to climate variability (e.g. frequent cyclones, annual floods, sudden storm surges and salinity intrusion) exacerbated by the impact of global warming. Nearly seven million people in Bangladesh's coastal area face the impacts of extreme climate events such as super cyclone 'Sidr' (in 2007), cyclone 'Bijli' (in 2008) and more recently cyclone 'Aila' (in 2009). Scientific evidence suggests that with one meter of sea level rise³ the vast majority of coastline will be inundated, which would affect mostly the ultra-poor living at the margin⁴ (Rashid 2014). Due to the inherent vulnerability arising from the anticipated climate change impacts, a risky geographic setting and comparatively low economic strengths investigations are overdue of how these coastal communities adapt, and what facilitates or hinders their adaptive responses.

Although the coastal communities possess rich local knowledge that largely facilitates their responses to climate change and utilization of natural resources, over the years outside actors (i.e. various government and non-government, local and international organizations) have also influenced their adaptation strategies. Well documented, government-led disaster preparedness and response initiatives have largely been top-down and fail to recognize the role of community in formulating adaptive responses (Parvin and Johnson 2015). The significant role of other actors (i.e., international organizations, NGOs) remains under-represented and under-researched. In addition research is limited on coastal communities' climate knowledge-base and responses, the effectiveness of the incentives from outsiders to influence grassroots responses and the overall trustworthiness of community-based processes to generate holistic bottom-up approaches to climate change adaptation.

This paper reports doctoral research that explores grassroots technologies as assets for poor coastal communities of Bangladesh, the interaction of such technology with available livelihoods capitals (e.g. Ellis 2000), how local knowledge

¹ Bangladesh is the third most vulnerable country to sea level rise in the world and in next two or three decades the average rising temperature will be expected 2 °C and will worsen intense cyclones recognized by World Bank, 2013.

² The long coastline covers an area about 47,201 km² (Karim and Mimura 2008).

³ 0.3 m Sea Level rise would increase 22.7 % depth of flooding and will flood 20 km from the coastline and 5690 km² is a High Risk Zone (HRZ) (Karim and Mimura 2008).

⁴ Coastal zone of Bangladesh comprises distinctive problems and prospects but is relatively income-poor in comparison with rest of the country (Rashid 2014).

contributes to the creation of such technologies, and how they can be useful to build a community's trust in itself and outside actors to enhance adaptive capacity. A conceptual relationship will be established that identifies the interactions among livelihood resources, local knowledge, and community trust in the process of climate change adaptation. A process to validate this framework, through co-learning with communities in the Gabura region of coastal Bangladesh, will be described under which preliminary field observations of specific grassroots technologies are already in progress.

Research Needs

Adaptation to climate change is the adjustment with the environment or surroundings, in the ability, competency or capacity of a system to adapt with climatic stimuli (Burton 1996). Adaptation encompasses adjustments in ecological, social and economic systems in response to the impacts of climate change (Briggs 2005; IPCC 2007). The concepts of adaptation, adaptive capacity, vulnerability and resilience are interrelated and have a wide application to global change. In a developing context adaptation occurs in different levels in society and may be autonomous or planned change that is anticipatory, reactive, passive or spontaneous, through individual activity or group behavior in order to reduce society's vulnerability to climate change stimuli and impacts (Fankhauser et al. 1999; Smit et al. 1999, 2000; Burton et al. 2005). Community adaptation to climate change in developing countries generally happens via autonomous processes facilitated by social capital and access to natural resources (Adger et al. 2003).

As the nature of autonomous adaptation is a dynamic social process with cultural and place-based specificities, sensitivity is needed to understand how coastal communities behave within changing climate regimes and weather extremes to adopt radically different adaptation strategies. Adger (2001), in the context of coastal settlements of South Asia and the Caribbean, argues for adaptive responses that focus on social capital and collective action. However, in the context of Asia's mega-deltas collective actions and their outcomes may remain unachievable. Conway (2015) argues that inequitable and hidden social policies undermine (autonomous) adaptation, and politics leads to unequal and sometimes contradictory outcomes for intended beneficiaries. Such contradictory and unintended outcomes further lead to increased mistrust among the beneficiaries and other stakeholders dealing with disasters. According to Roy et al. (2012), together the impoverished geography, lack of a workable socio-political platform, ineffective support from public institutions, aid and dependency on NGOs, and the limits to the communities' own agency and structures reduce the capacity for autonomous responses to changed climate circumstances.

Recent post-disaster experiences from the coastal settlements have unveiled gaps in perceptions about disaster preparedness and recovery among different stakeholders. Parvin and Johnson (2015) argue that the political economy of climate

change initiatives in Bangladesh leaves little scope to address vulnerability of grassroots communities, and existing policy responses are not able to address the structural dynamics prevalent in disaster relief, response and mitigation pathways. This happens because of the government agencies' surface level understanding of vulnerability and the top-down nature of response design, which fails to acknowledge the contribution of grassroots stakeholders. Mahmud and Prowse (2012) claim that cyclone preparedness and relief interventions are subject to corrupt practices that may lead to significant lack of trust. However, research in the pro-poor context of Bangladesh has created the hope that lessons can be drawn from grassroots experiences of coping with extreme weather for reducing vulnerability to climate change (Jabeen et al. 2010). Post-disaster experiences from the specific context of Gabura have established that grassroots responses are mostly effective as adaptive measures during typical hazards and the responses require little intervention from the outside actors except in extreme hazards (Alam et al. 2015).

Woolcock and Narayan (2000) identify the importance and usefulness of social capital, especially the bonding (of strong ties or intra-community) and bridging (of weak ties or extra-community) aspects respectively among family members, friends, neighbors and community people in the recovery phases. They also recognize the importance of linking relationships (both intra-local and extra-local) in long-term recovery with outside actors who have greater political or economic power, for example, the national and international NGOs, local government, and community-based organizations. Recently, Islam and Walkerden (2014), in the specific context of coastal Bangladesh, identified the importance of social capital, especially the bonding, bridging and linking relationships among family members, neighbors and community people. Accordingly, a framework developed to direct research in these coastal areas should triangulate locally-based knowledge, livelihood resources and community trust that results in varying grassroots responses within a broader framing of autonomous climate change adaptation.

Conceptual Framework

Indigenous Knowledge Overlapping Local Knowledge

Indigenous and local knowledge are concepts that overlap, have much in common in their definitions and are often used interchangeably. Both are place-based, contextual, and experiential, most often transmitted orally and through social learning and engagement across generations, and evolve over time and observation (Agrawal 1995; Ellen et al. 2000; Sillitoe 2006, 2007; Cleveland and Soleri 2007 in Orlove et al. 2010). They may also be considered as the 'personal' assets of local communities (Smith 2001; Briggs and Sharp 2004). Bicker et al. (2003) views local knowledge as embedded in indigenous knowledge that embodies grassroots'

traditional lifestyles. Orlove et al. (2010) considers indigenous knowledge to be deeply rooted in local culture and generally associated with long-settled communities that have strong ties to the natural environment. Perhaps it is the type of community rather than the characteristics of the knowledge that is the fundamental difference between these two concepts. Local knowledge could be a product of any place-based community's relationship with its local environment, whereas indigenous knowledge implies a community's long-term cultural ties (Agrawal 1995) or traditional ownership of a place. In that sense, the term indigenous knowledge appears more appropriate in association with the Gabura community in Bangladesh and will be used hereafter.

An appreciation of the importance of indigenous knowledge appears critical to support the formulation of bottom-up approaches to climate adaptation. Recognition of indigenous knowledge is associated with community empowerment (Briggs and Sharp 2004). It plays a central role in traditional approaches to management of natural resources (Berkes et al. 2000) and in local-level decision-making in agriculture, health care, food preparation, education, and community sustainability (Warren 1991; Warren and Cashman 1988). Orlove et al. (2010) describe four major components of local experience that can help to understand climate change impacts as: the awareness of weather signals; the observation of meteorological events; cultural and regional information on climate change; and, opportunities for co-learning with local people (e.g. farmers) to understand seasonal impacts on local agricultural production. Mercer et al. (2010) suggest that the integration of indigenous knowledge and scientific knowledge can help to reduce vulnerability and disaster risk.

Adaptive Capacity and Grassroots Response

Grassroots responses are embedded in the community's store of indigenous knowledge from past experience of climate variability (annual flooding, storm surge, cyclone, consistent rainfall) that stimulates autonomous responses to cope with extreme events (Alam et al. 2015). Such responses rarely result from planned or designed adaptation or policy-making. Rather they evolve through short-term and long-term dynamic processes of local experimentation utilizing intimate indigenous knowledge of natural systems (Alam et al. 2015; Mercer et al. 2010; Warren and Cashman 1988). Orlove et al. (2010), for example, noted the significant role of grassroots responses emerging from indigenous knowledge of climate variability and weather conditions in crop production.

Specific grassroots responses are therefore most likely the product of a community's adaptive capacity, which depends on the availability, transformation and substitution of individual capitals from the range of livelihood resources (Nelson et al. 2007). Livelihood resources are generally considered in terms of a suite of capitals that may include human, social, cultural, financial, physical, political and natural capital (Scoones 1998; DfID 1999). Adaptive capacity of the

least developed countries (LDC), such as Bangladesh is considered low and vulnerability is high (McCarthy 2001). For successful adaptation strategies, limitations in one type of capital, such as financial capital in coastal communities of Bangladesh, must be overcome by finding novel ways to combine the resources at hand. This process is likely to rely heavily on trust in the exchange of knowledge through local social capital and networks (Woolcock and Narayan 2000) to develop grass roots innovations in the use of local natural capital (Adger et al. 2003), which effectively embody a community's collective wealth (Scoones 1998).

Community Trust

The conceptualization of trust by different authors shows its specificity with the scale of interaction (i.e., personal, family, neighborhood, community levels, etc.). Narayan-Parker (1999) referred to 'trust' as social capital by using the term 'cross cutting ties' (as bonding and bridging networks) between the formal and informal groups among family, relatives, neighbors and outside actors for collective actions to establish the identity, trust, values and access to power and economic welfare. Woolcock (1998) and Woolcock and Narayan (2000) outlined community trust as operating in two ways, horizontally or the 'strong ties' (through bonding and bridging at the micro level) and vertically or the 'weak ties' (network relationships among local governments, international organizations or NGOs and others at the macro level). Furthermore, Putnam (2001) observed the importance of three elements, namely trust/social value, norms and networks, in upholding good social bondage and community trustworthiness.

In the context of developing countries, Nooteboom (2006) noted that development of trust has an intrinsic value and relies on a combination of personalized trust and local trustworthiness that requires strong support from institutions for its development. However, most often trustworthiness in indigenous communities rests on their past experience, intuition and historical experimentation of coping with environmental conditions using local materials (Orlove et al. 2010). The building of trust between government and communities is generally accepted as creating productive relationships that lead to socially acceptable planning and positive management outcomes (Smith et al. 2013a). Community trust can be established if there is sufficient transparency among community stakeholders and among the community and outside actors.

In the context of Bangladesh, NGOs' such as Action Aid among others are focusing on social and economic development, trying to secure natural resource management (NRM), ecosystems, mangrove regeneration (Sarker 2010) and livelihood resources and empowerment through the introduction of saline-tolerant

crops⁵ to enhance adaptive capacity (Iftekhhar and Islam 2004). International NGOs, may enter positions of trust with the community in relation to adaptation through provision of transitional shelter, initiatives to support the education of cyclone affected children, coordination with government agencies⁶ to provide safe water and environmental sanitation facilities or provision of potable water through the installation of tanks for rainwater harvesting.

Smith et al. (2013b) suggest that for some aspects of an individual's level of trust, high levels may be negatively related to public involvement in resource-related activities. Mahmud and Prowse (2012) claimed that ultra-poor households' disaster interventions are significantly affected by corruption, particularly in relation to public works and non-governmental interventions. Therefore, political capital emerges as an important factor in grassroots' disaster responses. Issues such as political nepotism and corruption can erode trustworthiness both horizontally (among community members) and vertically (among the coastal community and outsiders). So in the context of grassroots' climate change responses in coastal Bangladesh, the 'community trust' built over the relationships of bonding-bridging-linking networks need attention to understand how local knowledge can be further mobilized to ensure sustainable management of livelihood resources.

Conceptualizing Autonomous Climate Change Adaptation

Figure 21.1 shows a conceptual framework that links changing climate as a driver of autonomous adaptation, mediated through indigenous knowledge, livelihood resources and community trust that results in the development of grassroots technology at a range of temporal scales and social hierarchies.

The conceptual framework conceives livelihood resources as central to any autonomous response, particularly in a developing-country context, such as Bangladesh, where state-sponsored, planned adaptation plays only a minor role in supporting its citizens' adaptive responses. In this context, empirical evidence suggests that the ultra-poor, who are often landless with no significant financial or physical capital, depend heavily on natural resources and social and cultural supports from their peers for survival. Local knowledge and community trust, although generally considered part of the stock of human and social capitals respectively, are therefore shown as separate components of the model because of their importance in the adaptive capacity of indigenous communities. Together

⁵ Saline-tolerant crops like coconut, guava, plum, corn meal, tamarind, cabbage, celery, basil, bindweed, spinach and paddies like bina-9, bina-10 are suitable as salinity intrusion in Gabura after cyclone Aila.

⁶ The Government agencies like UNICEF, DPHE (Department of Public Health Engineering) providing temporary learning center and drinking water, local NGOs like NGF, JCF, CREL, CNRS are advocating the local people for the empowerment and helping to secure the livelihood resources and natural resource management at a minimum scale in Bangladesh coastal community.

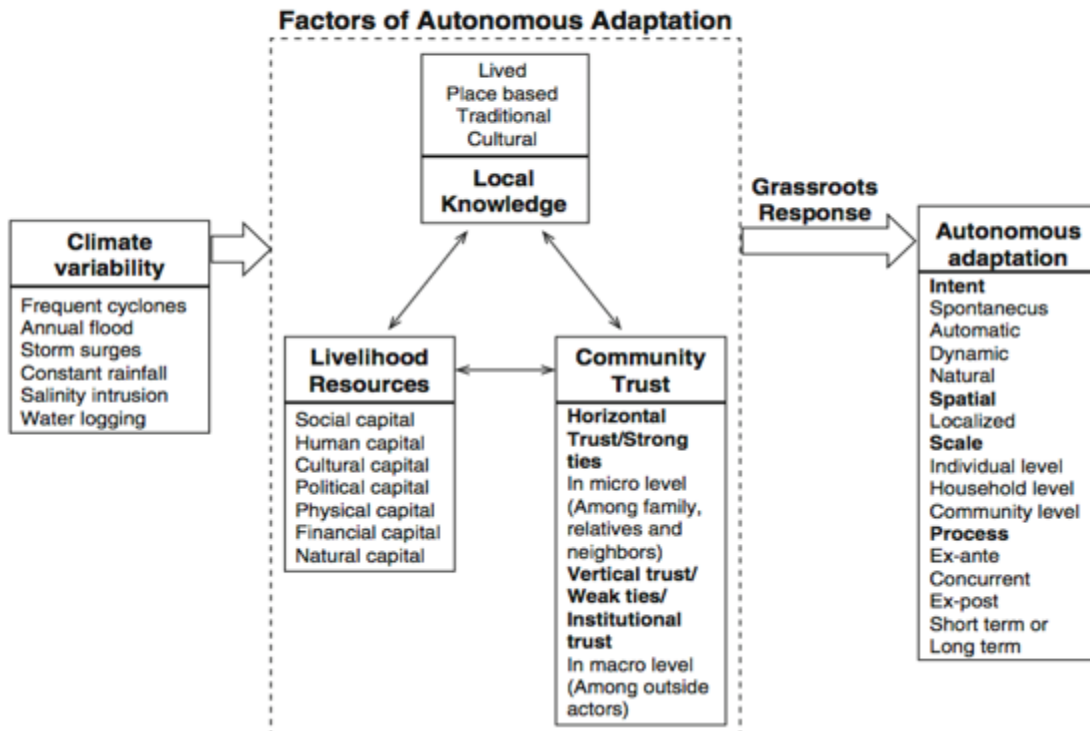


Fig. 21.1 Conceptual frameworks linking to local knowledge, livelihood resources, community trust and grassroots technologies. *Source:* authors

their triangulations determine the level of grassroots responses and form the nature of autonomous adaptation to climate variability.

Preliminary Evidence of Grassroots Technology

Gabura, is an island of the coastal 'Union' under Shyamnagor Upozila at Satkhira district of Khulna division bounded by the Kholpetua and Kopotakhsa Rivers (Fig. 21.2). Once part of the world's largest mangrove forest, now it is the fringe of the Sundarbans. In 2009, the region was hit by super cyclone Aila that burst protective the embankment allowing saline water inundation of the island up to 6 m deep (Choudhury 2009). Significant human and livestock casualties occurred, local communities were displaced, and local ecosystems and natural resource livelihoods were disrupted. The cyclone's impacts continue to disrupt the island's culture, as the historically practiced cultivation systems were rendered useless for up to 4 years.

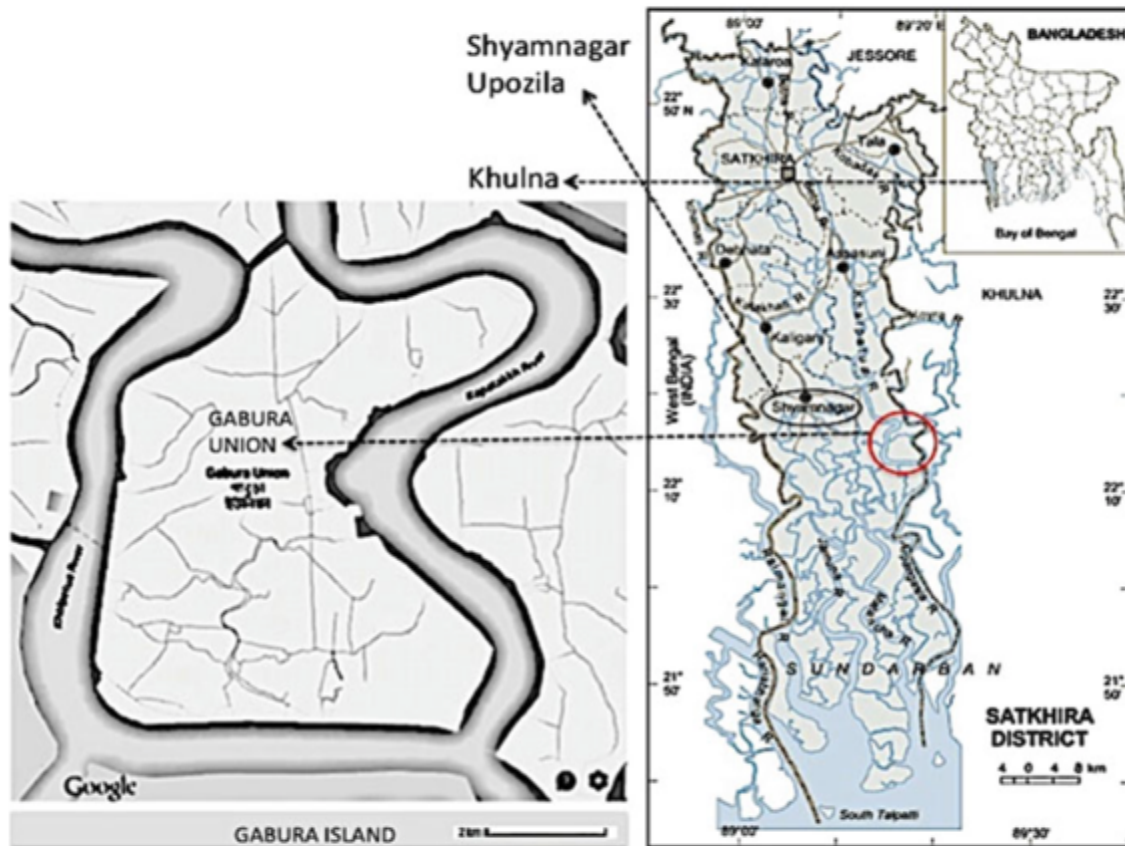


Fig. 21.2 Location of Gabura Island in Shyamnagar Upozila of Khulna Division, which is the site of field studies in Bangladesh. *Source:* Google Map

International aid agencies have offered local assistance. However, preliminary field observations suggest that their interventions are transforming indigenous lifestyles and may be influenced by complex political relationships among multiple actors with positive and negative outcomes for the local community.

The livelihoods of coastal people in Bangladesh are natural resource-dependent and they continually struggle to increase adaptive capacity to cope with climate variability (Adger et al. 2003). However, grassroots technologies (Fig. 21.3), in response to both climatic stimuli and non-climatic drivers, have appeared spontaneously despite chronic limitations in access to resources (Alam et al. 2015). Table 21.1, summaries the field observation of selected grassroots responses by coastal people in Gabura Island that emerged after the cyclone Aila at a range of scales, and the role of external assistance from aid agencies and without outside interventions in the development of the response.



Fig. 21.3 Examples of grassroots technologies observed in Gabura. (a) Tying down boats to secure from storm surge; (b) Raised plinth height of the houses; (c) Tethering to secure house roofs; (d) Protection of mud walls from rainfall; (e) Plumbing modified to allow upstairs toilet during flooding; and, (f) Tanks for rainwater harvesting as drinking purpose

Conclusion

The literature review and preliminary field observations from the coastal community of Gabura, Bangladesh have demonstrated the importance of local knowledge, livelihood resources and community trust in the emergence of grassroots technology for autonomous adaptation to climate change in developing contexts. Grassroots responses are spontaneous and dynamic. This paper identifies some of the grassroots innovations of coastal communities and identifies the contribution of local knowledge that can be an asset to the creation of such technologies. It also

Table 21.1 Grassroots responses during the post-disaster situation in Gabura, Bangladesh

Grassroots response		With aid and outside interventions	Without outside intervention
Livelihoods		Elevated land is used for mangrove plantations and regeneration. Low lying land is used for shrimp and crab farming and fishing and fish processing	At household level people are engaging in fishing and boat puller. The boats are tying down to secure from gusty winds
Food/health	Food storage	Having experience of cyclone Aila, underground storage used to preserve the dry food and others utensils in community levels	The dry food, matchboxes, mud chulli (cooker), homestead fuel are stored above flood level on the side shelf, on the bed top or on the wooden false ceiling underneath the roof
	Water	UNICEF and DPHE are providing water tank to the community people for rainwater harvesting	The villagers are Harvesting rainwater by using plastic sheet on roof and sealed water clay pots and preserve sweet water pond for cooking and potable purpose
	Plantation	Plantation can protect the embankment from gusty wind and storm surge and the soil erosion from excessive rainfall; few local NGOs are helping to secure the natural resources	Plantation in household level as a source of housing construction like sidewall, source of food and vegetable or firewood or physical boundary of housing
	Poultry/farming	In community level a common space is preserved for homestead animal	The household women are making a small mud/ brick house for poultry farming in two levels in a temporal scale
	Toilet	A shared tin-shade toilet is allocated in community level for 4/5 families	In household level sometimes plumbing modified to allow upstairs toilet by using a pan with a sewerage pipe is adjoined the water flow to outside of the house
	Fuel	The community people are collecting straw and wood from the Sundarbans with controlled access by introducing a 'pass' system of the forest department	In household level the villagers are making some fuel ball with mud and straw for fuel

(continued)

Table 21.1 (continued)

Grassroots response		With aid and outside interventions	Without outside intervention
Shelter/ housing	Walls	Tin partition wall is provided to reduce climate hazards and the lower portion is colored to protect from salinity and rust The houses are relocated on high lands and on stilt	At household level the boundary wall is made by mud and provide shades on the top of the wall as protection from rainfall Battered and inclined walls are used. To strengthen the sidewalls straw, sticks and mud are combined together
	Roof	Roofing materials are changed to CI sheet or asbestos rather than goalpata (a leaf that is easy to collect from the Sundarbans used as thatched roof and it is highly vulnerable) and bamboo bracings are used	The roof is tied by rope to big trees or the embankment as to secure roofs from gusty wind or storm surge and the inclination is kept less than 40°
	Plinth	The plinth of the houses are raised up to 6/7 f. by cement plaster or brick soling experiencing from sea level rise in cyclone Aila as a protection from riverbank erosion	The plinth of the houses are raised up 4/5 f. without plaster and brick soling experiencing the sea level rise in cyclone Aila and a wooden ladder is provided to get inside the houses
	Yard	The gray yards in Gabura Island are now becoming green with lot of saline-tolerant crops and vegetables and mangroves regeneration prescribed by NGOs and AID agencies	In household level the people are using the snail and seashells and covering the yard as to reduce from soil erosion collected from the Sundarbans
Embankment		The embankment is elevated up to 8/10 f. from the sea levels and CNRS has taken initiatives for plantation (Babla tree) to protect from saline water flooding	The other sides of the embankment the people are engaging to regenerate the mangroves and cropping on the low land

Source: Field observation, 2015

explores the idea that technologies are the outcomes of novel uses of livelihood resources. However, it remains to find ways to foster a community's trust in locally developed technology to support the process of climate change adaptation. The role of livelihood resources, in particular indigenous knowledge, is established in the literature, but requires study for a deeper understanding of its place-based significance in Gabura.

While the role of social capital in adaptation process has been articulated at large in climate change literature (Narayan-Parker 1999; Woolcock and Narayan 2000; Woolcock 1998), trust is an important dimension of social capital (bonding,

bridging and linking networks) has been less well researched and requires further study in relation to grassroots technology and climate change adaptation.

Real development for communities such as the people of Gabura will be achieved only when local people get involved in the decision making processes (Mercer et al. 2007) and community trust is enhanced and grassroots technologies are acknowledged formally as legitimate attempts to formulate adaptive responses. This can be achieved by taking a holistic approach to adaptation policy development.

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Chapter 05: Female contribution to grassroots innovation for climate change adaptation in Bangladesh

Chapter five is published as an article in the journal 'Climate and Development'. This chapter focuses on the opportunities opened up for women in absence of male community members through migration for employment. Women developed novel adaptation strategies through engagement with NGOs, changed gender roles based on their local knowledge and leveraging social capital to grassroots innovation (e.g., agricultural innovation and handmade production). This chapter answers the following sub research question: *'How do women contribute to grassroots innovation through local knowledge dissemination and building network relationships with NGOs?* The literature reviews were outlined on the roles of local knowledge and social capital relationship. This paper builds on the data collected through structured, semi-structured and key informant interviews, focus group discussions and questionnaire surveys. The paragraph below adds some clarifications that were not resolved within the publication.

- Survey administration protocol - The survey was administrated by gender-matched field researchers. For example, on those occasions where the female participants were uncomfortable in the presence of the male research assistant, the male research assistant left the venue. A similar strategy was followed for male participants.
- Cyclone Aila - Although cyclone Aila was a category 1 cyclone, the devastation it caused was long lasting due to the breakdown of embankment (flood levees),

that overtopped and permanently inundated the agricultural land causing water logging and salinity.

The published paper is attached in the following pages.

Table 5.1: Statement of authorship

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Author's contribution

Name of principal author (Candidate)	Momtaz Bintay Khalil
Contribution	Data collection and analysis Literature review Conceptual development Writing of manuscript Revision of drafts Acted as corresponding author

Co-author's contribution

Name of first co-author	Brent C. Jacobs
Contribution	Supervised development of work Assistance in data analysis Guidance in literature review Assistance in conceptual development Manuscript evaluation and edit
Name of second co-author	Kylie McKenna
Contribution	Supervised development of work Manuscript evaluation and edit
Name of third co-author	Natasha Kuruppu (Manuscript evaluation and edits)



Female contribution to grassroots innovation for climate change adaptation in Bangladesh

Momtaj Bintay Khalil , Brent C. Jacobs , Kylie McKenna & Natasha Kuruppu

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Female contribution to grassroots innovation for climate change adaptation in Bangladesh

Momtaj Bintay Khalil^{a,b}, Brent C. Jacobs^a, Kylie McKenna^a and Natasha Kuruppu^{c*}

^aInstitute for Sustainable Futures, University of Technology Sydney, Ultimo, Australia; ^bUrban and Regional Planning Department, Khulna University of Engineering and Technology, Khulna, Bangladesh; ^cInternational Institute for Global Health, United Nations University, Shibuya, Tokyo, Japan

ABSTRACT

This paper reports a mixed-method study from 2016 in Gabura, Bangladesh examining female contribution to climate change adaptation in the period post-cyclone Aila in 2009. Out of 110 households studied, male household members were absent in 66 cases because they had migrated to nearby towns and regional centres for alternative livelihood options. Male members' absence created opportunities for Gabura women to develop a range of novel adaptation strategies through engagement with aid agencies, changed gender roles, leveraging social capital and utilizing local knowledge. For example, women are increasingly contributing to income through works within and outside of the house in agricultural innovations and handmade productions. These adaptations are built on social capital and trust between community women and the NGOs through mobilization and sharing of local knowledge. Based on the findings, a framework for informed autonomous adaptation is proposed. The generalization of coastal women in developing contexts as passive victims of climate change due to social norms and instead highlights women's active agencies in adaptation is challenged. There is a need for a critical understanding of gender-specific dynamics in post-cyclone aid interventions towards *in-situ* climate change adaptation.

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Introduction



Bangladesh is highly vulnerable to climate change; its low-lying deltaic morphology exposes large areas of the country to inundation and sea-level rise. Twenty percent of the total population of Bangladesh lives below sea level; 32% of the country's total area is coastline and almost 23% of the land is inundated by flooding (Karim & Mimura, 2008). Historically, common extreme events such as cyclones, flooding and storm surges affect the coastal areas (Ahmed & Kelman, 2018; World Bank Group, 2017). On average, sea level is rising by 10–12 cm per decade (Bhuiyan & Dutta, 2012), resulting in negative effects on living standards, and threatening ecosystems, agriculture and coastal people's livelihoods. (World Bank, 2017). Human alterations of the landscape through the construction of embankments have reportedly made these coastal settlements more vulnerable to long-term inundation (Auerbach et al., 2015).

In 2009, tropical cyclone Aila severely disrupted the coastal island of Gabura, southwestern Bangladesh. Approximately 9.3 million people were affected and 500,000 people were left homeless (Khatun, Gossami, Akter, Paul, & Barman, 2017). Following Aila, long-term inundation disrupted the livelihoods of Gabura, which were mostly dependent on agriculture, fishing, shrimp farming and natural resource extraction from the Sundarbans (Alam, Asad, & Parvin, 2015; Mallick, Rahman, & Vogt, 2011). Post-Aila, socio-spatial shifts occurred due to male migration away from Gabura in search of alternate livelihoods. One such shift, the changed the role of women in the community, is the focus of our paper, which documents

women's contribution to grassroots innovation in climate change adaptation.

Studies have claimed that women in developing countries are more vulnerable than their male counterparts to the impacts of climate change (Cannon, 2002; Rahman, 2013; Sultana, 2010). Five factors contribute to gender inequality in developing countries (Edvardsson Björnberg & Hansson, 2013): power relations, economic resources, labour division, cultural patterns in social roles, and biological differences. Additionally, social-cultural roles and biological divisions between the genders shape gender relationships (Dankelman, 2008). A recent report identified important relative gaps between women and men arising under four key areas: health, education, economy and politics; differences likely to be further amplified under a changing climate (Ford et al., 2010; World Economic Forum, 2017).

In coastal Bangladesh, women are disproportionately affected by a range of climate impacts exacerbated by their impoverished and marginalized social settings (Agrawala, Ota, Ahmed, Smith, & van Aalst, 2003; Alston, 2015). For instance, women remain confined by cultural and religious norms within domestic premises (Cannon, 2002) and possess relatively limited access to knowledge (i.e. information, education, social networking and political support) and natural resources in comparison with men (Arora-Jonsson, 2011; Sultana, 2010). In rural settings, women are routinely marginalized in food security and water resource management, often working as labourers with limited involvement in decision-making

CONTACT Momtaj Bintay Khalil  Momtaj.B.Khalil@student.uts.edu.au  Assistant Professor, Department of Urban and Regional Planning, Khulna University of Engineering & Technology, Khulna 9203, Bangladesh

*Present address: UNEP- DTU, UN City, Copenhagen, Denmark.

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and at higher risk than men to health hazards (Dankelman, 2008; Efroymson, Biswas, & Ruma, 2007; Rahman, 2013, p. 76). Women bear the consequences of salinization of drinking water, because they are forced to travel long distances, often on foot, to collect domestic water supplies (Bagri, 2017; Rahman, 2013). Women are sometimes excluded from decision-making roles compared to their male counterparts (Dankelman, 2008; Denton, 2002; Haider, 2014; Nasreen, 2010; Sultana, 2010).

Gender discrimination may amplify the vulnerability of women to natural disasters at all stages of the emergency management cycle: risk, preparedness, response, physical and psycho-social impact and recovery (Enarson & Fordham, 2001). Women are less likely to receive critical information and social norms exclude them from disaster preparedness activities (Dasgupta, Şiriner, & De, 2010), a key component of emergency management (Ahsan, Takeuchi, Vink, & Warner, 2016). In coastal Bangladesh, women often have limited opportunity to escape from areas affected by disasters (Tanny & Rahman, 2017) because they are subject to reduced mobility due to strict gender codes of social behaviour. Only a third of women in Gabura received the evacuation order on the eve of Aila (Parvin, Sakamoto, Shaw, Nakagawa, & Sadik, 2019).

Despite generalized narratives of women's exclusions and passivity, this paper presents alternate narratives. Recalling Mohanty (1991), we argue that there are many overlapping intersections (e.g. colonialism, capitalism, race, gender, development, etc.) that govern the situation of women and influence their agency. Underpinned by a range of behavioural studies, Patt, Dazé, and Suarez (2009) argue that women have the capacity to contribute to climate change adaptation through the performance of their household roles. For instance, women's responsibilities encompass household duties, protection of children, the elderly and sick and belongings during flooding (Roy, Hanlon, & Hulme, 2016). An enhanced appreciation of their capacity to perform these responsibilities could alter the understanding of the relative impacts of climate change on men and women and strengthen community-based adaptation.

Climate change is a strong driver of adaptation mediated by aspects of community adaptive capacity (Pelling, 2010). Specifically, in Bangladesh, the consequences of climate change, such as flooding and cyclones, are the main drivers in the search for adaptation pathways (Mallick & Vogt, 2014). IPCC (2007) indicates that communities with limited financial resources have reduced adaptive capacities and are sensitive to effects on natural resources (i.e. local water and food supplies). Historically, in 'poor' coastal areas, communities are more inclined to seek immediate actions (short-term coping responses or autonomous adaptation) rather than the long-term, often less certain, planned adaptation strategies that may incur greater initial costs in terms of labour and financial resources (Adger, Huq, Brown, Conway, & Hulme, 2003). For women in such situations, cultural barriers are obstacles that restrict women's skills development and limit their ability to formulate adaptation strategies (Dasgupta et al., 2010; Nasreen, 2010).

Local knowledge is defined as a community knowledge resource that is transmitted orally over generations in a given locality; often considered synonymous with indigenous,

traditional or cultural knowledge of a community (Agrawal, 1995; Ellen, Parkes, & Bicker, 2000; Sillitoe 2006). Local knowledge is considered useful in a cross-cultural context to enable active participation between the 'insiders' (local people in a community) and the 'outsiders' (NGOs and other non-local actors) (Sillitoe 2006). Given that local knowledge is often an authentic reflection of the livelihoods, local culture and everyday life of local inhabitants (Warren & Cashman, 1988), even the least privileged member of a community has some knowledge to share of their practices (Orlove, Roncoli, Kabugo, & Majugu, 2010). Reference can be drawn from theoretical foundations of Hayami and Ruttan (1971, 1985), who argued that development of an innovation 'is a function of the resource endowments of the geographic regions in question' (Chhetri & Easterling, 2010). In this regard, local knowledge and the actors (i.e. women, in our case) who hold and utilize such knowledge can be considered as critical resources for adaptation.

Nelson, Meadows, Cannon, Morton, and Martin (2002) argue that gender should be considered seriously in understanding climate change impacts and adaptive capacity because most climate change issues, policies and programmes are not gender neutral. Until recently, scholars and the mainstream policymakers (including UNFCCC, IPCC) largely overlooked the issue of gender equality in climate change, paying little attention to female contributions to adaptation, despite increasing recognition of the role of women in other aspects of life in the developing world (MacGregor, 2010; Patt et al., 2009).

This paper examines the role of local knowledge and social capital in enabling climate change adaptation by Gabura women through dissemination of grassroots innovations in the post-cyclone Aila context. We argue that women are uniquely positioned to make a significant contribution to climate change adaptation due to their intimate links to the domestic context where they perform a range of important tasks (Alam & Rahman, 2014). Accordingly, women need to be explicitly and actively engaged in formal adaptation efforts if entrenched gender inequalities that mediate their vulnerability to climate change and other stressors are to be challenged; and thereby, overturn the prevailing perception that community adaptation is primarily the domain of male actors due to women's limited role in public decision-making. We aim to demonstrate that women are efficient mobilizers of local knowledge and can capitalize on knowledge sharing beyond their immediate household to enhance adaptive capacity, in particular, through their ability to form effective networks with external actors.

Study area and methodology

The study took place at Gabura Union, which is under Shyamnagar upazila of Satkhira District in Khulna division, Bangladesh (Gabura Union, 2015). Gabura is considered an island surrounded by two rivers (Figure 1). The south of the region was once part of the Sundarbans, the largest mangrove forest in the world, which usually serves as a bio-shield to protect the coast from cyclones and tidal surges. The Union covers an area of 33 square miles and consists of 15 villages, in nine wards with a total population of about 38,825 comprising

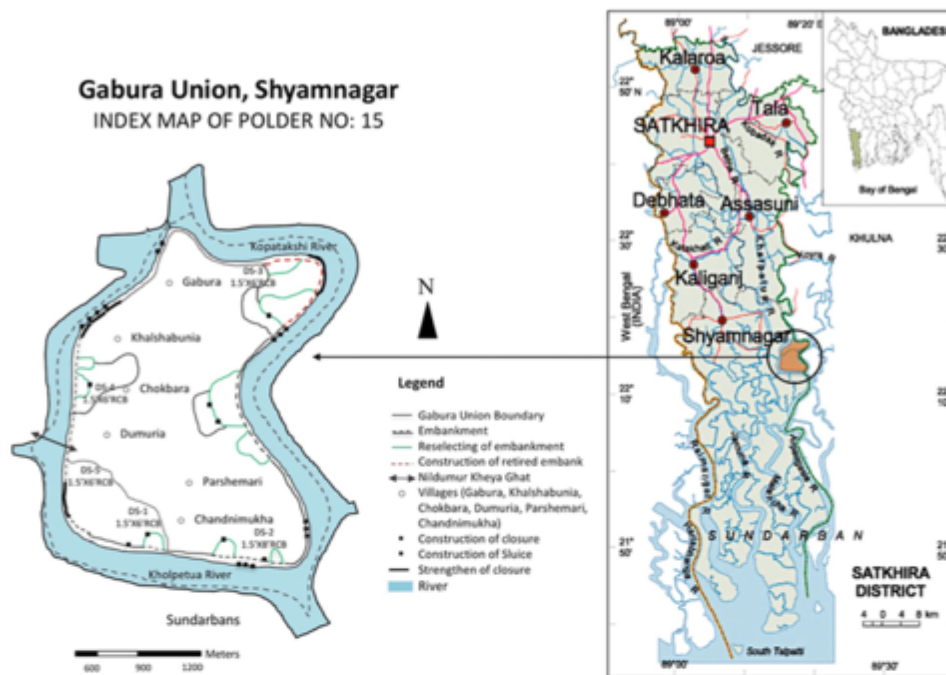


Figure 1. Gabura Union, Shyamnagar upazila, Khulna division, Bangladesh. Source: Google Maps.

approximately 7500 households with almost equally male-female gender ratio. The area is frequently subject to storm and tidal surges, cyclones, annual flooding, salinity intrusion and drought. Recent major cyclones include Sidr in 2007 and the super cyclone Aila in 2009.

Aila disrupted the island ecology, changed the livelihood structure and severely damaged croplands and mature fruit trees, which devastated local food production. Salt water inundation and prolonged water logging following Aila raised the level of soil salinity and polluted surface and ground water sources. The loss of local water sources required women to travel on foot for up to five hours a day to collect potable water. Also, the traditional agricultural practices, on which the majority of villagers relied, became unviable. The natural resource base of the Sundarbans was also depleted. This disruption to local ecosystem services fundamentally changed the livelihood patterns of the population by forcing new divisions of labour along lines of gender within and outside of the island and driving population displacement; up to 90% of males (especially the landless) migrated to cities (Kartiki, 2011; Mallick et al., 2011; Mallick & Vogt, 2014).

Historically, the Gabura community is both socio-economically and biophysically vulnerable. The major sources of vulnerability stemmed from a failure of local authorities to prioritize development in health and education. Literacy is low (about 31%), well below the national literacy rate. Limited employment opportunities mean the community relies on subsistence livelihoods and food production from low-lying agricultural land (Mallick et al., 2011; Mallick & Vogt, 2014). After Aila, Gabura women faced further challenges from

resource scarcity, social isolation and financial hardship, leading them to seek employment (Kartiki, 2011). Household members remaining in Gabura suffered high levels of economic crisis through the failure of the male household heads to provide regular remittances (Mallick & Vogt, 2014). With the exception of a few elite families with assets or well-established political and familial ties, Gabura women belonged to the lowest socio-economic cohort, and suffered from a range of intersecting social disadvantages (Gabura Union, 2015). These sources of vulnerability are likely to be amplified by increased frequency and intensity of extreme climate events. Gabura, therefore, provides an ideal case study to explore the adaptive strategies of women in a post-disaster context.

The lead author of this paper has an in-depth understanding of the changes that occurred in Gabura due to Aila, having conducted fieldwork there over several years (2012–2014) prior to the current study. The current case study was undertaken between January to April 2016. Data were collected through a mixed-method approach using face-to-face semi-structured interviews, household questionnaire surveys, focus group discussions (FGD), and ethnographic observations. Face-to-face interviews also involved local experts and key informants including the Chairman of Gabura Union, members of local government, local service providers (LSP), local trainers (LT), community-based organizations (CBOs), officials from non-government organizations (NGOs) at local and national level, and International NGOs (INGOs). The survey was undertaken in seven villages to cover the diverse impacts and changes caused by Aila. We identified key female respondents through local NGOs to have an overall understanding of women's role

Table 1. Sampling procedures and recruiting of research participants.

Categories	Nos	Samplings procedures and methods
Households	110	Selected at randomly through snowball sampling and NGOs and community member's recommendation
FGD	4	Participants selected purposively
Semi-structured interviews	35	Participants selected purposively
KII (local participants)	20	Mostly selected after completion of FGD and few through NGOs
KII (local Government)	7	Union Parishad Chairman, Member of UP, village leader (Morol & Morol wife) and female members
KII (NGOs officials, local level)	8	Selected purposively (NGF, Sushilon, FDMC, CREL, CNRS, World Vision, Uttoron, Dhaka Ahsania Mission)
KII (NGO officials, national level)	6	Selected purposely (CREL, CNRS, World vision, Uttoron, JJS, PKSF)
KII (INGOs officials)	4	USAID, Winrock International, UK aid (involved in Gabura since Aila)
KII (Academics)	7	Academics from KU, KUET, RU (Involved in Gabura research)
KII (Disaster practitioners)	3	Disaster practitioners and researchers in national level (involved in Gabura since Aila)

Source: Field observation, household survey at Gabura and Munshigang Union, Khulna division.

in adaptation and future preparedness for cyclones in the post-Aila context. The sampling procedures, methods and participant's selections are described in Table 1.

The findings from 35 face-to-face semi-structured interviews with the female household heads are reported here. The first 15 households were selected through snowball sampling, 8 households through NGO recommendations and the remaining 12 were selected after completing FGD. All female interviewees had their husbands or multiple male family members migrated to a nearby town or regional centres in search of economic opportunities. Among the 110 households involved in questionnaire surveys, male members were absent in Gabura in 66 cases.

The FGDs were conducted in four villages. The lead author's personal observations were recorded concurrently in a field diary and through photographs. The FGDs included both male and female participants (on average 80% female and 20% male). The interviews took place in participants' homes, public places and offices of NGOs officials. A further eight semi-structured interviews with the local NGO officers and staff, six interviews with the national level NGOs and four with INGO officials were conducted separately.

All interviews were audio-recorded, with participant consent, transcribed and anonymized. The qualitative data underwent thematic analysis in five phases, i.e. data collection, coding, searching themes, recordings and reviewing (Saldana 2015). A number of key themes emerged from this analysis; however, in this paper we will present analysis of the gendered dimensions of adaptation strategies with specific reference to female contributions only.

Results

In the initial stage of the fieldwork, a male household head offered a statement:

Receiving training in the name of climate change is a wastage of time. Floods and cyclones can happen any time; it is not in our hand. And when it will happen it is beyond our control. So, taking

training on preparation is absurd. We have everyday problem to deal with, if you have the money in pocket, everything can be solved. Why do not they give us money? If they want to do schooling, our women have plenty of time, we can't sit idle and learn new things like children at this stage. We have big responsibilities; we need to find real work. [Jamal, 52 years old, male household head]

This quote broadly reflects the views expressed by male community members involved in this study (about every 3 out of 5). It illustrates several paradoxes and misconceptions about climate change adaptation, in particular, how affected communities often disregard the importance of preparedness for natural disasters, which results in a neglect of knowledge acquisition in favour of short-term financial relief that is viewed as more lucrative. Most importantly, the quote portrays the patriarchal cultural norms, where male community members assume the responsibilities of 'real work' to look after families. In contrast, women are viewed as being idle within the household. The gender division of labour with an assumed male responsibility for the family situates women as passive role players. In this context, the attention on women by NGOs and their involvement in training is viewed as 'empowerment of women [that] threatens masculinities' (see Jackson, 2013, p. 1). While we accept that 'Men can also experience gendered vulnerabilities as men' (ibid p. 21), we argue that such a crisis of masculinity created opportunities for Gabura women to thrive. The following sections reveal women's changing role and agency in climate adaptation strategies and their contributions to the family that remain largely invisible to male household members.

Changing dimensions of women's work

As a consequence of climate change in coastal Bangladesh, temporary and permanent migration to cities for improved livelihood opportunities is a common response among male community members, leaving women alone to look after the family and children (Cannon, 2002; Sultana, 2010). Our findings indicate a similar trend with male community members taking advantage of greater social mobility to pursue employment outside of Gabura (Mallick & Vogt, 2014). While some men limit this pursuit of employment to daily commuting to the nearest town centre, such as Satkhira, most males opt for long-distance migration to a regional centre, such as Khulna city or to the capital city, Dhaka. This migration may take place on a seasonal basis. However, there are also instances of males relocating to these cities semi-permanently, restricting their family contact to annual visits. These changes to family arrangements have created a unique gap in villages where women have begun to pursue employment outside of their homes in search of adaptive solutions, and to explore less traditional livelihoods strategies. For example:

I worked 6 hours a day as a day labourer of maintaining my family in absence of my man. He went to Dhaka for job opportunities just after Aila leaving four children with me. After about six months I lost communication. Even I do not know if he is alive. But I cannot sit idle here. So, I started to take up this job of excavating earth to keep alive my children. [Flower, 39 years old, female]

Lack of communication or complete loss of connection with a male family member causes considerable tension within the

community. However, other tensions arise because of women's pursuit of non-traditional work outside of the home. For example:

I started doing mobile labour. Especially after Aila, there are a lot of reconstruction works, such as rebuilding the roads, rebuilding the embankment [see Figure 2(g,h)]. So, some opportunities of day labour opened up. However, because I am woman, I earn [250/300 BDT/ 3.0-3.5 USD] half of money than a male member earns. The overseer says that we are women, we are weak, and so we are less productive. But you know, we do not take break for smoking every hour. [Zobeda, 40 years old female, household head]

I started to do outside work with my husband just after Aila. Aila was so devastating. It left nothing to rely on. So, everybody has to move out to find options. But after the initial shock was over, we started to face the same old question, why would the house-wife need to go outside? And after you face this question more frequently you start to feel uneasy. So, I needed to find opportunities within home. And the NGOs opened the eye. [Maya, 32 years old female, household head]

These statements reflect a very common scenario for poor coastal women in Bangladesh after Aila. Baden, Green, Goetz, and Guhathakurta (1994) argued that women in Bangladesh value their emotional attachment to their families and they act to hold the family together in difficult situations; whereas in contrast, most males prefer to be independent. In the absence of male support for the family through their labour, for some women, male and female roles in Gabura were reversed. However, for others, social tensions (e.g. sexual harassment, exploitation, economic inequality, social status, etc.) in the community led them to become more proactive within the home. Domestic labour has always been predominantly performed by women through, for example, food preparation, water management, washing cloths and kitchen utensils, fuel collection, caring for children and poultry, domestic gardening, handicrafts making, etc. However, this labour is generally unpaid and not considered 'productive'. Consequently, in the aftermath of Aila, women were forced to explore alternative uses of labour (e.g. cutting earth, producing vegetables) in order to survive. Rani, for example, began vegetable gardening with the help of an NGO. Ultimately following training, she found employment as a LSP (Local Service Provider) making local handicrafts using materials provided by the NGO. She stated:

I am working as a LSP with an NGO. Initially I started with small gardening. But after some success, I took proper training from NGO to support my family financially. At home, with other five women together, we make handicrafts such as handmade panda, rabbit and dolls [in Figure 2(ab)], nakshi kantha [cloths with cultural designs in Figure 2(c)]. These items are exported to USA by the local NGOs (e.g. CREL, CNRS). We earn 40/60 tk per pieces [monthly income of BDT 4000-4500/ 50-55 USD]. NGOs provide the sewing materials. We also make mats from garden leaves and sell in the market [in Figure 2(d)]. My LSP responsibilities with NGOs I now train up other women, I am now financially solvent. [Rani, 40 years old female]

Other types of labour have become increasingly gender-defined in the post-Aila context. For example, 7 years after Aila, people in Gabura Union are still facing hardship in relation to the availability of drinking water. Water collection requires a long-distance journey (4-5 hours a day on foot or by boat) to the next nearest union at Munshigang. About

90% of the Gabura population are dependent on pond water, and PSF (Pond-Sand-Filter) are installed by the NGOs for cooking purposes (Harun & Kabir, 2013; Mallick et al., 2011). Sometimes water can be purchased from a water treatment plant, recently established by NGOs (e.g. Dhaka Ahsania Mission, Susilon and so on). However, the nearest plant is located a considerable distance from Gabura, making it an unsuitable and unaffordable source of daily water supplies (costs are BDT15-20 per day). Most households have installed a domestic Rainwater Harvesting System (RWHS) but, owing to seasonal variation in rainfall, it is not a secure source for year-round water supply. As a result, almost every day during summer women walk up to 6 km to the nearest safe water sources. This task exclusively falls to women, sometimes with support from children and girls resulting in absenteeism from schools. For example:

I have a 10 years old daughter. She was in class 2 but after the Aila she stopped school. Her father was quite reluctant in continuing her school, we needed hands for other important things at home. She walks 4 to 5 km to collect fresh water. But I know, she likes school and wants to go back. [Tara, 37 years old female, housewife]

Following Aila, there was a sharp increase in school absenteeism as children began to devote more time to supporting their mothers in household activities (e.g. water collection, cooking, washing utensils and clothes). Although initiatives to address absenteeism have been implemented (i.e. UNICEF, UNDP, BRAC providing education materials, textbooks, uniforms, constructing temporary learning centres, etc.) (Dankelman, 2008), there is considerable pressure from the family on girls to leave school.

I am the eldest one of a big family. I have 5 more sisters and a brother. My brother is the only earning member in our family, collecting fish and crabs from the Sundarbans and selling in the market. My father is very old and unable to work. I was enrolled in a college in Satkhira. Now my study has stopped for financial crisis. My two younger sisters have to leave school due to the crisis. I want to continue my studies and also I want to have a job to support my family financially. But Aila left only one option for me - work for the family's survival. So, I have taken some training from NGOs and started to work in handicrafts. [Lily, 21 years old female]

However, the intensification of gender-based oppression during the post-Aila period has led to some positive outcomes for women as they became more proactive in exploring diverse livelihood opportunities, which in turn has led to greater empowerment (Roy, 2012). A participant stated:

When I first started to participate in the workshop, I was very shy and hesitant and barely I could say my name in front to other people. Over time I learnt to speak out and now I am discussing and sharing our community problem and family problem to the other women and outsiders and also sharing my domestic knowledge and experience. [Shower, 32 years old female]

Women's contribution to innovation

The disruption to Gabura society caused by Aila has seen a slow shift in gender dynamics with the rigid and polarized male-female relationships apparently in decline. For example, one female household head, Alo, described the extreme hardship experienced during and immediately after Aila through lack



Figure 2. Examples of women's contribution to labour and income generation through making handmade products and working outside home. Source: Author's field observations, 2016.

of food, loss of livelihood options and her husband's unemployment. She stated:

Aila took away everything: house, household belongings, money, kitchen utensils, stored foods, everything, I lost my father. Aila almost stopped our lives. My husband was a farmer but for the saline water all agricultural lands are ruined and my husband is left with nothing to do. So, he started fishing from the canals of Sundarbans. But you could not do it daily. And what a mess - suddenly everybody becomes a fisherman. So, after a while he started to travel to the nearest city for work. I have three school going children, Aila also stopped their education at that time. [Ailo, 44 years old female household head]

Women's contribution to innovation in Gabura after cyclone Aila is most evident in changes to food production practices. Knowledge of practices to produce food crops on saline land appears to have existed in the community prior to Aila. However, the hardship in the aftermath of Aila stimulated networking with NGOs by women and allowed the transfer of new knowledge:

We believed that if we could connect to these women properly, they could turn these grey lands into green again. But we never expected that they were up for 'Gold'. These women are great innovators. When you reach to the edge of the cliff and nowhere to go, only then such innovations take place. [NGO worker]

Knowledge transfer was mediated through a number of local and INGOs (e.g. CREL, CNRS, Sushilon, FDMC, World Vision, PKSF, NGF, Uttoron and JJS) and involved training women in a range of small scale, home-based gardening, smart agricultural farming (SAF), fishing and poultry farming activities. NGOs advocated alternative and new coastal livelihood options in the agricultural sector on salt-tolerant soil, providing some materials for hand-manufactured products, also helping in the regeneration of mangroves as livelihood options and ecosystem protection. Observations from Gabura provide evidence of the success of women in a range of agricultural innovations, in particular, practices that mitigated the effects of salinization of soil using recycled organic materials. NGOs also provided seeds and economic support to promote the application of new practices. The success of these NGO programmes is evident in the widespread adoption by the Gabura community of food production systems such as tower method farming, sac/bag cultivation, composite farming system and cultivation on macha system (Figure 3(a,b,c and d), respectively). All these techniques reduce the impact of soil salinity on plant growth and maximize the utilization of space for food production (important in areas subject to prolonged inundation with seawater).

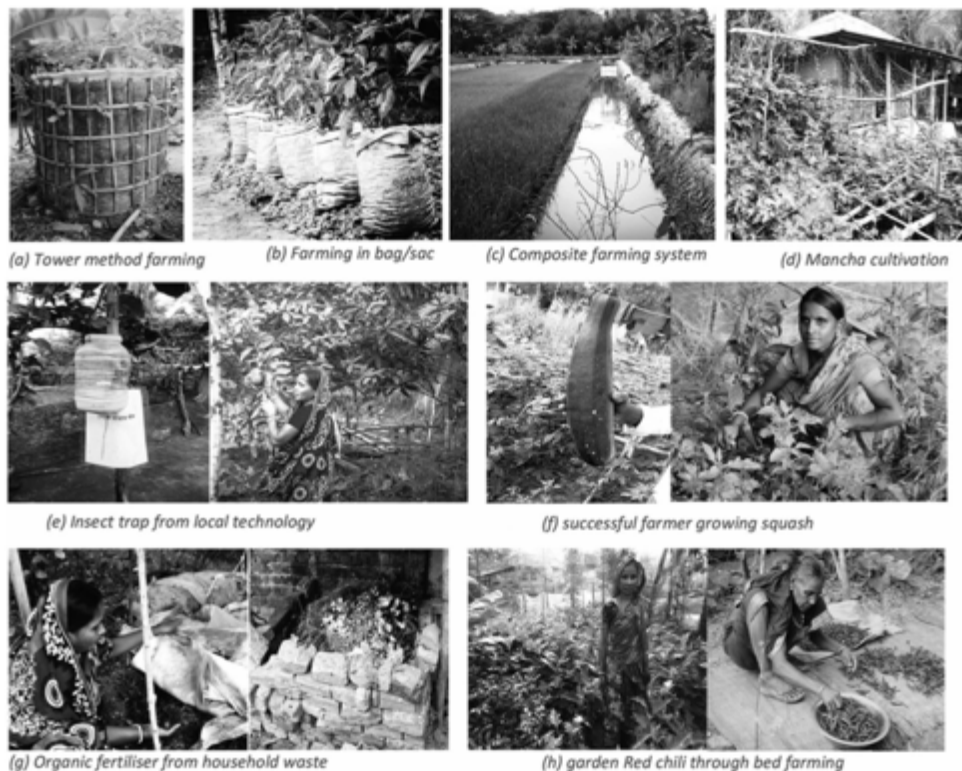


Figure 3. Women's contribution in agricultural innovations through NGO supports. Source: Field observation, 2016.

For example, Queen is a successful innovator through NGO support in Munshigang union, in the production of homemade organic compost for use in the *macha* system, to allow gardening on saline soil. Her role and contribution to salt-tolerant vegetable production were recognized through an award (50,000 BDT/USD 6025.00) from USAID in 2016 (personal communication with Sheikh Md. Ziaul Huque, regional coordinator, CREL). She has been a source of inspiration for the neighbourhood women in Gabura:

On 2011, after two years of Aila, I started to mix salty soil layer of my domestic yards with limestone and homemade organic fertilizer from household waste (Figure 3 g). I worked tirelessly over 14/16 h a day constantly with my husband in the hope that it would bring in change. Some of these techniques came from our old parents. But Aila's impact was so devastating. The sub-soil got polluted. Initially, the quantity of harvesting was in a small-scale, but we were happy. Then we took few trainings from NGOs 'tower method farming technology', 'bag cultivation'. As we had to put less labour on soil treatment, we grew [new crops] in the following season. Thus, we could solve our food problem for the whole year and we shared these new techniques with our neighbours and others interested from Gabura union. Many are benefiting. [Queen, 44 years old female household head]

Queen also added:

This is the first time we discovered and grew a new vegetable, 'squash' [Figure 3(f)], in our garden and we used homemade organic fertilizer on the soil and our locally made insect trap helping us to protect from insects [Figure 3(e)]. We got the seeds from

an international NGO (USAID) and the harvesting expectation is very good. This year we grow 40 kilograms squash and the size is big (Figure 3(f)). In future, we hope we will be able to grow this vegetable in a bigger scale and which will meet our economic support.

Another success story in agriculture came from Jasmine, who is also a successful example of a salt-adaptation vegetable gardener, working with an NGO as a LSP, she stated:

I took proper training to support my family financially. On 2011, I have started to grow salt-tolerant vegetables by providing limestone on the soil to reduce the saltiness from soil. Initially the harvesting was minimum but I kept trying to do succeed. Then I took some training from NGOs. They come to help us and teach us 'climate smart farming system' without providing chemical on soil rather using our organic fertilizer. On 2015 we were able to meet our expectation and growing more vegetables than previous year. Now I am working as a LSP with an NGO. [Jasmine, 45-years-old female, household head]

Reflecting on the agricultural innovation and how it inspired others, Happy added,

I am taking lessons from Jasmine as she took training properly from NGOs on smart farming and trained us. Initially our production was very slow but now following the farming method, I grew chili, tomato, squash and bitter gourd in a bigger scale, we fulfil our expectation and also selling in market after meeting the family needs. Now after five years of Aila we are surviving happily. [Happy, 35-years-old female household]

Table 2. Changes in women's lives before, during and after Aila. Source: Author.

	Before	During	After
A. Women's roles and contribution			
Economic activities	Women labour always engaged within domestic premises and sometimes outside to support husband in field processing of agricultural harvests and cattle rearing. Specific economic contribution of women seldom acknowledged.	Agricultural activities disrupted, women remained inactive during this period. Some level of engagement in disaster relief, hunting and labour in government's food for works programmes in government-led post-disaster infrastructure recovery	Increased engagement in domestic food production, primary entrepreneurs in salt-tolerant vegetable gardening using a range of methods, salt-based rice cultivation (i.e. Biri-R) with the help of NGOs. Day wage-labour, working as LSP, trainer with NGOs. Fishing and crab culture. Tailoring, knitting, handmade production (making mats from household leaves, fish net, fishing baskets), swing activities. Producing organic fertilizer from household waste, mobile chulli (burner).
Household income	Rarely accounted for, if any	Nil	Increased significantly (BDT 5000–7500 /USD 60–90 from BDT 1500–2500/USD 18–30)
B. Spheres of social capital			
Bonding networks (family /immediate relatives)	Always maintained strong family ties, however, remained mostly disempowered and ill-recognized	Maintained strong bonding ties with family members and gave psychological and labour support, however, not well recognized	Strengthened (in absence of male members through migration for employment) Supporting the family and male partner with new income opportunities Improved psychological support and overall wellbeing
Bridging networks (local community)	Maintained some community ties (mostly through religious institutions, such as madrasa), however, they were not appropriately mobilized to formulate effective adaptation strategies.	Minimal during the emergency response period to Aila. Focused primarily on individual and family survival	Became well organized through creation of women's group and shared economic practice
Linking networks (Outside the community)	Very minimum tokenistic level of involvement, sometimes only to increase the head count as recipient of relief or micro-finance borrowing	Centred on relief activities (i.e. food, water, shelter and livelihoods support) from NGOs, not long-term effectiveness	Strong relationships with NGOs and outside actors to work with and build on new strategies and opportunities for empowerment and to support the family and community
C. Local knowledge dissemination and employment			
Domestic agriculture	Small-scale domestic gardens, but economic opportunities not explored	Complete disruption. The whole island became unsuitable for gardening	New techniques adopted (such as, tower farming, bed farming, macha cultivation, composite farming system)
Drinking water management	Travel required to collect water	Water collection required from further distance	New household water filtration techniques Community level water conservation ponds (where women pump water to replace amount extracted)
Handicraft- based sharing economy	Practice existed to serve family needs but economic opportunities not exploited as a climate adaptation strategy	Complete disruption	Mainstreamed to explore economic potential (doll making, sewing, handloom, etc.) NGOs helped to link to the outside market and established new business partnerships

Source: Field observation, household survey and face-to-face interviews at Gabura Union, 2016.

Table 2 summarizes the changes in Gabura women's lives in three aspects: women's contributions, social capital spheres and local knowledge dissemination.

Discussion

In the traditional patriarchal village system in Gabura, women are socially and structurally marginalized both inside and outside of their homes. Bound by the culture they have very little decision-making power (Dankelman, 2008; Haider, 2014; Sultana, 2014). But as evident in our case study, women's participation with aid agencies has disrupted the historically constructed 'bias' against women in development policies and processes (Kanji, Tan, & Toulmin, 2007). Gabura women were active agents of change through subsistence activities within domestic premises that were 'upscaled' to long-term adaptation strategies in community settings. This finding aligns with other studies (e.g. Boserup, 2007) that suggest migration of male members opens up spaces for women. The devastation of cyclone Aila stimulated Gabura women to move away from the

local norms of domesticity and undertake significant transformative adaptation through knowledge exchange with NGOs and local knowledge sharing with other women. These opportunities arose as male community members in Gabura were more inclined towards relocation to regional centres for economic opportunities, creating social and economic voids in the community that women were required to fill, often as survival strategies (e.g. Ganapati, 2012).

Through this paper, we found that adaptive strategies differed between men and women, and we challenged the predominant conception that 'climate change adaptation is a male role'. Rather we explored the ways that women in Gabura emerged as role models of adaptation through their intimate links to their private domestic context and their willingness to engage with the outside world. With external support, largely through NGOs, they became key actors in mobilization and sharing of knowledge through their ability to form effective networks to trial, adopt and promote adaptation strategies. Previous researchers have theorized that successful innovation adoption of new technologies is the product of local social-

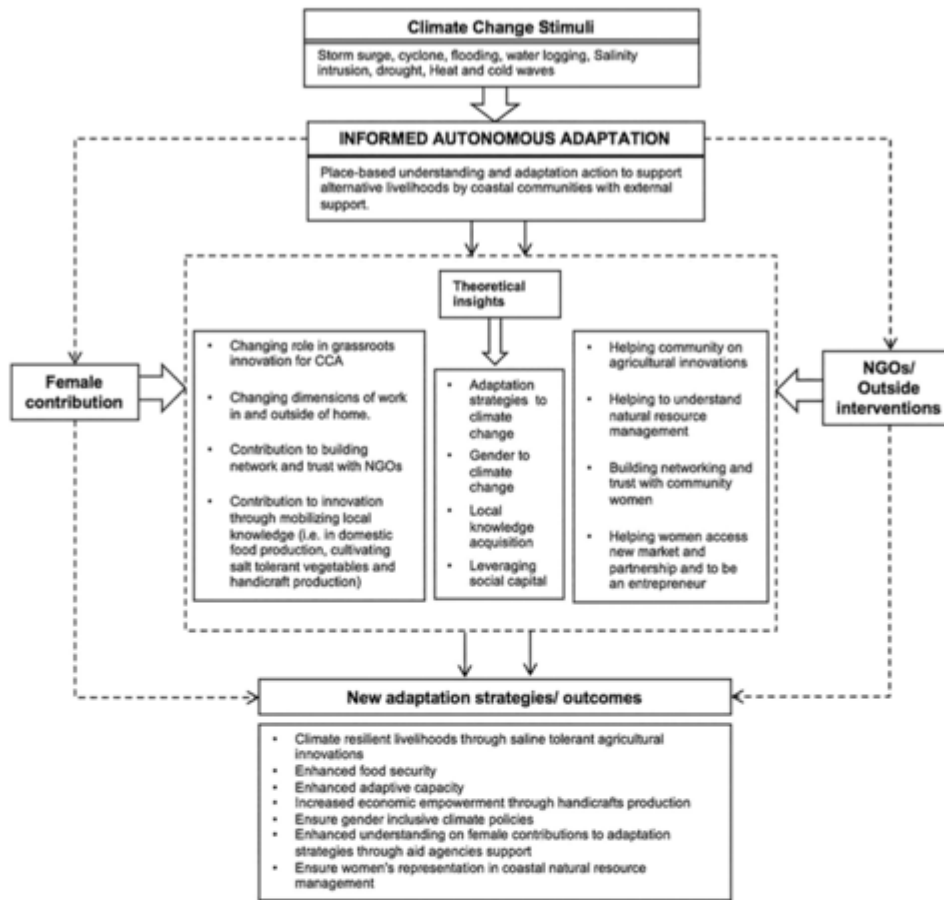


Figure 4. Conceptual framework for informed autonomous adaptation mediated through the female household's contributions and NGOs interventions. Source: author.

economic resource endowment leveraged by institutional arrangements (Chhetri, Easterling, Terando, & Mearns, 2010). Our findings provide further empirical support for the role of extreme climate events in theories of induced innovation in a development context and their convergence with an understanding of community adaptive capacity (Rodima-Taylor, Ollwig, & Chhetri, 2012).

We offer a conceptual model of the contribution of female households in climate change adaptation in a post-extreme-event context. Through this model, we propose a framework for 'informed autonomous adaptation' (Figure 4). The framework describes place-based understanding and adaptation action to support a range of outcomes through female contributions to the mobilization and acquisition of local knowledge, social capital and network building with the help of outside aid actors (such as NGOs) for grassroots innovation.

Changes occurred in the post-Aila context in Gabura in three main areas: changed gender roles; acquisition and sharing of new knowledge; and leveraging forms of social capital in household adaptation strategies. For example, we found

women's increasing contribution to adaptation through their changed role in food and handicraft production, the changing nature of their work outside of home, their involvement in diverse livelihoods options, building social capital and trust at multiple scales, especially with the NGOs, and finally in adoption and diffusion of innovations through mobilization and sharing local knowledge. These adaptation strategies enhanced climate resilient livelihoods through the adoption of saline-tolerant agricultural innovations (e.g. Figure 3). These findings are in keeping with those from other geographical and cultural contexts (e.g. Kuruppu, 2009 in the South Pacific; Ganapati, 2012 in Turkey, Joakim & Wismer, 2015 in Indonesia). Such innovations reinforce long-term climate change adaptation and vulnerability reduction by enhancing food and economic security for these communities (Rashid, 2014). The framework (Figure 4) points to the importance of women's representation in natural resource management as well as gender-inclusive climate policies, which are currently falling short in both adaptation research and practice, and need greater exploration (Roy, 2012).

Changed gender roles

There is general agreement that women in the developing world, especially in coastal areas, are highly vulnerable to climate-related extreme events (Cannon, 2002; Dankelman, 2008; Sultana, 2010). Exposure and sensitivity to hazards, such as cyclones, are recognized as strong drivers of adaptation mediated by the communities' adaptive capacity (e.g. Pelling, 2010). While the hardships that follow extreme climate events are undoubtedly severe, they can stimulate significant change in gender roles; specifically, we found women in Gabura were more actively engaged in developing strategies for disaster preparedness and mitigation, and at the same time, maintaining and preserving the environment (Roy, 2012). For example, Gabura women found work outside of their traditional domestic duties: increased engagement in domestic food production, in fishing and crab production, in cultivating salt-tolerant vegetables, in producing household organic fertilizer and applying it to remediate salinized soils, in production of handicrafts and in rearing poultry to be more financially solvent. In Gabura, women were a rich resource of local knowledge acquired through the lived experience of their environmental surroundings. In common with previous studies (e.g. Feldman & Welsh, 1995), we found Gabura women participated in training, which allowed them to capitalize on local knowledge, manage natural resources differently and improve household finances through access to markets for handmade products with NGO support. These kinds of adaptation strategies through entrepreneurship successfully improved women's lives (Joakim & Wismer, 2015; Roy, 2012).

Women were not only driven to acquire knowledge, but they also proved adept at sharing practical knowledge through their membership in relatively cohesive community networks (Feldman & Welsh, 1995; Gururani, 2002). In keeping with the findings of others, (Baden et al., 1994; Dankelman, 2008; Denton, 2002; Sultana, 2014), we found that prior to Aila the women of Gabura were largely confined within their domestic context because of deep religious and cultural boundaries. However, post-Aila, these women utilized their agency to combine place-based, tacit understanding of their situation with knowledge acquired from NGOs to transform their livelihoods, in particular for the production of food and small-scale industry. The women in Gabura increasingly disseminated knowledge and technologies related to their local context to enhance their existing practices, and to make them more resilient to, and prepared for, future climate and other stressors. In Gabura, women were pivotal in adopting innovative agricultural techniques, such as use of recycled organic materials as soil amendments to support household food production on saline soils. Other women developed small-scale industry based on traditional handicrafts to improve their financial situation. These findings are consistent with those of Kuruppu (2009) and Takasaki (2011, 2012) from Pacific Island communities. Importantly, the findings show that women shared their knowledge and success stories with neighbouring women in the village, which ensured the benefits of adoption were spread throughout their community and are consistent with theories on diffusion of innovation in sustainable practices (Rogers, 2003).

Leveraging social capital

Social capital can be considered as an umbrella concept for understanding a range of social factors and institutional changes within communities (Narayan-Parker, 1999). The role of social capital in community resilience to natural disasters has received considerable recent attention (e.g. Cretney, 2018; Meyer, 2018) with both attitudinal (norms and values) and structural (networks) dimensions identified as important (Hooghe & Stolle, 2003). We found evidence in Gabura of gender differences in both attitudinal and structural dimensions of social capital. Compared to women, men were less inclined to see value in training and skills development, less attached to place and emphasized the value of financial support post-Aila. In relation to structural aspects of social capital, bonding and bridging ties support development of relationships and trustworthiness, maintain relations in a family, and sometimes networks within a community (Ostrom & Ahn, 2009; Woolcock, 2001). Women were effective at building and using these types of connections in support of adaptation in the post-Aila situation. Such social ties are considered a fundamental resource in a community for climate-change adaptation (Pelling, 2010).

The third type of structural social capital, linking (Woolcock, 2001), was also critical to adaptation. Through our study, we found women in Gabura were key actors in developing linking networks with NGOs. NGOs made significant contributions to the Gabura community in disaster preparedness and recovery phases (through introducing new ideas on farming in saline soils). However, other authors have found that, in some cases, a lack of timely resource sharing with local communities and ineffective support in implementation of planning by NGOs and policymakers can delay disaster recovery processes (Khan & Rahman, 2007; Roy, Jahan, & Hulme, 2012). Our observations indicate that Gabura women are important mediators of local knowledge sharing and network building; findings likely to be applicable to other communities in coastal Bangladesh.

We found no evidence among Gabura women of the negative aspects of social capital: exclusion of outsiders, excess claims on group members, restrictions on individual freedoms, and downward levelling norms (Portes, 1998). However, lack of evidence does not necessarily imply that negative social capital did not exist, merely that our sampling techniques failed to uncover it. Murphy (2007) suggests that the magnitude of a disaster event may influence the effective utilization for recovery of pre-existing social capital by a community. It is also not possible to determine from our data how the current structure of social capital was influenced by community networks that existed prior to Aila or how pre-existing networks may have contributed to community members' participation in adaptation. These aspects of social capital require further study (e.g. Akbar & Aldrich, 2018).

Conclusion

Nielsen and Reenberg (2010) identified culture as a significant barrier to adaptation strategies to climate change that hinder

women's development. However, contemporary research on adaptation is beginning to overturn such stereotyping. For example, in Asia women are actively engaged in leadership roles and income generation through novel partnerships with outsiders (Giri, 2017), in South Asia women's empowerment has enabled successful linkages with NGOs bringing positive and successive changes to communities (Agarwal, 2015; Sultana, 2014). UNFCCC (2015) found that up to 43% of women contribute to the agricultural labour force in developing countries when they receive support from policymakers. Furthermore, Warren (2000) reported that half of the world's food is grown through the labour of women in developing countries. These success stories resonate with our findings to reaffirm the proposition that women can be effectively mobilized for successful adaptation with adequate institutional support (Rashid, 2014). We suggest that policymakers should empower women to take a more prominent role in adaptation to climate change to improve planning and implementation of adaptation strategies.

Our findings align with the concept of cartographies of struggle (Mohanty 1991) in that women's vulnerability emerges through the intersection of a range of factors and their agency. In Gabura, because women were bound largely by culture to remain *in situ* in a post-disaster context, external support (through knowledge dissemination, in-kind and cash incentives) was critical to their empowerment. Our conceptual framework (Figure 4), of 'informed autonomous adaptation' suggests that the changes in post-Aila Gabura occurred through changing gender roles, acquisition and sharing of knowledge, and development of social capital between insider women and outsider aid agencies. A key finding of this study is how aid agencies can empower women by attending to their customized needs in a range of home-based, small-scale livelihood opportunities rather than seeking to serve everybody through more traditional 'aid-centric' interventions, now considered obsolete. The findings reinforce earlier arguments that women's oppression or empowerment is 'relational' (Rubin, 1975).

Women in coastal Bangladesh are stereotyped as less competent than men in responding to a range of post-disaster difficulties. However, our findings emphasize the agency of Gabura women, post-Aila, as homemakers, critical mobilizers of local knowledge, and reliable mediators of forms of social capital in support of grassroots innovation for climate adaptation. We call for more sensitive engagement with the intersectional nature of women's vulnerability. Furthermore, we accept that gender dynamics and NGO relations may operate differently in other coastal communities, that men are also part of the 'topography of these climate change induced landscapes' and that men's roles in adaptation should not be excluded from consideration (Chant & Gutmann, 2002). Our findings emphasize the need for a critical understanding of gender-specific needs and a re-evaluation of *in-situ* adaptive capacities of both women and men to inform policy engagement with women on vulnerability reduction to future cyclones in coastal communities of Bangladesh.

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Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

Momtaj Bintay Khalil is a PhD candidate in the University of Technology Sydney's Institute for Sustainable Futures. Momtaj is also a faculty (on research leave) in the Urban and Regional Planning Department at Khulna University of Engineering and Technology, Bangladesh. Momtaj holds Master of Urban Design degree from the University of Hong Kong. Her research interests include climate change adaptation, gender, women, social capital and local knowledge.

Brent Jacobs is an Associate Professor and Research Director in the University of Technology Sydney's Institute for Sustainable Futures. His current research interests include transformation, vulnerability and adaptive capacity of communities to support climate change adaptation. He leads the Adaptive Communities Node of the New South Wales Climate Adaptation Research Hub.

Kylie McKenna is an Associate and an acting Director of the Centre for Social Research at Papua New Guinea's Divine Word University, while on leave from her position at the Institute for Sustainable Futures at University of Technology Sydney. Her expertise is in helping stakeholders identify, analyze and respond to challenges of social and environmental change, work which she has applied in an international development context especially in PNG for the past decade. Kylie was awarded a PhD in Sociology from the Australian National University in 2012, and is the author of Corporate Social Responsibility and National Resource Conflict published in 2016 (Routledge).

Natasha Kuruppu is a climate adaption specialist (PhD) whose work has focused on community adaptation in the Asia-Pacific region. More recently she has been working within the nexus of theory and practice and supporting the work packages of UN Environment, policy makers, private sector and communities in developing countries integrate and operationalize climate adaptation initiatives at various levels of governance. She also advises and supports government agencies in the Pacific Islands implement adaptation related activities in meeting their National Determined Contributions under the Paris Agreement. Her main interests are in building the capacity amongst climate vulnerable communities and adaptation scholars/practitioners in developing countries so they are empowered to take a lead in defining and shaping their own climate resilient development pathways.

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Chapter 06: Linking social capital and gender relationship in adaptation to a post-cyclone context

Chapter six was submitted as an article to the journal '*International Journal of Disaster Risk Reduction*', has been peer-reviewed and is now under authors' revision. This chapter focuses on three forms of social capital relationships (bonding-bridging-linking networks) that are useful for the Gabura coastal community. Social capital is a factor in adaptation, in particular, how linking social capital plays an important role for making a social network among women and NGOs that contributed to strengthen bonding and bridging social capital in post cyclone context. This chapter answers the following sub research question: '*What is the role of linking social capital in helping to reconstruct other forms of social capital to support climate change adaptation?*' Data were collected in mixed method approach based on household questionnaire survey and semi-structured and key informant interviews with the participants (household head and NGOs staff). The literature reviews described the three forms of social capital (bonding, bridging, and linking) relationships and their dynamics that contribute to women's adaptation responses in a post-cyclone recovery context.

The under-revision manuscript is attached in the following pages.

Table 6.1: Statement of authorship

Title of paper (Chapter 6)	Linking social capital and gender relationship in adaptation to a post-cyclone context
Publication status	Under revision by author
Publication details	Khalil, M. B., Jacobs, B. C., McKenna, K. Linking social capital and gender relationship in adaptation to a post-cyclone context. <i>International Journal of Disaster Risk Reduction</i> (under revision)

Author's contribution

Principal author (Candidate)	Momtaz Bintay Khalil
Contribution	Data collection and analysis Literature review Conceptual development Writing of manuscript Revision of drafts Acted as corresponding author

Co-author's contribution

Name of first co-author	Brent C. Jacobs
Contribution	Supervised development of work Assistance in data analysis Guidance in literature review Assistance in conceptual development Manuscript evaluation and edits
Second co-author	Kylie McKenna
Contribution	Supervised development of work Manuscript evaluation and edits

Linking social capital and gender relationship in adaptation to a post-cyclone context

Abstract

Linking social capital refers to the relationship between a community of insiders (e.g. family, relatives, neighbourhood), outside organisations (e.g. NGOs, aid agencies) and other individuals. Its value in climate change adaptation is widely accepted in developing countries because it can enable access to local knowledge and resources. Women in coastal Bangladesh are subject to exclusion from access to natural resources and are frequently unable to connect with outsiders because of socio-cultural and religious barriers leading to a lack of opportunity for interaction with linking actors. To explore changes in linking social capital for adaptation among women in the post-cyclone Aila-2009 context, a mixed method approach was employed in the villages of Gabura Union (Bangladesh). We argue that the social disruption caused by Aila allowed women formed links with NGOs, contributing to local adaptive responses (e.g. in agricultural innovation and household handicrafts production). Our observations suggest that of the three commonly identified forms of social capital (i.e. bonding, bridging and linking), bonding relationships within the family appeared to become weaker after a major disaster, which may be attributed to the greater mobility of male family members to search for new economic opportunities in cities. Over time, linking relationships with NGOs contributed to strengthening bonding and bridging among women through establishment of social networks for knowledge sharing and production. These altered relationships and enhancement of linking social capital have produced new adaptation strategies in a post-cyclone context.

Keywords: Linking social capital, gender, women, NGOs, post-cyclone adaptation, Bangladesh

1 Introduction

Bangladesh is ranked the fifth highest disaster-risk country in the world due to its exposure to sea level rise (Ahmed and Kelman, 2018; World Risk Report, 2016). Extreme weather events associated with climate change, such as cyclones, flooding and storm surges threaten the lives and livelihoods of communities in coastal parts of the country (Agrawala et al., 2003; Alam & Collins, 2010; Shameem et al., 2014). Women are affected disproportionately by natural disasters (Cannon, 2002) because domestic tasks, such as provision of water (Sultana, 2010), food and fuel for their households become more time consuming in the aftermath of such events (Rahman, 2013; UN Women, 2014). Despite this, the gendered dimensions of the impacts of extreme weather events on lives and livelihoods have been neglected until recently (Alston, 2015; Nelson et al., 2002).

Compounding these existing vulnerabilities for women, the patriarchal society of Bangladesh confines women in the domestic sphere (Cannon, 2002; Nasreen, 2010; Rahman, 2013); meaning they are frequently unable to connect with 'outsiders' because of socio-cultural restrictions that constrain women's mobility (Ayeb-Karlsson et al., 2019; Jordan, 2019). As a result, women in coastal Bangladesh suffer relatively higher exposure to food insecurity, scarcity of alternative livelihoods, and are marginalised as labourers (UN Women, 2014; Tanny & Rahman, 2016). Historically women's role in decision making relating to climatic events is limited. They are generally excluded from engagement in participatory action (Agrawal, 2001; Alston, 2015; Djoudi & Brockhaus, 2011 p.126). As a consequence, women's contributions to

adaptation often go unrecognised by policy makers (Alston, 2015; Denton, 2002; Rahman, 2013). The undervaluing of women's contributions to adaptation and exclusionary attitudes towards them, exacerbate existing challenges for women related to uneven resource access (Alam & Collins 2010; Denton, 2002). Despite efforts towards vulnerability reduction by policy makers; the involvement of women in long-term post-disaster preparedness and mitigation remains limited. For example, mainstreaming adaptation in planning (Ayers et al., 2014) is an examples of policy activities for climate change where women are not involved. However, there are opportunities to understand current and potential roles for women in adaptation through deeper analysis and greater involvement of women in interactions with linking actors (i.e. NGOs).

NGOs have been important agents of linking networks in Bangladesh over the past two decades in facilitating opportunities for community empowerment (Islam, 2016; Mojumder & Panday, 2019; Murtaza, 2012). In particular, NGOs are helping empower women through their participation in climate adaptation training (Islam, 2015; Kabir et al., 2019; Labonte, 2004). In some cases, male migration opens up spaces for women to work outside of their homes for economic development (Kartiki, 2011, Khalil et al., 2020). For example, NGOs support women to generate alternative sources of income (such as fish and shrimp farming, mangrove regeneration, and saline-tolerant farming practices etc.) (Murtaza, 2012; Sarker, 2010; Shameem et al., 2014). NGOs play a role in these activities through the establishment of new relationships and networks built on trust, for example, microfinance activities (Dowla, 2006) and exchange of knowledge with the grassroots communities (Cummings et al., 2019). For example, UNDP's (2015, 2016) 'Growing Together in Bangladesh' program encourages

collaboration among community farmers (especially women farmers) and policy makers; these types of initiatives reinforce women's leadership skills, promote grassroots technology adoption and improve food security.

Despite the recognised benefits of NGOs in supporting women's contributions to adaptation, the role of women in initiating these linking networks is less recognised (Lowndes, 2004). Instead, women are often stereotyped as victims of disasters, excluded and passive recipients of assistance from aid agencies (Labonte, 2004). Women's exclusion from access to information and communication channels appears to render them unable to benefit fully from post-disaster development aid (Mahmud & Prowse, 2012). This paper challenges these assumptions through examination of the roles women have played in establishing effective linking networks for climate change adaptation in coastal Bangladesh. The focus here is on the relationships among women and NGOs using a 'social capital' lens, to explore the research question: *'how linking social capital operates in helping to reconstruct other forms of social capital to support women's adaptation in a post-cyclone context'*.

In the following section, this paper explores the three common forms of social capital relationships described by Woolcock (2001); and Woolcock and Narayan (2000) (i.e. bonding, bridging and linking, see Table 1). Then the paper begins with a review of the theoretical framework of social capital relationships with a specific focus on gender and women's contributions to climate change adaptation. Following an outline of the definitions of social capital and its conceptual origins, we then explain the case-study area of Gabura, and the research methods used in our analysis. This includes results of a household questionnaire survey among Gabura household members (male and

female) and some selected NGOs officials and also included with semi-structured interviews. Drawing on this data, we show how Gabura women have been able to enhance adaptive capacity by mobilizing their local knowledge through networking with NGOs. While all three forms of social capital are important for these coastal communities in Bangladesh, we argue that, through collaboration with NGOs, linking social capital is a key driver for the empowerment of women in climate adaptation; in particular, linking relationships are required to strengthen bonding and bridging relationships in a post-disaster context. These findings could inform gender differentiated policy development, which expands on previous research in this context (e.g. Masud-all-Kamal and Hassan, 2018; Islam and Walkenden, 2015).

Table 1 describes the characteristics of the three forms of social capital.

Table 1: Bonding, bridging and linking social capital and their relationships

Social Relationships	Themes	Characteristics
Bonding	Homogeneous relationship between insiders of a community (i.e. family, relatives, and close friends)	Horizontal and strong ties, thick trust, internal connections
Bridging	Heterogeneous relationship between insiders and outsiders who are acquaintances (i.e. relatives, friends and neighbours)	Horizontal and weak ties, thin trust, internal and external connections
Linking	Vertical relationship between community insiders and outsiders (i.e. aid agencies, NGOs, community based organizations and local Government) to resources access	Vertical and weak ties, thin trust, external connections

Source: Woolcock (2001), Woolcock and Narayan (2000)

2 Social capital relationship

Social capital is broadly defined as social connections and relationships (Adger, 2003). It is associated with a range of terms, such as: 'trust', 'values', 'ties', 'trustworthiness', 'connections', and 'networks', and has been defined by social scientists from various disciplinary backgrounds (i.e. Adger, 2003; Bourdieu, 1989; Coleman, 1988; Putnam, 1995; Woolcock, 2004). However, in this paper we choose a common overlapping definition applied in climate change: the trust and social networking relationships among actors for climate change adaptation (Adger, 2003; Pelling and High, 2005). Social capital incorporates a range of multilevel dimensions; micro (individual), meso (group) and macro (societal) (Coleman, 1988; Putnam, 1995). Putnam (1995) emphasises the micro-level dimensions and argues that social capital is synonymous with individual trust. The work of Bourdieu (1989) and Coleman (1988) highlighted social capital at the meso level-that is, to enable access to resources through networking connections and relationships among actors (i.e. community and social groups). Lin (1999b) and Portes (2000) conceptualized social capital as rooted in social networks and relationships. Narayan and Cassidy (2001) measured social capital among people in Ghana and Uganda and identified connections and trustworthiness as the components that link two-different groups in resource distribution.

Social capital can be viewed as the 'lubricant' of a society that can smooth relationships among actors through the establishment of trust (Burt, 2005; Field, 2003; Pelling, 2010). Rostila (2011) highlighted social capital as embedded in two facets of social relations facilitated at the individual and collective levels. Two forms of

connections were identified: 'bonding' among family and 'bridging' among those who do not hold a close connection, described by Putnam (2000) in his book 'Bowling Alone'. Woolcock and Narayan (2000) addressed bonding and bridging relationships among formal and informal actors. Adger (2003) and Islam & Walkerden (2014) described bonding social capital as based on family kinship and ties and distinguished this from linking social capital, which is based on trust and reciprocity with externals. Some recent studies, (e.g. Hsueh, 2019; Kawamoto and Kim, 2019; Monteil et al., 2020) pay more attention to the roles of the three forms of social capital in supporting processes in post-disaster recovery, which are important to enhance adaptive capacity to climate change for resource management and economic wellbeing (Adger, 2003; Pelling & High, 2005).

In the Bangladesh context, social capital acts as a factor in support of adaptation and plays an important role in household recovery process in cyclone affected communities, (Islam and Walkerden, 2015; Masud-All-Kamal and Hassan, 2018). Jordan (2015) reported that in the context of 2007's cyclone Sidr in Bangladesh, social capital assisted in identifying the future challenges to disaster resilience mediated through links at household level. Trust and network relationships are central to bridge new connections between insiders and outsiders (Islam and Walkerden, 2014). For example, Masud-All-Kamal and Hassan (2018) reported on the roles of social capital in two Bangladesh village communities affected by cyclone Aila. They identified bonding and bridging social capital as important during the emergency period, but for long term recovery, linking social capital was beneficial to access livelihood resources, ensure food security and support cash-for-work programs. Hawkins and Maurer (2009) studied 40 families in New Orleans following Hurricane Katrina and showed

that bonding and bridging relationships initially worked to strengthen relationships among affected communities in sharing belongings, but that for longer term economic survival establishment of linking with outsiders was necessary for access to resources.

Figure 1 illustrates the relationships in between the three forms of social capitals and how the relationships work.

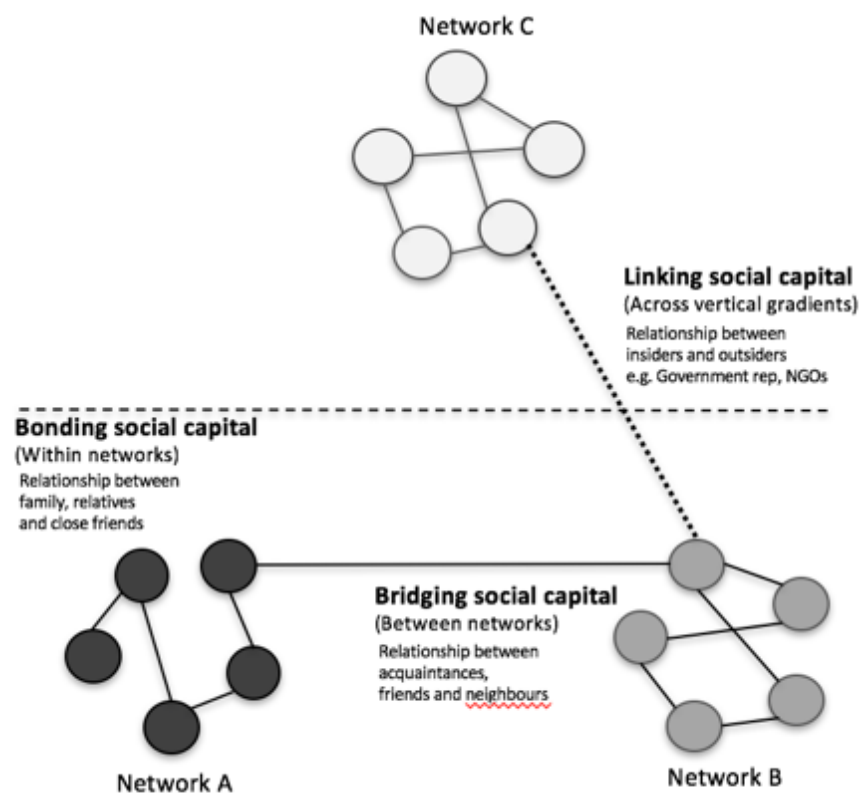


Figure 1: The three forms of social capital relationship (bonding, bridging and linking).

Source: Redrawn by author, adapted from Aldrich (2011)

2.1 Bonding social capital

Bonding social capital is a horizontal tie and a sense of belonging associated with trust and connections among family, relatives and close friends (Narayan, 1999; Woolcock, 1998). It is the most homogeneous relationship, developed through a sense of belonging and ties within family members. The bonding relationship is crucial for the immediate physical and psychological support among family, close friends and neighbourhoods in the post-disaster recovery period (Hsueh, 2019). In the Bangladesh context, due to socio-cultural and religious restrictions, women are restricted in working outside of home, are afforded limited mobility and, therefore, are unable to connect with outsiders (Ayeb-Karlsson et al., 2019; Rahman, 2013; UN Women, 2014 p.9). As a result of these restrictions, women are emotionally attached to family and bonding ties them strongly together, compared to men (Dankelman, 2008). Islam and Walkerden, (2014) suggested that bonding relationships are always useful in the Bangladesh context and do not break down to support basic needs provision for families (i.e. food intake) during the immediate response of recovery processes.

2.2 Bridging social capital

In contrast to bonding, bridging relationships play an important role in connecting dissimilar groups with non-intimate individuals and acquaintances (i.e. relatives, friends and neighbours) (Woolcock, 2000). Granovetter (1973) argues that bridging ties are important in the transmission of novel information through social contacts with individuals outside the family group. Bridging relationships enable access to resources

and information, facilitated through civic engagement (Granovetter, 1983; Hsueh, 2019). For example, sharing household of resources and belongings (i.e. food, shelter, water resources) is a common bridging practice among rural women in Bangladesh (Islam and Walkerden, 2014). Some authors suggest that bridging relationships are a particular type of social network in a community that people develop among neighbours to support their livelihoods and recover from losses following disruptive events such as natural disasters (Islam and Walkerden, 2014; Jordan, 2015). Ganapati (2012) suggested that bridging connections among women could strengthen their capacity towards empowerment and reduce their vulnerability.

2.3 Linking social capital

Linking is a special form of social capital embedded in social networks and relationships (Lin, 1999a; Putnam, 1995). Linking social capital refers to the vertical relationships among community insiders and outsiders (Woolcock, 2001). It is often associated with 'weak ties' as it operates among dissimilar groups (Woolcock, 2000). In developing countries, however, linking social capital represents 'strong ties', as the link with NGOs provides resource access, community empow/erment and economic development options (Adger, 2003; Islam, 2016). For example, Nikkhah and Redzuan (2010) examined women's participation with NGOs in Iran and discovered economic sustainability increased through the relationships between community women and local NGOs through empowerment. Trust and networks are components of the community's successful relationships in a disaster recovery phase (Kawamoto and Kim, 2019; Nakagawa and Shaw, 2004).

In the Bangladesh context, linking relationships are important in reducing the impacts of climate change during disaster recovery phases (Islam, 2016; Islam and Walkerden, 2014, 2015; Masud-All-Kamal and Hassan, 2018). A dramatic rise in the activity of NGOs in Bangladesh's coastal belt since Sidr in 2007 suggests an increasingly prominent role in social support, some of which has been targeted at empowerment of women through, for example, microcredit programmes for female-led business enterprises to enhance economic flexibility (Mojumder and Panday, 2019). Linking relationships with NGOs improve disaster recovery through physical and financial capital supports (Islam and Walkerden, 2015). These findings are further supported by Agrawal (2015) and Azim and Sultan (2010). Kabir et al. (2019) documented, in the South Asian context, that women's empowerment was enabled through successful economic outcomes in linking networks.

2.4 Linking social capital and gender relationship gap

A gross generalization about rural coastal women is that they are passive recipients of aid agencies and receive unequal economic access in the workplace due to unfavourable wage distribution (Bakshi et al., 2019; Esarey & Chirillo, 2013). Socio-cultural and religious barriers restrict women's opportunities of working outside of home, which renders them less visible and leads to intensification of a range of vulnerabilities (Rahman, 2013). Due to a lack of access to information and technology, rural women in Bangladesh remained overlooked by policy makers (Alston, 2014; Hossain and Saiful, 2012). So, linking social capital is often seen as missing during recovery phases of a disaster because of unequal resource distribution, and

relationship gaps among actors can limit the establishment of linking networks (Islam & Walkerden, 2015; Masud-All-Kamal & Hassan, 2018). To some extent, coastal women are treated inequitably, for example through deprivation of relief material (Aise, 2019) and limited opportunities to access livelihood capitals (Alam & Rahman, 2017). This situation may be exacerbated because of a lack of strong linking ties with NGOs are associated with corrupt practices (Aase, 2019).

Despite the high degree of gender segregation in Bangladesh, some scholars emphasize that extreme climate events can trigger positive changes in gender relationships; women become more active in skill development, have strengthened coping capacity and assume community leadership roles through networking relationships with NGOs (Ashraf & Azad, 2015; Alam & Rahman, 2017). For instance, in Latin America women's involvement is the key issue in social changes to leading to alleviation of poverty (Molyneux, 2002). Boserup (2007) suggested women's contribution to agricultural industries that supported economic development resulted from links with NGOs. The role of social capital in networking, then, is beneficial in women's empowerment during a disaster recovery phase (Ganapati, 2012). Similar scenarios were found in the last two decades in Bangladesh, where women's involvement and networking with NGOs raised their economic sustainability through empowerment (Islam, 2016; Kabir et al., 2019). In a post-cyclone context, social capital and linking relationships enhance adaptive capacity in coastal communities through the social connections with outsiders (Adger, 2003; Khalil et al., 2020; Pelling and High, 2005).

This paper will examine the importance of these three forms of social capital (bonding, bridging, linking) in a post-disaster context where women's contribution to adaptation may be enhanced through the connections with NGO. In particular, women's active participation in interventions by aid organizations may be an essential support for adaptation actions and enhanced adaptive capacity in a post-cyclone context (Khalil and Jacobs, 2021).

3 Methodology and study area

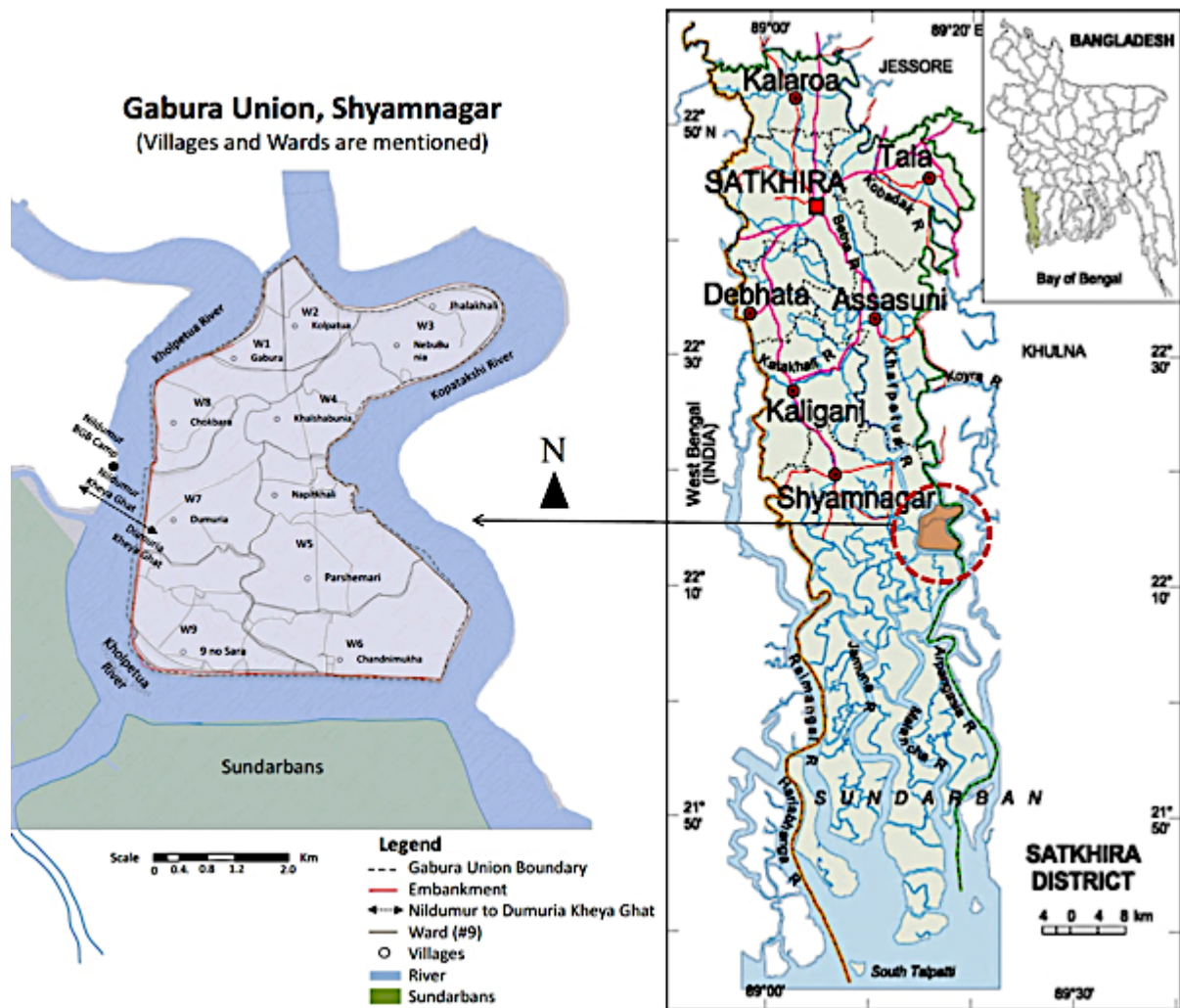


Figure 2: Gabura Union, the study location in Shyamnagar Upazila, Khulna Division.

Source: Adapted from Banglapedia (2014), redrawn by author.

The study was conducted at Gabura Union⁴² (see Figure 2) under Shamnagar *Upazila* of Satkhira District in Khulna Division of Bangladesh (the detailed information is available in the author's previous research, see Khalil et al., 2020; Khalil and Jacobs, 2021). Gabura is located in the south-western coastline of Bangladesh and consists of an island surrounded by two rivers. The southern part of Gabura is on the fringe of Sundarbans (enlisted as UNESCO World Heritage Sites) (see Khalil and Jacobs, 2021), the biggest mangrove forest in the world, which served as a bio-shield to protect the coast from cyclones and tidal surges. The Union covers an area of 85.5 square km and consists of 15 villages, with a total population of about 38,825 comprising approximately 7,500 households with almost equal male-female ratio (male - 19,307 and female - 19,518) (Gabura Union, 2015). The area is frequently subjected to storm surges, cyclones, annual flooding, salinity intrusion and drought (Khalil et al., 2020).

Gabura is one of the most disaster-affected unions in Shyamnagar (Gabura Union, 2015). The households and houses were completely destroyed in cyclone Aila, which was a category 1 cyclone that affected 3.9 million people and resulted in 190 deaths. In particular, the storm surge of Aila devastated vegetation and damaged and contaminated drinking water sources due to soil salinity. Prior to Aila, the livelihoods of Gabura were mostly agriculture dependent, including fishing from local rivers, cultivating crabs, shrimps and natural resources extraction from Sundarbans. Post-Aila, the Gabura landscape has changed due to drastic disruption of the island ecology and has affected the livelihood structure (Khalil and Jacobs, 2021). There was severe

⁴² Gabura Union is isolated by two rivers Kholpetua and Kopotakha on northern and western boundaries. The southern part was formerly the world's largest mangrove forest, the Sundarbans.

damage to croplands which devastated local food production and the land-based agricultural ecology was disturbed due to the storm surge, salinity intrusion and prolonged waterlogging (Gabura Union, 2015). The local ecosystem and natural resources of the Sundarbans were also depleted. This disruption changed the livelihood patterns, pushing population displacement (especially male migration to cities) by forcing new divisions of labour along lines of gender within and outside of the island (Mallick, 2014). Given these ongoing transformations, Gabura becomes an interesting case study to explore how women who remain in villages operate through links with NGOs.

The fieldwork took place between January and April in 2016. Seven villages in Gabura (i.e. Dumuria, Chokbara, 9 no Sara, Chadnimukha, Napitkhali, Jhalakhali, Nebu Bunia) were covered in this fieldwork to encompass the diverse impacts and changes caused by Aila. Data were collected through a mixed method approach (i.e. qualitative and quantitative) (Creswell, 1999; Creswell and Clark, 2007) using face-to-face and semi-structured household interviews, a household questionnaire survey, focus group discussions, and ethnographic observations. The fieldwork involved key informant interviews with the local experts including the Chairman of Gabura Union, members of local government (e.g. Local Service Providers, Local Trainers), community based organizations (CBOs), local and international NGOs, academics, disaster experts and practitioners from a range of fields. All the participants were selected purposively.

In total 110 household questionnaires survey were completed in seven different villages; among them male household members were absent in 66 cases, because they had migrated to nearby cities for livelihood opportunities. On average, 60% were

female households (aged 20-65, including the elderly and widows). A few participants were selected from the nearest Munshigang Union⁴³ who were successful in household agricultural innovations and were recommended by NGOs. The focus group discussions were conducted in four villages to follow up the key themes that arose during structured and semi-structured interviews. Both male and female household members were invited, and participation of both genders was ensured in all FGDs; although the percentage of female participants was greater than males in FGDs. The data relevant to the understanding of women's relationships and networks with the NGOs in future adaptation in the post-cyclone context are analysed in this paper.

The three forms of social capital (bonding, bridging and linking) were examined by asking the participants to reflect on their relationships with family members, neighbours and outsiders in pre-and post-Aila contexts. The following three key questions were asked: before and after Aila, Q1. How strong was the relationship with family members? Q2. How strong was the relationship with neighbours? Q3. How strong was the relationship with outsiders?

Questionnaire survey data on the three forms of social capital were tabulated according to gender. These data were depicted as a histogram using Microsoft Excel. The change in distribution of the proportions of social capital components before and

⁴³ Munshigang Union is located in Shyamnagar *Upazila* of Satkhira district. It is an area of about 39 square km with a total population is about 31832 with 7206 households. The livelihood is mainly agriculture and fishing and involved day labourer. The union is separated from the Sundarbans by a river name Malonchi (Profile of Munshigang Union, 2014).

after cyclone Aila was tested using a Chi-Squared test of independence at $P=0.05$. Semi-structured interview data were translated and transcribed and underwent thematic analysis.

4 Results: Social capital typology and gendered relationships in post-cyclone context

The analysis of field survey data showed that respondents rated the strength of the three types of social relationships (bonding, bridging and linking) differently before and after Aila. Both the magnitude and direction of these changes were influenced by gender. Figure 3 shows the results in a histogram as percentages (%) and Figure 4 shows χ^2 analysis of the observed distribution of respondents who rated each of the three types of social capital as 'strong' before and after cyclone Aila differed from the expected distribution.

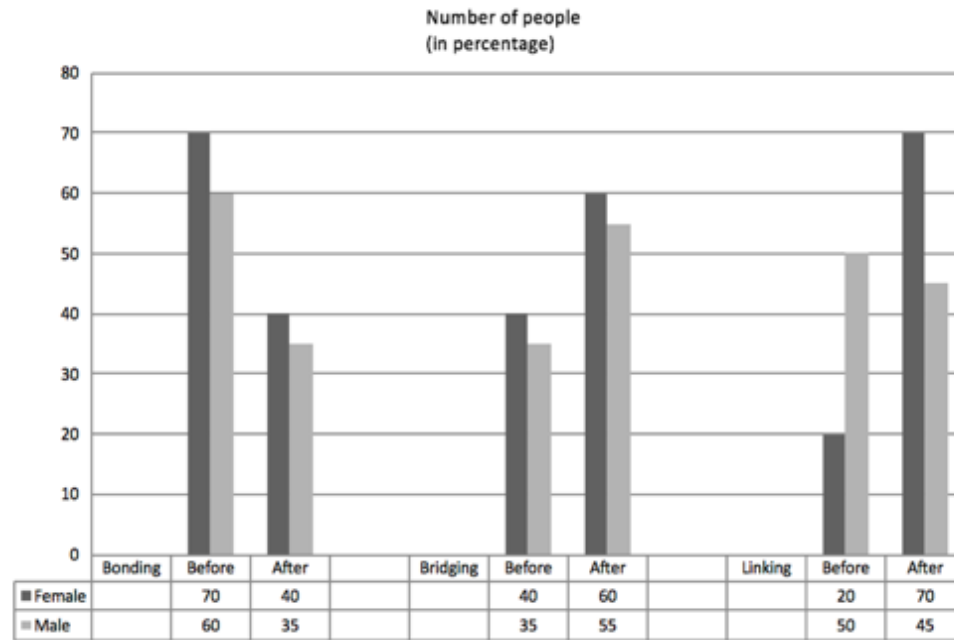


Figure 3: Participants (%) that rated each of the three types of social capital as 'strong' before and after cyclone Aila.

Source: Household questionnaire survey data result at Gabura union, 2016

(Continued to the following page in Figure 4)

Observed											Percentages					
Categories	1	2	3	4	5	6	Row totals				1	2	3	4	5	6
Condition 1	70	40	40	60	20	70	300				53.8	53.3	53.3	52.2	28.6	60.9
Condition 2	60	35	35	55	50	45	280				46.2	46.7	46.7	47.8	71.4	39.1
Column totals	130	75	75	115	70	115	580				100.0	100.0	100.0	100.0	100.0	100.0
Expected																
Categories	1	2	3	4	5	6										
Condition 1	67.241379	38.793103	38.793103	59.482759	36.206897	59.482759										
Condition 2	62.758621	36.206897	36.206897	55.517241	33.793103	55.517241										
Computing Chi-squared																
Categories	1	2	3	4	5	6										
Condition 1	0.1131742	0.0375479	0.0375479	0.0044978	7.2545156	1.8595702										
Condition 2	0.1212581	0.0402299	0.0402299	0.004819	7.7726953	1.9923967										
Sum:	19.278482															
df:	5															
P-value	0.0017055															

Figure 4: The Chi² analysis of the observed and expected distribution that rated by participants (%) each of the three types of social capital as ‘strong’ before and after cyclone Aila.

Source: Household questionnaire survey data result at Gabura union, 2016

For bonding relationships, out of 66 female respondents, 70% identified bonding (within families) relationships as 'strong' before cyclone Aila. After Aila, this proportion had declined to only 40% among females. There was a similar pattern for males, with 60% and 35% of 44 respondents rating bonding relationships as strong before and after Aila respectively.

For bridging relationships (among neighbours), the pattern was reversed with 40% and 60% of female respondents rating bridging social capital as strong before and after Aila respectively. This change was similar for males where bridging relationships were strong before Aila for 35% of respondents and for 55% after Aila.

Linking relationships (with outsiders), showed a markedly different pattern that was gender specific. For females, strong linking relationships were more common after Aila than before, while for males the reverse was observed. Only 20% out of 66 female respondents identified linking with NGOs as strong relationships before Aila, whereas, after Aila this percentage increased to 70% of respondents. Males rated their linking relationships as stronger before Aila than after the cyclone.

The survey findings on social capital relationships were explained through qualitative evidence from interviews and focus group discussions.

4.1 Linking relationships

Before Aila, women had less connection with NGOs, and the economic opportunities such connections may bring were not explored. As a result of Aila's disruption and their husbands' relocation to cities, women sought opportunities for greater inclusion

and engagement in public participation. Eventually, women in Gabura began to pursue employment outside of homes in search of new food production techniques (e.g. tower method farming, bed farming, macha cultivation, composite farming system) for food security (Khalil et al., 2020). NGOs provided the necessary start-up supports (e.g. free handloom products) and also assistance to access markets for selling products. Women's involvement with NGO's significantly increased after Aila and they were successful in developing economic opportunities. For example, Jasmine describes her relationship with NGOs:

"Initially our husbands didn't trust in NGOs. Their friendly behavior convinced us to trust them. They helped us and taught us some salt tolerant agriculture methods and provided us with seeds. I took up the challenges and worked with an NGO as a local service provider (LSP) and lead other women in my village on salt tolerant farming method. At first our production was slow due to saline soil. After 5 years of Aila, we are able to meet our expectation. Our success is able to change the tone of our husbands; our men are happier now, feel less burdened for the family and help us sell products in market. My husband appreciates me and encourage me to grow more even better."

[Jasmine, 45 years old female, household head]

The consequences of cyclone Aila encouraged women to be linked through networking relationships with NGOs that enabled the transfer of local knowledge to adapt to future climate change. With external support, largely through NGOs, the women have

become the key actors in mobilization of local knowledge, in network building and establishment of trust through their ability to form effective networks to trial, adopt and promote adaptation strategies. A NGO officer stated:

“These women have leading capabilities to make decision. If they [are] empowered respectably, they could be great innovators through knowledge acquisition. We need to scale up these women through mental support. If we could connect with this climate affected women regular through material support, and proper train up on CSA [Climate Smart Agriculture] demonstration, they could ensure their food security and turn this grey island green”

[NGO officer]

Another NGO staff member regularly supported women in Chokbara village. Rekha, a resident of that village, described her development of trust with NGOs:

“I’m working as a local trainer in Chokbara village, keeping in touch with the women of the community and noted their problem in a regular note book. At each monthly meeting we share our problems and ideas with our friend [an NGO staff] since 2013. Our relationship grows stronger over time as a family member. He trained us on fish aquaculture, climate smart agricultural [CSA] farming and concern us other social issues (e.g. risk of

early marriage for adolescent girls). We, the women of Chokbara village are working with him like a big family.”

[Rekha, 36 years old female]

Previously women were found to be routinely marginalised, making it difficult for them to negotiate the existing patriarchal connections inherent in local government positions dominated by males and which also dominated the linking relationships to NGOs. In some cases, women could not rely on community, local government and local leaders, because of uneven allocation and distribution of disaster relief. Instead, they had to develop new connections and trust with outsiders (i.e. NGOs). This finding is similar to the situation reported by Aase (2019) following cyclone Sidr (2007). The links with outsiders became more important for these marginalised women than bridging social capital with their local community, as the distribution of cyclone relief by NGOs was less prone to nepotism. Shahana explained:

“We the women of Nebu Bunia village don’t rely on Union Chairman and local members rather we have trust in NGOs. Our village is far from the embankment; we are less benefitted; sometimes financial reliefs from any media do not reach our village. Those who maintain better connection with Chairman or NGOs get more access to relief and money.”

[Shahana, 43 years old female]

NGO staff reported finding relationships with male community members difficult to establish. Household interviews also suggested that, in the context of Gabura, where

there was little land unaffected by seawater inundation to allow rapid re-establishment of food production immediately after Aila, male members started to look for short term financial gain rather than knowledge acquisition on disaster preparedness and appeared less interested in training and skills development. To them women were less busy at home. A male respondent stated:

“Train up on climate change is like schooling a child, wastage of time; other responsibilities we need to do, such as income generation for our family. Our women have plenty of time to be schooling and sit idle.”

[Rahman, 55 years old household head]

The statement illustrates the patriarchal mind-set of village males in the post-Aila recovery period. An NGO officer in Chokbara village described the relationship with the male community members:

“It is really hard to work with the male community members. They are very much irregular in monthly meetings. They are less interested in any new climate adaptation ideas. Therefore, we are not recruiting any new male members on a leading role in our regular program. Rather we are involving many more women who are interested in working with us and learning new adaptive ideas to survive future climate change.”

[NGO officer]

4.2 Bridging relationships

Bridging relationships flourished in the post-Aila period in two ways. First, in the short-term, women established bridging connections with their community of neighbours by sharing foods and household belongings. Such practices maintained strong relationships in the absence of key income earning members of the family. Nuri recalled her memories that taught her a lesson in survival with less resources and strengthened her ties to neighbours. She explained:

“Aila collapsed our life and livelihoods. We live without food and water and our home and lands were completely submerged. We leave everything behind and forced us to take shelter at the top of the embankment. Leaving in those makeshift shelters with three children wasn’t easy, we somehow learned to live with little food and few resources. We, five family members and three neighbours were by our side, it was our strength. We started living in a single small room, you can’t imagine how hard we lived. But our relationship with our neighbour has become stronger”

[Nuri, 35 years old female]

Secondly, women established bridging relationships with other women through the link with NGOs, which fostered economic wellbeing in the post-cyclone context. Moreover, economic opportunities were strengthened through women-to-women connections in the neighbourhood. These sharing attitudes encouraged women to use their local knowledge and limited resources in agricultural production and other income producing opportunities, such as manufacture of handicrafts. In the post-Aila period,

women made social connections through bridging relationships with their neighbours. Bridging relationships often provided not only material support but also mental support. For example,

We shared our belongings, food, and help each other selflessly. In the absence of my husband, my neighbour Rekha involved me in their shared group and kept me alive by occupying some way. The platform gave me mental support, sometime money or resources or even sometimes we just talked and shared our problems, so we couldn't lose hope. NGOs have taught us how to do things more efficiently. I'm glad that I can make some money from this shared platform for survival. It's a women's platform where we share all the problems and successes in everyday life."

[Alo, 38 years old female]

In contrast to women, men behaved differently in maintaining bridging relationships. Their relationships were often 'political' in nature with like-minded peers (such as affiliation with political parties) in the neighbourhood. The benefit of maintaining these types of bridging relationships appears to lie in increased opportunities to access disaster relief coming to the village through NGOs. For example,

"I always go to the community clubs, play carom board, discuss relief opportunities with my friends and get better information about other jobs. Sometimes I engage in discussion with

community leaders and chairman and have better access to opportunities.”

[Mazid, 45 years old male household]

For the males who remained in the village the nature of bridging relationships was altered and their links with NGOs tended to be transactional. Their bridging relationships often involved being present and appearing to be passive in social hubs (e.g. smoking idly in the tea stall). However, this was not always the case with some men supporting their wives' new income and food producing activities, which led to more active engagement with neighbours and information sharing with wives. So, the nature of the relationships of men and women with NGOs were different. Men engaged in bridging activities to get access to NGO support in the form of aid and relief supplies (transactional). Women engaged with NGOs to share knowledge with and through their bridging networks (relational).

4.3 Bonding relationships

Bonding relationships are an important element in the rural social context of Bangladesh. Our findings revealed that cyclone Aila resulted in changes to bonding social capital as, following Aila, many male community members travelled to outside of local villages for jobs. For example, Nuri stated:

“I rarely go out and work outside without my husband. Now, I have started working as a day labourer to survive and keep my two children alive. My husband went to Satkhira, the nearest town to look for a job after Aila. About three months later I was

informed through my neighbor that he was moving to Dhaka and suddenly I lost all contact.”

[Nuri, 38 years old female]

The husband's relocation to the city for paid employment opportunities appears to have weakened the family's bonding relationships through infrequent communications and weaker family ties. Approximately, 20% of the 66 female participants indicated through the questionnaire survey that their husbands visit the family about every six months. There were reported instances of husbands starting new families in another city and not returning to Gabura. In the absence of the husband, the females often assumed the role of household heads and played a key role in maintaining bonding relationships with family members. More frequently women were required to find ways to maintain families, as often their husband's remittances failed to cover the household expenses. In absence of their husbands, women's role in family support was elevated and they were required to adopt new income solutions outside of homes. The relocation of the male family members as a consequence of Aila stimulated women to seek a range of alternative livelihood opportunities both within and outside of the home. For example, Nuri elaborated,

“After 5 years of Aila, I found a way to survive in absence of [my] husband. I got some training by being involved in the community women shared group. Sometimes, we (me and my elder daughter) make a source of money [income] from home by making handicrafts (i.e. fish nets, mats) and sell the products in

the weekly market. My two daughters (15 and 10 years old) are involved in other household chores and reduce my work burden.”

[Nuri, 38 years old female]

Nuri's struggle and success were an inspiration to other women in Gabura community. Here, bonding relationships were strengthened through showing responsibility by taking care of other family members.

In some cases, alternative scenarios were observed in Gabura. For example, the type of bonding between husbands (who were in the villages) and family changed and became stronger. Males began working with their wives to develop new economic opportunities to support the family group (i.e. agricultural demonstrations). Such economic opportunities were explored as women tended to become more active in supporting their families by engaging in outside work with their husbands, thus the bonding relationship was strengthened differently from the typical husband-wife family relationships. Rani, for example, was a resident of the nearest union of Munshigang in the village of Harinagar Bazar and had been involved in agricultural production with her husband since 2011 after Aila. She became a role model for other women in the village. She stated, while proudly showing her small patch of land:

“My man is always helping me with household work. After Aila he didn't move to cities for a job, rather he involved me with agricultural demonstration. We took some training together on climate smart agricultural [CSA] farming by NGOs. We started working to transform our saline soil into an agricultural land. Our production was slow, but we didn't lose hope. After five years of

Aila, we have reached our satisfaction. This year (2016), we grew 20 kg of squash and other salt tolerant vegetables (e.g. eggplant, bitter gourd and chilli). After meeting our daily needs, we sold the rest of the vegetables at a local weekly market.”

[Rani, 40 years old, female]

In summary bonding relationships declines after Aila where family ties are disrupted through male migration. Over time, however, women often took the responsibility for maintaining their family relationships and played an important role in maintaining bonding relationships. When the husbands remained in Gabura after Aila with the family, the bonding relationships changed and strengthened as some women were afforded greater freedom to work with their husbands inside and outside of home (e.g. in agriculture based on some training activities). A NGO officer stated,

“We support women in alternative livelihoods through training activities. This ensured their food security, a source of financial help to keep the family together. In rebuilding their family bonding ties, it is important to keep linking relationship with us (NGOs) and establish bridging ties with neighbourhoods. Because women get outside information through us (NGOs) and this relationship has helped strengthened family bonding [to be] otherwise family will be disintegrated.”

[NGO officer]

Table 2 provides a summary on the effects of cyclone Aila on the three forms (bonding-bridging-linking) of social capital relationships.

Table 2: Summary of social capital relationship (before and after Aila)

Relationship	Before	After
Bonding relationship (family /immediate relatives)	<p>Women always maintained family bonding relationships, however, efforts remained mostly unrecognized.</p> <p>Men less involved in family bonding, mostly rely on female household members in the family.</p>	<p>Strengthened among women (in absence of men through migration for employment).</p> <p>Climate change forced women to take on more household workload compared to men (i.e. water and other natural resources collected from natural settings to survive.)</p> <p>Women began supporting the family and male partners with new income opportunities (e.g. food production), strengthened bonding relationships in some families.</p> <p>Overall, family bonding was initially weakened due to husband’s migration</p>
Bridging relationship (neighbourhood/ local community)	<p>Maintained at household level through sharing belongings but not appropriately mobilized to formulate effective adaptation strategies.</p> <p>Male members maintained these relationships through community religious institutions (such as, mosque, madrasa)</p>	<p>Well organized through creation of women’s group and shared economic practice through the connections with NGOs.</p> <p>Sharing their local knowledge experiences in the regular meeting place; resulting in grassroots innovation applied to agricultural production and handicrafts sector.</p> <p>For some men who remained in the village, the nature of bridging relationships was altered through women’s engagement with neighbours in a knowledge sharing platform.</p>

(continued)

Table 2 (continued)

Relationship	Before	After
Linking relationship (Outsiders, NGOs)	Women had very minimum involvement and limited networks with outsiders due to social restrictions Men had closer relationships with outsiders to allow access to financial resources and development aid.	Strong relationships among women with NGOs and outside actors to work with and build on new strategies and opportunities for empowerment and to support the family and community. Economic opportunities explored through the women's empowerment. Some men who remained in the village developed relationships with NGOs and in partnership with their wives became involved in shared farming activities to secure food.

Source: Household questionnaire survey and face-to-face interviews at Gabura Union, 2016

5 Discussion

This chapter contributes to a wider rethinking of women's role in social capital relationships through network building with NGOs. Underpinned by a range of behavioural studies in development contexts, women emerged as having an important role in adaptation challenges to climate change, through their contributions to local economic prosperity stemming from connections to external actors (Alam and Rahman 2017; Masud-All-Kamal & Hassan 2018; Patt et al. 2009). These changes in local connections were particularly important for women because of their husband's search for new economic opportunities outside of their hometown weakening bonding relationships in the Gabura community.

In post-Aila Gabura, linking social capital was found to be important in adaptation through networking relationships with NGOs. These ties appeared to be key components to overcoming the gender gap among male and female counterparts towards new economic opportunities. Similar findings examined by Cummings et al., (2019) in the cyclone Sidr context, demonstrated that linking social capital at grassroots level was the key component for exchange of new knowledge and provided access to resources. In Gabura, NGOs played a significant supportive role for these vulnerable women in taking initiatives towards climate adaptation after Aila. The transparency of NGOs in the distribution of aid relief has been shown to engender public trust (e.g. Armstrong, 2005), and women in Gabura indicated that it was an important element in establishing strong linking relationships following Aila. In some cases, villagers reported being isolated from relief networks due to a lack of transport and communication. Moreover, individuals, most often males, who maintained better

connections with village officials, had greater access to resources and relief from NGOs, (e.g. Bakshi et al., 2019). Such kinds of nepotism in cyclone preparedness slow down adaptation efforts (Mahmud & Prowse, 2012). These findings suggest that the nature of the relationships of men and women with NGOs were different. Male relationships with NGOs appeared to be largely transactional and related to obtaining access to NGO support in the form of aid and relief supplies. Women engaged with NGOs in a more relational manner to share knowledge with and through their bridging networks (Agarwal, 2000). We suggest equal engagement in training workshops could enhance gender inclusion and encourage wide participation in community leadership roles, although the motivations for participating in such events may be gender specific. Following examples of Azim and Sultan (2010), Lowndes (2004) and UN Women (2014), appropriate policy support and equal gender access and participation in climate related programs may enhance the leadership potential in women through empowerment and can balance each gender's contribution to successful adaptation. Overall, opportunities for women that can accrue from connections between community insiders and outsiders will likely be enhanced when the linking social capital relationships are more flexible.

The bridging relationships among women in Gabura were also critical to recovery. Women established strong bridging connections to neighbours through sharing belongings and other necessities. Bridging relationships among the community of women in Gabura improved with the establishment of new platforms as important mediators of local knowledge sharing and effectively mobilised opportunities for economic development. Thus, the community benefitted by being equipped with new ways to face climate change consequences. Islam and Walkerden (2014) have

identified that bridging and bonding relationships can fail after natural disasters. My findings suggest that although these networks initially failed (or at least were substantially weakened), they recovered where linking connections were established, with flow on benefits to the wider community. For example, in the absence of their husbands, the female household heads played a key role in maintaining family bonding relationships to support their households through the linking ties with the NGOs. In addition, some men were able to see the benefits of altered gender roles in family support as new livelihood opportunities (e.g. local food production) emerged. Consequently, over the long run, bonding relationships were strengthened as men frequently assisted their wives' entrepreneurship.

For example, Figure 5 summarises the three forms of social capital among women in the post-cyclone context.

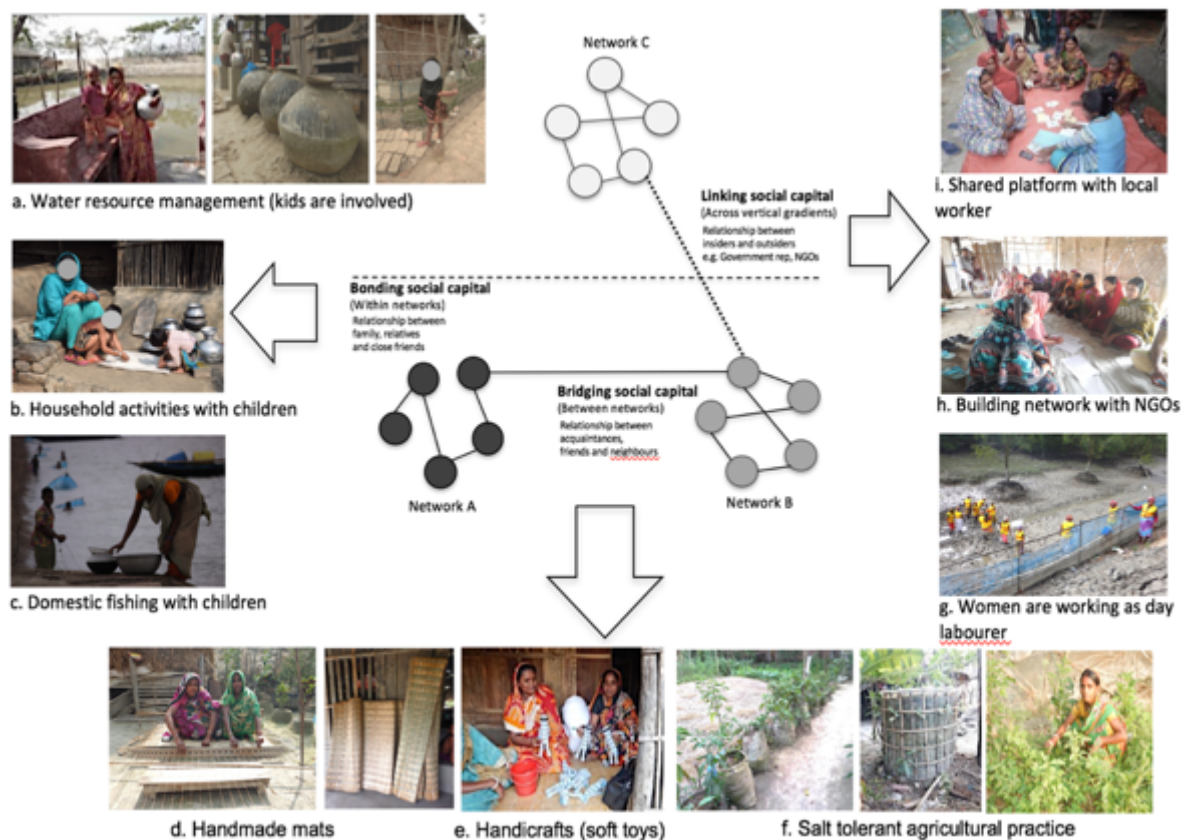


Figure 5: Summary of how the three forms of social capital operate in a post-cyclone context.

Source: Pictures were taken by author in 2016, and the inside framework concept is adapted from Aldrich (2011) and redrawn by author.

Bonding relationships operate at household level within the networks among family members; for example, women and children were involved in household activities, water resource management and fishing (Figure 5 a, b and c). Bridging relationships work in between networks; for example, women working with other neighbourhood women in producing handicrafts (Figure 5 d, e). Responding to opportunities to form linking relationships in the post-Aila situation, women in Gabura established strong linking relationships and new social networks with the NGOs for local knowledge acquisition and sharing and access to place-based resources, resulting in new

adaption strategies and grassroots innovation, examples also reinforced in previous studies (Khalil et al., 2016; 2020; Khalil and Jacobs, 2021). For example, improved small scale handicrafts businesses at home, salt tolerant agricultural innovation and the emergence of working outside of home as day labourers (Figure 5 e, f and g) created access to markets and overall economic development, which further strengthened the bridging and bonding networks. Through the NGO support, community women came together to share their local knowledge and the NGOs offered tailored training to empower women (Figure 5 h, i) and provided funds where required.

In general, women are highly vulnerable to extreme climate events in Bangladesh (Cannon, 2002; Rahman, 2013). Most women in Gabura are the victims of climate related extreme events; despite this they continue to contribute to domestic responsibilities within resource constraints. Female survey participants indicated that following Aila their husbands visited the family infrequently, with some losing contact over time as they established new families in other cities. These families also suffered an economic crisis following Aila because they failed to receive regular remittances from husbands (Mallick, 2014). In Gabura, overall, the altered gender relationships following cyclone Aila contributed to all three forms of social capital (i.e. bonding, bridging and linking) in the community; a similar perspective was recently described by Masud-All-Kamal and Hassan (2018). In the aftermath of the cyclone, women's involvement in linking networks altered the historically existing gender inequality of this coastal Bangladesh community. Such change may be part of a wider societal trend as other published examples of changed gender roles in an Asian context found women and girls to play increasingly positive roles in leadership, skills development and

income generation (e.g. Boserup, 2007; Giri, 2017; Jost et al., 2016). The hardship of Aila stimulated women to rebuild their lives through reinforcing trust and network relationships with NGOs to adapt to climate change. Women's roles were transformed significantly through involvement in working outside of home for food security especially in the absence of their husbands. As a result, the overall scenario is being transformed from an existing vulnerable situation to greater economic security through skill development and empowerment of women.

6 Conclusions

This study speaks to the need for a clear gender inclusive/sensitive approach to post disaster intervention which can focus more on linking networks than previously as a social capital domain where women are traditionally less likely to participate. We argue that NGOs should focus more on women who are eager to build their capacity and have a stronger motivation towards relational interactions with flow on benefits to the general community. If women work better in the linking domain, the positive outcomes will expand to enhance the other forms of social capital. The best ways to address viable recovery options that simultaneously support adaptation pathways and that bridge gender relationship gaps through better links with NGOs are still under debate; with emerging examples of the roles of NGOs in adaptation pathways at grassroots level (e.g. Desai, 2002; Mercer, 2002). In this case, prior to Aila, most female members in the village indicated they concentrated primarily on family relationships. However, following the cyclone local NGOs provided the impetus for women to search for ways

to survive, and now, 6 years after the cyclone, their struggle is becoming a distant memory.

To conclude, the post-cyclone Aila experiences at Gabura present fresh perspectives on women's role in coastal village communities to develop connections with outsiders that can contribute significantly to adaptation. This is a contrasting perspective to the cultural stereotypes in coastal villages in Bangladesh. We conclude that the forms of social capital (i.e. bonding, bridging and linking networks) operated differently here after a major disaster due to husband's migration, whereas women remained in place. This situation created opportunities for women to 'step out of home' and link with NGOs. Over time, these linking relationships contributed to strengthening the bonding and bridging relationships within communities in various ways. These findings present a more nuanced understanding of how gender-based social capital is built to reproduce new adaptation strategies in a post-cyclone context where women are key contributors. Policymakers should pay more attention in designing policy-making on women's roles based on social capital and gender relations in a post-disaster context.

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Chapter 07: Understanding place-based adaptation of women in a post-cyclone context through place attachment

Chapter seven was published as an article in the journal 'Environmental Development'. This chapter focuses on the women's place-based adaptation through using place attachment theory to examine the utilisation, substitution and transformation of livelihood capitals in adaptation in a post-cyclone context. This chapter answers the following sub research question: '*How does place attachment contribute to women's use of livelihood capitals for adaptation in post-cyclone context?*' The data were collected based on qualitative analysis through semi-structured and key informant interviews and focus group discussions. The theory of place attachment is described and the roles of local livelihood capitals that influence women's place-based adaptation in post-cyclone context is explored. The paragraph below adds some clarifications that were not resolved within the publication.

- Some conceptual ideas were developed in previous work on place attachment in Khulna Rupsha slum (see Appendix XIII, of this thesis, see Khalil and Jacobs, 2016), which are not only about Bangladesh, but also demonstrate that place attachment is not confined to rural areas where a clan may have dwelt for generations.
- 110 is the number of respondents to the questionnaire survey. Whereas the fieldwork involved key informant interviews (43), the participant categories were

not mentioned in this chapter. Some further details about FGD are available in chapter 3, Table 3.7

- The embankment is the main transport connection inside the village and to protect the villages from the flooding. Breaking of the embankment in several places in Gabura may have exacerbated long-term inundation (for up to 2/3 years), causing widespread salinization of the island's surface soils, and as a result, the destruction of agricultural land (Khalil et al., 2020).
- The geographical location of Figure 4 under 'place' box of this published paper will be in the south-west corner. A request for correction has been sent to the journal's editorial team for the final publication.

The published paper is attached in the following pages.

Table 7. 1: Statement of authorship

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Author's contribution

Name of principal author (Candidate)	Momtaz Bintay Khalil
Contribution	Data collection and analysis Literature review Conceptual development Writing of manuscript Revision of drafts Acted as corresponding author

Co-author's contribution

Name of first co-author	Brent C. Jacobs
Contribution	Supervised development of work Assistance in data analysis Guidance in literature review Assistance in conceptual development Manuscript evaluation and edits



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Understanding place-based adaptation of women in a post-cyclone context through place attachment

Momtaj Bintay Khalil^{*}, Brent C. Jacobs

Institute for Sustainable Futures, University of Technology Sydney, Australia

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ABSTRACT

This paper explores place-based adaptation by women in the coastal settlements of Gabura, Bangladesh through the lens of place attachment theory in the post-cyclone Aila context (after 2009). Place attachment refers to the relationship between people, place and processes in which place-based livelihood resources may be a central consideration. Place attachment is relevant because, unlike men, Gabura women are constrained by their socio-cultural context to remain in place following a natural disaster, in this case cyclone Aila, and therefore must rely on a limited range of local resources to support adaptation through the construction of place-based livelihoods. Drawing on a mixed method approach, we explore women's place-based adaptation (a set of livelihood outcomes) as resulting from multilevel social connections among 'people' (e.g. women and NGOs), the 'place' (i.e. Gabura, located adjacent to Sundarbans) and its natural resource endowments, and the 'process' of transformation of capital from one form (social and natural capital) into other forms (physical and financial) via knowledge sharing (human capital). This paper highlights women's place-based adaptation that reinforces their place attachment (through place dependency and identity) in a post-cyclone context. Rather than seeing the inability of women to leave a place after a disaster as a disadvantage, a place-attachment approach revealed the capacity of women to transform in place where the post-cyclone necessities and constraints were drivers for change.

1. Introduction

This paper will examine place-based adaptation of women in the coastal settlements of Gabura, Bangladesh in a post-cyclone Aila context (after 2009) using Scannell and Gifford's conceptualisation of 'place attachment' theory (Scannell and Gifford, 2010). The concept is useful to examine the specific localised strategies of women in the development of place-based adaptations. There is a significant research gap in the lack of recognition of the unique contribution of women to responses at household level in post-cyclone context of coastal Bangladesh, in light of the socio-cultural restrictions that constrain women's adaptation (Ayebe-Karlsson et al., 2020; Jordan, 2019). Through the lens of place attachment, we consider the question: 'How does place-attachment contribute to women's use of livelihood capitals for adaptation in a post-cyclone context?' We focus on how 'forced' attachment¹ to place (through socio-cultural

^{*} Corresponding author. Department of Urban and Regional Planning, Khulna University of Engineering & Technology, Khulna 9203, Bangladesh.
E-mail addresses: Momtaj.B.Khalil@student.uts.edu.au (M.B. Khalil), Brent.Jacobs@uts.edu.au (B.C. Jacobs).

¹ In the context of Bangladeshi coastal settlements, women's mobility outside is not "normalised" due to socio-cultural restrictions (Alam et al., 2020b); therefore, women are unable to 'escape' from the places compared to their male counterparts. Women are forced to stay in place (Ayebe-Karlsson et al., 2020) and adapt with the place-based resources (Roy, 2012).

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constraints) encouraged women to access and combine in novel ways place-based resources in the construction of livelihoods that are better adapted to a changing environment.

In Gabura, following cyclone Aila in 2009, the migration of male household members to cities for employment (Saha, 2017) caused a disruption to the traditional domestic roles of women in the village and inspired them to explore opportunities for place-based adaptation within the island's landscape (Khalil et al., 2020; Roy, 2012). For example, women became actively engaged in fish cultivation and some groups participated in training on salt tolerant farming activities to secure food for their families in the post-cyclone context (Khalil et al., 2020). Some women travelled to the nearby Sundarbans mangrove forest to collect fish and crabs or started fishing in local rivers and canals and engaged in a range of food-for-work programmes (Roy, 2012). Overall they began to take on the roles that their husbands used to perform before the cyclone (Ayeb-Karissou et al., 2020).

Post-Aila,² the intersection of the long-term waterlogging of Gabura's farmlands, the agricultural-based background of villagers (Bernier et al., 2016), the relocation of male community member's outside the village (Mallick, 2011), and the interventions of aid organizations that recognized women as active agents of change (Boserup, 2007) heightened the significance of place dependence and attachment for women. However, the ability of women to use and transform their stocks of local resources, often through NGO support (e.g. Khalil et al., 2016; Khalil et al., 2020), was largely unacknowledged by male household family members and policy makers (Djoudi and Brockhaus, 2011). Given women's roles are influenced by the strong connections they have with the island ecology, this paper adopts the concept of 'place attachment' as a theoretical lens to analyse how the attachment of women to Gabura Island has enabled them to adapt 'in place' in a post-cyclone context.

In the following section, the concept of place attachment is discussed using Scannell and Gifford's (2010) framework of 'person, place and process' dimensions as a tool to conceptualize place (i.e. Gabura) affected by cyclone Aila in 2009 (the driver of change) and the responses of local actors (i.e. women in Gabura) in this context. The data for this study was collected in a mix method approach and synthesized into a conceptual framework to show how livelihood capitals can be seen as place-based resources for a coastal community (especially for women) who may not be able to relocate in a post-cyclone context. Place attachment is important for place-based adaptation of women in a post-disaster adaptation process.

2. Place attachment

Scholars have conceptualized place attachment in multiple ways; such as, 'sense of place' (Hay, 1998), 'place identity' (Lalli, 1992; Ujang, 2012), 'place making' (Giuliani, 2003; Williams et al., 1992), and 'place dependence' (Dixon and Durrheim, 2000). Place attachment is a dynamic concept with its theoretical foundations borrowed from multiple disciplines. Researchers have long attempted to describe the different attributes and opportunities of the concept in rethinking people's relationship to particular places, and its impact on social life and environmental outcomes (Brown and Perkins, 1992; Gosling and Williams, 2010). Place attachment can be defined as 'an affective bond or link between people and specific places' (Hidalgo and Hernandez, 2001 p. 274). Altman and Low (1992) developed a conceptual basis for place attachment by drawing on a diverse body of research that describes concepts such as, topophilia (emotional attachment), place identity, genres of places, sense of place, rootedness, community sentiment and identity, etc. (Altman and Low, 1992 p. 3). Place attachment as defined by Rollero and De Piccoli (2010) has links to perception of the environment.

We consider the concept of place attachment according to Scannell and Gifford (2010) as consisting of three dimensions: 'person, place and process'. The person dimension can involve both individuals and social groups. At the individual level, a person can develop personal connections to a place, while at the group level, place attachment may refer to the symbolic meanings triggered by religious sentiment, historic events or ethnic rituals of a place that keeps the community members tied to that particular place (Low, 1992). The 'process' dimension refers to the way in which individuals and groups are emotionally related to a place, and the nature of the psychological interactions that occur in relation to the particular setting (Kelly and Barsade, 2001). For example, people may experience a strong emotion or 'affect' (i.e. pride) or a general sense of well-being by being at a particular place (Kelly and Barsade, 2001). A person's bond may contain cognitive elements, such as memories, beliefs, meaning and knowledge that make the place particularly important (Blunt and Varley, 2004). As explained by Rose, 'a sense of place develops from every aspect of an individual's life experience' (Rose, 1995 p. 88).

The most important dimension of place attachment is the place itself – the 'content' of a place that invokes the connection and includes multiple locations (Kyle et al., 2004). These connections are made up of two dimensions: social and physical (environmental) place attachments. Social place attachment resides in the strong social ties and kinship of the family and surroundings (Storie et al., 2019), while physical attachment is 'the rootedness among those who do not hold close attachment'. Women in Gabura, our study site, for example, have both belongingness to family and are 'stuck' in place - as they are unable to 'escape' because of socio-cultural restrictions. Furthermore, Brandenburg and Carroll (1995) defined place using two factors – the social and cultural context of a given space, where people transform space into place. Sometimes, specific physical attributes of a place (e.g. pristine) can invoke particular sentiment to guide actions such as wilderness protection or better environmental behaviour by a community member (e.g. Devine-Wright and Clayton, 2010). Places may also be constructed through many years of social practices and the social relations these generate, which keep individuals bonded with the place and guide pro-environmental actions (Ruming et al., 2012). For example, Australian Aboriginal communities have place-based social and environmental practices that have existed for thousands of years. In this instance, places and practices are embedded in each other to inform "caring with" the place as 'Country' and for the people living

² 'Post-Aila' refers to the aftermath and recovery from Category 1 Cyclone Aila that hit the South-western Bangladesh in May 2009.

in it (Suchet-Pearson et al., 2013).

Some scholars have suggested that there are several dimensions of place attachment that can be understood through the concepts of place identity and place dependence (Kyle et al., 2004; Ujang, 2012). Place identity leads to self-identity (Proshansky, 1978), rootedness (Tuan, 1980) and a sense of belonging to a place (Williams et al., 1992), including the physical, cultural and emotional contexts that shape the identity of a place (Ujang, 2012; Williams et al., 1992). People who have lived in a particular place for a long-time, may develop an attachment to that place; those people form a strong place-based identity (Dixon and Durrheim, 2000). Behavioural consistency among people-place relationships is also described as place-dependence (Altman and Low, 1992; Williams and Vaske, 2003). Behavioural consistency is thought to reinforce individual psychological attachment to a particular place and it enables specific place-based actions and long-term retention in a particular place (Florek, 2011; Williams et al., 1992). Alternatively, people with low levels of psychological attachment may leave the place for better opportunities elsewhere (Florek, 2011).

Both 'place identity' and 'place dependence' can co-evolve and trigger post-disaster adaptation actions by understanding the values of a particular place's resources in two ways: first, through an individual's dependence on the available resources (e.g. natural capital) of a given place, which leads to an individual's understanding of place values and care for the resources and surroundings (Kruger and Williams, 2007). For example, in the coastal areas of Bangladesh, the mangrove forests of the Sundarbans are a sign of place values, a valuable symbol of livelihood resources and a strong support for coastal settlements (Getzner and Islam, 2013). Second, some migrants, especially female household heads from migrant families, mobilise their former identities as specific competencies to negotiate their adaptation in new urban settings (Alam et al., 2020a, b). In the case of Gabura following cyclone Aila, most male household members migrated to the city for new livelihood opportunities (Mallick and Vogt, 2014; Mallick and Siddiqui, 2015), whereas women remained in place suggesting that there may be a gendered dimension to place attachment.

In this paper, we will use Scannell and Gifford's (2010) articulation of place attachment to understand the attachment of women to Gabura that facilitates a number of ways to rethink more gender sensitive adaptive actions in the face of post-disaster adaptation challenges reliant on place-based resources (Fig. 1). The women in Gabura occupy the 'people' component of the model, which helps us consider the ways in which individuals or groups relate to a place. Gabura and the nearby Sundarbans, occupy the 'place' component that acts as a domain or 'container' of existing natural resources that are transformed by the 'people' through their social and physical settings (Williams et al., 1992; Patterson and Williams, 2005). The process dimension refers to how the behaviours/actions of these actors are processed through psychological components (e.g. behaviour, knowledge, and emotion) for potential adaptation outcomes (Giuliani, 2003; Williams et al., 1992), such as changes in physical and financial capital in support of alternate livelihoods. A preliminary model (see Fig. 1) attempts to integrate these elements by drawing on the findings of the previous research by the authors (see Khalil et al., 2016; Khalil et al., 2020) and will be populated and refined using the results obtained in the current paper.

In the next section, the relationship of place attachment to the use and transformation of livelihood capitals is discussed as

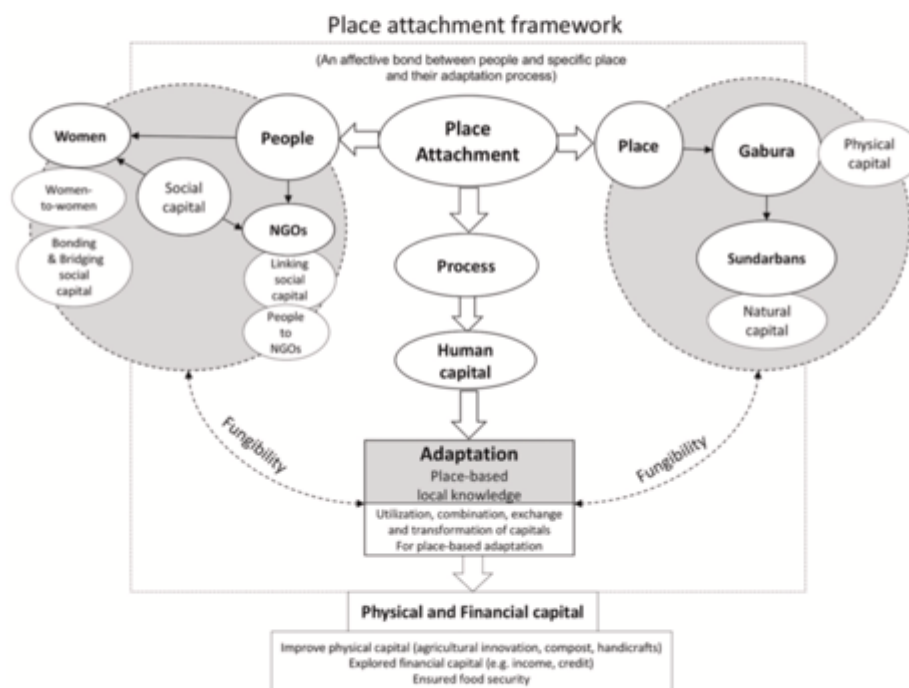


Fig. 1. A conceptual framework of place attachment.
Source: Drawn by lead author.

resources that are the product of a place and that reinforce place identity and dependence between women and Gabura. These aspects of livelihood capitals and place attachment are important in considering place-based adaptation of women in the post-cyclone recovery context.

3. Livelihood capitals and place-based resources

The concept of livelihoods refers to 'making a life living' in order to secure the basic needs of everyday life (Allison and Ellis, 2001; Dehann and Zoomers, 2005), including material and social resources (Rakodi, 2002). People often migrate from one place to another to secure livelihoods (Olwig and Sorensen, 2003). For example, in the context of climate change in Bangladesh, people are influenced to migrate by various pull and push factors (such as food, water, paid employment, housing) (Alam and Miller, 2019; Mallick and Vogt, 2014; Mallick and Siddiqui, 2015) and to seek safety from environmental hazards (Black, 2001; Myers, 2002). Roy et al. (2016) estimated that every day at least 4000 Bangladeshis move to cities seeking a safer life from extreme weather events. However, the ability to migrate is mediated by gender (Alam et al., 2020a). In many cases, husbands take migration pathways to the city for their livelihoods and economic opportunities, and often leave their families behind (Mallik et al., 2003). In the absence of their husbands, rural women struggle to make a living and rely on a limited range of local natural and livelihood resources (Alam et al., 2020b; Roy, 2012).

'Livelihood capitals' are place-based resources, consisting of five types of capitals (i.e. human, natural, physical, social and financial) (DFID, 1999; Ellis, 1999; Ellis, 2000; Scoones, 1998). Place-based values form over time in individuals and communities and develop into important environmental relationships that lead to an attachment to a place (Scannell and Gifford, 2017). In the context of poor rural households, access to place-based resources ensures that the basic needs are met (e.g. food security) to secure their livelihood outcomes (Allison and Ellis, 2001; Ellis, 1999, 2000; Scoones, 1998). Of particular importance to rural households is natural capital, which refers to the supply of natural resources provided by nature (e.g. soil, water, biodiversity). Human capital refers to the knowledge, education, skill, experience and empowerment of individuals and communities and can incorporate indigenous knowledge (Scoones, 1998 p. 8). Social capital includes social connections, relationships and networking among actors (Islam and Walkerden, 2015; Scoones, 1998 p. 8). Other capitals, which may be more or less important depending on the context, are physical capital, which refers to the stock of manufactured 'production' produced by a transformation process that creates new forms of capital (e.g. housing, water supply, sanitation infrastructure) (Costanza and Daly, 1992 p. 41); and financial capital, which refers to money and access to the economy (Allison and Ellis, 2001; DFID, 1999; Scoones, 1998). In relation to five livelihood capitals, the 'Sustainable Livelihoods Approach' (SLA) is an important framework (Allison and Ellis, 2001; Chambers and Conway, 1992; DFID, 1999; Scoones, 1998) to address development in developing world contexts. Five types of livelihoods capitals and their roles are described in Table 1.

An important aspect of the livelihoods approach is understanding how people use and manage livelihood capitals at household level through their relationship to place and through the interchange of capitals from one form into another to achieve livelihood outcomes (e.g. economic success and improved social wellbeing) (Ellis and Allison, 2004; Scoones, 1998). This interchange of livelihood capitals can be explained by 'fungibility' conceptualized by Lipton (1984), and synonymous with 'fungible', 'interchangeable' or 'exchangeable'. The term 'fungibility' is often used by economists (e.g. Ellis, 1993; Lipton 1984) to describe a product that can be interchanged to economic benefit without being reduced in value. Following the concept of 'fungibility', place-based adaptation may be explained as a combination of livelihood capitals that may be transformed in support of new ways of making a living that can reduce vulnerability (Fig. 1).

Livelihood capitals of a place can be transformed in two ways: first, the direct connections to a specific place through the care and management of available natural resources (e.g. care of trees, land, pond, fish, landscape, soil and ecology). Second, indirect connections among actors that influence access to forms of capital, requiring social capital relationships and networking, and exploitation of natural capital that can be transformed into other forms of capitals (e.g. financial and physical capital) through this social capital (Adger, 2003; Chambers and Conway, 1992; Scoones, 1998). Physical capital is the outcome of interacting social and human capital (DFID, 1999). Education is an important dimension of human capital through increasing access to information and knowledge. People and place dimensions of place attachment can be seen in the transformation of livelihood capitals and are shaped by the 'process' dimension leading to livelihoods outcomes (Ellis, 1993; Lipton, 1984).

For instance, people living in the coastal areas of Bangladesh, have access to a range of ecosystem services to sustain local livelihoods and other income generation opportunities. 'Sundarbans ecosystems' are the source of local livelihood capitals and place-based resources (Shameem et al., 2014). Coastal ecosystems reduce the impacts of disaster, regenerate after disasters, and continue to produce resources that may be transformed into new forms of livelihood capitals for human wellbeing (Adger et al., 2005). For the Gabura community, the natural capital of the Sundarbans ecosystem is not only a source of diversified livelihood capitals (e.g. fishing, crab, shrimp collection and honey harvesting) but a source of physical resources (e.g. for construction of household resources) and economic wellbeing (Shameem et al., 2014; Uddin et al., 2003). Before the cyclones (Sidr³ and Aila) only male household members accessed the Sundarbans resources for livelihoods; whereas, after Aila women had to rely on their access to local resources and their ability to transform those resources into other forms of capital, a process facilitated through support from the NGOs (Roy, 2012; Roy et al., 2013; Khalil et al., 2020). Following Aila, the livelihoods trajectories of women had changed and exploitation of the natural capital of Sundarbans became a source of place-based resources and their best hope for the survival after their husbands relocated.

³ Cyclone Sidr was a category 4 tropical cyclone, that struck the southwest coast of Bangladesh on November 15, 2007 with heavy rain and a wind speed of 260 m/h. It is reported that at least 3447 people were killed and 55,000 were physically injured during Sidr (Paul and Dutt, 2010).

Table 1
Types of livelihood capitals and roles.

Types of capitals	Roles
Natural	Natural capital refers to stock of natural resources provided by nature (e.g. land, water, biodiversity, fish, shrimp, crab, honey)
Physical	Physical capital refers to stock of production; transformed natural capital into new forms of production by human capital (e.g. house, embankment, roads, water supply (pond-sand-filter), sanitation, fish traps, weaving materials for handicrafts, compost from natural resources)
Social	Social capital refers to social relationship (e.g. networks, bonds, norms and trust relationships among a community insiders (person-to-person, household members) and outsiders (i.e. NGOs).
Human	Human capital refers to the knowledge, skill, experience, capabilities and for action based labour in a community (e.g. education, knowledge, training, skills)
Financial	Financial capital refers to wealth and access to economy (e.g. income, credit, savings/debt etc.)

Source: Bourdieu (1986); DFID, 1999; Scoones (1998).

4. Intersection of place and women's adaptation

Place attachment theory enables exploration of the intersections between place-based livelihood capitals and place-based adaptation. Climate change act as a driver of adaptation and contributes to the establishment of place attachment, which is directly linked to factors such as physical, social, and environmental conditions (Amundsen, 2015; Rose, 1995). From a gender perspective, women are important actors in place-based adaptation and landscape management (Alam and Rahman, 2014; Sultana, 2014). In general, research has established that women play an important role as conservationists of natural resources (Agrawal, 1992, 2001; Mies and Shiva, 1993; Moore, 2008; Roy, 2012; Shiva, 1986; Warren, 2000). For instance, women in India play an important role in land conservation and contribute to agricultural development (Narayanan & Kumar, 2007; Prasad and Singh, 1992) and can contribute to decision making about livelihoods transition through their engagement with nature (Bhandari, 2013). Women's involvement in household roles influences domestic planting of food crops and biodiversity conservation that could enhance place-based adaptation (Howard, 2003; Colfer and Minarchek, 2013 p. 418).

Traditionally women in coastal Bangladesh were engaged in the natural resource-based activities (such as, collection of wild food, fodder and fuelwood) (Bernier et al., 2016). After Aila due to the impacts of soil salinity on food production, women's engagement in horticulture activities was reduced (Bernier et al., 2016), rather they became involved in training programs to secure livelihoods opportunities through utilizing existing natural resources. In the post-cyclone context, in contrast to male household heads who often migrated to urban areas (Mallick and Vogt, 2014; Mallick and Siddiqui, 2017), women were tied (attached) to place due to social-cultural restrictions, (Ayebe-Karlsson et al., 2019; Rahman, 2013). For example, in most cases women were not permitted to evacuate in response to imminent tropical cyclones (Ayebe-Karlsson, 2020); only a third of women in coastal settlements routinely receive the evacuation orders (Parvin et al., 2019). Only after men had left were women able to play a decision-making role in resource management and contribute to economic wellbeing through empowerment and support for social capital (Ahmed et al., 2012; Boserup, 2007; Djoudi and Brockhaus, 2011). However, the resources available to support women's place-based adaptation were largely limited those available from the Sundarbans ecosystem as a source of economic well-being (Iftekhar and Islam, 2004; Iftekhar, 2006; Shameem et al., 2014). The role of natural capital in combination with forms of social capital (bonding ties with family, friends and community) (Brown et al., 2015; Cox and Perry, 2011) could be seen as central to strengthening place attachment (Lewicka, 2005) and reducing vulnerability.

In this paper, women's place-based adaptation is explored using place attachment theory in light of the activation of social capital through support networks, women's strong connection with the island ecology and the requirement for them to adapt in place in post-cyclone context.

5. Study area and methodology

The study area of Gabura Union (see Fig. 2) is located in Shyamnagar Upazila⁴ of Satkhira district⁵ under Khulna division, Bangladesh (Gabura Union, 2015). The Union covers an area of 85.5 square km and consists of 15 villages, and the total population is about 38,825 comprising approximately 7500 households with an almost equal male-female ratio (male-19,307 and female-19,518) (Gabura Union, 2015). Due to the low-lying coastline landmass (i.e. almost 65% of the landmass is flood plain of total land) (Mallick et al., 2005), Gabura is frequently subject to storm surges, cyclone and annual flooding (Mallick et al., 2011; Parvin and Johnson, 2012). It was one of the most affected unions in Shyamnagar during cyclone Aila (category 1 cyclone) in 2009 (Gabura Union, 2015). The settlement is more than 100 years old and people are believed to have been living here for up to five generations (Parvin and Johnson, 2012).

Gabura Union is completely surrounded by water and isolated by two rivers, i.e. Kholpetua and Kopatakshi located on the northern

⁴ The Upazilas are the second lowest tier of administrative unit of local Government in Bangladesh (Administrative geography of Bangladesh, 2020; Mallick et al., 2011). Shyamnagar Upazila is mostly affected during cyclone Aila.

⁵ The Districts are the first tier of administrative unit of local Government in Bangladesh (Administrative geography of Bangladesh, 2020; Mallick et al., 2011).

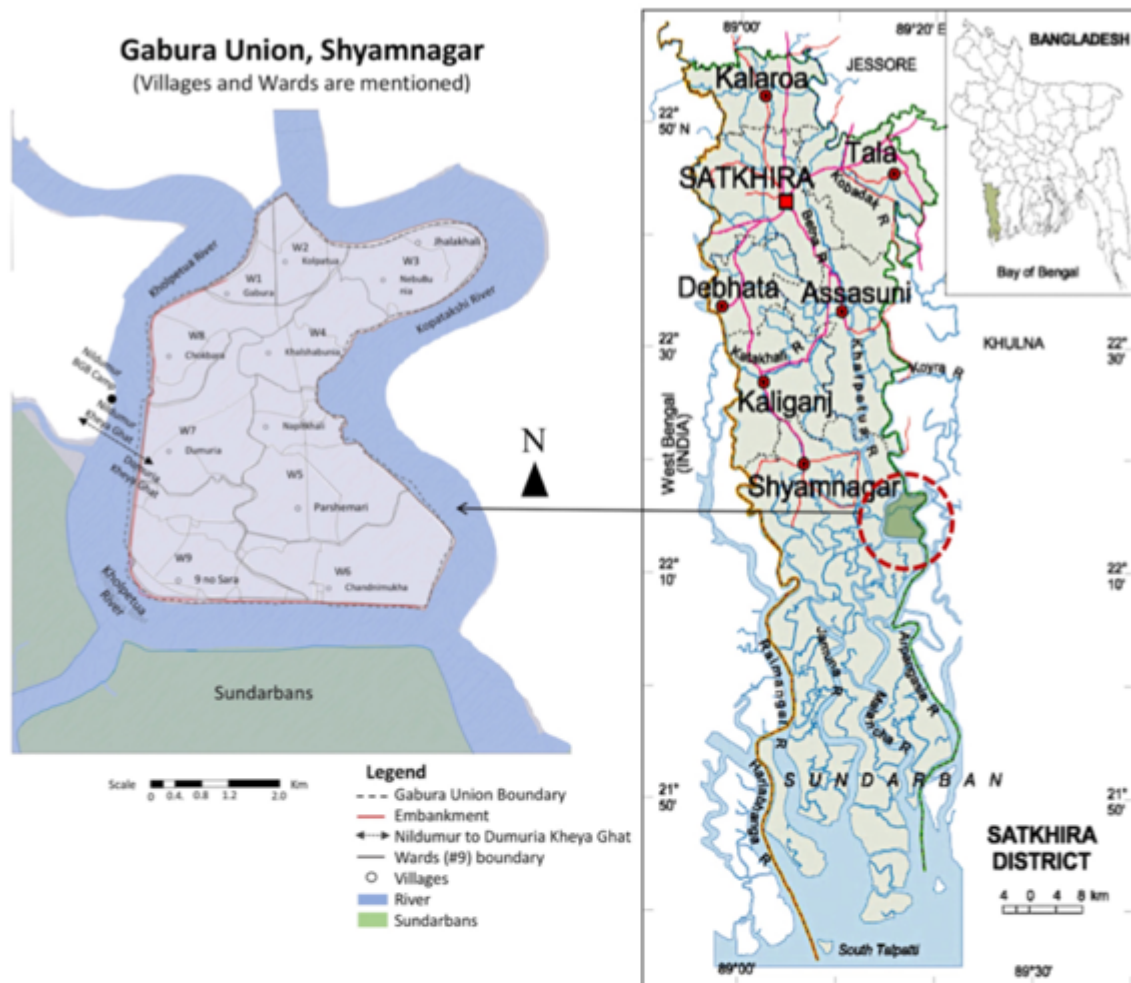


Fig. 2. Gabura Union, the study location is in Shyamnagar Upazila, Khulna Division, Bangladesh.
Source: Map adapted from Banglapedia (2014) and drawn by lead author.

and western boundaries, and an embankment. To the south-west is Sundarbans⁶ (enlisted as UNESCO World Heritage Sites), one of the largest mangroves forests in the world (Iftekhar and Islam, 2004, see Fig. 3). Livelihoods here are closely connected to seasonal and place-based resources, mostly from the Sundarbans (e.g. fishing, shrimp and crab cultivation, honey collection) (Getzner and Islam, 2013; Mallik et al., 2011; Parvin and Johnson, 2012; Roy, 2018).

Historically, Gabura Island and its populations have been both socio-economically and biophysically vulnerable. The major sources of vulnerability stemmed from a failure of local authorities to prioritize health issues, with poor water quality through salinization, a lack of proper sanitation, and flooding frequently disrupting food production causing food insecurity (Parvin and Ahsan, 2013; Roy et al., 2009). Increased soil salinity through inundation by seawater during Aila devastated coastal people's lives and livelihoods and completely destroyed their houses and household belongings (Gabura Union, 2015; Mallick et al., 2005). Parvin and Johnson (2012) reported that the natural process of sedimentation could not take place in Gabura due to construction of a high elevation embankment. Therefore, the island became lower than sea level and the green terrain in Gabura was turned to a salinity-affected grey island after

⁶ Sundarbans, occupy a large landmass and a dense forest, stretched across Bangladesh and India, covered an area of approximately 6000 km² in the Bangladeshi part (Uddin et al., 2013 p.153). Sundarbans ecosystems served wildlife and mangroves (Iftekhar, 2006). Mangroves serve as a bio-shield protection to the coastal settlements and reduce climate disaster (i.e. cyclones and tidal surges) (Dasgupta et al., 2019; Irfanullah, 2020). More than three million coastal people's livelihoods are directly or indirectly relied on the ecosystem services of the Sundarbans (Uddin et al., 2003; Roy et al., 2013). Two major cyclones (i.e. Sidr in 2007 and Aila in 2009), reduced mangrove forestations and increased soil salinization poses threats to coastal settlements and affect ecosystem services (Mallick et al., 2005; Shameem et al., 2014).

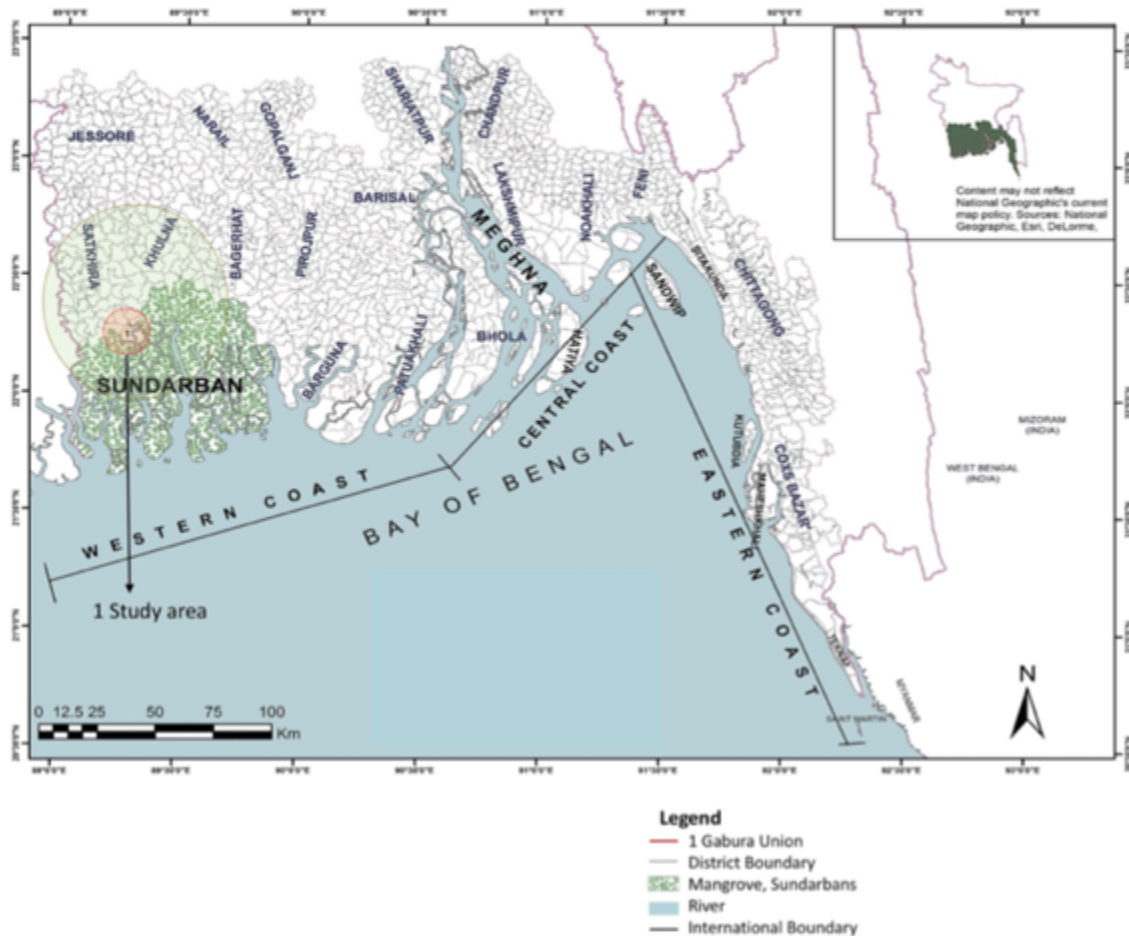


Fig. 3. The Sundarbans, adjacent to the study location of Gabura Union. Source: Map adapted from Banglapedia (2014) and Quader et al. (2017).

cyclone Aila (Alam et al., 2015).

The increased soil salinity and changing climate patterns transformed coastal livelihoods with mixed outcomes. These changes included a shift from agriculture to greater reliance on water-based livelihoods practices (e.g. fishing, catching shrimp and crab farming etc.) in the Sundarbans and employment of local labour as seasonal wage workers (Moumita et al., 2015; Islam, 2006). Bernier et al. (2016) indicated that increased soil salinity after Aila resulted in an expansion of shrimp farming replacing agricultural practices. With male household member's migration to urban areas (Mallick et al., 2005) female household members began to work outside of their traditional roles to support their families financially (Khalil et al., 2020). Through their engagement with the Sundarbans ecosystem, this place provides an opportunity to study women's engagement in post-cyclone climate adaptation through the lens of place attachment (Roy, 2012).

This paper is a part of the lead author's PhD thesis⁷ from which it uses a section of analysis that is relevant to the understanding of women's place attachment and their adaptation processes in the post-cyclone context. The fieldwork took place from January to April in 2016. Data were collected through a mixed method approach (Creswell, 1999; Creswell and Clark, 2007) using face-to-face and semi-structured interviews with two group of participants: Gabura households (25) and NGO officials (18), household questionnaire survey (110), focus group discussions (04), and participant observations. Out of 110 household interviews, male members were absent in 66 cases, through migration to the nearest town or regional centre for employment. The fieldwork also involved key informant interviews (43) including the Chairman of Gabura Union and members of local government, local village leader (Morol), senior citizens, some selected local actors (e.g. local service provider, local trainer), international NGOs staff and some selected disaster

⁷ The PhD thesis titled "women's role in adaptation to climate change in Bangladesh" was submitted in January 2021 and is now under examination.

practitioners and university academics. Participant households were selected purposively through snowball sampling (Atkinson and Flint, 2004). Some household participants (03) and an NGO staff also involved in walking and talking interviews to have a deeper understanding of their work settings and the networks and actors involved (Alam et al., 2020b; Anderson, 2004; Clark and Emmel, 2010; Kinney, 2017). Participant observations (Jorgensen, 2015) allowed to observe the villages and the community's actual settings closely without disturbing their normal life. The observations were continued through taking photographs. The issues were documented include the actions that were taken through NGOs in post-disaster recovery phase, and challenges faced by participant women, livelihoods conditions of the women and their adaptation processes. Following ethics protocols provided by UTS, HREC (Human Research Ethics Committee), all interviews were audio recorded with participant's consent and data anonymized with participants identified through a self-selected pseudonym. Interview data were transcribed and translated into English from the native language (i. e. Bangla) for qualitative thematic analysis.

6. Results

The following statement illustrates the need to understand the place-based adaptation of women through place attachment:

"My husband lost his agricultural lands and travelled to the nearest city for a job after Aila. It was difficult for all five family members to move to the city. We can't afford to rent a single room or buy foods in the city. The NGOs helped to rebuild the damaged house. I get fish from local rivers and vegetables from my yard. I took some training on vegetable gardening and fish cultivation. My eldest son (18-year-old) started working outside. So, I'm here with my children."

[Alo, 43 years old female household]

The above statement is a common story of survival of many coastal women since 2009, when the category 1 cyclone Aila hit south western coastal Bangladesh. The extent of devastation to the social lives of the island communities in the south-western coastal areas, such as Gabura, caused by Aila was unimaginable. Aila devastated life, livelihoods and properties (Dasgupta et al., 2019; Kartiki, 2011). Most notably for these island communities, after the cyclone, most of the income-earning male members of the community left their family members in the villages and moved to regional urban centres for alternate livelihoods (Mallick et al., 2005; Mallick and Siddiqui, 2015). For example, in Alo's case, it was a rational choice for her husband to leave the family in the village and explore economic opportunities in nearby cities. A significant portion of women faced such kinds of climate related impacts (e.g. economic hardship) in Bangladesh (Mallick and Siddiqui, 2015). However, for many female household heads like Alo, the decision to stay in the village and support her family was enabled through the utilisation of place-based livelihood resources.

For most of the female participants ($n = 66$), husbands (about 60%) had migrated to urban centres (e.g. Satkhira, Khulna, Dhaka) for employment, which left these women alone with children and other extended family members (e.g. in-laws, brothers and sisters). In the absence of the main income earning members of the family, typically the male head of the household, the women struggled to provide for the family.

7. Place

People have been living in Gabura for many generations. Because of this long-term occupation, participating women were typically found to have extensive knowledge about the context and surroundings, the availability of natural capital (e.g. soil, landscape, water), and traditional livelihood techniques (e.g. from agriculture to shrimp and fish cultivation), the patterns of changes in the local weather over years and above all the resources available from the Sundarbans. For example, Tara, a household head, has been living in Gabura for the past 41 years. Her deep knowledge of the local environment helped her adapt after Aila. She explained:

"My husband was in the Sundarbans during Aila and didn't return home. We even don't know if he is alive or not. But I didn't leave my village, my home. I am from here. I know every corner of the village - the rivers, the trees, this island - these all are my home. I can get fish from the local rivers and grow vegetables in my backyard. The house was rebuilt with NGO's support, and I started living here again with my two children. I don't need to pay house rent; it makes me feel relieved. I got some training from NGOs to get involved in works."

[Tara, 41 years old female household head]

Tara's statement describes her deep relationship to the place. Like other women in her village, she was comfortable to remain in place rather than face the uncertainty of an unknown place by migrating to the city. This place-based 'belongingness' is shaped by their experience, memories and attachment to the place. This finding is consistent with Blunt and Varley (2004) and Heywood (2005) who described how a place can be considered 'home' through physical experience and relevant memories.

Besides this emotional bond with the place, Gabura community's livelihoods are ingrained in the natural capital of the Sundarbans ecosystem, that contributes diverse livelihoods resources. Similar findings were observed by Roy (2012) and Roy et al. (2013) in other contexts. Rekha, a household head, highlighted her livelihood dependency on the Sundarbans:

"If the Sundarbans survives, my family will survive, and we will sustain in this troubled place. My elder son (20 years old) started to catch crabs from the Sundarbans and sell them in the market; it makes some money and reduces some burden on my shoulder. There are some seasonal opportunities in the crab fattening farm that I occasionally take. Sometimes I catch fish from the local rivers with my younger son. Materials for making a house are collected from the Sundarbans. NGOs helped plant

mangroves on our lawns and near embankments to protect our house from future cyclones. The Sundarbans is our hope for survival."

[Rekha, 39 years old female household]

Sundarbans hold a unique place value and contribute to life in Gabura by meeting a range of dependencies. The availability of natural resources supported the production of local handicrafts (Khalil et al., 2020), which were then sold and contributed to the financial capital of the community and ensured food security. The natural resources of Sundarbans ecosystems also contributed to physical capital for Gabura settlements by providing building materials (e.g. wood, straw, leaves) used to construct and maintain village shelters and dwellings. Kibria et al. (2019) described similar findings that coastal people's wellbeing and livelihoods are linked to Sundarbans ecosystem services. Overall, place and the attachment of women to place plays a significant role in supporting a range of adaptations in the post-cyclone period.

8. People

Women in Gabura are central in family bonding relationships. Women sustained their households through their emotional attachment to family and the strong bonding ties with family members (e.g. Khalil et al., 2020). Participants revealed that the ability of women to secure basic needs from their surroundings (e.g. food, homestead fuel, fodder and wild fruit) strengthened connections to their domestic setting at a time when these connections were stressed or disrupted through the deaths or absence of family members. This dependence on and knowledge of place reinforced women-to-women attachments, that in turn created an intimate feminine landscape at neighbourhood level where material resources, information and local knowledge were shared with each other. These activities were considered critical supports for the community in the post-cyclone period. Moni explained her experiences:

"Alo, Tara, Rubi - we are living close and working together. Alo is my next-door neighbour. She has created a women's platform, an opportunity for all of us with supports from NGOs. We have received credit on a turn basis by maintaining these relationships. Material supports also benefitted us. Rubi bought a sewing machine and started to make handicrafts. Alo and Tara maintained regular contact with NGOs and shared new ideas of livelihoods at monthly meetings. Through this relationship, I have benefitted financially and learned various farming knowledge. These and have given me psychological strength in my husband's absence. These women's platform strengthened our neighbourhood relationship after Aila."

[Moni, 38 years old, female household]

Before Aila, women were constrained to the home and rarely went outside to seek economic opportunities, partly because of social and cultural restrictions but also because there was little need to seek outside employment as their husbands reserved the role of supporting the family. The absence of male household members influenced women to step outside of home for work and to establish and maintain links with outsiders (i.e. NGOs). These linking relationships with NGOs reinforced women to become active, move forward and develop some novel adaptation strategies through engagement in training programs with NGOs (Khalil et al., 2020). Rubi stated:

"In the absence of my husband, my neighbour Alo involved me in their shared group and kept me alive by showing some livelihood sources. I took some training from a local NGO and started salt-tolerant vegetable gardening in my yard. The production was much slower but met my daily needs. Besides, I bought a sewing machine by receiving loans from an NGO and could secure alternate income sources. I sell products in the local market with the help of an NGO."

[Rubi, 32 years old, female household]

In Gabura, women like Alo, Tara, Moni or Rubi are living next to each other. They meet in a regular monthly meeting (sometimes weekly) to stay connected to other household women. Similar findings by Lewicka (2005) illustrate that people in villages or small towns have a high level of interactions within their communities and neighbourhoods compared to an urban area. Their established social platform for women mobilized and enhanced bonding and bridging social capital, which in turn ensured the success of their decision to remain in place. The role of place-based support through connections to NGOs such as access to small loans (e.g. micro-credit) to generate household business opportunities was also critical in allowing women to stay in place. The success of some women then also inspired other women to work together. These women-to-women social ties not only strengthened bridging and linking relationships but also reinforced the bonding relationships (Islam and Walkerden, 2014) within families and led to successful adaptation capacity building in post-cyclone context (Khalil et al., 2020).

9. Process

People and place combined to promote the process of adaptation in the post-cyclone context. Underpinned by a number of studies (e.g. Johnson and Ruttan, 1992; Lebel, 2013) successful adaptation may be supported by place-based traditional or local knowledge. Gabura women possess place-based local knowledge and are geographically connected to changing climate patterns such as cyclone frequency and intensity (e.g. Aila in 2009 and Sidr in 2007). Moreover, the island ecosystem (i.e. Sundarbans) is a critical support system for women and reinforced place-based dependency. While Aila's impact forced male community members to move to cities, some women began a process of knowledge acquisition, inspired to explore the surrounding resources driven by the need to support surviving family members, the search for alternative livelihoods and their inability to relocate. For example, Alo stated her adaptation process in the post-Aila period:

"I had faced hardship during Aila. But I didn't lose hope and turned around again. After Aila, I started mending Nakshi Kantha (handcrafted mats). I had this knowledge from an early age. I started selling some of them in the weekly local market. But it wasn't enough to survive with three children in the absence of my man (husband). Then I took some training from a local NGO. Now I am working as a local trainer in an NGO. We have created a women's platform with NGOs' help, where we have 25 women working. I recently bought a sewing machine with some financial support from that platform. It became my source of income. My neighbourhood women have benefitted and followed my success."

[Alo, 43 years old female household]

Previously whereas women were seldom participating with outsiders, the post-cyclone context changed the traditional gender roles, influenced women to work outside of home, leveraged their social capital and involved them in building a meaningful relationship with community insiders (i.e. households and neighbourhoods) and outsiders (i.e. NGOs) (Islam and Walkerden, 2015; Khalil et al., 2020). This linking relationship empowered women to build on their traditional local knowledge and develop new skills (human capital).

The use and conversion of available livelihood capitals (social and natural capital) coupled to enhanced human capital helped women adapt in place. In search of alternative livelihood options, many women like Alo, Tara, and Rubi started learning through training facilities supported by NGOs about localised processes to convert available natural resources from Sundarbans. In understanding how adaptation in post-Aila period involves place-based resources, an NGO officer stated:

"I have been working with women in Gabura for the last five years and have noticed that these women have a more profound attachment to the place and surroundings. They know their culture, traditional knowledge and patterns of climate change. Their livelihoods are linked to the Sundarbans' resources. After Aila, the women started to explore these Sundarbans-based livelihoods more to ensure food security. We (NGOs) supported them with various livelihoods training (e.g. salt-tolerant farming method). Some women, such as, Alo, Rubi succeeded by applying these methods. We believe that more positive results can come with proper application."

[NGO officer]

One of the main drivers of new agricultural practices was soil salinization following Aila. The process of adapting to salinized soils transformed the typical agricultural practices to a greater reliance on 'water-based' livelihoods. These included small-scale fisheries and crab cultivation and have contributed to food security and economic wellbeing of these coastal women. Socio-ecological alteration is the reason for this transformation of livelihoods practice from land-based to water-based food production (Bernier et al., 2016). An NGO staff member in Gabura explained his experience of connections with these coastal women after Aila:

"It wasn't easy to connect with these affected women initially due to different socio-cultural constraints. Aila changed the pre-existing situation. Women needed to secure food while their husbands were away. We had to establish trust for these women's involvement. We had selected several women in leading roles who had the potential to train up other women. At the monthly meeting, we noticed that 80% of the participants were women. If we can regularly connect with these women with training and material support; their livelihoods and food security will be ensured."

[NGO officer]

Findings revealed that the women in Gabura are tied to place with a long history (over four or five generations). Parvin and Johnson (2012) mentioned the settlement at Gabura Union is more than 100 years old. This long-time relationship influenced them to remain attached to the island and encouraged the process of acquisition of new skills to supplement their traditional knowledge of the island ecology in support of post-cyclone adaptation strategies.

10. Discussion

In this paper, women's place-based adaptation in the post-cyclone recovery context of Gabura was examined by using the lens of place attachment. Place attachment is conceptualized following the tripartite model, 'person-place-process' (Scannell and Gifford, 2010). Underpinned by previous studies on place attachment (Amundsen, 2015; Fresque-Baxter and Armitage, 2012; O'Brien et al., 2004) we argue that both the processes of place attachment and place-based adaptation are interlinked and there is value in looking into their intersections to understand post-disaster adaptation. In Gabura, following the cyclone Aila, place-based adaptation occurred through a number of interconnections of context and scale: 1) attachment to home; 2) attachment of people-to-people (e.g. neighbourhood and outsiders); 3) attachment to the natural resources.

Traditionally, women in Gabura have deep attachment to their families associated with their domestic responsibilities within home and surrounding landscape. Considering the people dimension of place attachment, Gabura women's interconnectedness with home promoted relationships at the neighbourhood level, a similar finding to that of Anton and Lawrence (2014) in an Australian context. These attachments created an intimate 'bridging' relationship at the neighbourhood level that influenced women to engage in other livelihood activities by forming groups with other women, in the absence of key wage-earning male members of the family. These bridging relationships at the neighbourhood level strengthened other relationships (e.g. bonding relationship) among the family members that held families together and strengthened attachment to place; similar findings were explored by Prezza et al. (2001) and Lewicka (2005). These women-to-women neighbourhood relationships influenced the establishment of knowledge sharing platforms and work outside of home through connections with outsiders (i.e. NGOs) and enhanced place-based adaptation based on local natural resources. Local NGOs played a supportive role for Gabura women in post-cyclone context in the use and transformation of local

resources (capitals). Similar examples drawn by Goodrich et al. (2017) and (2019) in the context of Hindu-Kush Himalayas explained how the contextual situations lead to gender vulnerability and changes, such as the migration of male members forcing women to take on new roles and responsibilities with supports from NGOs.

With the help of NGOs, trust and linking relationships were established, and women trained in alternate and natural resource-based livelihood opportunities (Khalil et al., 2020). Women's shared local knowledge coupled with NGO training resulted in social transformation at the neighbourhood-level where women used their limited but accessible, place-based resources to secure livelihoods. These contributions deepened women's attachment to Gabura. Similar examples are also documented by Narayanan and Kumar (2007), the relationship of women to the natural resources of their surroundings and their traditional knowledge influenced place dependence.

The application of place attachment theory helped explain how these marginalised women could achieve place-based, post-disaster adaptation (e.g. salt tolerant agricultural innovation) by capitalising on place specific resources and knowledge. Gabura is an important place for this coastal community in two ways: first, the natural resources of Sundarbans ecosystems play a direct and indirect role in providing livelihoods to these climate-marginalised people. The livelihoods resources of the Sundarbans, such as fish, shrimp, crab, honey, food, firewood and habitat resources (e.g. timber, wood, straw, golpata⁸ [*Nipa fruticans*] etc.) (Getzner and Islam, 2013; Shameem et al., 2014; Uddin et al., 2013) contributed to the 'place' dimension of place attachment. The availability of resources from the island's ecosystem has reinforced place dependence as critical support systems for women to remain in place. The finding echoes with previous studies (Ahhammad et al., 2013; Uddin et al., 2013) that argued for the importance of place-based eco-systems (e.g., mangrove forests and the river system) in protecting exposed coastal communities from natural disasters.

Additionally, many local and international NGOs are working in Gabura (e.g. local NGOs: Dhaka Ahsania Mission, Susilon, World Vision, NGF, JCF; NGOs: CREL, CNRS, BRAC⁹) have helped the coastal communities explore opportunities to utilise and transform the natural capital of the Sundarbans to improve livelihoods. These interventions by aid organizations have led to success in the cultivation of salt-tolerant vegetables, crabs and shrimp cultivation in saline water. These innovative approaches involve a combination of social, natural and human capitals that ultimately transform into physical and financial capitals that ensure food security and form the basis of place-based adaptation for women. This observation is consistent with previous findings on the contribution of different types of capital to economic development and social wellbeing (Dakhli and De Clercq, 2004; Mulder et al., 2006).

Inspired by the findings, an analytical framework is conceptualized (see Fig. 4) following the tripartite model of the 'person-place-process' dimensions, which describes how women as the 'people' dimension are attached to Gabura villages and surroundings (e.g. the Sundarbans) as the 'place' dimension. The framework illustrates place-based adaptation (including a set of livelihood outcomes), as resulting from multilevel social connections among 'people' (e.g. women and NGOs), the 'place' (i.e. Gabura, located beside Sundarbans) and its natural resource endowments, and the 'process' of the transformation of capital from one form (social and natural capital) into other forms (physical and financial capital) via knowledge sharing (human capital).

NGOs are supporting these women in this transformation in two ways. First, the NGOs often helped women gain access to the natural capital collection of the Sundarbans, then helped them transform natural capitals into physical and financial capital (i.e. agricultural innovations and handmade productions). Thus, food security, household resources and economic well-being were ensured. Second, NGOs supported women's empowerment through training in livelihoods programs (e.g. salt tolerant agricultural cultivation, fish or shrimp farming etc.) and thereby improved human capital (i.e. women's empowerment through training facilities) and enhanced social capital (e.g. bonding and bridging relationship). With the NGO support women's financial capital was ensured through handmade production that was not previously a commercial activity.

The coastal women of Gabura (e.g. Alo, Tara or Moni) have been attached to this place since birth and the continued residence of their families over generations. The long-term connection of women with the local context has transformed their ways of thinking about the island ecology, increased their potential in the search for livelihoods based on traditional knowledge and understanding of climate. This knowledge of landscape, biodiversity and surroundings was important for these women to recover from the effects of the cyclone and adapt to the dramatically altered environment in the post-cyclone context. Similar findings were described by Mugambiwa (2018) that traditional knowledge, place-based resources, social relationships and kinship are important components in the process of adaptation. Consistent with other literature (e.g., Howard 2003; Narayanan and Kumar, 2007), the integral connection between women and biodiversity can enhance place-based adaptation through the use of traditional knowledge and resources from the surrounding landscapes. These findings are particularly significant because it is beyond this poor coastal community's capacity to move to cities with 5–6 family members and pay for shelter and food. Research by Mallick et al. (2017) and Mallick and Siddiqui (2015) reported the value of non-migration in successful in-situ adaptation emphasising the utility of place attachment as a tool to understand adaptation changes in communities. Thus, this paper makes an important contribution in highlighting the role of women's place attachment in understanding their place-based adaptation in the post-cyclone recovery context because of their relative inability to migrate following a natural disaster.

11. Conclusion

The study examined how place attachment played a role in enabling women's adaptation in a post-cyclone context. The findings

⁸ Golpata, a species of nipa palm (*Nipa fruticans*), grows in the Sundarbans. The leafy plant is used for thatching and fencing.

⁹ NGF-Nowabanki Gonomukhi Foundation, JCF-Jagoroni Chakra Foundation, CREL-Climate-Resilient Ecosystems and Livelihoods, CNRS-Centre for Natural Resource Studies, BRAC-Bangladesh Rural Advancement Committee and NGOs-Non-Government Organizations.

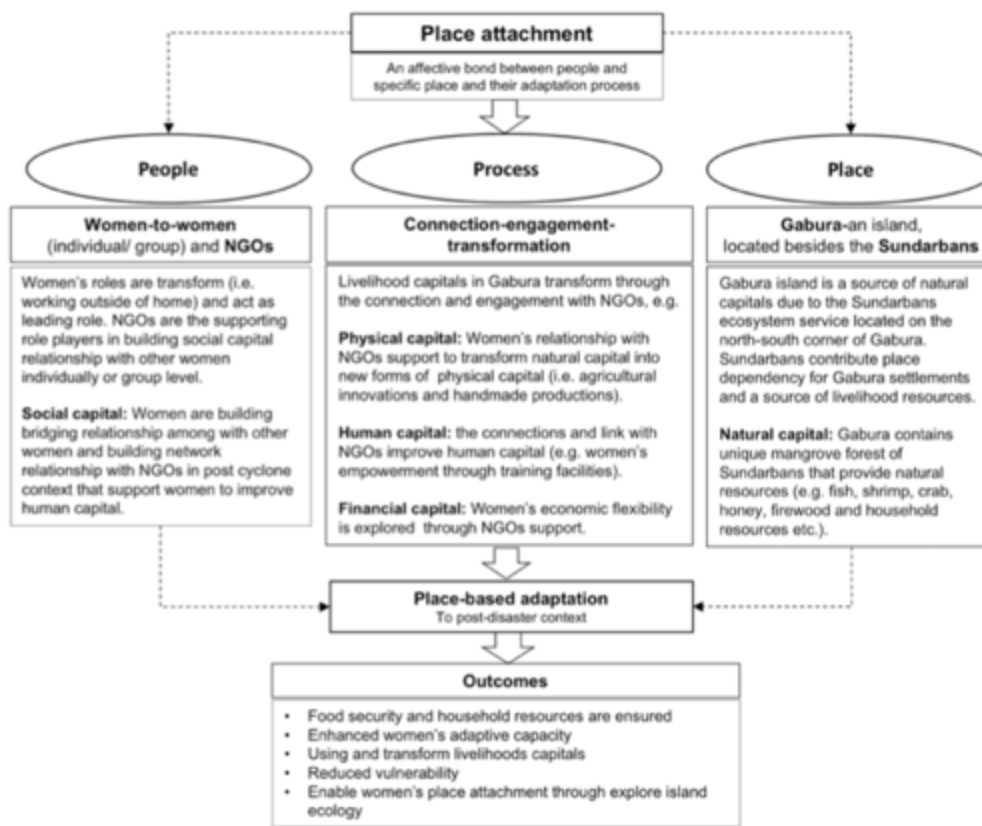


Fig. 4. The role of place attachment for place-based adaptation in post-cyclone context. Source: Drawn by lead author.

suggest that although socio-cultural norms restricted Gabura women from migration, they could manage to adapt through the use, conversion and transformation of place-based livelihood resources. Of these resources, forms of social capital were critical for these women to embark on alternative livelihoods and innovations, such as the change from land-based to water-based livelihoods and adapt to salt-tolerant agricultural innovations and commercial production of traditional handicrafts. Women's place dependence, a component of place attachment, was demonstrated through the necessity to utilise the local natural capital of the Sundarbans (as one of the few resources at their disposal). Their knowledge of the island ecology enabled their survival in the absence of the male household heads. Women were able to take on less traditional leadership roles at the village level. Rather than seeing their inability to leave a place after a disaster as a disadvantage, a place-attachment approach revealed women's capacity to transform in place, where the post-cyclone necessities and constraints were drivers for such transformation.

As practical implications, the findings highlight the need for greater consideration of gender inclusive pathways for post-disaster recovery that focuses on in-situ potentials to include the place-based natural capital (e.g., the Sundarbans) and those immobile actors, women in our case who are often deemed incapable of changing their circumstances. We argue that the local government actors, NGOs and INGOs who work with these coastal communities should focus more on enabling and empowering women household heads for post-disaster recovery. A key lesson from this study, reinforced by previous studies (Khalil et al., 2016, 2020), is that NGOs and traditionally marginalised actors (typically women), can build successful partnership that encourage innovation in the use of natural capital. There should be diversification of supports (e.g. financial, physical and social capital) to cater to both women and men. Appropriate place-based livelihoods support may discourage male members' out-migration, thereby reducing the disruption to the community's demographic fabric.

As a point of departure, we highlight some specificities of the present study and future research agenda. We acknowledge that this study is based on a unique coastal settlement because of its geographic proximity to the Sundarbans, which significantly enabled women's place-based adaptation through the availability of natural resources. The findings may not be generalised for other coastal settlements that lack similar natural capitals making place-based adaptation difficult. Future studies could examine the contribution of remittances by male members to women's adaptation in origin. There could be a comparison of adaptation pathways by families with absentee male members and those where both male and female household heads are present. Longitudinal studies could focus more on if the women's successful place-based adaptation encouraged the male member's return to the origin and how both male and female

members could enhance adaptation by utilizing their social networks within the village. We conclude by highlighting the importance of employing the place attachment lens for more gender-inclusive pathways for place-based adaptation in a post-cyclone context.

Author's contribution

Momtaz Bintay Khalil: Conceptualisation, data collection-transcription and analysis, methodology, literature review, original draft preparation and writing. Dr Brent C Jacobs: Supervision, reviewing and editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Chapter 08: General discussion

This chapter integrates the findings presented in previous chapters (Chapter 4, 5, 6, and 7) leading to the conclusions of my thesis. The chapter triangulates the discussion of the three findings chapters with a particular focus on gender perspectives to understand adaptation challenges to climate change confronted by poor coastal women in Bangladesh in the post-cyclone Aila context. In response to Gabura women's roles in adaptation to climate change this thesis contributes empirical evidence to existing knowledge in four conceptual areas: 1. the role of local knowledge for grassroots innovation, 2. the contribution of linking social capital and its development between marginalised women and NGOs, 3. the role of place attachment and 4. access, use and transformation of livelihood capitals in place-based adaptation of women.

Each findings chapter reviewed the relevant literature and addressed an overarching research question and four subsidiary questions (see Chapter 1). The overarching research question asked:

'What is the contribution of local knowledge and social capital to women's place-based adaptation in post-cyclone context of Bangladesh?'

The subsidiary questions were asked:

SRQ 1: *'How does local knowledge contribute to the creation of grassroots technologies?'* – Chapter 4 addressed this question.

SRQ 2: *'How do women contribute to grassroots innovation through local knowledge dissemination and building network relationships with NGOs?'* – Chapter 5 covers this question.

SRQ 3: *'What is the role of linking social capital in helping to reconstruct other forms of social capital to support women's adaptation in post-cyclone context?'* – Chapter 6 covers this question.

SRQ 4: *'How does place attachment contribute to women's use of livelihood capitals for adaptation in a post-cyclone context?'* - Chapter 7 covers this question.

Empirical evidence was gathered to address these research questions through a mixed method approach in a case study located at Gabura Union in the Sundarbans region of coastal Bangladesh (Figure 3.1, in Chapter 3), an area frequently ravaged by cyclones.

Chapter 4 was a published book chapter that identified how the roles of local knowledge and community trust contributed to grassroots innovation to climate change adaptation (Khalil et al., 2016). First findings chapter, Chapter 5, explained how the roles of local knowledge and types of social capital contributed to women's grassroots innovation as adaptation in a post cyclone context (Khalil et al., 2020). Second findings chapter, Chapter 6, examined the three forms of social capital (bonding, bridging and linking social capital) to understand the importance of linking relationships between the community of women and NGOs in supporting adaptation responses. Third and final findings chapter, Chapter 7, explored women's place-based adaptation in the coastal settlements of Gabura, Bangladesh through the lens of place

attachment theory and its influence on access, utilisation and transformation of livelihood capitals in pursuit of alternative livelihood options.

The following section provides a scaffold to structure the overall lessons in the thesis that were discussed in the key findings chapters. Finally, I wrap up the discussion by acknowledging some limitations of the study and suggest some recommendations for future research.

8.1 Local knowledge and grassroots innovation

Chapter 4 (published chapter, see Khalil et al., 2016) identified grassroots technologies (see Appendix XI: Grassroots technology and local responses) are the outcomes of local knowledge and community's trust (i.e. social capital) in climate change adaptation. This chapter partially addresses the broad research question and a sub research question, SRQ 1: '*How does local knowledge contribute to the creation of grassroots technologies?*'. I identified a range of grassroots responses in the villages of Gabura, frequently the result of local interventions through NGO assistance that included: development of alternative livelihoods, food production, health, water and sanitation, and construction of shelter, housing and embankment dwellings (see Table 21.1, Chapter 4). In Gabura, to cope with climate extreme events under severe resource limitations, grassroots technologies emerged from autonomous adaptation processes under severe resource limitations, with planned adaptation playing only a secondary role in supporting these adaptive responses in the context of Bangladesh. Chapter 4 concluded that for poor coastal people with limited access to physical and financial capital, adaptation depends on the available natural resources (Adger et al.,

2003) and local knowledge that can be assets in creating grassroots technologies (Alam et al., 2015), coupled to social support from policymakers in capacity building and decision-making processes (Pelling and High, 2005; Mercer et al., 2007). This chapter concludes with a conceptual framework (Figure 21.1 in Chapter 4) that links local knowledge, social capital and climate change adaptation to understand autonomous adaptation as an important aspect of grassroots innovation for poor coastal community's adaptation strategies in a post-cyclone context.

However, communities often fail to appreciate and trust their innate adaptive capacity, often latent until activated by an extreme weather event. For example, during this initial pilot field study, I observed that, while often unacknowledged because of their traditionally limited role outside of their domestic setting, women in Gabura made a substantial contribution to grassroots innovation. This situation led me to a deeper examination of women's contribution to grassroots innovation for adaptation challenges through understanding of women's role and their capacity for leadership through the contribution of social capital and based on their traditional local knowledge, described in Chapter 5.

8.2 Exploring female contribution to grassroots innovation

To better understand women's adaptation to climate change, Chapter 5 (published paper, see Khalil et al., 2020) described the roles of local knowledge and social capital that contribute to grassroots innovation by women. This chapter discussed Gabura women's changing roles and their contributions to climate change adaptation challenges in the post-cyclone Aila context. The hazard associated with an extreme

climate event, such as cyclone Aila, provides an essential trigger for innovation (Nelson et al., 2007). However, my findings indicate that in the traditional patriarchal village system, women in Gabura were bound by their culture and had limited decision-making power. Women were socially and structurally marginalized both inside and outside of their homes. Moreover, women generally are less informed about disaster preparedness, and have limited opportunities for education and skill development; the findings are consistent with a range of other studies (e.g. Alam and Rahman, 2014; Dankelman, 2008; UN Women, 2014).

In the post-cyclone context, women in coastal settlements faced economic hardship and food insecurity in absence of their husbands (Mallick and Siddiqui, 2015). Due to male household member's migration to cities, Gabura women found the degree of change possible within their domestic premises to be inadequate as adaptation strategies. Their survival often depended on overcoming traditional social norms. Male migration to cities in the post-disaster context created social and economic voids in the community that women were required to fill as survival strategies, findings consistent with those of Bernzen et al. (2019) and Ganapati (2012). So, the devastating situation of cyclone Aila stimulated Gabura women to move away from the local norms of domesticity and undertake significant transformative adaptation challenges through local knowledge sharing with other women and knowledge exchange with NGOs.

Adaptive strategies differed between household men and women. These strategies were explored through the fieldwork and walking interviews, in which Gabura women emerged as role models of adaptation through their intimate links to the domestic

context and their willingness to engage with the outside world. With external support, largely through NGOs, they became key actors in mobilization and sharing of knowledge through their ability to form effective networks to trial, adopt and promote adaptation strategies. In support of these findings, other researchers (e.g. Chhetri et al., 2010) have theorized that successful innovation and adoption of new technologies is the product of local social and economic resources leveraged by institutional arrangements.

To address the research question SRQ 2: '*How do women contribute to grassroots innovation through local knowledge dissemination and building network relationships with NGOs?*', this chapter revealed that changes occurred in Gabura women in the post-Aila context, in three areas: 1. changed roles for women in the community; 2. acquisition and sharing by women of new knowledge; and 3. leveraging forms of social capital (particularly bridging and linking relationships) in support of adaptation strategies. The changing nature of women's work outside of home and their involvement in diverse livelihoods options increased their contribution to adaptation through their changed roles. Women were instrumental in building social capital and trust at multiple scales, especially with NGOs, and finally through mobilization and sharing of local knowledge.

8.2.1 Changed gender roles based on local knowledge and social capital

In general, women in the developing world, especially in coastal areas, are considered highly vulnerable to climate-related extreme events (Cannon, 2002; Dankelman,

2008). While the hardships of extreme climate events are undoubtedly severe, they can stimulate significant changes in gender roles to adaptation; lived experience of natural hazards, such as cyclones and flooding, are recognized as strong drivers of adaptation (Pelling, 2010). My findings indicated that women began to perform roles usually played by their husbands before Aila. Specifically, Gabura women found work outside of their traditional domestic duties including increased engagement in domestic food production, in fishing and crab production, in cultivating vegetables tolerant of soil salinity (see Appendix XII: Female contribution to agricultural innovation in salt-based soil), in producing household organic fertilizer and applying it to remediate salinized soils and producing clay stoves fuelled from local materials. In keeping with the findings of others, (Baden et al., 1994; Dankelman, 2008; Denton, 2002; Jordan, 2019), I found that prior to Aila the women of Gabura were largely confined within their domestic context because of deep religious and cultural boundaries. However, after Aila, some women developed small-scale industry producing traditional handicrafts based on local knowledge to improve their financial situation, similar examples are drawn by other authors (e.g. Alam et al., 2015; Alam and Rahman, 2020; Barua and Rahman, 2017) who have reported the important role of local knowledge in adaptation to climate change.

8.2.2 Roles of local knowledge and social capital

Local knowledge is the community's traditional knowledge that is transmitted orally over generations. In common with previous studies the concept of local knowledge used in this study is derived from traditional or cultural knowledge which is transmitted

orally among the community over generations (Agrawal 1995b; Ellen et al., 2000; Feldman & Welsh, 1995; Sillitoe, 2006; Warren & Cashman, 1988). Gabura women were a rich resource of local knowledge through the long-time lived experience of their environmental surroundings. In the post-Aila situation, to secure their livelihoods and for food production, Gabura women utilized their agency to combine their place-based knowledge and understanding of their situation with knowledge acquired from NGOs. To support household food production on saline soils, Gabura women participated in training activities, which allowed them to capitalize on local knowledge, and acquired new knowledge from NGOs ensuring they became adept in agricultural innovation (Fig 3, Chapter 5). These adaptation techniques improved household finances through access to markets with NGO support. These kinds of adaptation strategies through entrepreneurship improved women's lives and livelihoods (Joakim & Wismer, 2015; Roy, 2012), and made them more resilient to be prepared for the future climate stressors through strengthened social capital (Aldrich, 2012; Aldrich and Meyer, 2015).

Social capital is identified as an important asset for developing countries described in various dimensions (e.g. norms, values, trust, connections, networks and relationship) (Adger, 2003; Bourdieu, 1989; Coleman, 1988; Cretney, 2018; Meyer, 2018; Narayan, 1999; Putnam, 1995; Woolcock, 2004). For the Gabura coastal community, social capital worked in both attitudinal and structural dimensions from a gender perspective. For example, in post-cyclone context in comparison to women, men were less inclined to see value in training and skills development, less attached to place and emphasized the values of financial capital. Some scholars (e.g. Ostrom & Ahn, 2009; Woolcock, 2001) suggest that in relation to structural aspects of social capital, social ties support

development of relationships and trustworthiness, maintain relations in a family, and sometimes networks within a community neighbourhood. Women were effective at building and using these types of connections and strengthening relationships in support of adaptation in the post-Aila situation. Women shared their success stories with neighbouring women in the village and with outsiders, which ensured the benefits of adoption were spread throughout their community. Male community member's migration to cities in pursuit of livelihood opportunities opened up options for Gabura women in building linking networks with the NGOs, and with NGO's support they started working outside of home to secure their own livelihoods. NGOs made significant contributions through introducing new ideas on food production on saline soils, which helped to empower women. These climate resilient adaptation strategies enhanced their food security and enabled access to the economy through small-scale commercial handcrafts production. These adaptive strategies are conceptualised in a proposed framework 'informed autonomous adaptation' (Figure 4, Chapter 5) that links to women's changed gender roles, through the mobilization and acquisition of local knowledge and social capital with the community of insiders and outsiders, which supported a range of contributions by women to grassroots innovation in a post-cyclone context.

8.3 Examination of social capital

Chapter 6 (under revision) described the theoretical basis of the three forms of social capital (bonding, bridging and linking social capital), the relationships that developed between Gabura women and NGOs, and how linking social capital strengthened

bonding and bridging social capital at household level in post-cyclone context. These three forms of social capital (bonding, bridging and linking) are described as various types of relationships in social networks by Woolcock & Narayan (2000) and Woolcock (2004), and in a developing world context by Alam & Rahman (2017); Islam and Walkerden (2015); Masud-All-Kamal & Hassan (2018); Patt et al. (2009). Bonding social capital is the relationship between family members and relatives, a horizontal tie; bridging social capital is the relationship among acquaintances (e.g. relatives and neighbourhood), a horizontal and vertical tie; and linking social capital represents the vertical relationships among the community insiders and outsiders (Woolcock, 2004; Woolcock & Narayan, 2000; Nakawaga & Shaw, 2004). Based on the research question, SRQ 3: '*What is the role of linking social capital in helping to reconstruct other forms of social capital to support women's adaptation in post-cyclone context?*'- this chapter discussed a major contribution in rethinking of women's role in social relationships through network building with NGOs.

8.3.1 The roles of three forms of social capital (linking-bridging-bonding)

In Gabura, most women are the victims of climate related extreme events; despite this they continued to contribute to the community through their domestic responsibilities within resource constraints. The devastation of cyclone Aila left little in the way of local resources which stimulated Gabura women to move away from the local norms of domesticity and made them initially dependent on the external supports (i.e. NGOs) to address adaptation challenges. Women's roles were transformed significantly through this interaction with NGOs and they were found to be involved in working outside of

home for food security, in the absence of their husbands. As a result, women were transformed from an existing state of vulnerability to greater empowerment through economic and skill development, facilitated by social capital.

Linking social capital, through connections with external actors was found to be an important support for women in adaptation challenges to climate change (Lowndes, 2004; Zohir, 2004). These ties appeared to be a key factor in overcoming the gender gap among male and female household members towards new economic opportunities. The nature of the relationships of men and women with NGOs were different. Male relationships with NGOs appeared to be largely transactional and related to obtaining access to NGO support in the form of aid and relief supplies; whereas women engaged with NGOs in a more relational manner to share knowledge with and through their bridging networks (Agarwal, 2000). The links between social capital and knowledge at grassroots level among women and NGOs were mediated through sharing local knowledge and the exchange of new knowledge providing access to resources not generally available to women, similar findings were reported by Cummings et al., (2019) in the cyclone Sidr context. Post-cyclone Aila, women's linking relationships with NGOs were strengthened, whereas male networks with NGOs weakened. The post-Aila situation transformed women's roles and they started working outside of home. My research suggests that NGOs offered new possibilities (for economic activity) so that women felt empowered and trained, e.g. in climate-smart farming methods (Khalil et al., 2020). This strengthened linking social capital and in turn other forms of social capital (bonding and bridging) among the community's 'insider' women.

My research indicates that bridging relationships among women in Gabura were also critical to recovery. Generally, women maintain strong bridging connections to neighbours through sharing belongings and other necessities (Jordan, 2015). However, notable changes happened in the post-Aila period; the relationships among women were activated in sharing local knowledge resources to generate tangible livelihoods opportunities. They established new shared platforms which were important mediators of local knowledge sharing and effectively mobilised to develop visible economic opportunities. Male community member's absence and relocation to cities for economic purposes created opportunities for Gabura women to step out of home and, through improved the bridging relationships, work together in handicrafts production with other women with the help of material supports from NGOs in the post cyclone context (Khalil et al., 2020). Following cyclone Sidr in 2007, Islam and Walkerden (2014) identified changes in bonding and bridging relationships that were considered critical to survival after that natural disaster. My findings suggest that although these networks are initially important, the success of long-term recovery efforts is enhanced if linking connections are established with flow on benefits to the wider community (Hsueh, 2019; Monteil et al., 2020).

Bonding relationships within the family at Gabura appear to have been altered and, in many cases, became weaker during post-Aila context, which resulted in greater reliance on linking connections for resource sharing and knowledge and skills development, and which in turn strengthened other forms of social capital (Cummings et al., 2019). These changes in local connections were particularly important for women because of their husband's relocation to the city in search of new economic opportunities. The female household heads played a key role in maintaining family

bonding relationships to support the household expenses. Some women established themselves as income earning community members supporting their families with new economic opportunities through agricultural production (e.g. local food production), and there was evidence in Gabura that their husband/family members started to appreciate the benefits. This situation contributed in the long run to strengthened bonding relationships in some families, as male household members frequently assisted their wives' entrepreneurship (a situation that rarely occurred in the past). Overall, the altered gender relationships in Gabura following cyclone Aila, contributed to rebuilding all three forms of social capital relationships (i.e. bonding, bridging and linking).

8.4 Understanding place-based adaptation through place attachment

Chapter 7 (published paper, see Khalil and Jacobs, 2021) described the theory of place attachment and the roles of livelihood capitals that contribute to women's place-based adaptation in a post-cyclone context. Place attachment consists of multiple dimensions according to a range of scholars' interpretations, such as, place identity, place making, sense of place, place dependence etc. (Dixon and Durrheim, 2000; Lalli, 1992; Lynch, 1980). In my thesis, place attachment was conceptualized following the tripartite model, 'person-place-process', by Scannell & Gifford (2010); it refers to the relationships between people and place and the processes that join the two. Drawing on a mixed method approach and based on a sub research question, SRQ 4: *'How does place attachment contribute to women's use of livelihood capitals for*

adaptation in post-cyclone context?', the aim of this chapter was to explore place-based adaptation based on Gabura women's own place-based stories in post-cyclone Aila context.

8.4.1 Intersection of place attachment, livelihood capitals and women's adaptation

Place attachment theory helped to understand how the marginalised women in Gabura are able to sustain their families in a post-disaster context by capitalising on limited place-based resources and local knowledge. Gabura women had a deeper attachment with the family associated with their domestic responsibilities within the home compared to men. These attachments in turn create an intimate relationship at the neighborhood level that influenced women collectively to become engaged in the search for alternate livelihood opportunities, in the absence of income-earning male family members. These neighbourhood women-to-women relationships enabled access to information resources to augment their place-based local knowledge. Women's social bonds at neighbourhood level strengthened relationships within and among families that enhanced attachment to place, similar findings were reported by Prezza et al. (2001) and Lewicka (2005). These women-to-women relationships influenced them to establish connections to outsiders (i.e. NGOs) which allowed women to utilise their limited, but accessible place-based resources from the Sundarbans to secure livelihoods. These relationships in turn influenced and shaped women's attachment to Gabura by capitalising on place specific resources and

knowledge accrued over generations. Narayanan and Kumar (2007) also identified an association between local natural resources and traditional knowledge that influenced place dependency, a component of place attachment.

Gabura is an important place for these coastal communities in two ways: firstly, the natural resources of Sundarbans ecosystems contributed to diversified livelihoods directly and indirectly for these climate marginalized communities. The Sundarbans contributed livelihood resources, such as fish, shrimp, crab, honey, food, firewood and housing resources (e.g. timber, wood, straw, golpata etc.) as exemplified by Getzner & Islam (2013), Shameem et al. (2014), and Uddin et al. (2013). The availability of natural resources from the Sundarbans ecosystem, about which they had considerable local knowledge, provided a critical support system for women to remain in place, with NGOs assisting them to make use of these resources for improved livelihood security. For example, the conservation and possible expansion of mangrove forests for exposed coastal communities is recognised as providing protection from natural disasters (Ahammad et al., 2013). Furthermore, the tidal river systems that surround Gabura are rich in biodiversity and help to retain the soil fertility (Sarker et al., 2010; Uddin et al., 2013). Secondly, many aid organizations and local and international NGOs came forward with help for Gabura coastal communities to explore local livelihoods opportunities and to utilise and transform the natural capital of the Sundarbans to improve livelihoods. The interventions by NGOs and aid organisations have led to success for these communities in salt tolerant vegetable farming methods, and crab and shrimp cultivation in saline water. All of these novel food production methods involve combinations of social, natural and human capitals

that eventually transform into physical and financial capitals, to enable place-based adaptations, help ensure food security and reduce overall vulnerability.

'Livelihoods capitals' are considered as place-based resources, consisting of five types of capitals (i.e. human, natural, physical, social and financial) (DFID, 1999; Ellis, 2000; Scoones, 1998). In my thesis, I conceptualized an analytical framework following Scannell and Gifford's (2010) tripartite model of 'person-place-process' dimensions (Fig 4: The role of place attachment for place-based adaptation in post-cyclone context, Chapter 7). The framework explained the involvement of place attachment in adaptation encompassing interactions among people (e.g. women and NGOs) and the place (i.e. Gabura and the Sundarbans), and how the socio-ecological and livelihood processes initiated by the multi-level linkages to place-based resources transformed them into other forms that enhanced place-based adaptation. The integral connection between women and biodiversity can lead to enhanced development using traditional and local knowledge to promote place-based adaptation through using resources from surrounding landscapes. My research demonstrates the importance of NGOs in supporting these women in this transformation to access natural capital of the Sundarbans and transform the natural resources to physical and financial capital for improved livelihood security. My thesis illustrates that through social capital relationships women were able to remain in place through the transformation of local resources into new forms of capital that ensured place-based adaptation in post-cyclone context.

8.5 Reflections on the findings

The three findings chapters (Chapter 5, 6 and 7) in this thesis document the stories of Gabura women in adaptation challenges. Figure 8.1 in the following page synthesises the reflections and outcomes from the findings, triangulating on four key conceptual areas (the role of local knowledge; the contribution of social capital; the role of place attachment and access, use and transformation of livelihood capitals (i.e. natural resources) in place-based adaptation in understanding how women in Gabura navigated the post-Aila context.

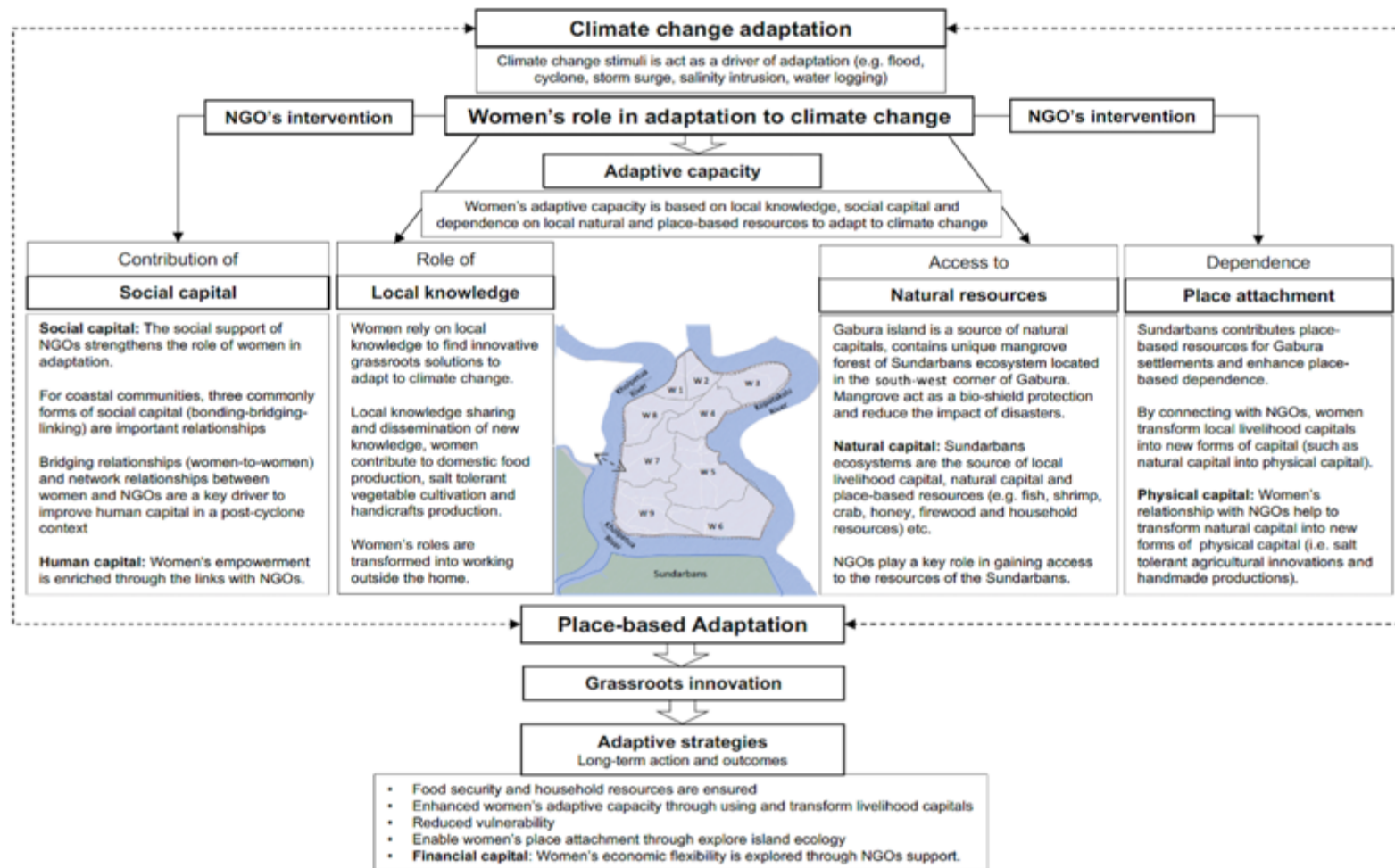


Figure 8.1: Reflection of the findings (women's role in adaptation to climate change)

Source: Author

In seeking to understand women's role in adaptation challenges local knowledge, social capital, place attachment and local livelihood capitals provided a useful framework to explore the complexity of changes that take place at community scale in a post-cyclone period. Action by women in combination with NGOs interventions were important to ensure successful adaptation action. These important findings through the application of multi-theoretical approaches employed in this thesis have aided understanding and coherence of the complex issues of climate change (Pelling and High, 2005), gendered dimensions (Hogue and Lord, 2007; Metcalfe & Woodhams, 2012), knowledge transfer (Watson and Hewett, 2006) and adaptation in a deeper way and may have relevance to other settings in south Asia with a similar cultural context.

Despite many hardships triggered by natural disasters and the social settings of coastal Bangladesh, women were found to be uniquely positioned to make a significant contribution to local action on climate change adaptation (in Gabura) due to their intimate links to their domestic settings. Women's domestic and family responsibilities enhanced community-based adaptation and influenced women to maintain connections to other women at neighbourhood level and further extend their trust to outsiders (e.g. NGOs). NGOs played an important role in the movement of rural women from the domestic sphere to greater empowerment (Azim & Sultan, 2010; Kabeer, 2011). Women were strongly attached to place and maintained bonding ties with the family and built bridging connections with their neighbourhood, which helped them utilise their knowledge of local forms of capitals (i.e. natural and social capital) in search of alternative livelihoods solutions to reduce vulnerability. Rather than seeing their inability to leave a place because of socio-cultural and financial constraints on

migration after a disaster as a disadvantage, women demonstrated a capacity to transform in place. With cyclone Aila as a stimulus, women's close attachment with Gabura helped them to adapt and refit with novel livelihoods.

Chapter 09: Conclusion

Here I wrap up my thesis with some concluding remarks. This chapter summarises the significance of my study linked to the methods, empirical evidence associated with theoretical insights, states the answer to the research questions and mentions some recommendations for future studies. As discussed in Chapter 8 General Discussion, the thesis is articulated on four sub themes: the role of local knowledge, the contribution of social capital, place attachment and local livelihood capitals, which were discussed in three individual key findings chapters.

This thesis has significance for several aspects of research: methodologically, empirically, theoretically and in practice.

Methodologically, the data collection through my field work seeks to integrate multi-theoretical approaches that have been extensively used in various contexts to understand relevant complex issues, such as, assembling information on gender dimensions and women's roles (Hogue and Lord, 2007; Metcalfe and Woodhams, 2012; Quinlan et al., 2016) from a range of sources to inform analysis of adaptation to climate change (Pelling and High, 2005). The study was designed as a mixed method approach by combining the data collection from both qualitative and quantitative interviews (Hennink et al., 2010). A major part of data collection was qualitative through semi-structured, face-to-face, household's interviews, walking and talking interviews and focus group discussions. This process helped to document multiple stories linked to the female participants. Semi-structured interviews with women from selected households and with NGOs, who are playing a leading role in Gabura, helped to document important information about the linking relationship between them. These

stories revealed that the adaptations of climate affected women were based on their local knowledge and unique social relationships. The quantitative analysis, although limited, allowed an examination of the strength of social relationships among the male and female household members and NGOs before and after the impacts of cyclone Aila.

Empirically, participant observations during fieldwork, that included extensive use of photography to document women's 'village life', were important in this study. Such close observation and engagement with the local coastal women led me to observe actual settings of villages and communities and to gain experience about their adaptation technology in relation to climate change. My physical engagement through village walking and talking interviews helped me clarify the situation of Gabura women, their struggles for livelihoods in the absence of their husbands, and the strength of relationships formed within their neighbourhoods and with outsiders in the context of post-cyclone recovery. This empirical approach also led me to see how the NGO officials are connected to the women affected by climate change and how their inclusion helped empower women to adapt to future extreme climate events. The empirical evidence documents the notion of challenges that rural coastal women face and may provide an example of adaptation applicable to other contexts where women are required to survive socio-cultural restrictions while coping with external shocks. Emerging themes and stories of women were documented through interviews including the range and scope of changes in livelihoods (e.g., food, health, water, sanitation and housing situation); the interventions by NGOs that best supported adaptation; and the leadership shown in local innovation by women actors generally considered to be highly constrained in their capacity to respond. Evidence was

assembled on the kind of resources needed for adaptation and the values of place attachment in understanding post-cyclone adaptation.

Theoretically, the significance of this thesis is three-fold: first, to learn about women's contribution to innovation for climate change adaptation, I explored 'gendered dimensions' based on the changes in women's roles through their exploitation of place-based resources (e.g. role of local knowledge and social relationships) that were used extensively by women to recover from the effects of Aila. Second, I explored women's contribution to and utilisation of social capital to enable adaptation in the post-cyclone context. Third, I used the theory of place attachment to understand women's place-based adaptation through their use and transformation of livelihood capitals.

The thesis builds on and aligns with an extended body of work on climate change research in the context of Bangladesh (Ayeb-Karlsson et al., 2020; Ayeb-Karlsson 2020; Jordan, 2019; Mallick et al., 2005; Mallick and Vogt, 2014; Kartiki, 2011). The research sought to understand the key theme of 'gendered dimensions and climate change adaptation' that emerged from field work. For example, the contribution of women to climate change adaptation at household level, which is undervalued by male family members, led me to think deeply about climate-affected women's contribution to innovation, and their leadership role in adaptation to climate change was explored following examples from multiple previous studies (Bhati & Singh, 1987; Boserup, 2007; Dankelman, 2008; Denton, 2002; Nelson et al., 2002; Rahman, 2013; Sultana, 2010; Sultana, 2014). In common with some previous studies (Alam et al., 2015; Alston, 2014; Feldman & Welch, 1995; Joakim & Wismer, 2015; Roy, 2012), women in Gabura coastal communities were found to be active agents in adaptation challenges to climate change. I documented the changing dimensions of women's

roles in village life, such as finding work outside the home and their position in the absence of husbands due to their migration to nearby urban areas.

The study also describes some of the place-based resources that contribute to adaptation in the post-cyclone context for coastal women, such as the roles of local knowledge and the contribution of social capital as important assets (Khalil et al., 2020). Local knowledge is place-based traditional knowledge and has been discussed extensively by a range of authors (e.g. Agrawal, 1995a, 1995b; Boserup, 2007; Bicker et al., 2003; Hayami & Ruttan, 1985; Patt et al., 2009; Warren & Cashman, 1988). Grassroots technologies are the outcomes of the application of traditional knowledge (e.g. Alam et al., 2015; Khalil et al., 2016) used by women. I argue that women are in a position to make a significant contribution to the acquisition of knowledge, by sharing of their local knowledge and augmenting it with new knowledge gained through the connections with NGOs in a post-cyclone context. This is an important angle that my research highlights and it can contribute to an emerging body of recent research that examines climate change and “im-mobility” of women (Ayeb-Karlsson 2020a; Ayeb-Karlsson 2020b; Ayeb-Karlsson et al., 2020; Jordan, 2019). Indeed, my research looks into the lives of community members for whom migration is not an option. My research shows that these Gabura women could find place-based adaptation strategies with some external support (Khalil and Jacobs, 2021). The findings reinforce the importance of gender dimensions in climate change adaptation research where immobility forms an integral part of an adaption strategy and the findings from my research could benefit other studies.

While women live with limited livelihood resources, they survived largely through the changed nature of extended social ties that developed locally among the women in

the neighbourhood and between women and NGOs, in the absence of their husbands. Three common forms of social capital relationships (bonding, bridging and linking) are important and have been described in my research, following previous reviews of the concept (e.g. Islam & Walkerden, 2014, Islam & Walkerden, 2015; Masud-All-Kamal & Hassan, 2018; Woolcock, 2000, 2001; Woolcock & Narayan, 2003, 2004). Social capital is associated with different terms, such as: 'trust', 'values', 'ties', 'trustworthiness', 'connections', 'networks' and 'relationship' has been defined by social scientists from various disciplinary backgrounds (i.e. Adger, 2003; Bourdieu, 1989; Coleman, 1988; Putnam, 1995; Pelling and High, 2005; Woolcock, 2004), are important components of the relationships between women and NGOs in my research.

This study explored 'place attachment' to understand women's place-based adaptation in a post-cyclone context (Khalil and Jacobs, 2021). Place attachment is defined by Scannell and Gifford (2010) following the three dimensions of 'people, place and process'. Place attachment is important for coastal women because they are dependent on local livelihood capitals for their livelihood strategies and women are constrained by their local cultural norms to stay in the village even after cyclone Aila. Although many male community members moved to larger urban centres for economic opportunities, women were influenced to maintain social relationship with the neighbourhood and extended their relationships with NGOs. With the help of NGOs women use local livelihood capitals to transform natural and social capital into physical capital. In my research, a place attachment approach was adopted following the examples of multiple studies (e.g. Altman & Low, 1992; Lynch, 1980; Scannell & Gifford, 2010, 2011; Ujang, 2012; Williams et al., 1992).

Women are important actors in place-based adaptation and landscape management through utilization of place-based resources (e.g. the Sundarbans) explored in my research (Roy, 2012; Roy et al., 2013; Roy, 2019). In relation to gendered dimensions, some research has established that women play an important role as conservationists of natural resources (e.g. Agarwal, 2001; Mies and Shiva, 1993; Shiva, 1986) or women act as natural environmental carers (e.g. Moore, 2008; Leach and Green, 1997); this was an important dimension of gender and place dynamics explored in my research.

Together these four conceptual fields allow me to understand how the women of Gabura have navigated, in the post-Aila context, the interaction of attachment to Gabura, social relationships, sharing of local knowledge and acquisition of new knowledge to devise innovative adaptation strategies. Although not a planned outcome of this research, I believe that the use of a multi-theory framework, such as the approach I used in this thesis, provides deeper insight into the issues faced by Gabura communities than would have been revealed through a single approach. Multi-theoretical approaches have been used extensively in a diverse range of contexts to understand complex issues in organisational sustainability (Wang et al., 2015), gendered dimensions (Hogue and Lord, 2007; Metcalfe and Woodhams, 2012) and knowledge transfer (Watson and Hewett, 2006) among others.

In practice, this thesis aims to inform decision makers and development practitioners (i.e. NGOs, aid agencies) on working with coastal communities in Bangladesh; especially coastal women who are bound to home by the socio-cultural context, and have relatively limited access to interventions, information and knowledge compared

to men. Women's contributions to adaptation challenges at household level are often not recognized by male family members, so they remain at greater risk. My thesis provides evidence that the establishment and support of relationships between women and NGOs can help to reduce the gap between men and women at the household level and indicates that aid interventions should give greater acknowledgement to women's contributions to adaptation. Following this research I recommend that aid practitioners and policymakers should engage more closely with climate-affected women, so that women and men can be equally involved in training on climate change related programs to reduce vulnerabilities. NGO interventions should focus on ways to bridge the gap for actors to devise locally innovative adaptation solutions to climate change.

9.1 Final notes: some specificities, limitations and future research

Despite the positive findings of this thesis on the significant role of women in adaptation there are some limitations of the research. In common with complex social-ecological systems in general (as defined by Nelson et al., 2007 in relation to adaptation to environmental change), multiple overlapping issues emerged from the fieldwork including the role of local knowledge, and the contribution of social capital, place attachment and livelihood capitals that were interlinked and complicated by factors related to gender. In considering this complexity, I was required to review and incorporate diverse areas of study into my thematic analysis of field data. This inevitably extended the time needed to undertake a thorough analysis. However, many

issues remained unexplored. Below I highlight a number of specific areas for future research and make some recommendations.

1. ***Males and local knowledge.*** This research recognised the role of local knowledge as important for a coastal community with a focus on women's contribution to climate change adaptation. Grassroots technologies were the outcomes of the application of traditional knowledge predominantly used by women in my study. However, it must be acknowledged that local or traditional knowledge is also held by male community members in farming communities. There is an opportunity for future research to look into how male community members engage with and employ traditional technologies in climate change adaptation. Such research may unpack some interesting additional gender dimensions on the role of traditional knowledge in climate change adaptation and disaster recovery. Local knowledge in combination with scientific or institutional knowledge can be beneficial for the local community (e.g. Mercer et al. 2010). Policy support that recognises the importance of local knowledge in formulation of adaptive responses should be considered for sustainable development.
2. ***Absent males and social capital.*** This study examined the contribution of social capital to climate change adaptation for a coastal community. Types of social capital operated both separately and in combination. Linking social capital was especially useful for coastal women to strengthen the two other forms of social capital (bridging and bonding). Similarly, this thesis sought to unpack the different dimensions of social capital that women navigate in the post-disaster context. However, it should be remembered that male community members also navigate and contribute to social capital. In the post-disaster context in Gabura, men were

positioned differently in various social networks. For example, male community members who travelled to the nearest towns and cities, while absent from my analysis are not entirely disconnected from the social relationships in Gabura. Instead, it can be argued that relocation may have extended geographically many existing networks and social relations where men maintain their connections with their family members back in the village. My research suggests that while around 60% of males lost contact, in 2016 (the year of my data collection) up to 40% remained in contact with the Gabura community. These remote relationships may illuminate the concept of social capital differently and may make a significant contribution to climate change adaptation in ways that are largely unexplored. So, beyond the women-centric view of social capital explored in this study there is a need to recognise those other relationships in the post-disaster context.

3. ***Gender and place attachment.*** This study explored place attachment as significant for coastal women as they are largely dependent on the place-based natural resources for their livelihood opportunities and income generation. In relation to the concept of place attachment this thesis makes a critical contribution by recognising how women as the 'people' dimension are attached to Gabura villages and surroundings (e.g. the Sundarbans) as the 'place' dimension. However, this is only a part of the story. In any place, there are multiple actors involved in its processes. For example, women owing to cultural norms and societal prejudices have particular ways to engage with a place at the domestic level, at the community level or at a much broader village level. A comparative exploration of how male and female members in the same community 'attached' to a particular place and the impact of this on climate change adaptation merits

investigation. In addition, how policymakers are engaged with the community in the sustainable management of resource extraction and exploitation from the Sundarbans is a critical area of future research as the survival of these coastal communities is entangled with the health and resilience of this ecosystem.

4. ***Longitudinal study.*** There are some other issues that I want to highlight as a limitation of situating this research in Gabura specific to the context of cyclone Aila. The thesis has been specific to look into one island community in the post-disaster context. The Gabura community and how they have responded to the post-disaster context continues to be the subject of much detailed research. However, it must be acknowledged the community has been exposed to multiple disasters in the years following Aila and that these events have also affected these island communities. This thesis portrays a snapshot of the situation in Gabura based on field work conducted in 2016, several years after Aila. The impact of natural disasters may be cumulative. After the completion of my field work in 2016, the region was hit by two or three powerful tropical cyclones, such as cyclone Bulbul in 2019 and cyclone Amphan in 2020. There is a need to recognise how processes of adaptation are altered through successive disasters and it would be interesting to see how these women have adapted their post-disaster actions and social networks in collaboration with NGOs as a consequence of repeated shocks. Research focusing on longitudinal studies to understand how the processes of adaptation by women may have evolved overtime would be a useful addition to knowledge.
5. ***Support for women.*** There is some bias about women in coastal Bangladesh as being incapable of doing things on their own or being unable to participate in any

decision-making role to fight against climate change. But my study suggests that such perceptions are ill-founded. The problem is not about the innate capacity of women rather it lies in a lack of institutional support to provide them with the appropriate 'tools' to adapt. So, in this regard my thesis is an interesting example and reveals some of the gendered dimensions of climate adaptation and disaster recovery.

Considering those specificities, this research will conclude with some remarks and recommendations for extension of these findings from the island communities of Gabura to communities in other coastal contexts. In other places where men continued to stay in villages, questions are raised as to how gender influences the mechanisms of adaptation and what are the different levels of negotiations with policymakers to promote disaster recovery; were the dynamics altered between male and female community members in producing joint adaptive solutions? These questions suggest exciting potential reasons to continue research at the intersection of gender, social capital, local knowledge, place attachment and climate change adaptation.

I wrap up this thesis by reiterating that framing research and exploring adaptation issues from a women's perspective revealed lessons about the most vulnerable members of communities, not only for coastal Bangladesh, but in a developing world context globally. Through examination of the struggles of women, who remain immobile in the post-disaster context, and the ways women navigate that context provided insight into the operation of social capital and local knowledge. However, adaptation to climate change is the product of a continuous process which requires that policymakers acknowledge and respond to research findings to address the problems of vulnerable communities. In conclusion, I suggest that there is a need for

NGOs and policymakers to adapt their engagement with vulnerable communities to ensure they are inclusive and equitable (Thomas and Twyman, 2005) with respect to gender and to ensure that community responses to extreme climate events deliver adaptation solutions that are just, effective and lasting.

Bibliography

Note: This following list refers to chapters 1, 2, 3, 8 and 9 (i.e. Introduction, Literature reviews, Methodology, Discussion and Conclusion chapters). Chapters 4, 5, 6 and 7 are the result chapters, where chapters 4, 5 and 7 are published as papers and chapter 6 is under revise paper, which contains their reference lists with them.

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Appendices



Appendix I: Ethics Approval Letter

HREC Approval Granted – ETH15-0006

From: Research.Ethics@uts.edu.au [<mailto:Research.Ethics@uts.edu.au>]
Sent: Tuesday, 22 December 2015 4:57 PM
To: Brent Jacobs; Momtaj.B.Khalil@student.uts.edu.au; Research Ethics
Subject: HREC Approval Granted - ETH15-0006

Dear Applicant

Thank you for your response to the Committee's comments for your project titled, "Framing indigenous knowledge and community trust in grassroots responses to climate change adaptation-learning from coastal settlements of Bangladesh". Your response satisfactorily addresses the concerns and questions raised by the Committee who agreed that the application now meets the requirements of the NHMRC National Statement on Ethical Conduct in Human Research (2007). I am pleased to inform you that ethics approval is now granted.

Your approval number is UTS HREC REF NO. ETH15-0006 Approval will be for a period of five (5) years from the date of this correspondence subject to the provision of annual reports.

Your approval number must be included in all participant material and advertisements. Any advertisements on the UTS Staff Connect without an approval number will be removed.

Please note that the ethical conduct of research is an on-going process. The National Statement on Ethical Conduct in Research Involving Humans requires us to obtain a report about the progress of the research, and in particular about any changes to the research which may have ethical implications. This report form must be completed at least annually from the date of approval, and at the end of the project (if it takes more than a year). The Ethics Secretariat will contact you when it is time to complete your first report.

I also refer you to the AVCC guidelines relating to the storage of data, which require that data be kept for a minimum of 5 years after publication of research. However, in NSW, longer retention requirements are required for research on human subjects with potential long-term effects, research with long-term environmental effects, or research considered of national or international significance, importance, or controversy. If the data from this research project falls into one of these categories, contact University Records for advice on long-term retention.

You should consider this your official letter of approval. If you require a hardcopy please contact Research.Ethics@uts.edu.au.

To access this application, please follow the URLs below:

* if accessing within the UTS network: <https://rm.uts.edu.au>

* if accessing outside of UTS network: <https://remote.uts.edu.au> , and click on "RMENet - ResearchMaster Enterprise" after logging in.

We value your feedback on the online ethics process. If you would like to provide feedback please go to: <http://surveys.uts.edu.au/surveys/onlineethics/index.cfm>

If you have any queries about your ethics approval, or require any amendments to your research in the future, please do not hesitate to contact Research.Ethics@uts.edu.au.

Yours sincerely,

Professor Marion Haas
Chairperson
UTS Human Research Ethics Committee
C/- Research & Innovation Office
University of Technology, Sydney
E: Research.Ethics@uts.edu.au

Ref: E11

Appendix II: A letter of consent was approved by UTS, HREC.



CONSENT FORM

I, _____ agree to participate in the research project “Framing indigenous knowledge and community trust in grassroots responses to climate change adaptation-learning from coastal settlements of Bangladesh.” This research is a part of Doctor of Philosophy conducted by Momtaj Bintay Khalil, PhD Candidate, Institute for Sustainable Futures, University of Technology, Sydney (Telephone: +61 _____) is supervised by Dr. Brent Jacobs, Research Director in the Institute for Sustainable Futures, University of Technology, Sydney.

I understand that, this research is exploring local knowledge and grassroots technologies from the coastal communities of Bangladesh. The purpose of this study is to identify the interactions among community people and outside actors (such as NGOs) that contribute to effective grassroots responses to climate change adaptation.

I understand that I have been asked to participate in this research that my position is able to provide information of my previous experience of facing the impacts of cyclone Aila, and the challenges that I taking to reduce the impacts. The participation will involve an informal interview/ or a focus group discussion and it will take approximately 1-1.5 hours in an average day and spread over a period of several weeks.

I also understand that this interview will involve audio recording. In each situation, the recording device will be made visible to me. I am also aware that I will not be identified in any report or publication from this study and the summary of the results of the data can be made available to me.

I am aware that I can contact Momtaj Bintay Khalil or her supervisor Dr. Brent Jacobs if I have any concerns about the research. I am aware that my participation in this study is entirely voluntary and also understand that I am free to withdraw my participation from this research project at any time.

I agree that Momtaj Bintay Khalil has answered all my questions fully and clearly and also the research data gathered from this project may be published in a form that does not identify me in any way.

Signature (participant)

____/____/____

Production Note:

Signature removed prior to publication.

Signature (researcher or delegate)

____/____/____

NOTE:

This study has been approved by University of Technology, Human Research Ethics Committee representative. If you have any complaints or reservations about any aspect of your participation in this research which you cannot resolve with the researcher, you may contact the Ethics Committee through the Ethics Secretariat (Research.Ethics@uts.edu.au) or you may further contact to Momtaj Bintay Khalil (Telephone: +61 _____, Email: Momtaj.B.Khalil@student.uts.edu.au) or her supervisor Dr. Brent Jacobs (Phone: +61295144170, Email: Brent.Jacobs@uts.edu.au). Any complaint will be treated in confidence and investigated fully and you will be informed of the outcome.

Appendix III: A letter of consent (in Bengali) was approved by UP Chairman.

গবেষণা তথ্য

“সমুদ্র উপকূলবর্তী অঞ্চলের স্থানীয় জ্ঞান এবং জনসাধারণের বিশ্বাস স্থাপনের মাধ্যমে জলবায়ুর পরিবর্তন নিরসন সম্ভাবনা”

এই গবেষণা মমতাজ বিনতে খলিল, ইনস্টিটিউট ফর সাসটেইনেবল ফিউচার্স, ইউনিভার্সিটি অব টেকনোলজি, সিডনী, অস্ট্রেলিয়া এর পি.এইচ.ডি প্রার্থী কর্তৃক প্রস্তুত।

(টেলিফোন: +৬১৪১৫৪৭৪৩৯২, ই-মেইল: Momtaji.B.khalil@stude3nt.uts.edu.au)। এই গবেষণার তত্ত্বাবধানে আছেন ডক্টর ব্রেন্ট জেকবস, গবেষণা পরিচালক, ইনস্টিটিউট ফর সাসটেইনেবল ফিউচার্স, ইউনিভার্সিটি অব টেকনোলজি, সিডনী।

এই গবেষণার প্রধান উদ্দেশ্য বাংলাদেশের সমুদ্র উপকূলবর্তী অঞ্চলের স্থানীয় জ্ঞান এবং সম্প্রদায়ের বিশ্বাস স্থাপনের মাধ্যমে জলবায়ুর নিরসন সম্ভাবনা অন্বেষণ করা। এছাড়া কমিউনিটির সদস্য এবং বাইরের কর্মকর্তাদের সাথে মিথস্ক্রিয়া স্থাপন করা।

এই গবেষণার দরিদ্র পরিবারের প্রধানদের সাথে ইন্টারভিউ ও ফোকাসগ্রুপ আলোচনা করা হবে। কমপক্ষে ২৫/৩০ হবে। এছাড়া ৪/৫ জন অভিজ্ঞ ব্যক্তির কাছ থেকে তথ্য উপাত্ত সংগ্রহ করা হবে এবং এই আলোচনা অংশগ্রহনকারীদের উপযোগী নির্বাচন করা হবে। সময়সীমা কমপক্ষে স্থান ১-১:৩০ ঘণ্টা।

এই ইন্টারভিউতে অডিও যন্ত্র ব্যবহার করা হবে এবং এই যন্ত্র অংশগ্রহনকারীদের দৃশ্যমান থাকবে। এবং এই গবেষণার ফলাফল অথবা যে কোন প্রকাশনায় আপনার অবগত থাকবেন। এই গবেষণায় আপনার ফোন ধরনের প্রশ্ন ও উত্তর জ্ঞানের জন্য মমতাজ বিনতে খলিল অবগত থাকবেন। (ফোন: +৬১৪১৫৪৭৪৩৯২)।

এই গবেষণায় আপনার অংশগ্রহন সম্পূর্ণ বেতনহীন এবং যে কোন সময়ে আপনি অংশগ্রহন প্রত্যাহার করতে পারবেন।

এই গবেষণায় ফলাফল অথবা প্রকাশিত কোন তথ্যে আপনাকে ব্যক্তিগতভাবে সনাক্ত করা হবে না। এবং যে কোন ধরনের ব্যাখ্যায় গবেষক আপনাদের কাছে অবগত থাকবেন।

তারিখ:

স্বাক্ষর (অংশগ্রহনকারী)


তারিখ:

স্বাক্ষর (গবেষক)

বিদ্রূপ: এই গবেষণা ইউনিভার্সিটি অব টেকনোলজি, সিডনী, হিউম্যান রিসার্চ এথিক্স কমিটি কর্তৃক অনুমোদিত। আপনার কোন অভিযোগ থাকলে আপনি এথিক্স কমিটির সাথে সরাসরি ই-মেইল এর মাধ্যমে যোগাযোগ করতে পারেন। (ই-মেইল: Research.Ethics@uts.edu.au) অথবা গবেষক মমতাজ বিনতে খলিল অথবা জনাবা মমতাজ এর তত্ত্বাবধায়ক ডক্টর জেকবস এর সাথে যোগাযোগ করতে পারেন। (ই-মেইল: Brent.Jacobs@uts.edu.au) আপনার যে কোন ধরনের অভিযোগ সম্পূর্ণভাবে অনুসন্ধান করা হবে।

Production Note:

Signature removed
prior to publication.


Chairman
12 No Gabura Union Pansol
Shyamnagar, Salkhira.

Appendix IV: Letter of approval (in Bengali) by the UP Chairman

চেয়ারম্যান ১২নং গাবুরা ইউনিয়ন পরিষদ

পোঃ চাদনীমুখা
উপজেলা : শ্যামনগর

সূত্র :

তারিখ :

৩রা নভেম্বর, ২০১৫

ইউনিভার্সিটি অব টেকনোলজি হিউম্যান রিসার্চ এডভান্স কমিটি

ইনস্টিটিউট ফর সাসটেইনেবল ফিউচার্স

নিউ সাউথ ওয়েলস, ২০০৭, অস্ট্রেলিয়া।

প্রিয় হিউম্যান রিসার্চ এডভান্স কমিটির সদস্যবৃন্দ,

গাবুরা ইউনিয়ন পরিষদের পক্ষে, আমি এই পত্রের মাধ্যমে মমতাজ বিনতে খলিল, ইনস্টিটিউট ফর সাসটেইনেবল ফিউচার্স, ইউনিভার্সিটি অব টেকনোলজি, সিডনী নিউ সাউথ ওয়েলস ২০০৭, অস্ট্রেলিয়া এর পি,এইচ,ডি প্রার্থী কর্তৃক প্রস্তাবিত "বাংলাদেশের সমুদ্র উপকূলবর্তী অঞ্চলের আঞ্চলিক জ্ঞান ও জনসাধারণের বিশ্বাস স্থাপনের মাধ্যমে জলবায়ুর পরিবর্তন নিরসন সম্ভাবনা" গবেষণার আমাদের আবগতি প্রকাশ করছি।

মমতাজ বিনতে খলিল তার গবেষণাকালীন সময়ে সমুদ্র উপকূলবর্তী এলাকায় দরিদ্র পরিবারের প্রধানদের সাথে ইন্টারভিউ এবং ফোকাসগ্রুপ আলোচনা করবেন। সেই বিষয়ে আমরা অবগত আছি। আমরা জনাবা মমতাজকে গাবুরা ইউনিয়ন পরিষদের তথ্য কেন্দ্র থেকে সামাজিক নিরাপত্তা এবং কমিউনিটির পরিবারের প্রয়োজনীয় তথ্য উপাত্ত প্রদান করতে সম্মত আছি।

গাবুরা ইউনিয়ন পরিষদের চেয়ারম্যান হিসেবে আমি সব নির্বাহী ক্ষমতার অধিকারী এবং ইউনিয়ন প্রশাসনিক কার্যক্রম নিরীক্ষণ করে থাকি। আমি জনাবা মমতাজকে গাবুরা ইউনিয়নে গবেষণা সুসম্পন্ন করার অনুমতি প্রদান করছি।

যদি আপনার কোন প্রশ্ন থাকে তাহলে নির্ধিকায় আমার অফিসের সাথে যোগাযোগ করুন। (ফোন নং)

বিনীত,

Production Note:

Signature removed
prior to publication.

G.M. Masudul Alam
Chairman
12 No Gabura Union Parishad
Sathyanagar, Satkhira

চেয়ারম্যান

গাবুরা ইউনিয়ন পরিষদ, শ্যামনগর, সাতক্ষীরা
বাংলাদেশ।

Appendix V: Consent letter for Key Informants Interviews (KII)

অনুমতি পত্র
(কী ইনফরমেন্টস ইন্টারভিউ)

ইউনিভার্সিটি অব টেকনোলজি, সিডনী
ইনস্টিটিউট ফর সাসটেইনেবল ফিউচার্স
হিউম্যান রিসোর্স এডিসন কমিটি
নিউ সাউথ ওয়েলস, ২০০৭, অস্ট্রেলিয়া।

গবেষণা নামকরণ: “সমুদ্র উপকূলবর্তী অঞ্চলের স্থানীয় জ্ঞান এবং জনসাধারণের বিশ্বাস স্থাপনের মাধ্যমে জলবায়ুর পরিবর্তন নিরসন সম্ভাবনা”

গাবুরা ইউনিয়ন পরিষদের পক্ষে, আমি----- এই পত্রের মাধ্যমে মমতাজ বিনতে খলিল, ইনস্টিটিউট ফর সাসটেইনেবল ফিউচার্স, ইউনিভার্সিটি অব টেকনোলজি, সিডনী নিউ সাউথ ওয়েলস ২০০৭, অস্ট্রেলিয়া এর পি,এইচ,ডি প্রার্থী কর্তৃক প্রস্তাবিত “বাংলাদেশের সমুদ্র উপকূলবর্তী অঞ্চলের স্থানীয় জ্ঞান এবং সম্প্রদায়ের বিশ্বাস স্থাপনের মাধ্যমে জলবায়ুর পরিবর্তন নিরসন সম্ভাবনা” গবেষণায় আমাদের আবগতি প্রকাশ করছি।

মমতাজ বিনতে খলিল তার গবেষণাকালীন সময়ে সমুদ্র উপকূলবর্তী এলাকায় দরিদ্র পরিবারের প্রধানদের সাথে ইন্টারভিউ এবং ফোকাসগ্রুপ আলোচনা করবেন। সেই বিষয়ে আমরা অবগত আছি। আমরা জনাবা মমতাজকে গাবুরা ইউনিয়ন পরিষদের তথ্য কেন্দ্র থেকে সামাজিক নিরাপত্তা এবং কমিউনিটির পরিবারের প্রয়োজনীয় তথ্য উপাত্ত প্রদান করতে সম্মত আছি।

গাবুরা ইউনিয়ন পরিষদের কী ইনফরমেন্টস হিসেবে আমি ইউনিয়নের প্রশাসনিক কার্যক্রম নিরীক্ষন করে থাকি। আমি জনাবা মমতাজকে গাবুরা ইউনিয়নে গবেষণা সুসম্পন্ন করার অনুমতি প্রদান করছি।

যদি আপনার কোন প্রশ্ন থাকে তাহলে নির্দিধায় আমার অফিসের সাথে যোগাযোগ করুন। (ফোন নং)

বিনীত,

(স্বাক্ষর)

নামঃ

কী ইনফরমেন্টস

গাবুরা ইউনিয়ন পরিষদ, মুন্সীগঞ্জ, খুলনা

বাংলাদেশ।

Appendix VI: A consent letter for focus group discussion (FGD) with the participants

অনুমতি পত্র (ফোকাসগ্রুপ)

ইউনিভার্সিটি অব টেকনোলজি, সিডনী
ইনস্টিটিউট ফর সাসটেইনেবল ফিউচার্স
হিউম্যান রিসোর্স এথিক্স কমিটি
নিউ সাউথ ওয়েলস, ২০০৭, অস্ট্রেলিয়া।

গবেষণা নামকরণ: “সমুদ্র উপকূলবর্তী অঞ্চলের স্থানীয় জ্ঞান এবং জনসাধারণের বিশ্বাস স্থাপনের মাধ্যমে জলবায়ুর পরিবর্তন নিরসন সম্ভাবনা”

গাবুরা ইউনিয়ন পরিষদের পক্ষে, আমরা এই পত্রের মাধ্যমে মমতাজ বিনতে খলিল, ইনস্টিটিউট ফর সাসটেইনেবল ফিউচার্স, ইউনিভার্সিটি অব টেকনোলজি, সিডনী নিউ সাউথ ওয়েলস ২০০৭, অস্ট্রেলিয়া এর পি,এইচ,ডি প্রার্থী কর্তৃক প্রস্তাবিত “বাংলাদেশের সমুদ্র উপকূলবর্তী অঞ্চলের স্থানীয় জ্ঞান এবং সম্প্রদায়ের বিশ্বাস স্থাপনের মাধ্যমে জলবায়ুর পরিবর্তন নিরসন সম্ভাবনা” গবেষণায় আমাদের আবগতি প্রকাশ করছি।

মমতাজ বিনতে খলিল তার গবেষণাকালীন সময়ে সমুদ্র উপকূলবর্তী এলাকায় দরিদ্র পরিবারের প্রধানদের সাথে ইন্টারভিউ এবং ফোকাসগ্রুপ আলোচনা করবেন। সেই বিষয়ে আমরা অবগত আছি। আমরা জনাবা মমতাজকে গাবুরা ইউনিয়ন পরিষদের তথ্য কেন্দ্র থেকে সামাজিক নিরাপত্তা এবং কমিউনিটির পরিবারের প্রয়োজনীয় তথ্য প্রদান করতে সম্মত আছি।

গাবুরা ইউনিয়ন পরিষদের ফোকাসগ্রুপ আলোচনায় আমরা জনাবা মমতাজকে গাবুরা ইউনিয়নে গবেষণা সুসম্পন্ন করার সম্মতি ও অনুমতি প্রদান করছি।

যদি আপনার কোন প্রশ্ন থাকে তাহলে নির্ধিকায় আমার অফিসের সাথে যোগাযোগ করুন। (ফোন নং)

বিনীত,

(স্বাক্ষর)

নামঃ

ফোকাসগ্রুপ আলোচনায় অংশগ্রহনকারীদের পক্ষ থেকে
গাবুরা ইউনিয়ন পরিষদ, মুলীগঞ্জ, খুলনা
বাংলাদেশ।

Appendix VII: Questionnaire survey



Thesis title

Women's role in adaptation to climate change in Bangladesh

[This questionnaire was filled-out by researcher along with research assistants through a face-to-face interview with household-heads. It has to put the tick (✓) mark and fill required information where is needed]

To examine 'women's role in adaptation to climate change' in post-cyclone (Aila, 2009) context of Gabura Union, Bangladesh, a quantitative household questionnaire survey was conducted in 2016. Three main areas were focused: the roles of local knowledge, social capital relationships and place-based adaptation. In particular, social capital relationships between male and female households head in the family, and among the insiders and outsiders of the community (e.g. women and the NGOs) were identified through this questionnaire survey.

Section 01

1.1 Demographic view (participant's Information)

Demographic	information
Date of survey	
Name of interviewee	
Gender (male/ female)	
Name of the village, Union, Upozila	
Education	
Family member (no of children)	
Living duration	
Occupation	
Income/asset	
Housing qualities	
Livelihood capitals (before and after Aila)	
Interview time	

1.2 Do you have experience of Aila?

Duration	Put [✓] mark
Before	<input type="checkbox"/>
During	<input type="checkbox"/>
After	<input type="checkbox"/>

1.3 Types of damages during Aila

Damages	Put [✓] mark
Drinking water sources	<input type="checkbox"/>
Water logging, salinity	<input type="checkbox"/>
Houses	<input type="checkbox"/>
Trees, vegetable gardens,	<input type="checkbox"/>
Livestock/ poultry	<input type="checkbox"/>

Embankment	<input type="checkbox"/>
Road/ culvert	<input type="checkbox"/>
Health benefits	<input type="checkbox"/>
Local markets	<input type="checkbox"/>
Electricity	<input type="checkbox"/>
Others (specify)	<input type="checkbox"/>

1.4 Supports after Aila (by NGOs/ local Govt.)

Supports	Put [√] mark
Relief	<input type="checkbox"/>
Capitals (money)	<input type="checkbox"/>
Treatment/ medicine	<input type="checkbox"/>
House/ Housing resources	<input type="checkbox"/>
Sanitary latrine	<input type="checkbox"/>
Agriculture seeds/	<input type="checkbox"/>
Livestock	<input type="checkbox"/>
Handlooms	<input type="checkbox"/>
Street/ embankment repair	<input type="checkbox"/>
Others (specify)	<input type="checkbox"/>

Section 02

2.1 Roles of local knowledge

Q. Do you know any local ideas that you learn by yourself/ from others? Yes No

Q. What are those?

Sources	Put [√] mark
At household level	<input type="checkbox"/>
Sanitation	<input type="checkbox"/>
Salt tolerant agriculture practise	<input type="checkbox"/>
Fishing	<input type="checkbox"/>
Produce handicrafts	<input type="checkbox"/>
Other	<input type="checkbox"/>

Q. What other sources do you learn from?

Sources	Put [√] mark
Myself	<input type="checkbox"/>
Training	<input type="checkbox"/>
Workshop	<input type="checkbox"/>
Neighbourhood	<input type="checkbox"/>
Husband	<input type="checkbox"/>
Community meeting with women	<input type="checkbox"/>
Monthly meeting with NGOs	<input type="checkbox"/>
Community male/ female household	<input type="checkbox"/>
Communication with chairman	<input type="checkbox"/>
Mosque	<input type="checkbox"/>
Others (Specify)	<input type="checkbox"/>

Q. Do you want to learn more local ideas? Yes No

If yes, which sources are more reliable for learning?

Source	Put [√] marks
NGO	<input type="checkbox"/>
Local Govt.	<input type="checkbox"/>
Neighbours	<input type="checkbox"/>
Relatives	<input type="checkbox"/>
Community female	<input type="checkbox"/>
Community male	<input type="checkbox"/>
Local shop keepers	<input type="checkbox"/>
Mosque	<input type="checkbox"/>
Others (Specify)	<input type="checkbox"/>

Section 3

3.1 Contribution of social capital

Q. Relationship with husband/ family

Relationship	Put [√] mark	Reasons
Is your husband living with you?	Yes <input type="checkbox"/> No <input type="checkbox"/>	
If no, where he lives	Munshigang <input type="checkbox"/> Satkhira <input type="checkbox"/> Khulna <input type="checkbox"/> Dhaka <input type="checkbox"/> Sundarbans <input type="checkbox"/>	
If migrated, why	For job <input type="checkbox"/> travel to Sundarbans <input type="checkbox"/> travel to city <input type="checkbox"/> started new family <input type="checkbox"/> others <input type="checkbox"/>	
How many times has he connected you?	Weekly <input type="checkbox"/> fourth nightly <input type="checkbox"/> monthly <input type="checkbox"/> Yearly <input type="checkbox"/> no connection <input type="checkbox"/>	
Is your husband sending money from the city?	Yes <input type="checkbox"/> No <input type="checkbox"/>	
How many times does he send money?	Weekly <input type="checkbox"/> fourth nightly <input type="checkbox"/> monthly <input type="checkbox"/> Yearly <input type="checkbox"/>	
Is the money cover your family expenses	Yes <input type="checkbox"/> No <input type="checkbox"/>	

Q. How do you support your family in absence of husband?

Types of working	Put [√] mark
Work outside home	<input type="checkbox"/>
Day labourer	<input type="checkbox"/>
Fishing	<input type="checkbox"/>
Working in a crab farm	<input type="checkbox"/>
Agriculture farming	<input type="checkbox"/>
Making and selling handicrafts	<input type="checkbox"/>
Livestock raring	<input type="checkbox"/>
Others (specify)	<input type="checkbox"/>

a) Do you have any contact with others sources?

Sources	Put [√] mark
Neighbour	<input type="checkbox"/>
NGOs	<input type="checkbox"/>
Local government	<input type="checkbox"/>
Community male/ female	<input type="checkbox"/>
To sharing platform	<input type="checkbox"/>
Training	<input type="checkbox"/>
Workshop	<input type="checkbox"/>
Others (specify)	<input type="checkbox"/>

3.2 Relationship with wife/ family

Relationship	Mark	Reasons
Do you live with family?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
If no, where do you live?	Munshigang <input type="checkbox"/> Satkhira <input type="checkbox"/> Khulna <input type="checkbox"/> Dhaka <input type="checkbox"/> Sundarbans <input type="checkbox"/>	
If migrated, why	For job <input type="checkbox"/> travel to Sundarbans <input type="checkbox"/> travel to city <input type="checkbox"/> started new family <input type="checkbox"/> others <input type="checkbox"/>	
When did you leave family?	<input type="checkbox"/> Before <input type="checkbox"/> After Aila	
How many times do you connect with family?	Weekly <input type="checkbox"/> fourth nightly <input type="checkbox"/> monthly <input type="checkbox"/> Yearly <input type="checkbox"/> no connection <input type="checkbox"/>	
Do you send money to family?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
If yes, how many times	Weekly/ fourth nightly/ monthly/ yearly/ no connection	
Does money cover your family expenses?	If no, what is other options?	

Q. How do you support to your family?

Types	Put [√] mark
Send money	<input type="checkbox"/>
Day labour	<input type="checkbox"/>
Going to Sundarbans	<input type="checkbox"/>
Fishing	<input type="checkbox"/>
Work in crab farm	<input type="checkbox"/>
Agriculture farming	<input type="checkbox"/>
Making and selling Handicrafts	<input type="checkbox"/>
Livestock raring	<input type="checkbox"/>
Others (specify)	<input type="checkbox"/>

Q. Do you have any connection with others sources?

Types	Put [√] mark
Neighbour	<input type="checkbox"/>
NGOs	<input type="checkbox"/>
Local government	<input type="checkbox"/>
Neighbours	<input type="checkbox"/>
Community Male/ Female	<input type="checkbox"/>
Sharing platform	<input type="checkbox"/>
Training	<input type="checkbox"/>
Workshop	<input type="checkbox"/>
Others	<input type="checkbox"/>

3.3 Relationship with neighbourhood. Put [√] marks

Q. Do you have relationships with your neighbourhood? Yes No

Q. How often do you meet with your neighbours?

Daily Weekly Fourth nightly Monthly Others

Q. How is the relationship with your neighbour?

Good Better Very good Roughly No relation

Q. When is the relationship gets better with your neighbour?

Before Aila During Aila After Aila

Q. What kind of things do you share with your neighbours?

Types	Put [√] mark
Household things	<input type="checkbox"/>
Working together	<input type="checkbox"/>
Working together in fish farm	<input type="checkbox"/>
Working together in vegetable garden	<input type="checkbox"/>
Working together in handicrafts making	<input type="checkbox"/>
Adaptation ideas /local knowledge	<input type="checkbox"/>
Others	<input type="checkbox"/>

Q. What kind of ideas do you share with the neighbours in the meeting?

Types	Put [√] mark
Household problem	<input type="checkbox"/>
Family problem	<input type="checkbox"/>
Community problem	<input type="checkbox"/>
Adaptation ideas /local knowledge	<input type="checkbox"/>
Handicrafts manufacturing process	<input type="checkbox"/>
Others (specify)	<input type="checkbox"/>

Q. Do you play any role in the community platform?

Roles	Put [√] mark
Participant	<input type="checkbox"/>
Take training	<input type="checkbox"/>
Local trainer	<input type="checkbox"/>
Local service provider	<input type="checkbox"/>
Volunteer	<input type="checkbox"/>
Others	<input type="checkbox"/>

Q. Who is helping to run the community platform?

Sources	Put [√] mark
Neighbourhood women	<input type="checkbox"/>
Community women	<input type="checkbox"/>
NGOs	<input type="checkbox"/>
Local trainer	<input type="checkbox"/>
Local service provider	<input type="checkbox"/>
Member (male/female)	<input type="checkbox"/>
Chairman	<input type="checkbox"/>
Local Political leaders/ Matbor	<input type="checkbox"/>
Others	<input type="checkbox"/>

Q. Do you have any contact with women from other communities? Yes No

3.4 Relationship with NGOs (outsiders). Put [√] mark

Q. How is your relationship with the NGOs?

Good Better Very good Roughly No relation

Q. When is the relationship gets better with the NGOs?

Before Aila During Aila After Aila

Q. Did you attend any training or workshop of NGOs? Yes No

Q. What are the name of the NGOs? Ans:

Q. Do you think these trainings are helpful? Yes No

Q. What are the benefits of the trainings?

Q. Do you think these trainings are helpful? Yes No

Q. If yes, specify the benefits:

Q. If No, what are the reasons?

Reason	Put [√] mark
You do not trust NGOs	<input type="checkbox"/>
Migrated to city for job	<input type="checkbox"/>
Wastage of time	<input type="checkbox"/>
Less money	<input type="checkbox"/>
Useless	<input type="checkbox"/>
Husband does not allow	<input type="checkbox"/>
Hard to trust for support	<input type="checkbox"/>
Others (specify)	<input type="checkbox"/>

Q. Do you believe the assistance you receive from NGOs/ local government is effective?
 Yes No

Q. In which sector do you trust?

Sector	Put [√] mark
Livelihoods (jobs)	<input type="checkbox"/>
Food/ Health support	<input type="checkbox"/>
Economic support	<input type="checkbox"/>
Water collection	<input type="checkbox"/>
Sanitation	<input type="checkbox"/>
House/ shelter	<input type="checkbox"/>
Home gardening	<input type="checkbox"/>
Handmade production	<input type="checkbox"/>
Market access	<input type="checkbox"/>
Others	<input type="checkbox"/>

Q. Who is helping the most to get access to resources/ money?

Source	Put [√] mark
NGOs (local)	<input type="checkbox"/>
NGOs (international)	<input type="checkbox"/>
Chairman	<input type="checkbox"/>
Member	<input type="checkbox"/>
Neighbourhood	<input type="checkbox"/>
Community women/ men	<input type="checkbox"/>
Relatives	<input type="checkbox"/>
Others specify	<input type="checkbox"/>

3.5 The role of NGOs

Q. How do you connect household men and women in the community?

Types	Put [√] mark	Male/Female ratio
House inspection	<input type="checkbox"/>	
Training	<input type="checkbox"/>	
Workshop	<input type="checkbox"/>	
Monthly regular meeting	<input type="checkbox"/>	
Others	<input type="checkbox"/>	

Q. Name of your NGOs:

Q. Types of trainings or workshops you conduct?

Q. Types of trainings or workshops you conduct?

Types	Participant ratio (male/female)
1.	
2.	
3.	

Q. What was your role before, during and after Aila?

Duration	Role
Before	
During	
After	

Q. Do you think these trainings are useful? Yes No

Q. If yes, reason? Ans:

Q. Do you think local ideas are effective? Ans:

Section 4

Local adaptation technologies. (Put [√] mark)

Q. Do you use any local ideas at household level? Yes No

Q. If yes, what sector you use the local ideas? When?

Ideas	Before Aila (Put [√] mark)	After Aila (Put [√] mark)
Livelihoods-Fishing/ Boating/	<input type="checkbox"/>	<input type="checkbox"/>
Plantation	<input type="checkbox"/>	<input type="checkbox"/>
Food/ Health	<input type="checkbox"/>	<input type="checkbox"/>
Water preservation	<input type="checkbox"/>	<input type="checkbox"/>
Housing/ shelter	<input type="checkbox"/>	<input type="checkbox"/>
Sanitation	<input type="checkbox"/>	<input type="checkbox"/>
Vegetables gardening	<input type="checkbox"/>	<input type="checkbox"/>
Agriculture farming	<input type="checkbox"/>	<input type="checkbox"/>
Handmade production	<input type="checkbox"/>	<input type="checkbox"/>
Others, specify	<input type="checkbox"/>	<input type="checkbox"/>

Q. Please mention the name of the village/ house/ union and the technologies you found?

Technologies	Put [√] mark	Village name/ union
Households level	<input type="checkbox"/>	
Agriculture	<input type="checkbox"/>	
Handicrafts production	<input type="checkbox"/>	
Fishing	<input type="checkbox"/>	
Livestock/ Poultry	<input type="checkbox"/>	
Crab fattening farm	<input type="checkbox"/>	
Water resource management	<input type="checkbox"/>	
Sanitation	<input type="checkbox"/>	
Others	<input type="checkbox"/>	

Q. Who is helping to learn the technologies? Put [√] mark

NGOs Local Govt. Neighbourhood Relatives Community female-male
Others

Q. Did you get any help from outsiders (NGOs) in technology development? Yes No

Q. What is the contribution of NGOs in technology production?

Contribution	Put [√] mark
Economic support	<input type="checkbox"/>
Training	<input type="checkbox"/>
Workshop	<input type="checkbox"/>
Knowledge sharing	<input type="checkbox"/>
Provide handloom materials	<input type="checkbox"/>
Regular meeting	<input type="checkbox"/>
Mental support through talking	<input type="checkbox"/>
Others	<input type="checkbox"/>

Q. Which ideas/ technologies are useful?

Section 5

The role of Sundarbans (place-based resources). Put [√] mark

Q. What is the roles of the Sundarbans?

Roles	Put [√] mark
Reduce cyclones	<input type="checkbox"/>
Provide (fish, crab, shrimp, honey, wood)	<input type="checkbox"/>
Firewood	<input type="checkbox"/>
Housing resources (wood, bamboo, golpatata)	<input type="checkbox"/>
Source of income	<input type="checkbox"/>
Mangroves	<input type="checkbox"/>
Others	<input type="checkbox"/>

Q. How many times do you visit the Sundarbans?

- Daily Weekly Fourth nightly Monthly Others

Q. What resources do you collect from the Sundarbans?

- Fish Crab Firewood Honey Housing materials Others

Q. Do you want to protect Sundarbans? Yes No

Q. What is your roles to protect the Sundarbans?

Duration	Roles
Before	<input type="checkbox"/> Save the mangroves <input type="checkbox"/> Plant mangroves at household level <input type="checkbox"/> Collect less resource (fish, crab, wood) <input type="checkbox"/> Train up to protect resources
During	
After	<input type="checkbox"/> Save the mangroves <input type="checkbox"/> Plant mangroves at household level <input type="checkbox"/> Collect less resource (fish, crab, wood) <input type="checkbox"/> Train up to protect resources

Focus Group Discussion

Thesis title: 'Women's role in adaptation to climate change in Bangladesh'

[This questionnaire was filled-out by researcher through a face-to-face interview with household-heads. It has to fill required information where is needed]

Possible questions for focus group discussion

- Q. Do you know anything about local knowledge/ your own local technology?
- Q. Do you believe that local ideas are helpful for adaptation?
- Q. How will you contribute to the family after the cyclone?
- Q. How will your neighbourhood, friends and relatives contribute after the cyclone?
- Q. How is your relationship with your family members?
- Q. How is your relationship with the neighbourhood?
- Q. How is your relationship with the NGOs?
- Q. How do local NGOs help in the post-cyclone context?

Q. What kinds of social support did you get from your community after the cyclone?

Categories	Types of support
Neighbours	
Friends	
Relatives	
Community people	

Q. What kind of support did you get from local civil society after the cyclone?

Civil society	Types of support
Local Govt.	
UP chairman	
local NGOs	
Local leaders	
Members	
Mosque imam	
Local teachers	
Local trainer/ LSP	
Social worker	

Q. What is the gap between the local people and NGOs?

Outcomes

- To learn the importance of local knowledge and grassroots technology.
- To learn the importance of social capital relationships.
- To understand the gaps between the household members and among the community internal and external actors (NGOs).
- To understand the place-based adaptation to climate change.

Key informant interviews

Thesis title: 'Women's role in adaptation to climate change in Bangladesh'

[This questionnaire was filled-out by researcher through a face-to-face interview with key informant interviews. It has to fill required information where is needed]

Possible questions (Local knowledge)

1. Do you have any ideas about local technology of the Gabura coastal community?
2. What kind of local technology have you seen in Gabura?
3. Do you believe these technologies are effective in adaptation to climate change?
4. How do you help to produce these technologies?
5. What is the gap between the local people and NGOs?
6. Do you believe your local technologies can improve relationship gaps?
7. How can grassroots technology be effective for the community insiders?

Technology	Local Interventions	Outside Interventions
Livelihoods		
Food/Health		
Water		
Sanitation		
Housing/ shelter		
Household level		
Vegetables gardening		
Handicrafts production		

Possible questions (social capital)

1. How strong was the relationship with family members?
2. How strong was the relationship with neighbours?
3. How strong was the relationship with outsiders?
4. What is the gap between internal community and external members?
5. How can this gap be filled?
6. How is the linking relationship work?

What is the Contribution of local civil society (local govt., NGOs)?

Civil society (local)	How contribute
Local Government	
Local NGOs	
UP Chairman	
Community leaders/ Morol	
Community members	
Mosque Imam	

7. What is the role of the Sundarbans (place-based resources) in Gabura?
8. Who is helping the community to get access to Sundarbans resources?
9. Are women involved in the collection of Sundarbans resource?
10. How do you help women to collect the resources from the Sundarbans?

Appendix VIII: Focus group discussions and key female participants



Source: Author's field survey in 2016

Appendix IX: Water resource management by women and children



Source: Author's fieldwork in 2016

Note: 1) Water collection by woman from a pond at Chairman's house 2) Six-year-old girl has dropped out from school for water collection. 3) Water collections by a 7-year-old boy 2 km away. 4) Children were seen involved in domestic activities with mother. 5) Water preservation in pitcher 6) Children are crossing river by boat for drinking water collection.

Appendix X: Weekly local *haat* (market) at Gabura Union



Source: Author's fieldwork in 2016

Note: 1) The resources are coming by boat from the nearby unions and the city. 2, 3, 4, 5) The weekly local shops inside the *haat* nearest wapda Dam seat on Monday in Gabura Union. 6) Children were seen to be involved in carrying groceries in the markets. 7, 8) Children were seen to be involved in selling the local products in market.

Appendix XI: Grassroots technology and local responses



(Continued)

Source: Author's fieldwork in 2016

Note: 1) Tethering boat in embankment. 2) Houses on a raised platform. 3) Tethering the roofs on to secure from gusty wind. 4) Raised latrine. 5) Modified up-stair toilet. 6) Rain water preservation in clay pot. 7) Installation of PSF (Pond-sand-filter) for the supply of cooking water.

Appendix XI (continued)



8



9



10



11



12



13



14



15



16

Source: Author's fieldwork in 2016

8, 9) Preservation of plastic bottles for making life jacket. 10) Handmade hammock for kids. 11) Handmade mats made from garden leaves (*maile*). 12) Handmade mats used as play mats. 13) Handmade soft toys. 14) Portable clay cook stove. 15) Fuels pellets from cow dung. 16) Fuels made by mud and straws.

Appendix XII: Female contribution to agricultural innovation in salt-based soil



Source: Author's fieldwork in 2016

Note: 1, 2, 3, 4) Successful farmers in agricultural innovations in salt-based soil. 5) Tower method farming. 6) Farming in a bag/sac. 7) Composite farming system. 8) Macha cultivation. 9) Squash on saline soil. 10) Bottle guard. 11) Red Chilis from garden. 12) Homemade organic fertilizer. 13) Locally made of Insect trap.

Appendix XIII: 'Place attachment strategies of climate migrant communities in urban informal settlements: Learning from Khulna Rupsha Slum, Bangladesh.'

Bangladesh Planning Research Conference (BPRC)

5-6 February 2016

Paper ID: 305

Place Attachment Strategies of Climate Migrant Communities in Urban Informal Settlement: Learning From Khulna Rupsha Slum, Bangladesh

Montaj Bintay Khalil¹ and Dr. Brent C. Jacobs²

Abstract

Urban Informal settlements in Khulna, Bangladesh are organically developed places, often unplanned and with illegal occupancy. Often these settlements do not comply with the city's development control and are poorly supported with basic settlements infrastructure and amenity spaces from the public planning bodies. Water logging, drainage congestion, lack of drinkable water, salinity intrusion, heat waves and yearly cyclones are frequent climate change impacts as part of these informal settlers' day to day struggle. In spite of the spatial discrimination from the formal government institutions and climate change threats, this climate induced poor migrant communities have been making creative utilization of their minimum spaces, based on their grassroots technologies. The aim of this paper is to examine the relationship among the utilization of grassroots technology and multipurpose uses of tiny spaces by these under privileged people in climate change adaptation and how these processes help in place attachment strategy which often remains under recognized. This paper performs visual observation into the climate change adaptation process of urban informal settlers in three levels, at settlement level, at community level and at household level on a case of Rupsha slum in Khulna and tries to understand the place attachment process with the emotional bonding and environmental psychology. The study helps to understand the place making process with the attachment by urban informal citizens from a very different lens where person, place and process are the key components. Understanding the relationship between place attachment, grassroots effort and climate change adaptation and how these processes help formal planning bodies in place making which often remains is under recognized.

Key words: Urban Informal settlements, climate migrant, grassroots technologies, place attachment, climate change adaptation.

1. Introduction

During the last three decades massive demographic shift inform of rural-urban continuum caused by large number of job seekers in urban areas, privatization of the economic sectors and climate induced migration is taking place in the south-western coastal cities in Khulna, Bangladesh (Parvin et al., 2013). Most commonly, frequent cyclone, storm surge, flooding, water logging, drainage congestion, heat waves, salinity intrusion exacerbated by the impacts of global warming. The risky geographic settings (Agrawala et al., 2003), demographic shift and comparatively low economic strength in Bangladesh has led a large sum of urban poor to those informal settlements in course of their struggle of urban spaces. These informal settlements are organically developed places, often unplanned without much intervention from the formal institutions and mostly created through informal negotiations and illegal occupancy (Dixon, 2000). These are the frequent and everyday destination of climate poor migrants in most third world countries like Bangladesh. These informal settlements can be considered ideal case studies to explore the concept of place attachment strategies. This study will draw the concept of place attachment proposed by scholars (Scannel & Gifford, 2010) a conceptual framework where person, process and place are three key components to uncover place attachment. This study will examine two different types of housing from household level in urban informal settlements to describe the relationship between place attachment strategy and the planning process. Investigate how these large numbers of urban poor associate (belongingness) them with the slum with their limited resources and economic constraints and what are the processes (informal access and control of urban spaces) that help them to navigate in slum environment, what are the meanings created through their day-to-day interaction with the settlement, what are the social relations (through their search for livelihood opportunities) manifested through their everyday informal nature of negotiation with urban space and how they are challenged or facilitated by the mainstream formal institutions or other urban actors. How do they negotiate settlements through dwelling within those transitional spaces that are neither urban nor rural, always an entry or arrival, active, frequent and always changing. From where and why are these people coming in this place and making their space

¹ PhD Candidate, Institute for Sustainable Futures, University of Technology Sydney, Australia.
Faculty member (On study leave), Department of Urban and Regional Planning, Khulna University of Engineering & Technology. Email: Montaj.B.Khalil@student.uts.edu.au; moon.nusha@gmail.com

² Research Director, Institute for Sustainable Futures, University of Technology Sydney, Australia

by their own choice and emotional attachment. Whether these settlements are planned or unplanned, the decision making process is coming from the planned intervention and from power in the settlement.

2. Literature review

2.1 Place attachment and planning process

Based on the tripartite components of people, process and place are identified by the theories of place attachments by Scannell and Gifford as a three dimensional conceptual framework. Place attachment is multidimensional and the bonding among people and place in individual or collective action where emotional response or feeling and meaningful environment are the main theme for making the identity of a place (Scannell and Gifford, 2010). Place is always active and frequently changing according to human taste and their functional requirements. Place identity is also explained as a concept of human geography and social activity or environmental physiology (Dixon, 2000). Place attachment can be understood as the lived-experience of the users and the power relationship between complex and conflicts and as a continuing process (Lombard, 2009). Place attachment is an indication of kinship and physical appearance, is an encounter part and key components for the sense of a place identity (Ujang, 2012). It is also belonging the emotional attachment & relationship and functional process of a space produce by people and their bonding according to the choice of people for making the place (Williams et al., 1992). A successful public space is characterized by the presence of people and often self-reinforcing process for the functional need (Ujang, 2012; Carmona, et al., 2003).

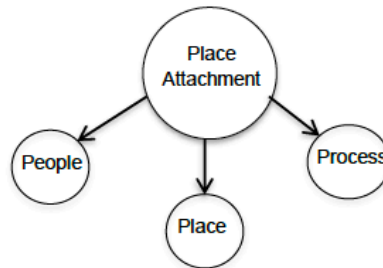


Figure 1: The tripartite model of place attachment
Source: Scannell and Gifford, 2010

2.2 Adaptation strategies

Adaptation encompasses adjustments in ecological, social and economic systems to the impacts of climate change variability (Briggs, 2005). Adaptation or adaptive capacity occurs in different levels in society and may be autonomous/spontaneous adaptation or planned adaptation/policy-making way through individual activity or group behaviour in order to reduce society's vulnerability to climate change (Smit et al., 1999; Smith et al., 2000; Lim, Burton, & Nations, 2005). In developing countries the adaptation to climate change generally happens via autonomous processes facilitated by social and environment relationship and limited financial capital and accessible to natural resources (Adger et al., 2003). As the nature of autonomous adaptation is a dynamic social process and always changing with the users, sensitivity is needed to understand how is the adaptation strategy of the informal settlements people in urban slum within the climate change and weather extremes.

2.3. Grassroots responses and livelihoods

Grassroots responses are most likely the product of a community's adaptive capacity, which depends on the availability, transformation and the replacement of individual capitals from livelihood resources (Nelson et al., 2007). Livelihood resources are generally considered in different capitals like human, social, financial or natural capitals (Scoones, 1998; DfID, 1999). For the least developed countries, such as Bangladesh the adaptive capacity is low and high vulnerability (McCarthy, 2001). For successful adaptation strategies, limitations of financial capital must be overcome by finding novel

ways to combine the natural resources at hand. Grassroots technologies, in response to both climatic stimuli and non-climatic drivers, have appeared spontaneously in spite of financial limitations in access to natural resources (Alam et al. 2015). This place making process is likely relying on natural resources and social relationship and the responses coming from the migrant people by their daily uses of spaces.

2.4. Conceptual analytical framework

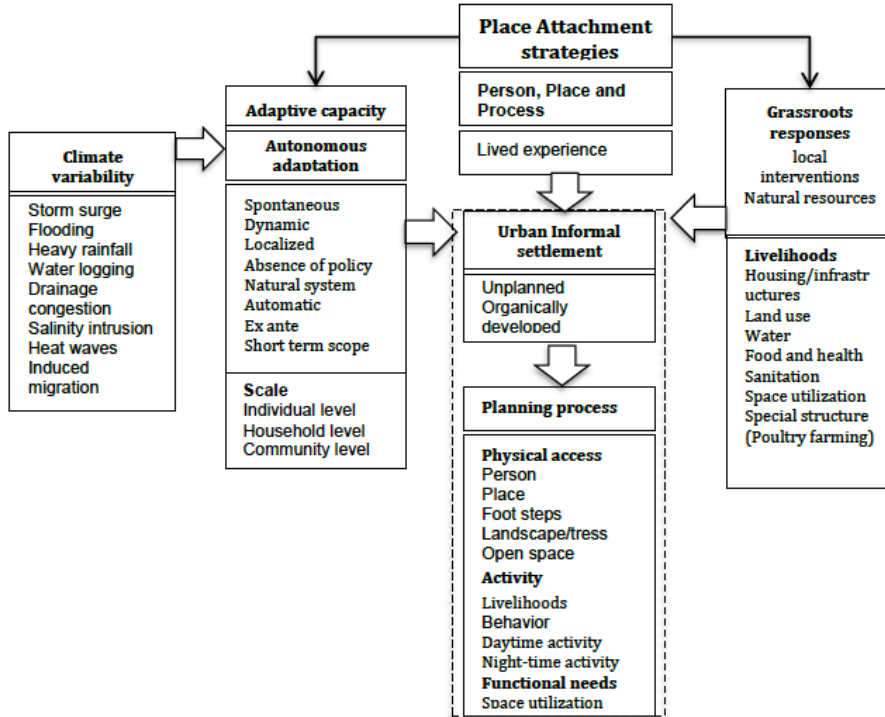


Figure 2: The conceptual analytical framework
Source: Author

Figure 2, shows a conceptual framework that links climate variability as a driver of autonomous adaptation that links to urban informal settlements that is formed as place attachment strategies and shaped by the people, place and the process that is created by these informal settlers and have been making creative utilization of their minimum spaces, based on their own technologies and adaptive capacity.

3. Study area

To explore place attachment in urban informal settlements in Khulna, Bangladesh, Rupsha slum is one of the best example for the place attachment that is a low-lying piece of land standing on the banks of the river Rupsha. Historically Khulna as the third major city of the southwestern Bangladesh became an industrial city of strategic importance with the introduction of paper mill, shipyard, jute mills and the country's largest river port that created job opportunities for the low income urban poor and vulnerable migrants communities. However, ongoing political turmoils during the 1990s and lack of vision from the local governments led to closure of these industries that transformed the large working population to urban poor who now seek for informal economic practice to survive in the city (Roy et al, 2013). In addition Khulna's newly grown economic importance for its expanding shrimp processing

industries has made an attractive job destination for migrants from the surrounding rural settlements (Roy et al, 2012).

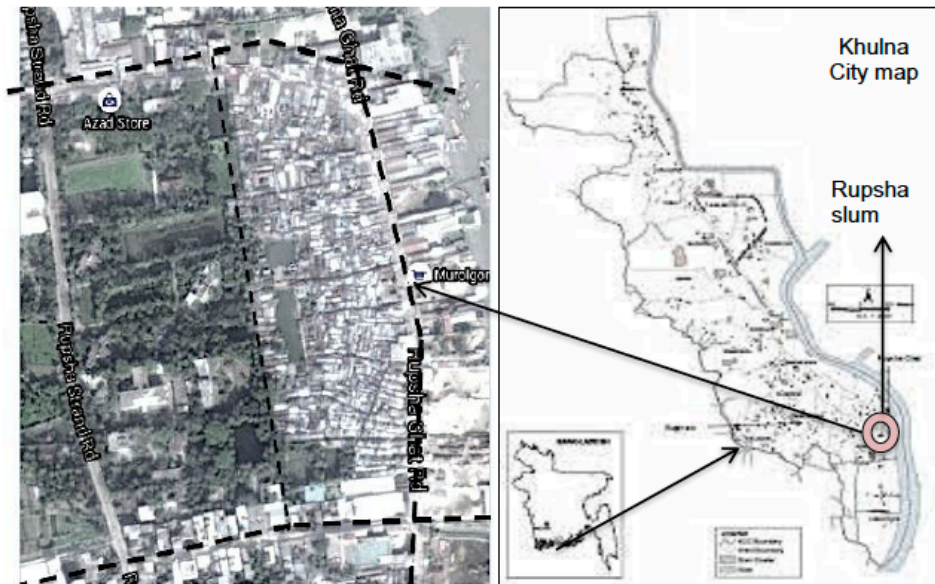


Figure 3: Rupsha slum (urban informal settlements) in Khulna, Bangladesh
Source: Google map

This migrant poor population housed a temporary low-cost accommodation with the help of local planning bodies as to create a shelter in the city. So the urban poor in Khulna are often destined to the shanty slums in the fringes of the CBDs, the selected case study is the Rupsha Slum in Khulna Bangladesh is one of the biggest urban informal destinations that covers an area of 6.13 acre and accommodate a population size of about 15,876 of 3,700 households with illegal and unauthorised construction. These pro-poor migrant communities are voluntarily contributing to place making as part of their social struggles in urban slums. Often these informal settlements do not comply with the city's development control and are inadequately supported with basic infrastructure, service and the amenity spaces due to lack of interest from the formal institutions. Furthermore, climate change and related urban environmental hazards exacerbate added vulnerability to the settlements, therefore, pushing these slum dwellers to incorporate creative strategies to cope with these informal resorts within cities what this paper wants to explore.

4. Methodologies and methods

This study performs visual observation of migrant informal communities to explore their range of adaptation processes and the responses both spontaneous (by local people) and planned way (by the formal bodies) in three levels (at individual, household or community level) tries to understand the processes of how they remain attached to the places.

Based on the tripartite components of people, process and place, this study will examine two household samples to describe pro-poor place making in informal settlements, place attachments and the policies of planning. In doing so, It investigates why these large number of urban poor come to slum, with their limited resources and economic constraints how they adapt to slum environment what are the social relations manifested through their everyday informal nature of negotiation with urban space and how they are challenged or facilitated by the mainstream formal institutions or other urban actors. This study performs visual observation of migrant informal communities to explore their range of place making processes in household level and tries to understand the processes of how they remain attached to the places over generation. The observation is based on the household survey and public participations (male and female), semi-structured interviews and focus group discussion in the informal settlements during daytime and night-time.

5. Findings

The households in urban informal settlements are mostly relying on their own autonomous adaptation process and the natural resources and the grassroots responses that rooted from local livelihoods and coming from the limited financial access. In Rupsha slum, the adaptation strategies of the poor migrants are shaped by the climate change impacts and socio-economic context and by their autonomous adaptation way to the natural system. It is an experimental practice to adjust to the climatic stimuli. So the pro poor migrant communities are trying to adjust with the nature through their economic constraints and their own grassroots technologies.

Although the poor people in urban informal settlements are neglected by the Government they engage themselves in different seasonal livelihood options includes shrimp processing and preparing, industrial job in ice factory, daily labour, building construction, hawkers, women engaging them in home based income, match factory, managing self small daily business, job in river belt stone and sand factory, seasonal firewood cutting, making poultry farming on the upper floor or making movable wooden box underneath of the bed of their house inside.

Housing

Most of the houses are making temporary (kacha) as for climate change adaptation process. For example, they apply traditional local materials to build their temporary houses (i.e., organic material bamboo for structure and stilt, Goal pata (palm leaf) and thatch for roof and mud or brick for side walls, found material like plastic sheet, polythene sheets and cement bag on the roof and windows by plastic or wooden frame to protect the house from rain, paper, hard board for temporary partition etc. (Haque, A. N. et al., 2014). They raise the plinth level rise by bamboo stilts or mud during water logging or flooding.

Food-health, water, Sanitation

The dry food, matchboxes, mud chulli (cooker), homestead fuel are stored above flood level on the side shelf inside the houses side walls, on the bed top, on the wooden false ceiling, temporary upper floor and also underneath shelf of the roof.

The availability of water is not quiet easy in urban informal settlements. The settlement people are harvesting rainwater by using plastic sheet on roof and sealed water clay pots and preserve water from the tube well in clay pots from a long distance. The NGO s are also helping by providing some shared tube well inside the settlements area.

Shared tin shed toilet is allocated for the sanitation in the informal settlements for 6/7 families. Some households are preserving a small space inside the house for temporary sanitation during the night-time.

Poultry farming

The settlements people in household level making an extra space with the extended floor as for poultry farming for their financial help. Also inside the room they make an extra wooden box to preserve the poultry and put underneath the coat and during the night-time they put their pets inside the kitchen.

5.1 Multiple uses of spaces through social relations

The informal migrants transform their daily using spaces to multiple uses of spaces in different methods and different time. Due to lack of enough spaces they are organizing their individual single spaces in three domains like public, semi public and private spaces. They are using the public circulation spine not only for walking but also for their daily activities like cooking, bathing, sleeping, and some sorts of the recreational spaces for children and the space for their social interaction. The semi public space are using in daytime for social interaction and household working and night-time for sleeping. This multiple uses of spaces which making their places more meaningful according to their everyday life experience. Sometimes they are making the poultry facilities by making an inbox under the bed or a pocket like space with kitchen shelf and sometimes the extended space in the upper floor towards the bi-lane. During flooding or water logging the migrant communities provide the spontaneous adaptation strategy like storage the things on the bed or making up upper storage shelf. To reduce the heat stress they try to make the wall maximum perforation and making windows without shutter. They contribute to their place with emotional attachment as their daily practice into the

transitional space. The community feels like this is the best space as they are making their place according to their own choice and activity. Few communities are living this place over generation by paying a low budget to the Government.

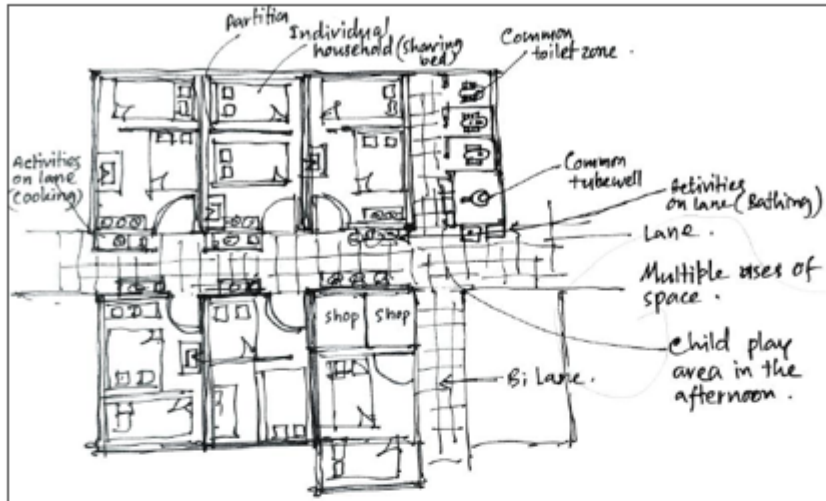


Figure 4: Multiple uses of space (Informal settlements common plan)
Source: Sketch by author

Examples

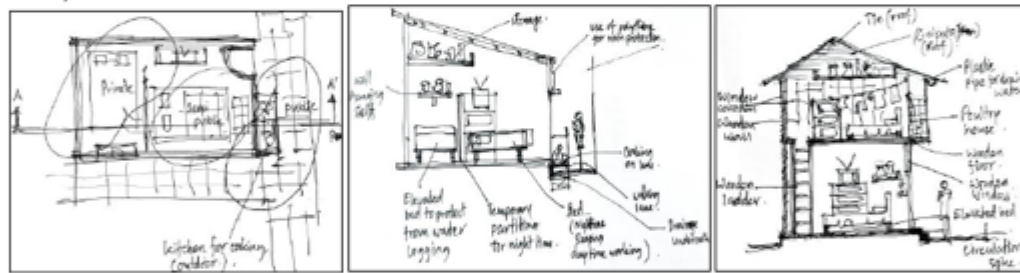


Figure 6: Multiple uses of spaces, single and double story (plan and section)
Source: Sketch by author

The place is divided into three types: Public, semi public and private zone.

Public: Circulation spine, cooking, working, playing, sharing and bathing

Semi public: During daytime the space is using for social interaction, working and during night-time for sleeping

Private: bed for working during daytime, and during night-time for sleeping



Figure 7: Daytime activity - Circulation spine is using as playing, cooking, bathing activity zone and livelihoods
Source: Field observation, 2015



Figure 8: Night-time activity on the bed and private zone
Source: Field observation, 2015



Figure 9: Adaptive capacity and own technologies (Poultry facilities inside the houses and kitchen, mud chull for cooking, shelf for preserving dry foods, child bathing in a paint box.
Source: Field observation, 2015

6. Conclusion

This case study helps to understand the place-making process by urban informal citizens bodies with their emotions and feelings and personal living experience and affection to the place from a very different lens. Understanding the relationship between place making and place attachment between the people and the place, communities socio-economic changes, and grassroots effort to climate change adaptation will help the formal planning bodies to better understand the urban informal settlements and similar transitional spaces in cities. Without having any resources the poor migrant people are trying to apply bottom up approach rather than top down scientific practice. This study is to examine the framework relationship among the utilization of place formed by the place attachment by these under privileged people with their affection and interaction to the place and this place making

strategy is often remains under recognized by the formal bodies. In spite of the range of discriminations imposed by the formal institutions and climate change threats, these informal settlers have been making creative utilization of their minimum spaces, based on their own technologies. Not only in terms of physical features but in terms of livelihood, their temporal nature of spatial practice in daily life, socio-economic kinship, mode of compromising on natural hazard, policy making access and social attachment and control over limited resources make the negotiation of spaces more meaningful.

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